2. QUALITATIVE HAZARD AND ACCIDENT ANALYSIS

CONTENTS

TABLES

2. QUALITATIVE HAZARD AND ACCIDENT ANALYSES

This chapter identifies and evaluates the potential hazards associated with the operation and reviews the hazard classification of the Waste Handling Facility.

2.1 Introduction

The hazards of principle concern are those that can result in an uncontrolled release of radioactive and/or hazardous material that could adversely affect the off-site public, facility workers, co-located workers, or the environment. A fire in the building is evaluated only as an initiator of hazardous and radioactive constituents release from containers. Per DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports,"[1] standard industrial hazards were evaluated only to the degree that they can be a contributor to a significant uncontrolled release of hazardous material (for example, forklift accident causes container rupture). Only incidents within the building are evaluated. Transportation-related events are evaluated in Hazard Assessment Document (HAD)-94, "Transportation."[2]

2.2 Requirements

MCP-2451, "Safety Analysis for Other than Nuclear Facilities,"[3] and DOE-ID Orders 420.C, "Safety Analysis Review and Approval Process,"[4] and 420.D, "Requirements and Guidance for Safety Analysis,"[5] list the requirements, standards, and DOE orders applicable to hazard and accident analyses. There are no unique requirements applicable to this facility.

2.3 Hazard Classification

The Waste Handling Facility is categorized as a "moderate-hazard, other-than-nuclear facility" in a separate document.[6] The facility's moderate hazard classification is derived from the chemical inventory hazards and the potential that facility workers could be exposed to doses in excess of 2 rem from a sealed source. This classification means that this is a nonnuclear facility that requires a DOE-ID approved safety analysis.

The facility is not classified as a nuclear facility; therefore, specific limits to maintain the hazard classification of the Waste Handling Facility are specified only for radioactive and fissile material inventories.

2.3.1 Radioactive Material Inventory

A broad variety of LLW and MLLW from a variety of INEEL facilities is brought to the facility for sampling, characterization, and repackaging. The waste has an exposure rate less than 500 mR/h at 1 m.[7] A worst case shipment was used to envelope the radioactive material inventory for the facility.

The facility contains radioactive materials in quantities above those discussed in Appendix B of 40 CFR 302,[8] and hazardous material above the 40 CFR 355[9] and 29 CFR 1910.119[10] limits, thus meeting the designation for a DOE-ID approved safety analysis.[11]

The facility's radioactive material inventory is maintained below the Hazard Category 3 thresholds given in Attachment 1 of DOE-STD-1027-92.[12] Operational limits are used to maintain the radioactive inventory to less than the Hazard Category 3 thresholds. This results in the operational safety requirement (OSR) in Section 3.4 that limits the radioactive material inventory to below the Hazard Category 3 thresholds given in Attachment 1 of DOE-STD-1027-92.

The amount of radioactive waste managed at the facility on a day-to-day basis is highly variable, as is the amount of radioactive material from container to container. Radionuclides in the waste typically are present as a contaminant, rather than as a primary constituent of the waste. Because a consistent waste inventory cannot be described for the facility, a container currently managed at INTEC was selected to represent a radiological bounding case for INTEC waste storage units. The container is a 4 × 4 × 8 ft box of debris with a relatively high total reported activity of approximately 7 Ci, as shown in Table 2-1. Although it is expected that most containers to be managed at the facility will have contents exhibiting much less activity, such containers have historically been managed, and it is assumed that they could be again in the future.

Table 2-1 presents the radionuclide profile from the INEEL Waste Tracking System (IWTS) radionuclide worksheet for the container. In addition to this inventory, the 40 CFR 302 Appendix B reportable quantities (RQs) and DOE-STD-1027 Hazard Category 3 thresholds are presented in the table. Daughter products and minor radionuclides are not consistently reported on IWTS container worksheets, and the actual total activity of the container may be slightly higher. (A full profile is not available, but would include many more than the 56 radionuclides presented in the table.) Three of the radionuclides were present in amounts above the 40 CFR 302 RQs, as indicated in the table.

2.3.2 Fissile Material Inventory

The fissile material is dispersed in the waste and in a form that precludes the possibility for a criticality. In most cases, the fissile material exists only as contamination of the waste material. Waste characterization data provide the basis for waste acceptance at the facility. The legacy waste characterization data for the containers show no container with more than 15 g of fissile material. The majority of the waste to be handled includes lead debris and debris from maintenance and demolition. The maintenance and demolition debris consists mainly of concrete, piping, insulation, and lumber that may be contaminated with metals (such as mercury, beryllium, or lead), corrosive materials (acidic or basic), radioactive materials, asbestos, or PCBs. Although not a primary waste stream, the facility may also receive chemical wastes. Containers handled in the facility include 5-, 10-, 30-, 55-, and 85-gal drums, wooden boxes ranging in size from 2 × 2 × 2 ft to 4 × 4 × 8 ft, and various waste bins (B-25 bins). The OSR in Section 3.4 lists requirements during characterization and repackaging to maintain the characterization of the fissile material inventory for the facility as dispersed waste. The requirements ensure that any fissile material requiring repackaging be packaged in a container meeting pertinent DOT regulations for that specific package.[13] Also, though not anticipated, if a package is found with greater than 200 g of fissile material upon inspection, the container must be isolated from the rest of the fissile material in the building by 12 ft, pending evaluation.

Table 2-1. Radioactive material inventory and comparison with regulatory thresholds.

Nuclide	Activity (Ci)	40 CFR 302.4 App. B RQ (Ci)	RQ Ratio	DOE-STD-1027 Threshold (Ci)	Ratio to Threshold	Nuclide	Activity (Ci)	40 CFR 302.4 App. B RQ (Ci)	RQ Ratio	DOE-STD-1027 Threshold (Ci)	Ratio to Threshold
Am-241	3.190E-03	0.010	3.190E-01	5.20E-01	6.13E-03	Pu-236	3.507E-07	0.100	3.507E-06	2.00E+00	1.75E-07
Am-242	9.820E-07	100.000	9.820E-09	8.20E+03	1.20E-10	Pu-238[a]	**2.525E-02**	0.010	2.525E+00	6.20E-01	4.07E-02
Am-242m	1.017E-06	0.010	1.017E-04	5.20E-01	1.96E-06	Pu-239	3.507E-03	0.010	3.507E-01	5.20E-01	6.74E-03
Am-243	1.402E-06	0.010	1.402E-04	5.20E-01	2.70E-06	Pu-240	6.664E-04	0.010	6.664E-02	5.20E-01	1.28E-03
Cd-113m	2.490E-04	0.100	2.490E-03	1.18E+01	2.11E-05	Pu-241	1.964E-02	1.000	1.964E-02	3.20E+01	6.14E-04
Cm-242	1.087E-06	1.000	1.087E-06	3.20E+01	3.40E-08	Pu-242	5.261E-07	0.010	5.261E-05	6.20E-01	8.49E-07
Cm-243	1.999E-06	0.010	1.999E-04	8.20E-01	2.44E-06	Ra-224	3.507E-07	10.000	3.507E-08	2.00E+02	1.75E-09
Cm-244	1.297E-04	0.010	1.297E-02	1.04E+00	1.25E-04	Rh-102	1.157E-07	10.000	1.157E-08	2.80E+02	4.13E-10
Co-60	3.507E-03	10.000	3.507E-04	2.80E+02	1.25E-05	Sb-125	1.788E-03	10.000	1.788E-04	1.20E+03	1.49E-06
Cs-134	3.858E-03	1.000	3.858E-03	4.20E+01	9.19E-05	Sb-126	3.858E-06	10.000	3.858E-07	2.80E+02	1.38E-08
Cs-135	5.611E-05	10.000	5.611E-06	4.20E+02	1.34E-07	Sb-126m	2.666E-05	1000.000	2.666E-08	2.40E+04	1.11E-09
Cs-137[a]	**3.508E+00**	1.000	3.508E+00	6.00E+01	5.85E-02	Se-79	2.841E-05	10.000	2.841E-06	3.60E+02	7.89E-08
Eu-152	1.894E-04	10.000	1.894E-05	2.00E+02	9.47E-07	Sm-151	2.245E-02	10.000	2.245E-03	1.00E+03	2.25E-05
Eu-154	1.332E-02	10.000	1.332E-03	2.00E+02	6.66E-05	Sn-121m	4.560E-06	10.000	4.560E-07	1.78E+03	2.56E-09
Eu-155	1.613E-02	10.000	1.613E-03	9.40E+02	1.72E-05	Sn-126	2.666E-05	1.000	2.666E-05	1.70E+02	1.57E-07
H-3	8.417E-04	100.000	8.417E-06	1.60E+04	5.26E-08	Sr-90[a]	**3.507E+00**	0.100	3.507E+01	1.60E+01	2.19E-01
I-129	3.507E-06	0.001	3.507E-03	6.00E-02	5.85E-05	Tc-99	6.664E-04	10.000	6.664E-05	1.70E+03	3.92E-07
Nb-93m	1.052E-04	100.000	1.052E-06	2.00E+03	5.26E-08	Te-125m	4.209E-04	10.000	4.209E-05	7.20E+02	5.85E-07
Nb-94	7.365E-05	10.000	7.365E-06	2.00E+02	3.68E-07	Th-228	3.507E-07	0.010	3.507E-05	1.00E+00	3.51E-07
Nb-95	3.880E-04	10.000	3.880E-05	9.60E+02	4.04E-07	Th-230	5.261E-08	0.010	5.261E-06	6.20E-01	8.49E-08
Ni-63	2.104E-03	100.000	2.104E-05	5.40E+03	3.90E-07	Th-231	1.368E-06	100.000	1.368E-08	1.20E+04	1.14E-10
Np-237	1.894E-04	0.010	1.894E-02	4.20E-01	4.51E-04	Th-234	1.333E-06	100.000	1.333E-08	2.80E+03	4.76E-10
Np-239	1.402E-06	100.000	1.402E-08	7.80E+03	1.80E-10	U-232	1.263E-07	0.010	1.263E-05	8.20E-01	1.54E-07
Pa-233	1.894E-04	100.000	1.894E-06	4.60E+03	4.12E-08	U-234	5.261E-05	0.100	5.261E-04	4.20E+00	1.25E-05
Pb-212	3.507E-07	10	3.507E-08	3.20E+02	1.10E-09	U-235	1.368E-06	0.100	1.368E-05	4.20E+00	3.26E-07
Pd-107	1.087E-06	100	1.087E-08	4.20E+03	2.59E-10	U-236	2.175E-06	0.100	2.175E-05	4.20E+00	5.18E-07
Pm-146	4.910E-06	10	4.910E-07	4.20E+02	1.17E-08	U-238	1.333E-06	0.100	1.333E-05	4.20E+00	3.17E-07
Pm-147	2.455E-02	10.000	2.455E-03	1.00E+03	2.46E-05	Zr-93	1.438E-04	1.000	1.438E-04	6.20E+01	2.32E-06
						Total Ci	7.159E+00		4.191E+01	-	3.34E-01

a. Radionuclide present in quantity above the 40 CFR 302 RQ

2.3.3 Hazardous Chemical Inventory

The chemicals staged in CPP-653 include, but are not limited to, acids such as nitric, hydrofluoric, and sulfuric; bases such as sodium hydroxide; and a variety of chemicals such as aluminum nitrate, PCBs, xylene, nitrates, and hydrogen sulfide. The number and types of containers are described in Section 1.6.

Table 2-2 lists the chemicals expected to be managed at the Waste Handling Facility in quantities greater than the 40 CFR 355 and 29 CFR 1910.119 limits. The data in Table 2-2 are based on INTEC waste inventory records for January 2000 through September 2002. This historic INTEC inventory is considered applicable to the facility's function as a waste sampling, characterization, and repackaging unit. The table presents the 40 CFR 355 and 29 CFR 1910.119 limits, as well as the UBC/IBC exempt amounts for hazardous materials. The hazard classification is a result of the potential inventory of nitric acid, which exceeds the moderate hazard threshold. Maximum inventory limits are not required to maintain the facility as a moderate hazard classification because no upper inventory limits are specified for chemicals. However, the moderate hazard has an upper receptor concentration of immediately dangerous to life and health (IDLH). As shown in Section 2.6, the off-site exposure does not exceed thresholds for the public, and thus, does not influence the hazard classification of the facility.

Table 2-2. Chemical inventory above threshold and comparison with regulatory thresholds.

Hazardous Substance	CAS No.	CPP-653 Inventory		29 CFR 1910.119 TQ (lb)	40 CFR 355 TPQ (lb)	UBC/IBC (lb)
		Containers (55-gal drum)	Net Weight (lb)			
Hydrofluoric acid	7664-39-3	1	205	1,000	100	500 (Toxic)
Nitric acid	7697-37-2	5	2,487	500	1,000	250 (Oxidizer Class 2)

CAS Chemical Abstract System
CFR Code of Federal Regulations
IBC International Building Code
TPQ threshold planning quantity
TQ threshold quantity
UBC Uniform Building Code

2.3.4 Natural Phenomena

The major concern related to natural phenomena hazards is to provide egress and remove people from the building in natural phenomena events.[14,15,16,17] CPP-653 is classified as a performance category (PC)-1 structure.[18] As discussed in Chapter 1, the facility design criteria meet the PC-1 criteria. The various natural phenomena events are analyzed in Section 2.5.2.

2.3.5 Flammable Materials

Fire hazards from flammable materials are standard occupational hazards and require no specific hazard analyses provided that the structure meets standard codes of record and a fire does not act as an initiator of a hazardous or radioactive material release. Forklift and truck fuel is a typical flammable material hazard. Chemical processes may have the potential to generate hydrogen gas and pressure in waste containers, presenting the potential for a localized explosion or container rupture. These events are further evaluated relative to explosive hazards.

2.4 Hazard Identification and Evaluation Methodology

The methodology used to identify and evaluate potential hazards to the public, co-located workers, facility workers, and the environment from the facility and operations is summarized in the following sections.

2.4.1 Hazard Identification

A "hazard" is a source of danger (material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to an operation or to the environment (without regard for likelihood or credibility of accident scenarios or consequence mitigation).[1] The potential energy sources and initiating events that could result in injury to workers or affect the inventory of hazardous materials contained within the facility are identified. Historical operational incidents at INEEL and at other DOE facilities are also used to identify potential hazards. The primary source of historical incident information is the DOE Occurrence Reporting and Processing System (ORPS).[19] The list of hazards, and applicability to the facility, is provided in Section 2.5.

2.4.2 Hazard Evaluation

A qualitative hazard evaluation is performed to evaluate all potential facility hazards that can result in an unmitigated radiation or chemical exposure to workers. Each hazard is evaluated to determine potential exposure scenarios and the potential causes, which include internal events, external events, and natural phenomena. Sabotage and terrorism are not addressed.

The likelihood of each hazardous event without controls was qualitatively estimated. No credit was taken for controls (design or administrative features) that prevent the event. The likelihood category was based on available data, operating experience, and/or engineering judgment. If there was uncertainty about the correct likelihood category, the higher frequency category was conservatively assumed.

A qualitative estimate is made of the potential unmitigated consequences to the facility workers, the co-located worker, and the public for each hazardous event. Safety analysis guidance defines the facility worker as located inside the facility (specifically, in the immediate vicinity of the release). The on-site (co-located) worker is located outside the facility and is assumed to be 100 m from the release or, for elevated or buoyant releases, at the point where the release reaches ground level. The off-site public is a hypothetical maximally exposed individual at the site boundary.

Environmental consequences include off-site contamination or major liquid release to the groundwater for high consequences, site contamination for moderate consequences, and site contamination outside around the facility for low consequences.

"Unmitigated" means that a material's quantity, form, location, dispersibility, and interaction with available energy sources are considered, but no credit is taken for safety features (ventilation system, fire suppression) that could prevent or mitigate a hazard. However, this does not require ignoring passive design features that confine hazardous material if their failure is not postulated by design (evaluation) basis events. If there is uncertainty in the consequence category, the more severe consequence category is conservatively assumed.

Design and administrative features or controls that prevent the release of hazardous materials or mitigate the consequences of the release were identified for each potentially hazardous event. Environmental effects are not evaluated against risk criteria because no criteria is required.

2.5 Hazard Analysis Results

2.5.1 Hazard Identification

A qualitative hazard evaluation was performed for the Waste Handling Facility hazards that can result in an unmitigated radiation or chemical exposure to workers.[20] Hazard identification for this study included the following activities:

- Reviewing relevant DOE accident experience
- Comparing potential process and facility hazards against a checklist of energy types addressed by DOE-prescribed programs and occupational safety and health (OSH) standards
- Reviewing the facility material inventory against the hazardous material limits.

The inventory of hazardous materials is used along with the likelihood of potential injuries to identify the facility hazard classification, as discussed in Section 2.3.

2.5.1.1 DOE Experience. DOE information relevant to container handling was previously obtained from the ORPS database.[19] Table 2-3 lists selected events relevant to operations at the facility. The events listed are typical of routine operations, including contamination from waste materials, poor handling practices (not following procedures), forklift accidents, overpressurized containers, leaking containers, and improper labeling of containers.

2.5.1.2 Hazard Summary. Table 2-4 identifies the hazards that are routinely covered by OSH programs. Table 2-5 summarizes the nonroutine material and energy source hazards of facility operations that could potentially affect the public, workers, or the environment. The facility hazards are systematically evaluated and identified for further discussion, if not covered by the applicable standards or programs. The hazards analyzed further in Section 2.5.2 include the following:

1. Flammable materials
2. Ionizing radiation
3. Fissile materials
4. Radioactive materials

Table 2-3. Database of historical events relevant to the Waste Handling Facility system.

Event Description	*Significance*
1. ***ORPS Number:*** *ID-WINC-LANDLORD-1994-0001* Four drums of solution were transported from the HCRWF to the CPP-666 fuel dissolution process for disposal. It was found approximately two months later that one of the drums that was supposedly sent to CPP-666 for disposal was still in CPP-1619. Investigation revealed that one of the drums released for disposal was not the correct drum.	The potential effect was a reduction of safety for personnel. All waste stored within the affected waste bay at CPP-1619 is acidic; therefore, a hazard did not exist to the system it was introduced to. The potential existed for the drum to have contained acidic waste in concentrations that could have required additional PPE and more stringent handling requirements.
2. ***ORPS Number:*** *ID-WINC-WASTEMNGT-1994-0005* Seven bags of waste generated at the Tank Farm were transported to CPP-1617. One of the bags contained a heavy valve. A cut was noticed on the bag containing the valve. The plant-issued coveralls of a waste handler were discovered to be contaminated. Further surveys indicated a pickup bed liner, the scales at CPP-1617, a small area of the floor at CPP-1617 and a wheelbarrow used at the Tank Farm was contaminated.	A worker was contaminated as a result of the incident. It was identified that procedures for proper waste packaging and procedures requiring radiation surveys before the transfer of waste to a clean area were not followed.
3. ***ORPS Number:*** *ID-BBWI-RWMC-2001-0003* An equipment operator was unloading a 139-lb waste drum from a trailer using a drum handler attached to a forklift. The bottom trailing edge of the drum did not clear the side rail on the trailer and the drum was dragged across the rail. This caused the drum to twist in the drum handler and to release its grip on the drum. The drum dropped 3 to 4 ft landing upright on the floor of the building.	The building was evacuated in accordance with facility procedures. A survey revealed no contamination was present in the building. There were no injuries to personnel or damage to the drum. This event could have resulted in contamination of personnel, injuries and a release of radioactive material.
4. ***ORPS Number:*** *ID-BBWI-RWMC-2001-0018* An equipment operator slowly approached and positioned his forklift to line up with a waste drum. As the equipment operator approached the drum, the operator looked up to check the position of the drum lid locking ring bolt. The operator looked back down as the forklift drum handler struck and pierced the side of the drum.	The building was evacuated in accordance with facility procedures. A survey revealed no contamination was present in the building. Although the drum was pierced, the 90-mil polyethylene drum liner was not punctured. This event could have resulted in contamination of personnel and a release of radioactive material.
5. ***ORPS Number:*** *ID-EGG-RWMC-1990-0005* An equipment operator was attempting to engage a plywood separator from the top of a third tier of drums. While engaging the plywood with the forklift drum handlers, the forklift rolled downgrade toward the stack of drums. This caused drums to rock and they fell forward off the stack and dropped horizontally onto the building floor.	All work in the area was stopped. A survey revealed that the integrity of the containers was not breached. This event could have resulted in contamination of personnel and a release of radioactive material.
6. ***ORPS Number:*** *ORO-BJC-K25WASTEMAN-1999-0016* A drum lid and lid ring fell approximately 2 1/2 to 3 ft to the floor, while removing a flat drum lid from a 55-gal overpack drum. This event occurred during repackaging operations. Failure to follow procedural requirements and possible pressurization of the drum were believed to be the cause of this incident.	The safety significance of this event is that personnel could be injured by a lid or lid ring being propelled (if a drum is pressurized) or falling from a drum. Following procedures and mitigative features, such as use of a drum web, could have prevented this event.

Table 2-3. (continued).

Event Description	*Significance*
7. ***ORPS Number:*** *ORO-LMES-Y12WASTE-1998-0001* A forklift operator was placing a 30-gal drum onto a metal self-contained skid without selecting a handling fixture. As the operator backed away from the skid, the forklift tines caught the edge of the upper drum ring, causing the drum to fall over onto the floor. The plastic bung plug popped out as a result of the drop releasing approximately 2 gal of waste material to the floor.	The operator failed to follow procedures by attempting to place the drum into the skid without a drum handling fixture. This event did not result in a reportable quantity of materials being spilled, environmental concerns or personnel safety issues. This event could have resulted in personnel chemical exposures or injuries.
8. ***ORPS Number:*** *ORO-MK-WSSRAP-1996-0020* Subcontractor personnel were preparing to consolidate the contents of 8 open-top drums. The lid retaining bolts were loosened on 6 of the 8 drums and the drums were opened without a problem. Upon opening the seventh drum, the operator lifted the drum ring and the lid blew 1 ft above the drum, landing 5 ft away.	No injuries occurred from this event. The workers were dressed out in the proper PPE. The liquid waste did not escape from the drum during the event. This event could have resulted personnel chemical exposures or injuries.
9. ***ORPS Number:*** *ORO-SURA-TJNAF-1992-0003* Personnel were conducting a planned transfer of 7 waste drums containing an equimolar mixture of hydrofluoric, nitric and phosphoric acids from a hazardous waste storage facility to the transporter's truck. As the transporter was preparing to load the sixth drum, the high-density polyethylene drum was noticed to be leaking. The contents of the drum leaked into the secondary containment pit within 30 min of discovery of the drum failure.	The immediate area of the spill was evacuated. No injuries occurred from this event. The spill was fully contained within the designed secondary containment and the chemical control team neutralized the acid. It was believed that the nitric acid component may cause brittleness in the drum when storage exceeds 6 weeks. Contributing causes included a lack of waste handling procedures and safe volume filling limits.
10. ***ORPS Number:*** *RL-WHC-SOLIDWASTE-1992-0044* While preparing to unload a truck of mixed waste containers, an operator discovered that one of the containers had a puncture hole. The puncture to the container appears to been caused by the drum lifting device.	The waste container was surveyed and no contamination was detected. The container was placed into an overpack. This event could have resulted in contamination of personnel and a release of radioactive material.

HCRWF Hazardous Chemical/Radioactive Waste Facility
PPE personal protective equipment

Table 2-4. Hazards regulated by DOE-prescribed OSH standards.

Hazard	Applicable to Facility (Yes/No)	DOE-Prescribed Program and OSH Standards
High voltage (≥600 V)	No	29 CFR 1910 Subpart S; NEC 70
Low voltage (<600 V)	Yes	29 CFR 1910 Subpart S; NEC 70
Volatile flammable or reactive gases or liquids	Yes	29 CFR 1910 Subpart H, .144, .1200; 29 CFR 1926.152
Explosive materials	Yes	29 CFR 1910.109; DOE Explosive Safety Manual (DOE Manual 440.1-1)
Cryogenic systems	No	ASME Boiler and Pressure Vessel Code
High temperature (≥125°F at contact or 203°F	No	ASME Boiler and Pressure Vessel Code, ANSI/ASME Standard B31
High pressure (≥25 psig for gas or vapor or ≥200 psig for liquids)	Yes	ASME Boiler and Pressure Vessel Code, ANSI/ASME Standard B31
Low pressure	Yes	ASME Boiler and Pressure Vessel Code, ANSI/ASME Standard B31
Inert and low-oxygen atmospheres	No	29 CFR 1910.119, .120, .1200; 29 CFR 1926.651
Toxic materials	Yes	29 CFR 1910.119, .120, .1200, Subpart Z; 29 CFR 1926.353; ACGIH TLVs
Nonionizing radiation	No	29 CFR 1910.97; ACGIH TLVs
High-intensity magnetic fields	No	ACGIH TLVs
High noise levels	Yes	29 CFR 1910.95, .1200; 29 CFR 1926.52; ACGIH TLVs
Mechanical and moving equipment dangers	Yes	29 CFR 1910.147, .211 through .222; 29 CFR 1910 Subparts O, P, Q; 29 CFR 1926 Subpart W
Working at heights	No	29 CFR 1910.25, .28; 29 CFR 1926.951, .451
Excavation	No	29 CFR 1926 Subpart P
Material handling dangers	Yes	29 CFR 1910.120, .176 through .182; 29 CFR 1926.953; DOE-STD-1090-2001 Hoisting and Rigging
Material Transportation	Yes	Hazardous Material Transportation Program, DOE Orders 460.1A and 460.2
Pesticide use	No	29 CFR 1910.1200
Temperature extremes (high and low temperatures during activities)	Yes	29 CFR 1910.120, .1200; ACGIH TLVs
Inadequate illumination	No	29 CFR 1910.37, .68, .120, .177 through .179, .219, .303; 29 CFR 1926.26
Construction	No	29 CFR 1926
Ionizing radiation	Yes	Radiation Protection Program, 10 CFR 835
Reactive materials: alkali metal and corrosives	Yes	Chemical Safety Program DOE Order 5480.4; 29 CFR 1910.1200, .1450
Structural or natural phenomena	Yes	DOE Order 420.1A, DOE-ID AE Standards, DOE-GDE-420.1-2, 29 CFR 1910.119, Subpart E
Fire	Yes	Fire Protection Program, DOE Order 420.1A
Biological agents	Yes	29 CFR 1910.1030, 40 CFR 725 and 32 CFR 627
Other	No	29 CFR 1903.1 (General Duty Clause)

ACGIH American Conference of Government Industrial Hygienists
AE architectural engineering
ANSI American National Standards Institute
ASME American Society of Mechanical Engineers
CFR Code of Federal Regulations
DOE Department of Energy
DOE-ID Department of Energy Idaho Operations Office
NEC National Electric Code
OSH occupational safety and health
TLV threshold limit values

Table 2-5. CPP-653 nonroutine hazards identification summary.

Hazard	Hazard Source(s)	Concern
Flammable materials	Chemicals stored in the Waste Handling Facility	Potential for a fire causing a release of radioactive and hazardous material.
Ionizing radiation	Radioactive material stored in stored in the Waste Handling Facility	Dose to workers.
Radioactive materials	Radioactive material stored in stored in the Waste Handling Facility	Radioactive material release from ruptured container. The inventory limits discussed in Section 2.3.1 limit the extent of a radioactive material release from a ruptured container.
Fissile materials	Fissile and fissionable material stored in the Waste Handling Facility	Radioactive material release from fissile material. The inventory limits discussed in Section 2.3.2 preclude an inadvertent nuclear criticality.
Hazardous chemicals	Chemicals stored in the Waste Handling Facility may include nitric acid, hydrofluoric acid, hydrochloric acid, etc.	Potential for a release of hazardous material.
Pressure	Compressed gas cylinders may be stored in the Waste Handling Facility	Compressed gas cylinder or valve becoming mobile (missile) after rupture or breakage causing release of radioactive or hazardous material. Pressure buildup due to chemical reaction resulting in a pressure release and potential injuries to workers.
External events	Postulated accidents at nearby facilities or locations	Potential damage from facilities acting as an initiator of a radioactive and hazardous waste release.
Explosive materials	Release and ignition of flammable gases; incompatible chemical mixtures	Potential for radioactive or hazardous material release as a result of explosion of gas generated in waste packages, incompatible chemical mixtures.
Kinetic energy	Mobile equipment such as forklifts and portable cranes used in the Waste Handling Facility (see standard occupational hazards)	Potential for damaged equipment injuring personnel, hazardous/radioactive material contamination spread, and exposure to personnel.
Natural phenomena	Earthquake, extreme wind, flood, lightning, range fire, etc.	Potential initiator of a radioactive and hazardous material release.

5. Hazardous chemicals
6. Pressure
7. External events
8. Explosive materials
9. Kinetic energy
10. Natural phenomena.

Two accident scenarios are analyzed in Section 2.6, encompassing hazards from hazardous chemical materials. Fissile material hazards are not considered in-depth, because of the OSR imposed on the fissile material in Section 2.3.2. Following the OSR limits for fissile materials precludes a criticality.

The radioactive materials hazards are limited by the OSR inventory controls imposed in Section 2.3.1. This OSR precludes a radioactive material release of a type associated with nuclear facilities.

2.5.2 Hazard Evaluation

This section provides the results of an evaluation of the hazards identified for this facility. Table 2-6 summarizes the qualitative evaluation of each hazard type, hazardous event, causes, and controls. The guidelines used for determining acceptable risk are discussed in a separate document.[20] Sections 2.5.2.1 through 2.5.2.7 provide a summary of the hazard evaluation, defense in-depth, worker protection, environmental protection, and accident selection. The following discussion explains those hazards and events presented in Table 2-6 that could potentially lead to a release of hazardous or radioactive material or pose a radiation exposure hazard.

1. **Flammable materials**—Flammable materials are managed in the facility and a fire could occur. Potential initiators of a fire in the facility include electrical shorts, flammable gases released from pressurized containers, reactive incompatible chemicals improperly stored, spontaneous combustion, and fuel from forklifts or trucks used to move waste.

   Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide additional controls on combustible loadings and ignition sources.

Table 2-6. CPP-653 hazard evaluation results summary

Hazard	Hazardous Event	Initiator/Cause	Preventive and Mitigative Features: Design[a]	Preventive and Mitigative Features: Administrative
1. Flammable materials	Fire in facility, personnel burns, ruptured containers (see Events 3 and 5)	Ignition source is present and ignites flammable materials (forklift or truck fuel)	Concrete building	Operational Safety Program (Section 3.5.1
2. Ionizing radiation	a. Worker close to waste for too long	Operator error		Radiation Protection Program (Section 3.5
	b. Waste container exceeding the waste limits is inadvertently received	Operator error, instrument calibration error, or waste reconfiguring to concentrate radioactive material		Radiation Protection Program (Section 3.5
3. Radioactive material	a. Waste spills during handling, storage, or characterization releasing radioactive material, potentially resulting in exposure to workers, the public, and the environment	Equipment failure or operator error results in a drop or puncture of a waste container; corrosion of container		Operational Safety Program (Section 3.5.1 Radioactive and Hazardous Waste Manag Program (Section 3.5.9)
	b. Fire spreading to or originating in the waste releasing radioactive material, potentially resulting in exposure to workers, the public, and the environment	Vehicle or forklift induced fire which spreads to waste containers; combustion of gas inside waste container	Concrete building	Operational Safety Program (Section 3.5.1 Radioactive and Hazardous Waste Manag Program (Section 3.5.9) Emergency Preparedness Program (Sectio
4. Fissile material	A criticality from fissile material	The fissile material is in a form and dispersed in the waste that precludes the possibility for criticality		Criticality Safety Program (Section 3.5.8)
5. Hazardous chemicals	a. Waste spill during handling/staging releasing hazardous material, potentially resulting in exposure to workers, the public, and the environment	Equipment failure or operator error results in a drop or puncture of a closed waste container; corrosion of container	Container	***Appropriate containers*** Hazardous Material Protection Program (Section 3.5.5). Radioactive and Hazardous Waste Manag Program (Section 3.5.9) Operational Safety Program (Section 3.5.1 Emergency Preparedness Program (Sectio
	b. Waste spill during sampling releasing hazardous material, potentially resulting in exposure to workers, the public, and the environment	Equipment failure or operator error results in a puncture, or toppling of an open waste container		***Training for sampling and handling ope*** Hazardous Material Protection Program (Section 3.5.5). Radioactive and Hazardous Waste Manag Program (Section 3.5.9) Operational Safety Program (Section 3.5.1 Emergency Preparedness Program (Sectio

Table 2-6. (continued).

Hazard	Hazardous Event	Initiator/Cause	Preventive and Mitigative Features	
			Design[a]	Administrative
6. Pressure	Pressurized container failure results in projectile injury, chemical released from pressurized container (see Events 3 and 5)	Improper handling of compressed gas container; failure of container		Operational Safety Program (Section 3.5.1 Hazardous Material Protection Program (S
7. External event	Building failure ruptures containers (see Events 3 and 5)	External explosion	Concrete building	See Items 3 and 4
8. Explosive material	Explosion of gas generated in waste packages injures personnel, ruptures containers (see Events 3 and 5)	Explosion from ignition of released flammable gases, incompatible chemical mixtures		Operational Safety Program (Section 3.5.1 Hazardous Material Protection Program (S Radioactive and Hazardous Waste Manag Program (Section 3.5.9) Emergency Preparedness Program (Sectio
9. Kinetic energy	Damaged equipment injures personnel, ruptures containers (see Events 3 and 5)	Moving piece of equipment (forklift, portable crane) fails or operator error		Operational Safety Program (Section 3.5.1 Hazardous Material Protection Program (S
10. Natural phenomena[b]	Building damage/collapse injures personnel and ruptures containers (see Events 3 and 5)	Seismic event, flood, high winds, temperature extremes, lightning, snow, and range fires	UBC/IBC design	Configuration Control Program (Section 3 Operational Safety Program (Section 3.5.1 Emergency Preparedness Program (Sectio

a. Operational safety requirement (OSR) and safety-requirement-level controls are highlighted in ***bold italics***. See Chapter 3., "Hazard Controls," for additional infor on OSRs and safety requirements.

b. Natural phenomena risk. (The risk of natural phenomena hazards is discussed in Item 9 of Section 2.5.2.)

IBC International Building Code
OSR operational safety requirement
UBC Uniform Building Code

2. **Ionizing Radiation**—Two events involving ionizing radiation are considered: personnel being near the waste for too long and worker exposure to waste with an excessive exposure rate.

   (a) Worker near the waste for too long—This event addresses worker exposure to direct radiation from waste managed in the facility. Workers will typically be within 1 m of an individual waste container for 0.5 to 1.0 hr. Containers received at the facility will typically have a 1-m exposure rate, much less than 500 mR/h. Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide worker protection consistent with the as-low-as-reasonably-achievable (ALARA) philosophy.

   (b) Receipt of remote-handled waste—Receipt of a waste container with an exposure rate greater than 500 mr/h would result in greater than 5 rem exposures. A waste container could exceed this level as a result of operator error, instrument calibration error, or waste reconfiguring to concentrate radioactive material. Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provides additional worker protection.

3. **Radioactive Material**—Radioactive material releases can occur as a result of spills or fires. These events are addressed in the following subsections.

   (a) Waste spill—Waste containers can be dropped, toppled, or punctured, resulting in the release of radioactive material. There are numerous potential initiators including equipment failure (forklift or portable gantry crane), operator error, and natural phenomena (earthquake). Containers are expected to survive most drop or toppling events without spilling the contents and releasing significant quantities of radioactive material, so most events would not result in the release of radioactive material. Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide additional controls.

   (b) Waste fire—While the building is constructed of fireproof materials, a fire is possible inside the facility. Fuel for a fire includes vehicle fuel (from trucks or forklifts), propane for the shrink-wrapping, and some of the waste itself. There are numerous potential initiators, including electrical equipment and the vehicles. Drums or fire-retardant boxes require high-intensity flames for prolonged periods before the containers breach and the waste combusts. Fires of that magnitude are not likely to occur, and if they do occur, are likely to be extinguished before they breach the containers. However, some of the containers are routinely open for sorting or characterization and will be more vulnerable to fire. A fire in the facility is likely to be detected quickly by the smoke and flames, allowing workers to evacuate or use protective equipment before the radioactive material is released from the waste. Radioactive material released by the fire could rise and eventually spread throughout the facility. The consequences to a facility worker who does not evacuate and does not use protective equipment could be between 5 and 25 rem.[21] If the facility doors are open, the radioactive material released from the fire could rise with the smoke. If the facility doors are closed, then the building will retard release. Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide additional controls.

4. **Fissile Material**—The facility manages waste containing small amounts of fissile material. Criticality hazards have been evaluated based on the fissile content of the waste. The fissile material is dispersed in the waste and in a form that precludes the potential for criticality. Criticality is not a possible event. Based on the hazard analysis presented in Reference 20, no additional controls are required to manage the risk. This is consistent with the Criticality Safety Program (see Section 3.5.8), as listed in Table 2-6, provides additional controls.

5. **Hazardous Chemicals**—Chemical releases can occur as a result of fire, spills, improper sample handling, container failure, or equipment malfunction or accident (such as forklift). Chemicals such as acids and nitrates, caustics and nonreactive agents, oxidizers, and flammables and combustibles are present in the waste.

   (a) Release during management of closed container—This event involves the breach and spill of a waste container during activities involving a closed container (such as during staging or when moving a container). Nitric acid and hydrofluoric acid are considered the most hazardous wastes handled in the facility. Large quantities (such as 55-gal drums) of concentrated acid are handled infrequently. A release from a closed container during routine management could be the result of equipment failure or worker error that causes the container to be dropped, container corrosion, or a staged drum punctured by equipment.

   Nitric acid was chosen as an evaluation basis accident because it is assumed to be the largest quantity of hazardous material available for release. This event was selected for further analysis in Section 2.6. Based on the hazard analysis presented in Reference 20, the OSR appropriate container control listed in Section 3.4.4 is required. A release of hydrofluoric acid is qualitatively identified as presenting the greatest exposure risk to facility personnel. This event was selected for further analysis in Section 2.6.

   (b) Release during invasive management (open container)—Events associated with an open container, such as sampling (repacking of liquid waste is not anticipated) are most likely to involve a small release (less than a quart). Events such as a drop of sample, use of wrong equipment, toppling a drum, or improper sampling technique could be the result of worker error.

   Based on the hazard analysis presented in Reference 20, the OSR training control discussed in Section 3.4.3 is required. Workers are trained for all activities where containers must be opened, such as during sampling. This control reduces the likelihood of a spill. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, reduces the likelihood and mitigates the worker consequences for this event.

6. **Pressure**—Pressure has the potential to be a hazard in the event of rupture of a compressed gas cylinder due to improper handling. Overpressurization caused by chemical reactions in a waste container can also present a hazard. The hazard created by either event would be significant, as small objects, such as pieces of the cylinder/container, could become projectiles, and pressure events could result in release of radioactive or hazardous materials. Events 3.a and 5.a address the potential consequences if a pressurized event were to result in release of radioactive or hazardous material. Standard industrial safety handling procedures specify the safe handling of both waste

containers and compressed gas cylinders in the facility (Section 3.5.1). Periodic visual inspections are conducted to ensure that the containers are in good condition and that there are no visible indications of bulging containers (Section 3.5.1). Even though the risk associated with this hazard event is acceptable, as presented in Reference 20, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide additional controls.

7. **External Events**—External events causing damage to the facility, such as the walls and roof collapsing as a result of a large tanker truck exploding next to the building, could cause damage to containers; thus, causing the release of radioactive or hazardous materials. Ruptured chemical containers could generate fumes and mists that may be toxic. Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide additional controls.

8. **Explosive Materials**—Gases generated by material reactions within containers, radiolysis, or co-mingling incompatible waste containers could cause a deflagration if subjected to an initiating event, such as a spark from an electrical device. A pressure wave greater than 10 psi is not expected because of the special conditions required to create these pressure waves. A hydrogen detonation is not expected because it requires ignition in a closed space with concentrations of at least 13%. Inside the waste container is not likely to have high concentrations of both elemental hydrogen and oxygen. Deflagration events could result in the release of radioactive or hazardous materials (see Events 3.b and 5a). Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide appropriate controls.

9. **Kinetic Energy**—Kinetic energy associated with moving or rotating mechanical equipment is a potential source of hazards in the facility. Portable cranes, forklifts, handcarts, and trucks may release kinetic energy if the equipment or a critical part fails. Machine guarding is required by occupational regulations. Paragraphs 3.a, 5.a, and 5.b address the release of radioactive and hazardous materials that could result. Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Even though the risk associated with this hazard event is acceptable, the institutional safety programs (Section 3.5), as listed in Table 2-6, provide additional controls.

10. **Natural Phenomena**—The natural phenomena hazards applicable to the facility include earthquake (seismic event), flood, high winds, temperature extremes, lightning, snow, range fires, and volcanic activity. The current INEEL design criteria for the natural phenomena hazards are tabulated in Table 1-2. The Waste Handling Facility meets the requirements for UBC/IBC seismic risk Zone II B criteria. Volcanic activity has been dismissed as an applicable hazard for the facility. There are no design criteria for volcanic activity. The seismic event is the most significant natural phenomenon hazard that bounds the various initiating events. Based on the hazard analysis presented in Reference 20, no OSR or safety requirements are necessary to manage the risk. Additional controls were imposed in response to other hazards discussed above.

2.5.2.1 Summary. As shown in Table 2-6, for all hazardous events where the estimated risk without controls exceeded established risk criteria in Reference 20, OSRs are identified to reduce the risk to acceptable levels. CPP-653 ORSs derived from the accident analysis are discussed in Chapter 3. Two OSRs controlling inventories resulted from limitations based on the hazard classification of the facility.

2.5.2.2 Planned Design and Operational Safety Improvement. There are no planned design and operational safety improvements for the facility.

2.5.2.3 Defense In-Depth. The hazards to the off-site public, on-site worker, and facility worker associated with the facility are identified in Table 2-6. The identified OSRs control the hazard to the facility worker below the risk criteria. The OSRs are discussed in Section 3.4. The hazards are limited to the facility worker and co-located worker at a distance of 100 m. The building structure and institutional safety programs (see Section 3.5) provide a layer of defense in-depth.

2.5.2.4 Operational Safety Requirements. The OSRs identified for the facility are listed in Section 3.4. The fissile material inventory control and the radioactive inventory control are required to properly bound the facility inventory associated with the hazard classification discussed in Section 2.3. The use of appropriate containers and worker training for management of open containers control the hazard of acid spills to acceptable levels.

2.5.2.5 Worker Safety. Worker safety is ensured at the facility by the OSRs discussed in Section 3.4.

2.5.2.6 Environmental Protection. The environment is protected by the institutional safety programs discussed in Section 3.5.

2.5.2.7 Accident Selection. Accidents involving a large spill of nitric acid and a large spill of hydrofluoric acid were selected for more detailed analysis. The scenarios were developed to envelope conditions for the facility. The scenarios analyzed encompass several of the events presented in Table 2-6. The remaining hazards are left to the controls specified by the institutional safety programs discussed in Section 3.5.

2.6 Accident Analysis

An "accident" is an unplanned sequence of events that results in undesirable consequences.[1] The purpose of this section is to estimate the consequences from a postulated accident in the facility. This section presents the quantitative analysis of a postulated evaluation basis accident for the Waste Handling Facility.

Two different acid spill scenarios in the facility were selected as the evaluation basis for the Waste Handling Facility. An accident involving a relatively large volume spill of nitric acid from four drums and a hydrofluoric acid spill from one drum are analyzed in this section.

2.6.1 Nitric Acid Spill

A waste spill event is anticipated, but most containers are filled with solid debris contaminated with hazardous chemicals or radioactive material. Typically, few waste containers are expected to be drum-sized quantities of concentrated acid waste. Because they are handled infrequently, a large (one or more 55-gal drums) nitric acid spill is considered an unlikely event.

2.6.1.1 Scenario Development. It is postulated that a pallet of four drums containing concentrated nitric acid is being moved into the facility when the pallet falls, causing a breach of all four drums. While this quantity of liquid acid waste is not expected frequently, a shipment of four drums of waste nitric acid was handled at INTEC in 2002, and several drums of liquid acid waste may be managed in the near future. The drop could be due to either equipment failure or human error. Dropped drums are not expected to breach, but it is conservatively assumed that all four drums breach and the contents are completely spilled. Both overhead doors are assumed to be open, allowing the fumes to be readily transported to co-located workers and the public. Closed doors would retard transport of the acid fumes to co-located workers and the public.

2.6.1.2 *Source Term.* The release involves four 55-gal drums of 12-molar nitric acid with a total volume of 833 L (220 gal). The concentration of acid downwind is sensitive to the evaporative surface area, but is not sensitive to the total volume spilled. However, the spill volume determines how long the chemical will continue to evaporate. The spilled acid is conservatively assumed to spread to an average depth of 5 mm (0.197 in.), which covers an area of 167 m^2 (1,793 ft^2). The spill produces an acid vapor in the area that spreads throughout the facility and is transported to co-located workers and the public. The acid evaporation rate was calculated to be 0.82 g/sec.[21]

2.6.1.3 Consequence Analysis. Consequence analyses were performed for receptors located 100 m, 2,414 m (TRA), 4,024 m (CFA), and 13,700 m (public access) from the facility.[21] Consequences are only addressed qualitatively for the facility workers, since concentrations in the building are extremely variable, depending upon the worker location, worker evacuation time, and wind speed and direction. Only the nonradiological consequences were evaluated for the accident. Radiological consequences were not analyzed, since only trace quantities of radioactive material are likely to be present in the acid waste, and the release rate from an evaporating pool would be very low.

Inhalation of nitric acid vapors by a facility worker would immediately cause choking and coughing. The vapors are noticeable at levels below 0.1 ppm and are extremely irritating, which would help prevent a facility worker from being overexposed, unless the worker became trapped or restrained in the spill area. However, a worker in the immediate vicinity of the spill could be splashed with acid or inhale high concentrations before evacuating the area. This event could be fatal to workers in the immediate vicinity and at nearby locations if they do not evacuate immediately or have appropriate protective equipment.

Workers outside in the immediate vicinity of the spill are likely to notice the gradually increasing acid vapor concentrations and evacuate before the exposure is life threatening. Workers who evacuate when the vapors are initially detectable will not experience permanent health effects. Workers who do not promptly evacuate could be exposed to acid vapors that could exceed the ERPG-3 values and be life threatening.

The acid concentrations were calculated for several distances. The evaporation rate is proportional to the pool surface area (given in the previous section) and the air velocity over the pool. The air velocity over the spill was assumed to be 1.04 m/sec, the same as the ambient wind speed.

The Radiological Safety Analysis Computer Program (RSAC-6)[22] was used to calculate the dispersion coefficients (χ/Q). Meteorological diffusion parameters were calculated for conservative meteorology conditions (stability class F with fumigation, wind speed is 1.04 m/s) using the Hilmeier-Gifford Gaussian plume diffusion model in RSAC-6. The calculated concentrations for the evaluation basis accident are compared to the risk criteria in Section 2.4.2. The ERPG values for nitric acid are given in Section 2.6.1.4.[23] The χ/Q values and calculated nitric acid concentrations are shown in Table 2-7.[21]

Table 2-7. Nitric acid concentrations resulting from container release.

Distance (m)	χ/Q (sec/m^3)	Nitric Acid Concentration (ppm)
100 (co-located worker)	3.22E-02	10.5
2,414 (TRA)	1.67E-04	0.055
4,024 (CFA)	7.79E-05	0.026
13,700 (nearest off-site individual)	1.48E-05	0.005

CFA Central Facilities Area
TRA Test Reactor Area

2.6.1.4 Comparison to Guidelines

The concentration guidelines for nitric acid are as follows:

TLV-TWA	2 ppm (temporary emergency exposure limit [TEEL]-0 of 1 ppm is used when the time-weighted average [TWA] is greater than the Emergency Response Planning Guidelines [ERPGs]-1)
ERPG-1 and TLV-TWA	1 ppm
ERPG-2	5 ppm
ERPG-3	20 ppm.

Facility workers could easily be exposed to acid concentrations that exceed the ERPG-3 values, so the unmitigated consequences for the facility worker are designated as high. The unmitigated concentrations at selected points of interest for the co-located worker and off-site public are listed in Table 2-7. Based on the unmitigated accident analysis, the estimated consequences are greater than ERPG-2 for the co-located worker 100 m from the release; thus, the consequences are designated as moderate. The concentrations at the 2,414-m and 4,024-m locations, and for the nearest public access are less than ERPG-1 levels; thus, the consequences to those receptors are designated as negligible.

Use of appropriate containers (including drums with polyethylene liners, carboys, lab-packs, or equivalent packaging) will reduce the likelihood of a waste container failure. For example, lined drums are resistant to the corrosive contents and to breach from drops or other operational events likely to be encountered. The likelihood of a large acid spill event, together with the use of appropriate containers is designated extremely unlikely. When operations require the container to be opened, such as during sampling, the training program for hazardous waste workers reduces the likelihood of a spill. No additional controls are required, even for the facility worker. Even though not required, the Operational Safety Program (see Section 3.5.1) further reduces the likelihood and worker impacts for drum handling events.

2.6.1.5 Summary of Safety SSCs. There are no safety structures, systems, and components (SSCs) associated with this scenario.

2.6.1.6 Summary of OSR Controls. Two OSRs are associated with the handling of concentrated nitric acid waste. One OSR requires that all containers of concentrated nitric acid be in appropriate containers (such as polyethylene-lined containers, carboys, lab-packs, or equivalent). This requirement that appropriate containers be used for even small quantities of concentrated acid is driven by facility worker requirements, since small quantities (less than 100 gal total) do not threaten co-located workers or the public. The other OSR requires implementation of the training for hazardous waste workers for protection of facility workers. This program will address safe operating practices during sampling or other operations involving open containers of concentrated nitric acid. These controls are discussed further in Section 3.4.

2.6.2 Hydrofluoric Acid Spill

As discussed above, a waste spill event is anticipated, but most containers are filled with solid debris contaminated with hazardous chemicals or radioactive material. Typically, few waste containers managed at the facility are expected to be drum-sized quantities of acid waste, and it is most likely that the one drum handled would be nitric, hydrochloric, or sulfuric acid, not hydrofluoric acid. Because they are handled infrequently, a large (55-gal drum) hydrofluoric acid spill is considered an unlikely event.

2.6.2.1 Scenario Development. It is postulated that a single drum containing hydrofluoric acid is being moved into the facility when the drum falls and ruptures. While this quantity of liquid acid waste is not expected frequently, a 55-gal drum of unused hydrofluoric acid was handled at INTEC in 2002, and similar containers may be managed in the near future. The drop could be due to either equipment failure or human error. Dropped drums are not expected to breach, but it is conservatively assumed that a breach occurs and the entire contents of the drum are spilled. Both overhead doors are assumed to be open, allowing the fumes to be readily transported to co-located workers and the public. Closed doors would retard the transport of acid fumes to co-located workers and the public.

2.6.2.2 Source Term. The release involves one 55-gal drum of concentrated (70%) hydrofluoric acid with a total volume of 208 L (55 gal). The concentration of acid downwind is sensitive to the evaporative surface area, but is not sensitive to the total volume spilled. The spill volume determines how long the chemical will continue to evaporate. The spilled acid is conservatively assumed to spread to an average depth of 5 mm (0.197 in.), which covers an area of 42 m^2 (447 ft^2). The spill produces an acid vapor in the area that spreads throughout the facility and is transported to co-located workers and the public. The acid evaporation rate is calculated to be 12.5 g/s.[21]

2.6.2.3 Consequence Analysis. Consequence analyses were performed for receptors located 100 m, 2,414 m (TRA), 4,024 m (CFA), and 13,700 m (public access) from the facility.[21] Consequences are only addressed qualitatively for the facility workers, since concentrations are extremely variable, depending upon the worker location, worker evacuation time, and wind speed and direction. Only the nonradiological consequences were evaluated for the accident. Radiological consequences were not analyzed, since only trace quantities of radioactive material are likely to be present in the acid, and the release rate from an evaporating pool would be very low.

Inhalation of hydrofluoric acid vapors by a facility worker would immediately cause choking and coughing. The vapors are noticeable at levels below 0.1 ppm and are extremely irritating, which would help prevent a facility worker from being overexposed, unless the worker became trapped or restrained in the spill area. However, a worker in the immediate vicinity of the spill could be splashed with acid or inhale high concentrations before evacuating the area. This event could be fatal to workers in the immediate vicinity and at nearby locations if they do not evacuate immediately or use appropriate protective equipment.

Workers outside the immediate vicinity of the spill are likely to notice the gradually increasing acid vapor concentrations and evacuate before the exposure is life threatening. Workers who evacuate when the vapors are initially detectable will not experience permanent health effects. Workers who do not promptly evacuate could be exposed to acid vapors that could exceed the ERPG-3 values and be life threatening.

The resulting acid concentrations were calculated for several distances.[21] The evaporation rate is proportional to the pool surface area (given in the previous section) and the air velocity over the pool. The air velocity over the spill was assumed to be 1.04 m/sec, the same as the ambient wind speed.

The RSAC-6 computer program[22] was used to calculate the dispersion coefficients (χ/Q) used to determine concentrations at receptor locations. Meteorological diffusion parameters were calculated for conservative meteorology conditions (stability Class F with fumigation, wind speed is 1.04 m/s) using the Hilmeier-Gifford Gaussian plume diffusion model in RSAC-6. The calculated concentrations for the evaluation basis accident are compared to the risk criteria in Section 2.4.2. The calculated χ/Q values and hydrofluoric acid concentrations are shown in Table 2-8.[21]

Table 2-8. Hydrofluoric acid concentrations resulting from container release.

Distance (m)	χ/Q (sec/m^3)	Hydrofluoric Acid Concentration (ppm)
100 (co-located worker)	3.22E-02	578
2,414 (TRA)	1.66E-04	2.77
4,024 (CFA)	7.79E-05	1.29
13,700 (nearest off-site individual)	1.47E-05	0.245

CFA Central Facilities Area
TRA Test Reactor Area

2.6.2.4 Comparison to Guidelines

The concentration guidelines for hydrofluoric acid are as follows:[23]

TLV-TWA	none (TEEL-0 of 2 ppm is used when TLV-TWA does not exist)
ERPG-1	2 ppm
ERPG-2	20 ppm
ERPG-3	50 ppm.

Facility workers and co-located workers at the 100 m location could easily be exposed to acid concentrations that exceed the ERPG-3 values; thus, the unmitigated consequences for those receptors are designated as high. The estimated consequences exceed ERPG-1 for the worker 2,414 m from the release, and the consequences are designated as low. The concentrations at the 4,024-m worker and nearest public access locations are below ERPG-1; thus, the consequences to these receptors are designated as negligible.

The use of appropriate containers (such as drums with polyethylene liners, carboys, lab-packs, or equivalent) will reduce the likelihood of a waste container failure. The likelihood of a large acid spill event given use of appropriate containers is designated extremely unlikely. When operations require the container to be opened (such as during sampling), the training program for hazardous waste workers reduces the likelihood of a spill to extremely unlikely. Even though the risks associated with this hazard event such as this are acceptable, additional controls are provided by the Operational Safety Program (see Section 3.5.1) and Emergency Preparedness Program (Section 3.5.4) for drum handling events.

2.6.2.5 Summary of Safety SSCs. There are no safety SSCs associated with this scenario.

2.6.2.6 Summary of OSR Controls. There are two OSRs associated with the handling of concentrated hydrofluoric acid waste. One OSR requires that all containers of concentrated hydrofluoric acid be in appropriate containers (such as polyethylene-lined containers, carboys, lab-packs, or equivalent). This requirement that appropriate containers be used for even small quantities of concentrated acid is driven by facility worker requirements. The other OSR requires implementation of the training of the hazardous waste workers for safe operating practices during sampling or other operations involving open containers of concentrated hydrofluoric acid. These controls are discussed further in Section 3.4.

2.7 References

1. DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports," U.S. Department of Energy, July 1994 (including Change 1, January 2000).

2. HAD-49, "Transportation Hazard Assessment," Rev. 2, October 22, 2001.

3. MCP-2451, "Safety Analysis for Other than Nuclear Facilities," Rev. 2, April 5, 2001.

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