

**NEI 96-07, Appendix D, *Supplemental
Guidance for Application of 10 CFR 50.59
to Digital Modifications***

David Ramendick

**SUMMARY OF NEI 96-07, APPENDIX D, SECTION 4,
“EVALUATION GUIDANCE”**

March 8, 2017 • NRC

OBJECTIVES

- Summarize Proposed Appendix D, Section 4 (Evaluation Guidance)
- Illustrate Proposed Section 4 Guidance using Main Feedwater Control System Replacement example
- Solicit NRC Staff Input
 - Scope of topics expected to be addressed in 50.59 Evaluation Questions 1, 2, 5 and 6
 - Expected content of responses to 50.59 Evaluation Questions 1, 2, 5 and 6

SECTION 4 – General Information

- Introduction (including the CAUTION)
 - Reiterates the necessity of using both the main body and Appendix D
 - Provides administrative information
- Common Cause Failure (CCF) Outcomes
 - Source: CCF Susceptibility Analysis
 - Possible *CCF Outcomes*
 - CCF Not Credible
 - CCF Credible, but CCF likelihood \ll CCF due to a single random failure

SECTION 4 – General Information

- Examples
 - Used to illustrate a specific aspect or topic provided in the guidance
 - Not “all inclusive”
 - Focuses only on the aspect or topic being discussed
 - Deliberate exclusion of some aspects or topics that could, upon inclusion, change the conclusion
 - Extensive use of the Main Feedwater (MFW) System
 - MFW is one of the few non-safety-related systems whose failure can initiate an accident.
 - Failure of the MFW System is one of the few SSC malfunctions that is also an accident initiator.

SECTION 4.1 – Accident Frequency

Criteria to be Considered

- Negligible: *“A negligible effect on the frequency of occurrence of an accident exists when the change in frequency is so small or the uncertainties in determining whether a change in frequency has occurred are such that it cannot be reasonably concluded that the frequency has actually changed (i.e., there is no clear trend toward increasing the frequency).”*
- Attributable
 - “Definition” – Due to, or related to, the proposed activity
 - If the CCF outcome is **not credible**, then the impact is NOT attributable
 - If the CCF outcome is **credible**, then the impact **may** be attributable

SECTION 4.1 – Accident Frequency

Illustration of Guidance Using Appendix D, Example 4-2

Proposed Activity:

A licensee has two non-safety-related main feedwater pumps (MFWPs), each with its own flow control valve. There are two analog control systems (one per MFWP and flow control valve combination) that are physically and functionally the same. Each analog control system will be replaced with a separate digital control system. The hardware platform for each digital control system is from the same supplier and the software in each digital control system is exactly the same.

CCF Outcome:

CCF is credible, but CCF likelihood \ll CCF due to a single random failure

SECTION 4.1 – Accident Frequency

Application of *Attributable*

- Affected Accident: Loss of Feedwater event
- Accident Initiators (Equipment-related)
 - Loss of one MFWP
 - Closure of one flow control valve
- Conclusion: Attributable to the digital modification
- Justification: The feedwater control system provides signals to the MFWPs and the flow control valves

SECTION 4.1 – Accident Frequency

Factors to Consider

- Use of software
- Use of digital components (e.g., microprocessors)
- Creation of a software CCF
- Intended benefits
- ? **[Additional input from NRC Staff requested]**

SECTION 4.1 – Accident Frequency

Expected Response Content

Based on the factors that were considered, the proposed activity has an attributable impact on the frequency of occurrence of the Loss of Feedwater event. However, the net change in the frequency of occurrence of the Loss of Feedwater event is negligible due to the interdependent effects of CCF (“negative”) and the improved SSC performance (“positive”).

SECTION 4.2 – Malfunction Likelihood

Criteria to be Considered

- Negligible: *“A negligible effect on the likelihood of occurrence of a malfunction exists when the change in malfunction is so small or the uncertainties in determining whether a change in likelihood has occurred are such that it cannot be reasonably concluded that the likelihood has actually changed (i.e., there is no clear trend toward increasing the likelihood).”*
- Attributable
 - “Definition” – Due to, or related to, the proposed activity
 - If the CCF outcome is **not credible**, then the impact is NOT attributable
 - If the CCF outcome is **credible**, then the impact **may** be attributable

SECTION 4.2 – Malfunction Likelihood

Illustration of Guidance Using Appendix D, Example 4-6

Proposed Activity:

Same main feedwater control system replacement previously described.

CCF Outcome:

CCF is credible, but CCF likelihood \ll CCF due to a single random failure

SECTION 4.2 – Malfunction Likelihood

Application of *Attributable*

- Affected Malfunctions:
 - Loss of one MFWP
 - Closure of one MFWP flow control valve
- Malfunction Initiator (Equipment-related): Failure of a feedwater control system
- Conclusion: Attributable to the digital modification
- Justification: The feedwater control system provides signals to the MFWPs and the flow control valves

SECTION 4.2 – Malfunction Likelihood

Factors to Consider

- Use of software
- Use of digital components (e.g., microprocessors)
- Creation of a software CCF
- Intended benefits
- ? **[Additional input from NRC Staff requested]**

SECTION 4.2 – Malfunction Likelihood

Expected Response Content

Based on the factors that were considered, the proposed activity has an attributable impact on the likelihood of occurrence of the loss of a MFWP or the closure of a MFWP flow control valve. However, the net change in the likelihood of occurrence of the loss of a MFWP or the closure of a MFWP flow control valve is negligible due to the interdependent effects of CCF (“negative”) and the improved SSC performance (“positive”).

SECTION 4.5 – Different Accident

- General Considerations
 - 50.59 “Accident” = Anticipated Operational Occurrences (AOOs) and Postulated Accidents (PAs)
 - Criteria to be Considered
 - Credible
 - Bounded/Related
- Guidance Application
 - Relationship of *CCF Outcomes* to “Credible” criterion
 - Application of “Bounded/Related” criterion

SECTION 4.5 – Different Accident

- Relationship of CCF Outcomes to *Credible* Criterion
 - CCF *Not Credible* = Accident of a different type is NOT credible
 - CCF *Credible* = Accident of a different type is credible
- *Bounded/Related* Criterion (for credible ONLY)
 - Use of *events/sequences* to address “bounded”
 - Application of proposed revision to NEI 96-07, Rev. 1 discussed in Draft Regulatory Guide DG-1334 (Section C.1.a.) to address the “related” criterion

SECTION 4.5 – Different Accident

- Application of the *Bounded* Criterion Guidance:
Events/sequences currently considered in the UFSAR form the basis for comparison of events, which makes it possible to identify and evaluate the limiting case.
- Application of the *Related* Criterion Guidance:
Accidents of a different type are credible accidents that the proposed activity could create that have an impact on the type of *events/sequences* previously evaluated in the UFSAR (i.e., a **different** accident analysis would be needed for this different type of accident, not just a **revision** of a current accident analysis).

SECTION 4.5 – Different Accident

Illustration of Guidance Using Appendix D, Example 4-9

Proposed Activity:

Same main feedwater control system replacement previously described.

CCF Outcome:

CCF is credible

SECTION 4.5 – Different Accident

Application of *Bounded/Related*

(Satisfaction of the “Credible” criterion has been established.)

- Malfunction/Accident Initiator: Loss of one MFWP
- Accident Type: Decrease in heat removal by the secondary system
- Has a **NEW** event/sequence been created? YES...loss of both MFWPs.
- Conclusion: No impact on the accident type
- Justification: Still a “decrease in heat removal from the secondary system”

SECTION 4.5 – Different Accident

Application of *Bounded/Related*

(Satisfaction of the “Credible” criterion has been established.)

- Is a **NEW** accident analysis required? NO...the loss feedwater flow is already analyzed.
- Is a **REVISION** of an accident analysis required? YES...to incorporate the new feedwater flow value (i.e., zero).
- Conclusion: Does NOT create the possibility of an accident of a different type
- Justification
 - Accident type is not impacted
 - Current accident analyses address reduction/loss of feedwater

SECTION 4.6 – Different Result

- Criteria to be Considered
 - Credible
 - Bounding
- Guidance Application
 - Relationship of *CCF Outcomes* to “Credible” criterion
 - Application of “Bounding” criterion

SECTION 4.6 – Different Result

- Relationship of CCF Outcomes to *Credible* Criterion
 - CCF *Not Credible* = Malfunction with a different result is NOT credible
 - CCF *Credible* = Malfunction with a different result is credible
- *Bounded* Criterion (for credible ONLY)
 - Types of Malfunctions
 - Sources of Results
 - Types of Results

SECTION 4.6 – Different Result

NOTE on 50.59 “FMEA”

- **FMEA** as used in NEI 96-07 is distinct from common technical usage (i.e., as described in IEEE Standards)
- As used in NEI 96-07, no regulatory requirement dictates the structure and/or content of a FMEA
- As a practical measure within NEI 96-07, UFSAR-described “FMEA” may be thought of as ‘how malfunctions are postulated as potential single failures to evaluate plant performance in the accident analyses’

SECTION 4.6 – Different Result

TYPES OF MALFUNCTIONS

- **Previously evaluated**, consistent with any Failure Modes and Effects Analyses (FMEAs) as evaluated in the accident analysis
- **New**, based on any new FMEAs performed to reflect the source (identified on the next slide)

SECTION 4.6 – Different Result

SOURCE OF RESULTS

Failure to perform a design function as evaluated in the accident analysis (e.g., Chapters 6 and 15)

SECTION 4.6 – Different Result

FOCUS ON END RESULTS

- Final state/condition
- Plant level result/response as evaluated in the safety analysis

SECTION 4.6 – Different Result

Illustration of Guidance Using Appendix D, Example 4-11

Proposed Activity:

Same main feedwater control system replacement previously described.

CCF Outcome:

CCF is credible

SECTION 4.6 – Different Result

Application of *Bounded*

(Satisfaction of the “Credible” criterion has been established.)

- Types of Malfunctions
 - Previously Evaluated: Loss of one MFWP
 - New: Loss of both MFWPs (from the new FMEA that was performed)
- Types of Results (Previously Evaluated): End Result is **Loss of Feedwater event** (plant level)
- Types of Results (New): End Result is **Loss of Feedwater event** (plant level)

SECTION 4.6 – Different Result

Application of *Bounded*

(Satisfaction of the “Credible” criterion has been established.)

- Conclusion: Does NOT create the possibility of a malfunction with a different result
- Justification: The *end result* is acceptable as evaluated in the safety analysis (i.e., Loss of Feedwater event)

QUESTIONS / COMMENTS / FEEDBACK

