DUKE POWER COMPANY

McGUIRE NUCLEAR STATION

UNITS 1 & 2

EVALUATION
OF
MAIN STEAM LINE BREAK
IN
DOGHOUSE

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MCGUIRE NUCLEAR STATION

UNITS 1 & 2

Doghouse Main Steam Line Break (MSLB) Evaluation

I. HISTORY:

Revised information has been received from Westinghouse giving mass/energy release rates for a Main Steam Line Break (MSLB) inside containment. The original Westinghouse information indicated a saturated steam condition from the steam generators; however, revised information identifies steam generator tube uncovery and the formation of superheated steam.

Duke Power had previously assumed the same saturated steam condition for an MSLB in the Doghouses located outside containment as for an MSLB inside containment. Consequently, environmental qualification parameters for the Doghouses were based on original analysis results of 330°F peak temperature. Utilizing the new data from Westinghouse, revised Duke Power environmental analysis with superheated steam conditions indicated a potential increase in Doghouse temperature from the 330°F parameter to approximately 457°F peak Doghouse temperature. Hence, the potential existed that safety related components could be subjected to temperatures higher than the qualification basis of 330°F, and could possibly preclude components from performing their intended safety functions following a postulated MSLB in either Doghouse.

In light of the MSLB activities relative to the Catawba licensing, a meeting was held with the NRC staff on July 20, 1984 to discuss the status of the MSLB activities for McGuire. As a result of this meeting, the NRC staff requested that Duke submit a summary of the preliminary McGuire evaluation that had been conducted. This summary evaluation was submitted on August 8, 1984 with H. B. Tucker's letter to Ms. E. G. Adensam, Chief Licensing Branch No. 4. The preliminary evaluation had shown that for an MSLB in the Doghouse, all essential safety functions are expected to be completed before adverse temperature effects due to increased Doghouse temperatures would occur. Spurious actuation of components following initial positioning was also evaluated. Thus, Duke Power had concluded that plant safety would not be adversely affected in the event of a design basis MSLB in the Doghouse.

Mr. Tucker's letter of August 8, 1984 also noted that additional analysis/evaluation would be completed on a schedule consistent with and in support of Catawba licensing to confirm the preliminary evaluation. The final report on the Catawba evaulation was submitted to the NRC staff on March 15, 1985 as Supplement 2 to Significant Deficiency Report No. 413-414/84-16. The results of additional analysis/evaluation for McGuire are presented in this report.

II. EVALUATION:

Westinghouse performed a steamline break analysis for a spectrum of break sizes and power levels (full power, 70%, 30% and 0%) to determine associated protection system actuation times and predicted superheat initiation times. The analysis was performed using safety analysis assumptions of initial conditions and protection system time responses to provide a conservatively early prediction of steam generator tube bundle uncovery and. therefore, the earliest superheat initiation time. The results of this analysis are described in Attachment 1.

Attachment 2 indicates which equipment is required to remain functional during and/or following an MSLB in the Doghouse. The attachment also shows the time margins between the completion of the required Doghouse equipment actuation and the onset of temperatures higher than the qualification parameters of the equipment at which time the Westinghouse/Duke analysis conservatively assumes equipment failure. In addition, Attachment 2 includes results of Duke's heat transfer analysis performed on the solenoid valves used to operate the Main Steam Isolation Valves (MSIV's) and Steam Generator Power Operated Relief Valves (PORV's) to take into account the temperature/time lag for this equipment. Attachment 3 contains the revised pages from the NUREG-0588 response that are applicable to the MSLB in the Doghouse.

Although it is concluded from the evaluation outlined in Attachment 2 that the required equipment has sufficient margin between required actuation time and the time when equipment qualification temperature is exceeded, a Westinghouse core reponse analysis for the postulated consequential failure due to an MSLB of the MSIV's, Steam Generator PORV's, and Main Feedwater Isolation Valves that are located in the faulted Doghouse was performed (see Attachment 4). This analysis involves a 1.0 ft^2 MSLB upstream of the MSIV in one of the doghouses. The 1.0 ft^2 maximum size break area is considered to be appropriate for this analysis because of the following reasons:

1. The conservative computer code PISOL was used by Duke Power in performing the Main Steam piping stress analysis. Resultant pipe break stress ratios (actual stress/allowable stress) are all less than 0.6.

2. Any break would most likely be postulated to occur at a branch line connection to the Main Steam piping. These connections in the doghouse involve piping with a maximum cross-sectional area of 0.2 $ft.^2$ which yields a safety factor of 5.

3. For any postulated break size greater than 1.0 $ft.^2$, under conservative "worst case" conditions, all safety actuations occur prior to tube uncovery, and therefore prior to the generation of the superheated steam and resulting harsh environment.

4. A 1.0 $ft.^2$ rupture size bounds smaller breaks because it results in a more severe cooldown of the reactor coolant system, and thus a greater peak heat flux.

III. SUMMARY:

- All electrical equipment in the faulted Doghouse that is required to automatically actuate on a safety signal will perform its intended function for at least 30 minutes prior to reaching its qualification temperature, with at least a margin of 433% between the time actuation occurs and the time equipment internals exceed their qualification temperature.

- The Westinghouse core response analysis demonstrates that it is acceptable for the MSIV's, Steam Generator PORV's and the Main Feedwater Isolation Valves located in the faulted Doghouse to fail during an MSLB in the Doghouse and still allow safe shutdown of the plant.

In conclusion, the analysis/evaluation outlined above has shown that the higher temperatures generated in the event of an MSLB in the Doghouse will not affect the capability to shutdown the reactor and to maintain it in a safe shutdown condition, and that qualification of all equipment in the Doghouse has been demonstrated.

RESULTS OF WESTINGHOUSE SYSTEMS ANALYSIS

Large Break

Typical response to large breaks approximately 0.5 ft.^{2} and greater (power level affects the cut-off of break size) in the doghouse main steam line will be as follows:

- Reactor trip will occur on overpower ΔT, low steam line pressure, or low-low steam generator level.
- Main feedwater isolation valve (MFIV) closure will occur due to reactor trip and low Tavg or due to safety injection signal.
- Safety injection will be initiated upon receipt of a low pressurizer pressure signal or low steam line pressure signal.
- The motor driven auxiliary feedwater pumps (MDAFP's) will start upon receipt of the safety injection signal or low-low steam generator level.
- The turbine driven auxiliary feedwater pump (TDAFP) is not required for this break since one MDAFP can supply adequate flow if the other MDAFP fails to start.
- Low steam pressure in the faulted steam generator causes main steam isolation valve (MSIV) closure.

All the above functions will occur before the temperature in the Doghouse exceeds equipment qualification temperatures. Isolation of auxiliary feedwater to the faulted steam generator may be accomplished by the operator by closing the motor operated valves located in the doghouse, or by closing the control valves from the control room or manual isolation valves located in the auxiliary feedwater pump room.

Intermediate Break

For intermediate breaks, approximately 0.3 ft.^{2} to 0.5 ft.^{2} (power level affects the range of break sizes), response will be as follows:

- Reactor trip will occur on low-low steam generator level. Note that all steam generators will approach low-low level at approximately the same time.
- MDAFP's will start upon receipt of first low-low level signal. TDAFP will start upon receipt of the second low-low level signal.
- MFIV closure will occur due to reactor trip and low Tavg.
- Safety injection will occur due to low pressurizer pressure.

- Main steam isolation will occur due to low steam line pressure; this may actually happen after tube uncovery. However, Duke analysis using revised Westinghouse mass-energy release data shows that main steam isolation will occur before temperatures in the higher elevations of the doghouses (where the main steam isolation valves are located) exceed the current equipment qualification parameter of 330°F.

Faulted steam generator isolation is accomplished as described for the large break.

<u>Small Break</u>

Depending on exact break size and power level, small break (less than approximately 0.3 $ft.^2$) response will be as described for intermediate breaks, or as follows. For a narrow band of break sizes within this category (approximately 0.1 to 0.2 $ft.^2$), the feedwater control system will automatically increase feedwater flow and prevent reactor trip and tube uncovery. Blowdown through the break will be limited to saturated conditions. The operator will initiate reactor trip and position valves from the control room. Faulted steam generator isolation is accomplished as described for the large break.

McGuire 1 & 2
Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB: Yes	No	Discussion
Valve - Main Steam Isolation.	SM 1, 3, 5 & 7	Open	Closed	Isolate Steam Generator to Control Cooling	(1)		• Valves are air operated, fail closed, with redundant normally energized solenoids that deenergize to close on a main steam isolation signal. • During the "worst case" conditions (70%) power w/0.5 Ft^2 Break in compartment 3) the main steam isolation valves will actuate 338 sec. after the MSLB and 12 sec. before the atmosphere temperature reaches 340°F (Qualification Temperature). However, heat transfer analysis performed on the solenoid valves used to operate the main steam isolation valves show that the coil assembly

McGuire 1 & 2
Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
							temperature lags the atmosphere temperature and does not reach 340°F for at least 30 minutes after the MSLB, which is a margin of at least 433%. • See Attachment 3, page 27, for NUREG-0588 response.
Valve-Steam Generator Power Operated Relief Valve (PORV's)	SV1, 7,13 & 19	Closed	Closed	Isolate Steam Generator to Control Cooling	(1)		• Valves are air operated, fail closed, with redundant normally energized solenoids that deenergize to close. If open, valves close automatically on a main steam isolation signal. • During the "worst case" conditions (70%) power w/0.5 Ft.^{2} break in compartment 3) the steam generator PORV's will actuate 338 sec. after the MSLB and 21

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
							sec. before the atmosphere temperature reaches 346°F (qualification temperature). However, heat transfer analysis performed on the solenoid valves used to operate the PORV's show that the coil assembly temperature lags the atmosphere temperature and does not reach 346°F for at least 30 minutes after the MSLB, which is a margin of at least 433%. • See Attachment 3, page 25 for NUREG-0588 response.
Valve-Main Steam Isolation By-Pass	SM9, 10, 11, & 12	Closed	Closed	Isolate Steam Generator to Control Cooling		√	• Valves are air operated, fail closed, with redundant normally energized solenoids that deenergize to close. If open, valves automatically close on a main steam isolation signal.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB		Discussion
					Yes	No	
							• Due to valve size (3"), flow rate will be minimal and cooldown rate will not be exceeded if these valves are lost as a consequence of the MSLB. • See Attachment 3, page 25a for NUREG-0588 response.
Valve-Main Feed-water Isolation	CF26, 28, 30 & 35	Open	Closed	Valves serve as a backup to prevent steam generator overfill and to prevent loss of feedwater from the steam generator.		√	• Electro-Hydraulic operated valves. • Steam generator overfill through the main feed-water lines is prevented by tripping the main feedwater pumps and closing the pump dis-charge isolation valves located in the turbine building. The main feedwater pump and isolation valves close automatically on a high steam generator level

McGuire 1 & 2
Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
							signal. In addition, steam generator overfill can be prevented by closing the feedwater control valves also located in the turbine building. Feedwater control valves close on both a feedwater isolation signal and high steam generator level signal. • Loss of feedwater is prevented through the main feedwater lines by two (2) check valves in series and by closure of the feedwater control valve (located in turbine building) in each flow path. The feedwater control valves close on a feedwater isolation signal.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
Valve-Reverse Purge Isolation (Feedwater Purge Isolation)	CF134, 135, 136 & 137	Closed	Closed	Valves prevent loss of feedwater from the steam generator.		√	• See Attachment 3, page 29a, for NUREG-0588 response. • Valves are motor operated. • Valves are used only at low power and are normally closed. • Non-safety grade motor operated valves located in the turbine building can also be used to isolate flow. • See Attachment 3, page 24a, for NUREG-0588 response.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
Valves-Feedwater Supply to upper Nozzle.	CF126, 127, 128 & 129	Closed	Closed	Valves serve as a backup to prevent steam generator overfill and to prevent loss of feedwater from the steam generator.		√	• Valves are motor operated gate valves • Steam generator overfill through the upper nozzle lines is prevented by tripping the main feedwater pump and closing the pump discharge isolation valves located in the turbine building. The main feedwater pump and isolation valves are tripped closed automatically on a high steam generator level signal. In addition, steam generator overfill can be prevented by closing the feedwater control valves also located in the turbine building.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
							Feedwater control valves close on both a feedwater isolation signal and high steam generator level signal. • Loss of feedwater through the upper nozzle lines is prevented by redundant check valves in series. • See Attachment 3, page 24b for NUREG-0588 response.
Valves-Tempering Isolation	CF151, 153, 155 & 157	Open	Closed	Valves serve as a backup to prevent steam generator overfill and to prevent loss of feedwater from steam generator.		√	• Valves are motor operated gate valves. • Steam Generator overfill through the tempering lines is prevented by tripping the main feedwater pump and closing the pump discharge isolation valves located in the turbine building.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB: Yes	Required To Mitigate Effects of MSLB: No	Discussion
							The main feedwater pump and isolation valves close automatically on a high steam generator level signal. In addition, steam generator overfill can be prevented by closing the feedwater control valves also located in the Turbine Building. Feedwater control valves close on both a feedwater isolation signal and high steam generator level signal. • Loss of feedwater through the tempering lines is prevented by one (1) check valve in each flow path. • Valves close on safety injection signal.

McGuire 1 & 2
Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
							• See Attachment 3, page 24c, for NUREG-0588 response.
Valve-Auxiliary Feedwater Isolation	CA38, 42, 46, 50, 54, 58, 62 & 66	Open	Open	Valves supply Auxiliary Feedwater flow and isolate the faulted steam generator.		√	• Electric motor operated gate valves with manual initiation. • Flow to the faulted steam generator can be isolated by closing the control valves located in the feedwater pump room, by closing manual isolation valves or by tripping the pumps that are not required. • See Attachment 3, page 22a & 24 for NUREG-0588 response.
Valves-Steam Generator PORV Isolation	SV25, 26, 27 & 28	Open	Closed	Valve serve as a backup to isolate steam generator to control cooling		√	• Electric motor operated gate valves with manual initiation.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
							• The PORV's are the primary source for isolating the steam generator pressure boundaries (see valves number SV1, 7, 13 & 19 above). • See Attachment 3, page 24d for NUREG-0588 response.
Valves-Main Steam Low Point Drain Isolation	SM 83, 89, 95 & 101	Open	Closed	Valves serve as a backup to isolate the steam generator pressure boundary to control cooling		√	• Air operated gate valves with manual initiation. • Drains are orificed to prevent excess steam flow. Limited flow through orifice will not affect cooldown during MSLB. • The solenoid valves for these operators are non-safety related and are not listed on NUREG-0588 response.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB: Yes	No	Discussion
Valves-Auxiliary Feedwater Pump Turbine Steam Suppy Isolation	SA 48 & 49	Closed	Either	Not Applicable See Discussion		√	• The turbine driven auxiliary Feedwater Pumps are not required for any steam line break. Assuming a single failure of one motor driven pump, adequate time is available for the operator to realign the other motor driven pump to supply flow to intact steam generators. Both the motor and turbine driven auxiliary feedwater pumps are located in the feedwater pump room so they are not affected by the steam line break. • See Attachment 3, page 26, for NUREG-0588 response.
Instrumentation-Auxiliary Feedwater Flow Transmitters	CAFT5091 CAFT5101 CAFT5111 CAFT5121	-	-	-		√	• This equipment may fail under the higher MSLB temperatures. However,

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB: Yes	Required To Mitigate Effects of MSLB: No	Discussion
							Post-Accident monitoring of the auxiliary feedwater function can be accomplished by the steam generator level transmitters which will not be affected by a steamline break in the Doghouse since the level transmitters are located in the containment. • See Attachment 3, page 66, for NUREG-0588 response.
Instrumentation-Doghouse Water Level Transmitters	CFLS6440 CFLS6450 CFLS6460 CFLS6470 CFLS6480 CFLS6490 CFLS6500 CFLS6510 CFLS6520 CFLS6530 CFLS6540 CFLS6550	-	-	-		√	• The function of these transmitters is to determine water level for pipe breaks not associated with the MSLB. • See Attachment 3, page 30a, for NUREG-0588 response.

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
Control and Power Circuits	-	-	-	-		√	• A review to determine functional requirements and/or failure modes of all doghouse components and cables was performed. No postulated cable failures were identified which would cause spurious repositioning of valves required to mitigate the consequences of a doghouse MSLB. • All safety-related control circuits in the Doghouses were reviewed to determine if any cable failures could affect other safety-related circuits. All safety-related control

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Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	No	Discussion
							components in the Doghouses are protected by separate fuses that are coordinated with upstream feeder breakers to avoid affecting any other related circuits.
Cable-S/G PORV and MSIV Control	EP/HYPALON, TEFZEL and XLPE insulated cable	-	-	-		√	• The S/G PORV & MSIV control cables provide power to the redundant normally energized S/G PORV & MSIV air control solenoids. As stated above, these solenoids deenergize to close automaticaliy on a main steam isolation signal. In the unlikely event of a cable failure, open or short, power to the solenoids would be

McGuire 1 & 2
Summary of Electrical Equipment
Exposed to Higher MSLB Temperatures

Equipment	Identification Number	Normal Operating Position	Preferred Position During MSLB	Function Performed During MSLB	Required To Mitigate Effects of MSLB Yes	Required To Mitigate Effects of MSLB No	Discussion
							lost and the solenoids would go to their deenergized safety position. Additionally, the S/G PORV's & MSIV's preferred position during a MSLB is closed. Therefore, the solenoid cables are not essential to mitigate the consequences of a MSLB. • See response to NUREG-0588, Attachment 3, pages 33, 34, 35, 36 & 37 • See Note 2.

NOTES:
(1) Although it is desirable that valve(s) properly position, the Westinghouse analysis for the core response (Attachment 4) due to the consequential failure of the main steam isolation valves, PORV's, and the main feedwater isolation valves located in the faulted Doghouse has demonstrated that the reactor can be safely shutdown and maintained in a safe shutdown condition, even if these valves fail in the faulted doghouse.
(2) Valves that actuate on a safety signal (Main Steam Isolation, Feedwater Isolation, High Steam Generator Level, etc.) will not resposition after actuation because of electrical circuit design features such as isolation, interlocks and protective devices.

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Motor Operators - Aux. Feedwater Isolation (Doghouse)

MANUFACTURER: Limitorque

MODEL #: SMB Order Numbers: 383584-A & 391179-A, -B

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 340°F Press: 105 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Limitorque Test Report: B0058, Appendix B, 1/11/80 (MDM-1205.34-0002)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Motor Operators - Aux. Feedwater Isolation (Doghouse)

MANUFACTURER: Rotork

MODEL #: NA-1

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 340°F Press: 70 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: For operators with S/N below B-4800 - Rotork Test Reports N11/4, December 1970; TR116, October 1973; TR222, June 1975 (MCM-1205.34-0001).

For operators with S/N above B-4800 - Wyle Report 43979-1, Rev. A, dated 12/19/78 (MCM-1205.34-0010).

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Motor Operators - Reverse Purge Isolation (Doghouse) MANUFACTURER: Rotork MODEL #: NA-1

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 340°F Press: 70 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: For operators with S/N below B-4800 - Rotork Test Reports N11/4, December 1970; TR116, October 1973; TR222, June 1975 (MCM-1205.34-0001)

For operators with S/N above B-4800 - Wyle Report 43979-1, Rev. A dated 12/19/78 (MCM-1205.34-0010).

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Motor Operators - Feedwater Supply to Upper Nozzle (Doghouse)   MANUFACTURER: Rotork   MODEL #: NA-1

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 385°F Press: 70 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: For operators with S/N below B-4800 - Rotork Test Reports N11/4, December 1970;'TR116, October 1973; TR222, June 1975 (MCM-1205.34-0001).

For operators with S/N above B-4800 - Wyle 43979-1, Rev. A, dated 12/19/78 (MCM-1205.34-0010)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Motor Operators - Tempering Isolation (Doghouse)

MANUFACTURER: Rotork

MODEL #: NA-1

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100%	Temp: 340°F Press: 70 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: For operators with S/N below B-4800 - Rotork Test Reports N11/4, December 1970; TR116, October 1973; TR222, June 1975 (MCM-1205.34-0001).

For operators with S/N above B-4800 - Wyle 43979-1, Rev. A, dated 12/19/78 (MCM-1205.34-0010)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Motor Operators - S/G PORV Isolation (Doghouse)   MANUFACTURER: Rotork   MODEL #: NA-1

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 340°F Press: 70 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: For operators with S/N below B-4800 - Rotork Test Reports N11/4, December 1970; TR116, October 1973; TR222, June 1975 (MCM-1205.34-0001).

For operators with S/N above B-4800 - Wyle 43979-1, Rev. A, dated 12/19/78 (MCM-1205.34-0010)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Solenoid Operators - S/G PORV's (Doghouse) MANUFACTURER: Valcor MODEL #: V70900-21-3

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 300°F* Press: 8.85 psig RH: 100%	Temp: 346°F Press: 87 psig RH: 100%	5.6 min.	30 min. (Note 11)	N/A	N/A

*Doghouse environment at time safety function completed - Ref. MCC-1381.05-00-0156.

QUALIFICATION REPORT: Test Reports QR70900-21-1 Rev. A (MCM-1210.04-0118); QR52600-515 Rev. B (MCM-1210.04-0115); MR70905-21-3-1 (MCM-1210.0119)

METHOD: Test & Similarity

MDIC

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Solenoid Operators - Main Steam Isolation By-pass (Doghouse)

MANUFACTURER: Valcor

MODEL #: V70900-21-3

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 346°F Press: 87 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Reports QR70900-21-1 Rev. A (MCM-1210.04-0118); QR52600-515 Rev. B (MCM-1210.04-0115); MR70905-21-3-1 (MCM-1210.0119)

METHOD: Test & Similarity

MDIC

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Solenoid Operators - Aux. Feedwater Pump Turbine Steam Supply Isolation (Doghouse)

MANUFACTURER: ASCO

MODEL #: NP 8316E34E

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 346°F Press: 110 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Report: AQS21678/TR (MCM-1210.04-0117)

METHOD: Test

EQUIPMENT ID: Valve Operator - MSIV (Doghouse)

MANUFACTURER: Atwood & Morrill

MODEL #: 34" MSIV w/Chicago Fluid Pwr. actuator

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 325°F* Press: 8.85 psig RH: 100%	Temp: 340°F Press: 110 psig RH: 100%	5.6 min.	30 min. (Note 4) (Note 11)	N/A	N/A

*Doghouse environment at time safety function completed - Ref. MCC-1381.05-00-0156.

QUALIFICATION REPORT: Test Report Procedure No. 20139500 dated 5/1/79 (MCM-1205.34-0005)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Valve Operator - Main Feedwater Isolation Valves (Doghouse)

MANUFACTURER: Borg Warner

MODEL #: 12" Gate w/Elect Hyd. Oper. NVD P/N 88500

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 345°F Press: 110 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Report No. 1989, dated 05/18/83

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Level Switch (Doghouse) MANUFACTURER: Magnetrol MODEL #: A103F-3X-Y-MPG-TDM-S1MD4DC-S1MD4DC-S1MD4DC

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F	Temp: 285°F	15 seconds following a main feedwater line break	Continuous	±0.25"	±0.25"

QUALIFICATION REPORT: Duke QTF Report TR-053 and TR-060.

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Stem Mounted Limit Switches (Doghouse)   MANUFACTURER: NAMCO   MODEL #: EA180, EA740

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 340°F Press: 70 psig RH: 100%	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: NAMCO Test Report QTR-106 dated 9/2/81 (MCM-1205.34-0009) and NAMCO Test Report QTR-111, Rev. 0 dated 10/01/81 (MCM-1205.34-0008)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Cable - Control (Doghouse)

MANUFACTURER: Brand Rex

MODEL #: XLPE Insulation (Procurement Specs: MCS-1354.02-4, 5, 7 & & 9 & MCS-1354.04-14)

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F (Note 5)	Temp: 346°F	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Reports FC4113 (MCM-1354.00-0007) FC5120-1 (MCM-1354.00-0023) and FC5120-3 (MCM-1354.00-0024)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Cable - Instrumentation (Doghouse)

MANUFACTURER: Eaton (Samuel Moore)

MODEL #: EP/Hypalon Insulation (Procurement Specs: MCS-1354.03-1, 2, 3 & 5 & MCS-1354.04-2 & 5)

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F (Note 5)	Temp: 340°F	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Report F-C3683 (MCM-1354.00-0006)

METHOD: Test

EPSS

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Cable - Control, Instrumentation, and Power (Doghouse)

MANUFACTURER: Okonite

MODEL #: EP, EP/Hypalon, & Hypalon Insulation (Procurement Specs: MCS-1354.01-1, 2 & MCS-1354.02-4, 6, 9 & MCS-1354.03-4)

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F (Note 5)	Temp: 340°F	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Reports N1, May 2, 1975 (MCM-1354.00-0010); FN-1, July 3, 1978 (MCM-1354.00-0013); G-3, June 28, 1979 (MCM-1354.00-0012; 110E, November 12, 1970 (MCM-1354.00-0016); Duke Test Report TR032, November 5, 1982 (MCM-1354.00-0022); G1, February 17, 1976 (MCM-1354.00-0045)

METHOD: Test

EQUIPMENT ID: Cable - Control (Doghouse)

MANUFACTURER: Okonite

MODEL #: Tefzel 280 Insulation (Procurement Spec: MCS-1354.04-6)

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F (Note 5)	Temp: 341°F	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Report K-0-1, September 1979 (MCM-1354.00-0011), and K-8-1, April 4, 1981 (MCM-1354.00-0044)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Cable - Control and Power (Doghouse)

MANUFACTURER: Anaconda

MODEL #: EP Insulation and EP/Hypalon Insulation (Procurement Specs: MCS-1354.01-2 & 4, & MCS-1354.02-3, 6 & 9

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F (Note 5)	Temp: 346°F	Continuous	Continuous	N/A	N/A

QUALIFICATION REPORT: Test Reports F-C4350-2 (MCM-1354.00-0008) and F-C4350-3 and Supplement (MCM-1354.00-0009)

METHOD: Test

McGUIRE NUCLEAR STATION - UNITS 1 AND 2
SUMMARY OF ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

EQUIPMENT ID: Transmitter - Auxiliary Feedwater Flow (Doghouse)

MANUFACTURER: Rosemount

MODEL #: 1153DD5

HELB ENVIRONMENT (1)	ENVIRONMENT TO WHICH QUALIFIED	OPERABILITY REQUIRED IN HELB ENVIRONMENT(2)	OPERABILITY DEMONSTRATED	ACCURACY REQUIRED (% OF SPAN)	ACCURACY DEMONSTRATED (% OF SPAN)
Temp: 240°F Press: 8.85 psig RH: 100% (Note 5)	Temp: 350°F Press: 120 psig RH: 100%	Continuous	Continuous	±28.13%	±28.13%

QUALIFICATION REPORT: Wyle Test Report 45592-1 (MCM-1210.0178)

METHOD: Test

MDIC

MCGUIRE NUCLEAR STATION UNITS 1 AND 2

ENVIRONMENTAL QUALIFICATION OF CLASS 1E EQUIPMENT
LOCATED OUTSIDE CONTAINMENT AND EXPOSED TO HELB ENVIRONMENT

Note 1

The methods employed to evaluate pipebreaks and to determine the resulting environmental parameters are discussed in Duke Power Company Report MDS/PDG-77-1. The Evaluation of the Effects of Postulated Pipe Failures Outside Containment for McGuire Nuclear Station.

Note 2

The pipe rupture environment is assumed to exist for 2 1/2 hours based on 30 minutes at the peak temperature after which action by the operator isolates the break and allows the Auxiliary Building temperature to decrease to normal in 2 hours. Use of the term "Continuous" indicates operability required/demonstrated throughout the pipe rupture period.

The pipe rupture environmental analysis for the Doghouse was conducted separately taking into consideration different sizes of main steam line breaks. All equipment located in the Doghouse is identified under "Equipment ID."

Note 3

Rotork Test Report TR-3025 shows that when the qualified temperature for these valves is exceeded, the torque switches may fail on the next operation of the valves. Since at least one additional operation is available after the valve's temperature qualification has been exceeded, the valve can be relied upon to move to its safety position. No further safety function is required.

Note 4

The test was conducted for 30 minutes, however, the Class 1E solenoids which operate the FWIV's de-energize upon initiation of containment isolation and allow the FWIV's to close within 5 seconds. With the solenoid valves de-energized, the FWIV's will remain in a closed position indefinitely.

Note 5

This equipment is not required to mitigate the consequences of a MSLB in the doghouse. Therefore, the "Pipe Rupture Environment" parameters are for the HELB for which the equipment is required.

Note 6

The HELB analysis has identified pipe breaks resulting in higher temperatures; however, there are no cables exposed to temperatures above 330°F, except in the doghouse which is addressed separately.

Note 7

The components listed are general application devices. These components are installed in metal enclosures and depending on their specific design application, may be located in various areas of the Auxiliary Building. This table addresses the qualfication of these components with respect to the worst-case pipe break environment applicable to the components location.

Note 8

The qualified operating temperature is based on the maximum current flowing through the fuse or resistor and appropriate fuse or resistor derating.

Note 9

The only requirement of the optical isolator is to retain its input integrity during the accident.

Note 10

Accuracy demonstrated is the shift in the actual resistance due to the change in temperature during the accident.

Note 11

The 30 minute "Operability Demonstrated" parameter is based on Duke Power Company's McGuire Nuclear Station Evaluation of Main Steam Line Break in the Doghouse.

McGUIRE STEAM LINE BREAK CORE RESPONSE ANALYSIS WITH CONSEQUENTIAL FAILURES DUE TO SUPERHEATED STEAM

Background

The McGuire letter to the NRC concerning the effects of superheated steam mass and energy releases outside containment provided justification of safety related operation prior to equipment qualification (EQ) envelopes being exceeded. In addition, Duke Power provided arguments that the equipment would remain in their actuated positions even if the EQ envelopes were subsequently exceeded. As a result of NRC review on the environmental effects of superheated steam on equipment in the Catawba plant doghouses, Duke Power has requested this additional analysis of the effect of a consequential failure of affected equipment at McGuire.

Identification of Causes and Accident Description

The steam release arising from a rupture of a main steam line would result in an initial increase in steam flow which decreases during the accident as the steam pressure falls. The energy removal from the RCS causes a reduction of coolant temperature and pressure. In the presence of a negative moderator temperature coefficient, the cooldown results in an insertion of positive reactivity. If the most reactive rod cluster control assembly (RCCA) is assumed stuck in its fully withdrawn position after reactor trip, there is an increased possibility that the core will become critical and return to power. A return to power following a steam line rupture is a potential problem mainly because of the high power peaking factors which exist assuming the most reactive RCCA to be stuck in its fully withdrawn position. The core is ultimately shut down by the boric acid injection delivered by the Safety Injection System.

The analysis of a main steam line rupture was performed in support of the McGuire OFA transition licensing submittal (Reference 1) to demonstrate that the following criteria are satisfied:

Assuming a stuck RCCA with or without offsite power, and assuming a single failure in the engineered safety features, the core remains in place and intact. Radiation doses do not exceed the guidelines of 10CFR100.

Although DNB and possible clad perforation following a steam pipe rupture are not necessarily unacceptable, the OFA analysis, in fact, shows that no DNB occurs for any rupture assuming the most reactive assembly stuck in its fully withdrawn position.

The major rupture of a steam line is the most limiting cooldown transient and is analyzed at zero power with no decay heat. Decay heat would retard the cooldown thereby reducing the return to power. A detailed analysis of this transient with the most limiting break size, a double-ended rupture, was performed for the McGuire OFA transition.

The following functions provide the protection for a steam line rupture:

1. Safety Injection System actuation from any of the following:

   a. Two-out-of-three low steam line pressure signals in any one loop.

   b. Two-out-of-four low pressurizer pressure signals.

   c. Two-out-of-three high containment pressure signals.

2. The overpower reactor trips (neutron flux and delta-T) and the reactor trip occurring in conjunction with receipt of the safety injection signal.

3. Redundant isolation of the main feedwater lines.

   Sustained high feedwater flow would cause additional cooldown. Therefore, in addition to the normal control action which will close the main feedwater valves a safety injection signal will rapidly close all feedwater control valves and feedwater isolation valves, trip the main feedwater pumps, and close the feedwater pump discharge valves.

4. Trip of the fast acting steam line stop valves* (designed to close in less than 5 seconds) on:

   a. Two-out-of-three low steam line pressure signals in any one loop.

   b. Two-out-of-four high-high containment pressure signals.

   c. Two-out-of-three high negative steam line pressure rate signals in any one loop (used only during cooldown and heatup operations).

Fast-acting isolation valves are provided in each steam line; these valves will fully close within 10 seconds of a large break in the steam line. For breaks downstream of the isolation valves, closure of all valves would completely terminate the blowdown. For any break, in any location, no more than one steam generator would experience an uncontrolled blowdown even if one of the isolation valves fails to close, unless a consequential failure results in reopening of both MSIVs in the doghouse. This would cause an additional cooldown of the primary system, with a possible increase in the peak return to power. The following section of this report documents the analysis of these effects and consequences.

Besides the MSIVs, the affected equipment in the doghouse are the steam generator power-operated relief valves and the main feedwater isolation valves. The PORVs are assumed to open as a result of a consequential failure due to superheated steam. The consequential reopening of the main feedwater isolation valves would not affect the transient since the safety injection signal also trips the main feedwater pumps, and closes the feedwater control and feedwater pump discharge valves.

* main steam isolation valves (MSIVs)

Analysis of Effects and Consequences

Method of Analysis

The analysis of the steam line rupture has been performed to determine:

1. The core heat flux and RCS temperature and pressure transients resulting from the cooldown following the steam line break described below. The LOFTRAN code modified for the calculation of superheated steam enthalpy has been used.

2. The thermal and hydraulic behavior of the core following the steam line break. An evaluation of the transient statepoints from this analysis verifies that the DNB design basis is met.

The analysis assumptions are the same as those of the OFA transition steam line break analysis, with exceptions noted herein. The most restrictive single failure in the safety injection system is assumed. The major difference of this analysis is the assumption of a consequential failure of affected equipment in the doghouse due to superheated steam. Specifically, the following scenario of events is analyzed:

1. A 1.0 ft^2 rupture occurs in one of the steam lines upstream of the MSIV in one of the two doghouses. This case bounds smaller breaks because it results in a more severe cooldown of the reactor coolant system, and thus a greater peak heat flux.

2. All four steam generators blow down through the break until steam line isolation occurs by closure of the MSIVs.

3. Following steam line isolation, initially only the faulted loop steam generator (loop 1) blows down. Saturated steam is released to the doghouse until tube bundle uncovery occurs, after which the steam exiting the break becomes superheated.

4. The MSIVs in the affected doghouse are assumed to reopen when the superheated steam enthalpy reaches 1210 Btu/lb. This is conservative since the enthalpy is lower than that which resulted in the EQ envelope being exceeded in the compartment analyses performed for the Duke Power plants. The result is an uncontrolled blowdown of both affected steam generators (loops 1 and 2).

To ensure conservatism in the analysis, cases were analyzed for both a "late" and a "predicted" time of uncovery of the steam generator tube bundle. In addition, cases were analyzed with reactivity feedback calculations based on the core properties associated with an assumed stuck RCCA positioned in either the loop 1 or loop 2 core sectors.

Results

A time sequence of events for the four cases analyzed is shown in Table 1. As shown by Table 1, the consequential MSIV failures do not affect the peak return to power for any case. For the cases in which reactivity feedback is calculated based on loop 2, the additional cooldown induced by the MSIV failures resulted in an increase in core heat flux. However, the heat flux remained below the peak value attained earlier in the transient.

A detailed evaluation of the transient statepoints for all cases analyzed verifies that the DNB design basis is met (i.e. DNBR above the limit value of 1.30) and the conclusions of the McGuire OFA transition licensing submittal remain valid.

Reference

1. Duke Power Transmittal to NRC, "Safety Evaluation for McGuire Units 1 and 2 Transition to Westinghouse 17x17 Optimized Fuel Assemblies."

TABLE 1

TIME SEQUENCE OF EVENTS

Case 1 - Late Tube Uncovery, Reactivity Calculations Based on Loop 1.

Event	Time (sec)
Steam line ruptures	0
Steam line isolation occurs	9
Criticality attained	28
Peak heat flux reached	248
Steam generator tube bundle uncovery occurs	335
Consequential failure of MSIVs in affected doghouse	344

Case 2 - Late Tube Uncovery, Reactivity Calculations Based on Loop 2.

Event	Time (sec)
Steam line ruptures	0
Steam line isolation occurs	9
Criticality attained	49
Peak heat flux reached	268
Steam generator tube bundle uncovery occurs	540
Consequential failure of MSIVs in affected doghouse	595

Case 3 - Predicted Tube Uncovery, Reactivity Calculations Based on Loop 1.

Event	Time (sec)
Steam line ruptures	0
Steam line isolation occurs	9
Criticality attained	28
Steam generator tube bundle uncovery occurs	228
Peak heat flux reached	230
Consequential failure of MSIVs in affected doghouse	274

Case 4 - Predicted Tube Uncovery, Reactivity Calculations Based on Loop 2.

Event	Time (sec)
Steam line ruptures	0
Steam line isolation occurs	9
Criticality attained	49
Peak heat flux reached	268
Steam generator tube bundle uncovery occurs	334
Consequential failure of MSIVs in affected doghouse	548