Task IV.E: Safety Decision-Making (Rev. 3)

The objective of this task is to develop plans for an integrated program of safety decision-making. These plans include: (1) an expanded program of regulatory research covering methodologies for making safety decisions and safety-cost tradeoffs, with application both to decisions regarding the overall risk of nuclear power plants and the nuclear fuel cycle and to specific licensing and inspection decisions; (2) early resolution of safety issues after they are identified, including application of the decisions to operating reactors, reactors under construction, and standard designs; (3) elimination of repetitive consideration of identical issues at several stages of the licensing process; (4) expanded use of rulemaking to implement safety criteria developed as a result of the various Task Action Plans; and (5) improved and expanded systematic assessments of operating reactors.

ITEM IV.E.1: EXPAND RESEARCH ON QUANTIFICATION OF SAFETY DECISION-MAKING

DESCRIPTION

This issue is described in NUREG-0660[1] as follows:

"The purpose of this task is to proceed toward better quantification of safety objectives, including safety-cost tradeoffs. The concept will use ongoing research that one might quantify risk and possible application of formal decision-making techniques to the regulatory environment. Future programs will build on the risk assessment and systems reliability work currently underway and incorporate a better assessment of common-mode and human failures. Safety objectives will be developed for components and systems, and eventually these might be amalgamated into a more tightly bounded, quantitative safety standard, as opposed to a safety objective having fairly large inherent uncertainties."

The approach to the resolution of this item is also outlined in NUREG-0660[2] as follows:

(1)	RES will assemble a research task force from a wide variety of professional disciplines. The task force will formulate several possible sets of numerical criteria using different technical approaches. The formation of the research task force and the conduct of its meetings are being coordinated through IEEE with cooperation from other professional societies
(2)	BNL has been contracted to independently formulate criteria to investigate the implications of safety criteria and to determine the impact of attempting to satisfy such criteria.
(3)	Decision theory and survey methods for obtaining criteria are being investigated as extensions of previous projects on risk analysis. These methods can provide a separate approach to obtain acceptable risk criteria.
(4)	Negotiations are underway with various governmental and private agencies for information on proposed criteria. In addition, letters have been sent to several hundred individuals announcing the project and requesting their contributions.
(5)	To assure that the criteria receive rigorous peer review, negotiations are underway with the National Science Foundation, the National Academy of Sciences, and the American Statistical

[1] 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.
[2] 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.

	Association.

The current accomplishments include completion of NUREG/CR-1614,[3] NUREG/CR-1539,[4] NUREG/ CR-1930,[5] NUREG/CR-1916,[6] and NUREG/CR-2040.[7] The current status is such that PNL, ORNL, BNL, ANL, IEEE, NRC (Office of Policy Evaluation), and the ACRS are completing various elements of the overall program. These activities will develop and exhibit approaches with which to better factor risk evaluation into NRC decision-making regarding reactor plant safety. This issue does not appear to have a direct effect on public risk reduction or to have any industry cost directly associated with its resolution. Therefore, it is a licensing issue.

CONCLUSION

A value/impact handbook (NUREG/CR-3568)[8] was developed by the staff to support specific cost/benefit analyses of proposed rules. In November 1986, RES determined that all other staff work required by this issue was being pursued in the ongoing work related to the Commission's Safety Goal.[9] Thus, this Licensing Issue has been resolved.

ITEM IV.E.2: PLAN FOR EARLY RESOLUTION OF SAFETY ISSUES

DESCRIPTION

This TMI Action Plan[10] item required NRR, in consultation with other appropriate offices, to develop a plan for the early identification, assessment, and resolution of safety issues. This item is related to the establishment and implementation of an NRC program to identify and resolve safety issues and, therefore, is considered a licensing issue.

CONCLUSION

The plan was presented in SECY-81-513[11] on August 25, 1981 and is currently being implemented by SPEB. Thus, this Licensing Issue has been resolved.

ITEM IV.E.3: PLAN FOR RESOLVING ISSUES AT THE CP STAGE

DESCRIPTION

According to NUREG-0660,[12] NRR and ELD transmitted a consent calendar item to the Commission on February 14, 1980, entitled "Response to Staff Requirements Memorandum (Affirmation Session 79-40) With Respect to Post-CP Design and Other Changes," SECY-80-90. This paper discussed five options regarding the establishment of construction requirements. The recommendation of this consent paper is to

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[3] NUREG/CR-1614, "Approaches to Acceptable Risk: A Critical Guide," U.S. Nuclear Regulatory Commission, September 1980.
[4] NUREG/CR-1539, "A Methodology and a Preliminary Data Base for Examining the Health Risks of Electricity Generation from Uranium and Coal Fuels," U.S. Nuclear Regulatory Commission, August 1980.
[5] NUREG/CR-1930, "Index of Risk Exposure and Risk Acceptance Criteria," U.S. Nuclear Regulatory Commission, February 1981.
[6] NUREG/CR-1916, "A Risk Comparison," U.S. Nuclear Regulatory Commission, February 1981.
[7] NUREG/CR-2040, "A Study of the Implications of Applying Quantitative Risk Criteria in the Licensing of Nuclear Power Plants in the U.S.," U.S. Nuclear Regulatory Commission, March 1981.
[8] NUREG/CR-3568, "A Handbook for Value-Impact Assessment," U.S. Nuclear Regulatory Commission, December 1983.
[9] Memorandum for V. Stello from E. Beckjord, "Closeout of TMI Action Plan Items," November 13, 1986.
[10] 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.
[11] SECY-81-513, "Plan for Early Resolution of Safety Issues," U.S. Nuclear Regulatory Commission, August 25, 1981. [8109140067]
[12] 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.

publish an advance notice of public rulemaking to obtain comments on these options. After receipt of public comment on the above, the staff will prepare a plan to implement methods to resolve as many issues as possible at the construction permit stage before major financial commitments in construction occur.

An advanced notice of rulemaking was published in the Federal Register in December 1980 with a public comment period ending on February 9, 1981. On August 18, 1981, the Director of the Division of Risk Analysis sent a memo to distribution proposing an approach to the Rule and requested examples of the types of characteristic alterations representing post-CP changes. The draft of the Rule is currently being reviewed.

In view of the intent of this item, it is concluded that its resolution does not have a direct effect on public risk reduction and is, therefore, considered to be a licensing issue.

CONCLUSION

Staff stated in the Supplement to this report published in 1986 that the resolution of this Licensing Issue was available. As a part of the improvements to NUREG-0933, the NRC staff clarified in SECY-11-0101, "Summary of Activities Related to Generic Issues Program," dated July 26, 2011,[13] that the Generic Issues Program will not pursue any further actions toward resolution of licensing and regulatory impact issues. Because licensing and regulatory impact issues are not safety issues by the classification guidance in the legacy Generic Issues Program, these issues do not meet at least one of the Generic Issues Program screening criteria and do not warrant further processing in accordance with Management Directive 6.4, "Generic Issues Program," dated November 17, 2009.[14] Therefore, this issue will not be pursued any further in the Generic Issues Program.

ITEM IV.E.4: RESOLVE GENERIC ISSUES BY RULEMAKING

DESCRIPTION

This TMI Action Plan[15] item states that the NRC will undertake the additional task of developing a program for reviewing new criteria before their promulgation to determine whether rulemaking would be the desirable means of implementation. The intent will be to implement new NRC criteria by rule, wherever feasible and timely, instead of by license changes, orders, or changes in regulatory guides.

This item does not have a direct effect on public risk reduction nor is there any industry cost associated with the completion or implementation of the issue resolution. Thus, it is considered a licensing issue.

CONCLUSION

In November 1986, RES concluded that ongoing NRC activities such as the Safety Goal Program, RES independent review of rulemaking, and the Commission policy on backfitting had effectively addressed the concerns of this issue.[16] Thus, this Licensing Issue has been resolved.

ITEM IV.E.5: ASSESS CURRENTLY OPERATING REACTORS

DESCRIPTION

Historical Background

As part of developing plans for an integrated program of safety decision making, NRR, in consultation with other appropriate offices, will develop a plan for approval by the Commission for the systematic

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[13] SECY-11-0101, "Summary of Activities Related to Generic Issues Program," July 26, 2011. [ML111590814]
[14] Management Directive 6.4, "Generic Issues Program," U.S. Nuclear Regulatory Commission, November 17, 2009.
[15] 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.
[16] Memorandum for V. Stello from E. Beckjord, "Closeout of TMI Action Plan Items," November 13, 1986.

assessment of the safety of all operating reactors. Development of such a plan will take into account the SEP, the ACRS comments on the program, the IREP plan, and ongoing TMI lessons-learned activities. This value/impact assessment of Item IV.E.5 deals with the work under the SEP. Value/impact assessments of IREP and NREP are presented in Items II.C.1 and II.C.2, respectively.

SEP is now reviewing the 10 oldest plants against current licensing review safety criteria, including the SRP, to provide the basis for integrated and balanced backfit decisions. This review is nearly complete and, therefore, is not part of this assessment. The next SEP phase involves evaluation of 11 additional plants. In this next phase, PRA evaluations will be coordinated with the deterministic review method (review against current licensing safety criteria). The PRA will be done as part of NREP (TMI Action Plan Item II.C.2).

Possible Solutions

As safety-related problems are identified for each plant, resolutions are developed using procedural and administrative changes, possible credit for non-safety systems where justified, and hardware backfits as necessary to reduce risk levels. The process used to decide appropriate corrective actions employs the judgment of a team of NRC staff familiar with each plant.

PRIORITY DETERMINATION

This priority determination uses potential risk reduction analyses and cost estimate information provided by PNL.[17]

Frequency/Consequence Estimate

This public risk reduction analysis for SEP considers only the 11 additional plants currently proposed to be reviewed in the first group of Phase III plants, since much of the review of the first 10 plants in Phase II has been performed. The 11 plants consist of 7 PWRs and 4 BWRs with estimated average remaining lives of 24 and 22 years, respectively. In Item II.C.2 (NREP), it is estimated that an overall core-melt frequency reduction of 2×10^{-4}/RY could be achieved for one-third of the plants to be reviewed under NREP. Although the NREP evaluation of these plants will identify some areas of potentially high risk, the NREP methods do not address areas such as external events and structural design which are included in the SEP deterministic review. For this issue, it is assumed that the risk reduction estimated for NREP could be achieved by the SEP considering only the benefit resulting from using the deterministic review method for external events and other issues outside the scope of PRAs (e.g., adequacy of design, structural issues, and design errors).

Using the base case core-melt frequency and the base case public risk for each type plant, and assuming a population of 340 persons per square mile over an area having a 50 mile radius, the average risk per core-melt is 2.5×10^6 man-rem for PWRs and 6.8×10^6 man-rem for BWRs.

Using the average risk value and the assumption stated above that the deterministic review method can achieve the core-melt frequency reduction estimated for NREP for one-third of the plants reviewed, we can estimate the potential reduction for the SEP Phase III as follows:

1. PWRs:

   Risk Reduction = $(2.5 \times 10^6$ man-rem/core-melt$)(2 \times 10^{-4}$ core-melt/RY$) = 500$ man-rem/RY

2. BWRs:

   Risk Reduction = $(6.8 \times 10^6$ man-rem/core-melt$)(2 \times 10^{-4}$ core-melt/RY$) = 1{,}360$ man-rem/RY

   Summed over the average remaining plant life for the 11 plants proposed, the total public risk reduction is calculated to be approximately 80,000 man-rem.

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[17] 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.

Cost Estimate

1. Industry Cost:

   Based on SEP studies completed to date, the following costs per plant are estimated: up to $2M for engineering studies to identify areas of plant modification and $2M to $20M to design and install modifications.

   For purposes of this analysis, assume a conservative implementation cost per plant of $2M for engineering studies at each of the 11 plants plus $10M average design and installation (including capital equipment cost) at one-third of the plants. For 11 plants, the total industry cost is $[(11)(2) + (1/3)(11)(10)]M or $55M.

2. NRC Cost:

   Based on past studies, NRC staff effort has totaled 10 man-yr/plant plus $700,000 contract technical support per plant. Thus, total development and implementation cost, at $100,000/man-year, is:

   (10 man-years/plant)($100,000/man-yr) + ($700,000/plant)(11 plants) = $19M.

   Assuming NRC staff effort for review and inspection of plant modifications at one-third of the plants is 0.5 man- wk/RY and the average remaining life of these plants is 23 years, then the total plant review cost is:

   (0.5 man-wk/RY)($2,000/man-wk)[(1/3)(11)(23)RY] = $0.1M.

Value/Impact Assessment

Based on a public risk reduction of 80,000 man-rem, the value/impact score is given by:

$$S = \frac{80{,}000 \text{ man-rem}}{\$(55 + 19)\text{M}}$$

$$= 1{,}000 \frac{\text{man-rem}}{\$\text{M}}$$

$$S = \frac{80{,}000\text{man} - \text{rem}}{\$(55+19)\text{M}}$$

$$= 1{,}000\text{man} - \text{rem} / \$\text{M}$$

Other Considerations

If the cleanup of an accident is assumed to require 19,900 man-rem and the same assumption on accident frequency reduction is retained, the total reduction in occupational exposure would be 170 man-rem. An estimate of the occupational exposure to implement any changes cannot be made without identifying the specific changes. However, there would likely be some increase in occupational exposure, but it would be small compared to the public risk reduction.

An additional consideration is that plant damage is estimated to be $1,650M per plant for core-melt. Thus, total averted plant damage for one-third of the plants with a reduced core-melt frequency could be ($1,650M)(2 x 10^{-4}/RY)[(1/3)(11)(23)RY] = $28.9M

Uncertainties

Since the 11 plants considered are older plants, it is possible that the assumed 10^{-4}/RY risk reduction may be achieved for more than one-third of the 11 plants as assumed, thus resulting in greater risk reduction with an associated increase in implementation cost. However, the value/impact score would not change appreciably.

CONCLUSION

The value/impact score indicates a medium priority. However, the potentially large, though uncertain, risk reduction of nearly 80,000 man-rem justified a high priority ranking.

Work completed by the staff on this item was closely related to the accomplishments under Item II.C.2. Whereas Item II.C.2 called for the initiation of IREP studies (i.e. plant-specific PRAs) on all remaining operating reactors, Item IV.E.5 called for the development of a plan for the systematic assessment of the safety of all operating reactors. The Integrated Safety Assessment Program (ISAP), presented in SECY-84-133[18] and SECY-85-160,[19] provided for a comprehensive review of selected operating reactors to address all pertinent safety issues and to provide an integrated cost-effective implementation plan for making needed changes. Under ISAP, each plant would be subject to an integrated assessment of safety topics, a probabilistic safety assessment, and an evaluation of operating experience.

NRC guidance, as described in the Severe Accident Policy Statement (see Item II.B.8), states that OLs will be expected to perform plant-specific PRAs in order to discover instances of particular vulnerability to a core-melt or poor containment performance, given a core-melt. Thus, this item was RESOLVED and no new requirements were established.[20]

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[18] SECY-84-133, "Integrated Safety Assessment Program (ISAP)," U.S. Nuclear Regulatory Commission, March 23, 1984. [8404100072]

[19] SECY-85-160, "Integrated Safety Assessment Program—Implementation Plan," U.S. Nuclear Regulatory Commission, May 6, 1985. [8505230571]

[20] Memorandum for W. Dircks from H. Denton, "Close- out of Generic Issues II.C.2, 'Continuation of IREP' and IV.E.5, 'Assess Currently Operating Reactors,'" September 25, 1985. [9909290069]