NEI 96-07 Appendix D Criterion 6 Examples

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Examples Will Show:

Sec. 4.3.6 of Appendix D is consistent with NEI 96-07, R1

- Two decades of implementation
- Developed with NOPR and 1999 Final Rule SOC in mind
- Logic and treatment of Criterion 6 is consistent with the application of other 10 CFR 50.59 Evaluation criteria

Sec. 4.3.6 of Appendix D avoids uneven application of 50.59

- Consistent with NEI 96-07, R1
- Consistent with NRC's "Reliability" Principle of Good Regulation
- Supports NRC focus on risk-significant issues

Examples for Discussion

- Instrument Air Compressor Digital Controls
- Diesel Generator Jacket Water Surge Tank Level Control
- Containment Fan Coolers Digital Controls
- Digital Feedwater Control System

- As time allows:
  - Feedwater Debris Strainer

Instrument Air (IA) Compressor Digital Controls

- The Instrument Air system provides compressed, filtered and regulated air in support of various plant needs.
- Compressed air is supplied to the IA system by three 50% capacity (405 scfm), oil-free, reciprocating air compressors, each with its own after-cooler, moisture separator and air receiver.
- When Instrument and Station Air Systems are separated, only two of the three IA compressors are required to supply the IA header requirements for both units.

Instrument Air Compressor Digital Controls

Example Plant UFSAR

In the event that the one operating compressor fails to supply the full air demand, or an electrical trip of an operating compressor occurs, the resulting continuous low pressure in the supply line initiates an automatic start of the standby compressors.

Instrument Air Compressor Digital Controls

UFSAR

- The IA compressors discharge to an IA header which is common to both units.
- FMEA: 2 of 3 IA compressors are required during normal ops; low P in the supply line auto starts standby IA compressors
- Safety analyses: assume loss of the Instrument Air System

Proposed Activity

- Install new IA compressors with digital controls
- Likelihood of SCCF of all compressors "*not sufficiently low*" = 0 of 3 compressors
- Possible loss of normal feedwater event

IA Compressor Digital Controls

Scenario	UFSAR Description	3.12 Safety Analyses	SA current → new	different result?/LAR?
Plant 1 – NEI	2/3 → 0/3	Loss of Normal Feedwater (LONF)	IA system assumed to fail (no change)	No
Plant 2 – NEI	No existing description	LONF	No change	No
Plant 1 – NRC	2/3 → 0/3	LONF	No change	Yes
Plant 2 – NRC	No existing description	LONF	No change	Not Clear

IA Compressor Digital Controls Illustrates

- Appendix D's approach is consistent with NEI 96-07, Rev. 1
  - using the safety analysis level
- Appendix D's approach supports NRC focus on risk-significant issues
  - The NRC's approach appears to require LARs for a lot of very reasonable and benign modifications.

Diesel Generator (D/G) Jacket Water Surge Tank Level Control

- Diesel generator supplies power to required emergency loads
  - D/G needs jacket water supply in order to perform its design function
- Two 100% redundant trains

- Surge tank is described as having a manual-operated supply and drain, along with various alarms and a high temperature D/G trip
  - Low level alarm actuates at 200 gallons remaining in a 450 gallon surge tank
  - Drain line averages 5 GPM
- Effect of operator error on surge tank draining is discussed

D/G Jacket Water Surge Tank Level Control

DIESEL GENERATOR COOLING WATER SYSTEM
SINGLE FAILURE ANALYSIS (Sheet 1 of 2)

Component	Failure Mode/Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
Essential spray ponds system	Leak or rupture in supply line/ corrosion	Loss of cooling of combustion air, jacket circ. water loop and lube oil circ. loop	High temperature indication and alarm on jacket water circulating loop and lube oil circulating loop	Redundant diesel generator remains in service	
Circulating water temperature control valve	Fails to throttle flow to cooler/ valve sticks open	Continuous flow through cooler causing low temperature in system. Diesel runs cold, less efficient	Low temperature indication on jacket water circulating loop	Redundant diesel generator remains in service	Operator may throttle cooling water flow
	Fails to throttle flow to bypass/ heat exchanger/valve sticks closed	Loss of cooling of jacket water circulating loop excessive temperature	High temperature indication and alarm on jacket water circulating loop	Redundant diesel generator remains in service	
Engine-driven circulating water pump	Inoperable/ mechanical failure	Low header pressure	Low-pressure alarm	Redundant diesel generator remains in service	
Surge tank	Leaks/corrosion	Low water level	Gauge	Makeup water replaces losses	

D/G Jacket Water Surge Tank Level Control

UFSAR

- One D/G train operates
- FMEA: low water → makeup water replaces losses
- Safety analyses: assume single failure; one train operates

Proposed Activity

- Replace manual control with digital controllers and air-operated valves
- Likelihood of SCCF of both controllers "*not sufficiently low*" = 0 of 2 D/G
- FMEA would examine losing both trains
- Safety analyses would reflect FMEA outcome

D/G Jacket Water Surge Tank Level Control – new/revised FMEA

- Procedures already exist for:
  - Local operator monitoring of D/G operation
  - Response to Low Surge Tank alarms
    - MCR Trouble Alarm typically points to a local panel
  - Operator manipulation of surge tank supply and drain valve

- 40 minutes (200 gallons being drained at 5 GPM) are available after alarm generation
- Operator complies with procedural guidance
- Surge tank function is preserved → D/G design function is preserved

D/G Jacket Water Surge Tank Level Con.

Scenario	UFSAR Description	3.12 Safety Analyses	SA current → new	different result?/LAR?
Plant 1 – NEI	Detailed FMEA	D/G Operation	At least one D/G operates (no change)	No
Plant 2 – NEI	No existing description	D/G Operation	No change	No
Plant 1 – NRC	Detailed FMEA	D/G Operation	No change	Yes
Plant 2 – NRC	No existing description	D/G Operation	No change	Not Clear

D/G Jacket Water Surge Tank Level Control Illustrates

- Appendix D's approach produces a consistent answer independent of UFSAR detail, avoiding "uneven application"
  - NRC's approach appears to differ based upon level of UFSAR detail (reinstates problem of "uneven application")
  - NRC's approach is not clear for plants with no existing UFSAR description
- Appendix D's approach is consistent with NEI 96-07, Rev. 1
  - Both developed with NOPR and 1999 Final Rule SOC in mind
  - Revised FMEA = The result of the logically required operator actions in response to the effect of the level controller's failure is the preservation of the D/G's function

Containment Fan Coolers Digital Controls

- Limits the containment ambient temperature during normal plant operating conditions
- Reduce containment ambient temperature and pressure following a Loss of Coolant Accident (LOCA) or a Main Steam Line Break (MSLB) inside containment
- Provides mixing of the sprayed and unsprayed regions of the containment to improve airborne fission product removal
- Provides a mixed atmosphere for hydrogen control

- Five containment fan coolers provided

Containment Fan Coolers Digital Controls

SINGLE FAILURE ANALYSIS - CONTAINMENT HEAT REMOVAL SYSTEMS

Component	Malfunction	Comments and Consequences
A. Spray Nozzles	Clogged	Large number of nozzles precludes clogging of a significant number.
B. Pumps		
Containment spray pump	Fails to start	Two pumps provided. Operation of one required.
C. Automatically Operated Valves: (9001A/B): (Open on coincidence of two out of four high-high containment pressure signals)		
Containment spray pump discharge isolation valve	Fails to open	Two complete systems provided. Operation of one required.
D. Valves Operated From Control Room for Spray Recirculation, if Used (9003A/B):		
Containment spray header isolation valve from residual heat exchanger discharge	Fails to open	Two complete systems provided. Operation of spray recirculation not required.
E. Containment Fan Coolers	Fails to start	Five fan coolers provided. Two required for minimum safety feature operation.

Containment Fan Coolers Digital Controls

UFSAR

- 2 of 5 coolers required to operate following a DBA
- FMEA: at least two operable coolers has no effect on the Containment Heat Removal System
- Containment pressure safety analyses: two coolers assumed to operate

Proposed Activity

- Install digital controls for each containment fan cooler
- Likelihood of SCCF of all fan coolers "*not sufficiently low*“ = 0 of 5 coolers following a DBA
- Calculation that used the cooling rate produced by two fan coolers revised to using a value of zero (0)

Containment Fan Coolers Digital Controls

Scenario	UFSAR	3.12 Safety Analyses	(vi) different result?	(vii) DBLFPB exceeded or altered?	LAR?
Plant 1 – NEI	2/5 → 0/5 coolers	Ctmt Press.	Yes – SA Acc. Crit. NOT Met	No – SA Acc. Crit. Met	Yes
Plant 2 – NEI	No existing description	Not Credited	No	No	No
Plant 1 – NRC	2/5 → 0/5 Coolers	Ctmt Press.	Yes	No	Yes
Plant 2 – NRC	No existing description	Not Credited	Not Clear	No	Not Clear

Containment Fan Coolers Digital Controls Illustrates

- Appendix D's approach produces a consistent answer independent of UFSAR detail, avoiding "uneven application"
  - NRC's approach appears to differ based upon level of UFSAR detail (reinstates problem of "uneven application")
  - NRC's approach is not clear for plants with no existing UFSAR description
- Appendix D's approach focuses on the same safety analysis as criterion 7, but with differing assumptions
  - Criterion 6: to "create a possibility," assume SCCF (0/5 coolers)
  - Criterion 7: to reflect performance as designed, assume single failure (at least 2/5 coolers)

Digital Feedwater Control System

- Main Feedwater Regulating Valves (MFRV) and Bypass Feedwater Regulating Valves (BFRV) automatically control feedwater flow and maintain steam generator water level.
- The Steam Generator Water Level Control System (SGWLCS) establishes and maintains the steam generator water level within predetermined limits during normal operating transients. The SGWLCS also maintains the steam generator water level within predetermined limits and unit trip conditions.

Digital Feedwater Control System

UFSAR

- A switchover from the BFRVs to the MFRVs is initiated manually by the operator at approximately 25 percent power
- UFSAR Section 15.1.2, "Feedwater System Malfunctions that Result in an Increase in Feedwater Flow," considers the full opening of one feedwater regulating valve

Proposed Activity

- Install digital controls to use the BFRV alone, the MFRV and BFRV in parallel, or the MFRV alone to automatically control feedwater flow as power level changes.
- Possible increase in feedwater flowrate in two loops due to both the MFRVs and BFRVs going fully open.

Digital Feedwater Control System

- The reanalysis of the “hot full power case” feedwater malfunction event in one loop demonstrated that the results and conclusions discussed in UFSAR Section 15.1.2 are acceptable with the proposed change and assuming a SCCF. An analysis of a “hot full power case” feedwater malfunction event in two loops was also performed and also demonstrated that the results and conclusions discussed in UFSAR Section 15.1.2 for the “hot full power case” for one loop are also satisfied. Specifically, the peak heat flux does not exceed 118 percent of its nominal value, and the DNBR remains above the design DNBR limit of 1.24/1.23. Additionally the RCS pressure remains below 110% of RCS design pressure.

Digital Feedwater Control System

Scenario	UFSAR Description	3.12 Safety Analyses	SA current → new	different result?/LAR?
Plant 1 – NEI	1 con/ loop → 1 con/ 2 loops	Increase in FW Flow	1 FRV full open → 4 FRV full open (2 MFRV & 2 BFRV)	No – SA Acc. Crit. Met
Plant 2 – NEI	No existing description	Increase in FW Flow	See above	No – SA Acc. Crit. Met
Plant 1 – NRC	1 con/ loop → 1 con/ 2 loops	Increase in FW Flow	See above	Yes
Plant 2 – NRC	No existing description	Increase in FW Flow	See above	Not Clear

Digital Feedwater Control System Illustrates

- Appendix D's approach is consistent with NEI 96-07, Rev. 1
  - using the safety analysis level
- Appendix D's approach produces a consistent answer independent of UFSAR detail, avoiding "uneven application"
  - Consistent with NRC's "Reliability" Principle of Good Regulation
  - Supports NRC focus on risk-significant issues

Criterion 6 – Four Major Points

1. NEI 96-07, Definition 3.9, “malfunction of an SSC important to safety” is used within Section 4.3.6 of Appendix D consistently
2. The rulemaking record is clear – the rule’s intent to identify a “different result” is to examine the **safety analyses**
3. Consistent with NEI 96-07, Rev. 1, Section 4.3.6 of Appendix D avoids uneven application of 10 CFR 50.59
4. Section 4.3.6 of Appendix D is consistent with the other 10 CFR 50.59 Evaluation criteria

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