Task I.C: Operating Procedures (Rev. 4)

The objective of this task was to improve the quality of procedures to provide greater assurance that operator and staff actions were technically correct, explicit, and easily understood for normal, transient, and accident conditions. The overall content, wording, and format of procedures that affected plant operation, administration, maintenance, testing, and surveillance were to be included.

ITEM I.C.1: SHORT-TERM ACCIDENT ANALYSIS AND PROCEDURES REVISION

The four parts of this item were evaluated separately below.

ITEM I.C.1(1): SMALL-BREAK LOCAs

This item was clarified in NUREG-0737[1] and requirements were issued.

ITEM I.C.1(2): INADEQUATE CORE COOLING

This item was clarified in NUREG-0737,[2] requirements were issued, and MPA F-04 was established by DL/NRR for implementation purposes.

ITEM I.C.1(3): TRANSIENTS AND ACCIDENTS

This item was clarified in NUREG-0737,[3] requirements were issued, and MPA F-05 was established by DL/NRR for implementation purposes.

ITEM I.C.1(4): CONFIRMATORY ANALYSES OF SELECTED TRANSIENTS

DESCRIPTION

Background

This NUREG-0660[4] item required confirmatory analyses of selected transients by NRR to provide the basis for comparisons with analytical methods that were being used by the reactor vendors. These comparisons were to ensure the adequacy of the analytical methods being used to generate emergency procedures. At the time this issue was initially evaluated, NRC had performed a limited number of confirmatory transient analyses and the remainder was being defined.

Safety Significance

The safety significance was the reduction in operator errors and upgrading of operating systems through confirmatory analyses of selected transients by NRC. These confirmatory analyses were expected to provide greater assurance that operator and staff actions were technically correct.

Possible Solution

Confirmatory analyses, using the best available computer codes, provided the basis for comparisons with the analytical methods that were being used by the reactor vendors. These comparisons, together with comparisons with other data, constituted the short-term verification effort to ensure the adequacy of the analytical methods being used to generate emergency procedures.

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[1] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[2] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[3] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[4] NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," U.S. Nuclear Regulatory Commission, May 1980, (Rev. 1) August 1980.

PRIORITY DETERMINATION

Frequency Estimate

To evaluate this issue, PNL assumed[5] improvements in two areas: the reduction in human error rate for operators, estimated to be 7%, and other operation improvements (set points for control systems, maintenance, hardware upgrade, etc.) estimated to be 4.5%. The total improvement percentages were applied to the base case frequencies and affected release categories for both PWRs and BWRs. The dominant accident sequences and base case frequencies for Oconee (B&W) were used for PWRs; for BWRs, Grand Gulf 1 was used as the model.

For PWRs, the base case core-melt frequency was determined to be 8.2×10^{-5}/RY. Considering the above improvements, the adjusted case core-melt frequency was determined to be 7.3×10^{-5}/RY with a resultant reduction in core-melt frequency of 9×10^{-6}/RY. For BWRs, the base case and adjusted case core-melt frequencies were determined to be 3.7×10^{-5}/RY and 3.3×10^{-5}/RY, respectively, with a resultant reduction in core-melt frequency of 4×10^{-6}/RY.

Consequence Estimate

Because of the multifactor influence of the estimated improvements, all seven of the PWR release categories and all four of the BWR release categories were assumed to be affected. The potential public risk reduction for PWRs was calculated to be 6.5×10^4 man-rem, assuming 95 plants with an average remaining life of 28.5 years. The potential public risk reduction for BWRs was calculated to be 4×10^4 man-rem, assuming 49 plants with an average remaining life of 27 years. In all cases, a population density of 340 persons per square-mile and typical meteorology were assumed. The total reduction in public risk, based on the above results, was about 1.05×10^5 man-rem.

Cost Estimate

Industry Cost: The industry cost was estimated to be $61M based on the following assumptions: (1) a rate of $1,900/man-week; (2) 30 man-weeks to implement the resolution; (3) seven man-weeks/RY for operation and maintenance; and (4) 144 plants with an average remaining life of 28 years.

NRC Cost: The NRC cost, including implementation and reviews, was estimated to be $2.8M.

Total Cost: The total industry and NRC cost associated with the possible solution was estimated to be approximately $64M.

Value/Impact Assessment

Based on an estimated public risk reduction of 105,000 man-rem and a cost of $64M for a possible solution, the value/impact score was given by:

$$S = \frac{105{,}000 \text{ man-rem}}{\$64\text{M}}$$

$$= 1{,}650 \ \frac{\text{man-rem}}{\$\text{M}}$$

Other Considerations

Other factors considered were the accident avoidance costs and the potential occupational risk reductions. The accident avoidance cost was the product of the reduction in the probability of core-melt and industry cost factors, assuming cleanup, repair, refurbishment, and replacement power cost over a 10-year period.

The total accident avoidance cost for all 95 PWRs and 49 BWRs, which included existing operating plants and those plants expected to commence operation, was estimated to be approximately $49M. Therefore,

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[5] NUREG/CR-2800, "Guidelines for Nuclear Power Plant Safety Issue Prioritization Information Development," U.S. Nuclear Regulatory Commission, February 1983, (Supplement 1) May 1983, (Supplement 2) December 1983, (Supplement 3) September 1985, (Supplement 4) July 1986, (Supplement 5) July 1996.

the net industry cost for this issue, when reduced by the accident avoidance cost, would be approximately $12M.

The occupational dose incurred from accident recovery was estimated at 20,000 man-rem.[6] The total occupational dose reduction due to accident avoidance, considering all PWRs and BWRs, was 600 man-rem. Assuming a 5% reduction in annual operational doses due to imposed operating guidelines and upgraded control systems, the best estimate annual operational dose reduction would be 20 man-rem/RY. For all plants and all remaining plant life, the potential occupational dose reduction was 81,000 man-rem. These estimates indicated that the potential reduction in occupation doses during normal operation was significant and supported a high priority ranking for the issue.

CONCLUSION

Based on the value/impact score and the potential reduction in core-melt frequency, the issue would have been given a medium priority ranking. However, because of the potential public risk reduction of 105,000 man-rem, the issue was given a high priority ranking (see Appendix C). All required work was completed[7,8] and the issue was RESOLVED with no new requirements.

ITEM I.C.2: SHIFT AND RELIEF TURNOVER PROCEDURES

This item was clarified in NUREG-0737[9] and requirements were issued.

ITEM I.C.3: SHIFT SUPERVISOR RESPONSIBILITIES

This item was clarified in NUREG-0737[10] and requirements were issued.

ITEM I.C.4: CONTROL ROOM ACCESS

This item was clarified in NUREG-0737[11] and requirements were issued.

ITEM I.C.5: PROCEDURES FOR FEEDBACK OF OPERATING EXPERIENCE TO PLANT STAFF

This item was clarified in NUREG-0737,[12] requirements were issued, and MPA F-06 was established by DL/NRR for implementation purposes.

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[6] NUREG/CR-2800, "Guidelines for Nuclear Power Plant Safety Issue Prioritization Information Development," U.S. Nuclear Regulatory Commission, February 1983, (Supplement 1) May 1983, (Supplement 2) December 1983, (Supplement 3) September 1985, (Supplement 4) July 1986, (Supplement 5) July 1996.
[7] Memorandum for W. Minners from R. Mattson, "Schedules for Resolving and Completing Generic Issues," January 21, 1983. [8301260532]
[8] Memorandum for W. Dircks from R. Mattson, "Closeout of TMI Action Plan I.C.1(4), Confirmatory Analyses of Selected Transients," November 12, 1982. [8212080586]
[9] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[10] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[11] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[12] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.

ITEM I.C.6: PROCEDURES FOR VERIFICATION OF CORRECT PERFORMANCE OF OPERATING ACTIVITIES

This item was clarified in NUREG-0737,[13] requirements were issued, and MPA F-07 was established by DL/NRR for implementation purposes.

[13] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.

ITEM I.C.7: NSSS VENDOR REVIEW OF PROCEDURES

This item was clarified in NUREG-0737[14] and requirements were issued.

ITEM I.C.8: PILOT-MONITORING OF SELECTED EMERGENCY PROCEDURES FOR NEAR-TERM OPERATING LICENSE APPLICANTS

This item was clarified in NUREG-0737[15] and requirements were issued.

ITEM I.C.9: LONG-TERM PROGRAM PLAN FOR UPGRADING OF PROCEDURES

DESCRIPTION

Historical Background

The NRC effort on this TMI Action item[16] (to be led by NRR with involvement by OIE, SD, and RES) was to develop a long-term program plan for the upgrading of plant procedures. This plan would incorporate and expand on existing efforts associated with the development, review, and monitoring of procedures. Consideration of studies to ensure clear procedures were called for with particular emphasis on diagnostic aids for off-normal conditions. The interrelationships of administrative, operating, maintenance, test, and surveillance procedures were to be considered. The topics of emergency procedures, reliability analysis, human factors engineering, crisis management, and operator training were also to be addressed.

The part of Item I.C.9 that addressed emergency operating procedures (EOP) was implemented in accordance with Item I.C.1 of NUREG-0737.[17] SECY-82-111[18] requested Commission approval of a set of basic requirements for emergency response capability and approval for the staff to work with licensees to develop plant-specific implementation schedules. A significant amount of work on EOPs had been completed and all four NSSS vendors had submitted technical guidelines based on re-analysis of accidents and transients; these were in the final stages of review. In the area of human factors, a survey of existing practices, research on EOPs, and pilot monitoring of some NTOL plants had been completed and criteria for development of EOPs were published for public comment in NUREG-0799.[19] NUREG-0899[20] was published in final form in September 1982 and incorporated resolution of comments received on NUREG-0799.[21] The recommended requirements for EOPs,[22] which included some of these completed or nearly-completed tasks, had been conditionally approved.[23]

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[14] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[15] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[16] NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," U.S. Nuclear Regulatory Commission, May 1980, (Rev. 1) August 1980.
[17] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[18] SECY-82-111, "Requirements for Emergency Response Capability," U.S. Nuclear Regulatory Commission, March 11, 1982. [8203180409]
[19] NUREG-0799, "Draft Criteria for Preparation of Emergency Operating Procedures," U.S. Nuclear Regulatory Commission, June 1981.
[20] NUREG-0899, "Guidelines for Preparation of Emergency Operating Procedures—Resolution of Comments on NUREG-0799," U.S. Nuclear Regulatory Commission, September 3, 1982.
[21] NUREG-0799, "Draft Criteria for Preparation of Emergency Operating Procedures," U.S. Nuclear Regulatory Commission, June 1981.
[22] SECY-82-111, "Requirements for Emergency Response Capability," U.S. Nuclear Regulatory Commission, March 11, 1982. [8203180409]
[23] Memorandum for W. Dircks from S. Chilk, "Staff Requirements—Affirmative Session, 11:50 a.m., Friday July 16, 1982," July 20, 1982. [8208040248, 8209010068]

The part of Item 1.C.9[24] that pertained to other long-term procedures (which were not addressed in NUREG 0737[25]) required further staff effort. The priority ranking of this issue was based on this remaining staff effort.

Safety Significance

Resolution of this issue was expected to have a significant impact on plant procedures. The changes in procedures, in turn, were expected to improve the safety-related performance of all plant operations staff. This would apply to both routine and abnormal operating conditions.

Possible Solution

At the time this issue was initially evaluated, staff actions under Item I.C.9[26] which pertained to normal and abnormal operating procedures, maintenance, test, surveillance, and other safety-related procedures were ongoing and scheduled in three phases:

(1) Survey ongoing studies, existing procedures, and practices of related industries; assess problems; and prioritize solutions (FY 1982-1983).

(2) Prepare guidance (NUREGs, Regulatory Guides) for industry use (FY 1983-1984).

(3) Issue requirements, prepare inspection guidance, review or audit as necessary (FY 1985-1986).

PRIORITY DETERMINATION

Frequency Estimate

To estimate the change in core-melt frequency for this issue, PNL[27] assumed a human error rate reduction of 30% for operations staff. PNL also assumed that the dominant accident sequences for the Oconee-3 (B&W) plant were representative of all PWRs and that the fractional risk and core-melt frequency reductions were applicable to the representative BWR (Grand Gulf-1).

For PWRs, the base case core-melt frequency was determined to be 7.8×10^{-5}/RY. The adjusted case core- melt frequency, considering the above improvement, was determined to be 5.6×10^{-5} /RY. The result was a reduction in core-melt frequency of 2.2×10^{-5}/RY for PWRs. For BWRs, the base case core-melt frequency was determined to be 3.5×10^{-5}/RY and the reduction in core-melt frequency was 9.9×10^{-6}/RY.

Consequence Estimate

All seven of the PWR release categories and all four of the BWR release categories were affected by the improvement. The potential public risk reduction for PWRs was calculated to be 53 man-rem/RY, assuming WASH-1400[28] release categories, a population density of 340 persons per square-mile, and typical midwest meteorology. The public risk reduction for BWRs was calculated to be 64 man-rem/RY. Therefore, the total public risk reduction for all plants (90 PWRs and 44 PWRs) was 2.1×10^{5} man-rem, assuming an average remaining life of 28 years.

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[24] NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," U.S. Nuclear Regulatory Commission, May 1980, (Rev. 1) August 1980.
[25] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.
[26] NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," U.S. Nuclear Regulatory Commission, May 1980, (Rev. 1) August 1980.
[27] NUREG/CR-2800, "Guidelines for Nuclear Power Plant Safety Issue Prioritization Information Development," U.S. Nuclear Regulatory Commission, February 1983, (Supplement 1) May 1983, (Supplement 2) December 1983, (Supplement 3) September 1985, (Supplement 4) July 1986, (Supplement 5) July 1996.
[28] WASH-1400 (NUREG-75/014), "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," U.S. Atomic Energy Commission, October 1975.

Cost Estimate

Industry Cost: The industry cost was estimated to be $447M and included $67M to implement and upgrade and $380M for operation and maintenance.

NRC Cost: The NRC cost including implementation and reviews was estimated at $9M.

Total Cost: The total industry and NRC cost associated with the possible solution was estimated to be approximately $(447 + 9)M or $456M.

Value/Impact Assessment

Based on an estimated public risk reduction of 210,000 man-rem and a cost of $456M for a possible solution, the value/impact score was given by:

$$S = \frac{210{,}000 \text{ man-rem}}{\$456M}$$

$$= 461 \frac{\text{man-rem}}{\$M}$$

Other Considerations

In the analysis of this issue, PNL[29] assumed a uniform 30% improvement in human error, including maintenance, through the dominant accident sequences. The 30% improvement was expected to overestimate reductions in maintenance outages. It was assumed that no significant reductions in maintenance outages would reduce the potential risk reduction calculated by PNL approximately 10%. These improvements transcended normal, abnormal, and emergency procedures during the event sequences as described in NUREG-0660,[30] Item I.C.9. However, the EOP concerns originally included in Item I.C.9 were separately addressed in NUREG-0737.[31]

It was believed that the results of the dominant accident sequences would be strongly influenced by the EOPs. This situation was expected to result in little or no change to the above value/impact score of 461 man-rem/$M since the smaller risk reduction that could be attributed to this issue, after the EOP effect was removed, was balanced by a lower implementation cost to complete the remaining part of the issue. The beneficial reduction in core-melt frequency and public risk calculated by PNL[32] was significantly less when dominant effects of the improvements in the EOPs were removed from the issue. Assuming that improved EOPs would contribute approximately 75% toward reducing the core-melt frequency and public risk, the benefit (risk reduction) attributed to improvements and upgrading of the other procedures was 25% of the total benefits previously calculated. This resulted in a total public risk reduction of $(0.9)(0.25)(2.1 \times 10^5)$ man-rem or 47,000 man-rem. These reductions were attributable to that part of Item I.C.9 not addressed in Item I.C.1 of NUREG-0737.[33]

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[29] NUREG/CR-2800, "Guidelines for Nuclear Power Plant Safety Issue Prioritization Information Development," U.S. Nuclear Regulatory Commission, February 1983, (Supplement 1) May 1983, (Supplement 2) December 1983, (Supplement 3) September 1985, (Supplement 4) July 1986, (Supplement 5) July 1996.

[30] NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," U.S. Nuclear Regulatory Commission, May 1980, (Rev. 1) August 1980.

[31] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.

[32] NUREG/CR-2800, "Guidelines for Nuclear Power Plant Safety Issue Prioritization Information Development," U.S. Nuclear Regulatory Commission, February 1983, (Supplement 1) May 1983, (Supplement 2) December 1983, (Supplement 3) September 1985, (Supplement 4) July 1986, (Supplement 5) July 1996.

[33] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.

CONCLUSION

The part of this issue that was clarified in Supplement 1 to NUREG-0737 (Generic Letter No. 82-33)[34] was resolved[35] with the publication of SRP[36] Section 13.5.2, Rev. 1, and Section 13.5.2, Appendix A, Rev. 0. With the exclusion of the EOPs (which were issued as requirements in NUREG-0737[37]), this issue was given a medium priority ranking (see Appendix C) and RESOLVED with no additional requirements.[38]

[34] Letter to All Licensees of Operating Reactors, Applicants for Operating Licenses, and Holders of Construction Permits from U.S. Nuclear Regulatory Commission, "Supplement 1 to NUREG-0737, Requirements for Emergency Response Capability (Generic Letter No. 82-33)," December 17, 1982. [ML031080548]

[35] Memorandum for T. Combs from H. Denton, "Revised SRP Section 13.5.2 and Appendix A to SRP Section 13.5.2 of NUREG-0800," July 17, 1985. [8508050283]

[36] NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, (1st Ed.) November 1975, (2nd Ed.) March 1980, (3rd Ed.) July 1981.

[37] NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980, (Supplement 1) January 1983.

[38] Memorandum for W. Dircks from H. Denton, "Close Out of Completed TMI Action Plan Item I.C.9, 'Long- Term Program Plan for Upgrading of Procedures,'" June 7, 1985. [8506200155]