From: Robert Palla /NRR
To: George Hubbard, Timothy Collins
Date: Wed, Sep 13, 2000 10:42 AM
Subject: Sections 2 and 3.5 of TWG

Attached FYI are draft revised Sections on Risk Informed Decisionmaking (Section 2) and Consequences and Risks of SFP Accidents (Section 3). As you will see, I am still waiting for the RES input on consequences vs time, but have some ideas about what we will present and what we will address in our discussion. I am working on 4.2 and will get you something on that later.

CC: Joseph Staudenmeier

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2.0 Risk-Informed Decision Making

Potential changes to regulatory requirements for decommissioning plants are described in SECY-00-0145, "Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning." This rulemaking plan would amend EP regulations for licensees who have permanently ceased operations and have permanently removed the fuel from the reactor vessel. The approach described therein would allow a significant reduction in the level of EP when decay heat levels and fuel heatup rates are substantially reduced, and additional EP reductions at some later time when the fuel will not be susceptible to a zirconium fire. Relaxations in requirements related to insurance, safeguards, staffing and training, and backfit would also be made on the bases of reduced decay heat levels and susceptibility of the fuel to a zirconium fire.

As a result of these changes licensees would no longer be required to: have a formalized EPZ; coordinate with state and local organizations within those EPZs as to specific responsibilities and actions; have an offsite EOF, onsite TSC, and onsite OSC; promptly notify the public using such things as the siren system, tone alert radios, or National Weather radios; and conduct biennial full participation exercises. However, the decommissioning licensee would still be required to promptly notify offsite authorities, characterize the releases, and make protective action recommendations; have a means of promptly notifying offsite organizations and communicating with the public; and hold onsite biennial exercises and semiannual drills.

This report provides the technical basis and decision making logic for assessing the merit of the above regulatory changes for decommissioning plants. The thrust of the technical assessment is on changes in EP requirements, but the same technical information also provides the underpinnings for decisions related to changes in insurance, safeguards, staffing and training, and backfit requirements.

The regulatory framework proposed in this report for decommissioning plants is based on the risk-informed decision making process described in RG 1.174 [Ref 1]. Although the focus of RG 1.174 is decision making regarding changes to the licensing basis of an operating plant, the same risk-informed philosophy can be applied generically to evaluate the acceptability of potential exemptions or changes to current regulatory requirements for decommissioning plants. RG 1.174 articulates the following safety principles which should be applied to the decommissioning case:

- "The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change, i.e., a "specific exemption" under 10 CFR 50.12 or a "petition for rulemaking" under 10 CFR 2.802.
- When proposed changes result in an increase in core damage frequency and/or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement
- The proposed change is consistent with the defense-in-depth philosophy.
- The proposed change maintains sufficient safety margins.
- The impact of the proposed change should be monitored using performance measurement strategies."

The intent and scope of these safety principles are discussed below. Since the application of this study specifically relates to exemptions to a rule or a rule change for decommissioning plants, a discussion of the first principle regarding current regulations is not necessary nor is it provided. A discussion on how the rest of these principles are satisfied, as demonstrated by the staff's safety assessment, is provided in Section 4.

2.1 Impact of Proposed Changes on Risk

The impact of the proposed change should be small. Guidance on acceptable levels of (total) risk to the public from a nuclear power plant is provided in the Commission's Safety Goal Policy Statement [Ref 2]. Additional guidance on the acceptable levels of risk increase from a change to the plant licensing basis is provided in RG 1.174. The guidance contained in these documents and summarized below is used in this report to evaluate the risks associated with SFP accidents and the impacts of potential changes to regulatory requirements for decommissioning plants.

Safety Goal Policy Statement

The "Policy Statement on Safety Goals for the Operation of Nuclear Power Plants," issued in 1986, establishes goals that broadly define an acceptable level of radiological risk that might be imposed on the public as a result of nuclear power plant operation. The Commission established two qualitative safety goals that are supported by two quantitative objectives. The qualitative safety goals stipulate that:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health

- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The following quantitative health objectives (QHOs) are used in determining achievement of the safety goals:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.

- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

These QHOs have been translated into two numerical objectives as follows:

- The individual risk of a prompt fatality from all "other accidents to which members of the U.S. population are generally exposed," such as fatal automobile accidents, is about 5E-4 per year. One-tenth of one percent of this figure implies that the individual risk of prompt fatality from a reactor accident should be less than 5E-7 per reactor year.

- "The sum of cancer fatality risks resulting from all other causes" is taken to be the cancer fatality rate in the U.S. which is about 1 in 500 or 2E-3 per year. One-tenth of one percent of this implies that the risk of cancer to the population in the area near a nuclear power plant due to its operation should be limited to 2E-6 per reactor year.

Although the Policy Statement and related numerical objectives were developed to address the risk associated with power operation, is it reasonable to require that these objectives continue to be met for as long as nuclear materials remain on the plant site. Accordingly, the staff has compared the estimated risks associated with SFP accidents to the QHOs. These comparisons are provided in Section 4.2.1.

Regulatory Guide 1.174

In 1995, the NRC published its PRA Policy Statement [Ref 3], which stated that the use of PRA technology should be increased in all regulatory matters to the extent supported by the state-of-the-art of the methods. Subsequent to issuance of the PRA Policy Statement, the agency published RG 1.174 which contained general guidance for application of PRA insights to the regulation of nuclear reactors. The guidelines in RG 1.174 pertain to the frequency of core damage accidents (CDF) and large early releases (LERF). For both CDF and LERF, RG 1.174 contains guidance on acceptable values for the changes that can be allowed due to regulatory decisions as a function of the baseline frequencies. For example, if the baseline CDF for a plant is below 1E-4 per year, plant changes can be approved that increase CDF by up to 1E-5 per year. If the baseline LERF is less than 1E-5 per year, plant changes can be approved which increase LERF by 1E-6 per year.

For decommissioning plants, the risk is primarily due to the possibility of a zirconium fire associated with the spent fuel cladding. The consequences of such an event do not equate directly to either a core damage accident or a large early release as modeled for an operating reactor. Zirconium fires in spent fuel pools potentially have more long term consequences than an operating reactor core damage accident because: there may be multiple cores involved; the relevant clad/fuel degradation mechanisms could lead to increased releases of certain isotopes (e.g., short-lived isotopes such as iodine will have decayed, but the release of longer-lived isotopes such as ruthenium could be increased due to air-fuel reactions); and there is no containment surrounding the SFP to mitigate the consequences. On the other hand, they are different from a large early release because the postulated accidents progress more slowly, allowing time for protective actions to be taken to significantly reduce early fatalities (and to a lesser extent latent fatalities). In effect, a spent fuel pool fire would result in a "large" release, but this release would not generally be considered "early" due to the significant time delay before fission products are released.

Even though the event progresses more slowly than an operating reactor large early release event and the isotopic make-up is somewhat different, the consequence calculations performed by the staff (reported in Appendix 4) show that spent fuel pool fires could have significant health effects on par with those for a severe reactor accident. These calculations considered the effects of different source terms, evacuation assumptions, and plume-related parameters on offsite consequences. Since an SFP fire scenario would involve a direct release to the environment with significant consequences, the staff has decided that the RG 1.174 guidance concerning LERF is applicable to the issue of SFP risks for decommissioning plants.

The LERF guidance is applied in two ways in this report. First, because the changes in EP requirements do not impact the frequency of events involving a large early release (i.e., the SFP fire frequency) but instead affect the consequences of these releases, the allowable increase in LERF stipulated in RG 1.174 is translated into an allowable increase in key risk measures. The estimated risk increases associated with changes in EP requirements are then compared to the allowable increases inferred from RG 1.174 in Section 4.2.1. Second, the RG 1.174 guidance is used to establish a Pool Performance Guideline (PPG). The PPG provides a threshold for controlling the risk from a decommissioning SFP. By maintaining the frequency of events leading to uncovery of the spent fuel at a value less than the recommended PPG value of 1E-5 per year, zirconium fires will remain highly unlikely, the risk will continue to meet the Commission's QHOs, and changes to the plant licensing basis that result in very small increase in LERF may be permitted consistent with the logic in RG 1.174.

A licensee would need to assure that the frequency of events leading to uncovery of the spent fuel would be less than the PPG in order to implement the risk-informed changes in the revised rule for decommissioning plants. This assurance could be provided by conforming with the seismic check list in Appendix 2b, the industry decommissioning commitments in Section 3.2, the staff decommissioning assumptions in Section 3.4, and other important assumptions identified in Section 3.2.2. The rationale for the PPG is presented in Appendix X. The role of the PPG in the license amendment process is discussed further in Section 4.3.

2.2 Defense-in-Depth

Defense-in-depth describes a multi-layered design and operational philosophy whose goal is to prevent the initiation of accidents or to prevent their progression to serious consequences. The defense-in-depth philosophy applies to the operation of the spent fuel pool, whether at an operating plant or in a decommissioning plant. The philosophy also applies to the potential regulatory changes contemplated for decommissioning plants. In accordance with the Commission White Paper on Risk-Informed Regulation (March 11, 1999), "Defense-in-depth is an element of the NRC's Safety Philosophy that employs successive compensatory measures to prevent accidents or mitigate damage if a malfunction, accident, or naturally caused event occurs at a nuclear facility. The defense-in-depth philosophy ensures that safety will not be wholly dependent on any single element of the design, construction, maintenance, or operation of a nuclear facility. The net effect of incorporating defense-in-depth into design, construction, maintenance and operation is that the facility or system in question tends to be more tolerant of failures and external challenges."

Therefore, application of defense-in-depth could mean in part that there is more than one source of cooling water or that pump make-up can be provided by both electric as well as direct drive diesel pumps. Additionally, defense-in-depth can mean that even if a serious outcome (such as fuel damage) occurs, there is further protection such as containment to prevent radionuclide releases to the environment, and emergency response measures to provide dose savings to the public. Implementation of defense-in-depth for SFPs is different from that applied to nuclear reactors because of the different nature of the hazards. The robust structural design of a fuel pool, coupled with the simple nature of the pool support systems, goes far toward preventing accidents associated with loss of water inventory or pool heat removal. Additionally, because the essentially quiescent (low temperature, low pressure) initial state of the spent fuel pool and the long time available for taking corrective action associated with most release scenarios provide significant safety margin, a containment structure is not considered necessary as an additional barrier to provide an adequate level of protection to the public.

Likewise, the slow evolution of most SFP accident scenarios allows for reasonable human recovery actions to respond to system failures, and provides sufficient time to allow for the implementation of protective actions without the full compliment of regulatory requirements associated with operating reactors. Section 4 summarizes the specific design and operational features of the SFP, industry commitments and the additional staff assumptions that ensure that SFP defense-in-depth is maintained. This level of defense is achieved through preventative measures, appropriate mitigating systems, and an appropriate level of emergency planning.

2.3 Safety Margins

A safety margin can relate to the difference between the expected value of some physical parameter (e.g., temperature, pressure, stress, reactivity) and the point at which adequate performance is no longer assured. An example of this would be a containment pressure calculation which may show a peak accident pressure of 40 psig is reached for a structure which has a design capability of 60 psig and an actual ultimate capability of 110 psig. In this case there is margin from the accident calculation of 20 psig to the design limit as well as a large margin of 70 psig to the actual expected failure limit.

The safety margins associated with fuel in the spent fuel pool for many physical processes and parameters are much greater than those associated with an operating reactor. The spent fuel pool is in a quiescent state, at or near ambient temperature and pressure. The decay heat levels are much lower than those of the fuel in an operating reactor. This allows much greater time for heating and boil off of the coolant water, and for heat up of the fuel itself, once uncovered. The fuel is covered with approximately 23 feet of water at or near ambient temperature. The pool is designed with ample margin to criticality, using both passive (geometry) and active (poisons) means of reactivity control. Section 4 describes the provisions that ensure the SFP maintains adequate safety margins in a decommissioning plant.

2.4 Implementation and Monitoring Program

RG 1.174 states that an implementation and monitoring plan should be developed to ensure that the engineering evaluation conducted to examine the impact of the proposed changes continues to reflect the actual reliability and availability of structures, systems, and components (SSCs) that have been evaluated. This will ensure that the conclusions that have been drawn will remain valid. This principle applies to the operation of the spent fuel pool at operating and decommissioning plants, as well as the potential regulatory changes contemplated for decommissioning plants.

Implementation and monitoring of important considerations could include such actions as: comparing a check list against the spent fuel pool seismic design and construction; control of heavy load movements; development and implementation of procedures and other provisions to ensure human reliability; monitoring the capability, reliability, and availability of important equipment; and checking the effectiveness of on-site emergency response and plans for communication with off-site authorities through training and drills. In many areas the implementation and monitoring may already be accomplished by utility programs such as those developed under the maintenance rule [Ref 4]. Section 4 describes the implementation and monitoring provisions in a decommissioning plant.