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Proposed WSRC Clearance Modifications

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Executive Summary

Westinghouse Savannah River Company (WSRC) proposes to modify criteria used for releasing material from Savannah River Site (SRS) radiological areas to other SRS areas (restricted releases) and for releasing material from SRS for uncontrolled use (unrestricted releases). These criteria are selected to be consistent with Department of Energy (DOE) Order 5400.5 [Ref. 1] requirements that permit the establishment of dose-based limits subject to the As Low As Reasonably Achievable (ALARA) process and provide for protection of SRS workers as well as the public. WSRC proposes to utilize the logic and principles in American National Standards Institute (ANSI) Standard ANSI/HPS N13.12 [Ref. 2] to provide SRS with consistent, dose-based and cost-effective clearance criteria that remain protective of the public and the environment. These modifications provide surface as well as volume clearance criteria. They are based on a national technical standard not developed by or for DOE. For these reasons, WSRC believes their use will ultimately enhance public credibility in SRS clearance practices. For most radionuclides, the proposed criteria represent only small differences from existent WSRC criteria. However, for tritium and a few beta-gamma emitters, notably Sr-90, the changes are more pronounced. The proposed SRS release criteria provide protection of individuals and the public at large and are consistent with ANSI/HPS N13.12. The proposed criteria provide reasonable assurance that the maximum dose due to release of property will be less than one mrem per year with the expectation that actual public doses will be much lower. Potential doses to DOE and DOE contractor staff will be a small fraction of dose limits established in the Code of Federal Regulations (CFR) 10CFR835 [Ref. 3].

Background

Surface clearance criteria in use by U. S. nuclear regulatory agencies such as DOE or the Nuclear Regulatory Commission (NRC) can be traced back to a 1964 Ad Hoc Atomic Energy Commission (AEC) Committee, and were intended to quantify AEC practices. These criteria were later documented in NRC Regulatory Guide 1.86 in 1974 [Ref. 4], and basically have not been changed since. These criteria are not fully dose-based and have internal inconsistencies. They include numeric criteria for removable and total radioactivity in several categories on surfaces, but do not address volume contamination.

The surface activity guidelines were first adopted for DOE-wide application on March 15, 1984, in a memorandum for the Office of Nuclear Safety [Ref. 5]. In 1990, they were included in Order 5400.5 and in subsequent revisions and clarifications [Ref. 1, 6]. The Order has not been revised since 1993 because DOE has been focusing on developing a regulation to replace Order 5400.5 and has proposed 10CFR834 [Ref. 7] for comment several times. Proposed 10CFR834 did not include (did not propose to promulgate) the surface activity guidelines. However, the preamble to the proposed rule indicated that while the surface guidelines were generally protective, they were not internally consistent or dose-based. The rule indicated a preference for dose/ALARA-based approaches but the preamble noted DOE would continue to permit the use of the guidelines as an alternative to dose/ALARA-based limits while DOE worked with other agencies to determine if they should be replaced.

The original surface clearance criteria (and those in Regulatory Guide 1.86) did not consider tritium (or other weak beta emitters). By default, most DOE sites, including SRS, have used the criteria for general beta-gamma emitters for tritium, even though it emits a very weak beta and offers much less risk per activity unit than most beta-gamma emitters. In the November 1995 Order clarifications [Ref. 6], DOE inserted a specific criterion of 10,000 dpm/100 cm^2 for removable surface tritium. In adding these supplemental criteria for tritium, DOE noted that because tritium is rarely a surface contaminant, the surface guidelines from Order 5400.5 should not be used; instead, the removable-only criterion was appropriate and fully protective. However, as with the surface guidelines, dose-based alternative limits are permitted. WSRC has not as yet implemented the more relaxed tritium clearance criterion in the 1995 DOE guidance [Ref. 6] because the expense to implement the change at SRS exceeds the expected cost benefit. However, the dose-based criterion WSRC proposes for tritium is cost effective.

When Order 5400.5 was last issued in 1993 [Ref. 1], the clearance criterion for total surface concentrations of transuranics and certain other radionuclides (primarily alpha emitters) was listed as "RESERVED." However, Chapter IV, Section IV.2 of the Order references DOE/CH-8901, "A Manual for Implementing Residual Material Guidelines" [Ref. 8], for use in establishing allowable levels of residual radioactive material on real property. Although not promulgated in the Order, the manual included the same values as the 1984 guidance memorandum [Ref. 5]. In clarifying guidance for Order 5400.5 issued in November 1995 [Ref. 6], DOE reissued the 1984 transuranics values as the only DOE-wide approved surface guidelines for transuranics.

In the November 1995 Order clarifications [Ref. 6], the same alpha total surface criterion as presented in Regulatory Guide 1.86 was inserted. Achieving this criterion requires multiple static counts (for one to three minutes for each area counted) over a grid of the surface, and hence implementation of the criterion is labor-intensive and expensive to implement. WSRC has long used criteria of 20 dpm/100 cm^2 for transferable alpha and 500 dpm/100 cm^2 for total alpha on surfaces, for both restricted and unrestricted release of materials. WSRC continues to believe these criteria to be fully protective. ANSI/HPS N13.12 risk evaluations fully support this position.

Proposed WSRC Clearance Criteria

The following single set of clearance criteria are proposed for use at SRS for both restricted and unrestricted release of material:

Table 1. Proposed WSRC Surface and Volume Release Criteria for Materials

Surface Criteria[1]	Transferable Contamination (dpm/100 cm^2)	Total Surface Contamination (dpm/100 cm^2)
Alpha	20	600
Beta-Gamma and U	1000	6000
Tritium	100,000	NA
Volume Criteria[2, 3]	Concentration (pCi/g)	
Alpha	3	
Beta-Gamma and U	30	
Tritium	2000	

1. Special restrictions will remain in WSRC procedures to adhere to the DOE Suspension (July 2000) on the unrestricted release of metals from SRS radiological areas for recycle purposes.
2. Volume criteria will not apply to metals while the DOE Moratorium (January 2000) on unrestricted release of volume-contaminated metals remains in effect.
3. For soils, rubble, and debris, volume criteria will only be applied for the purposes of disposal in a state, DOE, or NRC permitted or approved landfill or disposal facility.

As is the case for current WSRC procedures for release of materials, alpha criteria will apply to alpha-emitting transuranics, Ra-226, Ra-228, Ac-227, Th-228, Th-230, Th-232 and Pa-231. The beta-gamma criteria will apply to beta-gamma emitters except for tritium and will apply to natural and enriched uranium and associated decay products. Consistent with Order 5400.5 [Ref. 1], these criteria will be applied to SRS-added radioactivity. They will not be applied to naturally occurring radionuclides not technologically enhanced by SRS activities, and not to trace radionuclides present in various media as a result of worldwide fallout. These criteria in and of themselves are not intended for use as remedial action standards for residual radioactivity; such cleanup standards involve a concurrence for a particular waste site by appropriate state and/or federal agencies, consistent with applicable environmental laws.

More detailed discussions on the restrictions and planned use of these criteria for specific materials to be released from SRS are included in the ALARA Considerations section of this proposal.

Discussion and Rationale

The proposed WSRC release criteria will be consistent with Order 5400.5 requirements and associated guidance applying establishment of dose/ALARA-based limits. They are based on the principles and logic of ANSI/HPS N13.12. The specific criteria are such that the dose that could be received by an individual will be within the primary clearance standard of ANSI/HPS N13.12, namely one mrem/year. That primary standard is consistent with the internationally recommended standard [Ref. 9], and also consistent with the recommendation of the National Council on Radiation Protection &

Measurements (NCRP) that one mrem/year be accepted as a negligible individual dose [Ref. 10]. The DOE process for evaluating and selecting release criteria is similar to the procedures under the current NRC case-by-case approach. The proposed criteria also provide levels of protection not inconsistent with those being considered for dose-based release strategies resulting from the NRC Commissioners' Directive on October 25, 2002 [Ref. 11] to proceed with rule making on criteria for release of material based on the same primary dose criterion.

ANSI/HPS N13.12 does not provide concentration criteria for transferable surface radioactivity. WSRC believes, however, there is continued protective value in maintaining transferable criteria for contamination control. Their use helps avoid the potential that an individual or personal property may have contamination below release criteria but above what might trigger alarms on egress monitoring equipment.

The proposed change in alpha criteria for total surface contamination is small; it modifies the existing WSRC total surface criterion of 500 dpm/100 cm^2 to 600 dpm/100 cm^2, consistent with surface screening criteria in ANSI/HPS N13.12. This change will not result in a change in methods for surveying material for release. WSRC will continue to scan surfaces with alpha detection instruments, and will confirm any areas with detectable alpha activity fall within the release criterion.

The change in the beta-gamma and uranium criterion is likewise small; it modifies the existing WSRC total surface contamination criterion of 5000 dpm/100 cm^2 to 6000 dpm/100 cm^2, consistent with ANSI/HPS N13.12. No change in survey methods to release materials is anticipated. WSRC will continue to scan surfaces with beta-gamma (and alpha for uranium) detection instruments, and will confirm any area with detectable activity is below the release criterion. The primary change is that the groupings of ANSI/HPS N13.12 were followed; as a result, the criteria for some radionuclides (e.g., Th-232) became more restrictive than for Order 5400.5, while the criteria for others, such as Sr-90, became less restrictive. These changes are consistent with dose evaluations performed for ANSI/HPS N13.12 for these radionuclides.

The proposed tritium release criterion of 100,000 dpm/100 cm^2 is a substantial change from the current WSRC criterion of 1000 dpm/100 cm^2. It is entirely consistent with the guidance of ANSI/HPS N13.12, which lists a clearance screening level of 600,000 dpm/100 cm^2 for total tritium surface contamination. Release guidelines assume that about 20 percent of surface contamination is transferable. Thus, ANSI/HPS N13.12 guidelines would indicate a transferable criterion of 120,000 dpm/100 cm^2. Separately, a DOE review committee recommended in 1991 a release level of 100,000 dpm/100 cm^2 for transferable tritium contamination [Ref. 12], after their conservative calculations indicated that it would take about 4 million dpm/100 cm^2 of tritium on an object to give an individual one mrem/year. Calculations by the NRC [Draft NUREG-1640, Ref. 13] with specific material flow patterns and less conservative assumptions indicated it would take about 130 million dpm/100 cm^2 of tritium on an object to give an individual one mrem/year.

There are certain tritium compounds, identified as Special Tritium Compounds (STCs), that may have higher dose conversion factors and are more difficult to detect. STCs are not a major component of tritium radiological hazards at SRS. However, WSRC has implemented a program for enhanced radiological controls when STC-related work is to be performed. When enhanced radiological controls for STCs are enacted at SRS, the proposed alternate criterion for tritium will not be applied.

WSRC proposes to use only a transferable surface criterion, consistent with Order 5400.5 guidance [Ref. 6] and with the recommendations of the DOE Tritium review committee report. WSRC concurs that transferable surface contamination is the only appropriate surface criteria for tritium, and that total surface tritium is neither measurable nor available to provide risk unless volumetric pathways are considered. A separate volumetric release criterion is provided in ANSI/HPS N13.12 and one is likewise proposed for use by WSRC.

The proposed WSRC volume concentration criteria are the same as those in ANSI/HPS N13.12, except that WSRC proposes a slightly more restrictive criterion (2000 pCi/g) for the tritium volume criterion. The more restrictive tritium criterion avoids potential conflict with the U. S. Department of Transportation (DOT) definition of radioactive material for the purpose of shipping regulations. Neither DOE nor NRC has yet provided specific criteria for unrestricted release of material with residual volume radioactivity. NRC calculations in Draft NUREG-1640 that indicate it would take about 30,000 pCi/g of tritium volume contamination to result in 1 mrem/year to the critical groups identified.

In Order 5400.5, materials that may contain volume contamination can be released on a case-by-case basis, with specific DOE approval. Lack of specific, measurable criteria for volumes has been difficult to understand by members of the public. WSRC proposes to implement the volume criteria presented in ANSI/HPS N13.12, recognizing that they provide the same level of protection against risk to individuals and the public collectively that the surface criteria do. Surface and volume criteria, used in conjunction, provide measurable, achievable, and consistent criteria for decisions on clearance of materials.

At SRS, materials are surveyed as they leave the pertinent radiologically posted boundary. If they do not meet the release criteria, they can only be released for restricted use, and are so labeled. If they do meet the release criteria, they can be moved to any other SRS location or can be released off-site without further survey. Central to this proposal is the WSRC plan to continue to use a single set of release criteria for both restricted and unrestricted release of materials from SRS radiological areas. To manage clearance of materials in any other fashion at SRS would significantly increase costs for additional and unnecessary surveys.

For ease of comparison, the current Order 5400.5 surface activity guidelines for unrestricted release are reproduced in Appendix A of this proposal. The 10CFR835 surface contamination values for use in posting, control and/or labeling, and restricted release are reproduced in Appendix B. ANSI/HPS N13.12 screening levels for clearance are presented in Appendix C.

Bases for WSRC Request for Alternate Criteria

Request for exemption to 10CFR835 Appendix D
WSRC believes this request for an exemption to 10CFR835 is in accordance with the criteria provided in 10CFR820.62 Subpart E, Exemption Relief [Ref. 14] for granting an exemption to a DOE Nuclear Safety Requirement.

10CFR820.62(a): As stipulated by Part 10CFR820.62, exemptions to 10CFR835 (one of the regulations promulgating DOE Nuclear Safety Requirements) are authorized by law. Further, WSRC believes that the requested exemption will not be inconsistent with any other known law.

10CFR820.62(b): The exemption would not present an undue risk to public health and safety, environment or facility worker. This exemption request involves the use of alternate risk/dose-based contamination values at SRS instead of the Surface Contamination Values of Appendix D to 10CFR835. The request is based on the principles and logic of ANSI/HPS N13.12 and results in criteria that remain protective of workers, the public and the environment.

10CFR820.62(c): The exemption is consistent with safe operations. Not only are the primary and secondary standards of ANSI/HPS N13.12 protective of workers as well as the public and the environment, they offer numeric and achievable contamination criteria for both surfaces and volumes. Since existing regulatory criteria are only for surfaces, this requested exemption accounts for materials that can become volumetrically contaminated. Further, utilization of ANSI/HPS N13.12 (a national technical consensus standard) would be fully consistent with Public Law 104-113 [Ref. 15]. WSRC believes the elements of the requested exemption to be fully consistent with the safe operation of a DOE nuclear facility.

10CFR820.62(d)(2): Application of existing criteria would result in resource impacts of requirements that are not justified by safety improvements. The underlying purpose of the regulation will still be achieved through the requested exemption. The proposed contamination values offer substantial improvements in cost effectiveness of SRS programs without any detrimental impact on the health and safety of SRS workers, the public, or the environment.

Request for SRS Supplemental Release Limits
WSRC believes it has followed the specifications in Order 5400.5 [Ref. 1] and it's subsequent guidance [Ref. 6] for requesting SRS Supplemental Release Limits. Order 5400.5 specifies detailed release scenario evaluations for determination that such limits are ALARA, based primarily on pathway analysis and dose estimation. Only bounding case ALARA evaluations are provided in this proposal, since the proposed WSRC clearance criteria are within the:

- 100 mrem/year dose limit to members of the public established in Order 5400.5,

- 25 mrem/year dose constraint DOE has introduced in subsequent guidance (and in Draft 10 CFR834), and
- DOE 1 mrem/year dose constraint applied to personal property.

DOE guidance [Ref. 16] provides instructions that no quantitative ALARA evaluations are necessary so long as proposed criteria provide reasonable assurance that doses to the public will be less than 1 mrem per year to an individual and less than 10 person-rem per year population dose.

ALARA Considerations

This section provides a discussion of the various types of materials that are released from SRS radiological facilities or areas. These discussions include estimates for the quantities of each class of material, the projected release pathways for each class, and bounding dose evaluations due to volumes of materials released.

Worker Protection

The only substantial change proposed in surface contamination values is for transferable tritium. The impact would be that areas posted for control of tritium contamination would be based on a transferable tritium surface contamination of 100,000 dpm/100 cm^2 instead of the current 10CFR835 Appendix D value of 10,000 dpm/100 cm^2. To evaluate the maximum potential dose impact on a worker from the proposed criterion, calculations were performed using RESRAD-BUILD (see Appendix D), with highly conservative assumptions. These calculations indicate a worker could receive a maximum of 2 mrem/year with the proposed tritium criterion, and substantially less with more realistic pathway assumptions. Actual operating experience with monitored workers who primarily work in areas that would no longer be posted as Contamination Areas indicate that seldom does such a worker receive 1 mrem/year. Based on dose pathway evaluations and operating experience, the increase in collective worker dose as a consequence of posting changes under the proposed criteria will be less than 0.5 person-rem per year. Cost savings will result primarily from increased efficiency in facility operations and radiological controls, and in decreased quantities of personal protective equipment used. Annual savings of $400K have been estimated. The proposed tritium criterion is not only cost effective, it brings radiological postings in tritium facilities more in line with the risks in other areas posted for control of alpha or beta-gamma emitting radionuclides. Hence the proposed tritium contamination value is believed to be ALARA for worker protection.

WSRC has evaluated the potential use of 10,000 dpm/100 cm^2 allowed by 10CFR835 Appendix D (instead of the current WSRC use of 1000 dpm/100 cm^2). Due to the nature of tritium facility operations and levels of surface tritium on facilities and materials, the 10,000 dpm/100 cm^2 criterion offers little if any potential cost savings. These evaluations are discussed further in the Cost Benefits and ALARA Considerations Summary sections of this proposal.

For worker protection against volume contamination, the dose to an individual worker exposed to deposited radionuclides at the maximum alpha, beta/gamma and tritium proposed volumetric release criteria was evaluated (See Appendix E). A worker exposed to such materials evenly distributed over a large area to a depth of 20 cm would receive about 22 mrem per year, primarily due to direct exposure from Cs-137. The typical SRS fission product waste stream is about one-third Cs-137, so this estimate is conservative. It is further conservative since WSRC does not plan to apply the volumetric criteria to soils, rubble and debris except for disposal in a landfill approved for such use (Table 1, Footnote 3).

Public/Environmental Protection

Evaluation of the potential impact of proposed changes in criteria for release of materials from SRS for unrestricted use is based on the type and quantity of materials to be released, their whereabouts after release, and the pathways of potential public exposure.

Soils, Rubble and Debris

Large quantities of soils are handled at SRS each year. The majority of movement involves relocation of soil that has not been radiologically impacted. However, it is estimated that about 250 cubic meters of potentially contaminated soil is disposed of each year. That quantity can vary considerably, depending on specific restoration, closure or D&D projects in a given year. For example, in FY03, disposal of an additional 150 cubic meters of such soil is anticipated. For potentially contaminated rubble and debris, even larger quantities are involved. An annual disposal of 2000 cubic meters of such material is estimated. Two specific D&D projects will add about 4500 cubic meters in FY03.

As a matter of practice, soils, rubble and debris are not released from SRS for fully unrestricted use. Their only release pathway is disposal. As denoted in Table 1, Footnote 3, for soils, rubble and debris, the proposed volume criteria will only be applied for the purposes of disposal in a state, DOE, or NRC permitted or approved landfill or disposal facility.

To evaluate potential impact from disposal of these materials, dose pathway analyses have been performed for two types of disposal of these materials. The first evaluation (see Appendix E) assumes that material contaminated to the proposed volume release criteria is spread uniformly over a 20 cm depth and a large area. The maximum dose to an industrial worker for such disposal is about 22 mrem/year, assuming 2000 hours of contact (primarily due to direct gamma exposure). While no such disposal is planned for such SRS materials, it serves as a bounding dose impact for workers who may come in contact with materials in the disposal process. However, a landfill worker directly exposed to wastes materials during disposal activities will receive a much lower dose than the bounding dose under realistic assumptions. The material will actually be disposed of over a ten-year period. Based on typical truck disposal times, it is estimated that the annual direct exposure time to a landfill worker will be about 80 hours, which reduces the annual dose to less than 0.9 mrem. For a local sanitary landfill, SRS wastes would represent only 1% of the wastes received by the landfill, providing dilution of the radiological source term and hence even further reducing the potential dose to a landfill worker. Further reductions in potential dose are afforded by shielding and distance provided by heavy equipment, shielding provided by daily clean cover over all newly buried waste, and realistic source terms that reduce Cs-137 concentrations to about one-third of the total (see Appendix F). Under realistic conditions, therefore, a landfill worker will receive far less than one mrem per year from SRS materials.

The second evaluation is for a conglomeration of soils, rubble, debris, and metals, all with radioactivity at volume concentrations equal to the proposed volume release criteria, disposed of in a sanitary landfill. This evaluation assumes 25,000 cubic meters of such material WSRC projects will be disposed of during the projected cleanup and closure of facilities and areas at SRS through 2012. Two pathway assessments are considered (see Appendix F). The first assumes a resident farmer scenario at the landfill following active controls. Under highly conservative pathway assumptions, the maximum dose to such an individual is about 0.001 mrem/year. Actual doses from this pathway will be much smaller since the material disposed of will not all be at the maximum concentration. Also, realistic SRS waste streams are either a mix of fission and activation products, a mix of tritium and fission/activation products, primarily transuranics, primarily uranium, or primarily tritium. Most SRS waste streams consists of radionuclides that contribute less to dose than the conservative assumptions of the bounding calculations. Less conservative assumptions lead to doses lower by about two orders of magnitude.

The second calculation for a conglomeration of soils, rubble, debris, and metals assumes a catastrophic failure of containment such that all radioactive material disposed of is released to the Savannah River in one year. That assessment indicates the bounding collective public dose down-river from SRS to be about 8 person-rem. The maximum individual dose down-river for this assessment was calculated to be 0.82 mrem. Most of the dose to an individual (0.72 mrem) was from fish consumption, due to the high bioaccumulation factor for cesium in fish. Realistic source terms of mixed fission product waste streams from SRS reduce the total dose to about 0.27 mrem. More realistic assessment of the movement of radioactivity into surface waters will reduce the maximum dose to much lower doses, well below 0.1 mrem per year. Collective doses are likewise much lower under more realistic conditions.

Metals

About 150 cubic meters of metals are removed from radiologically controlled areas at SRS each year. Two FY03 D&D projects are projected to add significantly to that waste stream – about 2000 cubic meters – in the short term. These metals are typically not impacted radiologically at volume, but may contain surface contamination. As discussed earlier, the only significant change in surface release criteria is for tritium. Metals with transferable tritium surface concentrations at proposed levels have almost no public dose impact, according to calculations provided in ANSI/HPS N13.12 and in NUREG-1640.

Metals that may have SRS-added radioactivity at volume, regardless of level, are not released from SRS for unrestricted use, as indicated by Table 1, Footnote 2. DOE imposed a Moratorium on such unrestricted releases in January 2000.

Metals that are removed from SRS radiological areas are not released from SRS for recycle purposes, as indicated by Table 1, Footnote 1. Such metals are considered for reuse or disposal. Dose assessments in Appendix F include projected disposal of metals no longer needed in SRS radiological facilities.

DOE has a Disposition of Scrap Metals Programmatic Environmental Impact Statement (PEIS) in progress, and is currently working on a draft PEIS. The outcome of this PEIS may have a significant impact on DOE release criteria for metals, and may result in promulgation of specific release criteria. Accordingly, it is premature to perform detailed dose evaluations for unrestricted release of metals from SRS. Restrictions imposed on the use of proposed WSRC criteria for release of metals (Table 1, Footnotes 1 and 2) will remain in effect until new DOE criteria, if needed, are developed.

Job Waste Streams from SRS Tritium Facilities

Currently, about 200 cubic meters per year of job waste from areas posted for control of tritium is now disposed of as Low Level Radioactive Waste (LLRW). Approximately three-fourths of this waste stream would be eligible for disposal in a sanitary landfill if postings are rolled back to proposed criteria.

Routine Flow of Materials from SRS Tritium Facilities

It is estimated that relatively small amounts of non-waste material (less than 100 cubic meters) will be released annually from SRS tritium facilities. This type of material includes measurement equipment, specialized tools, excess equipment, and miscellaneous materials. Much of this material is not released from SRS for unrestricted use, but is available for use again in the tritium facilities or other SRS facilities. Materials removed from these facilities that are no longer needed at SRS are processed through the Site's Excess Material and Asset Management program, and mode of release (or disposal) is dictated by the type of material. The release of such materials is included in evaluations described earlier in this section.

Cost Benefits

The primary cost benefits at SRS for alternate contamination values in lieu of 10CFR835 Appendix D and supplemental release limits in lieu of criteria in Order 5400.5 are two-fold. Some cost savings would result from improved radiological control efficiencies in SRS facilities and even higher cost savings would result from disposal or release of materials from SRS instead of disposal as LLRW. For worker protection, the greatest potential for cost savings is from changes in criteria for tritium. WSRC has considered moving to the existing DOE criteria for tritium of 10,000 dpm/100 cm^2 on surfaces. Most of the areas posted for control of tritium contamination have surfaces with tritium concentrations in the range of 10,000 – 100,000 dpm/100 cm^2 due to tritium processing methods. Changing from the current SRS tritium criterion of 1000 dpm/100 cm^2 to 10,000 dpm/100 cm^2 would result in very little savings, and WSRC has estimated that the cost of implementing that change would exceed the cost savings. As discussed under Worker Protection, the proposed tritium criterion offers net cost savings of about $400 K in radiological control efficiencies.

The second area for which major cost savings could be realized is in the release of materials. For release of materials with primarily a tritium source term, only small cost savings would be realized if the current DOE criterion of 10,000 dpm/100 cm^2 were implemented. Significant cost savings will be realized if the proposed tritium criterion is implemented. For all SRS waste streams (mixed fission/activation products, transuranics, uranium, tritium, and tritium/mixed fission/activation products), significant cost savings will be achieved through application of the proposed alternate criteria. Disposal of soils, rubble, debris, and metals in an approved landfill (see Table 1, Footnote 3) as opposed to disposal via LLRW pathways result in a cost savings of almost $1600 per cubic meter, with projected savings through 2012 of about $4 M/year. Additional cost savings will be realized due to reduced quantities of job wastes and other materials disposed of as LLRW, and in reductions in the magnitude of SRS areas posted for radiological control (primarily in areas posted for control of tritium). The total projected cost savings are $5 M/year through 2012.

ALARA Considerations Summary

Based on the very small doses projected and the substantial cost benefits predicted, the proposed release criteria are consistent with ALARA principles. While higher criteria could possibly be supported based on potential cost savings, WSRC has chosen to request alternate release criteria within the constraints of ANSI/HPS N13.12. Conformance with the consensus standard ANSI/HPS N13.12 criteria and the one mrem/year DOE dose constraint avoids the substantial challenge and expense that would be required to justify higher release criteria without the support of technical bases available in independent technical standards.

References

1. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," U. S. Department of Energy, first issued in February 1990 and revised in January 1993.

2. ANSI/HPS N13.12, "Surface and Volume Radioactivity Standards for Clearance," American National Standards Institute, issued August 31, 1999.

3. Federal Rule 10CFR835, "Occupational Radiation Protection," Change III, U. S. Department of Energy, Washington, D. C., January 1, 1999.

4. NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," U. S. Nuclear Regulatory Commission, June 1974.

5. DOE Guidance Memorandum, Office of Nuclear Safety, "Unrestricted Release of Radioactively Contaminated Personal Property," U. S. Department of Energy, Washington, D. C., March 15, 1984.

6. DOE Memorandum, Air, Water and Radiation Division (EH-412), "Application of the Department of Energy (DOE) 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Materials," U. S. Department of Energy, Washington, D. C., November 17, 1995.

7. Federal Rule 10CFR834, "Radiation Protection of the Public and the Environment," (Draft), U. S. Department of Energy, 1995.

8. DOE Manual DOE/CH-8901, "A Manual for Implementing Residual Material Guidelines," U. S. Department of Energy, Washington, D. C., 1989.

9. IAEA-TECDOC-855, "Clearance Levels for Radionuclides in Solid Materials – Application of Exemption Principles," (Interim Report for Comment), International Atomic Energy Agency, 1996.

10. NCRP Report No. 116, "Limitation of Exposure to Ionizing Radiation," National Council on Radiation Protection & Measurements, 1993.

11. Nuclear Regulatory Commission Staff Requirements Memorandum on SECY-02-0133, "Control of Solid Materials: Options and Recommendations for Proceeding," Nuclear Regulatory Commission, Rockville, MD, October 25, 2002.

12. DOE Tritium Surface Contamination Limits Committee, "Recommended Tritium Surface Contamination Release Guides," February 1991.

13. NUREG-1640, Volume 1, "Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities," (Draft Report for Comment), U. S. Nuclear Regulatory Commission, March 1999.

14. Federal Rule 10CFR820, "Procedural Rules for DOE Nuclear Activities," U. S. Department of Energy, Washington, D. C., August 1993.

15. Public Law 104-113, "National Technology Transfer and Advancement Act of 1995," 104^{th} U. S. Congress, March 1996.

16. DOE G441.1-XX, "Control and Release of Property with Residual Radioactive Material," Draft, U. S. Department of Energy, April 2002.

APPENDIX A

Current DOE Surface Activity Guidelines

(DOE Order 5400.5 Table IV-1, as modified in Table 1 of 11/17/ 95 Clarifications of Requirements)

Allowable Total Residual Surface Contamination (dpm/100 cm^2) [1]

Radionuclides[2]	Average [3,4]	Maximum [5,6]	Removable [6]
Group 1 - Transuranics, I-125, I-129, Ac-227, Ra-226, Ra-228, Th-228, Th-230, Pa-231.	100	300	20
Group 2 - Th-natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232.	1000	3000	200
Group 3 -U-natural, U-235, U-238, and associated decay product, alpha emitters.	5000	15000	1000
Group 4 - Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90, Tritium and others noted above. [7]	5000	15000	1000
Tritium (applicable to surface and subsurface)[8]	N/A	N/A	10000

[1] As used in this table, dpm (disintegration per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
[2] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.
[3] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.
[4] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.
[5] The maximum contamination level applies to an area of not more than 100 cm^2.
[6] The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
[7] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90, which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.
[8] Property recently exposed or decontaminated, should have measurements (smears) at regular time intervals to ensure that there is not a build-up of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in group 4 are not applied to tritium. The Department has reviewed the analysis conducted by the DOE Tritium Surface Contamination Limits Committee ("Recommended Tritium Surface Contamination Release Guides," February 1991), and has assessed potential doses associated with the release of property containing residual tritium. The Department recommends the use of the stated guideline as an interim value for removable tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure that non-removable fractions and residual tritium in mass will not cause exposures that exceed DOE dose limits and constraints.

APPPENDIX B

10CFR835 APPENDIX D – SURFACE CONTAMINATION VALUES

SURFACE CONTAMINATION VALUES[1] IN DPM/100 CM[2]

Radionuclide	Removable[2,4]	Total (Fixed + Removable)[2,3]
U-nat, U-235, U-238, and associated decay products …………………….	[7]1,000	[7]5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, I-125, I-129 ..….	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 …….	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[5] ….	1,000	5,000
Tritium and tritiated compounds[6] ………………………………………….	10,000	N/A

[1]The values in this appendix, with the exception noted in footnote 5, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides apply independently.
[2]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive materials as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
[3]The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) From measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds three times the applicable value.
[4]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note – The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
[5]This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.
[6]Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this appendix is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a “Total” value does not apply.
[7](alpha)

APPENDIX C

ANSI/HPS N13.12 – 1999

Table 1 Screening levels for clearance

Radionuclide Groups[a]	Screening Levels (S.I. Units)[b]	Surface Screening (Conventional Units) [b]	Volume Screening (Conventional Units) [b]
	(Bq/cm^2 or Bq/g)[c]	(dpm/100 cm^2)	(pCi/g)
Group 1 Radium, Thorium, and Transuranics: ^{210}Po, ^{210}Pb, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{232}Th, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Am, ^{244}Cm, and associated decay chains[d], and others[a]	0.1	600	3
Group 2 Uranium and Selected High Dose Beta-Gamma Emitters: ^{22}Na, ^{54}Mn, ^{58}Co, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{94}Nb, ^{106}Ru, ^{110m}Ag, ^{124}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{192}Ir, ^{234}U, ^{235}U, ^{238}U, Natural Uranium[e], and others[a]	1	6,000	30
Group 3 General Beta-Gamma Emitters: ^{24}Na, ^{36}Cl, ^{59}Fe, ^{109}Cd, ^{131}I, ^{129}I, ^{144}Ce, ^{198}Au, ^{241}Pu, and others[a]	10	60,000	300
Group 4[f] Other Beta-Gamma Emitters: ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{55}Fe, ^{63}Ni, ^{89}Sr, ^{99}Tc, ^{111}In, ^{125}I, ^{147}Pm, and others[a]	100	600,000	3,000

(a) To determine the specific group for radionuclides not shown, a comparison of the effective dose factors, by exposure pathway, listed in Table A.1 of NCRP Report No. 123I (NCRP 1996) for the radionuclides in question and the radionuclides in the general groups above shall be performed and a determination of the proper group made, based on similarity of the factors.

(b) Rounded to one significant figure.

(c) The screening levels shown are used for either surface activity concentration (in units of Bq/cm^2), or volume activity concentration (in units of Bq/g). These groupings were determined based on similarity of the scenario modeling results, as described in Annex B.

(d) For decay chains, the screening levels represent the total activity (i.e., the activity of the parent plus the activity of all progeny) present.

(e) Where the Natural Uranium activity equals 48.9% from ^{238}U, plus 48.9% from ^{234}U, plus 2.25% from ^{235}U.

(f) Radionuclides were assigned to groups that were protective of 10 µSv/y (1.0 mrem/y) and were limited to 4 groups for ease of application, as discussed in Annex B.

APPENDIX D

SRT-EST-2002-00183

November 6, 2002

(Orginal Signed)
Technical Review

TO: K.W. Crase
Health Physics Technology

FROM: G.T. Jannik
Environmental Analysis Section

Potential Dose to an Onsite Worker from Tritiated Surface Contamination using the RESRAD-Build Dosimetry Model

At your request, the Environmental Analysis Section has calculated the potential dose to an onsite worker from surfaces contaminated with tritium to a level of 100,000 dpm/100 cm^2. Estimation of this maximally exposed individual dose was completed in accordance with the US Department of Energy's RESRAD-Build Version 3.21 methodology.

The following conservative assumptions were made:

- The worker works 2000 hours per year in a 6m x 6m x 2.5m room.
- The RESRAD-Build default values for breathing rate (18 m^3) and room air exchange rate (0.8 per hour) were used.
- The entire surface area of all 4 walls, the ceiling, and the floor has transferable tritiated contamination at a level of 100,000 dpm/100 cm^2.
- Within one year, all of the surface contamination is either emitted into the room air or is directly ingested by the worker. Because of the conservative ingestion rate used in the calculations (0.00005 per hour) the direct ingestion pathway accounts for most of the potential dose.

Using these conservative assumptions, the potential annual dose to a maximally exposed onsite worker was estimated to be **1.99 mrem.**

cc: J.B. Gladden, 773–42A
A.A. Simpkins, 773–42A
P.L. Lee, 773–42A
M. Matheney, 707–48B
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EDG Files 2-copies

APPENDIX E

SRT-EST-2002-00187

November 11, 2002

(Original Signed)
Technical Review

TO: K.W. Crase
Health Physics Technology

FROM: G.T. Jannik
Environmental Analysis Section

Potential Dose to an Onsite Worker from Volume Contaminated Materials using the RESRAD Dosimetry Model

At your request, the Environmental Analysis Section has calculated the potential dose to an onsite worker from volume contaminated materials that are at the proposed release criteria of:

3 pCi/g	Alpha
30 pCi/g	Beta-Gamma
2000 pCi/g	Tritium

For this assessment, it was assumed that the alpha was all plutonium-239 and that the beta-gamma was all cesium-137.

Estimation of this maximally exposed individual dose was completed in accordance with the US Department of Energy's RESRAD methodology (Version 6.2).

The following conservative assumptions were made:

- The contaminated materials (soil, debris…) are deposited on a 10,000 m^2 area to a depth of 20 cm.
- The worker works entirely outdoors on this contaminated area for 2000 h/y starting immediately after placement.
- A breathing rate of 14,450 m^3/y and an incidental ingestion rate of 36.5 g/y were used.
- The RESRAD default value of 0.0001 g/m^3 was used for the mass loading for inhalation factor.

Using these conservative assumptions, the potential annual dose to a maximally exposed onsite worker was estimated to be:

Alpha (plutonium-239)	0.15 mrem
Beta-gamma (cesium-137)	21.3 mrem
Tritium	0.02 mrem
Total	**21.5 mrem**

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APPENDIX F

SRT-EST-2002-00188

November 12, 2002

(Original Signed)
Technical Review

TO: K.W. Crase
Health Physics Technology

FROM: G.T. Jannik
Environmental Analysis Section

Potential Doses from Volume Contaminated Materials Disposed of in a Regional Landfill

Potential Resident Farmer Doses:

At your request, the Environmental Analysis Section has calculated the potential dose to a resident farmer from volume contaminated materials that are at the proposed release criteria of:

3 pCi/g	Alpha
30 pCi/g	Beta-Gamma
2000 pCi/g	Tritium

For this assessment, it was assumed that the alpha was all plutonium-239 and the beta-gamma was all cesium-137. Estimation of this maximally exposed individual dose was completed in accordance with the US Department of Energy's RESRAD methodology (Version 6.2).

The following conservative assumptions were made:

- The contaminated materials (soil, debris…) are deposited in a 10,000 m^2 area to a depth of 2.5 m (volume = 25,000 m^3) and covered with a 1 m cap. This assumed cover depth is very conservative in that the majority of the materials will be buried much deeper in the landfill, which has an average depth of over 50 m.

- The entire 25,000 m^3 volume is contaminated at the release criteria concentrations. This volume was estimated by assuming that the current routine waste stream of about 2,500 m^3/y will continue through 2012 (10 y).

- Where applicable (i.e. soil, groundwater, and weather parameters), site specific parameters for the Three Rivers Regional Landfill were used (Jannik, 1999).

- The RESRAD default values for exposure factors were used.

Using these conservative assumptions, the potential annual doses to a resident farmer, at various years in the future, were estimated to be:

Years since placement	Dose (mrem)	Comment
0	1.6E-05	Residence occurs during first year after placement of waste (unrealistic scenario)
30	4.7E-04	Residence occurs after a 30 y administrative control period
50	1.0E-05	Residence occurs after a 20 y operational life followed by 30 y administrative period
100	1.1E-03	Residence occurs after the 100 y lease period for the Three Rivers Regional Landfill

Potential Maximally Exposed Individual and Population Doses

Additional assessments of dose from the volume contaminated materials were made for the SRS maximally exposed offsite individual and to the down river population. These assessments were made using the routine aqueous release model LADTAP XL©, which is the model used for demonstrating liquid pathway dose compliance at SRS. The prospective dose assessment methods described in Lee, (2001) were followed.

The following conservative assumptions were made:

- The entire amount of radioactivity contained in the 25,000 m^3 volume of contaminated materials is leached out of the landfill and deposited into the Savannah River all within one year of final placement. From this assumption, and using a soil density of 1.59 g/cm^3, the source term used was:

Alpha (plutonium-239)	1.19E-01 curie
Beta-Gamma (cesium-137)	1.19E+00 curies
Tritium	7.95E+01 curies

- The lowest annual flow rate (5,300 cfs) measured near Savannah River Mile 118, which is the assumed location of the SRS maximally exposed offsite individual, was used (Lee, 2001).
- All other maximally exposed individual and population dose exposure parameters used for routine dose assessments (Lee, 2001) were used in this assessment.

Using these conservative assumptions, the potential annual dose to a maximally exposed individual located near River Mile 118 was estimated to be **0.82 mrem**. A majority of this dose (0.72 mrem) was from the fish consumption pathway, caused by the high bioaccumulation factor for cesium in fish.

The down river population dose was estimated to be **8.1 person-rem**. Nearly 50% of this dose was caused by cesium in aquatic foods. Most of the remainder was caused by water consumption at the Beaufort-Jasper Water Treatment Plant (population served = 97,000 people) and at the City of Savannah Industrial and Domestic Water Supply Plant (population served = 11,000 people).

Potential Landfill Worker Dose

The annual potential dose to a landfill worker, who is directly exposed to the contaminated materials during placement in the landfill, also was considered. This dose was determined to be conservatively bounded by the dose (21.5 mrem) estimated for an onsite worker who works directly on a large area of the contaminated material for an entire 2,000 hour work year (Jannik, 2002).

The potential annual dose to a landfill worker will be much lower due to:

- Shielding and distance from the contaminated materials provided by the heavy equipment
- Shielding provided by daily clean cover placed over all newly buried waste
- Exposure to smaller volumes of contaminated materials because the waste will be disposed of over a ten-year period.

References

Jannik, G.T., *Potential Dose from the Onsite Disposal of Contaminated Railroad Ties into the Three Rivers Landfill using the DOE RESRAD Dosimetry Model,* SRT-EST-00341, Savannah River Site, Aiken, SC, 1999.

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Lee, P.L., *Environmental Dose Assessment Manual*, WSRC-IM-91-1, Revision 3, Savannah River Site, Aiken, SC, 2001