RDB received 4/25/05

AREVA

2/1/05
70FR5228

April 22, 2005
NRC:05:030

(1)

Rules and Directive Branch
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, DC 20055-0001

**Comments on "Regulatory Structure for New Plant Licensing, Part 1: Technology - Neutral Framework," Draft NUREG-3-2005.**

Framatome ANP (FANP) reviewed draft NUREG-3-2005 and offers the attached responses to the NRC questions published in the Federal Register */Vol. 70, No. 20, pp. 5228-5232*. These responses represent FANP's view on the proposed regulatory structure for new plant licensing as delineated in the draft NUREG and discussed in the March 14-16, 2005 NRC-sponsored workshop on this subject.

Framatome ANP continues to support the efforts of the NRC to develop a risk-informed and technology-neutral framework for licensing new reactors and we look forward to future interactions on this subject.

Sincerely,

Jerald S. Holm

Jerald S. Holm, Director
Regulatory Affairs
Framatome ANP, Inc.

Enclosures

cc: Adrian Heymer (NEI)
J. F. Williams (NRC)

SISP Review Complete
ADAMS Template = ADM-013

E-RIDS = ADM-03
Add A. Singh (AXS3)

bcc: NRC:05:030
R. D. Affolter
A. B. Copsey
M. R. Cox
G. F. Elliott
R. W. Ganthner
J. S. Holm
N. E. Hottle
F. Shahrokhi
M. A. Schoppman
S. M. Sloan

## Attachment A

## QUESTIONS FOR CONSIDERATION AT THE MARCH 2005 NRC WORKSHOP

*(excerpted from Federal Register, Vol. 70, No. 20, pp. 5228-5232)*

---

### A. LEVEL OF SAFETY

**Question 1:**

*Is it appropriate to use the Commission's Safety Goal Policy Quantitative Health Objectives (QHO) as the level of safety the technology neutral regulations should be written to achieve? If not, what should be used?*

**Response 1:**

FANP agrees with the principle that advanced reactors should achieve a level of safety consistent with that of ALWRs.

For currently licensed reactors, the risks of relatively high frequency, low consequence events are managed within the design basis using a deterministic safety philosophy, while the QHOs have been used to formulate safety goal policy for beyond design basis events. FANP finds the approach of using the QHOs to formulate technology-neutral regulations for the safety of new reactors to be reasonable, but notes that these QHOs are not sufficient for establishing frequency-consequence criteria for frequent and rare events within the design basis. The QHOs are only effective in managing risks for events with the potential for producing early and latent cancer fatalities in the vicinity of the reactor sites. For events with lower consequences and higher frequencies, criteria for dose limits such as 10CFR50 Appendix I and the dose criteria for design basis accidents in 10 CFR 50.34(a) combined with suitable frequency criteria for these events should be used in conjuction with the QHOs to provide a set of frequency-dose criteria for the full spectrum of licensing basis events.

### B. PROTECTIVE STRATEGIES

**Question 2:**

*Is the process described for the development of a technology-neutral regulatory structure reasonable? Is it complete? Is the relationship between the different pieces of the framework understandable? If not, where is it not understandable?*

**Response 2:**

FANP finds the process to be reasonable. However, there is a tendency throughout the framework document to fall back on defense-in-depth (DiD) measures whenever the uncertainties appear untenable. This tendency for invoking defense-in-depth is neither predictable nor reproducible.

FANP agrees in general that there should be risk goals and performance requirements. However, hardware addition DiD is not the only means to address uncertainties. Further, it is not clear how the defense-in-depth argument will be involved to disagree with a given design or design feature. The examples presented by the NRC at the workshop of DiD to derive conclusions about containment performance criteria failed to show that DiD will be invoked in a reasonable manner.

**Question 3:**

*What is meant by each protective strategy? For example, for Barrier Integrity protective strategy, what constitutes or defines a barrier?*

**Response 3:**

FANP has the following comments on the protective strategies.

Physical Protection- As this strategy is not developed in the framework, it is unclear what it will entail.

Barrier Integrity – This is recognized as an important element of protective strategies, however the framework would be enhanced by further developing this strategy to focus first on the inherent properties of the fuel barrier and recognize that these inherent properties provide the foundation for the safety case.

Limit the Frequency of Initiating Events – This is an important element of protective strategies. The development of this strategy in the framework could be enhanced by noting the importance of simplicity and how the robustness of the barriers can support the elimination of some initiating events (for example, use of vessels rather than piping on the pressure boundary, size and complexity of the pressure boundary, etc.). Also, there is a need to discuss separately the initiating events that challenge the reactor externally and those that are failure modes of the reactor and its SSCs.

Protective Systems – The discussion of protective systems as described in the framework is too general and should be broken down to reveal different strategies to make the protective systems more effective and reliable. The labeling of these strategies as "protective systems" seems to convey an LWR mindset as most safety functions on LWRs are provided by active systems. More emphasis should be placed on inherent reactor features that enhance safety, specifications for each of the barriers (especially the fuel barrier), the definition of reactor-specific safety functions to support each barrier, active and passive SSCs that support each safety function, definition of safe stable end states, and the success criteria for each safety function. Besides the barriers, most of the safety design philosophy of a reactor is covered under this item so the term "protective systems" oversimplifies.

Accident Management – FANP agrees with this element of the protective strategies.

**Question 4:**

*Is the use of protective strategies a reasonable approach for defining high-level safety functions? If not, what other approach(es) should be considered?*

**Response 4:**

The protective strategies are defined a level too high to determine the appropriate safety functions for reactor design. The protective strategies need to be broken down into a delineation of the properties and capabilities of the barriers, especially the fuel barrier, the definition of the inherent reactor features, and safe stable states, to permit the definition of reactor specific safety functions for the protection of each barrier. This context is needed for the designer to determine specific functions for each passive and active SSC that is to be provided to support each function. In the absence of this context, the capability is limited to address SSC safety classification.

**Question 5:**

*Is the use of a deductive analysis of each protective strategy, to identify technology-neutral requirements and performance-based measures, a reasonable approach?*

**Response 5:**

Although deductive reasoning seems reasonable, it is not clear how technology-neutral requirements can be developed without attempting first to develop technology-specific requirements for one or more reactors that are much different than an LWR. Those examples in comparison with current LWR requirements would help to identify what is truly generic. The current regulatory requirements are so heavily oriented toward LWR characteristics that it is difficult to sort out those aspects that are truly generic.

**Question 6:**

*Are the protective strategies described in Chapter 3, "Safety Fundamentals: Protective Strategies" reasonable? Are they complete? If not, what strategies are missing or not reasonable?*

**Response 6:**

See response to (3) above

**Question 7:**

*Are the basic principles of a performance-based approach presented in Chapter 3 sufficiently clear and reasonable? If not, where are they not clear or not reasonable?*

**Response 7:**

The basic principles of a performance-based approach presented in Chapter 3 are sufficiently clear and reasonable.

## C. QUANTITATIVE RISK OBJECTIVES

**Question 8:**

*Is meeting a frequency consequence (F–C) curve an appropriate way to achieve enhanced safety for new reactors? If so, how should the F–C curve be interpreted? How could this interpretation be done on a practical basis? Should another approach be used? If so, what should it be?*

**Response 8:**

FANP believes the approach is reasonable.

FANP has the following comments with the frequency-consequence curve in the framework:

(a) It must be made clear that the frequency in the F-C curve is the frequency of the entire event scenario, not just the initiating event or Postulated Initiating Event.

(b) It must be made clear that the frequency in the F-C curve is the sum of the frequencies of all event sequences with the same initiating event and similar response of systems, structures, and components (SSCs).

(c) It must be made clear that the F-C curve is to be utilized with a full scope PRA: internal and external events at full power, shutdown, and other operating modes.

(d) It must be clear that the F-C curve is to be utilized with the entire plant responding as in a PRA. The F-C curve is not to be utilized with only certain equipment responding, (e.g, not with only safety-related SSCs.)

FANP has the following concerns with the frequency-consequence curve in the framework:

(a) The basis for the frequency should be events per site year, where the site may have one or more plants and the plants may have more than one reactor. In the utilization of the curve, the events considered must include both single-reactor and multiple-reactor accidents as developed in the PRA.

(b) The boundary between the frequent and infrequent events should be $1x10^{-4}$ per site year and not $1x10^{-5}$ per reactor year. This is already more stringent than current LWRs can meet, as sequences that violate the single failure criterion would not be excluded and there would be an obligation to account for all events above the limit, which is missing in the DBA selection criteria for existing reactors. The differences between a lower limit for DBEs and an upper limit for beyond design basis accidents have been inadequately considered. Setting the limit at $1x10^{-4}$ per site year will lead to requirements to protect against credible common cause failures such as dual bus failures that current reactors are not designed for. Hence, setting the limit at $1x10^{-4}$ per site year is already consistent with increased safety margins for advanced reactors. There is no justification for the additional burdens that would be applied at $1x10^{-5}$ per reactor year.

(c) In establishing the low frequency and high consequence end of the curve there is significant conservatism in drawing the curve relative to what would be required to meet the safety goal QHOs.

In addition to this F-C curve, an integrated risk calculation (displayed in the conventional form of a complementary cumulative distribution function (CCDF)) should be performed to show compliance with and margins to the QHOs.

Additional details are needed for implementation of the F-C curve, including but not limited to:

- the foundation of whether the mean or an upper bound assessed frequency of an accident family or scenario is to be compared to the F-C curve to determine whether it falls in the anticipated, infrequent, or rare region,
- the foundation of whether the mean or an upper bound assessed dose consequence is to be compared to the F-C curve dose requirements depending on which of the three regions the event falls.

**Question 9:**

*The Top Level Regulatory Criteria (TLRC) is another curve, which represents exposure at the site boundary under various conditions. What are the advantages and disadvantages of these two curves?*

**Response 9:**

If by TLRC it is meant the proposed F-C curves presented by DOE for the MHTGR and by Exelon for the PBMR, FANP believes that pending the resolution of the comments above, the F-C curve may have consistency advantages over the TLRC curve which was a compilation of requirements from various regulatory sources. On the other hand, the difficulty in getting approval for new dose criteria for the F-C regions versus the current requirements shown on the TLRC must be weighed. The top requirement of the FANP ANTARES design to not disturb the normal day-to-day activities of the public translates to meeting the EPA's protective action guidelines that are more limiting than both the MHTGR/PBMR TLRC or the NRC's F-C curves dose requirements in the design basis and beyond design basis regions. Therefore, FANP prefers the approach that leads to an F-C curve that can be agreed to have the strongest technical basis.

A better basis is needed for the selected frequencies of the three regions. One way to test the reasonableness of these frequencies, particularly the lower bound of the design basis region, is to examine the insights gained by comparing a full scope (with external events) LWR PRA to the selected frequencies of the regions. FANP believes that not only is $10^{-4}$ per site year sufficiently low to meet the QHOs, but current and advanced LWRs do not consider as design basis events all event scenarios above a frequency any lower than $10^{-4}$ per site year.

**Question 10:**

*With respect to implementing the F–C curve, where and how should the consequences be evaluated? (For example: evaluated at a particular site and its boundary? Averaged over all weather or for a conservatively defined weather?)*

**Response 10:**

FANP believes that more dialogue is needed on implementation of the F-C curve. For the FANP ANTARES, consequences evaluated at the site boundary will be sufficient, but this may not be the case for all reactor technologies.

Generally, FANP would continue with current practice for each of the three F-C regions, that is,

- for the anticipated operational occurrences, the mean dose should be compared to the acceptable dose criteria,
- for the design basis events, the upper bound (95% confidence) dose should meet that region's acceptable dose criteria and the mean dose should be provided to show the level of conservatism, and,
- for the rare events beyond the design basis, the mean dose should be the basis for acceptability.

The weather should be treated consistently like other independent variables. A distribution should be specified for a generic or specific site (if available), and then that weather distribution combined statistically with the other parameters in determining the dose distribution from which the mean and upper bound values can be compared as stated above.

**Question 11:**

*Should the F–C curve shown in Figure 4–1 be expressed in terms of dose or curies released?*

**Response 11:**

Dose (total effective dose equivalent (TEDE)) is the best measure for comparison to the F-C curve and a better intermediate result than release as input to the comparison of the CCDF risk to the QHOs.

**Question 12:**

*Should the F–C curve be used as the acceptance criteria for all event sequences analyzed? If so, how should the cumulative effects of all event sequences be considered? Or, should the F–C curve frequency represent a cumulative frequency of all event sequences leading to a defined consequence?*

**Response 12:**

The F-C curve should be used to evaluate event scenarios that include all event sequences of similar initiating events and SSC response. This is different than summing all event sequences of similar consequences which could potentially mask the important differences in behavior of key safety systems and their response. The CCDF curve is the place to sum all sequences.

**Question 13:**

*Can specific regions under the F–C curve be related to safety margins so as to facilitate implementation of safety decision-making?*

**Response 13:**

Specific regions under the F-C curve can be related to safety margins to facilitate implementation of safety decision making. This visibility of the safety margins and the degree of uncertainty in both the frequency and consequence assessments are chief advantages of the F-C curve.

**Question 14:**

*Are the International Commission on Radiation Protection (ICRP) guidelines the appropriate criteria to use for specifying radiological limits for new reactors? Should other guidelines be used? If so, what are they?*

**Response 14:**

As discussed above in response to question (9), FANP believes there are consistency advantages to using the ICRP throughout the F-C curve. In particular, the ICRP is a better measure for the acceptable dose criteria in the anticipated operational occurrence region than 10CFR50 Appendix I as used in the MHTGR/PBMR TLRC curve. However, care must be taken not to introduce conservatism in the use of the ICRP limits for the QHO in the rare beyond design basis event region. Another key aspect in using the ICRP values is to assure they are consistent with the 10CFR50.34 dose requirements applied to existing reactors and to ALWRs. This will help ensure a consistent level of safety in the SARs for DBEs.

**Question 15:**

*Are the proposed technology-neutral risk guidelines appropriate? If not, what should be used?*

**Response 15:**

The frequency and consequence limits have been discussed above in responses to questions (8), (9), (10), (11), and (14). Risk is best measured with a CCDF curve against the QHOs as discussed in response to question (8), after the event scenario assessments against the F-C curve.

**Question 16:**

*Is the proposed use of 10 CFR Part 20 and GDC 19 of Appendix A to 10 CFR Part 50 Appendix A appropriate for worker protection? If not, what is appropriate?*

**Response 16:**

FANP finds the approach to be reasonable.

**Question 17:**

*Is the proposed approach for protection of the environment appropriate and adequate? If not, what is appropriate?*

**Response 17:**

FANP finds the approach to be reasonable.

**Question 18:**

*Are the objectives and issues identified in the discussion of construction objectives appropriate? Are they sufficiently complete? What additional considerations will be important for new reactor designs?*

**Response 18:**

FANP finds the approach to be reasonable.

**Question 19:**

*Are the operational objectives appropriate? What issues are not discussed that likely to be important for new reactors? Are any of the identified issues unnecessary for new reactors?*

**Response 19:**

FANP finds the approach to be reasonable.

**Question 20:**

*Is the proposed approach for the selection of AOOs and DBAs reasonable? Should another approach be used? If so, what should it be? Are the acceptance criteria reasonable?*

**Response 20:**

FANP finds the approach to be reasonable. However, the terminology should be DBEs instead of DBAs. All the events to consider are not accidents. Some that fall within the AOO and DBE regions will not have radiological consequences. Nevertheless, understanding the safety functions and the SSC that keep these zero dose scenarios within the acceptable doses is an important element of the technology-neutral framework.

In the absence of examples and case studies, it is difficult to identify the practical issues that arise from the idea of using a probabilistic approach to select the licensing basis events. At the March 2005 workshop, there was a general consensus that the framework should be tested with both LWR and HTGR examples, which use existing designs and associated PRAs that apply each basic step in the framework including characterization of the protective strategies employed in the respective safety design approaches, selection of LBEs, selection of safety related SSCs, development of reactor specific requirements, and implementation of containment performance and defense-in-depth criteria. The LWR example would provide guidance on the level of safety compared with existing reactors, and the HTGR example would prove the approach for a fundamentally different reactor type.

**Question 21:**

*Can a technology-neutral definition of accident prevention be developed? If so, what should it be? If not, what technology-specific definitions should be used?*

**Response 21:**

Prevention and mitigation are intrinsically technology-specific, as the definition must consider plant design features. Prevention and mitigation should be handled as suggested in a paper by Fleming and Silady[1]. This approach is to identify SSCs and design features responsible for prevention and mitigation across a full spectrum of accidents selected from the dominant contributors from the PRA. Appreciation of the importance of this could be better realized by working out examples and case studies as described in response to question (20).

**Question 22:**

*Should a risk-informed safety classification process build upon the risk criteria and process contained in 10 CFR 50.69? If not, what risk criteria and process should be used?*

**Response 22:**

FANP believes an important criterion that is not included in the framework is that the selection of safety-related SSCs, or SSCs that are candidates for special treatment, should be both necessary and sufficient to meet the F-C curves for DBEs and sufficient to prevent high consequence "cliff edge effects."

FANP believes that by utilizing the PRA for the selection of DBEs, the safety classification is sufficiently risk-informed.

The position on how the traditional risk metrics (e.g. risk achievement worth) that are applied in 10 CFR 50.69 are applied to this task needs to be evaluated. There are several aspects of how these risk metrics have been applied to LWRs that may not apply to any particular new reactor.. These risk metrics have been defined in terms of the LWR-specific risk metrics CDF and LERF, which may not apply to a new reactor. Also, the LWR application of risk importance is a function only of the beyond design basis events and would not be defined for the frequent and infrequent categories. The recommendation to use a risk metric that is a function of event sequences in the infrequent category to decide how to mitigate design basis accidents in the frequent category is inconsistent. Additionally, since the traditional risk importance metrics are defined in relative vs. absolute terms, an SSC in one reactor might have a high importance yet even if that SSC fails, the conditional risk might be lower than that for an SSC in another reactor which has a low relative importance. This process could easily lead to inconsistent levels of safety performance of SSCs in different reactors.

**Question 23:**

*What risk criteria and process are appropriate for non-LWR concepts (e.g., high temperature gas reactors) to address accident prevention and safety classification?*

---

[1] Fleming, Karl N. and Fred A. Silady, " A Risk Informed Framework for Defense-in-Depth for Advanced and Existing Reactors", Reliability Engineering and System Safety, Elsevier Publishing Company, 78 (2002) pp. 205–225

**Response 23:**

FANP suggests that the licensing approach documents submitted by Exelon for the PBMR and DOE for the MHTGR provide the best approach for the questions of accident prevention and safety classification. For the ANTARES, FANP is basing its process on that safety classification approach.

**Question 24:**

*What acceptance criteria should be used to reflect uncertainties? Should they be set at a defined level of confidence; or should evaluation of uncertainty in both the challenge and the capability be required? Should the consideration of integrated risk be applied to all reactors on a site, not just modular reactors?*

**Response 24:**

Uncertainty distributions should be assessed for the frequency and consequence of every event scenario on the F-C curve. The frequency uncertainty should be used in the judgment of which of the three regions the event falls. If a particular event frequency uncertainty band straddles the boundary between two regions, it may be prudent to examine the event in both regions. As discussed in response to question (10), the uncertainty distribution on the event's consequence is utilized differently depending on which of the region the event falls.

FANP believes that the F-C and CCDF curves should be utilized for all reactors.

**Question 25:**

*If integrated risk is to be considered on a per site basis, how should it be accounted for? Options include:*

- *— limit the number of reactors on a site?*
- *— site specific criteria?*
- *— nationwide criteria?*
- *— other criteria?*

**Response 25:**

If the framework is based on the F-C and CCDF curves as discussed and modified by these comments on a site basis, then there is a straightforward path to address the various possibilities of single reactor and modular reactor plants sited on existing and greenfield sites. In essence, every site has a budget that must be proportioned between the reactors with due consideration for commonality of SSCs and common events such as loss of offsite power and seismic events.

**D. TREATMENT OF UNCERTAINTIES – DEFENSE-IN-DEPTH**

**Question 26:**

Are the types of uncertainty adequately described? If not, what should be changed or added?

**Response 26:**

FANP finds the approach to be reasonable.

**Question 27:**

*What approaches to determining the degree of defense-in-depth provided by each protective strategy would be appropriate?*

**Response 27:**

FANP proposes that defense-in-depth be evaluated in accordance with the reactor-specific design philosophy that includes the inherent reactor features and the features and properties of each barrier, especially the fuel barrier, the approach of deploying reactor specific passive and active engineered safety features to support the barriers, and a detailed analysis of how each barrier and SSC serves to prevent and mitigate accidents across the full spectrum of risk dominant accident sequences from the PRA. Defense-in-depth should not be applied just to determine containment building requirements.

**Question 28:**

*How relevant is the rationalist approach, given the uncertainty associated with the unknown contributors?*

**Response 28:**

FANP agrees that a combination of rationalist and structuralist approaches will provide adequate DiD for unknown uncertainty contribution in a specific barrier or protective/mitigating system. Both the structuralist and rationalist approaches are subject to uncertainties. The rationalist approach does a better job in exposing the uncertainties. The problem with the rationalist approach is that it has only been used for LWRs and most of the regulations are not relevant to non-LWRs.

Uncertainties must be viewed in context of safety margins. Uncertainties are never completely eliminated and larger uncertainties are to be tolerated with larger margins.

**Question 29:**

*Are expert judgment approaches appropriate? What caveats and controls would be needed?*

**Response 29:**

FANP agrees; caveats and controls could be performance-based measures. Judgments must be made to address uncertainties whether a rationalist or structuralist approach is taken.

**Question 30:**

*Are there ways to structure the uncertainty associated with "unknown" aspects of the risk that can be helpful?*

**Response 30:**

Addressing the "unknown" contribution to uncertainties is best addressed by process defense-in-depth. In the technology development phase, DiD is introduced with small scale to integrated testing to expected and beyond service conditions; in the design process, DiD is introduced with safety margins and conservative analyses; in the construction and manufacturing phase, DiD is introduced with special treatment in procurement and QA; in the demonstration testing phase, DiD is introduced with reactor module testing of expected and infrequent events, and in the operation phase, DiD is introduced with monitoring, ISI, and IST.

Each of the results of these respective phases influences the uncertainties and the need for DiD in subsequent phases.

However, as with the known uncertainties, they are never completely eliminated. Ultimately, the best defense is a design whose safety is transparent by reliance on inherent and passive features and can be assured by monitoring of its safety functions during normal operation. Vigilance against the unknown must be maintained as commercial plant experience is gained.

**Question 31:**

*Could these be used to provide a qualitative description of the uncertainty that would provide a basis for assessment? What other possibilities are there?*

**Response 31:**

See response to question (30).

**Question 32:**

*Are there additional defense-in-depth principles that should be adhered to? If so, what are they?*

**Response 32:**

Mechanistic scenario-specific source terms are the driving force behind how much DiD is needed.

**Question 33:**

*Is the proposed defense-in-depth criterion for containment appropriate? If not, what should be used?*

**Response 33:**

Containment needs to be viewed as a function, not a building, and in the context of a mechanistic containment system.

**Question 34:**

*Is the defense-in-depth model advocated in the report appropriate? Does it achieve the proper balance between structuralist and rationalist aspects? If not, how should it be changed?*

**Response 34:**

FANP believes that designers should strive to strike a balance between the prevention and mitigation measures and the DiD is meant to be relied upon when safety margins are low and uncertainties are high. However, as indicated in response to question (30), a broader view of DiD is needed beyond adding additional events or design features to the risk-informed process.

**Question 35:**

*Is the implementation of the defense-in-depth model described in the report appropriate? If not, how it should be changed?*

**Response 35:**

FANP supports the philosophy of defense-in-depth and has developed an approach to defense-in-depth that has been presented at several of the NRC workshops. The FANP approach defines defense-in-depth with respect to design aspects, process aspects, and scenario aspects as suggested in the paper by Fleming and Silady.

There is no consistent, objective guidance provided to determine the adequate degree of defense-in-depth. One of the reasons is the difficulty in comparing the degree of defense-in-depth in reactor designs with fundamentally different inherent characteristics. Therefore, FANP believes it is appropriate to continue to address this issue on a design-specific basis, consistent with current practice.

FANP agrees with the discussion of the relationship of defense-in-depth to uncertainty in PRA performance. The strategy of using defense-in-depth to address uncertainty is well described, and the logic decision chart adds clarity to the application.

**Question 36:**

*Are incompleteness uncertainties reasonably accounted for? If not, how should they be dealt with?*

**Response 36:**

It is difficult to deal with incompleteness uncertainties outside the context of a specific reactor and a specific PRA so that the process for assuring completeness can be examined. Incompleteness uncertainty cannot be dealt with in the abstract and in a technology-neutral manner.

**Question 37:**

*Are the proposed factors for considering changes to existing emergency preparedness regulations or guidance appropriate? If not, what should be used?*

**Response 37:**

FANP agrees with the stated position regarding possible modifications of emergency preparedness requirements.

FANP disagrees with the use of "acceptance by the public" as a criterion. While we acknowledge the importance of public acceptance, we are concerned about the timing and method which would be applied for such a criterion. We believe that the immediate focus should be on development a framework and technical criteria to guide the reviews of advanced reactor designs. Further, we believe there is ample opportunity for public involvement in the licensing process. We believe it is difficult, if not impossible, for the NRC to prejudge acceptance by the public at this time.

**Question 38:**

*Does the proposed functional performance requirement and criterion for containment take into account such features as the fuel, core, and cooling system design?*

**Response 38:**

See FANP comments on the treatment of containment performance in response to question (44).

**Question 39:**

*Are the proposed performance requirement and criterion performance-based?*

**Response 39:**

See FANP comments on the treatment of containment performance in response to question (44).

**Question 40:**

*Are the proposed performance requirement and criterion risk-informed?*

**Response 40:**

See FANP comments on the treatment of containment performance in response to question (44).

**Question 41:**

*Does the proposed performance requirement and criterion adequately account for uncertainties, including completeness uncertainties?*

**Response 41:**

See FANP comments on the treatment of containment performance in response to question (44).

**Question 42:**

*Would the proposed performance requirement and criterion result in excessive regulatory burden, including containment design, construction and operating costs?*

**Response 42:**

See FANP comments on the treatment of containment performance in response to question (44).

**Question 43:**

*Does the proposed performance requirement and criterion provide for public confidence?*

**Response 43:**

FANP disagrees that public confidence should be a metric. See response to question (37).

**Question 44:**

*How should the options, including the proposed option, be revised in consideration of the above questions?*

**Response 44:**

(a) It is FANP's view that the "containment functional performance requirements" is interpreted too narrowly and that the six safety functions were defined based on LWR technology. This is in contrast with the NRC presentation at the January 2004 workshop, which described the "mechanistic containment system" concept. That concept reflected a broader view of the safety functions associated with the containment of radioactive material, accounting for all barriers that ensure mechanistic containment of radioactive material.

(b) FANP believes that containment accident prevention and mitigation safety functions 1-4 are relevant to containment functional performance requirements. The interpretation that "containment" is synonymous with containment structure or reactor building, as in the case with currently licensed LWRs, is too narrow. If the other SSCs have safety functions associated with containment of radioactive material, function 6 is not independent of the other five functions. Further, we believe this LWR-based approach is flawed because the role of the fuel barrier has not been considered in the formulation of requirements intended only for the reactor building. It is the view of FANP that this reflects an attempt to apply an LWR containment model to all reactor types and thus does not result in a technology-neutral resolution.

(c) The list of six functions for containment accident prevention and mitigation safety is not complete. For example, in a modular HTGR, the reactor building serves a supportive safety function of limiting air volume for control of chemical attack. This further illustrates that the formulation of reactor safety functions is design-specific and should include the functions of a particular SSC such as a reactor building or "containment."

(d) An integrated view of the plant and all of its safety functions is needed. An evaluation of one SSC must examine all of its functional safety requirements in context of its relationship to other plant SSCs that contribute to each of those requirements.

(e) Given the FANP concerns described in items a and b, we disagree that the first four options have been systematically and mechanistically considered. We believe the evaluation was flawed because it was based on an implicit assumption that the fuel and pressure boundary barriers are similar to that of an LWR. The importance of the containment structure in an LWR is based on scenarios in which the fuel and pressure boundary barriers are breached. In the absence of such scenarios, the benefits of the containment cannot be objectively assessed.

(f) The definition and evaluation of Option 2 are too vague. They must consider a specific design and specific "selected credible events" that would be added to Option 1. It is not clear how such options can be objectively defined on a technology-neutral basis.

(g) Air ingress is not an end state but a phenomena that needs to be considered with other relevant mechanistic source term phenomena. To the extent that such scenarios are considered to be beyond design basis accidents, treatment of air ingress should be handled as are severe accident phenomena in a light water reactor.

(h) Cross vessel failures were hypothesized in the MHTGR preapplication safety review (NUREG-1338). Resulting oxidation was not found to be significant in challenging the safety case which included a vented reactor building structure.

(i) The speculation that air ingress would challenge the fuel particle coatings needs to be further evaluated. There has to be a means to get a sizable air ingress, oxidation of the outer reflector graphite that the air would come into contact with, continued ingress to overcome the backpressure created by the oxidants, mass transfer from the outer reflector regions of the core to the fuel elements, extensive oxidation of the fuel element to reach the embedded fuel compacts,extensive oxidation of the fuel compacts to reach the embedded fuel particles and oxidation of the silicon carbide layer which may form a protective oxide layer, all of which requires high temperatures needed to drive the reaction rates.

(j) The delayed fuel release phenomena as one involving failures of fuel particles has been mischaracterized. In modular HTGR designs, with the temperatures that can realistically and mechanistically be reached in light of the core size, power density, and configuration, additional failures are a minor factor in comparison to radionuclide releases from initially failed particles from as-manufactured and in-service defects. Releases from initially failed fuel particles, which previous PRAs have shown to be relatively high risk contributors, need to be discussed

(k) Option 3 appears to be applicable only for modular HTGR designs, or a design that could show that short term releases do not have to be considered in the containment function. The statement that the prescriptive requirements to contain delayed releases are independent of other barriers is not true. It is dependent on the capability of the other barriers to contain radioactive material in the short term phase of the accident, which may or may not be valid for any particular reactor.

(l) The term "core challenge" event is not a technology-neutral term; and its usage in the context is nearly synonymously with "core damage" event, which is not a technology-neutral term. Core challenge events are not defined and hence that part of the discussion is impossible to interpret for a specific type of reactor. There are no criteria listed for distinguishing between core challenge events and any other initiating events that would be included in a PRA.

(m) The capability of the reactor building to reduce radionuclide releases to the environment independent of other transport barriers is not achievable for any design. Such a capability is highly dependent on mechanistic conditions associated with accident sequences in which the fuel barrier and pressure boundary barrier are challenged or failed. Independence implies that the failure probability of one barrier is unchanged for scenarios involving failure of another barrier; and review of PRA results shows that such independence is never realized. First, there are common cause events that could potentially fail two or more barriers. Second, failure of one barrier will in many cases impose loads on other barriers that will increase the failure probability relative to this idealized independent model.

(n) It is FANP's position that there should be no regulatory requirements for source term mitigation by the reactor building for design basis accidents if it is demonstrated that mitigation need not be credited to meet the design basis accident dose requirements. Instead, for SSCs there should be safety functions credited in the design basis accident safety analysis that lead to regulatory design requirements for those functions, and supportive safety functions, not associated with any safety related SSCs, that contribute to defense-in-depth and safety margins.

(o) FANP disagrees with the conclusion that Option 4 imposes a capability for the leak-tight containment of radioactive material comparable to existing LWRs. For existing (and proposed) LWRs, the capability for such leak-tight capability is only demonstrated for design basis accidents. This capability has not been demonstrated for LWR core damage events when the fuel barrier is breached. A containment performance capability for core damage events has only been established within the domain of PRAs for beyond-design-basis accidents using realistic assumptions. Therefore, Option 4 as stated is unlikely to be achieved for any reactor.

(p) It is the view of FANP that the topic of containment functional performance requirements is not consistent with the technology-neutral framework. This topic is design-specific and should be deferred until after the design-specific aspects of implementing the framework are developed. It should be further deferred until there is an opportunity to discuss how their specific designs meet the top level regulatory criteria of the framework and how they have addressed defense-in-depth provisions during preapplication interactions and application reviews of specific reactor designs.

## E. DEFINITION OF SCOPE OF REQUIREMENTS

**Question 45:**

*Should the technology-neutral requirements be developed as an independent alternative to licensing under 10 CFR part 50?*

**Response 45:**

FANP agrees an independent alternative is appropriate.

**Question 46:**

*Is there a near-term (i.e., 3–5 years) need for the framework?*

**Response 46:**

FANP is interested in the Part 4 technology-specific requirements for the ANTARES design. FANP encourages the NRC to continue the framework development on a timely basis.

**Question 47:**

*The derivation of detailed technical requirements is being developed. Is the process described (and illustrated with the barrier integrity example) for the identification of the scope and content of the detailed technical requirements from the protective strategies reasonable? How could it be improved?*

**Response 47:**

FANP believes that it would be better to develop technology-specific requirements in parallel, preferably for modular HTGRs, and defer the step of technology-neutral requirements.

**Question 48:**

*The approach for obtaining the needed administrative requirements is being developed. Is the process described so far reasonable? Are the discussions on analysis methods and qualification and on research and development appropriate?*

**Response 48:**

FANP agrees with the approach for obtaining the needed administrative requirements.

**Question 49:**

*Should the technology-neutral requirements build upon and utilize 10 CFR part 50 requirements as much as possible (i.e., whenever 10 CFR 50 requirements are technology neutral they should be incorporated)?*

**Response 49:**

A comparison with the Part 50 requirements is needed. The framework does not describe how this comparative review of the applicable regulations will fit within the risk informed framework.

**Question 50:**

*Are the desired characteristics of a technology-neutral regulatory structure listed in Sections 1.4 and 6.3 of the framework reasonable? Is the list complete? If not, what characteristic(s) is missing?*

**Response 50:**

FANP believes that the final form of the framework should:

(a) be technology-neutral and avoid application of LWR-specific criteria;

(b) be reproducible and avoid vague, arbitrary and inconsistent standards;

(c) support a stable and predicable regulatory environment;

d) use an appropriate blend of probabilistic and deterministic approaches;

e) result in an appropriate allocation of resources in managing risk; and

f) be tested with practical examples to demonstrate feasibility.

The testing plans appear to be coming too late to have any practical effect.

**Question 51:**

*Are the described checks for completeness of the framework adequate? What other checks could be performed?*

**Response 51:**

FANP agrees with the described checks for completeness of the framework.

**Question 52:**

*Is it reasonable and practical to maintain a living PRA, which would be used to periodically reclassify reactor accidents as operating experience accrues?*

**Response 52:**

FANP agrees that it is reasonable and practical to maintain a living PRA.

**Question 53:**

*From a regulatory perspective, in terms of enforceability, is it practical to include the technology-specific details in a regulatory guide, although included as part of the license, or directly in a regulation?*

**Response 53:**

FANP agrees with the approach.

**Question 54:**

*Would performance-based requirements developed according to Appendix A to CFR 10 Part 50, sufficiently address enforceability, given that prescriptive requirements are easier to enforce?*

**Response 54:**

FANP agrees with the approach.

**Question 55:**

*At what stage should the technology-specific regulatory guides be developed and to what level of detail? Currently, it is envisioned, prior to pre-application or pre-certification, to develop the technology-specific regulatory guides for each technology type, not for each applicant. The technology-specific regulatory guide would specify how to interpret such statements in the technology-neutral regulation as fuel damage, accident prevention.*

**Response 55:**

FANP believes that the appropriate stage for the technology-specific regulatory guides to be developed is during pre-certification.

**Question 56:**

*It is envisioned that these new technology-neutral regulations would be a voluntary alternative to 10 CFR Part 50. Should these regulations be voluntary or mandatory? What would be the motivation for an applicant to use this alternative? Should a licensee be allowed to seek an exemption to 10 CFR Part 50 to propose an alternative approach based on the technology-neutral regulations?*

**Response 56:**

FANP agrees with the approach.

**Question 57:**

*Is a technology-neutral framework desirable for licensing future reactors? What are the advantages of using a technology-neutral framework? What are the difficulties of using such a framework?*

**Response 57:**

FANP believes that a technology-neutral approach is a necessity for licensing reactor technologies that are different than LWRs.

## F. APPENDICES

**Question 58:**

*Will the identified set of appendices be helpful? Should any be dropped or redirected?*

**Response 58:**

FANP believes that the appendices should be helpful once they are finished and reviewed.

**Question 59:**

*Would additional appendices be helpful? If yes, what should be the topic and to what level should it be written?*

**Response 59:**

FANP believes that an appendix that walks through the framework for a modular HTGR would be helpful.

**Question 60:**

*Are there additional performance-based considerations that should be included in Appendix A?*

**Response 60:**

FANP believes that it seems adequate now but we need to exercise it before making final judgment on it.

**Question 61:**

*Are there additional examples of the use of surrogates to achieve higher level risk objectives that would be useful here? Are there additional characteristics/features/attributes of the various innovative designs that should receive special attention in appendix C?*

**Response 61:**

FANP believes that there could be additional examples of the use of surrogates to achieve higher level risk objectives, but it would be design specific and should not be included here.

**Question 62:**

*What should be the scope and depth of this appendix? At a higher level and look to professional organization to develop standard?*

**Response 62:**

FANP believes that Appendix C can be developed in a collaborative effort between NRC and professional organizations.

**Question 63:**

*Are there other sources that should be reviewed?*

**Response 63:**

FANP has not identified any other sources that should be reviewed.

## G. GLOSSARY

**Question 64:**

*Have the appropriate terms been identified? If not, what terms should be deleted or added?*

**Response 64:**

FANP believes that a completed glossary is needed in the document.

**Question 65:**

*Are the definitions reasonable? If not, why?*

**Response 65:**

FANP believes that a completed glossary is needed in the document.

**Question 66:**

*Should the definitions be standardized? Can the definitions be used elsewhere? If not, which definitions can not be standardized, and why?*

**Response 66:**

FANP believes that a completed glossary is needed in the document.

**Mail Envelope Properties** (426971EA.5D6 : 15 : 13782)

| | |
|---|---|
| **Subject:** | Draft NUREG-3-2005 |
| **Creation Date:** | Fri, Apr 22, 2005 5:50 PM |
| **From:** | MCFADEN Sherry L <Sherry.McFaden@framatome-anp.com> |
| **Created By:** | Sherry.McFaden@framatome-anp.com |

**Recipients**
nrc.gov
twf2_po.TWFN_DO
NRCREP

nrc.gov
owf4_po.OWFN_DO
JFW1 CC (Joseph Williams)

framatome-anp.com
F.Shahrokhi CC (SHAHROKHI F)
Gayle.Elliott CC (ELLIOTT Gayle F)
Sandra.Sloan CC (SLOAN Sandra M)
Jerald.Holm CC (HOLM Jerald S)

| Post Office | Route |
|---|---|
| twf2_po.TWFN_DO | nrc.gov |
| owf4_po.OWFN_DO | nrc.gov |
| | framatome-anp.com |

| Files | Size | Date & Time |
|---|---|---|
| MESSAGE | 430 | Friday, April 22, 2005 5:50 PM |
| TEXT.htm | 1681 | |
| nrc05030.pdf | 1346818 | |
| Mime.822 | 1847401 | |

**Options**

| | |
|---|---|
| **Expiration Date:** | None |
| **Priority:** | Standard |
| **Reply Requested:** | No |
| **Return Notification:** | None |
| **Concealed Subject:** | No |
| **Security:** | Standard |