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MURLEY,T.E. Office of Nuclear Reactor Regulation, Director (Post 870411

SUBJECT: Forwards addl info re proposed mods to LPCI swing bus electrical sys design,per JR Hall 880920 request. 56.6 Drws

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Iowa Electric Light and Power Company
October 4, 1988
NG-88-3315

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, DC 20555

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49
LPCI Swing Bus Design Modifications

References: 1) Letter from J. R. Hall (NRC) to L. Liu (Iowa Electric), dated September 20, 1988
2) Letter from W. Rothert (Iowa Electric) to T. Murley (NRC), dated August 31, 1988 (NG-88-2996)

File: A-107a, A-225, R-10

Dear Dr. Murley:

Reference 1 requested that we provide additional information for staff review regarding the proposed modifications to the Low Pressure Coolant Injection (LPCI) Swing Bus electrical system described in Reference 2 and the assumptions used in our previous Loss-Of-Coolant Accident (LOCA) analyses for the DAEC.

This letter and attachments provide the requested information. Attachment 1 describes the proposed modifications to the LPCI Swing Bus electrical system design. Attachment 2 provides confirmation that previous Loss-of-Coolant Accident (LOCA) analyses have properly assumed a Loss of Offsite Power (LOOP) with the spectrum of single failures.

Reference 1 also requested us to provide written verification that the previously-analyzed 125 VDC battery failure is the most limiting single failure of an electrical component in terms of minimum ECCS availability for the DAEC. We estimate that it will take six months following startup from the current refueling outage to complete a review of the DAEC design to determine the most limiting single failure. We will provide a more refined schedule for this review in our next semiannual update to the "Plan for the Integrated Scheduling of Plant Modifications for the Duane Arnold Energy Center" (Integrated Plan). The next semiannual update will be provided by November 3, 1988.

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If you have any further concerns or questions about this matter, please contact this office.

Very truly yours,

William C. Rothert
Manager, Nuclear Division

WCR/NLP/pjv+

Attachments:
1) Description of Proposed Modifications to the LPCI Swing Bus Design at the DAEC
2) Confirmation of Conformance with Staff Position Regarding Loss of Offsite Power in Loss-of-Coolant-Accident Analyses

cc: N. Peterson(w/o drawings)
L. Liu (w/o drawings)
L. Root (w/o drawings)
R. McGaughy (w/o drawings)
J. R. Hall (NRC-NRR)
A. Bert Davis (Region III)
NRC Resident Office
Commitment Control No. 880341, 880365, 880364, 880363

DESCRIPTION OF PROPOSED MODIFICATIONS TO THE LPCI SWING BUS DESIGN AT THE DAEC

As a result of several recent communications with the NRC regarding the effect of an assumed loss of one division of 125 VDC power on the accident analysis for a Loss-Of-Coolant-Accident (LOCA) coincident with a Loss Of Offsite Power (LOOP), we have determined that our current LOOP/LOCA analysis for this scenario does not accurately account for this failure mode because of a design deficiency in the power supply arrangement for the Low Pressure Coolant Injection (LPCI) mode injection valves and Recirculation System isolation valves.

These valves are powered from busses 1B34A and 1B44A, which are in turn powered from either 1B34 or 1B44 in a "swing bus" arrangement via breakers 52-3401 or 52-4401, respectively (see Drawings BECH-E001, Sheet 1 and BECH-E006, Sheet 1). Power is normally supplied from bus 1B34 with breaker 52-3401 closed and 52-4401 open. The design of these breakers is such that they are interlocked to prevent both from being closed at the same time. The system is also designed to be "power seeking" such that, in the event that one division of AC power is lost, busses 1B34A and 1B44A will be powered by the remaining division. Breakers 52-3401 and 52-4401 receive control power from their respective divisions of the 125 VDC system and are designed to fail "as-is" upon loss of control power.

Our current LOOP/LOCA analysis is not accurate should the following scenario occur:

> The plant is initially in a normal lineup (i.e., breaker 52-3401 is shut and breaker 52-4401 is open) and a LOOP/LOCA occurs. The worst case single failure would be the failure of Division I 125 VDC power (i.e., battery failure). In this case, the Division I emergency diesel generator (1G31) would not supply Division I AC power. Breaker 52-3401 would fail in the closed position and the interlock would prevent breaker 52-4401 from closing, even though power is available from Division II AC power. This would leave no LPCI available to provide water to the core and fuel damage could potentially occur unless the Operators intervene. Our current LOOP/LOCA analysis for this scenario assumes that two Residual Heat Removal (RHR) pumps would be available in the LPCI mode to provide makeup water to the core; however, under the above scenario, no RHR pumps would, in fact be available.

In our letter dated August 31, 1988 (NG-88-2996) we stated we would correct the aforementioned design deficiency prior to startup from our next refueling outage, currently underway. This item was also added to our Integrated Plan as a Schedule B item.

To correct the design flaw, we will replace the existing swing bus transfer breakers (52-3401 and 52-4401) with new breakers containing DC undervoltage trip devices. The DC undervoltage trip devices will open the transfer breakers upon a loss of DC control power and allow a swing bus transfer to occur.

In formulating the LPCI swing bus design modifications, we pursued four goals: (1) maintenance of the existing LPCI swing bus transfer features, (2) no adverse effects on circuit reliability resulting from the addition of a breaker trip function to the transfer breakers (52-3401 and 52-4401), (3) compliance with 10CFR50, Appendix R requirements, and (4) maintenance of proper circuit breaker coordination for the affected breakers in the DAEC AC electrical distribution system.

The existing LPCI swing bus transfer scheme utilizes two (2) electrically interlocked breakers (52-3401 and 52-4401) to accomplish the transfer of electrical power supplying busses 1B34A and 1B44A. These two breakers are designed such that busses 1B34A and 1B44A will be powered from the division of the AC distribution system with power available (i.e., "power seeking"). If both or no divisions are powered, the breakers will remain in their original positions (i.e., 52-3401 closed and 52-4401 open). In addition, the interlock feature of these breakers senses actual breaker position of the corresponding transfer breaker and thus, paralleling of the two divisions of AC power is not possible (i.e., both 52-3401 and 52-4401 cannot be closed simultaneously). The proposed modification will not defeat any of these existing interlocks and the bus transfer scheme will remain identical to the present design, provided 125 VDC breaker control power is available.

The breaker control power for breakers 52-3401 (Division I) and 52-4401 (Division II) is provided by each breaker's respective division of 125 VDC power. Should a loss of a division of 125 VDC power occur coincident with a LOOP/LOCA, it is required that the LPCI swing bus transfer breaker, which is powered by the failed division of 125 VDC power open to allow a swing bus power supply transfer to occur. To accomplish this function, the existing breakers (52-3401 and 52-4401) will be replaced with new breakers equipped with undervoltage trip devices that will trip the breaker open upon a loss of DC control power. The undervoltage trip devices will also utilize a short time delay to minimize the possibility of spurious trips.

The proposed modification will also revise the existing alternate shutdown capability system (ASCS) control circuits to allow control of the breakers feeding 1B34A (52-3401) and 1B34 (52-303) during shutdown from outside of the Control Room in the event of a loss of Division I DC control power. The ASCS changes will allow closing of the Division I swing bus breaker 52-3401 and opening of the 1B34 feeder breaker as required by our Emergency Operating Procedure (EOP) for safe shutdown of the DAEC from outside of the main Control Room. The EOP provides instruction for the repowering of 1B34 with Division II AC power via the swing bus in the event of a Control Room fire. Division II, the 10 CFR 50, Appendix R Alternate Shutdown division, is used to perform the following functions:

Close RHR cross-tie header isolation valve (MO-2010)

Close Division I RHR Pump 'A' shutdown cooling suction valve (MO-2011)

Close Division I RHR Pump 'C' shutdown cooling suction valve (MO-2016)

Open Division I RHR inboard shutdown cooling valve (MO-1908)

Because Division I DC is not protected against the effects of a Control Room fire there is no assurance that Division I DC power would be available to allow the opening of MO-1908. In the event of a loss of Division I DC control power, breaker 52-3401 will now trip. Because of the design of the undervoltage trip device this breaker could not be closed without DC control power. This design change revises the control circuits associated with Division I breakers 52-3401 and 52-303 to provide Division II control power to these breakers during shutdown from outside the Control Room when transfer switches in the Division II remote shutdown panel (1C388) and the Division II remote shutdown auxiliary panel (1C390) are both placed in the "EMERGENCY" position. These transfer switches are locked with the keys under the control of the Control Room operator. Dual isolation devices, which meet the engineering acceptance criteria outlined in existing DAEC design guides, are used to prevent the direct connection of Division I and II DC power supplies.

The replacement swing bus supply breakers and associated load center supply breakers will be installed with solid state overcurrent trip devices which will allow improved circuit breaker coordination. The breakers feeding the swing bus will be coordinated such that any circuit fault detected on the LPCI swing bus will be automatically isolated with no loss of upstream electrical loads or busses. The breakers feeding equipment supplied by the swing bus will be properly coordinated with the swing bus supply breakers such that any downstream equipment electrical faults will trip only the affected supply breaker.

The proposed modifications will be designed and installed using design criteria which are the same or more stringent than the design criteria used in the original plant design and have been developed with due consideration of the following requirements:

Seismic impact of structures, raceway, and raceway supports

Fire protection impact due to increased combustible loadings

Effect of cable additions on existing cables routed in cable trays

Attached to this description are a number of drawings which have been revised to indicate the proposed modification (Design Change Package (DCP) 1430). These drawings have been revised as part of our design change process and have been marked to show details of the proposed modification. "Construction delete" and "construction add" drawings are included in the attached drawings. The "construction delete" drawings show the existing design and identify wires, equipment and cables which have to be removed to incorporate the proposed change. The "construction add" drawings show the completed design and identify wires, equipment and cables required to implement this change. Several of the attached drawings are marked with DCP closure notes which identify actions to be taken to revise the drawing upon receipt of vendor information. Currently, vendor documentation associated with the replacement breakers has not been received or approved. This information will be incorporated onto existing drawings as part of our design change process. Copies of approved vendor documentation will be available for your review upon request.

LIST OF ATTACHED DRAWINGS

BECH-E027, Revision 12, "Construction Delete"

BECH-E027, Revision 12, "Construction Add"

BECH-E112, Sheet 31, Revision 0

BECH-E112, Sheet 32, Revision 0, "Construction Delete"

BECH-E112, Sheet 32, Revision 0, "Construction Add"

BECH-E112, Sheet 33, Revision 0, "Construction Add"

BECH-E121, Sheet 44H, Revision 0

BECH-E105, Sheet 15A, Revision 15

BECH-E105, Sheet 19A, Revision 13

BECH-E104, Sheet 21, Revision 9

BECH-E104, Sheet 21B, Revision 0

BECH-E104, Sheet 17A, Revision 0, "Construction Delete"

BECH-E104, Sheet 17A, Revision 0, "Construction Add"

BECH-E001, Sheet 1, Revision 12

BECH-E006, Sheet 1, Revision 13

BECH-E112, Sheet 29, Revision 1, "Construction Delete"

BECH-E112, Sheet 29, Revision 1, "Construction Add"

BECH-E134, Sheet 30, Revision 1, "Construction Add"

BECH-E134, Sheet 33, Revision 1, "Construction Add"

BECH-E134, Sheet 20, Revision 1, "Construction Delete"

BECH-E134, Sheet 20, Revision 1, "Construction Add"

E-6-FD, Sheet 3 of 5, Revision 0

E-009, Sheet 263, Revision 2

E-009, Sheet 169, Revision 4

Confirmation Of Conformance With The Staff Position Regarding Loss of Offsite Power in Loss-of-Coolant-Accident Analyses

In recent communications with the staff, a concern was raised regarding our compliance with the requirements of 10 CFR 50.46 and 10 CFR 50, Appendix K. Specifically, the staff was concerned that a Loss of Offsite Power (LOOP) was not explicitly assumed in our docketed Loss-of-Coolant-Accident (LOCA) analysis. The following information demonstrates that a LOOP was assumed coincident with a LOCA (and a single failure) in our docketed LOCA analysis.

During a LOOP/LOCA event all essential AC-powered equipment is powered from the Emergency Diesel-Generators (EDGs). As the EDG would become overloaded and would subsequently stall if all such equipment were loaded onto the EDG simultaneously, a loading sequence is utilized. Tables 8.3-1 and 8.3-2 of the DAEC Final Safety Analysis Report (FSAR), (attached), describe this loading sequence.

By comparing the timing sequence in FSAR Table 8.3-2 to the table of assumptions used in the current LOCA analysis (General Electric Report, NEDC-31310P, Table 3, attached), one sees that the pump starting times and injection valve opening times for the low pressure Emergency Core Cooling Systems (ECCSs) used in the LOCA analysis are conservative relative to those given in the FSAR for the LOOP/LOCA scenario. (Note: The differences in the FSAR and LOCA analysis values for the injection valve opening times are due to performance relaxations assumed in the analysis as described in Appendix B to NEDC-31310P.) This set of input parameters was used for the matrix of single failure and break spectrum calculations performed in this analysis.

If offsite power were available, the ECCSs remaining after the assumed single failure would not be as severe as that used in the LOCA analysis (see Table 6 to NEDC-31310P)(attached). For example, in the case of the EDG failure, the current analysis assumes that all the low pressure ECCSs powered by that EDG are unavailable, where, in reality, the low pressure ECCSs, would be available if off-site power were available. The same would be true for the 125 VDC battery failure scenario. If offsite power were available, the 125 VDC loads would be powered through the battery charger, as this is the normal line-up, (i.e., the battery "floats" on the charger during normal operation), and all the low pressure ECCSs would be available.

Lastly, we requested written confirmation from General Electric that it was their standard LOCA analysis methodology to assume a concurrent LOOP with a LOCA, in addition to a single failure, when performing analyses to demonstrate compliance with 10 CFR 50.46. General Electric provided such confirmation in the attached letter from Mr. H. C. Pfefferlen, dated September 27, 1988.

Based upon the above information, we conclude that our current LOCA analysis conforms to the requirements of 10 CFR 50.46 and 10 CFR 50, Appendix K.

Table 8.3-1

DIESEL-GENERATOR LOADING SEQUENCE AND RESPONSE - LOSS-OF-COOLANT ACCIDENT PLUS LOSS OF OFFSITE POWER[a]

Elapsed Time from Instant Diesel Output Breaker Closer	Load Increment (kW)	Total Load (kW)	Minimum Voltage (% of rated)	Recovery Time to 90% Rated Voltage (sec)	Available Frequency (% of rated)	Recovery Time to 98% Rated Frequency (sec)	Load Description (see Table 8.3-3)
0 sec	13						MCC 1B91
	135						MCC 1B34A and 1B44A
	435						MCC 1B32
	114						MCC 1B34
	104						River water supply pump
	4						Control building chiller auxiliaries
		805	73	1.2	96.7	3.07	
5 sec	612		80	1.3	97.2	3.91	Core spray pump
		1417					
10 sec	496		80	1.3	97.2	3.91	RHR pump
		1913					
15 sec	496		83	1.1	97.1	2.45	RHR pump
		2409					
60 sec	66		-	-	-	-	Control building chiller
		2475					
After 10 min	-162		-	-	-	-	MCC load requirement difference
	-496		-	-	-	-	Trip RHR pump
		1817					
	470		-	-	-	-	RHR service water pump
		2287					
	470		-	-	-	-	RHR service water pump
		2757					

[a] Additional loads may be applied at operator's discretion.

Table 8.3-2

STANDBY DIESEL-GENERATOR SYSTEM
SEQUENCE OF EVENTS FOLLOWING A
DESIGN-BASIS ACCIDENT WITH LOSS OF OFFSITE POWER

Event	Time (sec)	Comment
Accident	0	
Low reactor water level or drywell high pressure reached. Signal diesel-generator to start	3	This sequence applies to one diesel-generator and its associated loads
Diesel-generator ready to load	13	
Signal reactor coolant recirculation system line valves to close, LPCI valve to open, and core spray injection valve to open		
Connect emergency lighting and motor-operated isolation valves		
Start core spray pump	18	
Reactor core spray injection valve open	21	
Start first RHR pump (LPCI mode)	23	
Start second RHR pump (LPCI mode)	28	
LPCI valves open	31	
Reactor coolant recirculation system valve(s) closed	43	This completes the LPCI start sequence
Start additional loads (e.g., RHR service water pumps)	43+	Additional loads as desired may be added within the capacity of the diesel-generator

Note: All pumps will be at rated speed within 5 sec after receiving their respective "start" signals.

TABLE 3

SIGNIFICANT INPUT PARAMETERS USED IN THE LOCA ANALYSIS

A. Plant Parameters

	Nominal	Appendix K
Core Thermal Power (MW_{th})	1658	1691
Vessel Steam Output (lbm/hr)	7.172×10^6	7.344×10^6
Corresponding Power (%)	100	102
Vessel Steam Dome Pressure (psia)	1040	1055
Maximum Recirc Line Break Area (sq. ft)	2.52	2.52

B. Fuel Parameters

	P8x8R/BP8x8R	GE8x8EB
PLHGR (kw/ft)-Appendix K	13.4	14.4
-Nominal	12.8	13.8
MAPLHGR (kw/ft)	13.0	14.0
Worst Case Nodal† Exposure for ECCS Evaluation (MWd/MTU)	23000	17500
Initial MCPR - Appendix K	1.17	1.17
- Nominal	1.19	1.19
Axial Peaking Factor	1.4	1.4
Number of Fueled Rods per Bundle	62	60/62

C. Emergency Core Cooling System Parameters

LPCI System

Vessel Pressure at Which Flow May Commence (psid)	197
Minimum Rated Flow at Vessel Pressure (psid)	20
for two pumps (gpm)	9675
three pumps (gpm)	12420
four pumps (gpm)	15682

†Represents the limiting operating condition resulting in the maximum calculated PCT at anytime in the fuel lifetime.

TABLE 3

SIGNIFICANT INPUT PARAMETERS USED IN THE LOCA ANALYSIS

(Continued)

Initiating Signals and Setpoints Low-Low-Low Water Level or High Drywell Pressure (psig)	TAF 2.0
Maximum Allowable Time Delay from Initiating Signal to Pump at Rated Speed (sec)	27 30 (AFTER DBA)*
Injection Valve Fully Open (sec)	50 (after DBA)
Injection Valve Stroke Time (sec)	28
Maximum Vessel Pressure at Which LPCI Injection Valve Can Open (psia)	365
Minimum Break Size for Which Loop Selection Logic Assumed to Select Unbroken Loop (sq. ft.)	0.5
CS System	
Vessel Pressure at Which Flow May Commence (psid)	264
Minimum Rated Flow at Vessel Pressure (psid) for One System (gpm)	113 2718
Initiating Signals and Setpoints Low-Low-Low Water Level or High Drywell Pressure (psig)	TAF 2.0
Minimum Allowed (Runout) Flow (gpm)	3173
Maximum Allowable Delay Time from Initiating Signal to Pump at Rated Speed (sec)	16. 19 (AFTER DBA)*
Injection Valve Fully Open (sec)	37 (after DBA)
Injection Valve Stroke Time (sec)	18
Maximum Vessel Pressure at Which LPCS Injection Valve Can Open (psia)	365
HPCI System	
Vessel Pressure at Which Flow May Commence (psia)	1135
Minimum Rated Flow at Vessel Pressure (psia) (gpm)	1135 to 165 2700

* PER UFSAR TABLE 8.3-2, 3 SECONDS BETWEEN BEGINNING OF ACCIDENT AND PUMP START SIGNAL.

TABLE 3

SIGNIFICANT INPUT PARAMETERS USED IN THE LOCA ANALYSIS

(Continued)

Initiating Signals and Setpoints	
Low-Low Water Level	9 ft above TAF
or	
High Drywell Pressure (psig)	2.0
Maximum Allowable Time Delay from Initiating Signal to Rated Flow Available and Injection Valve Wide Open (sec)	45
ADS	
Total Number of Valves Installed	4
Number of Valves Assumed in Analysis	3
Minimum Flow Capacity of any 3 Valves (lbm/hr)	2.4×10^6
at Vessel Pressure (psig)	1125
Initiating Signals	
Low-Low-Low Water Level	TAF
Time Delay After Initiating Signals (sec)	125

TABLE 6

SINGLE-FAILURE EVALUATION

The following table shows the single, active failures considered in the ECCS performance evaluation.

Assumed Failure[1]	Systems Remaining[2]
Battery	ADS, 1 CS, 2 LPCI[3]
LPCI Injection Valve (LPCI IV)	ADS, 2 CS, HPCI
Diesel Generator D/G)	ADS, 1 CS, HPCI, 2 LPCI
HPCI	ADS, 2 CS, 4 LPCI

(1) Other postulated failures are not specifically considered because they all result in at least as much ECCS capacity as one of the above assumed failures.

(2) Systems remaining, as identified in this table, are applicable to all non-ECCS line breaks. For a LOCA from an ECCS line break, the systems remaining are those listed, less the ECC system in which the break is assumed.

(3) Analyses performed with 1 non-functioning ADS valve in addition to the single failure. See Table 3.

GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

HCP-88-051
September 27, 1988

R. A. Browning
Iowa Electric Light & Power Co.
3277 DAEC Road (Site Offices)
Palo, IA 52324

Dear Tony,

The purpose of this letter is to clarify the basis for the Duane Arnold ECCS analysis with regard to the availability of offsite power. We understand that this is a question raised by the NRC.

We can state, without reservation, that the ECCS analysis for Duane Arnold (NEDC 31310P) took no credit for availability of offsite power to emergency core cooling systems and in addition assumed a single failure within this equipment as required by 10CFR50. This is in accordance with GE internal procedures and consistent with all standard GE ECCS analyses. While the Duane Arnold ECCS report may not specifically state that this is the case, it should be clear from an inspection of the assumed ECCS equipment performance (e.g. start time and available systems) that no credit is given for offsite power.

I hope this clarifies this situation to your satisfaction.

Regards,

H. C. Pfefferlen
Nuclear Products Licensing
(408) 925-3392

cc: D. A. Hamon
C. H. Stoll
R. C. Mitchell
G. L. Sozzi