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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ORRHES Brief
Oak Ridge Reservation Health Effects Subcommittee

Screening-Level Evaluation of Additional Potential Materials of Concern, July 1999—Task 7

Site: Oak Ridge Reservation
Study area: Oak Ridge Area
Time period: 1942–1990
Conducted by: Tennessee Department of Health and the Oak Ridge Health Agreement Steering Panel

Purpose

The purpose of this screening-level evaluation was to determine whether additional contaminants that existed at Oak Ridge Reservation (ORR), other than the five already identified in the Oak Ridge Dose Reconstruction Feasibility Study (iodine, mercury, polychlorinated biphenyls [PCBs], radionuclides, and uranium), warrant further evaluation of their potential for causing health effects in off-site populations.

Background

In July 1991, the Tennessee Department of Health in cooperation with the U.S. Department of Energy initiated a Health Studies Agreement to evaluate the potential for exposures to chemical and radiological releases from past operations at ORR. The Oak Ridge Dose Reconstruction Feasibility Study was conducted from 1992 to 1993 to identify those operations and materials that warranted detailed evaluation based on the risks posed to off-site populations. The feasibility study recommended that dose reconstructions be conducted for radioactive iodine releases from X-10 radioactive lanthanum processing (Task 1), mercury releases from Y-12 lithium enrichment (Task 2), PCBs in the environment near Oak Ridge (Task 3), and radionuclides released from White Oak Creek to the Clinch River (Task 4). In addition, the study called for a systematic search of historical records (Task 5), an evaluation of the quality of historical uranium effluent monitoring data (Task 6), and additional screening of materials that could not be evaluated during the feasibility study (Task 7).

The Oak Ridge Health Agreement Steering Panel (ORRHES) was established to direct and oversee the Oak Ridge Health Studies and to facilitate interaction and cooperation with the community. This group is comprised of local citizens and nationally recognized scientists.

Methods

During the Task 7 Screening-Level Evaluation, three different methods (qualitative screening, the threshold quantity approach, and quantitative screening) were used to evaluate the importance of materials with respect to their potential for causing off-site health effects. Twenty-five materials or groups of materials were evaluated. Please see Table 1 for a summary of the methods used to evaluate each material/group of materials.

- Qualitative Screening—All materials used on ORR were qualitatively screened for quantities used, forms used, and/or manners of use. If it was unlikely that off-site releases were sufficient to pose an off-site health hazard, then these materials were not evaluated quantitatively. If off-site exposures were likely to have occurred at harmful levels, then the materials were evaluated quantitatively.

- Threshold Quantity Approach—When information was insufficient to conduct quantitative screening, inventories of materials used at ORR were estimated based on historical records and interviews of workers. These estimated inventories of materials were

determined to be either above or below a conservatively calculated health-based threshold quantity. If the estimates for a material were below the calculated threshold quantity, then it was determined to be highly unlikely to have posed a risk to human health through off-site releases.

- Quantitative Screening—The quantitative screening used a two-level screening approach to identify those materials that could produce health risks (i.e., doses) to exposed people that are clearly below minimum levels of health concern (Level I Screen) and above minimum levels of health concern (Refined Level I Screen). Health-based decision guides were established by the Oak Ridge Health Agreement Steering Panel and represent minimum levels of health concern.

  — The Level I Screening calculates a screening index for a maximally exposed reference individual who would have received the highest exposure. This conservative (protective) screening index is not expected to underestimate exposure to any real person in the population of interest. If the estimated Level I screening index was below the ORRHES decision guide, then the hazard to essentially all members of the population, including the maximally exposed individual, would be below the minimum level of health concern. In addition, the Level I screening index would be so low that further detailed study of exposures is not warranted because the screening index is below the threshold for consideration of more extensive health effects studies. However, if during the Level I Screening, the screening index was above the ORRHES decision guide, then the contaminant was further evaluated using Refined Level I Screening.

  — The Refined Level I Screen calculates a less conservative, more realistic screening index by using more reasonable exposure parameters than the Level I Screen. In addition, depending upon the contaminant, a less conservative environmental concentration was sometimes used. However, the transfer factors and toxicity values remained the same for both screening levels. The Refined Level I Screening maintains considerable conservatism because of these conservative transfer factors and toxicity values.

  If the Refined Level I screening index was below the ORRHES decision guide, then the hazard to most members of the population would be below minimum levels of health concern. In addition, the Refined Level I screening index would be so low that further detail study of exposure is not warranted because the screening index is below the threshold for consideration of more extensive health effects studies and was given a low priority for further study. However, if during the Refined Level I Screening, the screening index was above the ORRHES decision guide, then the contaminant was determined to be of high priority for a detail evaluation.

Study Group

The screening evaluation focuses on the potential for health effects to occur in off-site residents. The Level I Screen estimates a dose for the hypothetical maximally exposed individual who would have received the highest exposure and would have been the most at-risk. The Refined Level I Screen estimates a dose for a more typically exposed individual in the targeted population. The study group for exposure from lead were children because they are particularly sensitive to the neurological effects of lead.

Exposures

Quantitative screening used mathematical equations to calculate a screening index (theoretical estimates of risk or hazard) from multiple exposure pathways, including inhalation; ground exposure (for radionuclides); ingestion of soil or sediment; and ingestion of vegetables, meat, milk, and/or fish.

Outcome Measures

No outcome measures were studied.

Results

Screening-level analyses were performed for seven carcinogens. They were evaluated according to source, resulting in 10 separate analyses. Three of the Level I Screen analyses (Np-237 from K-25, Np-237 from Y-12, and tritium from Y-12) yielded results that were below the decision guides. Refined Level I Screens were performed on the other seven carcinogenic assessments. The results of five separate analyses (beryllium from Y-12, chromium VI from ORR, nickel from K-25, technetium-99 from K-25, and technetium-99 from Y-12) were below the decision guides, and two analyses (arsenic from K-25 and arsenic from Y-12) were above the decision guides.

Arsenic was released into the air from the burning of coal at several coal-fired steam plants located on the Oak Ridge Reservation and into the soil, sediment, and surface water from coal piles and disposal of fly ash from the steam plants. Lead was likely released into soil, sediment, and surface water from the disposal of liquid waste into the Y-12 storm sewers and may have been released into the air from process stacks and the plant ventilation system.

Screening-level analyses were performed for seven noncarcinogens. These, too, were evaluated according to source, resulting in eight separate analyses. One Level I Screen analysis (beryllium from Y-12) yielded results that were below the decision guide. Refined Level I Screens were performed on the other seven noncarcinogenic assessments. Four analyses (chromium VI from ORR, copper from K-25, lithium from Y-12, and nickel from K-25) were below the decision guides and three analyses (arsenic from K-25, arsenic from Y-12, and lead from Y-12) were above the decision guides.

Three materials (niobium, zirconium, and tetramethylammoniumborohydride [TMAB]) were evaluated using the threshold quantity approach because information was insufficient to perform quantitative screening. None of the three was determined to be present in high enough quantities at the Y-12 Plant to have posed off-site health hazards.

Conclusions

Based on the qualitative and quantitative screening, the materials were separated into three classes in terms of potential off-site health hazards: not candidates for further study, potential candidates for further study, and high priority candidates for further study. (as shown in Table 2).

- Not Candidates—Five materials at the K-25 and 14 materials used at the Y-12 Plant were determined to not warrant further study. All of these chemicals were eliminated because either (1) quantitatively, they fell below Level I Screening decision guides; (2) not enough material was present to have posed an off-site health hazard according to the threshold quantity approach; or (3) qualitatively, the quantities used, forms used, and/or manners of usage were such that off-site releases would not have been sufficient to cause off-site health hazards.

- Potential Candidates—Three materials at the K-25 (copper powder, nickel, and technetium-99), three materials used at the Y-12 Plant (beryllium compounds, lithium compounds, and technetium-99), and one material used at ORR (chromium VI) were determined to be potential candidates for further study. These materials were identified as potential candidates because (1) their Level I Screening indices exceeded the decision guides and (2) their Refined Level I Screening indices did not exceed the decision guides.

- High Priority Candidates—One material used at the K-25 (arsenic) and two at the Y-12 Plant (arsenic and lead) were determined to be high priority candidates for further study. They were chosen as high priority materials because their Refined Level I Screening indices exceeded the decision guides.

Two issues remaining from the Dose Reconstruction Feasibility Study were evaluated during Task 7: the possible off-site health risks associated with asbestos and the composition of plutonium formed and released to the environment.

- Asbestos—Asbestos could not be fully evaluated during the feasibility study; therefore, it was qualitatively evaluated during this task for the potential for off-site releases and community exposure. Available information on the use and disposal of asbestos, as well as, off-site asbestos monitoring was summarized. None of the investigations performed to date have identified any asbestos-related exposure events or activities associated with community exposure, making it very unlikely that asbestos from ORR has caused any significant off-site health risks.

- Plutonium—The records that documented the rate of plutonium release did not specify the isotopic composition of the product formed. As a result, during the feasibility study, the project team made the assumption that the plutonium that was formed and released was plutonium-239. If incorrect, this assumption could have significant ramifications on the screening of past airborne plutonium releases. Therefore, the composition of the plutonium formed and released was evaluated further during this task. Plutonium inventory from X-10 was calculated, and plutonium-239 was found to comprise at least 99.9% of the plutonium present in Clinton Pile fuel slugs. This result confirmed that the assumptions made in the feasibility study did not introduce significant inaccuracy into the screening evaluation that was conducted.

TABLE 1

Summary of Screening Methods Used for Each Material

Qualitative Screening			
Material	**Source**	**Notes**	
Boron carbide, boron nitride, yttrium boride, titanium boride, rubidium nitrate, triplex coating, carbon fibers, glass fibers, and four-ring polyphenyl ether	ORR	Evaluated based on quantities used, forms used, and manners of usage.	
Tellurium	Y-12	Evaluated based on quantities used, forms used, and manners of usage.	
Threshold Quantity Approach			
Material	**Source**	**Media**	**Threshold Values**
Niobium	Y-12 Used in production of two alloys, mulberry and binary	Air Surface Water	Evaluated using a reference dose derived from an LD50, an empirically derived dispersion factor for airborne releases from Y-12 to Scarboro, and estimated average East Fork Poplar Creek (EFPC) flow rates.
Tetramethylammoniumboro-hydride (TMAB)	Y-12 Use classified	Air Surface Water	Inventory quantities and specific applications remain classified.
Zirconium	Y-12 Used in production of an alloy, mulberry	Air Surface Water	Evaluated using a reference dose derived from an ACGIH Threshold Limit Value for occupational exposure, an empirically derived dispersion factor for air released from Y-12 to Scarboro, and estimated average EFPC flow rates.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening			
Material	**Source**	**Media**	**Exposure Values**
Arsenic Level I Screen and Refined Level I Screen	K-25 Y-12 Released as a naturally occurring product in coal, which was used in coal–fired steam plants	Air	Based on coal use and dispersion modeling to Union/Lawnville (K-25) and Scarboro (Y-12).
		Surface Water	Used maximum in Poplar Creek (K-25) and the 95% upper confidence limit (UCL) on the mean concentration in McCoy Branch (Y-12).
		Soil/Sediment	Used sediment core concentration detected in Poplar Creek to represent the early 1960s (K-25) and the 95% UCL on the mean concentration in McCoy Branch (Y-12).
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Beryllium compounds Level I Screen and Refined Level I Screen	Y-12 Used in production	Air	Used Y-12 stack monitoring data and an empirical dispersion factor for releases to Scarboro.
		Surface Water	Used maximum concentration measured in EFPC.
		Soil	Used maximum concentration measured in EFPC.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Copper Level I Screen and Refined Level I Screen	K-25 Use of copper powder is classified	Air	Based on airborne concentrations measured at the most-affected on-site air sampler that were adjusted according to the ratio of dispersion model results at that sampler to those at Union/Lawnville.
		Surface Water	Used maximum concentration measured during the Clinch River Remedial Investigation.
		Soil/Sediment	Used highest mean concentration in Clinch River.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer factor and an ATSDR bioconcentration factor.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening (continued)			
Material	**Source**	**Media**	**Exposure Values**
Hexavalent chromium (Chromium VI) Level I Screen and Refined Level I Screen	ORR Used in cooling towers to control corrosion	Air	Based on modeling of emission and drift from K-25 cooling towers to Union/Lawnville.
		Surface Water	Used maximum concentration measured in Poplar Creek before 1970.
		Soil	Used average concentration of total chromium measured during the EFPC Remedial Investigation; assumed to be 1/6 (16.7%) chromium VI.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Lead EPA's Integrated Exposure Uptake Biokinetic model	Y-12 Used in production of components, in paints, and as radiation shielding	Air	Estimated from background concentrations of lead prior to mid-1970s.
		Surface Water	Used maximum concentration measured in EFPC (a higher concentration was detected near Y-12; however it was considered to be anomalous).
		Soil/Sediment	Used maximum concentration measured in the EFPC Remedial Investigation, the 95% UCL, and the 95% UCL multiplied by 3.5 for a higher past concentration.
		Food Items	Based on concentrations in air, soil, and water and biotransfer and bio-concentration factors from literature.
Lithium Level I Screen and Refined Level I Screen	Y-12 Used in lithium isotope separation, chemical, and component fabrication	Air	Used stack sampling data from two lithium processing buildings and an empirical dispersion factor for releases to Scarboro.
		Surface Water	Used highest quarterly average measured in EFPC.
		Soil/Sediment	Used maximum concentration measured in the EFPC floodplain.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening (continued)			
Material	**Source**	**Media**	**Exposure Values**
Neptunium-237 Level I Screen	K-25 Y-12 Found in recycled uranium	Air	Based on levels in recycled uranium, an estimated release fraction, and dispersion modeling to Union/Lawnville (K-25) and Scarboro (Y-12).
		Surface Water	Based on reported releases to Clinch River (K-25) and EFPC (Y-12), corrected for dilution.
		Soil/Sediment	Used maximum concentrations detected in Clinch River (K-25) and EFPC (Y-12).
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Nickel Level I Screen and Refined Level I Screen	K-25 Used in the production of barrier material for the gaseous diffusion process	Air	Based on the 95% UCL for the year of the highest measured concentrations in on-site air samplers and dispersion modeling to Union/Lawnville.
		Surface Water	Used 95% UCL for the year of the highest concentrations in Clinch River.
		Soil/Sediment	Used highest mean concentration in Clinch River.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Technetium-99 Level I Screen and Refined Level I Screen	K-25 Y-12 Product of fission of uranium atoms and from neutron activation of stable molybdenum-98	Air	Used an average of concentrations modeled to Union/Lawnville (K-25) and Scarboro (Y-12).
		Surface Water	Used maximum concentration detected in Clinch River (K-25) and EFPC (Y-12).
		Soil/Sediment	Used maximum concentration from the K-25 perimeter and EFPC (Y-12).
		Food Items	Based on concentrations in air, soil, and water and biotransfer and bioconcentration factors from literature.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening (continued)			
Material	**Source**	**Media**	**Exposure Values**
Tritium Level I Screen	Y-12 Used in deuterium gas production and lithium deuteride recovery operations	Surface Water	Evaluated based on deuterium inventory differences and the peak tritium concentration in the deuterium that was processed at Y-12; the release estimate was used with the International Atomic Energy Agency method for tritium dose assessment, assuming all the tritium that escaped was released to EFPC.

TABLE 2
Categorization of Materials Based on Screening Results

Contaminant Source	Not Candidates for Further Study (Level I result was below the decision guide)	Potential Candidates for Further Study (Refined Level I result was below the decision guide)	High Priority Candidates for Further Study (Refined Level I result was above the decision guide)
K-25	Neptunium-237 (cancer) Evaluated qualitatively (quantities, forms, and manner of use were not sufficient): • Carbon fibers • Four-ring polyphenyl ether • Glass fibers • Triplex coating	• Copper powder (noncancer) • Nickel (cancer) • Nickel (noncancer) • Technetium-99 (cancer)	• Arsenic (cancer) • Arsenic (noncancer)
Y-12 Plant	• Beryllium compounds (noncancer) • Neptunium-237 (cancer) • Tritium (cancer) Evaluated using Threshold Quantity Approach (not enough material was present): • Niobium (noncancer) • TMAB • Zirconium (noncancer) Evaluated qualitatively (quantities, forms, and manner of use were not sufficient): • Boron carbide • Boron nitride • Rubidium nitrate • Rubidium bromide • Tellurium • Titanium boride • Yttrium boride • Zirconium	• Beryllium compounds (cancer) • Lithium compounds (noncancer) • Technetium-99 (cancer)	• Arsenic (cancer) • Arsenic (noncancer) • Lead (noncancer) Arsenic was released into the air from the burning of coal at several coal-fired steam plants located on the Oak Ridge Reservation and into the soil, sediment, and surface water from coal piles and disposal of fly ash from the steam plants. Lead was likely released into soil, sediment, and surface water from the disposal of liquid waste into the Y-12 storm sewers and may have been released into the air from process stacks and the plant ventilation system.
ORR (all complexes)		• Chromium VI (cancer) • Chromium VI (noncancer)	