THE EXEMPTION OF POST-1988 BURIED WASTES FROM DOE ORDER 435.1 REQUIREMENTS TO EFFECTIVELY MANAGE INTRINSIC UNCERTAINTY IN WASTE CHARACTERIZATION UNDER A CERCLA PROCESS

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ABSTRACT

The process for exempting post-1988 low level radioactive waste (LLW) from the performance objectives and other requirements of U.S. Department of Energy (DOE) Order 435.1 is discussed, and applied to below ground waste facilities in Solid Waste Storage Area 6 (SWSA 6) at DOE’s Oak Ridge Reservation. Approximately one half a million curies of radioactive waste was accumulated in buried disposal units in SWSA 6 since the 1960s, with less than 2% of the entire inventory placed after Sept. 1988. This waste, as well as waste contained in the above ground Interim Waste Management Facility and the closed and covered Tumulus I and II facilities in SWSA 6 would be subject to the performance assessment requirements of DOE Order 435.1. Although the waste in the above ground facilities constructed after Sept. 1988 is sufficiently characterized to develop a comprehensible performance assessment for those facilities, the waste in the below ground units is poorly characterized. Consequently, inclusion of those buried waste management units in the overall SWSA 6 assessment introduces large, unmanaged uncertainties. For this reason, the performance assessment developed for all the SWSA 6 waste units would be questionable. However, because the SWSA 6 below grade units are commingled with numerous other waste management units within a larger Melton Valley watershed area being addressed under CERCLA, and it would not be cost effective to extensively characterize the below ground units in SWSA 6, the inclusion of those units with the CERCLA wastes was considered. It was demonstrate that the five-year review, perpetual institutional controls and an active environmental monitoring program provided by CERCLA for the Melton Valley watershed remedial actions warranted the exemption of the below grade units in SWSA 6 from the performance assessment requirements of DOE Order 435.1. To support the exemption, an extensive roadmap was also developed, delineating how each applicable performance objective and other requirements of DOE Order 435.1, and its predecessor DOE Order 5820.2A, would be addressed by the Melton Valley watershed Record of Decision’s proposed actions and compliance with Applicable or Relevant and Appropriate Requirements (ARARs) and to be considered (TBC) guidance.

INTRODUCTION

Site-specific radiological performance assessments (PAs) and composite analyses (CAs) are required by the Department of Energy (DOE) Order 435.1 for the disposals of low level radioactive waste
(LLW) dispositioned at DOE facilities after September 1988. These assessments and other provisions of DOE Order 435.1 are used to manage these wastes. Wastes disposed of in the ground at a DOE facility prior to September 1988 are managed under the Comprehensive Environmental Restoration, Compensation, and Liability Act (CERCLA) of 1980 process. The purposes of the PA and CA are to demonstrate compliance with performance objectives and measures for LLW that ensure that waste is dispositioned to provide long-term protection of the public and the environment. The PA provides insight into how an individual disposal unit performs in the long term, up to and beyond 1000 years, after the disposal unit is closed. If there are other closed disposal units, however, whose environmental releases may combine with releases from the disposal unit for which the PAs are being developed and expose a common receptor, the collective impact of all disposal units must be considered in a composite analysis (CA) also mandated by DOE Order 435.1. Compliance with the PA performance criteria and CA requirements summarized in Table I may impose constraints on the quality and quantity of waste that can be dispositioned, how the disposal facility is designed, and whether the use of institutional controls are required. Source release models/environmental pathway analyses and land use considerations are used to provide an reasonable assessment of potential public and inadvertent intruder exposures over the 1000 year compliance period and beyond and to determine allowable disposal limits (concentrations or total activities) for the LLW disposal units.

<table>
<thead>
<tr>
<th>Component</th>
<th>Numerical Criterion</th>
<th>Point of Compliance</th>
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<tbody>
<tr>
<td>Performance Assessment</td>
<td>Performance objectives</td>
<td></td>
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<tr>
<td>All Pathways dose</td>
<td>$#25$ mrem/year. Not including doses from radon and progeny</td>
<td>Public receptor location</td>
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<tr>
<td>Air Pathway dose</td>
<td>$#10$ mrem/year, not including doses from radon and progeny</td>
<td>Public receptor location</td>
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<tr>
<td>Radon dose</td>
<td>For $^{220}$Rn and $^{222}$Rn an average flux of $#20$ pCi/m$^2$/second</td>
<td>Disposal unit surface</td>
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<tr>
<td>Hypothetical inadvertent intruder</td>
<td>100 mrem/year from chronic exposure</td>
<td>Disposal unit</td>
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<td></td>
<td>500 mrem/year from a single event</td>
<td>Disposal unit</td>
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<tr>
<td>Composite Analysis</td>
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<tr>
<td>All Pathway dose</td>
<td>$#100$ mrem/year primary dose limit from all sources: m Options and ALARA analyses required to reduce doses below 30 mrem/year.</td>
<td>Public receptor location</td>
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There are numerous closed, inactive waste management units on DOE’s Oak Ridge Reservation (ORR) that were developed as part of the Manhattan project and post-WWII nuclear weapon production at the Y-12 plant and East Tennessee Technology Park (formerly K-25 gaseous diffusion plant), and research and development activities at the Oak Ridge National Laboratory (ORNL). These waste management sites and the three main plant areas on the ORR where the wastes were generated are currently undergoing environmental restoration as required by CERCLA. In addition to an engineered waste disposal facility being developed to accommodate only CERCLA generated wastes, there is currently only one engineered disposal unit for operational LLW, the Interim Waste Management Facility (IWMF) in Solid Waste Management Area 6 (SWSA 6). This disposal facility currently contains about 65 percent of its intended capacity and is presently on standby status pending completion of the required PA/CA assessment process to obtain full authorization to continue disposing of operations generated
LLW in that facility. Since the IWMF is collocated with two other inactive disposal units of similar waste-vaults-in-tumulus-design, the Tumulus I and II, and many other post-1988 below ground waste disposal units, the PA and CA analysis required for continued operation of the IWMF is coupled with the compliant collective behavior of all the co-located waste disposal units. In this paper, a strategy is presented and discussed to reduce the scope of the PA and CA analysis to only considering the well defined aboveground vault-tumulus facilities (IWMF, Tumulus I and II) and relegating the more uncertain waste inventories contained in the post-1988, below ground to effective management under the CERCLA process with the other pre-1988 below ground waste disposal units.

SITE DESCRIPTION AND WASTE MANAGEMENT HISTORY

Description of Melton Valley and SWSA 6 Waste Management History, and Practices

Melton Valley is southwest of ORNL and has been used by DOE for waste management since 1940s. The 68-acre SWSA 6 site is located in the western part of the valley and has received waste from only ORNL operations since 1969. Figure 1 shows the general location of ORR, ORNL and other DOE plants, and SWSA 6.

![Fig. 1. ORR boundary and SWSA 6 location](image)

Waste management practices in Melton Valley have varied over the years and range from simple pre-1988 practices of burying wastes below ground in unlined trenches and covering them with compacted soil to more recent post-1988 methods of using below ground, engineered wells and wells-in-silos, and aboveground tumulus facilities containing cement vaults stacked on a concrete pad which has a leachate collection systems and multi-component Resource Conservation and Recovery Act (RCRA) type covers. The majority of the pre-1988 waste is located outside of SWSA 6 in Melton Valley, where they are being managed by the Melton Valley watershed CERCLA process and the post-1988 waste disposals are completely contained within SWSA 6 in below ground and aboveground facilities.
At least 2,000,000 curies of radioactive waste has been disposed of in Melton Valley since it’s use as a waste management area began in the 1940s, of which about 500,000 curies has been disposed of in SWSA 6. Waste units in the SWSA 6 area were used extensively prior to and after September 1988, and the post-1988 disposal units’ design included below ground engineered concrete constructed wells/wells in silos. Since September 1988, about 8500 curies of LLW has been disposed of in SWSA 6 using the wells and wells-in-silos, and above-ground waste disposal in Tumulus I and Tumulus II and the Interim Waste Management Facility (IWMF). The IWMF and Tumulus I and II facilities are engineered facilities to accommodate waste in concrete vaults and were designed primarily to dispose of high activity, short half-life waste. The current activity in the IWMF is approximately 200 curies and the Tumulus I and II facilities contain a total of about 79 curies. Figures 2 and 3 depict waste management practices in the Melton Valley and SWSA 6.

Fig. 2. Major waste management areas in Melton Valley subject to remedial action under CERCLA

PREVIOUS PA AND CA DEVELOPMENT FOR SWSA 6

An initial 1994 and 1997 revised PA were prepared and submitted to DOE’s peer review board and the Low Level Waste Federal Review Group for (LFRG), which also reviewed a CA, respectively. These assessments considered all below ground and aboveground disposal units in SWSA 6 that received waste after September 1988. Although both DOE-Headquarter (HQ) assessments of the PA noted that the
technical approach was appropriate and acceptable, high uncertainties in the inventories of the below ground disposal units used after September 1988 were too large to provide sufficient assurance that the performance goal and measures given in Table 1 could be reasonably met for all the waste disposal units in SWSA 6. Accordingly, the PA and CA for all the SWSA 6 disposal units considered were not accepted and no waste authorization was obtained for the continued operation of the aboveground IWMF facility. As a consequence of these review actions, the acceptable performance of the above ground disposal units, IWMF and Tumulus I and II, based on reasonably well known waste inventories, was rejected. The continued operation of the IWMF curtailed, because the entire PA/CA evaluation also embraced the below ground disposal units whose inventories were not well defined.

**EXEMPTION OF BELOWGROUND POST-1988 FROM PA AND CA**

To rectify this situation an exemption was sought from DOE –HQ and to exclude the below ground post-1988 disposal units (e.g., waste contained in trenches, wells, wells-in-silos, etc,) from the performance objectives and measures of DOE Order 435.1 summarized in Table 1. The basis for this exemption request is contained in DOE Order and associated Manual 251.1 –1A, *Directives System.*
exemption request was prepared to exclude the below ground post-1988 disposal units from DOE Order 435.1 requirements, and considered the following major provisions.

**Identification and Justification of Risks in Granting the Exemption:**

The granting of the exemption will not result in any additional risk to the public or environment. Controls will continue to be maintained over the site and limited access to the site and surrounding areas will ensure DOE requirements for protection of the public will be met. The primary radionuclides in SWSA 6 that could produce potential risks are fission products, with each having a half-life less than 30 years (i.e., $^{3}$H, $^{90}$Sr and $^{137}$Cs) and will decay sufficiently enough that the site will be safe for an intruder within 350 years. Hence, DOE’s stewardship of the SWSA 6 site will not last forever. Over the long-term, DOE will use the CERCLA process to close Melton Valley watershed and is committed to ensuring that the closure will meet all applicable DOE environmental, safety, and health (ES&H) requirements, including the requirement for closure defined by DOE Manual 435.1-1. In the near-term, if this exemption were not granted, the source term uncertainties associated with the performance assessment of the buried wastes in SWSA 6 would likely not be resolved and could result in the continued inability to effectively use the IWMF.

SWSA 6 contains an estimated inventory of 5,000,000 curies. Most of this inventory was dispositioned below-grade in more than 400 unlined trenches and auger holes prior to September 1988, and will be managed under the CERCLA process. After September 1988, engineered aboveground facilities (IWMF, Tumulus I and II) and cement-lined below-grade wells and wells-in-silos were used to disposition about 8,800 curies or less than 2% of the total SWSA 6 radionuclide inventory. These disposals consisted of about 200 curies in the IWMF, 79 curies in Tumulus I and II, and 8500 curies mostly contained in high-range wells/wells-in-silos.

The performance assessment (PA) requirements of DOE Order 435.1 are essentially structured for new or operating waste management facilities for which siting studies and waste inventory knowledge may be used to appropriately design and assess the facility’s performance relative to appropriate waste acceptance criteria. The intent of the PA for a waste facility is to ensure that the facility, when constructed, operated, and closed, will meet performance objective designed to protect the public and the environment. In the case of the buried wastes in SWSA 6 there is insufficient knowledge of the waste inventory to confidently perform a quantitative PA Therefore, it is appropriate to manage the below-grade SWSA 6 wastes as in-situ waste integrated with the Melton Valley watershed CERCLA process. The preferred remedial action alternative derived through the CERCLA process stipulates hydraulic isolation of the buried wastes in SWSA 6 through multi-component covers and groundwater diversion structures and institutional controls coupled with 5-year CERCLA reviews for as long as the waste remains hazardous to the public. These SWSA 6 actions are crafted in concert with other source actions in the Melton Valley watershed to ensure that the total incremental lifetime cancer risk for all sources in the watershed is within the EPA target risk range of $1 \times 10^{-6}$ to $1 \times 10^{-4}$ for a public receptor a White Oak Dam (located where White Oak Creek passes under Highway 95 in Fig. 3). A $1 \times 10^{-4}$ risk approximately corresponds to a dose of 4.4 millirem/year for a 30-year exposure period. Since this is the maximum dose permitted under CERCLA for all Melton Valley watershed sources, the dose contribution due to SWSA 6 buried sources will be managed to be far less than the 25 millirem year performance objective in DOE Order 435.1.

**Benefits of the Exemption:**

This exemption allows for a more consistent and systematic approach to the management of wastes on the Oak Ridge Reservation. The IWMF facility and Tumulus I and II will be authorized under DOE Order 435.1. Tumulus I and II are filled to capacity and have been in interim closure since 1992.
The pre- and post-1988 buried waste in SWSA 6 will be addressed consistently through the CERCLA process, which is logical given that the waste is commingled and already disposed. This exemption will assure the problem of inadequate characterization of the source term in the below-grade disposal units of SWSA 6 aboveground and below ground disposal units will be appropriately managed through utilization of the Melton Valley watershed CERCLA process. An integrated approach to waste management, monitoring, and closure of all SWSA 6 will ensure primary radiation protection requirements are met. This approach is anticipated to yield protective, as well as cost-effective, results. Lastly, this exemption will enable the development of more accurate modeling results for the SWSA 6 PA and hence an IWMF waste acceptance criteria with greater utility and defensibility.

Time Period for the Exemption:

The request is for a permanent exemption. The intent of the request is to permanently exempt this post-1988 SWSA 6 below-grade waste (i.e., those not disposed in IWMF or the Tumulus I and II) from the specific PA requirements. Prior to and following closure, the site will be managed to meet all applicable DOE ES&H requirements for protection of the public and environment.

Circumstances Warranting Exemption and Compensating Actions:

The following provides a summary for ascertaining that the exclusion of sources other than IWMF and Tumulus I and II post-1988 sources from the PA requirements of DOE Manual 435.1-1 is justifiable:

• the below-grade wastes have already been disposed (e.g., encased in grout) and there are insufficient data to adequately characterize the wastes;

• the waste is commingled with much larger quantities (in volume and curies) of pre-1988 waste being managed under the CERCLA process to comply with DOE ES&H requirements; and,

• extraction of the waste is not practical or cost-effective, and such an action could increase risk to workers, which would not be supported by ALARA.

The proposed approach is to manage these wastes along with the pre-1988 SWSA 6 wastes, including commitments for the following actions, to compensate for the lack of an all inclusive performance assessment for the buried waste in SWSA 6 and, thus, provide reasonable assurance that the Department’s ES&H requirements will be met:

• the Melton Valley Record of Decision, will consider all buried wastes in SWSA 6, and the remedial action, after implementation, will be subject to review at least every 5 years, as required by the CERCLA process;

• institutional controls, which are documented and included in land use control plans, will be implemented for as long as the residual wastes dispositioned in Melton Valley watershed remain hazardous; an active environmental monitoring program will be developed and implemented, including groundwater monitoring;

• a composite analysis that includes the post-1988 SWSA 6 wastes that are the subject of this exemption (along with the pre-1988 waste) will be prepared; and,

• the PA and CA for the aboveground IWMF and Tumulus I and II disposal units will be completed.
THE DOE Order 435.1 – CERCLA ROAD MAP

A key component to relegating the remediation of the below ground, post-1988 waste disposal units to the Melton Valley watershed CERCLA process is the demonstration that the CERCLA process will meet the objective and substantive requirements of DOE Order 435.1. This is attained by the CERCLA process’s compliance with applicable, or relevant and appropriate environmental regulations (ARARs), to be considered (TBCs) requirements, such as DOE Orders (e.g., 435.1), as well as CERCLA drivers (information and planning derived during implementation and completion of the CERCLA process). CERCLA drivers are obtained from remedial investigations (RIs), feasibility studies (FSs), remedial design work plans (RAWPs), and from associated promulgated regulations and U.S. Environmental Protection Agency (EPA) guidance for the preparation of those documents. A road map was developed to specifically relate DOE Order 435.1 requirements for the protection of human health and the environment to ARARs, TBCs, and CERCLA drivers pertinent to the Milton Valley watershed CERCLA process. (1.) This roadmap demonstrated that all DOE Order 435.1 objective and substantive requirements would be met by conducting the remedial action of the below ground, post-1988 SWSA 6 disposal units under the Melton Valley watershed CERCLA process.

CONCLUSION

The exemption was submitted to DOE-HQ in the fall of 1999 and was subsequently granted. The revised PA and CA for only the aboveground IWMF and Tumulus I and II disposal units have been completed and are currently under LFRG review. The fact that the aboveground SWSA 6 disposal units were collocated with and surrounded by sites being remediated under CERCLA was a major factor in obtaining an exemption for the below ground SWSA 6 waste units that received waste after September 1988. Unfortunately, not all DOE facilities will have the option to consider managing uncertain waste inventories through the exemption approach described in this paper. Consequently, it is suggested that a more flexible interpretation of how the PA and CA performance objectives of DOE Order 435.1 are attained should be considered, such as:

• use of institutional controls for as long as the waste is hazardous, as required by DOE Order 5400.5, Radiation Protection for the Public and the Environment, and not just apply the controls to a limited 100-year post-closure period.

• limit the inadvertent intruder to only an acute dose scenario and do not use a chronic exposure scenario.

• employ environmental monitoring to evaluate the effectiveness of less exhaustive remedial actions to compensate for uncertain data.

In essence, it is suggested that the PA and CA analyses process under DOE Order 435.1 more closely approximate a CERCLA action for the site.

REFERENCES

1. BJC (Bechtel Jacobs Company, LLC) 1999. DOE Order 5820.2A and 435.1 – CERCLA Road Map for the Low- and High-Range Wells/Wells-in-Silos, Fissile Wells, Asbestos Silos, and Biological Trenches, Solid waste Management Area 6, Melton Valley Watershed. Oak Ridge, Tennessee, BJC/OR-409, Bechtel Jacobs, P.O. Box 4699, Oak Ridge, TN 37831