NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

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ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Fort Calhoun Station Unit No. 1	05000285	1 OF 7

TITLE (4)
480V Circuit Breaker Coordination Outside Design Basis

EVENT DATE (5)			LER NUMBER (6)			REPORT NUMBER (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
03	20	91	91	-- 007 --	01	02	10	93		05000
									FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	1
POWER LEVEL (10)	70

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.402(b)		20.405(c)	50.73(a)(2)(iv)	73.71(b)
	20.405(a)(1)(i)		50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
	20.405(a)(1)(ii)		50.36(c)(2)	50.73(a)(2)(vii)	OTHER
	20.405(a)(1)(iii)		50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	(Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iv)	X	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
	20.405(a)(1)(v)		50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
George S. Cary, Nuclear Design Engineer	(402) 636-3478

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

During reconstitution of the design basis for the electrical distribution overcurrent tripping scheme, preliminary results (March, 1991) of a Breaker/Fuse Coordination Study identified twenty-one 480 volt molded case circuit breakers which had overlapping breaker coordination curves with safety-related 480V Motor Control Center (MCC) feeder circuit breakers. The lack of coordination could have resulted in the tripping of a MCC due to a fault on one of its non-coordinated loads. On March 20, 1991, this condition was determined to be outside the design basis of the plant. Two of the twenty-one loads were determined to have an unacceptable probability of faulting during a Design Basis Accident. The two affected loads were isolated from the 480V system.

This condition was caused by deficiencies in the original system design as constructed by the plant Architect/Engineer. A contributing cause was the lack of comprehensive design basis documentation to substantiate that coordinated breaker fault protection existed.

Since submittal of LER 91-007 Revision 00, a detailed walkdown of MCCs has been conducted, safety significant coordination problems have been corrected (under Modification MR-FC-89-013), and the Breaker/Fuse Coordination Study completed. During incorporation of walkdown data into the study, an additional inadequate coordination was identified. However, it had been corrected by MR-FC-89-013 prior to discovery.

The Fort Calhoun Station (FCS) Unit No. 1 plant electrical distribution systems are designed to meet demands for electrical energy for plant control and operation during normal, abnormal, and accident situations.

The 4160 V system is comprised of four electrically separated buses. Buses 1A1 and 1A2, which supply only 4160 V loads, are normally connected to unit auxiliary transformers T1A1 and T1A2. These transformers are supplied from the Main Generator 22kV/345 kV system. However if the Main Generator 22kV/345 kV system is unavailable, buses 1A1 and 1A2 can be supplied from the house service transformers T1A3 and T1A4, respectively. These transformers are supplied from the off-site 161 kV supply. Buses 1A3 and 1A4 (called "Safeguards" buses) are normally connected to house service transformers T1A3 and T1A4. However, if the off-site 161 kV supply is unavailable, buses 1A3 and 1A4 can be supplied from unit auxiliary transformers T1A1 and T1A2, respectively. In the event that both the off-site 161 kV and the Main Generator 22 kV/345 kV feeds are lost, buses 1A3 and 1A4 can be supplied from Diesel Generators D-1 and D-2 respectively for emergency power. Buses 1A3 and 1A4 supply all Engineered Safeguards (ESF) and essential support systems, either directly or through the 480 Volt distribution system.

The 480 Volt system is comprised of nine buses, powered from six 4.16 kV to 480 Volt transformers. Three of these buses are supplied by bus 1A3, three are supplied by bus 1A4, and three are manually connected to either bus 1A3 or 1A4, but normally not both, as this is prevented by interlocked bus-tie circuit breakers. Twenty-two Motor Control Centers (MCCs) receive power from the nine 480 Volt bus sections. The MCCs which are arranged throughout the plant provide power to both safety related and non-safety related equipment.

In the event of total failure of supply from the Main Generator 22kV/345kV system and the off-site 161 kV system, both 4.16 kV buses 1A3 and 1A4 are disconnected from their normal and alternate supply sources. Simultaneous load shedding of motor loads connected to 4.16 kV and 480 Volt buses is initiated by undervoltage relays. Diesel generators are started, run up to operating speed and voltage, and connected automatically to the Safeguards buses. If no Design Basis Accident (DBA) exists, reloading of the system is performed manually by the operator in accordance with an Emergency Operating Procedure. If a DBA has occurred, either a Pressurizer Pressure Low Signal (PPLS) or Containment High Pressure Signal (CPHS) would cause a Safety Injection Actuation Signal (SIAS), which eliminates selected 480 Volt MCCs and certain loads on other MCCs supplying loads not needed to mitigate the accident. PPLS or CPHS would also initiate the starting and loading of ESF equipment via automatic load sequencers.

Original design criteria as stated in the Updated Safety Analysis Report (USAR) for the electrical distribution system provide a high degree of reliability by using selective fault protection using full-rated circuit breakers. The fault of a single load on a bus or MCC would be mitigated prior to tripping the bus/MCC's feeder circuit breaker. This is primarily due to the individual circuit breakers on the bus/MCC having lower interrupt current ratings than the bus/MCC's feeder breaker. The lack of coordination could result in the tripping of an entire MCC and loss of all equipment (both safety related and non-safety related) on that MCC, due to a fault on one of its non-coordinated loads. In addition to providing reliability, breaker coordination is also credited to meet 10 CFR 50.49, Environmental Qualification of Electrical Equipment (EEQ) for both safety related and non-safety related equipment. Non-safety related equipment which is fed from safety related power sources and located in potential post-accident harsh environment areas is not specifically required to be environmentally qualified. This is allowed due to the fault protection equipment designed to isolate the non-safety related equipment from the safety related power source.

Design Basis Documents (DBDs) have been compiled as part of the Omaha Public Power District (OPPD) Design Basis Reconstitution Program. An open item existed concerning the lack of detailed documentation to substantiate the existence of coordinated relay/breaker fault protection. To resolve this issue a study of the entire FCS electrical distribution overcurrent tripping scheme was conducted. This Breaker/Fuse Coordination Study encompassed all electrical buses at FCS, including 161 kV, 22 kV, 4160 V, 480 V Switchgear, 480 V MCCs, 120 VAC Instrument, and 125 VDC buses. Each bus or MCC had coordination curves generated containing upstream overcurrent protection devices and the largest load overcurrent protective device plotted. In addition to these devices, a typical fuse (or largest fuse) was plotted for each DC distribution panel and the six inverters.

Preliminary data from this coordination study revealed several cases of inadequate coordination between various molded case circuit breakers supplying MCC loads and the respective MCC circuit breakers. Prompted by these findings, Engineering Analysis EA-FC-91-025, "FCS 480V Molded Case Circuit Breaker Coordination", was conducted to evaluate operability/reportability issues. The analysis assumed an unacceptable probability of common mode faulting during a DBA exists only in potential harsh High Energy Line Break (HELB) or Loss of Coolant Accident (LOCA) locations. Consequently, the analysis scope was limited to safety related power sources which supply power to non-safety related equipment in potential harsh HELB/LOCA locations. Faulting of equipment in other locations would be of acceptably low probability during the 100 hour short term and 1000 hour long term DBA accident scenarios.

The following criteria were used by OPPD to identify potential non-coordinating breaker conditions:

(1) Only safety related power sources were reviewed.

(2) Equipment tripped due to 480 V load shed resulting from SIAS was not evaluated. SIAS 480 V Load Shed initiates in the initial stages of a LOCA or HELB such that the non-safety related equipment which is load shed was not expected to fault during the DBA.

(3) Equipment normally out of service during normal plant operation was not evaluated.

Twenty-one 480 Volt molded case circuit breakers on eight different MCCs were determined to have overlapping breaker coordination curves with the MCC feeder circuit breakers. On March 20, 1991, this condition was determined to be outside the design basis of the plant and therefore reportable pursuant to 10 CFR 50.72(b)(1)(ii)(B) and 50.73(a)(2)(ii)(B). The plant was operating in Mode 1 at 70 percent power.

The loads associated with nineteen of the non-coordinated breakers were classified as one of the following types:

(1) Loads which are normally not in service.

(2) Rotating loads which are provided with thermal overload protection.

(3) Loads which feed sub-distribution panels with fused or breaker protected distribution circuits.

(4) Loads which feed static equipment.

While these loads were outside the design basis for the 480 volt system as described in the USAR they are, however, located in DBA mild environments. Based on engineering judgment and past plant experience, the possibility of a fault on this equipment was judged to be small and not expected to occur in conjunction with a DBA. Additionally, this type of failure is bounded by worst case single failure analyses.

Based upon the assumptions made in EA-FC-91-025, only two loads with uncoordinated load breakers were identified as located in DBA harsh environments. The two loads were welding machine outlets located in Room 81 (MCC-4A1, Breaker E06) and Containment (MCC-4B1, Breaker A4L).

Further analysis was conducted to determine the effect loss of MCC-4A1 or MCC-4B1 would have had during either a LOCA or HELB. It was determined that safe shutdown of the reactor could have still been achieved with the loss of either MCC. To eliminate this source of potential faulting, EA-FC-91-025 requested that both welding outlet breakers on the affected MCCs be danger tagged open. Plant personnel performed this on March 11, 1991 prior to the formal issuance of the analysis.

Safety Analysis For Operability (SAO) 91-03-00 was approved on March 25, 1991 which required: (1) danger tagging open or disconnecting the two non-coordinating welding receptacle breakers on MCCs 4A1 and 4B1, and (2) if either breaker had to be re-closed, then the MCC was to be declared inoperable. In the latter case, Technical Specification Limiting Condition for Operation 2.7 (Electrical Equipment) would have been applied, requiring the MCC be returned to operable status within eight hours. SAO 91-03-00 also concluded that the lack of optimum breaker coordination for the other loads did not present safety considerations outside the bounds of existing accident analyses. The individual local protection of the sub-distribution panels and the installed thermal overload devices in the identified motor circuits provided an adequate level of protection against potential MCC failures resulting from this breaker coordination overlap. This satisfactorily assured continued safe operation under both normal and accident conditions.

This condition was determined to have been caused by deficiencies in the original system design as constructed by the plant Architect/Engineer. A contributing cause was the lack of comprehensive design basis documentation to substantiate that coordinated breaker fault protection existed. This lack of documentation resulted in one modification, which installed inverter bypass transformer EE-4S, repeating the non-coordination error by copying what the original plant design had done.

LER 91-007 Revision 00 was submitted April 19, 1991 to report the subject findings.

Device data was collected, during the 1992 Refueling Outage, by a detailed walkdown of the station's twenty-two MCCs. This data was then used as an input into Engineering Analysis EA-FC-91-142, "Calibration Procedures Setpoint Determination in Support of MR-FC-89-013". EA-FC-91-142 calculated setpoints for RMS-9 trip units being installed during the 1992 Refueling Outage, and examined MCC feeder-to-loads coordination accordingly. This analysis also documented that proper coordination would exist once the trip units were installed.

The new RMS-9 trip units were installed under Modification MR-FC-89-013, "480 Volt Breaker Refurbishment Modification", on all ten safety-related MCCs (as well as nine additional non-safety-related MCCs) prior to startup from the 1992 Refueling Outage.

After the 1992 Refueling Outage, the walkdown data was compared to the preliminary data which had been used in EA-FC-91-025, to check for consistency. An additional inadequate coordination (which met the criteria for inclusion in EA-FC-91-025) was identified, however, it was determined that this additional item had already been corrected by Modification MR-FC-89-013. This additional problem, although corrected prior to discovery, was not addressed by LER 91-007 Revision 00. Therefore, this revision to the LER provides supplemental information regarding the additional inadequate coordination and the status of corrective actions.

The additional inadequate coordination existed (prior to the 1992 Refueling Outage) on a welding circuit in containment, fed from safety-related MCC-3B1, Breaker A01. In the event of a LOCA, it is postulated that a fault within the containment welding receptacle could have occurred causing the loss of MCC-3B1 due to lack of proper coordination. If the loss of MCC-3B1 were to coincide with a single failure of the "B" safety train (i.e., the failure of Diesel Generator No. 2), Control Room Heating, Ventilating and Air Conditioning (HVAC) would have been lost, as well as one additional Low Pressure Safety Injection (LPSI) and two additional High Pressure Safety Injection (HPSI) loop injection valves. The loss of this equipment is beyond that assumed in a single failure. It should be noted, however, that MCC-3B1-A01 is normally open during power operation.

The twenty-one coordination problems reported in LER 91-007 Revision 00, and the additional inadequate coordination identified from the walkdown data have been resolved.

The following corrective actions have been completed:

(1) SAO-91-03-00 was issued on March 25, 1991 to justify continued operation provided the affected welding receptacle breakers in Room 81 and Containment were tagged open or disconnected as delineated in EA-FC-91-025. SAO 91-03-00 was closed on August 10, 1992.

(2) The Containment welding receptacle breaker (MCC-4B1-A4L) was danger tagged open on March 11, 1991 and remained in that configuration until August 10, 1992 when SAO 91-03-00 was closed.

(3) The Room 81 welding receptacle breaker (MCC-4A1-E06) was danger tagged open on March 11, 1991. A Temporary Modification (TM-91-12) was performed to disconnect power from the receptacle by removing it from the circuit. This was accomplished on March 28, 1991.

(4) Production Engineering Division modification review procedure GEI-3 requires that a Breaker/Fuse coordination review be completed (per GEI-9) any time new loads are added or modified.

(5) The twenty-one coordination problems reported in LER 91-007 Revision 00, and the additional inadequate coordination identified from the walkdown data were resolved during the 1992 Refueling Outage by Modification MR-FC-89-013 which installed adjustable RMS-9 trip units on the MCC feeder circuit breakers. (MR-FC-89-013 has replaced the twenty-two MCC feeder breaker trip units.)

(6) The Breaker/Fuse Coordination Study (EA-FC-91-084, Revision 0) was completed April 1, 1992.

(7) Revision 1 of the Breaker/Fuse Coordination Study, which included the walkdown data and the new RMS-9 setpoint information, was completed December 1, 1992.

Other Licensee Event Reports which have been submitted addressing design deficiencies are LERs 91-03, 91-04, 90-03, 90-05, 90-07, 90-09, 90-16, 90-20, 90-23, 90-25, 89-09, 89-14, 89-15, 89-24, 88-09, 88-19, 88-20, 88-32, and 88-33.