POLICY ISSUE
NOTATION VOTE

September 14, 2000 SECY-00-0198

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: STATUS REPORT ON STUDY OF RISK-INFORMED CHANGES TO THE TECHNICAL REQUIREMENTS OF 10 CFR PART 50 (OPTION 3) AND RECOMMENDATIONS ON RISK-INFORMED CHANGES TO 10 CFR 50.44 (COMBUSTIBLE GAS CONTROL)

PURPOSE:

To provide the second status report on the staff's study of possible risk-informed changes to the technical requirements of 10 CFR Part 50, to provide the staff's recommendations for risk-informed changes to 10 CFR 50.44 ("Standards for Combustible Gas Control System in Light-Water-Cooled Power Reactors") that will both enhance safety and reduce unnecessary burden, and to provide policy issues for Commission decision.

BACKGROUND:

In a June 8, 1999, staff requirements memorandum (SRM) on SECY-98-300, the Commission approved proceeding with a study of risk-informing the technical requirements of 10 CFR Part 50. The Commission specifically directed the staff to pursue the *"study on an aggressive timetable and provide, for Commission approval, a schedule for this activity. The staff should periodically inform the Commission on progress made in the study....if the staff identifies a regulatory requirement which warrants prompt revision..., the Commission should be...provided with a recommended course of action."*

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The staff provided its plan and schedule for the study phase of its work to risk-inform the technical requirements of 10 CFR Part 50 in SECY-99-264, "Proposed Staff Plan for Risk-Informing Technical Requirements in 10 CFR Part 50," dated November 8, 1999. The plan consists of two phases: an initial study phase (Phase 1), in which an evaluation of the feasibility of risk-informed changes along with recommendations to the Commission on proposed changes will be made; and an implementation phase (Phase 2), in which recommended changes resulting from Phase 1, and approved by the Commission, will be made. SECY-99-264 discussed Phase 1 of the plan. In Phase 1, the staff is studying the ensemble of technical requirements contained in 10 CFR Part 50 to (1) identify candidate changes to requirements and design basis accidents (DBAs), (2) prioritize candidate changes to requirements and DBAs, and (3) establish the feasibility of and identify recommended changes to requirements.

The Commission approved proceeding with the plan in a February 3, 2000, SRM. In addition, the Commission directed the staff to highlight any policy issues for Commission resolution as early as possible during the process, particularly those related to the concept of defense-in-depth, and to develop a communication plan that facilitates greater stakeholder involvement and actively seeks stakeholder participation.

On April 12, 2000, the staff provided its first status report on Phase 1 of this work in SECY-00-0086 ("Status Report on Risk-Informing the Technical Requirements of 10 CFR Part 50 (Option 3)") and also indicated its intention to expedite recommendations for risk-informed changes to 10 CFR 50.44 ("Standards for Combustible Gas Control System in Light-Water-Cooled Power Reactors"). This paper provides the staff's second periodic status report on Phase 1, its recommendations on 10 CFR 50.44, and related policy issues for Commission consideration.

DISCUSSION:

Since the first status report in April 2000, the staff has accomplished a number of activities; it-

- used and revised the framework for studying 10 CFR Part 50.
- identified policy issues for Commission consideration.
- developed recommendations for risk-informed changes to 10 CFR 50.44.
- met with stakeholders (both external and internal) to obtain their input on these activities.
- initiated work to develop risk-informed alternatives to 10 CFR 50.46 ("Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors") and special treatment requirements.

A summary of each of these activities follows.

Risk-Informed Framework:

The staff has developed a framework that describes the approach, process and guidelines the staff will apply in reviewing, formulating, and recommending risk-informed alternatives to 10 CFR Part 50 technical requirements. An initial version of this framework was attached to SECY-00-0086. The staff is using this framework to develop recommendations for generic changes to the technical requirements and is not applying it on a plant-specific basis. The framework has been tested in risk-informing 10 CFR 50.44 and has also been the subject of comments by stakeholders. It has been updated since the initial version provided in SECY-00-0086 to reflect experience from its use and the comments received; however, it may undergo additional refinement as it is tested against more challenging rules such as 10 CFR 50.46.

The updated framework is provided as Attachment 1 and five of its key features are as follows:

1. The framework utilizes a risk-informed defense-in-depth approach to accomplish the goal of protecting public health and safety. This defense-in-depth approach builds on: (a) the principles in Regulatory Guide 1.174, (b) the Commission's White Paper on risk-informed and performance-based regulation, dated March 11, 1999, (c) the reactor oversight cornerstones, and (d) the Advisory Committee on Reactor Safeguards (ACRS) recommendations on defense-in-depth, as discussed in the ACRS letter to former Chairman Jackson, dated May 19, 1999.

2. The defense-in-depth approach includes elements that are dependent upon risk insights and elements that are employed independent of risk insights. Risk insights are used to set guidelines that-
   - limit the frequency of accident initiating events
   - limit the probability of core damage, given accident initiation
   - limit radionuclide releases during core damage accidents
   - limit public health effects caused by core damage accidents

   Safety function success probabilities (commensurate with accident frequencies, consequences, and uncertainties) are achieved via appropriate
   - redundancy, independence, and diversity,
   - defenses against common-cause failure mechanisms,
   - defenses against human errors, and
   - safety margins.

   The following defense-in-depth elements are employed independent of risk insights:
   - prevention and mitigation are maintained
   - reasonable balance is provided among prevention, containment and consequence mitigation
   - over-reliance is avoided on programmatic activities to compensate for weaknesses in plant design
   - independence of barriers is not degraded
   - the defense-in-depth objectives of the current General Design Criteria (GDC) in Appendix A to 10 CFR Part 50 are maintained

3. The framework considers both design-basis as well as core-melt accidents.

4. The framework considers uncertainties.

5. Consistent with Commission direction in its June 19, 1990, SRM, the staff is using the Safety Goals to define how safe is safe enough. That is, the framework is constructed in such a way that risk-informed alternatives to 10 CFR Part 50 will be developed consistent with this direction (using the subsidiary objectives of the Safety Goals as guidelines). The framework uses quantitative guidelines, based on the Safety Goals and its subsidiary objectives of 10^{-4} per reactor year (ry) for core damage frequency (CDF) and 10^{-5}/ry for large early release frequency (LERF), to assist the staff in determining the appropriate balance between prevention and mitigation and whether or not to recommend a risk-informed alternative to the current requirements.

Policy Issues:

The staff has identified two policy issues for Commission consideration, which are discussed in this section along with a recommended position:

- Selective implementation
- Backfit considerations

Selective Implementation

In SECY-98-300, the staff recommended that implementation of a risk-informed modification be voluntary, but that a licensee should not be allowed to choose which elements of the revised Part 50 to follow. In its response to the staff, the Commission stated that *"risk-informed implementation of Part 50 should be voluntary for licensees. ..... The Commission has disapproved the staff's recommendation that selective implementation not be allowed. This issue is prematurely before the Commission. A future Commission will be better able to judge the issue of selective implementation after the rules are drafted and rulemakings provide comment on this issue as it affects that rule...."*

The staff recognizes that licensees may voluntarily implement a specific risk-informed rule (e.g., 10 CFR 50.44). However, the staff recommends that a licensee not be allowed to select which specific requirements within a risk-informed rule to follow. The risk-informed alternative rules are being developed in an integral fashion and, therefore, represent a balance between reducing unnecessary burden and employing safety enhancements that address risk-significant concerns. Selective implementation of specific requirements within a rule could allow licensees to preferentially reduce burden without also implementing the risk-informed changes that address risk-significant concerns not currently addressed. Such selective implementation is not compatible with the intent of risk-informed regulation, which includes safety improvements justified by risk considerations.

As discussed below, the staff has developed a set of characteristics for a risk-informed version of 10 CFR 50.44. These characteristics reflect an approach of not permitting selective implementation within 10 CFR 50.44. If approved by the Commission, the staff would proceed to use these characteristics to develop a proposed rule and solicit public comment on that rule. As part of this rulemaking, the staff would explicitly request comment on selective implementation. Accordingly, the staff recommends that within the context of development of a risk-informed alternative to 10 CFR 50.44, no selective implementation be allowed.

Backfit Considerations

Risk-informed alternative rules may include a combination of elimination, modification, and addition of requirements. Therefore, the staff does believe that backfit considerations should not be totally ignored since some of the recommended safety enhancements may be sufficiently important to be considered as mandatory changes for all plants. For those risk-informed changes that appear to substantially enhance safety and that have the potential to be cost beneficial, the staff therefore recommends that these changes (i.e., proposed requirements) be sent to the generic issue program for prioritization and consideration as a mandatory change to existing requirements (using provisions of 10 CFR 50.109, "Backfitting"). This will require consideration of alternative means of implementing those changes that enhance safety and conducting detailed cost-benefit analysis.

However, since the licensee may voluntarily implement a risk-informed alternative to a given rule, the staff recommends that a backfit analysis of the risk-informed alternative not be required.

Risk-Informed 50.44:

As discussed in SECY-00-0086, the staff had identified 10 CFR 50.44 as a regulation that "warrants prompt revision" and has developed recommendations for a risk-informed alternative. The current rule was implemented to control combustible gases, such as hydrogen, that could burn or detonate and thereby challenge the integrity of the containment. Consequently, based on knowledge at the time, the following technical requirements were formulated and are contained in 10 CFR 50.44:

- Analytical requirements to address the conditions, source and amount of hydrogen
  1. The type of accident considered, viz. postulated loss-of-coolant accident (LOCA)
  2. The sources of hydrogen (fuel-cladding oxidation, radiolysis, and corrosion)
  3. The hydrogen source term: 5% clad oxidation reaction over a 2-minute period and 75% metal-water reaction of the active clad for Mark III and ice condenser containments[1].

- Physical requirements to mitigate these analytical requirements (first bullet)
  1. Measure hydrogen concentration
  2. Insure a mixed containment atmosphere
  3. Control combustible gas concentration resulting from a postulated LOCA
  4. Inert Mark I and II containments
  5. Install high point vents on the reactor coolant system
  6. Provide a hydrogen control system (i.e., igniters) for Mark III and ice condenser containments

Other requirements in 10 CFR Part 50 and implementing documents (e.g., regulatory guides) are associated with 10 CFR 50.44. These related requirements and documents have imposed

[1]10 CFR 50.44 does not impose the 75% metal-water reaction on large dry and subatmospheric containments. However, Generic Safety Issue 121 did address this source term for these containments and found it not to be a challenge.

additional "requirements" beyond those stated in 10 CFR 50.44 (e.g., safety-grade continuous monitors for measuring the hydrogen concentration). Therefore, in its evaluation of 10 CFR 50.44, the staff also examined the related regulations and implementing documents.

Based upon current risk information and research results, the staff believes that little to no risk significance or benefit is associated with some of the combustible gas control requirements of this regulation, potentially resulting in unnecessary burden. In addition, the staff also believes that the current requirements do not address some risk-significant concerns from accident scenarios. Therefore, the staff recommends changes to the requirements that represent both a safety enhancement (some of which may have an associated additional burden) and a reduction in unnecessary burden.

Core damage/melt accidents can potentially produce combustible gases (both hydrogen and carbon monoxide) from both fuel-cladding oxidation and core-concrete interaction. Risk insights associated with combustible gas generation and combustion have led to the following conclusions:

- Combustible gases are not a significant challenge to containment integrity for approximately 24 hours after the onset of core damage for:
  - large dry and subatmospheric containments due to large volume
  - Mark I and II containments due to inert atmosphere
  - Mark III and ice condenser containments due to igniters (except for station blackout)

- For station blackout for Mark III and ice condenser containments defense-in-depth is a concern since conditional large early release probabilities from combustible gases can exceed the guideline (0.1) contained in the attached framework document and range from 0.1 to 1.0

- Internal fire and seismic core damage sequences can have the characteristics of station blackout

- Combustible gas concentrations may be a challenge to containment integrity after 24 hours because of:
  - Core-concrete interactions in large dry, subatmospheric, ice condenser and Mark III containments
  - Oxygen generation from radiolysis leading to a de-inerted atmosphere in Mark I and II containments

A detailed discussion of the staff's feasibility study and recommendations is provided in Attachment 2. In summary, the staff considers the work described in Attachment 2 sufficient to establish the feasibility for risk-informed changes to the technical requirements of 10 CFR 50.44 and recommends the following characteristics for a risk-informed alternative to 10 CFR 50.44[2]:

1. Specify in the regulation a specific combustible gas source term using best available calculational methods for a severe accident that includes in-vessel (and ex-vessel)

[2]Implementation of this risk-informed alternative would also require changes to other associated regulations and implementing documents.

hydrogen and carbon monoxide generation in such a way that the alternative regulation addresses the likely sources of combustible gases. These sources would only address challenges to the containment that could potentially result in a large radionuclide release within 24 hours after the onset of core damage. This is consistent with the approach taken in the staff's review of the Advanced Light Water Reactors (ABWR, System 80+ and AP-600). This recommendation would involve a short-term (~3 months) effort by the staff to perform the calculations and to specify the source term in the regulation that is based on these calculations.

2. Eliminate the requirement to measure hydrogen concentration in containment. Hydrogen monitoring is not needed to initiate or activate the combustible gas control systems for each type of containment, hence hydrogen monitors have a limited significance in mitigating the threat to containment in the early stages of a core-melt accident. Hydrogen monitoring for emergency response purposes is addressed separately from 10 CFR 50.44.

3. Retain the requirement to insure a mixed atmosphere. The intent of this requirement is to maintain those plant design features (e.g., open compartments) that promote atmospheric mixing and is considered an important defense-in-depth element (i.e., meeting the intent of GDC 50).

4. Eliminate the requirement to control combustible gas concentration resulting from a postulated LOCA. This type of accident is not risk significant and the means to control combustible gas concentration (e.g., recombiners) does not provide any benefit for the risk-significant accidents or, if a vent-purge method is used, can result in unnecessary releases of radioactive material to the atmosphere. Long-term combustible gas control is addressed in Item 9 below.

5. Retain the requirement to inert Mark I and Mark II containments. Removal of this requirement would result in the integrity of these containments being highly vulnerable to gas combustion.

6. Retain the requirement for high point vents in the reactor coolant system (RCS). Combustible gases in the RCS can inhibit flow of coolant to the core, therefore, the capability to vent the RCS provides a safety benefit in its ability to terminate core damage.

7. Modify the requirement for the hydrogen control system for Mark III and ice condenser containments to control combustible gas during risk-significant core-melt accidents (e.g., station blackout). Since the control system uses igniters that are alternating current (ac) dependent, under station blackout conditions, these containments may remain vulnerable to gas combustion. Alternately, if station blackout could be shown by the licensee to be of low enough frequency, with due consideration of uncertainties and defense-in-depth, then the sequence would not be risk significant and the licensee would have complied with the requirement via the current igniter system. Such an approach represents a performance-based aspect of this recommendation.

8. Include a performance-based second alternative within this regulation that would allow a licensee to use risk information and plant-specific analysis on the generation and control of combustible gases to demonstrate that the plant would meet specified performance

criteria (e.g., maintain containment integrity for at least 24 hours for all risk-significant events). This may be especially attractive to future plants.

9. Recommend that long-term (more than 24 hours) control of combustible gas be included as part of the licensee's Severe Accident Management Guidelines (SAMG) since combustible gases still pose a challenge to containment integrity in the long term with the possibility of a large, late radionuclide release.

Accordingly, the staff recommends development of a proposed risk-informed alternative to 10 CFR 50.44 consistent with the recommendations in this paper. It is recognized that, since this recommendation is based upon a feasibility study, additional work is required to support the actual rule change. In addition to the calculation of the combustible gas source term discussed earlier, such work would include:

- detailed regulatory analysis on safety enhancements that have the potential to pass the backfit test

- assessing the relation to and need for conforming changes in emergency operating procedures and SAMGs

- assessing the implications of fire and seismic events on the combustible gas control system requirements in Mark III and ice condenser plants

- developing regulatory guides to implement the performance-based aspects of the recommended risk-informed alternative rule.

Also, the rulemaking process will provide opportunities for additional stakeholder feedback on the risk-informed alternative, its technical basis and the additional work needed to support rulemaking. The staff will provide a schedule for this rulemaking 3 months after receiving the SRM on this paper.

These recommendations represent a voluntary risk-informed alternative to the current 10 CFR 50.44, including a performance-based option. In selecting the risk-informed alternative to 10 CFR 50.44, licensees (1) would improve safety by better focusing on the risk-significant challenges from combustible gases, (2) would ensure control of combustible gases during all risk-significant events, and (3) would also eliminate those aspects of the current requirements that provide no safety benefit (e.g., recombiners). As discussed previously, the staff recommends that safety enhancements that have the potential to pass the backfit test be assessed for mandatory application through the generic issue program. The staff estimates that unnecessary burden reduction associated with this alternative is approximately $200K per unit per year (Ref. 2) and that the safety improvement will remove a significant vulnerability (~0.9 conditional containment failure probability) of containment failure during station blackout for Mark III and ice condenser containments. It is recognized that there would be costs associated with the safety improvement; however, the magnitude of these costs is dependent on the means selected by the licensee for implementation. Consistent with the recommendation above on selective implementation, the staff recommends that licensees not be allowed to select individual requirements within the alternative rulemaking (e.g., choose only to eliminate the requirement for measuring hydrogen concentration).

Also, consistent with the policy discussion on backfit considerations in this paper, the staff intends to evaluate the safety issue associated with the Mark III and ice condenser containment igniter power supply as potential backfits through the generic safety issue program.

On November 9, 1999, Mr. Robert Christie of Performance Technology submitted a "request for proposed rulemaking" to the staff on 10 CFR 50.44. As discussed in a January 4, 2000, letter from S. Collins to Mr. Christie, his request has been considered as part of the staff's study of possible risk-informed changes to 10 CFR 50.44. The recommended risk-informed alternative in this paper addresses Mr. Christie's request. A comparison of Mr. Christie's request with the staff's recommendation is contained in Attachment 3.

Stakeholder Communication:

The staff has held several meetings with stakeholders. These meetings have focused primarily on the framework, and changes to 10 CFR 50.44 and 10 CFR 50.46. The staff also attended an industry workshop on NRC risk-informed activities (in which one session addressed changes to technical requirements in 10 CFR Part 50). In addition, the staff has had several discussions with the ACRS (both the sub- and the full committee) and plans to continue to meet with them on a regular basis. The staff has continued to maintain the interactive Web site[3]. As information is ready for stakeholder review, it is posted to this Web page (and placed in the public document room for those who do not have internet access). Also, stakeholders can provide comments directly to the staff in this Web page; however, as of this date, stakeholders have not exercised this option.

Stakeholder feedback has included:

- Various comments on the framework that questioned whether-
  - the quantitative guidelines are to appear in a regulation.
  - the guidelines are being applied on a generic or plant-specific basis.
  - the Safety Goals are an appropriate measure for the quantitative guidelines.

- General agreement that selective implementation of requirements within a regulation should not be allowed.

- Agreement with the staff that the rulemaking on 10 CFR 50.44 needs to be expedited.

- Continue to work closely with the various owner's groups on 10 CFR 50.46.

Future Activities:

The staff has begun work to develop risk-informed alternatives to the current 10 CFR 50.46 and special treatment requirements. The work on 10 CFR 50.46 has involved several public meetings with the Westinghouse Owners Group, which is sponsoring work related to redefining the large break LOCA. RES is planning a public workshop on October 2, 2000, to discuss the

[3]The Web site is accessed via the NRC Web site under the Nuclear Reactors icon, and then selecting the "Risk-Informed Part 50 Initiatives" line item, followed by the "Risk-Informed Part 50, Changes to Technical Requirements (Option 3)" line item.

latest version of the framework (Attachment 1) and the status and issues associated with risk-informed changes to the technical requirements of 10 CFR 50.46. Making risk-informed changes to the technical requirements of 10 CFR 50.46 has the potential to affect many aspects of plant design and operation. Because of the extent of the potential impacts, we are approaching our study in stages, starting with assessing the possible risk-informed alternatives to the large break LOCA and their implications for requirements related to ECCS performance. Subsequent stages would look at implications for other plant design and performance requirements (e.g., containment) and ECCS acceptance criteria. We expect in December 2000, to be able to report on the first stage and on plans and schedule for the remaining stages. Also, in December 2000, we will report on plans for any other future work, including risk-informed alternatives to the special treatment requirements. This work on risk-informed alternatives to existing special treatment requirements will be coordinated with the ongoing effort on the scope of structures, systems and components subject to these requirements (referred to as Option 2).

RESOURCES:

RES and NRR resources for moving forward, upon Commission approval, with Phase 2 for risk-informing 10 CFR 50.44 are included in the current RES and NRR budgets for FY2001 and FY2002.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objections. The Office of the Chief Financial Officer has reviewed this paper for resource implications and has no objections.

RECOMMENDATION:

The staff recommends that the Commission approve for this paper-

- the proposed staff positions on the two policy issues and

- proceeding with rulemaking (and regulatory analysis) on the risk-informed alternative to 10 CFR 50.44 recommended.

In the interim, the staff will proceed with application of the Option 3 framework in the technical study of additional requirements consistent with its recommendations, unless otherwise directed.

/RA by Frank J. Miraglia Acting For/

William D. Travers
Executive Director
for Operations

Attachments:

1. "Framework for Risk-Informed Changes to the Technical Requirements of 10 CFR 50"
2. "Feasibility Study for a Risk-Informed Alternative to 10 CFR 50.44, 'Standards for Combustible Gas Control System in Light-water-cooled Power Reactors'"

3. Comparison to R. Christie's Petition for Rulemaking

References:

1. USNRC, "Safety Goals for the Operation of Nuclear Power Plants; Policy Statement," *Federal Register,* Vol. 51, p. 30028, August 21, 1986.
2. Letter from J.F. Colvin of Nuclear Energy Institute to Chairman Meserve of the NRC, 1-19-00

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PARALLEL CONCURRENCE

ROUTING AND TRANSMITTAL SLIP

DATE: 08/31/00

MEMORANDUM TO: The Commission

FROM: W. Travers

SUBJECT: STATUS REPORT ON STUDY OF RISK-INFORMED CHANGES TO THE TECHNICAL REQUIREMENTS OF 10 CFR PART 50 (OPTION 3) AND RECOMMENDATIONS ON RISK-INFORMED CHANGES TO 10 CFR 50.44 (COMBUSTIBLE GAS CONTROL)

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SIGN AND/OR	CONCUR	DATE
1. MDrouin	_____	/ /
2. MCunningham	_____	/ /
3. TKing	_____	/ /
4. FEltawila	_____	/ /
5. OGC	_____	/ /
6. CFO	_____	/ /
7. SCollins	_____	/ /
8. AThadani	_____	/ /
9. CPaperiello	_____	/ /
10. WTravers	_____	/ /

DUE TO EDO _____

ACTION: CIRCULATED: FOR YOUR INFO:
APPROVAL: COMMENT: SEE ME:
AS REQUESTED: NOTE & RETURN: PREPARE REPLY:
COORDINATION: PER CONVERSATION: