EVALUATION OF POTENTIALLY ADVERSE ENVIRONMENTAL EFFECTS ON NON-SAFETY GRADE CONTROL SYSTEMS

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TABLES

ACRONYMS

LOCA - Loss of Coolant Accident
SLB - Steam Line Break
FWLB - Feedwater Line Break

I. INTRODUCTION

This report is in response to Robert L Tedesco's letter of April 16, 1981 to James W Cook on the subject of "High Energy Line Breaks and Consequential Control System Failures - Midland Plant, Units 1 and 2," (IE Information Notice 79-22). The concerns listed in Information Notice 79-22 are addressed utilizing the same review the B&W operating plants used in 1979 as a result of a meeting (September 20, 1979) between the NRC and B&W Operating Plant Owners. The ground rules for the review as stated at the meeting are:

Evaluate impact on Licensing basis accident analyses due to consequential environmental effects on non-safety grade control systems.

- Identify Licensing basis accidents which cause an adverse environment for each plant.
- Define Safety Analysis inputs and responses used during Licensing basis accidents.
- Verify Safety Analysis conclusions or recommend actions justifying continued operation.

It is important to note that the Midland Plant has the distinct advantage of utilizing safety-grade control system/components in place of many of the non-safety-grade control systems/components utilized by the typical B&W 177 fuel assembly operating plant.

The scope of this response includes a confirmation that the Midland Plant equipment performance is consistent with that used in the Licensing basis analysis. Where non-safety-grade equipment performance could be affected by the adverse environment, a safety assessment has been prepared. The safety assessment was used to define potential problems due to the effects of an adverse environment on non-safety-grade control systems.

II. PLANT LICENSING BASIS

A. Safety Analysis Functions and Parameters

The plant licensing basis analyses were reviewed to define the inputs, assumptions and responses used for non-safety grade control systems. This information is summarized in Table I, which lists typical equipment actions and actuation times used in the safety analyses for B&W 177 fuel assembly plants. The data has been categorized to reflect the functional requirements as follows:

1. Reactor Power Control and Shutdown

2. Reactor Pressure Control

3. Steam System Isolation and Pressure Control

4. Feedwater System Isolation and Control

This categorization has been developed to focus upon those primary functions which have a potential for control system interaction.

Table I identifies the range of equipment actions and actuation times used in the plant safety analysis for steam line break, feedwater line break and large and small LOCA.

B. Midland Plant Unique Features

Table I lists typical B&W 177 fuel assembly plant non-safety-grade equipment response during high energy line breaks. In the Midland Plant, many of these components are safety grade as listed below. Included below, where applicable, is the response time of these safety-grade components to demonstrate they satisfy the response times in Table I.

1. Safety-Grade PORV and PORV Controls

2. Safety-Grade Main Steam Isolation Valves

   Valve Closure Time = 5 seconds (FSAR Table 16.3.6-1)

3. Safety-Grade Main Feedwater Isolation Valves

   Valve Closure Time = 10 seconds (FSAR Table 16.3.6-1)

4. Safety-Grade Auxiliary Feedwater Isolation Valves

   Valve Closure Time = 10 seconds (FSAR Table 16.3.6-1)

5. Safety-Grade Auxiliary Feedwater Initiation

   The maximum time for auxiliary feedwater to reach the steam generators for emergency operation, including diesel start time of 10 seconds, is less than 40 seconds (FSAR Section 10.4.9.2.3).

6. Safety-Grade Main Steam Relief Valves

III. SAFETY ASSESSMENT

A. Potential Environmental Effects

The non-safety-grade control systems have been reviewed to determine if an accident environment could adversely affect the analyzed course of the event. Specifically, the approach taken was to use the safety analysis functions and parameters from Table I as a basis to identify where potential control system effects could have an impact. The results of this evaluation is summarized in Table II. The matrix identifies, for six accident types, the control systems/components which could be affected by the environment caused by the event. Where a "_" entry is made in the matrix, no potential for environmental effects exists due to the physical location of the equipment with respect to the high energy line break, ie, breaks inside containment do not affect equipment outside containment and vice versa. The entries X, Y, or Z are explained as follows:

X - The adverse environment caused by the break could affect the equipment and, equipment malfunction could affect safety analysis functions identified in Table I.

Y - The adverse environment caused by the break could interact with the equipment, but, the equipment malfunction would not affect the safety analysis function identified in Table I and does not require further analysis.

Z - Designates that the equipment is safety-grade in the Midland Plant and does not need to be addressed further in response to IE Information Notice 79-22.

This structuring of the potential effects matrix provides a focus on those non-safety-grade control systems which are important and identifies areas for further evaluation of the impact on the safety analysis (ie, X's).

B. Impact on Plant Safety Analysis

Potential environmental effects which could adversely impact the plant safety analysis are identified in Table II with an "X". For each potential adverse effect, a safety assessment has been prepared to confirm plant safety or identify a potential problem area.

The results of the safety assessment are summarized in Table III, Impact of Control System Effects on the Midland Safety Analysis. These potential effects, due to an adverse environment, have been placed into two categories as follows:

1. Equipment Performance

Safety-grade equipment can be shown to perform the intended function, consistent with the safety analysis, in the adverse environment.

2. Period of Operability

The required period of operability for the equipment (ie, time frame in which the equipment must function) is considerably shorter than the time it takes for an adverse environment to have an impact.

The impact on the safety analysis is presented below for the control systems/components with an X entry in Table II.

a. CRDCS Under All Accident Environments

A significant increase in initial power level as a result of spurious rod withdrawal prior to reactor trip has not been included in the SLB, FWLB or LOCA analysis in the Midland FSAR. While it is likely that such an increase in power would be offset by the reduction in the time-to-trip for each of these accidents, confirmatory analysis has not been performed. The following summarizes the likelihood of significant rod withdrawal for each case.

1) For steam and feedwater line breaks, the time-to-trip is very short (up to 8 seconds for SLB and 13.4 seconds for FWLB). Adverse environmental effects on any non-safety-grade equipment, eg, out-of-core detectors, which could result in spurious rod withdrawal, is considered extremely unlikely to occur prior to the reactor trip. After the reactor trip the control rods are prevented from withdrawing due to the CRDCS power supply breakers being tripped.

2) The same rationale applies to all but the very smallest LOCA's, ie, time to low RC pressure trip is short for the majority of small breaks. Conversely, "leaks" (breaks too small to result in a low-pressure trip) are not expected to generate a severe environment.

From the above, it is concluded that adverse interaction resulting in significant reactor power increases prior to reactor trip is extremely unlikely.

b) Turbine Trip/Turbine Stop Valves

The concern for this system is related to operating plants that utilize the turbine stop valves as their primary main steam isolation system. The Midland design provides safety-grade Main Steam Isolation Valves as the primary main steam isolation system upstream of the turbine stop valves.

c) Turbine Bypass/ATM Relief Valves Under all Accident Environments

The concern for these systems is related to operating plants that do not have a safety-grade main steam isolation system upstream of non-safety-grade Turbine Bypass/Atmospheric (ATM) Relief Valves. The Midland design provides safety-grade Main Steam Isolation Valves upstream of the non-safety-grade Turbine Bypass/ATM Relief Valves.

d) Main Feedwater Control

1) Large LOCA

The large break Loss-Of-Coolant Accident relies upon safety-grade equipment for mitigation. Table I states the analysis conservatively assumes a loss of all feedwater for a large LOCA. The Midland design provides safety-grade Main Feedwater Isolation valves which isolate the main feedwater during a large LOCA.

2) Small LOCA

The small LOCA analysis and operating guidelines utilize OTSG level for RCS cooling and depressurization. At the Midland Plant the safety-grade auxiliary feedwater control system is utilized to control OTSG level for small LOCA and the safety-grade main feedwater isolation valves will isolate the main feedwater.

3) FWLB Inside/Outside Containment - SLB Inside/Outside Containment

To remain within the bounds of the safety analyses for these events, and prevent additional RCS overcooling, feedwater must be secured quickly to the affected OTSG and auxiliary feedwater initiated and properly controlled to the unaffected OTSG. Section II.B on Plant Unique Features has shown that the main feedwater will be isolated, within the allotted time (10 seconds), to both Once Through Steam Generators (OTSG) by the safety-grade Main Feedwater Isolation Valves, and that auxiliary feedwater will be initiated within 40 seconds. Auxiliary feedwater to the affected OTSG will be isolated by the safety-grade auxiliary feedwater isolation valves via Midland's Feed Only Good Generator (FOGG) feature which is safety-grade. The auxiliary feedwater is controlled by a safety-grade control system.

IV. SUMMARY

IE Information Notice 79-22 was issued to inform the nuclear industry that certain non-safety-grade equipment, if subjected to an adverse environment resulting from high energy line breaks inside or outside of containment could complicate the event beyond the FSAR analysis.

B&W reviewed the typical B&W 177 fuel assembly plant licensing basis analyses to define the non-safety-grade control system assumptions and responses used in the analyses and listed them in Table I of this report.

Next B&W did an evaluation to determine which of the licensing basis accidents (LOCA, SLB, FWLB) analyses could be impacted by an adverse environment affecting the equipment related to Table I. The result of this evaluation is listed in Table II. From Table II you can see that the Midland Plant has the distinct advantage of utilizing safety-grade control systems/components in place of many of the non-safety-grade systems/components utilized by the typical B&W 177 fuel assembly operating plants.

Table III of this report is entirely Midland specific and demonstrates that the IE Information Notice 79-22 concerns related to the typical B&W 177 fuel assembly plant will not complicate the LOCA, SLB, or FWLB events beyond the FSAR analysis for the Midland Plant Units 1 and 2.

TABLE I

TYPICAL B&W 177 FA EQUIPMENT RESPONSE DURING HIGH ENERGY LINE BREAKS

		Steam Line Break	Feedwater Line Break	Large LOCA	Small LOCA
I.	Reactor Power Control and Shutdown				
	Trip Function Utilized	High ϕ or low RC Pressure	High RC Pressure	Reactor Trip Not Used	Low RC Pressure
	Time of Reactor Trip	1.1-8.0 sec	8.2-13.4 sec		
II.	Reactor Pressure Control				
	Time to PORV Actuation	PORV Not Actuated for Steam Line Break	4-8 sec	PORV Response Not Important	PORV May Be Required for Depressurization In Long Term
	Time at which PORV Closes		∿20 sec		
III.	Steam System Isolation and Pressure Control				
(1)	Steam Line Isolation Time	1.6-8.5 sec	6.0-12.0 sec	Code Safety Valves are Used in the Analyses for Conservatism	Code Safety Valves are Used in the Analyses for Conservatism
(2)	Time to Steam Releif Valve Opening	7.0-16.0 sec	7.0-7.5 sec		
(2)	Time for Steam Relief Valve Closure	20-30 sec	25-30 sec		
IV.	Feedwater System Isolation and Control				
(1)	Main Feedwater Isolation Time	19-34 sec	∿18 sec	Analysis Conservatively Assumes a Loss of All Feedwater	Manual Level Control Requirements Based Upon Small Break Operating Guidelines
(1)	Auxiliary Feedwater Isolation Time	19-34 sec	∿18 sec		
(2)	Auxiliary Feedwater Initiation Time	∿40 sec	∿40 sec		
(2)	Main or Auxiliary Feedwater Control	Maintain Minimum OTSG Level	Maintain Minimum OTSG Level		

(1) Affected Steam Generator for SLB and FWLB
(2) Unaffected Steam Generator for SLB and FWLB

TABLE II

CONTROL SYSTEM/COMPONENTS RELATED TO TABLE I EQUIPMENT

	Non-Safety-Grade Control Systems	Licensing Basis Accidents SLB Inside Containment	SLB Outside Containment	FWLB Inside Containment	FWLB Outside Containment	Large LOCA	Small LOCA
I.	Reactor Power Control and Shutdown						
	Control Rod Drive Control System	x	x	x	x	x	x
II.	Reactor Pressure Control						
	Power Operated Relief Valve	Z	Z	Z	Z	Z	Z
	Pressurizer Heaters	Y	Y	Y	Y	Y	Y
	Pressurizer Spray	Y	Y	Y	Y	Y	Y
III.	Steam System Isolation and Pressure Control						
	Turbine Trip/Turbine Stop Valves	-	x	-	x	-	-
	Steam Line Isolation Valves*	Z	Z	Z	Z	Z	Z
	Turbine Bypass/ATM Relief Valves**	x	x	x	x	x	x
IV.	Feedwater System Isolation and Control						
	Main Feedwater Control**	x	x	x	x	x	x
	Main Feedwater Isolation Valves*	Z	Z	Z	Z	Z	Z
	Auxiliary Feedwater Isolation Valves*	Z	Z	Z	Z	Z	Z
	Auxiliary Feedwater Initiation**	Z	Z	Z	Z	Z	Z
	Auxiliary Feedwater Level Control**	Z	Z	Z	Z	Z	Z

* Affected Steam Generator for SLB and FWLB
** Unaffected Steam Generator for SLB and FWLB

- Environmental Effects Cannot Occur Due to Location of Equipment (inside containment vs outside containment)
Y Environment will not affect Safety Analysis Results
x Environment could affect Safety Analysis Results
Z These are safety-grade systems at the Midland Plant

NOTE: The Z entries are Midland specific while all other entries are for the typical B&W 177 Fuel Assembly Plants.

TABLE III

IMPACT OF NON- SAFETY-GRADE CONTROL SYSTEM/COMPONENT EFFECTS ON THE MIDLAND SAFETY ANALYSIS

	Licensing Basis Accidents					
	SLB Inside Containment	SLB Outside Containment	FWLB Inside Containment	FWLB Outside Containment	Large LOCA	Small LOCA
I. Reactor Power Control and Shutdown						
Control Rod Drive Control System	(2)	(2)	(2)	(2)	(2)	(2)
II. Reactor Pressure Control						
Power-Operated Relief Valve						
Pressurizer Heaters						
Pressurizer Spray						
III. Steam System Isolation and Pressure Control						
Turbine Trip/Turbine Stop Valves		(1)		(1)		
Steam Line Isolation Valves						
Turbine Bypass/Atm Relief Valves	(1)	(1)	(1)	(1)	(1)	(1)
IV. Feedwater System Isolation and Control						
Main Feedwater Control	(1)	(1)	(1)	(1)	(1)	(1)
Main Feedwater Isolation Valves						
Auxiliary Feedwater Isolation Valves						
Auxiliary Feedwater Initiation						
Auxiliary Feedwater Level Control						

(1) Safety-Grade equipment can be shown to perform intended function at the Midland Plant.
(2) Required period of operability is short.

NOTE: All open entries are either a (-) or a Y or a Z on Table II and will not impact the safety analysis.