

May 4, 1998

FOR: The Commissioners

FROM: L. Joseph Callan /s/ Executive Director for Operations

SUBJECT: STATUS REPORT OF STAFF ACTIVITIES RELATED TO REVIEWING THE VIABILITY OF ENTOMBMENT AS A DECOMMISSIONING OPTION FOR POWER REACTORS

**PURPOSE:**

To provide an interim status report of the staff's activities related to its evaluation of entombment as a viable decommissioning option for power reactor license termination.

**BACKGROUND:**

On April 3, 1997 (COMSECY-96-068), the Commission requested that the staff provide it with an analysis of whether or not the staff views entombment as a viable decommissioning option and how this option has been dealt with previously by the Commission. The Staff Requirements Memorandum (SRM) stated that if the staff concludes that entombment is not a viable option, then the staff should describe the technical requirements and regulatory actions which would be necessary for entombment to become a viable decommissioning option, and that the staff analysis should include the resources involved, potential decommissioning cost savings, and vulnerabilities. A status report of the staff's efforts to date is provided below.

**STATUS OF THE REVIEW EFFORT:**

In response to the Commission's request, the staff contracted with Pacific Northwest National Laboratory (PNNL) to evaluate the relevant technical issues necessary to support the analysis and evaluation of entombment as a option for decommissioning power reactors. The staff's approach was to divide the activities into two stages. The first was a preliminary assessment of the viability of entombment as a decommissioning option. If as a result of this preliminary assessment, entombment was determined to be a viable option, the second stage would include additional studies to evaluate entombment options that might reasonably be selected by licensees and that would be worthwhile for their generic applicability.

The first stage efforts are being completed. The preliminary assessment addressed realistic entombment scenarios and the ability to isolate the contained radioactive materials, such as was done for some of the in-situ disposals at Site Decommissioning Management Plan (SDMP) sites. This assessment included consideration of factors such as the behavior of the radioactive materials expected to be entombed, the integrity of the entombing structure, the site-specific sorptive and hydro-geological properties of the surrounding media, and relevant hypothetical radioactive contaminant transport behavior resulting in dose pathways for public exposure.

Based upon the first stage results, entombment appears to be a viable option for decommissioning. While this conclusion is preliminary, the next stage of the review will include an analysis of regulatory impacts in terms of the resources involved, potential cost savings, and vulnerabilities. This stage will be initiated when the PNNL report is completed.

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**DISCUSSION**

Important current requirements pertaining to the entombment option are contained in 10 CFR 50.82 which was published in 1988. The 1988 rule was structured so that use of any decommissioning option would result in termination of the license for unrestricted use. The term ENTOMB was defined in the Supplementary Information to the 1988 rule as the option in which radioactive contaminants are encased in a structurally long-lived material, such as concrete, the entombed structure is appropriately maintained, and surveillance is continued until the radioactivity decays to a level permitting unrestricted release of the property. During the entombment period, while radioactive decay is taking place, a Nuclear Regulatory Commission license would be maintained. The purpose of this entombment process is to isolate the entombed radioactive waste for the time required for it to decay to an acceptable level so that the reactor facility can be released and the license terminated. Consequently, an accurate characterization of the radioactive materials that are to remain is needed prior to entombment so that the time required for the decay to occur can be determined. Then, after sufficient time has elapsed to reach acceptable levels for release, the license is terminated, and no further concern with the containment would need to be considered. However, if the containment does not adequately isolate the radioactive contaminants prior to license termination, then complications may occur that could result in very expensive remedies. Therefore, prior to entombment, the adequacy of the entombment configuration's ability to isolate the entombed radioactive material over the time period needed for radioactive decay would need to be established. These issues are generally similar to those that have been addressed in release of SDMP sites where in-situ disposals have occurred.

One issue that may affect the viability of the entombment option is contained in Section 50.82(a)(3) and states that "Decommissioning will be completed within 60 years of permanent cessation of operations. Completion of decommissioning beyond 60 years will be approved by the Commission only when necessary to protect public health and safety. Factors that will be considered by the Commission in evaluating an alternative that provides for completion of decommissioning beyond 60 years of permanent cessation of operations include unavailability of waste disposal capacity and other site specific factors affecting the licensee's capability to carry out decommissioning, including presence of other nuclear facilities at the site." If the Commission were to approve a delay in completing decommissioning beyond 60 years, it would need to include institutional control considerations. Then the Supplementary

Information to the 1988 rule identified periods on the order of 100 years as being acceptable for private institutional control. The institutional control requirements of the 1997 rule (discussed below) would also have to be considered.

Another factor that impacts the viability of ENTOMB is addressed in the 1997 rule (10 CFR Part 20, Subpart E) that established a dose criterion for license termination. This rule includes a provision that permits license termination under restricted release conditions. Under a restricted release, the dose to the average member of the critical group must not exceed 25 mrem/yr with the restrictions in place, and, if the restrictions were to fail, the dose due to residual radioactivity could not exceed 100 mrem/yr (or 500 mrem/yr, if additional conditions are met). These caps were chosen to provide a safety net in the highly unlikely event that the restrictions failed, so that exposures in excess of the public dose limit would be minimized.

The staff believes that there are some entombment scenarios that could be implemented within the framework established under the 1997 rule and with limited modifications to 10 CFR 50.82. Other entombment scenarios may require more significant regulatory changes. Development of additional proposed requirements may require resolution of the health and safety concerns associated with long-term storage of radioactive material at a decommissioned site. The details of the staff views are more fully discussed in the Staff Preliminary Analysis of Entombment Option Section that follows.

#### STAFF PRELIMINARY ANALYSIS OF ENTOMBMENT OPTION:

The staff looked at three examples of entombment scenarios having regulatory significance. In Example 1, the radioactive waste that is intended to be entombed is placed in the entombing structure (i.e., the reactor containment building). The structure is not sealed at this time. The facility is then maintained under license in a safe storage configuration for the time required for the radioactivity to decay to a level such that the license could be terminated, which could be on the order of 100 years or longer (see discussion below). After the storage period, the source term is characterized, the entombing structure is closed, and the license terminated with restrictions. It is assumed that prior to sealing the entombing structure, records of survey measurements are maintained to document the occurrence of any significant movement of radioactivity to the biosphere or the observation of any significant structural degradation. If the predominant radionuclide entombed was Co-60, then the time required for the entombed radioactivity to result in a dose that is less than the 100 mrem/yr limit should the restrictions fail could be on the order of a 100 years. If Cs-137 was more predominant, then the time to reach acceptable levels could be 300 years. It is assumed that any greater than class C waste (GTCC), which contains very long-lived activation products, is removed prior to closure of the entombing structure. For the Example 1 entombment, the type, amount, and distribution of the radioactivity being entombed at the time of closure could be established with reasonable certainty and costs because significant decay (e.g., of the activation products contained within the reactor pressure vessel) has occurred. Based on such considerations, license termination for Example 1 entombment situations should fall within the framework of the current regulations with some limited revisions. The provision specified in Section 50.82 that decommissioning is expected to be completed within 60 years, absent a public health and safety reason for a longer period, would need to be revised.

In Example 2, shortly after the facility permanently ceases operations, the entombing structure is closed and termination of the license is requested. This would be based on an analysis that shows the entombment configuration is capable of credibly isolating the entombed radioactive material during the time required for decay to levels such that the dose provisions of the 1997 rule would be met. In the 1997 rule, the possibility of the restrictions failing is accepted. However, in example 2, failure of the entombment must be assumed to be extraordinarily unlikely during the time required for radioactive decay because the material intended for entombment could be at a very high radiation level. This would require consideration of amendments to the regulations to specify additional analysis. As discussed in Example 1, times on the order of 100 years or greater, depending on the radioactive material being entombed, would be required to reach these levels because it is also assumed, as in example 1, that any GTCC waste is removed prior to closure. The use of engineered features as a method for dose reduction is discussed in the Supplementary Information for the 1997 rule and is similar, when generalized, to the use of the entombment configuration. The 1997 rule also includes an additional requirement that periodic rechecks be performed every five years to assure that the institutional controls remain in place for restrictions where a 500 mrem/yr cap exists. This provision could be considered for the Example 2 situation and broadened to include easily verifiable engineering controls (e.g., detection of the presence of water in the entombed structure). Due to the short storage period prior to entombment, something on the order of 10 years, the amount of radioactive material intended for entombment could be very large and result in very high radiation fields (in contrast to Example 1 situations where the radiation fields decay to low values before the entombment structure is sealed). Because of this, interference from these radiation fields on the measurements needed to characterize the spacial distribution of the contributing radionuclides and their corresponding radiation levels could be more troublesome and expensive to obtain. Therefore, reasonable quantification of the entombed radioactive material would be more difficult for Example 2 situations than for Example 1 situations. Moreover, as already indicated above for Example 2 situations, before the license could be terminated it would be necessary to demonstrate that there would be reasonable assurance that the engineered features would not fail for the time period necessary for decay to acceptable levels. Rulemaking to permit license termination for Example 2 situations could be reasonably addressed following further review of the technical issues associated with demonstrating containment integrity.

In Example 3, GTCC waste is not removed prior to entombment closure. The risks associated with Example 3 entombment scenarios are currently being evaluated by PNNL, so the staff has not yet performed a preliminary assessment of this option. Additional information and analysis will be required before further conclusions can be drawn.

#### CONCLUSION:

Consideration of entombment as a generic decommissioning option for power reactors appears to have merit. Rulemaking would be needed before entombment could be treated as the other decommissioning options are today. However, before rulemaking is undertaken, additional information may be needed to support entombment other than Example 1 discussed above. We expect to complete this review in approximately 12 months. Following completion of this review, the staff will provide a report to the Commission which fully describes the options for rulemaking.

Executive Director for Operations

Attachments: SRM, dated: 4/3/97

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April 3, 1997

MEMORANDUM      L. Joseph Callan  
TO:                 Executive Director for Operations  
  
FROM:              John C. Hoyle, Secretary /s/  
  
SUBJECT:          STAFF REQUIREMENTS - COMSECY-96-068 - STRATEGIC ASSESSMENT ISSUE PAPER: DECOMMISSIONING - POWER REACTORS  
                      (DSI 24)

The Commission supports achieving finality in decommissioning requirements as soon as practicable. As the industry moves to a deregulated environment, decommissioning implementation costs must be understood and properly factored into planning decisions and/or rate recovery mechanisms. To this end, the Commission approves Option 2, pursue current direction and approaches more aggressively, for Decommissioning - Power Reactors (DSI 24) as the Final Commission View subject to the following comments.

The staff should address the issue of financial assurance for decommissioning. The staff should also address the issue of site specific decommissioning cost estimates by providing a rulemaking plan for Commission consideration.

(EDO)

(SECY Suspense: 4/30/97)

The staff should accelerate resolution of decommissioning rulemaking issues and consider the option of combining several rulemakings into a single rulemaking, or a few integrated rulemakings, if practicable. Risk-informed performance-based approaches to these rulemakings should be used only to the extent that the staff is ready to proceed with such an approach now.

The Commission is currently considering the issues of the radiological criteria for decommissioning in SECY-97-046 and the interim storage of greater-than-class-C waste in SECY-97-056.

The staff should consider the public comments received suggesting improvements in existing practices and rulemakings. These should include lessons-learned (e.g. packaging and transport), data available (e.g., survey costs) from recent decommissionings, and implementing radiological assessments coincident with the licensee's efforts.

To the extent that it does not compromise public health and safety, or delay the staff's completion of accelerated rulemaking, the staff should consider innovative regulatory approaches to decommissioning. Particular approaches to consider are those which can accelerate decommissioning in a safe manner, but with appropriate NRC oversight at critical stages in the process. Options the staff should consider include: taking a performance-based approach by only performing a radiological assessment of the site when it is ready to be released; placing an inspector onsite during specific phases of decommissioning (e.g. during active dismantlement); and, centralizing reactor decommissioning inspection programs in headquarters.

(EDO)

(SECY Suspense: 12/31/97)

The staff should provide the Commission with an analysis of whether or not the staff views entombment as a viable decommissioning option and how this option has been dealt with previously by the Commission. If the staff concludes that it is not a viable option, the staff should describe the technical requirements and regulatory actions which would be necessary for entombment to be a viable decommissioning option. The staff analysis should include the resources involved, potential decommissioning cost savings, and vulnerabilities.

(EDO)

(SECY Suspense: 9/2/97)

cc:                 Chairman Jackson  
                      Commissioner Rogers  
                      Commissioner Dicus  
                      Commissioner McGaffigan  
                      Commissioner Diaz  
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