POLICY ISSUE
(Information)

May 27, 1994 SECY-94-145

FOR: The Commissioners

FROM: James M. Taylor
Executive Director for Operations

SUBJECT: INCREASE OF TRITIUM AND IRON-55 UNRESTRICTED USE LIMITS FOR SURFACE CONTAMINATION AT SHOREHAM AND FORT ST. VRAIN

PURPOSE:

To inform the Commission of the staff's decision to increase certain unrestricted use limits for surface contamination on buildings, structures, and equipment for the decommissioning projects at Fort St. Vrain Nuclear Station (FSV) and Shoreham Nuclear Power Station (Shoreham). This increase applies only to fixed contamination from iron-55 (Fe-55) and tritium (H-3), and is a modification to one of the clean-up criteria that the Commission directed the staff to consider in the "Action Plan to Ensure Timely Cleanup of Site Decommissioning Plan Sites" (Action Plan) (i.e., Table 1 of Regulatory Guide 1.86 (RG 1.86))

SUMMARY:

Shoreham and FSV are currently decommissioning their facilities with the goal of releasing the buildings, equipment, and grounds for unrestricted use in the short term (i.e., the DECON option). The major radionuclide identified in contaminated structures and systems during the characterization of these facilities was cobalt-60 (Co-60). However, during the dismantling of the facilities, both licensees identified concrete containing unexpectedly high concentrations of H-3 and Fe-55 in areas subjected to neutron radiation during operations. Shoreham also identified Fe-55 in steel used as a liner for the bioshield concrete. The total (fixed plus removable) surface contamination

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levels of H-3 and Fe-55 on the concrete and steel exceed the current unrestricted use limits. Smaller concentrations of europium-152 (Eu-152) and Co-60 have also been identified on the activated material. Shoreham estimates that compliance with the current surface contamination limits for the H-3 and Fe-55 in the activated material will require the shipment of up to 73 additional cubic meters (2600 cubic feet) of slightly contaminated concrete and steel, above that required to comply with the Co-60 and Eu-152 surface contamination limits alone, to a licensed low-level waste facility at a cost of up to $1 million. FSV has estimated that compliance with the current surface contamination limits would require the removal and shipment of up to 260 additional cubic meters (9300 cubic feet) of activated concrete, at a cost of up to $4.5 million. Both licensees submitted requests to increase the unrestricted use limits for H-3 and Fe-55 surface contamination based on their conclusions that the risks from H-3 and Fe-55 are very small, at the current limits, and that application of the current limits to the activated material at their facilities is not in accordance with the as low as is reasonably achievable (ALARA) principle.

The staff evaluated the risk from H-3 and Fe-55 surface contamination relative to the other radionuclides listed in RG 1.86. The risks from Fe-55 and H-3 surface contamination at their respective RG 1.86 limits were found to be lower than the average risk from the other nuclides by at least a factor of 400. The risks are lower because Fe-55 emits only low-energy X-rays and H-3 emits only low-energy beta radiation. A detailed discussion of the relative risks, and additional background information, is contained in the enclosure.

Based on the magnitude of the disparities between risks, the staff concluded that it would be ALARA to increase the surface contamination limits for H-3 and Fe-55 at FSV and Shoreham, and that the magnitude of the increase could be limited to ensure that the risks from H-3 and Fe-55 remain consistent with the risks from the other nuclides in RG 1.86. The staff contemplated raising the total average surface contamination limits for H-3 and Fe-55 from the current 5,000 dpm/100 cm^2 limit to 2,000,000 dpm/100 cm^2. At this level, the risk from Fe-55 would be equal to the average risk from the other nuclides in RG 1.86, and the risk from H-3 would be less than the average. However, in consideration of ALARA, the staff selected 200,000 dpm/100 cm^2 as the new total average surface contamination limit for H-3 and Fe-55 at FSV and Shoreham.

RG 1.86 also contains maximum limits that are 3 times the average limit. Accordingly, the maximum limit for total H-3 and Fe-55 surface contamination was raised by a factor of 3 to 600,000 dpm/100 cm^2.

The existing limits for removable H-3 and Fe-55 surface contamination were also evaluated. Increasing the removable contamination limits is not considered ALARA, since standard remediation techniques are capable of lowering removable contamination to levels below the current limit. Therefore, the removable limits for H-3 and Fe-55 will remain at the current level of 1000 dpm/100 cm^2.

The primary bases for the staff's decision to increase the surface contamination limits for H-3 and Fe-55 were 1) that the risk from the increased limits are consistent with the risk from other nuclides, and 2) ALARA. However, to provide additional information, dose assessments were performed assuming that contamination is present at the increased limits.

At 200,000 dpm/100 cm^2, the estimated doses from H-3 and Fe-55 surface contamination are 0.01 and 1.1 E-03 mSv (1.0 and 0.11 mrem)/y, respectively. These potential doses will decline as Fe-55 and H-3 decay with half-lives of 2.6 years and 12.2 years, respectively.

The above calculations assume that the dose from the activated concrete is from the inhalation and ingestion of material resuspended or removed from contaminated surfaces, which are considered the most probable exposure pathways. Although considered unlikely, the staff also estimated the potential dose assuming that the activated concrete is removed from the buildings and disposed without restrictions. For this case, the groundwater pathway, and the other exposure pathways in the residential farmer scenario, were evaluated. The resulting potential doses from the unrestricted disposal of the material at Shoreham and FSV were estimated as 0.012 mSv/y (1.2 mrem/y) and 0.019 mSv/y (1.9 mrem/y), respectively. These modeled doses decline rapidly with time following the maximum due to the conservative assumption that all of the H-3 is leached in the first year. For example, the fourth and sixth year doses at both facilities are less than 5E-03 and 2E-04 mSv/y (0.5 and 0.02 mrem/y), respectively.

The modified Fe-55 and H-3 limits discussed in this paper are based on ALARA considerations specific to the FSV and Shoreham decommissioning projects. However, volumetric contamination of activated materials at decommissioning power reactors is a generic issue and the staff anticipates that other decommissioning reactors will make similar requests for exceptions to RG 1.86 for H-3 and Fe-55, and that such requests would likely be approved. This issue should be addressed generically in the guidance developed to implement the rulemaking on Radiological Criteria for Decommissioning. This guidance would supersede or modify RG 1.86. The staff expects to notify Shoreham and FSV that the limits have been increased no later than June 3, 1994. This early date is associated with the time required to remove and ship low-level waste, if necessary, to Barnwell prior to the June 30, 1994, deadline. A meeting with the Commission assistants to discuss this matter would be useful.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection.

James M. Taylor
Executive Director
for Operations

Enclosure:
As stated

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ADDITIONAL BACKGROUND AND TECHNICAL INFORMATION

In the Action Plan, the Commission directed the staff to consider existing guidance, and ALARA, when determining a site's suitability for unrestricted use pending the final rule on "Radiological Criteria for Decommissioning." Table 1 of RG 1.86, which contains surface contamination limits for buildings, structures, and equipment, was listed in the Action Plan as one of the existing criteria to consider. Accordingly, the staff approved the limits in RG 1.86 as the unrestricted use criteria for surface contamination at FSV and Shoreham.

The experience, to date, in applying the RG 1.86 surface contamination limits as unrestricted use criteria has been positive. In general, the limits are practical and ALARA, and have been applied by Nuclear Regulatory Commission licensees undertaking decommissioning. However, on December 23, 1993, the Public Service Company of Colorado (PSC) requested that NRC increase the surface contamination limits for Fe-55 and H-3 at FSV. The Fe-55 and H-3 contamination identified at FSV resulted from neutron activation and is primarily located in the concrete comprising the former prestressed concrete reactor vessel. PSC contends that the surface contamination limits for these two nuclides should be increased since: 1) the potential health and safety risk from these nuclides is very low; 2) the relative risk from these nuclides is very low compared to the other nuclides of concern at FSV, predominantly Co-60 and Eu-152; and 3) compliance with existing limits for these nuclides would cost an additional $4.5 million above the cost required to comply with the surface contamination limits for Co-60 and Eu-152.

In addition, on April 22, 1994, Shoreham requested that NRC consider revising the release criteria for Fe-55 and H-3 because of the recent identification of concrete and steel, from the biological shield, that contains elevated levels of H-3 and Fe-55 as a result of neutron activation. Shoreham asserts that applying the current unrestricted release criteria for Fe-55 and H-3 would cost up to $1 million without appreciable decrease in potential risk to public health and safety, and that Fe-55 and H-3 pose significantly lower risk than other nuclides in RG 1.86.

In response to the FSV and Shoreham requests, the staff reviewed the technical bases for Table 1 of RG 1.86 to determine if the limits for H-3 and Fe-55 are inconsistent with the other nuclides in Table 1. The RG 1.86 limits were developed using a semi-quantitative evaluation of relative risk based on the maximum permissible concentrations (MPC) for air and water listed in 10 CFR Part 20. The starting assumption in developing the limits was that licensees should not be expected to lower surface contamination below the existing environmental background levels caused by fallout from the atmospheric testing of nuclear devices. The predominant radionuclide found in the environment as a result of atmospheric testing is strontium-90 (Sr-90); the background level of Sr-90 was about 1000 dpm/100 cm^2 in 1974, when RG 1.86 was published.

The surface contamination limits in Table 1 of RG 1.86 were selected using the 1000 dpm/100 cm^2 environmental background level for Sr-90 as the baseline. Using the ratio of Sr-90 MPC's to the MPC's for the various nuclides as a measure of relative risk, the RG 1.86 surface contamination limits were generally set at one of three levels, i.e., 100, 1000, or 5000 dpm/100 cm^2. The upper limit of 5000 dpm/100cm^2 was set, in part, to limit direct radiation and, in part, as a level that seemed readily attainable. Note that the direct radiation exposure from both Fe-55 and H-3 is essentially zero. The ability to measure the contamination using standard industry instrumentation and methods was also considered in setting the RG 1.86 limits.

The developers of RG 1.86 were aware that disparities existed between the risks from the various nuclides at their respective RG 1.86 limits, but issued the guide as a matter of practicality, realizing that a method for more closely estimating the risk from surface contamination would not be accepted as a consensus in the near term. Before the FSV and Shoreham cases, there has not been a compelling reason to evaluate more closely the magnitude of the disparities. Note that the inconsistencies in RG 1.86 are being addressed generically in the rulemaking on "Radiological Criteria for Decommissioning."

To determine if the RG 1.86 limits for H-3 and Fe-55, i.e., 5000 dpm/100 cm^2, pose relative risks that are significantly lower than other nuclides, the staff evaluated the risk from each of the nuclides specifically listed in RG 1.86, as well as Co-60, Cs-137, Eu-152, C-14, Ni-59, Ni-63, H-3, and Fe-55. The risk from each nuclide was estimated by multiplying the RG 1.86 limit by the nuclide specific dose factors for surface contamination developed for the building occupancy scenario in NUREG/CR-5512, "Residual Radioactive Contamination from Decommissioning," October 1992. For example, the NUREG/CR-5512 dose factor for Sr-90 surface contamination is 1.51E-05 mSv/y (1.51E-03 mrem/y) per dpm/100 cm^2 and the RG 1.86 surface contamination limit for Sr-90 is 1000 dpm/100cm^2. Multiplying these two values results in a dose of 1.51E-02 mSv(1.51 mrem)/y. Note that the NUREG/CR-5512 dose factors are currently the staff's best estimate of dose from surface contamination. These dose factors were developed to support the ongoing rulemaking on "Radiological Criteria for Decommissioning."

The estimated doses for the 24 nuclides evaluated range from about 0.8 mSv/y (80 mrem)/y for uranium to about 2E-05 mSv (2E-03 mrem)/y for I-133. The resulting doses for Co-60, Fe-55, and H-3 are 0.14, 2.5E-04, 2.8E-05 mSv (14, 2.5E-02, and 2.8E-03 mrem)/y, respectively. The average dose for the 24 nuclides evaluated was about 0.1 mSv (10 mrem)/y.

Comparing the relative risks from Co-60 to both Fe-55 and H-3, it is seen that the risk from Co-60, at the RG 1.86 limit, is 5000 times greater than the risk from H-3 and 560 times greater than the risk from Fe-55. Because of the magnitude of these differences, and the estimated cost of compliance with the existing limits at FSV and Shoreham, the staff believes that it is appropriate to consider the surface contamination limits for H-3 and Fe-55 separately.

To determine the total surface contamination limits, the staff considered the average dose from the 24 nuclides at their respective RG 1.86 limits, and ALARA. In addition, to maintain simplicity in implementation, the limits for both H-3 and Fe-55 were both set at equivalent levels, using the dose from Fe-55 as the basis. This results in a more conservative dose for H-3. The estimated average dose from nuclides at the RG 1.86 limits, as evaluated above, is 0.1 mSv (10 mrem)/y, which translates to a limit of 2,000,000 dpm/100 cm^2. In consideration of ALARA, the limit finally selected for total surface contamination from Fe-55 and H-3 at FSV and Shoreham was 200,000 dpm/100 cm^2. At 200,000 dpm/100 cm^2, the estimated Fe-55 and H-3 doses are 0.01 and 1.1 E-03 mSv (1.0 and 0.11 mrem)/y, respectively. These potential doses will decline as Fe-55 and H-3 decay with half-lives of 2.6 years and 12.2 years, respectively.

The 200,000 dpm/100 cm^2 limit discussed above applies to average contamination levels. RG 1.86 also contains maximum limits that are 3 times the average limit. Accordingly, the maximum limit for H-3 and Fe-55 total surface contamination was raised to 600,000 dpm/100 cm^2.

The existing limits for removable H-3 and Fe-55 surface contamination were also evaluated. Increasing the removable contamination limits is not considered ALARA since standard remediation techniques are capable of lowering removable contamination to levels below the current limit. Therefore, the removable limits for H-3 and Fe-55 will remain at the current level of 1000 dpm/100 cm^2.

The above dose calculations assume that the exposure from the activated concrete is through the inhalation and ingestion of material resuspended or removed from contaminated surfaces, which are considered the most probable dose pathways. However, although considered unlikely, the staff also evaluated the potential dose assuming that the activated concrete is removed from the buildings and disposed without restrictions. The potential dose was estimated using the RESRAD environmental pathway and dose assessment code (ANL/EAD/LD-2). The resulting dose is considered conservative since, 1) the activity in the concrete and steel was assumed to be immediately available for uptake by plants and animals, and 2) all of the H-3 is assumed to leach from the concrete in the first year and migrate to groundwater. The resulting maximum potential doses from groundwater, plus the other exposure pathways in the residential farmer scenario, at Shoreham and FSV are 0.012 mSv/y (1.2 mrem/y) and 0.019 mSv/y (1.9 mrem/y), respectively. The modeled dose declines rapidly with time following the maximum due to the conservative assumption that all of the H-3 is leached in the first year. For example, the fourth and sixth year doses at both facilities are less than 5E-03 and 2E-04 mSv/y (0.5 and 0.02 mrem/y), respectively.