

8. HAZARD ASSESSMENT AND MITIGATION

The overall objectives of this hazard assessment and mitigation section are to provide guidance on the following activities:

- Evaluate existing OU 7-13/14 (i.e., Pits 4, 9, 10, and 6) buried waste contents where intrusive activities will occur to determine the radiological, chemical, biological exposure potential to OU 7-13/14 personnel by all routes of entry
- Evaluate all OU 7-13/14 integrated probing project tasks to determine the extent that existing radiological, chemical, and physical hazards may potentially impact task-site personnel
- Establish the necessary monitoring and sampling required to continuously evaluate exposure and contamination levels and determine adequate ALs to mitigate potential exposures and provide specific actions to be followed if ALs are reached
- Provide mitigating measures through (1) the use of engineering controls, (2) isolation methods for TRU mixed-waste contamination from personnel, (3) work practices to limit personnel exposure, administrative controls, and (4) appropriate respiratory protection and protective clothing to protect task-site personnel from hazards.

8.1 Site Activities Hazards

Personnel may be exposed to safety hazards, or chemical, radiological, and physical agents while working at OU 7-13/14 integrated probing project sites. Potential hazard contributors include (1) buried waste in Pits 4, 6, 9, and 10, (2) historical detection of chemical and radiological soil contamination, (3) radiation fields from exposing buried waste from these pits, and (4) potential “shine” from adjacent waste pits, trenches or logging sources. In addition, use of the drill rig and logging equipment in the EZ of the investigated pit will present direct physical hazards to workers. The magnitude of these hazards to personnel entering the work zones is dependent on both the chemical and radiological nature of the contaminants encountered and the tasks being performed. Engineering controls will be implemented (whenever possible) along with procedural work practices, real-time monitoring of contaminants, and site-specific hazard training to further mitigate potential exposures and hazards.

The greatest exposure and hazard potential is from intrusive operations in the SDA (probe installation) and sampling of Type-B probes where vapor and water samples are brought to the surface inside a glove bag. All cardboard and wood boxes, and approximately 70% of all metal drums, are breached and no longer provide an adequate layer of waste confinement based on past studies in the SDA. Flooding also is assumed to have occurred (McKinley and McKinney 1978).

Pits 4 and 10 were selected because available information indicates that they probably contain the contaminants identified as risk drivers (INEEL 2000c). Pit 6 was selected as an alternative pit to investigate for the same reason. Based on soil-gas survey data, the east end of Pit 4 has the highest organic vapor concentrations. Pit 10 corresponds to one of the areas with high soil gas concentrations and received waste shipments containing uranium, plutonium, and americium. The exact number and placement of probeholes is addressed in the *Operable Unit 7-13/14 Plan for the Installation, Logging, and Monitoring of Probeholes in the Subsurface Disposal Area*.

- Table 8-1 summarizes each primary task and the associated hazards and mitigation.
- Table 8-2 lists the dominant radiological contaminants buried in the respective pits that may be encountered during the project tasks.
- Table 8-3 lists the dominant nonradiological contaminants buried in the respective pits that present highest health hazards based on potential quantity of material present.
- Table 8-4 presents an evaluation of these radiological and nonradiological contaminants relative to potential routes of exposure and symptoms of overexposure. In Addition, the exposure potential by all routes stated is based on the quantity of material present, toxicity, distribution of containers in the pit, known migration from containers, and the likely matrix to be encountered during sampling tasks (the tasks with the highest potential of exposure).
- Table 8-5 lists hazards (radiological and nonradiological) to be monitored by the IH and RadCon personnel
- Table 8-6 lists IH and RadCon equipment available to monitor these hazards.
- Table 8-7 presents ALs and associated responses for specific hazards.

Engineering and administrative controls, specialized training, worker personal protective clothing strategies, personnel monitoring, and restricted access to designated work areas will form the basic protective measures to eliminate or minimize hazards present at the OU 7-13/14 task sites. Several of the nonradiological contaminants listed (e.g., asbestos, cadmium) have extremely low TLVs based on airborne exposure to these inorganic substances in their pure form. The release potential from these contaminants is considered low because of (1) the nature of the matrix in which they exist (i.e., sludge, moist soil), (2) the mixing action that occurred during flooding and subsidence, (3) the Type B porous stainless steel pore size, and (4) the manner in which samples will be collected (vapor and water form).

Operable Unit 7-13/14 integrated probing activities involve known radiological hazards. Because of these hazards, it has been determined that an RWP, according to the MCP-7, "Radiological Work Permit," will be required for all probe installation, logging, and sampling activities. To evaluate potential airborne radiological exposures, RadCon will use existing EDFs, in accordance with MCP-6, "Engineering Design File," and MCP-352, "Determining Radiological Monitoring Requirements."

To address hazardous and radiological conditions at the project site, SWPs, RWPs, and JSA may be used in conjunction with this HASP, as deemed appropriate by safety and health professionals. These permits further detail specialized protective equipment and dosimetry requirements. The IH and radiological monitoring are outlined in Subsections 8.4.1 and 8.4.2 of this HASP, respectively.

Table 8-1. Operable Unit 7-13/14 integrated probing project activities, associated hazards, and mitigation.

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
Mobilization and site preparation (Drill rig truck, logging truck, trailers, hydraulic line, and all support equipment)	<ul style="list-style-type: none"> o Radiological contamination— SDA subsurface soils o Radiation exposure— SDA near waste shipments from Pit 17 o Chemical/inorganic contaminants— SDA subsurface soil o Equipment movement/vehicle traffic— trailers, drill-rig, or logging truck pinch points; ergonomic concerns; and struck-by or caught-between potential o Lifting and back strain—moving hydraulic line, staging drilling materials o Subsidence of soil from heavy equipment-on or near SDA Pits (seasonal). o Heat and cold stress o Tripping hazards/working-walking surfaces—existing probes in ground, ice and snow-covered surfaces, drill-rig truck deck/ladders o Stored energy sources—electrical lines and panels, elevated materials, hoisting and rigging, gas cylinders (P₁₀). 	<ul style="list-style-type: none"> o RCT surveys, RWP (as required), dosimetry, direct reading instruments, comply with posted entry/exit requirements to SDA and project areas o Controlled areas, qualified operators, JSAs, SWP, TPRs or work package o Mechanical equipment movement, proper lifting techniques, two-person lifts o Trained operators, JSAs, SWPs, TPRs, qualified HEO (hoisting/rigging), coordination through RWMC shift desk prior to work o IH monitoring, work-rest cycles (as required) o Awareness of probe locations, salt/sand icy areas, use of nonskid/high friction materials on walking surfaces o Identify and mark all utilities, ensure all lines/cord checked for damage/continuity, GFCI usage on outdoor equipment, comply with minimum clearances for overhead lines, secure cylinders/caps bottles prior to movement.
Soil gas surveys and surface geophysical mapping	<ul style="list-style-type: none"> o Radiological contamination— SDA subsurface soils o Radiation exposure— SDA near waste shipments from Pit 17 o Chemical or inorganic contaminants— SDA subsurface soils o Equipment movement and vehicle traffic—pinch points and struck-by and caught-between potential • Lifting and back strain— staging materials, lifting carts • Heat and cold stress • Tripping hazards and working-walking surfaces— existing probes in ground, ice and snow-covered surfaces. 	<ul style="list-style-type: none"> o RCT surveys, RWP (as required), dosimetry, direct reading instruments, comply with posted entry/exit requirements to SDA and project areas o Controlled areas, qualified operators, JSAs, SWP, TPRs or work package o Coordination through RWMC shift desk prior to work o Proper lifting techniques, two-person lifts (as required) o IH monitoring, work-rest cycles (as required) o Awareness of probe locations, salt/sand icy areas, use of high friction footwear on walking surfaces

Table 8-1. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
Probehole installation (Type A and Type B); testing of Type-B probes at CTP; downhole logging	<ul style="list-style-type: none"> ◦ Radiological contaminants — SDA subsurface waste • Radiation exposure — logging source or neutron generator, potential shine from SDA waste material (Type-B probes) ◦ Chemical/inorganic contaminants — SDA subsurface soil and waste, paint, diesel fuel, hydraulic fluid, oil ◦ Equipment movement and vehicle traffic—drill-rig truck, logging truck, forklift, pinch points, ergonomic concerns, and struck-by or caught-between potential ◦ Lifting and back strain—drill string and case handling and tripod assembly setup ◦ Hazardous noise levels—open drill rig engine panel. ◦ Heat/cold stress ◦ Tripping hazards and working-walking surfaces — existing probes in ground, ice and snow-covered surfaces. 	<ul style="list-style-type: none"> ◦ RCT surveys, dosimetry, CAMs, hold points, logging procedures, interlock (neutron generator), source storage cask, HEPA filtered airhood around casing ◦ Controlled work areas, qualified operators, JSAs, SWPs, TPRs, PLNs, or work package • MSDS for chemicals on site, IH monitoring, PPE ◦ Casing storage at waist level, proper lifting techniques, two or three person lifts (probe casing) ◦ JSAs, SWPs, TPRs, and logging engineer, and coordination through RWMC shift desk prior to work ◦ Noise surveys and hearing protection (as required) ◦ IH monitoring, work-rest cycles (as required) ◦ Awareness of probe locations, salt and sand icy areas, use of high friction footwear on walking surfaces.
Sampling and data collection from installed, Type-B probes	<ul style="list-style-type: none"> ◦ Radiological Contaminants — water and vapor samples, glove bag operations ◦ Radiation exposure — from potential contamination encountered, waste shipments from Pit 17 operations ◦ Chemical and inorganic contaminants — sample preservation, argon gas ◦ Lifting and back strain—data transmitter and acquisition equipment, glove bag assembly ◦ Heat and cold stress ◦ Tripping hazards and working-walking surfaces — existing probes in ground, ice and snow covered surfaces. 	<ul style="list-style-type: none"> ◦ RCT surveys, dosimetry, direct reading instruments, HEPA filtered glove bag, glove bag training ◦ Controlled areas, qualified operators, JSAs, SWPs, TPRs, or work package ◦ Wear proper PPE for handling acids, proper handling of gas cylinders ◦ Proper lifting techniques, two-person lifts ◦ JSAs, SWPs, TPRs, coordination through RWMC shift desk prior to work ◦ IH monitoring, work-rest cycles (as required) ◦ Awareness of probe locations, salt and sand icy areas, use of high friction footwear on walking surfaces.

Table 8-2. Dominant radiological contaminants of concern at Pits 4, 6, 9, and 10 project sites.^{a,b}

Isotope	Estimated Activity in Pit 4 (Ci)	Corresponding Mass (g)	Estimated Activity in Pit 6 (Ci)	Corresponding Mass (g)	Estimated Activity in Pit 9 (Ci)	Corresponding Mass (g)	Estimated Activity in Pit 10 (Ci)	Corresponding Mass (g)
U-234	3.18E-00	5.14E+02	1.31E-00	2.12E+04	8.23E-02	1.32E+01	6.17E-00	9.97E+02
U-235	4.99E-01	2.33E+05	7.32E-02	3.42E+04	3.75E-03	1.73E+03	4.44E-01	2.07E+05
U-238	6.47E-00	1.94E+07	2.94E-00	8.83E+06	3.97E+00	1.18E+07	8.44E-00	2.53E+07
Pu-238	4.33E+02	2.51E+01	4.74E+01	2.59E+00	2.44E+01	1.49E+00	1.75E+02	1.02E+01
Pu-239	9.51E+03	1.52E+05	1.58E+03	2.53E+04	1.16E+03	1.87E+04	5.69E+03	9.10E+04
Pu-240	2.19E+03	9.46E+03	3.53E+02	1.55E+03	2.65E+02	1.17E+03	1.27E+03	5.59E+03
Pu-241	5.72E+04	5.72E+02	9.53E+03	9.53E+01	2.93E+03	2.84E+01	3.49E+04	3.49E+02
Pu-242	1.31E-02	3.33E+00	2.14E-02	5.43E+00	1.26E-02	3.20E+00	7.68E-02	1.95E+01
Am-241	2.2E+04	6.39E+03	3.66E+03	1.06E+03	2.26E+03	6.59E+02	1.33E+04	3.86E+03
Np-237	1.31E-01	1.86E+02	1.38E-02	1.96E+01	---	---	1.76E-01	2.49E+02
Co-60	1.25E+05	1.10E+02	3.42E+04	3.02E+01	5.11E-04	4.52E-07	2.25E+05	1.99E+02
Cs-137 (MAP) ^c	2.8E+04	3.24E+02	5.93E+03	6.85E+01	2.57E+00	2.97E-02	3.98E+04	4.60E+02
Sr-90 (MFP) ^d	1.7E+04	1.22E+02	5.52E+03	3.97E+01	2.33E+00	1.68E-02	1.84E+04	1.32E+02
Y-90 (MFP) ^d	1.13E+03	2.08E-03	1.23E+03	2.26E-03	2.33E+00	4.29E-06	4.37E+03	8.04E-03

a. B. H. Becker correspondence(1998). This inventory is not decay-corrected.

b. Nature of the waste when it was buried, radioactive decay, or mixing of container contents is not taken into account.

c. MAPs = mixed activation products.

d. MFPs = mixed fission products.

Table 8-3. Dominant nonradiological contaminants of concern at the Pits 4, 6, 9, and 10 project sites.^{a,b}

Chemical or Compound	Estimated Quantity (kg) (in Entire Pit 4)	Estimated Quantity (kg) (in Entire Pit 6)	Estimated Quantity (kg) (in Entire Pit 9) ^{c,d}	Estimated Quantity (kg) (in Entire Pit 10)
Acetone	7	2	---	5
Aluminum Nitrate Nonahydrate	16,700	6,990	---	13,900
Ammonia	247	0	---	0
Asbestos	15	6	400	13
Benzene	1	0	---	0
Beryllium	406	.004	---	1,270
2-Butanone	2	1	---	3
Butyl alcohol	14	2	---	7
Cadmium	163	2	---	234
Carbon tetrachloride	14,000	14,900	52,000	24,100
Ethyl alcohol	2	1	---	2
Formaldehyde	34	0	---	0
Hydrofluoric acid	654	273	---	542
Lead	50,700	13,100	5,200	49,000
Mercury nitrate monohydrate	71	29	---	58
Methyl alcohol	32	5	---	15
Methylene chloride	2,110	349	150	974
Methyl isobutyl ketone	776	324	---	644
Nitric acid	4,250	1,740	---	3,460
Potassium chloride	764	2,060	2,600	4,620
Potassium nitrate	17,200	46,300	58,000	104,000
Potassium and sodium dichromate (as Cr)	50	162	209	363
Potassium phosphate	382	1,030	---	2,310
Potassium sulfate	764	2,060	---	4,620
Silver	0	0	---	0.4
Sodium chloride	1,530	4,120	5,400	9,250
Sodium nitrate	34,600	92,800	120,000	208,000
Sodium phosphate	764	2,060	2,600	4,620
Sodium sulfate	1,530	4,120	---	9,250
Sulfuric acid	14	4	---	8
Terphenyl	118	0	---	0

Table 8-3. (continued).

Chemical or Compound	Estimated Quantity (kg) (in Entire Pit 4)	Estimated Quantity (kg) (in Entire Pit 6)	Estimated Quantity (kg) (in Entire Pit 9) ^{c,d}	Estimated Quantity (kg) (in Entire Pit 10)
Tetrachloroethylene	3,030	3,340	19,000	5,370
Toluene	32	0	---	0
Tributyl phosphate	87	36	---	72
1,1,1-Trichloroethane	12,500	12,300	15,000	20,200
1,1,2-Trichloro-1,2,2-rifluoroethane	1,320	218	---	610
Trichloroethylene	11,800	13,000	17,000	20,900
Trimethylolpropane-triester	39	0	--	0
Uranyl nitrate	20	8	---	16
Xylene	135	12	---	33
Zirconium	4,130	5,710	---	689
Zirconium alloys	415	173	---	504

a. B. H. Becker correspondence(1998).

b. Nature of the waste when it was buried, decomposition of organic materiel, or mixing of container contents is not taken into account.

c. Liekhus (1992).

d. Smith and Kudera (1996) (referenced as an informational document for the evaluation of health and safety concerns only).

Table 8-4. Evaluation of radiological and nonradiological contaminants at the Operable Unit 7-13/14 integrated probing project sites.

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Metals and Inorganic Compounds						
Aluminum nitrate nonahydrate (7784-27-2)	TLV-TWA— 2 mg (Al) /m ³	Ih, Ig, S	Severe eye irritation, irritating to mucus membranes and upper respiratory tract, skin irritation.	Behavioral (somnolence), skin and appendages (hair)	No	Low potential Distributed in pits and may have migrated from drums. (≈ 16,700 kg in Pit 4) (≈ 6,900 kg in Pit 6) (≈ 13,900 kg in Pit 10)
Ammonia (7664-41-7) VD-0.6 IE- 10.18eV	TWA—17 mg/m ³ STEL—24 mg/m ³	Ih, Ig, Con	Irritation to skin, eyes, and respiratory tract. Toxic by inhalation.	Eyes and respiratory tract	No—NIOSH No—ACGIH	Low potential Distributed in Pit 4 and may have migrated from drums. (≈ 247 kg in Pit 4)
Argon Gas (7440-37-1)	None Established	Ih, Con	Extensive tissue damage or burns can result from exposure to liquid argon or cold argon vapors. Exposure to oxygen-deficient atmospheres may produce dizziness, nausea, vomiting, loss of consciousness, death.	Eyes and skin (frostbite), respiratory system, central nervous system (asphyxiate)	No	Low potential Will be used as a carrier gas for Type-B probe gas sample analysis and used to pressurize line for collection of Type-B probe water samples (inside glove bag).

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy	Exposure Limit ^g (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Asbestos (12001-29-5) VD—NA	TLV—0.2 fiber/cc PEL—0.2 fiber/cc (29 CFR 1910.1101)	Ih, Ig, Con	Irritation of eyes and skin, chronic asbestosis, restricted pulmonary function.	Eyes and respiratory tract	A1—ACGIH Yes—NTP Yes—IARC Yes—OSHA	Low potential Source from pipe insulation and ACBM. Airborne release fraction would be nominal to low, due to matrix (wetted). (≈ 15 kg in Pit 4) (≈ 6 kg in Pit 6) (≈ 40 kg Pit 9) (≈ 13 kg in Pit 10)
Beryllium (7440-41-7) VD—NA	TLV—0.002 mg/m ³ Ceiling—0.005 mg/m ³	Ih, Ig, Con	Respiratory, eyes, dermis, chest pain (chronic-berylliosis)	Eyes/Respiratory tract, skin	Yes—NTP Yes—IARC No—OSHA	Low potential Distributed in drums containing 740-series sludge from RFP . (≈ 406 kg in Pit 4) (≈ 4 kg in Pit 6) (≈ .2 kg Pit 9) (≈ 1,270 kg in Pit 10).
Cadmium (7440-43-9) VD—NA	TLV—0.01 mg/m ³ * TLV—0.002 mg/m ³ ** PEL—0.005 mg/m ³ (29 CFR 1910.1027) * - inhalable fraction ** - respirable fraction	Ih, Ig	Respiratory, nervous system, irritation of mucous membranes, dryness of mouth, headache	Kidneys/ respiratory tract, blood, prostate	Yes—NTP Yes—IARC A2—ACGIH Yes—OSHA	Low potential Numerous trace sources added during several shipments. (≈ 163 kg in Pit 4) (≈ 2 kg in Pit 6) (≈ 540 kg Pit 9) (≈ 234 kg in Pit 10)
Hydrofluoric acid (7664-39-3) VD-0.7 IE-15.98eV	TWA—3 ppm (2.5 mg/m ³) TWA-PEL—3 ppm (2.5 mg/m ³)	Ih, Ig, S, Con	Irritation eyes, skin, nose, throat; pulmonary edema; eye, skin burns; rhinitis; bronchitis; bone changes	Eyes, skin, respiratory system, bones	No—NIOSH No—ACGIH	Low potential Distributed in the pits and may have migrated from drums. (≈ 654 kg Pit 4) (≈ 273 kg Pit 6) (≈ 542 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit" (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Lead (7439-92-1) VD—NA	TLV—0.05 mg/m ³ PEL—0.05 mg/m ³ (29 CFR 1910.1025)	Ih, Ig, Con	Lassitude, weight loss, anemia, nausea, vomiting, paralysis, constipation	GI tract, central nervous system, kidneys, blood, gingival tissue	No	Low potential Sources include shielding, aprons, gloves, and uncemented sludge. (≈ 50,700 kg Pit 4) (≈ 13,100 kg Pit 6) (≈ 5,200 kg Pit 9) (≈ 49,000 kg Pit 10)
Lithium oxide (12057-24-8) VD—NA	None established	Ih, Ig, Con	Corrosive to eyes, skin, nose and throat	Skin and eyes (corrosive)	No	Low potential Source is from discharging lithium batteries. (trace only—Pit 9)
Mercury (7439-93-2) VD-1.01	TLV—0.025 mg/M ³	S, Ih	Coughing, chest pain, respiratory distress, salivation, diarrhea, depression, irritability	Skin, eyes, respiratory central nervous system, kidneys	No	Low potential Five waste streams were added during four separate shipments. (≈ 10 kg in Pit 9)
Mercury nitrate Monohydrate (7783-34-8)	TLV-TWA— 0.025 mg (Hg)/m ³	S, Ih	Extremely destructive to mucus membrane, upper respiratory tract, eyes and skin. Burning sensation, coughing, wheezing, laryngitis, short breath, headache, nausea, vomiting.	Skin, kidneys, GI system nerves, blood	No	Low potential Distributed in the pits and may have migrated from drums. (≈ 71 kg Pit 4) (≈ 29 kg Pit 6) (≈ 58 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Nitric acid (7697-37-2) VD-2 to 3 IE-11.95 eV	ACGIH TWA—2 ppm STEL— 4 ppm OSHA	Ih, Ig, Con	Irritation eyes, skin, mucous membrane; delayed pulmonary edema, pneumonitis, bronchitis; dental erosion	Eyes, skin, respiratory system, teeth	No	Moderate-high potential To be used for Type B water sample preservation. Distributed in the pits and may have migrated from the drums. (≈ 4,250 kg Pit 4) (≈ 1,740 kg Pit 6) (≈ 3,460 kg Pit 10)
Potassium chloride (7447-40-7) VD-NA	None established	Ih, Ig, Con	Eyes, irritation of mucous membranes	None identified, primarily a localized irritant	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 764 kg Pit 4) (≈ 2,060 kg Pit 6) (≈ 2,600 kg Pit 9) (≈ 4,620 kg Pit 10)
Potassium dichromate (7778-50-9) VD-10	TLV—0.05 mg/m ³ * *chromate	Ih, Ig, Con	Respiratory, eyes, dermis, skin irritation, discoloration, mucous membrane ulcerating, perforated septum	Skin	Yes—NPT Yes—IARC No—Z List No—OSHA	Low potential Drums containing 740-series evaporator salt distributed in the pit. High pH matrix increases K ₂ Cr ₂ O ₇ potential. (≈ 22 kg Pit 4) (≈ 59 kg Pit 6) (≈ 95 kg Pit 9) (≈ 32 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS#, Vapor Density and Ionization Energy	Exposure Limit" (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Potassium nitrate (7757-79-1) VD-3	None established	Ih, Ig, Con	Respiratory irritation, (Ig—GI pain, nausea and vomiting)	None identified, primarily a localized irritant	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 17,200 kg Pit 4) (≈ 46,300 kg Pit 6) (≈ 58,000 kg Pit 9) (≈ 104,000 kg Pit 10)
Potassium phosphate (7778-77-0) VD-NA	None established	Ih, Ig, Con	Eyes, minor skin irritation	None identified, primarily a localized irritant	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 382 kg Pit 4) (≈ 1,030 kg Pit 6) (≈ 1,400 kg Pit 9) (≈ 2,310 kg Pit 10)
Potassium sulfate (7778-80-5) VD-NA	None established	Ih, Ig	None identified	None identified	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 764 kg Pit 4) (≈ 2,060 kg Pit 6) (≈ 2,600 kg Pit 9) (≈ 4,620 kg Pit 10)
Silver (7440-22-4) VD-NA	TLV—0.01 mg/m ³	Ih, Ig, Con	Respiratory irritation, blue-gray eyes, skin- irritation and ulceration, GI distention	Nasal septum, skin, eyes	No	Low potential Only trace amount in Pit 10, distributed during several shipments. (≈ 1 g Pit 9) (≈ 0.4 kg in Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Sodium chloride (7647-14-5) VP-NA	None established	Ih, Ig, Con	Eyes, irritation of mucous membranes	None identified, primarily a localized irritant	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 1,530 kg Pit 4) (≈ 4,120 kg Pit 6) (≈ 5,400 kg Pit 9) (≈ 9,250 kg Pit 10)
Sodium dichromate (10588-01-9) VD-10	TLV—0.05 mg/m ³ * * Chromate	Ih, Ig, Con	Respiratory, eyes, skin irritation or ulcerating	Kidneys, liver	Yes—NPT* Yes—IARC* Yes—Z List* Yes- OSHA* *chromium	Low potential Drums containing 740-series evaporator salt distributed in the pit. High pH matrix increases Na ₂ Cr ₂ O ₇ potential. (≈ 38 kg Pit 4) (≈ 103 kg Pit 6) (≈ 200 kg Pit 9) (≈ 231 kg Pit 10)
Sodium nitrate (7631-99-4) VD-2.9	None established	Ih, Ig, Con	Respiratory, eyes, dermis, (Ih and Ig may cause cyanosis)	None identified, primarily a localized irritant	No	Low potential Distributed in the drums containing 740-series sludge from RFP (≈ 34,600 kg Pit 4) (≈ 92,800 kg Pit 6) (≈ 120,000 kg Pit 9) (≈ 208,000 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Sodium phosphate (7558-79-4) VD-4.9	None established	Ih, Ig, Con	Respiratory, eyes, dermis	None identified, primarily a localized irritant	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 764 kg Pit 4) (≈ 2,060 kg Pit 6) (≈ 2,600 kg Pit 9) (≈ 4,620 kg Pit 10)
Sodium sulfate (7757-82-6) VD-NA	None established	Ih, Ig, Con	Respiratory, eyes, dermis	None identified, primarily a localized irritant	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 1,530 kg Pit 4) (≈ 4,120 kg Pit 6) (≈ 5,400 kg Pit 9) (≈ 9,250 kg Pit 10)
Sulfuric acid (7664-93-9) VD-3.4 IE-	ACGIH TWA—1 mg/m ³ STEL—3 mg/m ³	Ih, Ig, Con	Irritation eyes, skin, nose, throat; pulmonary edema, bronchitis; emphysema; conjunctivitis; stomatis; dental erosion; tracheobronchitis; eye, skin burns; dermatitis	Eyes, skin, respiratory system, teeth	No	Low potential Distributed in the drums containing 740-series sludge from RFP. (≈ 14 kg Pit 4) (≈ 4 kg Pit 6) (≈ 8 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10	Material or Chemical (CAS #, Vapor Density and Ionization Energy	Exposure Limit" (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
8-15	Uranium—insoluble compounds, as U (7440-61-1) (metal) VD-NA IE	TWA—0.2 mg/m ³ STEL— 0.06 mg/m ³ OSHA PEL-TWA— 0.25 mg/m ³	Ih, Ig, Con	Dermatitis; kidney damage; blood changes; (potential occupational carcinogen); in animals; lung, lymph node damage.	Skin, kidneys, bone marrow, lymphatic system, lung cancer	YES—NIOSH (potential)	Moderate potential Distributed in the pits. Most is in solid non-soluble form, from metals, filters, trash salt cakes, and scrap. U-238 is the uranium isotope of most concern. (See Table 8-2 for U-234,236). For U-238: (≈ 1.94E+04 kg Pit 4) (≈ 8.83E+03 kg Pit 6) (≈ 2.53E+04 kg Pit 10)
	Uranium—soluble compounds, as U (none) VD- IE-	TWA—0.05 mg/m ³	Ih Ig, Con	Dermatitis; kidney damage; blood changes; potential occupational carcinogen (in animals); lung, lymph node damage.	Skin, kidneys, bone marrow, lymphatic system, lung cancer	YES—NIOSH (potential)	Low potential Most is in solid, non-soluble form, from metals, filters, trash salt cakes, and scrap. A small percent of the U-235 could be soluble. Total U-235: (≈ 233 kg Pit 4) (= 34 kg Pit 6) (≈ 207 kg Pit 10)
	Uranyl nitrate (13520-83-7)	PEL—0.05 mg (U)/m ³	Ig, Ih, S	Irritation to eyes, mucus membrane, and upper respiratory tract. May be fatal if swallowed.	Liver, kidneys, lungs, brain	Yes—California Proposition 65	Low potential Distributed in pits and may have migrated from drums. (≈ 20 kg Pit 4) (≈ 8 kg Pit 6) (≈ 16kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit" (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Zirconium/ Zr-compounds (7440-67-7) VD-NA	TLV—5 mg/m ³ Ceiling-10 mg/m ³	Ih, Con	Respiratory, irritation of skin and mucous membranes, lung granulomas.	Respiratory system, skin	No	Low potential Source is from scrap metal. (≈ 4,545 kg Pit 4) (≈ 5,883 kg Pit 6) (≈ 12 m ³ in Pit 9) (≈ 1,193 kg Pit 10)
Organic Compounds						
Acetone (67-64-1) VD-2 IE-9.7 eV	TLV-500 ppm STEL-750 ppm Ceiling-1782 ppm	Ih, Ig, Con	Nervous system, respiratory, dermis, headache, contact with eyes may cause permanent damage.	Respiratory system, skin	No	Low potential Absorbed on rags in waste in numerous shipments. (≈ 7 kg Pit 4) (≈ 2 kg Pit 6) (≈ 44 g Pit 9) (≈ 5 kg Pit 10)
Benzene (VM+P Naptha) (8032-32-4)	ACGIH TLV—1370 mg/m ³ CL—1800 mg/m ³ 15 min.	S, Ih, Ig, Con	Wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting, coughing, burning sensations.	Central nervous system, skin, lungs	ACGIH Animal carcinogen	Low potential Absorbed on rags in waste in numerous shipments. (≈ 1 kg Pit 4) (≈ 2 kg Pit 6) (≈ 5 kg Pit 10)
2-Butanone (78-93-3) VD-2.5 IE-9.54 eV	TWA—200 ppm STEL—300 ppm	Ih, Ig, Con	Irritation of eyes, skin, nose; headache; dizziness; vomiting; dermatitis.	Eyes, skin, respiratory system, lungs, central nervous system	No-NIOSH No-ACGIH	Low potential Absorbed on rags in waste in numerous shipments. (≈ 2 kg Pit 4) (≈ 1 kg Pit 6) (≈ 3 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Butyl Alcohol (71-36-3) VD-2.55 IE-10.4 eV	STEL C—50 ppm* Ceiling—152 ppm* (Ceiling for both)* *n-Butanol	Ih, Ig, S, Con	Nervous system, respiratory, dermis, headache, shortness of breath.	Respiratory system, eyes, skin	No	Low potential Source from uncemented sludge. (≈ 14 kg Pit 4) (≈ 2 kg Pit 6) (≈ 1.2 kg Pit 9) (≈ 7 kg Pit 10)
Carbon tetrachloride (56-23-5) VD-5.3 IE-11.5 eV	TLV—5 ppm STEL—10 ppm Ceiling—63 ppm	Ih, Ig, S, Con	Nervous system, eyes, respiratory, irritation of eyes and skin; central nervous system depression, headache.	Central nervous system, eyes, liver, lungs, kidneys	A2—ACGIH Yes—NTP Yes—I ARC No—OSHA	Moderate-high potential Widely distributed in pits and probably has migrated from drums. (≈ 14,000kg Pit 4) (≈ 14,900kg Pit 6) (≈ 52,000 kg Pit 9) (≈ 24,100kg Pit 10)
Diesel fuel (8008-20-6) VD->1	100 mg/m ³ (diesel fuel/kerosene - ACGIH notice of intended changes for 2000)	Ih, Ig, S, Con	Nervous system, eyes, respiratory, dermis, headache, skin irritation.	Skin	No	Moderate potential Will be used to refuel equipment.
Ethyl alcohol (64-17-5) VD- IE-10.47 eV	ACGIH TLV-TWA—1000 ppm (1880 mg/m ³)	Ih, Ig, S, Con	Irritation eyes, skin, nose; headache, drowsiness, fatigue, narcosis; cough; liver damage; anemia; reproductive, teratogenic effects.	Eyes, skin, respiratory system, central nervous system, liver, blood, reproductive system	No-ACGIH	Low potential Absorbed on rags in waste in numerous shipments. (≈ 2 kg Pit 4) (≈ 1 kg Pit 6) (≈ 2 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Formaldehyde (50-00-0) VD- 1.07 IE-10.88 eV	ACGIH TLV - 0.37 mg/m ³ (0.3 ppm) OSHA (29 CFR 1910.1048) PEL-TWA —0.75 ppm STEL—2 ppm	Ih, Ig, S, Con	Irritation eyes, nose, throat, respiratory system; lacrimation (discharge of tears); cough; bronchitis spasm, dermatitis.	Eyes, skin, respiratory system, cancer, kidneys, liver, heart, nasal cancer	Yes-NIOSH Yes-ACGIH Yes-OSHA	Low potential Absorbed on rags in waste in numerous shipments. (≈ 34 kg Pit 4) (≈ 0 kg Pit 6) (≈ 0 kg Pit 10)
Methyl alcohol (67-56-1) VD-1.11 IE-10.8 eV	TLV —200 ppm STEL—250 ppm Ceiling—328 ppm	Ih, Ig, S, Con	Nervous system, eyes, respiratory, central nervous system depression, (contact with eyes may cause temporary corneal damage).	Eyes, skin, central nervous system	No	Low potential Source from uncemented sludge. (≈ 32 kg Pit 4) (≈ 5 kg Pit 6) (≈ 2.6 kg Pit 9) (≈ 15 kg Pit 10)
Methylene chloride (75-09-2) VD-2.9 E-11.3 eV	TLV—50 ppm OSHA (29 CFR 19 10.1052) TWA - 25 ppm STEL - 125 ppm	Ih, Ig, Con	Headache, dizziness, skin irritation.	Skin, central nervous system, eyes, cardiovascular system	No	Moderate potential Distributed throughout the pits. (≈ 2,110 kg Pit 4) (≈ 349 kg Pit 6) (≈ 150 kg Pit 9) (≈ 974 kg Pit 10)
Methyl Isobutyl Ketone (563-80-4) VD- IE-9.32 eV	TWA—200 ppm (705 mg/m ³) PEL—None	Ih, Ig, Con	Irritation eyes, skin, mucous membrane, respiratory system; cough.	Eyes, skin, respiratory system	No	Moderate potential Distributed throughout the pits. (≈ 776 kg Pit 4) (≈ 324 kg Pit 6) (≈ 644 kg Pit 10)

Table 8-4. (continued).

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Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy	Exposure Limit" (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Nitric Acid (7697-37-2) VD-2 to 3 E- 11.95 eV	ACGM TWA—2 ppm STEL—4 ppm	Ih, Ig, Con	Irritation eyes, skin, mucous membrane; delayed pulmonary edema, pneumonitis, bronchitis; dental erosion.	Eyes, skin, respiratory system, teeth	No	Low potential Distributed in the pits and may have migrated from the drums. (≈ 4,250 kg Pit 4) (≈ 3,460 kg Pit 10) Will be used for water sample preservation.
Nitrocellulose (111-76-2) VD->1	TLV—25 ppm * *(2-butoxyethanol)	Ih, Ig, S	Nervous system, respiratory, dermis, central nervous system, eyes.	Skin, liver, kidney, blood	No	Low potential Drums distributed throughout Pit 9. (≈ 90 g per drum)
PCBs (11097-69-1) VD-3	TLV—0.5 mg/M ³ * *(54% chlorine)	Ih, Ig, S, Con	Respiratory, nervous system, central nervous system depression, dermis, eyes, headache.	Skin, kidney, liver, central nervous system	Yes-NTP Yes-IARC No-OSHA	Low potential Series 743 contaminated oil source contained with only trace amounts. (≈ 266 g in Pit 9)
Terphenyl(o-, m-, p-) (84-15-1, 92-06-8, 92-94-4) VD-NA IE- 7.78—8.01 eV	ACGIH Ceiling—0.5 ppm (5 mg/m ³) OSHA Ceiling—1 ppm (9 mg/m ³)	Ih, Ig, Con	Irritation eyes, skin, mucous membrane; thermal skin burns; headache; sore throat; in animals: liver, kidney damage.	Eyes, skin, respiratory system, liver, kidneys	No	Low potential Distributed in Pit 4. (≈ 118kg Pit 4) (≈ 0 kg Pit 6) (≈ 0 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Tetrachloroethylene (127-18-4) VD-5.8 IE-9.3 eV	TLV—25 ppm STEL—100 ppm Ceiling—685 ppm	Ih, Ig, Con	Nervous system, respiratory, headache, loss of consciousness, dermis.	Liver, kidneys, eyes, upper respiratory, central nervous system	No	Moderate-high potential Widely distributed in pits and may have migrated from drums. (≈ 3,030 kg in Pit 4) (= 3,340 kg Pit 6) (≈ 19,000 kg Pit 9) (= 5,370 kg Pit 10)
Toluene (108-88-3) VD-3.14 IE- 8.82 eV	ACGIH WA= 50 ppm (188 mg/m ³) NIOSH TWA—100 ppm (375 mg/m ³) STEL —150 ppm (560 mg/m ³) Ceiling —200 ppm (10 min) OSHA PEL-TWA—200 ppm Ceiling —300 ppm and 500 ppm (10 min peak during 8-hr shift)	Ih, S, Ig, Con	Irritation eyes, nose; fatigue, weakness, confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); nervousness, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage.	Eyes, skin, respiratory system, central nervous system, liver, kidneys, bladder, blood	No	Low potential Absorbed on rags in waste in numerous shipments. (≈ 32 kg Pit 4) (≈ 0 kg Pit 6) (≈ 0 kg Pit 10)
Tributyl phosphate (126-73-8) VD-NA IE-	NIOSH TWA—0.2 ppm (2.2 mg/m ³) OSHA PEL-TWA—0.4 ppm (5 mg/m ³)	Ih, Ig, S Con	Irritation eyes, skin, respiratory system, headache, nausea.	Eyes, skin, respiratory system, central nervous system, blood	No	Low potential Absorbed on rags in waste in numerous shipments. (≈ 87 kg Pit 4) (≈ 36 kg Pit 6) (≈ 72 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
1,1,1-Trichloroethane (71-55-6) VD-4.6 IE-11.1 eV	TLV—350 ppm STEL—450 ppm Ceiling — 2460ppm	Ih, Ig, S, Con	Nervous system, dermis, respiratory, eyes, central nervous system depression, headache.	Central nervous system, skin, eyes, cardiovascular system	No	Moderate-High potential Widely distributed in pits and may have migrated from drums. (≈ 12,500kg Pit 4) (≈ 12,300kg Pit 6) (≈ 15,000kg Pit 9) (≈ 20,200kg Pit 10)
Trichloroethylene (79-01-6) VD-4.53 IE-9.5 eV	TLV—50 ppm STEL — 100 ppm Ceiling — 537 ppm	Ih, Ig, Con	Nervous system, headache, respiratory, eyes, pulmonary edema.	Respiratory, heart, liver, kidneys, central nervous system	No	Moderate-High potential Widely distributed in pits and may have migrated from drums. (≈ 11,800kg Pit 4) (≈ 13,000kg Pit 6) (≈ 17,000kg Pit 9) (≈ 20,900kg Pit 10)
1,1,2-Trichloro- 1,2,2-Trifluoroethane (76-13-1) VD-6.5 IE-11.99 eV	TWA—1000 ppm (7,600 mg/m ³) STEL—1250 ppm (9,500 mg/m ³)	Ih, Ig, Con	Irritation skin, throat, drowsiness, dermatitis; central nervous system depressant and depression (in animals); cardiac arrhythmia, narcosis.	Skin, heart, central nervous system cardiovascular system	No	Low potential Distributed in pits and may have migrated from drums. (≈ 1,320kg Pit 4) (≈ 218 kg Pit 6) (≈ 610 kg Pit 10)
Trimethylolpropane- triester (Triacrylate) (15625-89-5)	None listed.	Ih, S, Ig	Irritation to eyes, mucus membrane and upper respiratory tract. Causes skin irritation.	Mucus membranes, upper respiratory tract, skin.	Not listed	Low potential Distributed in Pit 4 and may have migrated from drums. (≈ 135 kg Pit 4) (≈ 12kg Pit 6) (≈ 33 kg Pit 10)

Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy)	Exposure Limit ^a (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Xylene (95-47-6) VD-5.2 IE-8.6 eV	TLV—100 ppm STEL—150 ppm Ceiling—651 ppm	Ih, Ig, S, Con	Nervous system, respiratory, dermis, eyes, headache, drowsiness.	Central nervous system, eyes, skin, GI tract, blood, liver, kidneys	No	Low potential Source from uncemented sludge. (≈ 135kg Pit 4) (≈ 12kg Pit 6) (≈ 5.6kg Pit 9) (≈ 33kg Pit 10)
Versenes (EDTA) (60-00-4) VD-NA	Not established	Ih, Ig, Con	Eyes, respiratory.	Respiratory system, eyes, GI tract	No	Low-moderate potential Distributed among (4,016) Series-745 sludge drums (≈ 280 kg in Pit 9)
Radionuclides—Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Np-237, U-238, U-236, U-235, and U-234 (dominant radioisotopes, 99.9% of radioactivity [Becker et al. 1998, Pit 9 ROD 19931, neutron logging source and neutron generator).						

**Radiological
Contaminant**

Expected Levels

Radionuclides (whole-body exposure)	INEEL—1.5 rem/yr project ALARA dose limit-per RWP or ALARA Task Posting of radiation areas per INEEL RCM, Table 2-3	Whole Body	Electronic dosimetry will be used to alert workers to increased gamma radiation fields. Albedo dosimetry and NRD instruments will be used to monitor for neutron radiation.	Blood forming cells, GI tract, and rapidly dividing cells	Yes	Low-moderate potential Low doses from repeated handling of logging sources. . Logging source installation and removal from tool/neutron generator (V&V NDA research). (High Radiation Area may be established during logging tasks)
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Table 8-4. (continued).

Pit 4, 6, 9, & 10 Material or Chemical (CAS #, Vapor Density and Ionization Energy	Exposure Limit" (Permissible Exposure Limit or Threshold-Limit Value)	Routes of Exposure ^b	Symptoms of Over-Exposure ^c (Acute and Chronic)	Target Organs and System	Carcinogen? (Source) ^d	Exposure Potential ^{e,f} (All Routes Without Regard to Personal Protection Equipment)
Radionuclides (fixed and removable surface contamination)	Posting of CAs per INEEL RCM, Table 2-4, § 835.404.c, and § 835.603.f	Ig, Con	Alarming personnel- contamination monitors and hand-held instruments (see Table 8-6)	GI tract, ionization of internal tissue	Yes	Low-moderate potential Contact with contaminated surfaces. Fixed and removable contamination levels not expected to exceed 100times Table 2-2 values for specific radionuclides.
Radionuclides (airborne radioactivity)	10% of DAC for specific radionuclide selected (10 CFR 835) Posting of airborne radioactivity areas per INEEL RCM, Table 2-4, and 10CFR 835.603.d	Ih, Ig, Con	Alarming continuous air monitors, portable air samplers, and surface swipe counting (see Table 8-6).	Respiratory system, GI tract, ionization of internal tissue	Yes	Low potential Isolated glove bag sampling system. Potential if HEPA system fails. Airborne levels exceeding 10% of specified DAC value possible in localized area if confinement breached.

a. ACGIH 2000 TLV Booklet and OSHA 29 CFR 1910 substance specific standards, and MSDS.

b. (Ih) inhalation; (Ig) ingestion; (S) skin absorption; (Con) contact hazard.

c. Nervous system: dizziness, nausea, lightheadedness; Dermis: rashes, itching, redness; Respiratory: respiratory effects; Eyes: tearing, irritation.

d. If yes, identify agency and appropriate designation (ACGIH A1 or A2; NIOSH; OSHA; IARC; NTP).

e. Personal exposure to personnel from waste constituents when conducting OU 7-13/14 integrated probing project tasks.

f. Estimates (≈) of specific compounds from Tables 8-2 and 8-3.

ACGIH = American Conference of Government Industrial Hygienists

CNS = central nervous system

CVS = cardiovascular system

DAC = derived air concentration

eV = electron volts

IARC International Agency for Research on Cancer

IE = ionization energy

GI = gastrointestinal

MSDS = Material Safety Data Sheets

NIOSH = National Institute for Occupational Safety and Health

NPT Non-Proliferation Treaty

PCB = polychlorinated biphenyl

PEL = permissible exposure limit

OSHA = Occupational Safety and Health Administration

REM = roentgen equivalent man

RCM = radiological control manual

STEL short-term exposure limits

TLV = threshold limit value

TWA = time-weighted average

VD = vapor density (air = 1)

Material Safety Data Sheets for these chemicals are available at the OU 7-13/14 trailer.