APPENDIX A

CONSULTATION LETTERS

This appendix will include consultation/approval letters between the U.S. Department of Energy (DOE) and the U.S. Fish and Wildlife Service regarding threatened and endangered species, and between other State and Federal agencies as needed. Letters currently supplied are from the U.S. Fish and Wildlife Service to DOE.

Appendix B

FACILITY DESCRIPTION INFORMATION

The following descriptions are taken from BNFL-5232-RCRA-01, Rev. 1, *Hazardous Waste Management Act/Toxic Substances Control Act* (HWMA/TSCA) permit application for the Advanced Mixed Waste Treatment Project (AMWTP) facility.

B-1 Non-Thermal Treatment Operations

Waste containers within the non-thermal treatment areas are managed in a manner to prevent container rupture or leakage and to minimize exposure of AMWTP facility personnel. Operating standards used in conducting non-thermal treatment activities include:

- Wastes slated for direct supercompaction are first identified by item description codes, generator-supplied information, and real-time radiography (RTR) examination. Other wastes for supercompaction and macroencapsulation are sorted, segregated, and size reduced in the pretreatment lines prior to supercompaction and/or macroencapsulation. Waste characterization information is reviewed prior to processing in the non-thermal treatment units to ensure that only compatible wastes are treated.
- All non-thermal treatment activities are performed by operating personnel trained to safely conduct the treatment and to respond to emergency incidents.
- All treatment activities are conducted with the knowledge of a supervisor and according to specific treatment procedures.
- Containers enter the non-thermal treatment areas through a combination of elevators, conveyors, and airlocks. Containers are lidded during compaction and after loading puck drums with waste and grout. Barcode readers throughout the facility verify waste container locations and destinations.
- The presence of liquids in supercompaction feed drums is minimized by prior RTR screening and liquid removal in the pretreatment lines.
- Special case waste is managed within the single case waste glovebox on a case-by-case basis, typically in small quantities and in a timely manner to reduce waste accumulation.
- No reactive (Hazardous Waste Number [HWN] D003) wastes are processed in the non-thermal treatment units. Waste streams potentially containing ignitable (HWN D001) wastes are processed in a manner to minimize reactions or fires (e.g., campaigning incompatible waste separately, using only low-sparking tools in the treatment areas when processing potentially ignitable wastes).
- The ventilation air is ultimately fed to banks of high efficiency particulate air (HEPA) filters and carbon filters prior to exhausting through the facility stack. The exhaust from the special case waste (SCW) glovebox is also fed through local carbon absorption units before exiting the facility stack.
- Secondary waste streams generated in the treatment areas are treated within the facility.

These operating standards are used to prevent releases of hazardous waste constituents, which may have adverse effects on human health or the environment. An overview of typical treatment operations is provided below.

B-1.1 Supercompactor

The 55-gallon direct-feed waste drums or 55-gallon transfer containers from the pretreatment lines are routed to the supercompactor via the central conveyor system. Only waste drums whose waste to waste compatibility assessments show no incompatibilities are compacted in series. Barcode readers and the data management system (DMS)/waste tracking system (WTS) identify and control drums of incompatible waste from entering the compaction gloveboxes until the gloveboxes have been emptied, visually inspected, and cleaned (if required). To maximize the size reduction process, the data management system incorporates an optimization algorithm that automates the waste drum selection for puck drum filling to achieve maximum packing densities. The data management system optimizes puck filling based on fissile content, weight, or puck height. Automatic control sequences to retrieve, deliver, compact, and deposit the waste drum/puck into the puck drum are initiated from the central control room.

At the supercompaction area interface point, a barcode reader identifies the waste drums before they are transferred, via roller conveyor, through an airlock and into the supercompactor infeed glovebox. There are two stations within the infeed glovebox: the drum lidding station and the drum lid crimping/drum piercing station. A roller conveyor is used to move the waste drum from the glovebox entrance to the lidding position. Waste transfer containers from the pretreatment lines require lidding before compaction, since they remain open during transfer through Zone 3 process areas. At the lidding station, a drum handling mechanism is used to center and secure the open waste drum during the lidding process. Lids are automatically fed from outside of the containment into the glovebox using a special seal arrangement. The feeder device fits the lid directly onto the top of the drum.

The drum handling mechanism transfers the lidded drum onto the compaction trolley at the drum lid crimping/drum piercing station, where a crimping head is lowered to fasten the lid into position, while at the same time piercing the drum to prevent overpressurization during compaction. After supercompactor feed drums have been lidded, crimped, and pierced, the drum handler arms are opened leaving the drum centrally located on the compaction trolley. The trolley moves the drum into the supercompactor glovebox to a position beneath the supercompactor.

With the drum and trolley in position, the mold/bolster is lowered around the drum and engaged onto the trolley. The lower press plate of the supercompactor is mounted on the top of the trolley and acts as a guide for the mold, which controls the puck diameter during the compaction cycle. The compaction process proceeds in two phases. First, the main ram is lowered, initially powered by a low-force ram, which forces the air out of the top section of the drum at a preset pressure. After the first compaction phase, high-pressure fluid is supplied to the main high-force compaction ram and is maintained at a higher pressure for a set period of time (1 to 5 minutes, depending on the waste being compacted). Preset compaction pressures are used to control the compaction process. Both rams are fed from a hydraulic power pack situated outside the glovebox. The resultant force reduces the puck height (on average) to one-fifth of the original drum height. On completion of the compaction cycle the mold and ram are raised, and the compaction trolley transfers the puck to the postcompaction glovebox.

All drums destined for direct supercompaction undergo RTR analysis at the waste storage facility (WSF) Type 1 module for the presence of liquids or prohibited waste. Those drums potentially containing liquid waste are transferred to the drum line to remove the liquid prior to compaction. Frequent releases of liquid from drums during compaction are not expected. When liquids are released, they are handled on a case-by-case basis. Sloped glovebox floors and a sump are provided to collect any liquids produced during the compaction process. The leak-tight base of the glovebox containment has sufficient capacity to hold a worst-case leak of 55 gallons. The sump has a capacity of approximately 2.5 liters and is equipped with a sensor to detect liquid at two levels (low level to detect any liquid collected and an alarm level at 90 percent full). If liquid is detected, it is removed using a sump pump located in the post compaction glovebox and placed into barcode labeled collection containers. The collection containers are linked, via the barcode labels and DMS, to the original waste containers/pucks and their waste processing information (characterization data, U.S. Environmental Protection Agency (EPA) HWNs, etc.). When the collection containers are filled, they are transferred out of the glovebox and delivered to the SCW glovebox for treatment, as required. In the event large amounts of liquid are released during the compaction cycle and the sump capacity (2.5 liters) is filled, the compaction cycle is completed. After the ram is disengaged, the liquid in the sump is transferred to collection containers. If the next drum contains incompatible waste, the glovebox surfaces are visually inspected and any liquids remaining are removed and wiped up.

The data management system measures the height and weight of the puck using the puck handler (puck handler includes a load cell for weight measurement and an encoder for puck height measurement). If the puck is unsuitable for direct deposit into the puck drum, it is diverted to the puck staging area and a more suitable puck is retrieved from this area. The puck staging area (holding up to 5 pucks) allows for the pucks to be temporarily staged, if required. Only pucks from a compatible waste treatment sequence are staged in this area at any one time. If pucks leak, the sloped floor of the puck staging area directs the liquid into the postcompaction glovebox sump where the liquids are removed and bottled as previously discussed. All surfaces of the puck staging area are visually inspected and cleaned (if required) between incompatible waste sequences. The puck handler transfers the pucks into puck drums at the grout filling station at the eastern end of the postcompaction glovebox.

From the central control room the operator continues to feed drums until the puck drum is ready for grouting. Central control room-initiated control sequences also allows the importing of empty puck drums into the area as required. Barcode readers are employed throughout the supercompaction area to verify the integrity of the waste tracking system. Software based interlocks stop the process if an out-of-sequence drum is detected. Extensive use of closed circuit television is employed to allow the central control room-based operators to complete their tasks.

B-1.2 Macroencapsulation System

The macroencapsulation system provides for the application of surface coating materials to substantially reduce surface exposure to potential leaching media in the disposal environment. The process components are located in three areas: the grout preparation area, the puck drum grout filling station, and the drum cure area.

The grout preparation area supplies a cement-based grout to the grout filling station to encapsulate pucks and baskets of metal debris that have been placed into a puck drum. The grout completely encapsulates the waste and is resistant to degradation by the waste, its contaminants, and substances that may contact the waste form after disposal.

The cement powders (ordinary Portland cement and pulverized fuel ash [PFA]) are delivered to the receiving storage hoppers by bulk tankers and transferred into the respective weigh hoppers by the ordinary Portland cement/PFA transfer conveyors. The data management system maintains appropriate recipes for the production of the grout and calculates the correct volume of grout required for each puck drum based upon puck height. All grout preparations and grout filling activities are under programmable logic controller sequence control and are normally initiated from the central control room or from the local control area workstation. The quantity of each powder, which is dependant upon the formulation envelope, is screw-fed into the grout mixing vessel along with the required volume of water from the water feed vessel.

Prior to drum filling, clean puck drums are fed into the supercompaction cell from the clean drum feed route by a roller conveyor. The drum is identified by a barcode reader and transferred into the interfacing glovebox bagless transfer airlock by roller conveyor. A bagless transfer system is used to allow drum lid opening while maintaining glovebox ventilation conditions. Once the puck drum is within the airlock, an operator removes the bolt ring and outer lid via gloveports. The puck drum is then clamped centrally onto a drum positioning machine and raised into position at the bagless transfer mechanism. The bagless transfer port is opened with the inner drum lid attached (held in position by vacuum pump). The puck drum is pre-loaded with an insert and an anti-flotation device. The insert is used to prevent direct contact between the waste and the container, the anti-flotation device keeps pucks below the grout surface. Before pucks or baskets are loaded, the anti-flotation device is removed from the drum using the puck handler and parked nearby.

The data management system decides if a puck or metal debris basket can be loaded directly into the puck drum or if it requires placement into one of the five positions at the puck staging area. Pucks are loaded automatically into the puck drum using the puck handler. Recovery facilities are available within the postcompaction glovebox, along with hand operated tools, to deal with abnormal pucks that do not fit into the puck drum. Waste that escapes from pucks are manually collected through gloveports and placed into open mesh bags, which are inserted between pucks during puck filling and are encapsulated.

Baskets of non-compacted metal debris (requiring encapsulation) are loaded into an empty puck drum in a similar manner as the pucks. The baskets are transferred in open transfer drums through the compaction gloveboxes to the

entrance of the postcompaction glovebox. At this point, the baskets are lifted out of the transfer drums using the puck handler and either placed into an empty puck drum or in one of the puck staging positions. The empty transfer drums are returned to the pretreatment lines.

After the puck drum is filled with pucks or metal debris baskets, the anti-flotation device is fitted and locked into position using the puck handler. A funnel device is then placed over the puck drum opening to prevent loose debris or grout from splashing onto the drum seal or through the purge area. Prior to grouting, the grout pipe is rotated down towards the puck drum to ensure that the grout flows directly into the drum. A pinch valve is fully opened and grout is pumped into the drum until the waste is covered. Level—control devices are used to prevent overfilling during the grouting process. At a predetermined level monitored by a laser (approximately 1 inch above the waste), the grout pump is stopped and the pinch valve partially closed. A second laser device is used to prevent drum overfilling by completely stopping all grout flow when the overfill level is reached. A disposable cleaning devise is manually loaded into the grout line and compressed air is used to blow the pig and the last of the grout down the line to the pinch valve. A rodding drive that pushes the pig into the puck drum along with the last of the grout is manually inserted through the changeover valve.

Excess grout is emptied from the mixing vessel and transferred into the grout waste collection tank. Periodic wash down of the process equipment is required. Additives to the excess grout that inhibit the cement mixture from curing may be used, enabling grout washings to be returned to the grout-mixing vessel and minimize effluent discharges.

When the grouting sequence is complete, the grout pipe is rotated out of the way, the funnel protector retracted, and the bagless transfer port closed and locked to allow drum lidding. The filled and grouted puck drum is then lowered from the glovebox to the drum lidding area, and the bolt ring and outer lid are fitted by an operator through gloveports. The puck drum is transferred from the bagless transfer airlock to the swabbing station by a roller conveyor. The puck drum is rotated and manually swabbed to check that the exterior of the drum is free from contamination and suitable for export. Externally clean puck drums (final waste form containers) are identified by a barcode reader and automatically transferred through an airlock to the drum cure area by a roller conveyor.

Within the drum cure area a drum transfer car moves the final waste form containers from an inlet conveyor to one of 15 staging bays. Each bay is a conveyer unit that holds two puck drums, for a total capactiy of 28 drums (one bay is reserved for puck drum transfers). The final waste form containers are allowed to cure for approximately 24 hours. After the final waste containers have cured they are transferred using the transfer car to the conveyor interface with the puck drum staging area, and then to the product certification area for external contamination monitoring and certification.

B-1.3 Special Case Waste Glovebox

The SCW glovebox is provided for treatment of SCW on a case-by-case basis. This glovebox is fitted to treat containerized/free liquids from waste containers and residual liquids recovered from the various liquid collection devices located throughout the pretreatment lines and the postcompaction glovebox, and elemental mercury. Other waste streams that may require processing in the special case waste glovebox on an irregular basis may include such items as hydraulic fluids, gas cylinders requiring venting, polychlorinated biphenyls (PCB)-suspect electrical equipment, elemental mercury and wastes indicated as SCW in Table C-1-1 of Book 1 of the AMWTP *Resource Conservation Recovery Act* (RCRA) Permit Application.

SCW items removed from waste containers in the pretreatment lines are either labeled with barcodes or placed into barcode-labeled containers. Whatever information is recorded in the DMS for the waste container(s) present during the extraction of SCW is applied to the newly-generated SCW. The type of information entered into the DMS includes: the identification of the original waste containers(s) and waste characterization information. Item description code (IDC)/waste category (WC), approximate quantity of SCW removed from each waste container, applicable EPA HWNs, additional characterization or process knowledge obtained prior to treatment, and targeted treatment processes. SCW items are then placed into a basket/transfer container at the SCW export station and routed (via the material transfer system [MTS]) to the SCW treatment interface point. The transfer containers are moved into the transfer airlock and identified by a barcode reader. With the SCW transfer container in the airlock, the glovebox hatch is

opened and an elevator lifts the transfer container up into the SCW glovebox. At this point, a hoist is used to retrieve the basket from the transfer container and move it to a basket set down area, where individual SCW containers can be removed and identified using a barcode reader. Residual liquids from the supercompactor are placed into small plastic containers and manually transferred to the glovebox and imported via bag/bagless transfer techniques. SCW from the pretreatment lines may also be manually transferred to the SCW glovebox (depending on size and quantities), however, the preferred route is via baskets/transfer containers and the MTS.

Once inside the glovebox, SCW is first identified using a barcode reader. Barcode labels are attached to the SCW containers not previously labeled in the pretreatment lines (e.g., SCW transfer containers filled with SCW items from a single IDC or drum may be placed into the same transfer container without labeling individual inner containers with barcodes; the bar-coded transfer container is used for tracking the SCW until received at the SCW glovebox). After all containers/items have been identified and labeled (if required), the exterior of the items are visually examined for clues verifying or identifying their contents. This is especially critical for inner containers containing unknown wastes streams. SCW items are then transferred using a combination of manual transfers and sample transfer mechanisms to various areas of the glovebox where further characterization and sampling activities can be performed.

Prior to further characterization and waste sampling, SCW containers are opened. Most of the SCW containers that need to be opened in the SCW glovebox are believed to be packaged in the small plastic containers, 1-gallon metal paint cans, or other containers without special opening requirements. When tools are required for opening containers, only tools that do not compromise the integrity of the gloves are used. A heavy-duty can opener is provided for any SCW listed in Table C-1-1 of Book 1 of the AMWTP RCRA Permit Application that may be packaged into rolled metal cans (similar to common produce cans).

After the SCW containers are opened, wastes are visually examined for phase separation, and pH and ignitability are measured. Multiphase liquids are separated by a settling/decanting process (if required) and placed into separate containers. Non-debris SCW is sampled using a variety of tools (spatulas, scoops, hand auger/coring devices, etc.), depending on the consistency of the HIS/organic homogeneous solids (OHS). Liquids are sampled using pipenes, syringes, etc. The samples are subjected to proximate analysis, bomb calorimetry, and X-ray fluorescence (XRF) analysis. SCW with unknown HWNs are also subjected to PCBs and organics analysis. Refer to Section C of Book 1 of the AMWTP RCRA Permit Application for a description of SCW analytical requirements. Sampled containers are placed into a staging rack until analytical results are available. Each position in the rack has separate containment properties and a segregated section of the rack is used to separate SCW with unknown HWNs from SCW with known HWNs.

If liquids are found to be acidic/basic, they are first neutralized. Neutralized liquids are mixed with an appropriate absorbent, based on analytical results. Absorbed liquids may be combined, if analytical results show them to be compatible. The following presents specific information on the treatment processes conducted in the SCW glovebox.

B-1.3.1 Neutralization. Neutralization is performed to obtain an optimum pH for subsequent treatment by absorption and then incineration. The optimum pH, which depends on the waste type and specific absorption agent(s) used, is established prior to conducting treatment. The following presents the treatment steps that are used in neutralizing a liquid waste:

- The weight or volume of the waste, as specified in the treatment procedure, is determined and recorded.
- A pH measurement is taken to verify the initial reading recorded in the treatment procedure.
- The appropriate types and amounts of neutralizing agents are weighed/measured out and added according to the treatment procedure. The primary acidic neutralizing agents include sulfuric acid or hydrochloric acid. The primary basic neutralizing agents include sodium hydroxide or various limes (such as calcium carbonate).
- The treatment agents and waste are mixed according to the method and duration specified in the treatment procedure.
- A pH measurement is taken to verify results against the pH end-point established in the treatment procedure and

to confirm treatment effectiveness.

- If treatment is not effective, the neutralization process is repeated.

Once neutralized, the liquid is mixed with appropriate absorbents as described below.

B-1.3.2 Absorption. The treatment objective is to select a suitable absorbent material to absorb any liquid waste in order to meet incineration waste acceptance criteria (WAC). Prior to absorption, aqueous and/or organic liquid wastes are separated (if present in multiple phases), sampled, analyzed, and neutralized as required. The following are the general steps that are used during the absorption/treatment process:

- The volume of waste to be treated is measured and verified against the volume stated in the treatment procedure.
- The amount of appropriate absorbent is measured as specified in the treatment procedure.
- The absorbent is added to the liquid waste in accordance with the treatment procedure.
- The absorbent and waste are mixed according to the method and duration specified in the treatment procedure.
- Treated waste is visually inspected for signs of free liquids. If no free liquids are present, the treatment is considered successful. If liquids are present, additional absorbent material is added and the waste is remixed.

The types of absorbents used vary with the type of liquid waste and are selected based on (1) recommended usage and specifications provided by manufactures and (2) compatibility with the waste. Absorbents may include natural materials such as vermiculite, silicates, clays, or cellulose; or synthetic materials such as activated carbon, polypropylene, or other proprietary components.

Containers with absorbed liquids are placed into transfer containers and routed to the incinerator for thermal treatment.

B-1.3.3 Amalgamation. Any elemental mercury recovered is treated via amalgamation using reagents such as sulfur. The following are the treatment steps used in the amalgamation process:

- The mercury is weighed, and results recorded to verify against the weight of mercury stated in the treatment procedure.
- The required treatment reagents are measured as required by the treatment procedure.
- Treatment reagents are added to the mercury in the sequence established by the treatment procedure.
- The mercury and treatment reagents are mixed according to the method and time specified in the treatment procedure.
- The mercury amalgam is allowed to cure in accordance with the time specified in the treatment procedure.
- Following the allotted curing time, the amalgam is visually inspected to determine whether or not a semi-solid to solid waste form was produced. If treatment results in a semi-solid to solid waste form, amalgamation is deemed successful. If not, additional treatment reagents are added to the mercury waste form, and the mixture is remixed and allowed to cure a second time. The treatment process is repeated until desired results are obtained.
- Amalgamated metal is transferred out of the AMWTP facility.

B-2 Incinerators

The AMWTP facility incinerator is used to treat solid wastes containing HWMA- and TSCA-regulated constituents. Three main categories of waste are processed in the incinerator: organic homogeneous solids, inorganic homogeneous solids, and soils. The incinerator is used to destroy organic hazardous constituents in the solid wastes.

Operations Description. The incinerator unit consists of the incinerator and its ancillary equipment. The ancillary equipment includes the waste feed system, the air pollution control system (APCS), and the ash removal system. The following provides a brief description of the incineration system. A more detailed description can be found later in this section.

Incinerator. The incinerator, shown schematically on Figure B-2-1, is a dual-chamber auger hearth system. The operating characteristics of the incinerator when processing waste are summarized in Table B-2-1.

Air Pollution Control System. The incinerator APCS, shown schematically in Figure B-2-2, is a combination dry filtration and wet scrubbing system. The system employs a liquid quencher, a venturi scrubber, and two absorbers in series for gas cooling, coarse particulate removal, acid gas scrubbing, and mercury removal. The second absorber is followed by a wet electrostatic precipitator (WESP), combustion gas reheaters, HEPA filters, and carbon absorption beds for fine particulate capture and additional mercury removal.

Table B-2-1. Incinerator operating conditions for mixed waste.

Parameter	Operating Condition
Thermal capacity	3.4 MMBtu/h
Feed capacity	Solid waste 650 lb/h
Types of feed	Solid combustible mixed waste; IHS, OHS, Soils
Temperature	PCC - 1400 to 1600 ° F Secondary chamber - 2200 to 2400 ° F
Auxiliary fuel	Propane
Waste feed system	Solids — sized reduced and fed continuously through auger system
Gas residence time	Minimum 2 seconds in SCC when operating at thermal capacity of system

Incinerator System Monitoring and Control. The AMWTP facility incinerator system has been designed to be remotely monitored and controlled. The system is continuously monitored and controlled by a programmable electronic system that has been programmed to receive signals from pressure, flow, temperature, level, and other transmitters located throughout the system. Further details of the monitoring and control devices located throughout the incinerator system are provided in the AMWTP RCRA Permit Application.

Figure B-2-1. AMWTP facility incinerator schematic.

Figure B-2-2. AMWTP facility incinerator Air Pollution Control System.

B-2.1 Emissions/Compliance

B-2.1.1 Trial Burn. A trial burn is proposed for the AMWTP facility incinerator to demonstrate compliance with the performance standards of *Idaho Administrative Procedures Act* (IDAPA) 16.01.05.008 (40 CFR 264.343) and the current incinerator guidance documents. The trial burn will be conducted to obtain a HWMA operating permit using what is known as the "Universal Approach" to permitting. With this approach, a single set of operating conditions is sought for burning a relatively broad range of waste. To accomplish this, the trial burn is designed to represent the worst-case mix of wastes and operating conditions that the incinerator could encounter during operation. The trial burn is designed to accomplish the following primary goals:

- Demonstrate compliance with the current hazardous waste incinerator guidance *(Guidance on Setting Permit Conditions and Reporting Trial Burn Results*, EPA/625/6-89/019, January 1989) herein called the Incinerator Guidance
- Demonstrate the ability of the AMWTP facility incineration system to comply with the performance standards of IDAPA 16.01.05.008 (40 CFR 264 Subpart O).
- Provide emissions data for multipathway health risk assessment.
- Allow comparison of the AMWTP facility emissions to the proposed Hazardous Waste Combustion Maximum Achievable Control Technology (MACT) rule.
- Demonstrate the ability of the AMWTP facility incineration system to comply with the TSCA performance standards of 40 CFR 761.70.

The trial burn has been designed in accordance with the EPA's Incinerator Guidance series in pursuit of a certain set of

desired operating conditions. The desired operating permit conditions, trial burn automatic waste feed cutoff set points, and the proposed means of demonstrating compliance are discussed in the AMWTP RCRA Permit Application, Book 4, Section D5-b.

B-2.1.2 New Incinerator Startup/Shakedown Conditions. Startup and testing of incinerator operations will occur for a period of several months with simulant chemicals and materials that are not regulated as hazardous wastes. This test period will be used to tune the controllers and test the incinerator, the feed system, the flame safety shutdown systems, the process interlocks, and the automatic waste feed cutoff system.

During the startup and testing period for the incinerator, a comprehensive set of procedures will be performed in order to bring the system online and ready for use. Activities to be performed during this testing period will include the following:

- The incinerator and the refractory material that lines its interior will be gradually brought up to operating temperature using auxiliary fuel.
- On-the-job training will be conducted for process operators, in addition to the formal training program.
- Operating data will be reviewed to evaluate the performance of the incinerator and its APCS.
- The operators will be trained in the AMWTP facility incinerator system, the control system, the automatic waste feed cutoff system, and the Contingency Plan procedures.

After the initial systemization and startup testing, the shakedown period will begin for the trial burn. The initial shakedown will consist of a 720-hour operating period using actual waste feed material. While an extension is not anticipated to be required, an additional 720 hours may be requested, for a total of 1,440 operating hours, to conclude the shakedown operations. During shakedown, the incinerator will be operated at the operating conditions and waste feed rates anticipated during the trial burn. See the AMWTP RCRA Permit Application, Book 4, Section D5 for additional details.

B-2.2 Incinerator System

The AMWTP facility incinerator system consists of the following primary components: waste feed system, primary combustion chamber (PCC), secondary combustion chamber (SCC), and ash removal system.

B-2.2.1 Process Description. Waste acceptable to the incinerator is received from the sorting area via the central conveyor. The waste and drum liner are separated from the container and are passed through a size reduction system prior to being fed to the incinerator. Several types of waste are fed to the incinerator including organic homogeneous solids, inorganic homogenous solids, and soil.

The incinerator PCC has been designed to continuously process size-reduced waste. After analysis and assay, the waste is delivered to the incinerator area in the original drum liners, dumped into a crusher and shredder for size reduction and collected in a intake hopper. The shredded waste is then transported to the incineration feed system hopper by a waste transfer auger. From the feed hopper, waste is continuously fed into the PCC using a dual screw, variable compression feeder designed to accommodate a wide variety of waste densities and compressibilities.

The refractory lined PCC typically operates between 1,500 to 1,600° F to dry, volatilize, pyrolyze, and combust the wastes and has been designed with precise flow control and air injection locations to minimize particulate entrainment in the offgas. Ash is continuously transported down the length of the PCC by an ash auger and is collected in containers in the ash removal system. These ash containers are sampled, lidded and then sent for assay before transport to the vitrification system feed hopper.

The SCC completes the combustion process with the addition of excess air at temperatures of 2,200 to 2,400° F. Conventional auxiliary heat burners maintain temperatures in the PCC and SCC.

B-2.2.2 Type of Incinerator. The AMWTP facility incinerator is a dual-chamber, auger hearth system. The PCC consists of a refractory lined steel containment vessel sealed to the environment to prevent fugitive emissions. The base of the chamber contains an air-cooled ash auger for transporting the waste and ash through the PCC. Preheated underfire air is provided through tubes located in the auger trough to assist in volatilizing and combusting the waste organic matter. Flue gas from the PCC passes through a refactory-lined interconnecting duct to the refractory-lined SCC where combustion of the residual organic compounds is completed. The SCC has been sized to provide a minimum 2.0-second gas residence time for the combustion gases.

B-2.2.2.1 Linear Dimension of the Incinerator. The PCC has outer dimensions of approximately 25 feet long by 9 feet wide by 10 feet high. The internal volume of the PCC is approximately 300 cubic feet. The SCC is cylindrical with an internal diameter (without refactory) of 6.5 feet, an external length of 19 feet and an internal volume of approximately 215 cubic feet. Additional details, including data sheet drawings of the PCC and SCC, may be found in the AMWTP RCRA Permit Application.

B-2.2.2.2 Description of the Auxiliary Fuel System. The auxiliary fuel for the AMWTP facility incinerator is propane. Propane burners are located in both the primary and secondary chambers. Two auxiliary burners are in the PCC; one located at the feed end and a second at the gas discharge end. The SCC has one burner located at the top of the vertically oriented vessel.

B-2.2.2.3 Combustion Burners. All three burners have a rich/lean mixture control capability for adjustment of stoichiometry. The ignition burner in the PCC produces a maximum flame length of approximately 3 feet. The pencil burner in the PCC produces a maximum flame length of approximately 7 feet and provides radiant heat to the waste being transferred down the length of the PCC by the auger.

All burners and flame safeguards systems have been designed to satisfy the most stringent and latest regulations specified by Factory Mutual, Underwriters Laboratory, and the National Fire Protection Association. All burners are equipped with ultra-violet flame detectors and are interlocked through the main programmable electronic system to ensure that all pre-ignition interlocks such as purging are satisfied before a burner can be ignited. When needed, the primary and secondary burners can be immediately brought on line without purging if the chamber temperature is above 1,400° F (per National Fire Protection Association 86).

B-2.2.2.4 Underfire Air System. Combustion air is preheated by an electrical resistence heater prior to entering the underfire air manifolds. Jet tubes in each of the manifolds direct the heated air at 1,500° F to the trough containing the ash auger and waste. The trough consists of three zones in sequence: moisture removal and volatilization, ignition, and carbon burn out. Underfire airflow rates can be adjusted to each zone to meet process requirements. The air supply blower has an approximate capacity of 1300 acfm at the inlet and a differential pressure of 30 in. w.g. The blower is provided with a HEPA grade filter and have continuous speed motor/drive capability.

B-2.2.2.5 Waste Feed System. The incinerator feed system continuously feeds shredded waste to the PCC. The feed system consists of the following major components: waste feed crusher, waste feed shredder, anomaly removal station, waste transfer auger, waste feed hopper, primary waste feed auger, secondary waste feed auger, and waste feed cutoff valve.

Waste feed material is delivered to the thermal treatment process area on the central conveyor. The IHS, OHS, and soils are typically contained in polyethylene drum liners and received in reusable transfer containers. Each transfer container is lifted by an elevator mechanism and the contents dropped into the inlet of the size reduction system equipment. Prior to delivery of the waste drums to the size reduction system, unacceptable feed constituents are identified by RTR and/or visual inspection and removed in the box and drum lines. Items that violate the incinerator WAC include metals, aerosol cans, explosives, containerized liquids, and pyrophorics.

A crusher and a slow speed shear shredder comprise the size reduction system. Waste in the drum liners is delivered into the mouth of a crusher where it is crushed to approximately 4 inches in size. The crusher is equipped with a hoisting tool, which is used during maintenance or for removing large pieces of uncrushable material. An operator has the capability to stop the crusher before large, uncrushable metal pieces are introduced into the crusher. The crusher is designed with toggle plates that act as "mechanical fuses" or high torque detection that will protect the mechanism.

Crushed material drops from the bottom of the crusher into a slow speed shredder. The waste feed shredder uses a dual auger/cutter within a sealed enclosure that size reduces the incinerator feed material to less than 1-inch pieces. All waste fed to the PCC is maximum of 1-inch diameter, waste exceeding this criteria is sorted out in the anomaly removal station described below. The shredder is designed with torque limitation protection to prevent blade breakage if non-shreddable material that passes through the crusher falls into the shredder. The shredder detects high torque and reverses blade direction; this is a standard technique for shredder protection. If several reversals of the blades are detected, the shredder control system will stop the blades and signal a problem. The shredder will have glovebox access so that the uncrushable material can be manually removed from the blades (with the assistance of a tool), and placed in a drum for separate disposition. The size reduction system is contained within a glovebox to control the release of emissions during size reduction activities and direct volatile vapors to the SCC burner.

Waste exiting the shredder enters an anomaly removal station. The anomaly removal station is a vibratory conveying system contained in a glovebox. Operator stations are provided along the sides of the conveyor where metal or polythylene shreds that are unsuitable for the conveying equipment are manually separated and delivered back to the shredder inlet for further size reduction. Metal can alternatively be separated and placed in containers for separate disposition. A permanent magnet suspended above the conveyor collects ferrous metals such as nuts, bolts, or small solid metal scrap. This metal is separated and placed into a container for disposition to SC/ME. Metal that is contaminated with PCBs is sent to storage and campaigned with other PCB metal.

The size reduction system consists of two parallel trains with redundant crushers, shredders, anomaly removal conveyors, and permanent magnets. The redundant trains are provided in order to improve availability of the thermal treatment process by allowing one train to operate while the other undergoes maintenance or repair. Only one train operates at a time. The size reduction system is designed to process the contents of a single drum at a time. For the design feed rate, this corresponds to approximately one to two drums per hour. The size reduction system processes a single drum, and the contents are conveyed downstream from the shredder before the next drum is introduced to the system. There is very limited blending of waste from different drums in the feed system. In general, the system is designed for minimal waste hold up; however, areas where major holdup of waste could possibly occur are designed to be accessible through the glovebox or with access via tools to minimize waste holdup. The system is not cleaned between the passages of individual drums unless a waste incompatibility situation is present.

Material passing to the end of the anomaly removal system is collected in a small hopper and conveyed by the waste transfer conveyor to the incinerator feed hopper. A rotary valve is used at the connection to the incinerator feed hopper to provide an airlock between the size reduction equipment gloveboxes and the incinerator feed system. The waste transfer auger is driven by a reversible, torque-sensing, variable speed electric motor to detect jamming by obstructions. The waste feed hopper has the capacity to contain approximately one hour’s worth of feed for the incinerator. The hopper assembly includes ultrasonic sensing devices for maintaining an appropriate waste level within the hopper. A nitrogen supply line to the waste feed hopper maintains the hopper and the waste feed glovebox at low oxygen conditions when necessary. A rotating agitator is included to prevent waste from bridging or caking and thereby ensures adequate supply of waste to the primary feed auger. The purpose of the primary waste feed auger is to provide a constant volumetric supply of waste feed material to the secondary feed auger. The secondary feed auger has a uniform core and flight pitch at the waste receiving end, but a decreasing flight diameter to compress and compact the waste at the delivery end. The waste is conveyed uncompressed until it reaches the conical shaped tapered section near its exiting end. The speed ratio between the conveyor auger and compression auger is adjustable. This permits a variable compression of the feed exiting the waste feed system. Dense waste material requires little compression, whereas less dense waste requires more compaction to provide a seal in the incinerator feed tube. The average waste density for OHS, IHS, and soil is 55 pounds per cubic feet. The compression ratio is adjustable from a 1:1 ratio for non-compressible waste to a maximum of 5:1 for highly compressible waste. Pre-operational testing will determine the ideal compression settings for the various waste forms. The compressed waste provides a gas pressure seal between the

PCC and the feed system of approximately 2 psi.

The waste feed cutoff valve provides emergency waste feed cutoff during upset conditions, when critical monitoring devices fail, or when it is necessary to isolate or remove the secondary waste feed auger from the PCC for feed system maintenance. The auger can be disassembled and retracted from the cutoff valve at its flange for repair or replacement while the PCC remains at operating temperature. The waste feed cutoff valve provides passive gas sealing between the feed system and the PCC, whenever compacted waste sealing is not available, as during startup conditions. The waste feed cutoff valve consists of an assembled valve body that houses a circular gate-blade with a sharp circular-edge ring made of carbide. A water-cooled tube flange extends from the valve body to prevent overheating of the valve, thus preventing premature combustion of the waste prior to entering the PCC. Internal switches and backup switch devices provide the position of the valve (open or closed) to the programmable electronic system (PES). An electric motor worm gear drive is sized to allow the valve to shear off all nonmetal waste materials while closing.

Auger Hearth System. The ash auger consists of four major subassemblies: the drive assembly, the middle section, the tail shaft, and the auger cooling system. The drive assembly is driven by a variable speed alternating current (AC) electric motor. A speed gear reduction system provides a maximum auger rotation speed of 1.1 rpm. The drive system operates in both forward and reverse directions. By combining the adjustable speed motor control with a computerized process controller, the auger rotation can be programmed to travel forward and backward to adjust the ash residence time, achieve carbon burnout, and promote mixing of the waste and ash with the heated underfire air. The anticipated initial program for continuous operation of the auger for the waste feed is a forward speed of 0.5 rpm for 3 minutes, and reverse speed of 0.5 rpm for 1 minute. Operational programmed speed depends upon test results to determine percent auger solids fill, waste characteristics, waste slippage within the auger, and required residence time.

The auger is designed to operate outside the equipment critical speed zone to prevent excessive vibration. Periodic inspection for excessive noise and vibration is made after each week of operation. This is accomplished by manual inspection of each auger bearing assembly and monitoring for excessive noise.

The middle section of the auger is located inside the incinerator and contains the spiral conveying flights. The flights have sections cut out to permit unimpeded thermal expansion and slippage of the waste during rotation. Waste material bridging in the incinerator is avoided by providing the appropriate feeder/auger interface. The waste feed table is designed to receive the waste exiting the incinerator feed tube and channel the cascading waste down into the center part of the auger. The waste striking the auger flights either breaks up and falls between the flights or rides the flight down into the channel where it is exposed to the underfire air. In either case the waste is directed to the desired location for incineration. The waste contained in the auger is continually stirred by the flights to prevent bridging as it travels through the incinerator. As the waste is incinerated the residue or ash displaces less space, diminishing the ability to bridge. Synchronization of the waste feed augers and ash auger speeds prevents overfilling of the ash auger. Programming of the speed synchronization will be performed during prototype testing.

The tail shaft of the auger consists of a solid shaft having a welded connection flange and accommodations for an incinerator seal and bearing. A specially-designed split seal is located at each end of the incinerator where the auger shafts penetrate the chamber wall. Bleed air will provide a dust barrier and cooling for the seal section facing the chamber. The remaining part of the assembly with contain a spring-loaded carbon wipe seal.

The fourth subassembly is the auger cooling system. Cooling air enters and exits the drive shaft assembly through a cooling air junction box. Heat is transferred to the air, maintaining an allowable temperature and yield strength for the auger barrel located in a high temperature environment. Heated air exiting the junction box is used as secondary air and is mixed with the combustion gas exiting the PCC.

Ash Removal System. Incinerator ash falls into the inlet of a screw conveyor and is conveyed through a rotary valve into an ash crusher. The screw conveyor has an external water jacket to cool the ash to -140° F before delivery to the crusher. The ash passes through the rotary valve and into the crusher intake. The rotary valve serves as an airlock between the incinerator chamber and the crusher. The crusher is a double role crusher with an outlet screen and is designed to crush the material to one-fourth inch. The crusher rolls are spring loaded and will allow oversize material to pass through if it cannot be reduced in size. After crushing, the ash is screened. Material that cannot be size

reduced, such as metal, will be collected on a screen, discharged into a container, and sent to microencapsulation for disposition.

Crushed ash passing through the screen falls into the intake hopper of an aeromechanical conveyor and is conveyed to a fissile assay station. The aeromechanical conveyor consists of two parallel tubular housing approximately 4 inches in diameter that enclose a continuous steel rope loop. Discs are attached to the steel rope at approximately 8-inch intervals. The conveyor has two sprockets; one of them is the drive sprocket and is connected to a motor. The motor and sprockets move the steel rope and disc assembly in a continuous loop. Material is moved in a fluidized form by pockets of air between the discs, assisted by the mechanical force of the moving discs. Upon completion of the fissile assay the ash is dropped into the intake of another aeromechanical conveyor and sent for final disposition to the microencapsulation process equipment.

A glovebox enclosure surrounds the screw conveyor, rotary valve, ash crusher, and aeromechanical conveyor intake. The enclosure is vented to the Area 400 (west) glovebox ventilation system.

B-2.2.2.6 Ash Removal System. Ash discharged from the end of the PCC ash auger flows by gravity through two cooling chambers located in series. Ash in the upper chamber is cooled from approximately 1,250 to 300° F via cooling air introduced through porous, non-clogging metal aerators. In the lower chamber, the ash is further cooled to less than 140° F by means of additional porous metal aerators, before being discharged to the ash transfer conveyer.

The ash transfer conveyor transfers the ash to a tramp metal removal and size-reduction station. Tramp metal is separated from the ash by a magnetic sorting device and the sorted metal is discharged into a container. Ash leaving the metals removal station proceeds to a conventional rotary jaw crusher for particle size reduction prior to being discharged into a container. The tramp metal removal and size-reduction station is shown on the piping and instrument design 1-05-55-510 found in Appendix D-3 of the AMWTP RCRA Permit Application.

B-2.2.2.7 Capacity of Prime Mover. AMWTP facility incinerator uses fully redundant induced draft fans with variable speed control to maintain negative pressure in the system and to draw flue gas through the PCC, SCC, and APCS and deliver it to the stack. The exhaust blowers are constructed of alloy or equivalent to prevent corrosion. Each fan has been designed to handle approximately 1000 standard cubic feet per minute when operating at a static pressure of approximately 72 in. w.g.

The AMWTP facility incinerator has been designed with the capability to be remotely monitored and controlled. Remote operation is performed from the central control room by experienced operators. The system is continuously monitored by a programmable electronic system that has been programmed to receive transmissions from pressure, flow, temperature, and performance transmitters located throughout the system. Based on preprogrammed information and system parameters, the programmable electronic system transmits signals to process control devices and to warning lights and alarms within the central control room, indicating a system malfunction.

B-2.3 Air Pollution Control System

The APCS for the AMWTP facility incinerator consists of the following: a saturation quencher, a venturi scrubber, two absorbers in series, a WESP, an offgas reheater, redundant first stage HEPA filtration, carbon adsorbers, redundant second and third stage HEPA filtration, associated pumps and blowers, and an exhaust stack (see Figure B-2-2).

B-2.3.1 Process Description

The combustion gas exiting the SCC at 2,200-2,400° F, by spraying the gas with scrub liquid. Cooling is accomplished by a concurrent atomized spray of recirculating scrub liquid through an array of three atomized spray nozzles oriented at a downward angle into the gas stream just below the top of the vessel. The average gas velocity through the offgas quencher is in the range of 12 to 16 feet per second. Average droplet size produced by these nozzles will be 400 to 100 m m. The total flow rate of liquid delivered through the spray nozzles is 4 to 6 times that required to saturate the gas

stream. Liquid is also introduced at the top of the quencher through 12 spray nozzles to provide a continuous wetted wall. The quencher is a vertical vessel fabricated of corrosion-resistant alloy Hastelloy C-22 or equivalent. The hot gas inlet transition section of the quench vessel, immediately above the upper scrub liquid inlet zone, is line with refractory.

A medium energy venturi scrubber operating at 30 in. w.g. differential pressure is located immediately downstream of the quencher to receive the moisture-saturated gas existing the quencher. The scrubber removes greater than 1 m m particulate from the gas stream at approximately 99 percent efficiency by impaction with atomized scrub liquid droplets. Removal efficiency for coarser particulate at this differential pressure increases to greater than 99.9 percent for greater than 5 m m particulate. Most of the sub-micron particulate passes through the scrubber and will be removed by the condensing WESP further downstream. In addition to its primary function, the venturi scrubber removes some acid gas (primarily hydrochloric acid [HCL]) and mercury from the gas stream.

The venturi scrubber consists of a converging section, a differential pressure control valve to serve as the venturi's variable throat, and a diverging section. Recirculating scrub liquid is atomized into the throat of the venturi for impaction with the particulate matter entrained in the gas stream. The venturi scrubber is oriented horizontally between the quencher and absorber No. 1. The gas- liquid mixture from the quencher is disengaged in the quencher sump so that only gas flows through the venturi throat, along with atomized recirculated scrub liquid. The venturi scrubber is fabricated of corrosion-resistant alloy Hastelloy C-22 or equivalent. The differential pressure across the venturi throat is controlled using an automatically actuated pinch valve.

The relatively particulate-free gas exiting the venturi scrubber undergoes scrubbing of the gas phase pollutants HCL and mercury in the first absorber. This first absorber, along with the quencher and venturi scrubber, operates with acidic recirculating scrub liquid controlled to a set point pH in the range of 2 to 3. Operation within this pH range avoids the reduction of mercuric chloride back to elemental mercury.

The main purpose of the first acidic scrub recirculation loop is to promote mass transfer of gas phase elemental mercury into the scrub liquid to form highly soluble mercuric chloride ($HgCl_2$) by reaction with sodium chlorite ($NaClO_2$) reagent. When acid gases are being formed in the incineration process from the combustion of chlorine-containing feed materials, the pH in this first scrub loop will be automatically controlled by addition of sodium hydroxide (NaOH) liquid. Sodium chlorite is added to this recirculation loop in slight excess of the estimated stoichiometric requirement for reaction with mercury. In the unlikely event that wastes with insufficient chlorine are fed to the incinerator for a prolonged period, the pH is maintained in the desired range by absorption of CO_2 to form carbonic acid. Makeup liquid to this loop to maintain a constant liquid inventory is from process makeup waste or recycled condensate as well as purge liquid from the absorber No. 2 recirculation loop. Purging of liquid or blowdown from absorber No. 1 is controlled primarily by continuous measurement of liquid density that corresponds to a dissolved solids concentration of about 4 weight percent or a suspended solids concentration of 1.5 weight percent, whichever is reached first. Blowdown to the brine evaporator feed tanks is also initiated to maintain constant liquid inventory in this loop.

In absorber No.1, the gas flows upward, countercurrent to the flow of cooled recirculating scrub liquid. Liquid is uniformly distributed to the top of the packing through a weir-trough type distributor to uniformly cover the entire cross-section of the top of the packing.

Absorber No. 1 also functions as a direct contact condenser to cool the offgas stream to a saturation temperature of about 100° F. The base of the absorber tower serves as a liquid sump for recirculation of the scrub liquid. If the offgas saturation concentration of mercury is exceeded in this first scrub loop (due to a mercury feed spike for example) elemental mercury will condense. A system is provided to gravimetrically collect liquid mercury in the low points of the quencher and absorber No. 1 sumps for periodic batch withdrawal by pumping to the mercury hold tank. Since elemental mercury is more dense than scrub liquid, mercury collects in the bottom of the mercury hold tank through a sight glass and double valves into a small transfer container and then transferred to the SCW glovebox for amalgamation.

Removal efficiencies of 95 to 99 percent for HCl and 90 percent for mercury are expected in this first scrub loop. The pressure drop across the absorber ranges from 2 to 4 in. w.g. Absorber No. 1 and all internal components, including packing, support plates, and liquid distributor, are fabricated of Hastelloy C-22 (or equivalent) for both corrosion and temperature resistance. There is no mist elimination device in this vessel.

Gas from absorber No. 1 flows to the base of absorber No. 2. This second absorber is physically configured similar to absorber No. 1, but has key operation differences. This second loop operates at a neutral to slightly basic pH in the 7 to 8 range. Operation within this pH range avoids absorption of CO_2 from the gas stream, which becomes significant above a pH of about 9. The purpose of this second absorber is to remove the remainder of the HCl in the offgas that passed through the acidic absorber No. 1 and to remove SO_2 that passes through the acidic absorber. No additional mercury removal is expected in this second absorber. Overall acid gas removal efficiencies for the wet scrub system (including the first and second loops) is expected to be greater than 99.9 percent for HCl and 90 percent for SO_2, depending on inlet concentrations of each pollutant. Absorber No. 2 has a mesh-pad type mist eliminator located in the upper section of the tower to remove fine mist droplets that would otherwise be entrained in the offgas. This mist eliminator is periodically flushed on an automatically-timed basis with fresh plant water from below through a wide-angle spray nozzle.

Caustic addition to the second loop is limited to that required for stoichiometric conversion of the absorbed acid to sodium chloride (NaCl) and sodium sulfate (Na_2SO_4) salts. Purging of liquid from this recirculation loop is based on a setpoint liquid density corresponding to a dissolved solids concentration of —2 weight percent. The purge or blowdown stream from this neutral pH loop is cascaded to the first or acidic loop. This approach provides an overall countercurrent flow of liquid with respect to the gas flow direction such that cleaner liquid (neutral loop) will pass to the less clean loop (acid loop) before being purged from the system.

As previously described for absorber No. 1, all internal components in this absorber, including packing, support plates, and liquid distributor, are fabricated of Hastelloy C-22 or equivalent for both corrosion and temperature resistance.

The condensing WESP located downstream of absorber No. 2 removes entrained fine scrubber liquid mist droplets and entrained submicron particulate matter in the gas stream. Without such a prefiltration device, moisture droplets that pass through the reheater with insufficient time to evaporate could condense on HEPA filters, a condition that can significantly shorten HEPA filter media life. The WESP achieves high removal efficiency for submicron solid particulate matter and submicron liquid mists so that the first stage HEPA filters achieve lifetimes on the order of months.

The WESP is a vertical vessel containing an array of 120 vertical 6-inch diameter x 6-foot long tubes through which the gas stream passes upward. High voltage (approximately 40 kV) is continuously applied to a 1-inch ionizing electrode located in the axial centerline of each tube to charge by corona discharge the particulate and mist droplets entrained in the gas phase. The charged particles and droplets are attracted to, and collected by, the cool falling liquid film on the inside surfaces of each tube, where they are removed permanently from the gas stream. The WESP outlet particulate loading is expected to be less than 0.0002 grain/dscf.

The WESP is water cooled to enhance collection of submicron particulate. Chilled water is recirculated on the shell side of the tube bundle within the WESP to promote condensation of moisture from the gas stream. A very thin falling film of condensate is uniformly maintained on the inside surfaces of the tubes to continuously collect the particulate that has migrated to the inside tube walls. This condensate, containing particulate, drains from the tubes and continuously collects in the WESP sump, where it flows by gravity to the absorber No. 2 sump. A timed periodic flush of the tube surfaces with fresh water from above will guarantee that the tube surfaces remain clean. All wetted parts associated with the WESP will corrosion resistant alloy or equivalent.

The saturated gas leaving the WESP at 88 to 100° F passes through an in-line electrical resistance reheater that raises the temperature of the gas stream to approximately 30° F above the gas saturation temperature. Raising the temperature prevents moisture condensation in downstream process equipment, including the HEPA filters. Two redundant offgas reheater housings are provided in series. Each reheater housing contains a single bank of electrical

resistance heaters. Only one bank of heaters is in service at any time, as each heater bank is capable of raising the flue gas to the desired temperature.

Two parallel, redundant HEPA filter trains are located downstream of the reheater. Each train, sized to accept the entire offgas flow rate, consists of three stages. The first stage contains redundant parallel HEPA filter modules 1A and 1B, two roughing filters, and a water-repellant glass paper nuclear grade DOE certified HEPA filter. The HEPA filters have a manufacturer's specified minimum particulate removal efficency of 99.9 percent for 0.3m m particulate. Removal efficiency for smaller and larger particles is higher.

Within each stage of each train, one filter element accommodates the gas flow rate. The circular cross-section cylindrical HEPA filters (518 organic debris [OD] x 624 mm long) are rated for 2,000 acfm, continuous service temperature of 392° F and a maximum temperature over short periods of 482° F. The HEPA filter housings for each stage are fabricated of epoxy-coated carbon steel and structurally reinforced to withstand the negative pressure with respect to ambient atmosphere.

The wet scrub system is expected to remove 90 percent of the elemental mercury (Hg^0) from the gas stream entering the APCS from the SCC. However, to reliably achieve the emission standard for mercury, a fixed two-stage activated carbon adsorber downstream of HEPA filter stage No. 1 is required to collect the remainder of the mercury in the gas stream at this point. Located downstream of the first HEPA filter stage, the staged carbon bed adsorber remains relatively uncontaminated from radioactivity, making changeout of carbon simpler and safer.

The function of this carbon adsorber is to remove residual gas phase elemental mercury downstream of the wet scrub system. A non-dusting extruded carbon is used. Mercury loading ranges from 13 to 15 weight percent, based on total carbon bed mass. Unlike organic physical adsorption on non-impregnated carbons, mercury removal efficiency in impregnated carbon adsorbers is relatively insensitive to temperature up to about 180° F.

The carbon adsorber is a stand-alone vertical vessel that will incorporate both the first and second stages of carbon adsorption. The optimum vessel design configuration will be investigated and established during the detailed design phase. Addition of carbon occurs at the top of the vessel and gravity withdrawal occurs at the bottom. To maximize carbon utilization, when the first stage (lower) bed is withdrawn after mercury breakthrough, the second stage (upper) bed is transferred by gravity to the lower chamber to function as the new first stage bed. Fresh carbon is then added to the second stage (upper) bed.

Each stage is designed to achieve a bed gas residence time of 1 to 1.5 seconds with a pressure drop per stage of 2 to 6 inches w.g. Carbon particle size is approximately 4.0 milimeters.

Though the primary function is mercury control, activated carbon adsorbers can remove some chlorinated dioxin and furan as well. Carbon adsorbent changeout frequency is approximated once every 2 to 3 years, depending on average mercury input concentrations over the period, rated loading capacity of the specific carbon, and total bed volume. Spent carbon adsorbent is recycled to the incinerator. In the incinerator, mercury on the recycled carbon is thermally decomposed to elemental mercury and volatilized. The wet scrub system collects the mercury at 90 percent efficiency. As previously described, so that the primary mercury discharge route for the overall system is the scrub liquid blowdown and ultimately microencapsulation.

The carbon adsorber vessel is fabricated of corrosion-resistant alloy or equivalent. The perforated carbon support plates, where corrosion is most likely, is fabricated of Hastelloy C-22 or equivalent.

The second stage of HEPA filtration contains redundant parallel modules 2A and 2B and consists of a single roughing filter and a water repellant glass paper, nuclear grade, DOE-certified, HEPA filter. The pre-filter within this second HEPA filter stage protects the HEPA filter within this stage. Circular cross-section cylindrical HEPA filters (518 mm OD x 624 mm long) are used. All other specifications for the HEPA filters are identical to those for the first stage HEPA filters.

The third (final) HEPA filter stage is a stainless steel or high alloy HEPA filter. This durable third stage alloy HEPA

filter provides environmental protection from any postulated temperature or pressure excursions within the process. Except for the metal filter media used, these filters are of the same size and particulate removal performance as the first and second sage HEPA filters. Following the third stage of HEPA filter modules, the flue gas passes to the induced draft fan where it is delivered to the stack. The parallel induced draft fans control the draft through the AMWTP facility incinerator and APCS. A variable speed drive allows control of the draft to maintain negative pressure within the incinerator system and to sustain the movement of the flue gas through the APCS. Only one induced draft fan is in service at any given time as each fan has the capacity to move the offgas at process flow rates from the incinerator system. The induced draft fan discharges the flue gas to the atmosphere via the stack.

The incinerator stack is located on the south side of the AMWTP facility. The stack has a nominal diameter of 7 inches and is approximately 90 feet in height. A description of the facility stack is provided in Section D of Book 1 of the AMWTP RCRA Application Permit. A continuous emissions monitor (CEM) measuring CO, CO_2, and O_2 is located in the incinerator stack. The CO and CO_2 are monitored using non-dispersive infrared (NDIR) analyzers. The oxygen is monitored using a paramagnetic analyzer.

The stack gas composition and the CEMs status is displayed by the PES at the operator console. The CEMs is equipped with automatic calibration systems to meet the requirements of 40 CFR 266 Appendix IX for daily calibration checks. After completion of the initial performance testing of the O_2 and CO instruments, the instruments calibration is adjusted if the daily calibration check indicates that the calibration drift exceeds the specification in 40 CFR 266 Appendix IX. As per the EPA performance specifications, a performance test will be conducted annually. The CEMs also transmits signals to the PES that indicate under-range, over-range, status, and instrument error conditions. The PES provides the operator with audible and visual alarms in response to these errors and initiates an automatic waste feed cutoff (AWFC) when required.

B-2.3.2 Location and Descriptions of Temperature, Pressure, and Flow-Indicating and Control Devices for the Air Pollution Control System. A detailed discussion of the instruments that monitor proper performance of the APCS is given in D-5b(2)(a) of the AMWTP RCRA Permit Application.

B-2.4 Automatic Waste Feed Cutoff System

The automatic waste feed cutoff system prevents the feeding of waste when key incineration conditions fall outside of the predetermined range. The system, as a minimum, automatically locks out operation of the solid feed system until proper operating conditions are restored. To enhance the reliability of the automatic waste feed cutoff system, each waste feed cutoff parameter has two completely redundant signals entering the programmable electronic system from redundant transmitters in the field. When one of the transmitters requires repair or replacement, the incinerator system is allowed to operate with only one transmitter for a period not to exceed six weeks.

When a waste feed cutoff condition occurs, the waste feed auger drive motors stop and the waste feed isolation valve closes. The valve provides positive gas sealing and thereby prevents PCC gases from flowing back through the feed system. A water cooled tube-flange extending from the valve body prevents overheating of the valve and premature combustion in the feed system prior to entering the PCC.

B-2.5 Programmable Electronic System

A programmable electronic system has been provided to control the thermal treatment process. The programmable electric system, at a minimum, meets the following hardware and software requirements:

- The system accurately collects, displays, stores and reports necessary process and safety parameters in real time.
- The system alarms and shuts down the process safely on electric or pneumatic control malfunction as well as on predetermined deviations from normal operation.
- The system provides a display console with a process alarm selection and detection display screen. This display screen provides an audible and visual alarm, calling attention to the display screen upon which the parameter has

been programmed to appear.

- The system generates all required permanent and backup records which include magnetic media and hard copies when required.
- The system performs data reduction such as input averaging, parameter trend display, and data recording at the required logging rate.
- The system allows operation, startup, and shutdown of the system from the central control room.
- The system allows dial-in capability for remote monitoring of operating parameters by regulatory authorities.
- The system tracks and determines the status of all waste material processes through the facility.

Additional information on the control system and data management is provided in Section D of Book 1 of the AMWTP RCRA Permit Application.

Further details of the sampling and monitoring procedures for the trial burn are included in Appendix Section D-5 of the AMWTP RCRA Permit Application. Included are: the sampling methods and equipment, analytical procedures, sample frequency, description of the sample locations, and quality assurance/quality control measures for the trial burn.

B-2.6 Maximum Achievable Control Technology

On March 20, 1996, the EPA proposed new emission standards for hazardous waste incinerators, hazardous waste-burning cement kilns, and hazardous waste-burning lightweight aggregate kilns. This ruling, also known as Hazardous Waste Combustion Maximum Achievable Control Technology Rule (61 FR 17358), proposed new emission standards on chlorinated dioxins and furans, other toxic organic compounds, toxic metals, hydrochloric acid, chlorine gas, and particulate matter. The AMWTP facility sampling and analysis plan has been designed to provide the data necessary to demonstrate full compliance with this ruling. After the MACT rule is finalized (estimated in Spring 1999), the AMWTP facility trial burn plan will be revised as necessary to address MACT standards.

B-2.7 ***Toxic Substances Control Act***

Because a TSCA permit will be required for the AMWTP facility incinerator, the sampling and analysis plan has included provisions to demonstrate a 99.9999 percent destruction and removal efficiency of all PCB waste during the low temperature trial burn. Further details associated with the PCB sampling and analysis are included in Appendix D-5 of the AMWTP RCRA Permit Application. Included are calculations showing that the sampling times and methods are adequate to demonstrate the required destruction and removal efficiency.

B-2.8 Maintenance

The AMWTP facility incinerator has been designed to minimize the requirement of hands-on access to equipment. To the extent possible, replaceable or serviceable components will be readily accessible via manipulator, cranes, or glovebox access port. The incinerator process will reflect the following order of preference for performing maintenance:

- Adjust the item or unit in place.
- Repair item or unit by contact maintenance.
- Replace item or unit with spare unless it is more economical to perform remote maintenance or remove, decontaminate, repair, and return it to service.

Maintenance activities specifically associated with the trial burn will include calibration of regulated instruments. Prior

to the trial burn, all of the equipment described in the Trial Burn Plan will be operational. The trial burn is currently planned to be conducted with the pre-filters and HEPA filters that are in place at the time of the trial burn (i.e., new brine and filters will not be used for the trial burn).

B-2.9 Fast Shutdown Procedures

The fast shutdown mode is activated when operation must be terminated as quickly as possible due to a likely threat to the health and safety of operating personnel or the environment. Fast shutdown mode can be initiated either manually by the operator pressing a button in the central control room, or automatically when one of the defined fast shutdown interlock limits has been reached. When activated, the fast shutdown mode automatically and immediately:

- Shuts off the waste feed
- Closes the waste feed cutoff valve
- Shuts off all PCC burners (secondary combustion chamber burners are maintained), and
- Stops the PCC air supply blowers.

In the event of a fast shutdown, stack ventilation would continue until thermal treatment process cooled to near ambient temperatures. Continued stack ventilation in this scenario would not affect the efficiency of the stack gas control system. TSCA compliance requires 99.9999 percent destruction of PCBs, which is primarily a function of incinerator temperatures and flame residence time. Because waste feed and fuel feed to the primary combustion chamber would be terminated in a fast shutdown scenario but fuel flow and combustion in the secondary combustion chamber (where most thermal destruction occurs) would continue, TSCA compliance would be maintained throughout this procedure.

B-2.10 Automatic Waste Feed Cutoff Pre-alarms

In order to minimize the occurrence of automatic waste feed cutoff events, pre-alarms are used to indicate that an automatic waste feed cutoff parameter is approaching its limit. All of the automatic waste feed cutoff parameters have a pre-alarm. In the event of an automatic waste feed cutoff pre-alarm, operating personnel will take corrective action to prevent the automatic waste feed cutoff from occurring. The pre-alarm setpoints were chosen to allow the operator sufficient time to take corrective action prior to an automatic waste feed cutoff event.

B-3 Vitrification

The melter is used to treat the ash from the incinerator unit, as well as collected cyclone and HEPA filter solids from the melter APCS. Figures B-3-1 and B-3-2 provide simplified process flow diagrams of the melter and the melter APCS, respectively.

The following section describes: 1) the miscellaneous treatment unit, including its physical characteristics, operation, maintenance and monitoring procedures, inspection, closure, and operating standards, and 2) the environmental performance standards for this miscellaneous treatment unit, including waste types processed, containment systems, prevention of air emissions, and mitigative design and operating standards.

The treatment objective for the vitrification process is a glass waste form that will meet the Land Disposal Restriction standards based on the toxicity characteristic leaching procedure. The toxicity characteristic leaching procedure is used to determine the leach rates for HMWA metal constituents. A detailed performance test plan for the vitrification process is provided in the AMWTP RCRA Permit Application.

B-3.1 Description of Melter

The vitrification process deploys one melter which includes a feed system, a melter, glass waste form handling system, and an APCS. The vitrification process is used to treat ash by-products from the incineration unit. The feed system

handles ash material from the incinerator system as well as recycled solids from the vitrification cyclone and high temperature filters. The melter feed materials are dry solids. The waste solids are conveyed in lidded containers to the melter feed area by the plant central conveyor system. Once in the feed area, waste solids are conveyed by a roller conveyor to one of approximately 56 storage slots flanking the conveyor where they are temporarily staged until needed. When scheduled for processing, the waste drum is conveyed to a drum tipper which transfers the material into a waste storage hopper connected at the bottom to a waste feed hopper. The waste feed hopper delivers an operator-specified mass flow to a screw conveyor which conveys the material toward the melter. A separate entry port along this screw conveyor line delivers metered and operator-specified amounts of glass forming chemicals to the screw conveyor and the blended feed is then delivered into the melter.

The glass forming chemicals are stored and blended in an area external to the main building. They are mixed in defined batches and delivered to storage hoppers in the melter feed area. The glass forming chemicals storage hoppers deliver material through a specially-designed double dump valve to the glass forming chemicals feed hoppers which connect to the main screw conveyor as described above. The double dump valve arrangement is designed to isolate the non-contaminated glass forming chemicals line from the contaminated waste feed line.

The combined mixture of waste feed and glass forming chemicals feed, once in the main screw conveyor, is conveyed to its feed port where an auger feeder assists in delivering the solid material to the melt surface. The auger feeder incorporates an outer water-cooled jacket to thermally isolate the feed screw conveyor material from the melter plenum.

The design of the feed system is based on the assumption that glass forming chemicals will be delivered to the site in bulk by truck. The dry chemicals are pneumatically unloaded from the truck and conveyed into individual storage silos. Each silo provides a 30-day supply of material. The silos are located external to the main facility in order to provide easy truck access and minimize the inactive storage within the facility.

Figure B-3-1. Simplified process flow diagram of the melter.

Figure B-3-2. Simplified process flow diagram of the melter Air Pollution Control System.

The target glass melting temperature is less than 2,200 °F, which allows for Inconel electrode-based melter technology. The residence time for the AMWTP facility melter is at least 48 hours in order to allow for complete dissolution of the solid feed into the molten glass pool with agitation provided by compressed air bubblers. The melter plenum is maintained under constant negative air pressure via the offgas blower to minimize radioactive release into the surrounding melter cell's ventilation system. Oxygen or enriched air is introduced into the melter plenum to convert any residual carbon from the incinerator ash to carbon dioxide. The melter lid is configured to minimize uncontrolled air in-leakage and permit glovebox maintenance on replaceable components. The melter is fitted with a film cooler to minimize the deposition of material in the discharge port. A water-cooled jacket around the melter is incorporated into the design to reduce the heating load to the melter cell's ventilation system.

The solid waste, along with glass forming chemicals, is continuously fed to the melter and converted to a glass (vitrified waste), incorporating toxic metals. The glass is poured into a container forming a monolith, then overpacked into another container, and sent for product certification. Table B-3-1 summarizes vitrification process specifications including availability, feed rates, and waste loading.

B-3.1.1 Physical Characteristics. The following are physical characteristics.

Feed System. The feed system handles ash material from the incinerator as well as recycled solids from the vitrification cyclone and high temperature filters. The waste solids are conveyed in lidded containers to the melter feed area by the plant central conveyor system. Once in the feed area, the solids are conveyed by a roller conveyor to one of the storage slots where they are temporarily stored until needed. When scheduled for processing, the waste drum is conveyed to a drum tipper) which dumps the material into one of three waste storage hoppers. Each waste storage hopper is connected at the bottom to its waste feed hopper.

Table B-3-1. Summary of vitrification process specifications.

Specification item	Measurement

Project span	13 years
Working days	330 days/yr
Plant availability	65% (for 12 operating years)
Duration	2574 days
Waste loading (oxide basis)[a]	50%
Incinerator ash feed rate	289 lb/hr
Glass Forming Chemicals additives rate	284 lb/hr
Glass product rate	567 lb/hr
	3.64 ft^3/hr
	20 forty-gallon drums/day[b]
Number of melters	1
Melter size	6.8 tons of glass/day

a. Glass formers from incinerator ash versus glass formers from additives.

b. At 90 percent volume utilization.

The melter has three feed addition ports to provide for suitable dispersion of the feed material onto the molten glass pool. Each feed port has its own independent feed system consisting of a waste storage hopper connected to a waste feed hopper, a glass forming chemical storage hopper connected to a glass forming chemical feed hopper, a screw conveyor, and a melter feed auger. Waste material from the waste feed hoppers described above is metered onto the main screw conveyors at the desired operator-controlled mass flow rate. Once on the conveyor, the waste material is conveyed toward the melter. A second input port into the main screw conveyor delivers the desired operator-controlled amount of blended glass forming chemicals. The glass forming chemicals supply glass forming components otherwise deficient in the waste. Glass forming chemicals are added to the feed stream based on physical and chemical characterization of the waste. The glass forming chemicals are blended and added in amounts required to efficiently produce a durable glass, thus becoming the principal means of process quality control. The glass forming chemicals will be stored and mixed in an area adjacent to the main plant building and pneumatically transferred into the plant. The glass forming chemical mixing and addition system is designed so that the glass composition can be maintained in the desired range by changing the relative amounts of the glass forming chemicals. In this way, the glass forming chemical recipe can be changed as needed to maintain the melt chemistry of glass forming elements within the desired range. The large glass pool dampens fluctuations in the chemical composition of the melt resulting from variability in waste chemistry.

The transfer of glass forming chemical material from the glass forming chemical storage hopper to the glass forming chemical feed hopper uses a valve arrangement that acts to isolate the radiologically clean glass forming chemical transfer lines from the waste feed conveyor lines. The valve arrangement is designed so that air and material flow are balanced to prevent back contamination of the glass forming chemical transfer lines.

The combined mixture of waste and blended glass forming chemicals is conveyed along the main screw conveyor to

the melt feed port. A vertical feed auger keeps the port from becoming clogged as the feed material comes off the screw conveyor. The auger is designed with a water-cooling jacket which serves the additional purpose of thermally isolating the feed material from the melter plenum. The feed auger tubes extend approximately 1 to 2 feet into the melter plenum to reduce the amount of carryover feed material into the offgas system.

Melter. Two discharge chambers are located side-by-side on the long wall of the melter. View ports to permit visual monitoring of the melter during operations are included. Access to and viewing of both discharge chambers are required on a regular basis during operations. The melter is mounted on a rail support system and positioned as close to the cell floor as practicable. The melter incorporates an integral cooling water jacket on all sides to help heat dissipation within the cell. The melter is a Duramelter manufactured by GTS Duratek.

Linear Dimensions of the Melter. The glass pool surface area is approximately 108 square feet, with internal dimensions of approximately 16 feet by 6.5 feet. The external dimensions of the melter, excluding the feed and APCS, are approximately 21 feet long by 16 feet wide by 9 feet high. The melter weighs approximately 250 tons empty and 270 tons containing glass.

Electrode Configuration. The electrical configuration for the melter consists of three pairs of Inconel 690 plate electrodes mounted parallel to each other within the melter. Forced-air-cooled electrode buses penetrate the side of the melter below the glass level to minimize thermal expansion. Active cooling of the buses and the use of a water cooling jacket prevent the glass from migrating through the refractory package adjacent to the electrode penetrations.

Melter Temperature Control. The normal operating temperature of the melter glass pool is held constant at 2,100 ^{o}F by controlling the electrical power into the melter. Three sets of electrodes located within the melter are independently governed by three silicon controlled rectifier silicon controller rectifier voltage controllers which are positioned outside the melter cell. The primary control loop is a temperature control loop that sets the secondary control loop silicon controlled rectifier voltage controller.

Temperature within the glass pool is measured by six Inconel sheathed thermocouple assemblies. There are two thermocouple assemblies placed equal distant between the electrodes for each set of electrodes. Each assembly contains 10 type "N" thermocouples within an MgO packing. Starting at the wetted end, the thermocouples are evenly placed within the wetted assembly length. This arrangement places seven thermocouples within the glass pool and three thermocouples within the melter offgas plenum. Three thermocouples within the glass pool are used for melter temperature control purposes. Thermocouple outputs are converted to 4 - 20 mA signalsproportional to transmitters. Should a thermocouple fail, the output from the transmitter is higher than 20 mA and an alarm is logged.

For each assembly, the three temperature signals from the middle level of the glass pool are used to make a log average for use by the control system to set the electrode voltage. Should a thermocouple fail, the system transfers to power control and uses the last valid electrode power set point to safely control the melter temperature. The electrode power is held at a constant value and the current is regulated to deliver constant power.

Description of the Electrical Power System. Power to each pair of electrodes is via a single-phase, alternating current, dry-type power transformer. Transformers are located outside of the melter cell to facilitate maintenance. Remote bus connectors are located outside of the cell to facilitate melter change-out.

Each electrode pair is controlled by glass pool temperature feedback from thermocouples placed within the melter refractory package and directly in the glass pool.

Refractory Package. The melter refractory package consists of three layers: glass contact refractory, a backup refractory, and an electrical isolating barrier. This package, used in conjunction with active cooling provided by a water jacket, provides glass containment, thermal insulation, and electrical isolation. Glass migration through the refractory package is limited to within the glass contact refractory by establishing an isotherm that will freeze molten glass below 1,250°F. The refractory package is designed to provide adequate containment if cooling is temporarily lost.

The first refractory layer, the glass contact refractory, consists of two Monofrax K3 (or equivalent) layers. The primary

layer is approximately 12 inches thick and the secondary layer is approximately 5 inches thick. Below the glass level Monofrax K3 (or equivalent) is used, and above the glass Monofrax H (or equivalent) is used because it provides better thermal properties and higher corrosion resistance.

The second layer, the backup refractory, consists of two 3-inch layers of Zirmul (or equivalent). Around the electrodes Monofrax E (or equivalent) refractory is used. This second layer provides a highly corrosion resistant barrier in the event of glass migrating through the contact refractory.

The third layer, the electrical isolation barrier, consists of a 0.5 inch layer of mica (or other insulating material). This layer provides additional isolation between the glass pool and the outer shell of the melter.

Thermal expansion within the refractory package is controlled in two dimensions by an expandable water jacket. Refractory is allowed to expand away from the discharge chambers, and about the melter center line on the long axis. Expansion is controlled by guides and a series of springs and jackbolts located along the melter bottom and side edges. These springs and jackbolts allow the refractory to expand as it heats up, but also provide sufficient force to compress the bricks as the melter cools. Refractory expansion and contraction occurs during thermal cycling. The spring and jackbolt system acts to prevent excessive gaps from forming between the refractory bricks which could allow glass migration and accelerated brick erosion.

Lid Design. The lid design of the melter consists of a protective Inconel 690 ceiling plate, a layer of castable Zirmul (or equivalent), and a stainless steel outer shell/water jacket.

Glass Discharge Chamber. Glass discharge from the melter is via two discharge chambers, each capable of discharging 6.8 tons of glass per day. Discharge is achieved by transferring glass from the bottom of the melter pool into the discharge chamber and subsequently pouring it into a container.

Discharge by gas lift is achieved by bubbling gas via an Inconel tube into an Inconel-lined riser situated within the refractory package. The gas lift is designed to lift glass approximately 10 inches above the glass pool level during normal operations. The lifted glass flows into the discharge chamber via an Inconel discharge trough. During discharge, the discharge chamber is heated by lid-mounted heating elements to prevent the glass from cooling.

The discharge trough is fabricated from Inconel and lined with refractory fiberboard for thermal insulation. Glass entering the discharge chamber flows freely down the discharge trough and pours into a container positioned below at the canister filling station. The gas flow rate controls the rate of discharge. Gas bubbling is stopped at the end of the required discharge operation, and pouring is discontinued once the glass residue in the trough has discharged. The melter is never emptied once operations begin.

Discharge chambers are positioned adjacent to the electrodes to keep the discharge chambers and electrodes at the same electrical potential to avoid joule heating between the Inconel riser and refractory.

B-3.1.2 Glass Waste Form Handling and Processing. An empty 40-gallon drum is introduced to the drum handling system inside a 55-gallon drum overpack. Drums are sealed by a bagless transfer seal (See Section D-8a[6]c of the AMWTP RCRA Permit Application for a description of the bagless transfer system). The drums are transferred to the lid removal station where the lid from the 55-gallon drum overpack is removed. A remotely-operated crane within the cell lifts the 40-gallon drum out of the larger drum and onto rollers for transport to the fill port and sampling station.

The operator samples melter glass at the fill station by inserting a sampling device into the molten glass stream. The sampling device is suitable for insertion into the X-ray fluorescence system. The glass sample is cooled and transferred out of the handling cell to the laboratory where sampling and analysis are performed. A detailed discussion of the sampling and analysis plan can be found in the AMWTP RCRA Permit Application.

The glass-filled drum is transported on rollers to a cooling station. The drum is cooled via a water or air cooling device for 1-2 hours so that it can be lifted by crane and placed back inside the 55-gallon drum overpack. The filled drum is smear tested for contamination. The drum is then transferred to the lid installation station where a 55-gallon lid is

installed on the drum.

The glass discharge chamber contains a sealed glovebox with viewports and closed circuit television camera and access to aid the operator in viewing conditions inside the handler, such as glass level, commencement of discharging, discharging rate, and sampling and testing of the glass waste form as required. A stairway and platform with railings allows the operator access to the viewports and access areas.

B-3.1.3 Location and Description of Temperature, Pressure, and Flow-Indicating and Control Devices for the Melter. The melter is designed with the capability to be remotely monitored and controlled. Remote operations are performed from the central control room by trained operators. The system is continuously monitored by a programmable electronic system that is programmed to receive transmissions from pressure, flow, temperature, and performance transmitters located throughout the system and transmit those signals to control devices. Based on preprogrammed information and system parameters, the controller transmits signals to either process control devices or to warning lights within the central control room indicating a system malfunction.

The critical devices in the system that transmit signals to the central control room and programmable electronic system are listed in Table D-8-5 of the AMWTP RCRA Permit Application.

B-3.1.4 Air Pollution Control System. The melter is close coupled to a multistage APCS that maintains the melter at a constant negative pressure, and contains and treats melter emissions. The melter exhaust consists of gases generated from the melting process. The melter exhaust is treated to reduce the airborne concentrations of gross particulate and toxic metals to meet the limits imposed for the facility.

Toxic metals partitioning to the offgas during the vitrification process are in the form of solid particulates; therefore their release to the environment can be controlled by HEPA filtration. Use of HEPA filters also ensures that the particulate loading of gas leaving the melter offgas train meets regulatory requirements.

The melter APCS includes a film cooler, a cyclone separator, two parallel high temperature filters, two parallel shell and tube heat exchangers, two parallel conventional HEPA filters, and three parallel main blowers (see Figure B-3-2).

Components downstream of the cyclone are duplicated to reduce downtime and to allow maintenance without interrupting operation.

B-3.1.4.1 Film Cooler. The first stage of the APCS for the melter consists of two components: an offgas port and a film cooler. Offgas exiting the melter carries solid particulates from the feed and vitrification process. High velocity air is injected into the offgas port to provide a cool film of air over the inside film cooler walls. The film effectively reduces particulate deposits by reducing their contact with the wall surfaces.

Due to the chemical composition variability of the AMWTP facility waste feed, the vitrification system is designed to handle a wide range of operating conditions. For example, the melter plenum temperatures range from 400 to 1,750^{o}F, depending on the size of the "cold cap" on top of the molten glass pool. The melter plenum effluent is contacted with film cooler air prior to its introduction to the cyclone. However, to maintain particle removal efficiency in the cyclone, its input volumetric flow rate (which depends on its temperature) should ideally be held constant. Hence, to meet this requirement, the film cooler's air temperature and flow rate is adjustable over a wide range of operating conditions. This flexibility requirement is met by including electrical duct heaters able to heat the incoming film cooler air up to 850^{o}F.

B-3.1.4.2 Cyclone. The fixed throat type cyclone dust collector operates with no moving parts, providing minimal operation and maintenance requirements. Gas with contaminated particulate from the melter enters the cylindrical/conical body of the cyclone tangentially at the top and then assumes a vortex pattern as it flows helically downward. Centrifugal force generated by the tangential air flow causes the heavier dust particles to move rapidly toward the cyclone wall. When the particles reach the wall, friction and gravity forces them to descend and discharge into a hopper. The cleaned gas spirals upward and exits at the top of the cyclone. Efficiency of the cyclone for the 10-micron diameter material is 80 to 85 percent and its operating temperature is between 750 and 930^{o}F at approximately

6 in. w.g. average pressure drop.

B-3.1.4.3 High Temperature Filter. The high temperature filter incorporates a ceramic or metal gas filter. Particulate-laden gases enter the filter through the inlet pipe. Larger particulate matter tends to quickly fall into the discharge hopper. The gas with the remaining particles rises upward, passing through the modules.

The ceramic/metal gas module is a porous cordierite or sintered metal powder monolith which contains numerous parallel passageways extending from one end face to an opposing end face. During operation, the cyclone discharge gas flows through each passageway and particulate matter is collected on the inner surfaces. The filtered gas stream passes through the media and exits the filter by the downstream end face. As the differential pressure across the filters rises, the ceramic/metal gas filter is cleaned by a jet pulse compressed gas stream. The high temperature filter operates between 660 and 930° F.

B-3.1.4.4 Heat Exchanger. The filtered offgas is cooled by means of a water-jacketed shell and tube heat exchanger before entering the conventional HEPA filter units.

B-3.1.4.5 Conventional HEPA Filter Units. Two parallel HEPA filter banks are included for the melter offgas system to ensure that particulate loading to the stack meets regulatory requirements. Each filter housing includes two nuclear grade HEPA filters in series, each with 99.97 percent efficiency for 0.3 micron particulate. Maximum design differential pressure across HEPA filters is 10 in. w.g. The maximum design temperature is 250^{o}F. HEPA filters are di-octyl phthalate tested after each replacement.

B-3.1.4.6 Capacity of Offgas Main Blower. The main blower maintains steady negative pressure within the melter over a broad range of differential pressure fluctuations across the system. It draws the flue gas from the melter APCS and delivers it to the stack. The main blower has a nominal capacity of 180 acfm at 130^{o}F and a static pressure of negative 80 inches w.g.

B-3.1.5 Standby Offgas Train. The melter operates under negative pressure (relative to the process cell) to prevent the release of contaminated gas to the cell. The melter is designed with a standby offgas port to remove melter gaseous emissions during main offgas port (film cooler) maintenance.

This additional port through the melter lid permits bypassing of melter emissions from the melter plenum around the film cooler to the cyclone. During normal operations, this flow path is kept closed by valves. A small purge air stream is continuously injected into the port to the melter plenum to minimize potential blockage of this port by melter particulate emissions.

At upset conditions or during maintenance operations on the film cooler, the standby offgas port is opened when the melter plenum pressure reaches a predetermined threshold value. A pressure sensor is interlocked with a control valve which opens the melter plenum to the standby vent line when this threshold is reached. The waste feed to the melter is temporarily discontinued. Ambient air is introduced to the standby offgas port to maintain a constant flow rate to the cyclone. Note that this system utilizes the rest of the APCS for gas cooling and particulate removal. When the upset condition or maintenance operation on the film cooler is completed, the small purge air stream into the standby port is resumed and the control valves to the standby vent line are closed. Normal waste feed to the melter can then be resumed.

B-3.1.6 Maintenance. The expected lifetime of a melter is approximately 6 years. The melter may be replaced twice during the lifetime of the facility. The melter is located on a set of tracks, or rails, which permits removal and replacement. The melter access ports are sealed and the unit externally decontaminated prior to removal.

Vitrification sub-systems (feed conveyors, filters, APCS components, associated blowers and piping) are repaired or replaced in-place as required. In most cases, a temporary enclosure is used to isolate the work area prior to repair or replacement.

B-3.1.7 Monitoring Procedures. Central control room operators monitor operations of the melter through

consoles and closed circuit television. The melter consoles display information from the programmable electronic system. The programmable electronic system provides operational data for analysis and records. Information obtained by the programmable electronic system is used to meet environmental monitoring and reporting requirements. In addition, the central control room operators are required to log events that occur during their shift.

B-3.1.8 Closure. Closure of the melter is addressed in the AMWTP RCRA Permit Application.

B-3.1.9 Mitigative Design and Operating Standards. The melter and ancillary equipment have been designed to operate in a manner to reduce the risk of waste constituents to the environment. The building protects the melter from precipitation, thereby precluding precipitation run-on and the potential for contaminated run-off. Specific design features and operating procedures that reduce the risk of waste exposure to personnel and the environment are explained below.

B-3.1.10 Melter Cells. Melter primary containment is provided by the outer melter box shell and prevents both gaseous releases and glass leakage to the cell. The outer shell is constructed of 304 Liters stainless steel. Penetrations through the outer shell are sealed by appropriate gaskets and flanges that allow remote removal and replacement. The external shell is fabricated to permit ease of removal and to facilitate melter disconnection in a remote environment.

The melter is contained within a set of adjacent Zone 2 process cells. The first cell houses the melter and the rail mounted transporter. The second cell is situated above the first cell and provides access to the dry feed conveyors/mixers and the top of the melter.

B-3.1.11 Glass Waste Form Delivery System Cell and Glovebox. The melter unit has two discharge chambers each protruding through the common wall into separate gloveboxes. A seal is provided between the bottom of the discharge chamber and the inside of the glovebox. The inside of the melter and the inside of the glovebox is considered a single, continuous Zone 3 containment area. This Zone 3 area has a single common ventilation system which is maintained negative relative to the Zone 2 process cells within which it is contained.

A bagless transfer system is used as the system interface for drum access. An overpack drum containing a 40-gallon drum and an inner container lid is placed into the transfer system. A seal is provided between the top rim of the drum and the transfer system. An inner lid removal tool, positioned directly above the drum removes the inner drum lid. The underside of the lid removal tool is kept clean; hence, the top of the inner lid is also kept clean. Once open, the inside of the container becomes part of the contiguous Zone 3 area. An inner drum grappling device located inside the glovebox removes the inner 40-gallon drum and places it onto a conveyor. The conveyor positions the drum under the pour spout for glass waste delivery. Once full and cooled sufficiently for transfer, the 40-gallon drum is conveyed back to the inner drum grappling device for placement back into a container. The inner drum lid removal tool places the inner lid back onto the drum before the seal with the transfer system is broken. Operations personnel check the outside of the drum for contamination, and provide decontamination if needed, prior to placing the outer drum lid and locking ring onto the outer drum. The contamination survey and installation of the outer lid and locking ring are expected to occur within a glovebox. The drums are then transferred to the product certification area.

A system of monitors (e.g., closed circuit television cameras) and instrumentation (e.g., weigh scales or level controls) is provided to ensure maximum loading of each 40-gallon drum. A remote splatter removal tool is provided to clean spilled glass from the floor and walls of the glovebox.

B-3.1.12 Offgas Handling System Cell. The cells immediately adjacent to the melter and glass waste form delivery process cells contain the APCS. This system consists of a cyclone, a pair of high temperature filters, gas cooling, and a pair of conventional HEPA filters.

Each of the high temperature filters and the cyclone incorporates an integrated hopper for recycle solids removal. The solids are dumped into containers for transport back into the melter feed system via the central conveyor system. The hoppers, drums, and conveyor are housed in a permanent glovebox with HEPA filtered exhaust.

B-3.1.13 Sample Removal. A process control sample is taken from the molten glass waste stream. A ladle is placed into the glass waste stream as it is being poured from the melter into a container. The ladle is removed from the

stream and held over the drum to allow the glass to solidify. Once solidified, the sample is removed from the pour area into a container. The transfer drum is then removed through the bagless transfer system as described for final waste form removal. A process operator performs this operation using an extension tool or remote manipulator.

B-4 Microencapsulation Process

The microencapsulation process would be used to grout and solidify the incinerator ash and salt from the brine evaporation in 55-gallon drums. The resulting 55-gallon drums of grouted ash are then ready for final shipping and disposal. The microencapsulation process (see Figure B-4-1) is similar in concept to the macroencapsulation process described in Section B-1.2.

There would be two microencapsulation drum lines located in the northwest portion of the building. Ash would be transferred from the incinerator area into the ash receipt hopper. The ash would be below 86° F and would be reduced in size to less than 6 millimeters. The receipt hopper has a nominal capacity of 1 day of ash production. Ash would then be transferred via screwfeeder to the ash blender. In combination with incinerator campaigns of high and low activity waste, ash blending ensures that the final product has a specific activity greater than 100 nCi/g.

From the ash mixing hopper, the material would be metered to the ash feed hopper until the required mass to fill one product drum has been received. Within this hopper, the material would be assayed to give the total fissile gram equivalent in the product drum. The ash would be transferred into a product drum via screwfeeder. The inside of ash hoppers and screw feeders are Zone 3 areas and would be maintained at a negative pressure to confine ash within the system.

Cement powder (ordinary PortlandÔ cement) and pulverized fuel ash would then be transferred for blending via an elevator to the cement intermediate mixing hopper. The cement mix would then be transferred to an intermediate cement hopper where the required quantity of cement for an individual drum is batched via screwfeeder into the cement feed hopper. The cement feed hopper would be weighed to confirm the correct mass and the material fed via screwfeeder into the product drum.

Next, product drums containing a mixing paddle and a bagless transfer inner lid would be supplied to the fill system. Chilled water is metered to the drum at the water addition station. The drum is moved to the in-drum mixing station and raised up to the bagless transfer port. The inner lid is removed by the lidding mechanism, and the top of the inner lid is kept clean by keeping it attached to the lidding mechanism throughout the fill cycle. The mixing head is lowered into position and coupled with the mixing paddle in the drum. The mixing paddle is then started, and the ash added to the water in the drum via the ash metering screwfeeder.

The process would be performed within a Zone 3 glovebox kept at negative pressure to confine any ash that may become airborne during loading. Chilled air is circulated around the outside of the drum in the Zone 2 area to cool the ash mixture. The drum mixing glovebox has a drip tray below the mixing drum to contain any liquid or powder spills.

Following mixing of the ash-water mixture, cement would be added to the drum, and the drum content mixed. The mixing paddle remains in the product drum. Samples of the mixture would be obtained before an inner lid is placed on the drum. Once the lid is in place, the drum is removed from the bagless transfer unit, manually swabbed for external contamination, fitted with an outer lid, and transferred to the drum cure area for curing.

Basic Process Parameters. The basic process parameters for the microencapsulation process are summarized in Table B-4-1. The instrumentation and alarm of process parameters for microencapsulation are described below.

Types and Quantities of Hazardous Materials. Table B-4-2 shows the types and quantities of hazardous materials in the microencapsulation process.

Figure B-4-1. AMWTP facility microencapsulation process.

Process Equipment. The principal design parameters for microencapsulation process equipment are summarized in Table B-4-3.

Table B-4-1. Microencapsulation process parameters.

Parameter Waste mass input to process	18,628,870 lb
Waste volume input to process	300,848 ft^3
Drum equivalent to process	42,104

Table B-4-2. Microencapsulation waste types and quantities[a].

Waste category	Total volume[b] ft^3	Total mass, lb
Inorganic homogeneous debris	233,114	14,550,360
Organic homogenous debris	56,010	3,505,314

Soil	9,005	595,242
Special case waste	2,684	167,550

a. In any given day, waste processed may be all one category (i.e., waste is segregated by type) or may be blended such that product drums meet Waste Isolation Pilot Plant specifications. The values shown are total for all waste to be processed over the life of the facility.

b. Volume is ash volume from this treatment of the specified waste category in the incinerator. Volume assumes the density of inorganic homogenous solids/organic homogeneous solids ash is 62.4 lb/ft^3 and soil is 74.9 lb/ft^3.

Table B-4-3. Microencapsulation process equipment design parameters.

Parameter	Value
Drum mixing glovebox volume	420 ft^3
Drum mixing glovebox materials of construction	Stainless steel
Maximum capacity	12 drums per day per line, 24 drums per day total
Maximum design pressure	-12 in. water gauge
Minimum design pressure	0 in. water gauge
Maximum design temperature	104° F
Minimum design temperature	50° F

Instrumentation and Control Systems and Equipment-Microencapsulation. The instrumentation and control systems for the microencapsulation process are as follows:

- Level on ash receipt and ash blend hoppers
- Neutron assay in the ash feed assay hopper
- Weight in the ash feed assay hopper
- Weight in the cement feed hopper
- Level in the product drum
- Temperature in the drum mixing glovebox
- Weight in the product drum
- Pressure in all Zone 3 areas.

B-5 Secondary Wastes

Operation of the AMWTP facility would generate additional wastes that would have to be treated. The amount of wastes and types are dependent on the throughput rates and the processes used in the facility. Tables B-5-1 and B-5-2

shows the operations throughput rates for the AMWTP facility processes for 65,000 cubic meters. Table B-5-3 show the secondary waste streams generated for the facility with the microencapsulation of incinerator ash process. Also shown is the proposed treatment for each of the waste streams. The AMWTP facility with vitrification of incinerator ash would generate more secondary waste as shown in Table B-5-4.

Table B-5-1. AMWTP unit operations total and annual throughput rates for 65,000 cubic meters.

	Total					Annual			
Unit Operation	Vol. thruput (m^3)	Mass thruput (kg)	No. of drums equiv	No. of boxes equiv	Time of operation	Vol. thruput (m^3)	Mass thruput	No. of drums equiv	No. of boxes equiv
Box Line	35,122	12,180,910	165,068	11,079	12.0	2,927	1,015,076	13,806	923
Drum Line	15,108	14,085,303	71,266		6.6	1,755	1,582,247	8,278	
Microen-capsulation	7,301	7,460,638	34,438		9.1	799	819,382	3,769	
Incineration	14,162	12,183,167	68,803		9.2	1,548	1,338,430	7,290	
Macroen-capsulation	17,147	15,540,077	80,881		8.9	1,931	1,771,101	9,110	
Supercom-paction	41,838	14,576,712	197,349		8.6	4,847	1,691,304	22,665	
Vitrification[a]	19,076	6,238,003	91,746		9.2	20.73	678,044	9,972	
a. Optional treatment for incineration ash.									

Table B-5-2. AMWTP unit operations daily and hourly throughput rates for 65,000 cubic meters.

		Daily						Hourly			
Unit Operation	Daily vol. output	No. of containers equiv.	Process factor	Vol. thruput (m^3)	Mass thruput (kg)	No. of drums	No. of boxes	Vol. thruput (m^3)	Mass thruput (kg)	No. of drums	No. of boxes equiv.
Box Line	8.9	2.6	80%	11.1	3,845		3.50	0.5	1.60		0.15
Drum Line	5.3	25.1	80%	6.6	5,993	32		0.3	2.50	1.3	

Microen-capsulation	2.4	11.4	85%	3.7	3,820	18		0.2	1.59	0.7	
Incineration	4.7	22.1	70%	6.7	5,794	32		0.3	2.41	1.3	
Macroen-capsulation	6.9	27.6	80%	7.3	6,709	35		0.3	2.80	1.4	
Supercom-paction	14.7	69.3	70%	21.0	7,322	99		0.9	3.05	4.1	
Vitrification[a]			65%	9.7	3,161	46		0.4	1.32	1.9	
a. Optional treatment for incineration ash.											

Table B-5-3. AMWTP facility with microencapsulation, secondary waste streams and treatment.

	Total			Annual		Daily				
Secondary waste streams	Volume thruput (m^3)	Mass thruput (kg)	Time of operation (years)	Volume thruput (m^3)	Mass thruput (kg)	Volume output (m^3)	Process factor	Volume thruput (m^3)	Mass thruput (kg)	Treatment
Blowdown Salts (LLMW)	818	959,743	9.1	89	105,235	0.270	70%	0.388	456	(To Microencapsulation)
Decon Water (Showers)	42	41,860	9.2	5	4,540	0.014	70%	0.20	20	(To Evaporator)
Zone 3 Liquid Waste (LLMW)	64	84,206	9.2	7	6,097	0.21	70%	0.030	30	(To SWC then Incinerator)
Refactory (INC)	32	22,848	8.6	3	1,904	0.008	70%	0.012	8	(To Supercompactor)
High Temperature Filters (LLMW)	32	8,810	8.6	4	906	0.011	70%	0.015	4	(To Supercompactor)
Packing (INC) (low-level waste, TBV)	12	5,352	8.6	1	446	0.003	70%	0.004	2	(To Supercompactor)
Candle Demister (INC) (low-level waste)	8	2,738	8.6	1	300	0.003	70%	0.004	1	(To Supercompactor)
Reheater (INC) (low-level waste)	4	1,688	8.6	0	141	0.001	70%	0.001	1	(To Supercompactor)
Failed Equip/Tools	485	204,551	8.6	53	22,291	0.160	70%	0.229	86	(To Supercompactor)

(LLMW)									
HEPAs (LLMW)	759	208,219	8.6	53	22,972	0.252	70%	0.380	99	(To Supercompactor)
Carbon Filters Inc	11	6,757	9.2	1	741	0.004	70%	0.005	3	(To Supercompactor)
Carbon Filters Facility	101	59,831	8.6	11	6,520	0.033	70%	0.048	28	(To Supercompactor)
Blowdown Brine	27,287	27,755,233	9.2	2,974	3,043,337	9.011	70%	12.9	13,175	(To Evaporator)
ANTI Cs (LLMW)	918	276,668	8.6	100	30,150	0.303	70%	0.433	131	(To Supercompactor)

Table B-5-4. AMWTP facility with vitrification, secondary waste streams and treatment.

	Total			Annual		Daily			
Secondary waste streams	Volume thruput (m^3)	Mass thruput (kg)	Time of operation (years)	Volume thruput (m^3)	Mass thruput (kg)	Process factor	Volume thruput (m^3)	Mass thruput (kg)	Treatment
Blowdown Salts (LLMW)	1,325	1,075,485	9.2	144	116,901	70%	0.623	506	(To LLMW disposal)
Decon Water (Showers)	55	264,790	12.0	5	22,066	100%	0.014	67	(To Evaporator)
Zone 3 Liquid Waste (LLMW)	64	312,867	9.2	7	34,007	70%	0.30	147	(To SWC then Incinerator)
Refactory (INC)	25	N/A	9.2	3					(To Supercompactor)
High Temperature Filters (LLMW)	42	N/A	9.2	5					(To Supercompactor)
Packing (INC) (low-level waste, TBV)	5	N/A	9.2	1					(To low-level waste disposal)
Candle Demister	85	N/A	9.2	9					(To low-level waste disposal)

(INC) (low-level waste)									
Reheater (INC) (low-level waste)	2	N/A	9.2	0					(To low-level waste disposal)
Failed Equip/Tools (LLMW)	60		12.0	5					(To Supercompactor)
HEPAs (LLMW)	1,374	N/A	12.0	114					(To Supercompactor)
Carbon Filters (LLMW)	5	N/A	12.0	0					(To Supercompactor)
Blowdown Brine	19,070	19,356,485	9.2	2.078	2,109,361	100%	6.3	6,392	(To Evaporator)
ANTI Cs (LLMW)	1,200	N/A	12.0	100					(To Supercompactor)

APPENDIX C

SETTLEMENT AGREEMENT

Public Service Co. of Colorado v. Batt

and United States v. Batt

UNITED STATES COURTS

DISTRICT OF IDAHO

OCT 17 1995

8:34 A.M. REC'D _____

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UNITED STATES COURTS

DISTRICT OF IDAHO

SETTLEMENT AGREEMENT

The State of Idaho, through the Attorney General and Governor Philip E. Batt in his official capacity; the Department of-Energy, through the General Counsel and Assistant Secretary for Environmental Management; and the Department of the Navy, through the General Counsel and Director, Naval Nuclear Propulsion Program, hereby agree on this 16th day of October, 1995, to the following terms and conditions to fully resolve all issues in the actions Public Service Co. of Colorado v. Batt, No. CV 91-0035-S-EJL (D. Id.) and United States v. Batt, No. CV-91-0054-S-EJL (D. Id.):

A. DEFINITIONS

For purposes of this Agreement, the following definitions shall apply:

1. The "State" shall mean the State of Idaho and shall include the Governor of the State of Idaho and the Idaho State Attorney General.

2. The "federal parties" means U.S. Department of Energy (DOE) and the U.S. Department of the Navy (the Navy), including any successor agencies.

3. "Treat" shall be defined, as applied to a waste or spent fuel, as any method, technique, or process designed change the physical or chemical character of the waste or fuel to render it less hazardous; safer to transport, store, dispose of; or reduce in volume.

4. "Transuranic waste" shall be defined as set forth in the EIS, Volume 2, Appendix E.

5. "One shipment of spent fuel" shall be defined as the transporting of a single shipping container of spent fuel.

6. "High-level waste" shall be defined as set forth in the EIS, Volume 2, Appendix E.

7. "DOE spent fuel" shall be defined as any spent fuel which DOE has the responsibility for managing with the exception of naval spent fuel and commercial spent fuel which DOE has accepted or will take title to pursuant to the Nuclear Waste Policy Act of 1982, 42 U.S.C. ' 10101 et seq. or comparable statute.

8. "Naval spent fuel" shall be defined as any spent fuel removed from naval reactors as a result of refueling overhauls (refueling) or defueling inactivations (defueling).

9. "Metric ton of spent fuel" shall be defined as a metric ton of heavy metal of spent fuel.

10. "Naval reactors" shall be defined as nuclear reactors used aboard naval warships (submarines, aircraft carriers, or cruisers), naval research or

training vessels, or at land-based naval prototype facilities operated by the Naval Nuclear Propulsion Program for the purposes of research, development, or training.

11. "Calendar year" shall be defined as the year beginning on January 1, and ending on December 31.

12. "Mixed Waste" shall be defined as set forth in the EIS, Volume 2, Appendix E.

13. "EIS" shall be defined as the Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Program Final Environmental Impact Statement issued April, 1995.

14. "ROD" shall be defined as the Record of Decision issued by DOE on June 1, 1995, concerning the EIS.

15. "INEL" shall be defined as the Idaho National Engineering Laboratory.

16. "Running Average" shall mean the total number of shipments of naval spent fuel to INEL, or transuranic waste from INEL, over any period' of three years, divided by three.

17. "The Court" shall mean the United States District Court for the District of Idaho before which is pending Public Service Company of Colorado v. Batt, No. CV 91-0035-S-EJL and United States v. Batt, No. CV 91-0054-S-EJL, and any appellate court to which an appeal may be taken, or with which an application for a writ of certiorari may be filed, under applicable law.

B. TRANSURANIC WASTE SHIPMENTS LEAVING IDAHO

1. "DOE shall ship all transuranic waste now located at INEL, currently estimated at 65,000 cubic-meters in volume, to the Waste Isolation Pilot Plant (WIPP) or other such facility designated by DOE, by a target date of December 31, 2015, and in no event later than December 31, 2018. DOE shall meet the following interim deadlines:

a. The first shipments of transuranic waste from INEL to WIPP or other such facility designated by DOE shall begin by April 30, 1999.

b. By December 31, 2002, no fewer than 3,100 cubic meters (15,000 drum-equivalents) of transuranic waste shall have been shipped out of the State of Idaho.

c. After January 1, 2003, a running average of no fewer than 2,000 cubic meters per year shall be shipped out of the State of Idaho.

2. The sole remedy for failure by DOE to meet any of these deadlines or requirements shall be the suspension of DOE spent fuel shipments to INEL as set forth in Section K.1.

C. SPENT FUEL & HIGH-LEVEL WASTE SHIPMENTS LEAVING IDAHO

1. DOE shall remove all spent fuel, including naval spent fuel and Three Mile Island spent fuel from Idaho by January 1, 2035. Spent fuel being maintained for purposes of testing shall be excepted from removal, subject to the limitations of Section F.1 of this Agreement.

2. Until all of the aluminum-clad spent fuel then stored at INEL has been shipped to the Savannah River Site, the cumulative number of shipments of spent fuel from the Savannah River Site to INEL under Section D as of the end of any calendar year shall not exceed the cumulative number of shipments of aluminum-clad spent fuel from INEL to the Savannah River Site for the same period.

3. DOE shall treat all high-level waste currently at INEL so that it is ready to be moved out of Idaho for disposal by a target date of 2035.

D. SHIPMENTS OF SPENT FUEL TO INEL

The federal parties may transport shipments of spent fuel to INEL only in accordance with the following terms and conditions.

1. Shipments of naval spent fuel to INEL shall take place as follows:

a. The Navy may make only those shipments of naval spent fuel to INEL that are necessary to meet national security requirements to defuel or refuel nuclear powered submarines, surface warships, or naval prototype or training reactors, or to ensure examination of naval spent fuel from these sources. The Secretary of Defense, upon notice to the Governor of the State of Idaho, shall certify the total number of such shipments of naval spent fuel required to be made through the year 2035.

b. The Navy shall not ship more than twenty four (24) shipments to INEL from the date of this Agreement through the end of 1995, no more than thirty six (36) shipments in 1996, and no more than twenty (20) shipments per year in calendar years 1997 through 2000. From calendar year 2001 through 2035, the Navy may ship a running average of no more than twenty (20) shipments per year to INEL. The total number of shipments of naval spent fuel to INEL through 2035 shall not exceed 575. Shipments of naval spent fuel to INEL through 2035 shall not exceed 55 metric tons of spent fuel.

c. Prior to January 1 of each calendar year through the year 2035, the Navy shall provide to Idaho an estimate of the number of shipments and the number of metric tons of naval spent fuel to be shipped during the following calendar year.

d. By January 31 of each calendar year, the Navy shall provide to Idaho the actual number of shipments and actual number of metric tons of naval spent fuel shipped during the preceding calendar year.

e. The naval spent fuel stored at INEL on the date of the opening of a permanent repository or interim storage facility shall be among the early shipments of spent fuel to the first permanent repository or interim storage facility.

f. The sole remedy for the Navy's failure to meet any of the deadlines or requirements set forth in this section shall be suspension of naval spent fuel shipments to INEL as set forth in Section K.1.

2. Shipments of DOE spent fuel to INEL shall take place-as follows:

a. If DOE and the U.S. Department of State adopt a policy to accept spent fuel from foreign research reactors into the United States, DOE may send to INEL a maximum of 61 shipments of spent fuel from foreign research reactors during the period beginning on the date such a policy is adopted and ending on December 31, 2000. The Secretary of Energy, upon notice to the Governor of the State of Idaho, must certify that these shipments are necessary to meet national security and nonproliferation requirements. Upon such certification, DOE may ship not more than 10 such shipments from the date such policy is adopted through December 31, 1996, not more than 20 such shipments from the date the policy is adopted through December 31, 1997, and not more than 40 such shipments from the date the policy is adopted through December 31, 1998.

b. Until such time as a permanent repository or interim storage facility for storage or disposal of spent fuel, located outside of Idaho, is operating and accepting shipments of spent fuel from INEL, DOE shall be limited to shipments of spent fuel to INEL as set forth in Sections D.2.a., c., d., e., and f. After a permanent repository or interim storage facility is operating and accepting shipments of spent fuel from INEL, the State of Idaho and DOE may negotiate and reach agreement concerning the timing and number of shipments of DOE spent fuel that may be sent to INEL, in addition to those otherwise permitted under this Section D.2., for preparation for storage or disposal outside the State of Idaho.

c. After December 31, 2000, DOE may transport shipments of spent fuel to INEL constituting a total of no more than 55 metric tons of DOE spent fuel (equivalent to approximately 497 truck shipments) and subject to the limitations set forth in Sections D.2.e., f., g., and h. below, except that the limitations of Section-D:2.a. above will not apply.

d. No shipments of spent fuel shall be made to INEL from Fort St. Vrain, unless a permanent repository or interim storage facility for spent fuel located outside of Idaho has opened and is accepting spent fuel from INEL, in which case such shipments may be made for the purpose of treating spent fuel to make it suitable for disposal or storage in such a repository or facility. Shipments of spent fuel from Fort St. Vrain shall remain at INEL only for a period of time sufficient to allow treatment for disposal or storage in such a repository or facility. The total number of Fort St. Vrain shipments shall not exceed 244, constituting no more than sixteen (16) metric tons of spent fuel, and shall be in addition to those allowed under Section D 2.c. above.

e. Except as set forth in Section D.2.d. above, DOE will make no shipments of spent fuel from commercial nuclear power plants to INEL.

f. After December 31, 2000, and until an interim storage facility or permanent repository is opened and accepting spent fuel from INERT, DOE shall not ship to INEL more than 20 truck shipments of spent fuel in any calendar year, except that:

(i) In one calendar year only, DOE may make not more than 83 truck shipments of spent fuel to INEL from the West Valley Demonstration Project;

(ii) DOE may not make more than 13 truck shipments in any of the nine calendar years succeeding the shipment of the West Valley Demonstration Project spent fuel to INEL; and

(iii) Shipments DOE is entitled to make to INEL in any calendar year, but has not made, may be shipped in any subsequent calendar year, notwithstanding the limitations in this Section D.2.f. on the number of shipments per year.

For purposes of this section and Section D.2.c., in determining the number of truck shipments, one rail shipment shall be deemed equivalent to 10 truck shipments, except that in the case of shipments from West Valley Demonstration Project, seven rail shipments shall be deemed to be equal to 83 truck shipments. DOE may elect to make rail shipments in lieu of truck shipments, in accordance with this conversion formula and subject to other limitations of this section.

g. Prior to January 1 of each calendar year through the year 2035, DOE shall provide to Idaho an estimate of the number of shipments and the number of metric tons of DOE spent fuel to be shipped during the following calendar year.

h. No later than January 31st of each calendar year, DOE shall provide to Idaho the actual number of shipments and actual number of metric tons of DOE spent fuel shipped during the preceding year.

i. The sole remedy for DOE’s failure to meet any of the deadlines or requirements set forth in this section shall be the suspension of DOE spent

fuel shipments to INEL as set-forth in Section K.1.

E. TREATMENT & TRANSFER OF EXISTING WASTES AT INEL

1. Treatment Commitment. DOE agrees to treat spent fuel, high-level waste, and transuranic wastes in Idaho requiring treatment so as to permit ultimate disposal outside the State of Idaho.

2. Mixed Waste Treatment Facility. DOE shall, as soon as practicable, commence the procurement of a treatment facility ("Facility") at INEL for the treatment of mixed waste, transuranic waste and alpha-emitting mixed low-level waste ("Treatable Waste"). DOE shall execute a procurement contract for the Facility by June 1, 1997, complete construction of the Facility by December 31, 2002, and commence operation of the Facility by March 31, 2003. Commencement of construction is contingent upon Idaho approving necessary permits.

a. Treatment of Non-INEL Wastes. Any and all Treatable Waste shipped into the State of Idaho for treatment at the Facility shall be treated within six months of receipt at the Facility, with the exception of two cubic meters of low-level mixed waste from the Mare Island Naval Shipyard which will complete base closure for nuclear work in 1996. DOE may request an exception to the six month time period on a case-by-case basis, considering factors at the shipping site such as health and safety concerns, insufficient permitted storage capacity, and base or site closures. Any transuranic waste received from another site for treatment at the INEL shall be shipped outside of Idaho for storage or disposal within six months following treatment. DOE shall continue to use the Federal Facility Compliance Act process, as facilitated by the National Governors' Association, to determine what locations are suitable for mixed low-level waste treatment and storage.

3. Operation of High-Level waste Evaporator. DOE shall commence operation of the high-level waste evaporator by October 31, 1996; and operate the evaporator in such a manner as to reduce the tank farm liquid waste volume by no fewer than 330,000 gallons by December 31, 1997. Efforts will continue to reduce the remaining volume of the tank farm liquid waste by operation of the high-level waste evaporator.

4. Calcination of Remaining Non-Sodium Bearing Liquid Wastes. DOE shall complete the process of calcining all the remaining non-sodium bearing liquid high-level wastes currently located at INEL by June 30, 1998.

5. Calcination of Sodium-Bearing Wastes. DOE shall commence calcination of sodium-bearing liquid high-level wastes by June 1, 2001. DOE shall complete calcination of sodium-bearing liquid high-level wastes by December 31, 2012.

6. Treatment of Calcined Wastes. DOE shall accelerate efforts to evaluate alternatives for the treatment of calcined waste so as to put it into a form suitable for transport to a permanent repository or interim storage facility outside Idaho. To support this effort, DOE shall solicit proposals for feasibility studies by July 1, 1997. By December 31, 1999, DOE shall commence negotiating a plan and schedule with the State of Idaho for calcined waste treatment. The plan and schedule shall provide for completion of the treatment of all calcined waste located at INEL by a date established by the Record of Decision for the Environmental Impact Statement that analyzes the alternatives for treatment of such waste. Such Record of Decision shall be issued not later than December 31, 2009. It is presently contemplated by DOE that the plan and schedule shall provide for the completion of the treatment of all calcined waste located at INEL by a target date of December 31, 2035. The State expressly reserves its right to seek appropriate relief from the Court in the event that the date established in the Record of Decision for the Environmental Impact Statement that analyzes the alternatives for treatment of such waste is significantly later than DOE’s target date. In support of the effort to treat such waste, DOE shall submit to the State of Idaho its application for a RCRA (or statutory equivalent) Part B permit by December 1, 2012.

7. Transfer of Three Mile Island Fuel. DOE shall complete construction of the Three Mile Island dry storage facility by December 31, 1998. DOE shall commence moving fuel into the facility by March 31, 1999, and shall complete moving fuel into the facility by June 1, 2001.

8. Transfer out of Wet Storage. By December 31, 1999, DOE shall commence negotiating a schedule with the State of Idaho for the transfer of all spent fuel at INEL out of wet storage facilities. DOE shall complete the transfer of all spent fuel from wet storage facilities at INEL by December 31, 2023. If DOE determines that transfer to dry storage of any portion of such spent fuel is technically infeasible, or that transfer to such dry storage presents significantly greater safety or environmental risks than keeping the fuel in wet storage, DOE shall inform the State and propose a later date or alternative action. If the State does not agree to such later date or alternative action, DOE may apply to the Court for appropriate relief. DOE shall, after consultation with the State of Idaho, determine the location of the-dry storage facilities within INEL, which shall, to the extent technically feasible, be at a point removed from above the Snake River Plain Aquifer ("Aquifer").

9. The sole remedy for DOE's failure to meet any of the deadlines or requirements set forth in this section shall be the suspension of DOE spent fuel shipment to INEL as set forth in Section K.1.

F. SPENT FUEL PROGRAM

1. Establishment of INEL as DOE Spent Fuel Lead Laboratory. DOE shall, within thirty days of entry of this Agreement as a court order, designate INEL as the Department's lead laboratory for spent fuel. DOE shall direct the research, development and testing of treatment, shipment and disposal technologies for all DOE spent fuel, and all such DOE activities shall be coordinated and integrated under the direction of the Manager, DOE-Idaho Operations Office. Such designation shall not permit the shipment to INEL of any spent fuel beyond that permitted by this Agreement with the exception that quantities of spent fuel brought to INEL for testing in excess of those permitted by this Agreement shall leave the State of Idaho within five years of the date of receipt at INEL.

2. Construction of Dry Storage. DOE shall include in its appropriation request for federal fiscal year 1998 to the Executive Office of the President funds necessary for DOE to initiate the procurement of dry storage at INEL to replace wet, below ground facilities. Spent fuel loading into dry storage shall commence by July 1, 2003.

3. Funding for Dry Cell Expansion Project. The Naval Nuclear Propulsion Program shall include in its appropriation request to the Executive Office of the President for federal fiscal year 1997 funds necessary for the Dry Cell Expansion Project ("Project") at the Expended Core Facility at the Naval Reactors Facility to accommodate removal of excess material and examination of naval spent fuel in a dry condition. The Project shall commence as soon as Idaho issues the required permit under the Clean Air Act and funding is appropriated. Completion of this project shall result in the expenditure of approximately $26 million dollars over the next five years.

4. Multi-Purpose Canisters. DOE and the Navy shall employ Multi-Purpose Canisters ("MPCs") or comparable systems to prepare spent fuel located at INEL for shipment and ultimate disposal of such fuel outside Idaho. Procurement shall be performed in accordance with the Federal Acquisition Regulation which ensures that companies in Idaho will have opportunity to bid on and obtain any competitive contracts for such work. The Record of Decision on the NEPA analysis shall be completed by April 30, 1999.

5. ECF Hot Cell Facility Upgrade. The Naval Nuclear Propulsion Program shall include in its appropriation request for federal fiscal year 1997 to the Executive Office of the President funds necessary to proceed with upgrades which shall require approximately $12 million of expenditures during the next three years.

6. ECF Dry Storage Container Loading Station. The Naval Nuclear Propulsion Program shall include in its appropriation request for federal fiscal year 1997 to the Executive Office of the President funds necessary to proceed with design and construction of a dry storage container loading station at ECF. This project shall require no less than $20 million of expenditures during the next five years.

7. Funding for Discretionary Environmental Remediation Work at the Naval Reactors Facility. The Naval Nuclear Propulsion Program shall undertake environmental remediation efforts at the Naval Reactors Facility totaling approximately $45 million over the next five years.

8. Water Pool Reracking. DOE may proceed with installing new racks into the water pool in the building at the Idaho Chemical Processing Plant Facility currently holding naval spent fuel to provide enhanced capability for spent fuel storage in the existing water pool space until dry storage can be made available. Installation of the new racks may commence as soon as Idaho issues the necessary permit under the Clean Air Act. Idaho shall issue said permit within 180 days after DOE re-submits its application to Idaho.

G. INEL ENVIRONMENTAL RESTORATION PROGRAM

1. INEL Environmental Restoration Program to Continue. DOE shall continue to implement the INEL environmental restoration program in coordination with Idaho and EPA. Such implementation shall be consistent with the schedules contained in the Federal Facilities Agreement and Consent Order (FFA/CO) entered into with the State of Idaho, EPA and DOE, and it shall include schedule requirements developed pursuant to the completed and future Records of Decision under the FFA/CO. The sole remedies for failure to implement the environmental restoration activities specified in the FFA/CO shall be those specified in the FFA/CO.

H. OBTAINING TIMELY FEDERAL FUNDING FOR COMPLIANCE WITH THIS ORDER

1. Compliance Funding. DOE and the Naval Nuclear Propulsion Program shall share budget information concerning INEL with Idaho prior to submitting the budget request to the Executive Office of the President. Consultations with the State of Idaho shall continue throughout the budget process. The current DOE estimate for the costs of the activities and projects described in Sections A through G over the next five years is approximately $200 million above established budget targets.

I. FEDERAL FINDS FOR THIS SETTLEMENT AGREEMENT

1. DOE shall provide to the State of Idaho beginning in federal fiscal year 1996 and continuing through 1997-2000, a total amount of $30 million for community transition purposes and any other purposes that are mutually acceptable to the parties, such as the non-Federal development of Boron Neutron Capture Therapy and Radiological Toxicology technology in Idaho.

2. Acoustic Research Funding. The Navy shall include in its appropriation request to the Executive Office of the President for federal fiscal year 1997 no less than $7 million for the Navy to construct a Ships Model Engineering and Support Facility at the Naval Surface Warfare Center, Carderock Division, Acoustic Research Detachment at Bayview, Idaho.

J. GOOD FAITH COMPLIANCE & AFFIRMATIVE SUPPORT

1. The federal parties and Idaho agree that the activities to be performed under this Agreement and the subsequent Consent Order are in the public interest. The federal parties and Idaho acknowledge the complexity of this Agreement and have agreed to act in good faith to effectuate its fulfillment. The federal parties and Idaho shall affirmatively support this Agreement and its terms, conditions, rights and obligations in any administrative or judicial proceeding. The federal parties and Idaho intend to seek a sense of the Congress resolution expressing support for the terms, conditions, rights and obligations contained in this Agreement- and the subsequent Consent Order and recommending to future Congresses

that funds requested by the President to carry out this Agreement be appropriated. In any administrative or judicial proceeding, Idaho shall support the adequacy of the EIS and ROD against any challenges by third parties. Idaho shall have the ability, in its sole discretion, to waive performance by the federal parties of any terms, conditions and obligations contained in this Agreement.

2. Idaho shall promptly issue, upon submission of legally sufficient applications, all permits, licenses or other approvals needed by the DOE, the Navy or the Naval Nuclear Propulsion Program for the performance of any of their respective obligations set forth in this Agreement.

3. No provision of this Agreement shall compel any party to act without due legal authority. Performance by every party under this Agreement shall be subject to and comply with all applicable federal statutes, regulations and orders, including the Anti-Deficiency Act. The inability of any party to comply with the provisions of this Agreement, or a delay in such compliance, as a result of any applicable federal statute, regulation or order shall not subject that party to judicial enforcement under Section K.2.a, but shall not preclude the application of Sections K.1.a. or K.1.b.

4. In the event any required NEPA analysis results in the selection after October 16, 1995, of an action which conflicts with any action identified in this Agreement, DOE or the Navy may request a modification of this Agreement to conform the action in the Agreement to that selected action. Approval of such modification shall not be unreasonably withheld. If the State refuses to accept the requested modification, DOE or the Navy may seek relief from the Court. On motion of any party, the Court may extend the time for W E or the Navy to perform until the Court has decided whether to grant relief. If the Court determines that the State has unreasonably withheld approval, the Agreement shall be conformed to the selected action. If the Court determines that the State has reasonably withheld approval, the time for DOE or the Navy to perform the action at issue shall be as set forth in this Agreement and subject to enforcement as set forth section in Section K.1.

5. Effect of Certain Court Orders.

a. Navy. In the event that a court order is entered in the case of Snake River Alliance Education Fund v. United States Department of Energy, No. CV-95-0331-S-EJL (D. Idaho), or in any other judicial proceeding, that prohibits in whole or in part any shipment of spent fuel to INEL by the Navy under section D, then all obligations, requirements and deadlines of the federal parties under this Agreement shall be suspended during the period of applicability of the order. Upon the vacating, dissolving or reversing of any such order, the obligations, deadlines and requirements provided for in this Agreement shall be extended by a period that corresponds to their period of suspension.

b. DOE. In the event that a court order is entered in the case of Snake River Alliance Education Fund v. United States Department of Energy, No. CV-95-0331-S-EJL (D. Idaho), or in any other judicial proceeding, that prohibits in whole or in part any shipment of spent fuel to INEL by DOE under section D, then the DOE has the option to suspend all DOE shipments to INEL and suspend all of DOE's obligations, requirements and deadlines under this Agreement during the period of applicability of the order. If DOE exercises this option, then upon the vacating, dissolving, or reversing of any such order, DOE's obligations, deadlines and requirements provided for in this Agreement shall be extended by a period that corresponds to their period of suspension.

K. ENFORCEMENT

1. Succession of Shipments.

a. DOE. If DOE fails to satisfy the substantive obligations or requirements it has agreed to in this Agreement or fails to meet deadlines for satisfying such substantive obligations or requirements, shipments of DOE spent fuel to INEL shall be suspended unless and until the parties agree or the Court determines that such substantive obligations or requirements have been satisfied. .

b. Navy. If the Navy or the Naval Nuclear Propulsion Program fails to satisfy the substantive obligations or requirements it has agreed to in this Agreement or fails to meet deadlines for satisfying such substantive obligations or requirements, shipments of Navy spent fuel to INEL shall be suspended unless and until the parties agree or the Court determines that such substantive obligations or requirements have been satisfied.

2. Other Enforcement

a. Judicial Enforcement. The Court may enforce the rights, obligations and requirements assigned by this Agreement, other than those exclusively enforceable under Section K.1., pursuant to all legal and equitable remedies available to the courts of the United States, including, but not limited to, use of the Court's contempt powers.

b. RCRA Enforcement. Nothing in this Agreement shall prohibit the State of Idaho from requiring necessary remedial actions as set forth in the Resource Conservation and Recovery Act, 42 U.S.C. section 6929 ("RCRA") (or statutory equivalent), including penalty and fine procedures, the sums of which shall be payable to the State of Idaho.

c. Payment Obligation. In the event that the federal parties do not carry out the requirement that all spent fuel located at INEL be removed from Idaho by January 1, 2035, then subject to the availability of the appropriations provided in advance for this purpose, the federal parties shall pay to the State of Idaho $60,000 for each day such requirement has not been met.

3. Prior Orders, Agreements end Decisions. The terms of this Agreement shall supersede all rights, duties and obligations set forth in any prior orders, agreements or decisions entered in this litigation, captioned Public Service Company of Colorado v. Batt, and United States of America v.

Batt, Nos. CV 91-0035-S-EJL and CV 91-0054-S-EJL, except for the provisions of paragraph 4 of the December 22, 1993 Court Order.

4. Dispute Resolution. In the event that any party to this Agreement contends that any other party has violated any terms of the Agreement, the parties shall seek to resolve their differences informally before asking for resolution by the Court.

L. CONSENT ORDER

1. The parties agree they shall jointly present this Agreement to the U.S. District Court with a proposed Consent Order which will provide for the incorporation of this Agreement, continuing jurisdiction of the Court and the administrative termination of this action without prejudice to the right of the parties to reopen the proceedings for good cause shown. This Agreement and Consent Order shall not preclude any party from applying to the Court under Rule 60, of the Federal Rules of Civil Procedure, or the Court from granting relief thereunder.

2. If the Consent Order is not entered by the Court, in accordance with Section L.1 above, within 45 days of lodging with the Court, then either party to this Agreement may elect to terminate this Agreement, in which case this Agreement becomes null and void, and of no force or effect.

For the Federal Parties:

/s/ /s/

Robert R Nordhaus Thomas P. Grumbly

General Counsel Assistant Secretary

Department of Energy for Environmental Management

Department of Energy

/s/ /s/

Steven S Honigman Admiral Bruce DeMars

General Counsel Director, Naval Nuclear

Department of the Navy Propulsion Program

For the State of Idaho

/s/ /s/

Philip E Batt Alan G Lance

Governor, State Attorney General,

State of Idaho State of Idaho

APPENDIX D

GLOSSARY

Terms in this glossary are defined based on the context in which they are used in this EIS.

100-year flood A flood event of such magnitude it occurs, on average, every 100 years (equates to a 1 percent probability of occurring in any given year).

500-year flood A flood event of such magnitude it occurs, on average, every 500 years (equates to a 0.2 percent probability of occurring in any given year).

abnormal condition Any deviation from normal conditions.

absorbed dose The energy imparted by ionizing radiation per unit mass of irradiated material. The unit of absorbed dose is the rad and the gray.

accelerator produced radioactive material Radioactive material that was produced in a charged particle accelerator.

acceptable ambient concentration for a carcinogen (AACC) Ambient air quality standards based on the probability of developing excess cancers over a 70-year lifetime exposure to one microgram per cubic meter (1 mg/m^3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant.

acceptable ambient concentration for a noncarcinogen (AAC) Ambient air quality standards based on occupational exposure limits for airborne toxic chemicals expressed in terms of a screening emission level or an acceptable ambient concentration for a noncarcinogenic toxic air pollutant.

accident An unplanned sequence of events that results in undesirable consequences.

actinide Any of a series of chemically similar, mostly synthetic, radioactive elements with atomic numbers ranging from actinium-89 through lawrencium-103.

acute exposure The absorption of a relatively large amount of hazardous material (or intake of hazardous material) over a short period of time.

adsorption The attraction and adhesion of ions or molecules in a gaseous or aqueous state to a solid surface.

air pollutant Any substance including, but not limited to, dust, fumes, gas, mist, odor, smoke, vapor, pollen, soot, carbon, or particulate matter that is regulated.

air quality The general condition of the air resources, usually expressed in terms of attainment of ambient air quality standards.

air quality concentration The specific measurement (or estimate) in the ambient air of a particular air pollutant at any given time.

air quality criteria Regulatory limits of air pollutants in ambient air designated by the varying amounts of pollution and lengths of exposure designed to limit the potential for specific adverse effects to health and welfare (see air quality standard).

air quality standard The prescribed level of a pollutant in the outside air that cannot be exceeded during a

specified time in a specified geographical area. Established by both Federal and State governments (see air quality criteria).

alluvium Sedimentary material deposited by flowing water, as in a river bed or delta.

alpha-emitter A radioactive substance that decays by releasing an alpha particle.

alpha low-level mixed waste (alpha LLMW) Low-level mixed waste containing, at the time of assay, concentrations of at least 10 but less than 100 nCi/g of waste of alpha-emitting radionuclides with an atomic number greater than 92 and half-lives greater than 20 years. The term "mixed" cannotes waste containing both radioactive and hazardous constituents as defined by the *Atomic Energy Act* and the *Resource Conservation and Recovery Act* (RCRA) respectively.

alpha-particle A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus that has a mass number of 4 and an electrostatic charge of +2.

ambient air That portion of the atmosphere outside of buildings to which the general public has access.

applicable or relevant and appropriate requirements Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances as specified under Federal and State law and regulations, that must be met when complying with the *Comprehensive Environmental Response, Compensation, and Liability Act* of 1980 (CERCLA).

aquifer A body of rock or sediment sufficiently permeable to conduct groundwater and to yield significant quantities of water to wells and springs.

as low as reasonably achievable (ALARA) A process by which a graded approach is applied to maintaining dose levels to workers and the public and releases of radioactive materials to the environment as low as reasonably achievable.

attainment area Any area which is designated, pursuant to 42 U.S.C. Section 7407(d) of the *Clean Air Act*, as having ambient concentrations equal to or less than national primary or secondary ambient air quality standards for a particular air pollutant or air pollutants.

atomic number The number of positively charged protons in the nucleus of an atom and the number of electrons on an electrically neutral atom.

background level The value assigned to the quantity of particulate or gaseous material in ambient air which originates from natural sources uninfluenced by the activity of man.

background radiation Radiation from cosmic sources, naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

basalt A general term for dark-colored, fine-grained igneous rock. Commonly extrusive and composed primarily of calcic plagioclase and pyroxene minerals.

baseline A quantitative expression of conditions, costs, schedule, or technical progress to serve as a base or standard for measurement; the established plan against which the status of resources and the progress of a program can be measured.

below regulatory concern A definable amount of low-level waste that is sufficiently small that it can be deregulated with minimal risk to the public.

best available control technology (BACT) An emission standard (including fuel cleaning or treatment or

innovative fuel combination techniques) for control of such contaminants. BACT shall be determined on a case-by-case basis, taking into account energy, environmental and economic impacts, and other costs, and shall be at least as stringent as any applicable Sections of 40 CFR Part 60 and 40 CFR Part 61. If an emissions standard is infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed as BACT.

beta-emitter A radioactive substance that decays by releasing a beta particle.

beta-particle A charged particle emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron.

beyond design basis accidents Accidents of the same type as a distinct design basis accident (fire, earthquake, and so forth) but defined by parameters that exceed in severity the parameters defined for the distinct design basis accident.

bound To estimate or describe an upper limit on a potential environmental consequence when uncertainty exists.

bounding That which represents the maximum reasonably foreseeable event or impact. All other reasonably foreseeable events or impacts would have fewer and/or less severe environmental consequences.

buffer zone An area designed to separate. Specifically, the portion of a disposal site that is controlled by the licensee and that lies under and between the disposal units and the boundary of the site.

by-product material (a) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (b) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content [*Atomic Energy Act* 11(e)]. By-product material is exempt from regulation under RCRA.

certification plan See waste certification plan.

certified waste Waste that has been confirmed to comply with the waste acceptance criteria of the treatment, storage, or disposal facility for which it is intended under an approved waste certification program.

certifying authority or official An organization or person outside the waste generator line organization who is responsible for certifying that the waste being sent to a treatment, storage, or disposal facility meets the requirements of the receiving facility's waste acceptance criteria.

characterization The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transportation, and disposal requirements.

chronic exposure The absorption of hazardous material (or intake of hazardous materials) over a long period of time (for example, over a lifetime).

Class I area Under the *Clean Air Act*, any Federal land that is classified or reclassified "Class I." The designation applies to pristine areas, such as national parks and wilderness areas, where substantial growth is effectively precluded in order to avoid any degradation of the air quality.

clean waste Waste products that are neither radioactive nor hazardous but require appropriate disposal in a solid waste landfill.

closure Deactivation, stabilization, and surveillance of a waste management unit, landfill, or other facility. Closure often refers to the process under RCRA involving the preparation and signing of a Closure Plan.

collective dose The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation. The units of collective dose are person-rem.

collective effective dose equivalent The collective dose is the sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

co-located workers Workers in a fixed population outside the day-to-day process safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located some distance from the reference facility area.

commercial waste management facility A facility located off U.S. Department of Energy (DOE) controlled property that is not managed by DOE to which DOE sends waste for treatment, storage, and/or disposal.

committed dose equivalent (H_{50}) The dose equivalent to organs or tissues of reference that will be received from an intake of radioactive material by an individual during the 50-year period following the intake. The International Commission on Radiological Protection defines this as the committed equivalent dose.

committed effective dose See committed effective dose equivalent.

committed effective dose equivalent (CEDE) ($H_{E,50}$) The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues. The International Commission on Radiological Protection defines this as the committed effective dose.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) A Federal law (also known as "Superfund") that provides a comprehensive framework to deal with past or abandoned hazardous materials. CERCLA provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment that could endanger public health, welfare, or the environment, as well as the cleanup of inactive hazardous waste disposal sites. CERCLA has jurisdiction over any release or threatened release of any "hazardous substance" to the environment. Under CERCLA, the definition of "hazardous" is much broader than under RCRA, and the hazardous substance need not be a waste. If a site meets the CERCLA requirements for designation, it is ranked along with other "Superfund" sites and listed on the National Priorities List. This ranking and listing is the Environmental Protection Agency's (EPA) way of determining which sites have the highest priority for cleanup.

committed equivalent dose See committed dose equivalent.

confinement General control of contaminants through engineering design, such as heating and ventilation systems that use high-efficiency particulate air filters to remove contaminants before discharge to the atmosphere. Such systems may break down or experience a loss of electric power that would "lose confinement" temporarily. This may require evacuation of the structure but would not lead to significant consequences to workers or a significant release.

contact-handled waste Packaged waste whose external surface dose rate does not exceed 200 millirem per hour.

containerization The process of placing radioactive or other hazardous material in a confining receptacle for storage or transport. For spent nuclear fuel, this is called canning.

containment The provision of a gastight shell or other enclosure around a reactor to confine fission products that otherwise might be released into the atmosphere in the event of an accident.

contamination The deposition of unwanted pollutants on the surfaces of structures, areas, objects, or personnel.

contingency plan A document setting out an organized, planned, and coordinated course of action to be followed in case of unanticipated events such as fire, explosion, or other events that may release toxic chemicals, hazardous wastes, or radioactive materials to threaten human health or the environment. The goal of the contingency plan is the

containment or mitigation of the impacts resulting from the event.

continuity of operations Activities that include developing strategic and long-range waste management plans, surveillance and maintenance of facilities and equipment, waste certification, proper training programs for personnel, and record/information administration.

control equipment Any method, process, or equipment which removes, reduces, or renders less noxious, pollutants discharged into the environment.

criteria air pollutant Under the *Clean Air Act* and the State of Idaho air quality regulations, any air pollutant for which there is a State or national ambient air quality standard.

cumulative impact The impact on the environment that results from incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impact can result from individually minor but collectively significant actions taking place over a period of time.

curie (Ci) The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

decay, radioactive The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation (see half-life; radioactivity).

decommissioning The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

decontamination The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

deep dose equivalent Applies to the whole body exposure and is the dose equivalent at a depth of 1 cm (1000 mg/cm^2).

defense waste Radioactive waste from any activity performed in whole or in part in support of the DOE atomic energy defense activities; excludes waste from DOE nondefense activities or waste under the purview of the U.S. Nuclear Regulatory Commission (NRC) or generated by the commercial nuclear power industry.

delta E A parameter used to define color shift in visual impact modeling. It is the primary basis for determining perceptibility of plume visual impact in screening analyses.

design basis accident Accidents that are postulated for the purpose of establishing functional requirements for safety-significant structures, systems, components, and equipment.

diffusion The process by which a pollutant plume is diluted by turbulent eddies.

discharge Under principles of hydrogeology, the amount of water passing through (or leaving) a given cross-sectional area in a given period of time. Under the *Clean Water Act*, discharge of a pollutant, which includes any addition of any pollutant or combination of pollutants to waters of the United States from any point source. This definition includes additions of pollutants into waters of the United States from surfaced runoff which is collected or channeled by man; discharges through pipes, sewers, or other conveyances owned by a State, municipality, or person which do not lead to a treatment works; and discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works.

dispersion In air pollution, the process of transport and diffusion of airborne contaminants in the atmosphere.

disposal Emplacement of waste in a manner that ensures protection of human health and the environment within prescribed limits for the foreseeable future with no intent of retrieval and that requires deliberate action to regain access to the waste.

disposal facility A facility or part of a facility at which hazardous waste is intentionally placed into or on any land or water and at which waste will remain after closure.

dissolution The ability of water to take a substance into solution.

DOE orders Requirements internal to the DOE that establish DOE policy and procedures, including those for compliance with applicable laws.

DOE site boundary A geographic boundary within which public access is controlled and activities are governed by the DOE and its contractors, not by local authorities. Based on the definition of exclusion zone, a public road traversing a DOE site is considered to be within the DOE site boundary if DOE or the site contractor has the capability to control the road at any time necessary.

dose (or radiation dose) A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined elsewhere in this glossary.

dose conversion factor Any factor that is used to change an amount or concentration of radioactivity to dose in the units of concern. Frequently used as the factor that expresses the committed effective dose equivalent to a person from the intake (inhalation or ingestion) of a unit activity of a given radionuclide.

dose equivalent The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The unit of dose equivalent is the rem. The International Commission on Radiological Protection defines this as the equivalent dose.

dose rate The radiation dose delivered per unit of time; measured, for example, in rem per hour.

dry storage Storage of spent nuclear fuel in environments where the fuel is not immersed in liquid for purposes of cooling and/or shielding.

earthquake magnitude A measure of earthquake size, determined by taking the common logarithm (base 10) of the largest ground motion recorded during the arrival of a seismic wave type and applying a standard correction for distance to the epicenter. Three common types of magnitude are Richter (or local) (M_L), P body wave (m_b), and surface wave (M_s).

effective dose See effective dose equivalent.

effective dose equivalent (EDE) The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that is irradiated. It includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem. The International Commission on Radiological Protection defines this as the effective dose.

effluent The wastewater, treated or untreated, that flows out of a facility. Generally, effluent is discharged into surface waters.

emission (air) Any controlled or uncontrolled release or discharge into the outdoor atmosphere of any air pollutants or combination thereof. Emission also includes any release or discharge of any air pollutant from a stack, vent, or other means into the outdoor atmosphere that originates from an emission unit.

emission standard A permit or regulatory requirement established by the Idaho Department of Health and Welfare, or U.S. EPA, which limits the quantity, rate, concentration of emissions, or impacts on a continuous basis, including any requirements which limit opacity, prescribe equipment, set fuel specifications, or prescribe operation or maintenance procedures to assure continuous emission control.

engineered barriers Manmade components of a waste management system or facility designed to prevent or impede the release of radionuclides or other waste material into the biosphere. This includes the waste form, radioactive waste containers, and other materials placed over and around such containers, and physical features of the system or facility.

environmental monitoring The process of sampling and analysis of environmental media in and around a facility being monitored for the purpose of (a) confirming compliance with performance objectives and (b) early detection of any contamination entering the environment to facilitate timely remedial action.

environmental restoration Cleanup and restoration of sites and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

environmental restoration program A DOE subprogram concerned with all aspects of assessment and cleanup of both contaminated facilities in use and of sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater, and decontamination and decommissioning are responsibilities of this program.

eolian Applied (a) to deposits arranged by the wind, (b) to the erosive action of the wind, and (c) to deposits that are due to the transporting action of the wind.

equivalent dose See dose equivalent.

existing facilities Facilities that are projected to exist as of the Record of Decision for this EIS.

exposure Being exposed to ionizing radiation or to hazardous material. Alternatively, a measure of the ionization produced in air by X or gamma radiation; the unit of exposure in air is the roentgen.

external accident Accidents initiated by manmade energy sources not associated with operation of a given facility. Examples include airplane crashes, induced fires, transportation accidents adjacent to a facility, and so forth.

external dose That portion of the dose equivalent received from radiation sources outside the body.

facility (a) Any building, structure, installation, equipment, pipe or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, or aircraft; or (b) any site or area where a hazardous substance has been deposited, stored, disposed of, placed, or otherwise come to be located.

facility area The area within the Idaho National Engineering and Environmental Laboratory (INEEL) boundary immediately surrounding a facility or group of facilities that functions under process safety management programs and a common emergency response plan. This definition covers any building within such an area regardless of whether it is dedicated to production, waste handling, or administrative issues; for example, an office building, a cafeteria, a production facility, a machine shop, and a waste handling facility all contained within a common boundary. If programs such as radiation protection, training, auditing, and evaluation are an integral part of safety management at each facility and emergency response plans cover the potential responses of individuals at all buildings, then the collection of buildings constitutes a facility area. All personnel in the area are facility workers, not co-located workers.

facility area boundary The geographic boundary of an area controlled on a daily basis by process safety management and a common emergency response plan.

facility security plan In the context of waste management, a security plan is one that provides the measures required by law, regulation, or good judgment for prevention of unknowing or unauthorized entry into a treatment, storage, or disposal facility; or operation of facility equipment and systems; or access to waste material or spent nuclear fuel.

facility worker Any worker whose day-to-day activities are controlled by process safety management programs and a common emergency response plan associated with a facility or facility area. This definition includes any individual within a facility/facility area or its 0.4-mile exclusion zone. This definition can also include those transient individuals or small populations outside the exclusion zone but inside the radius defined by the maximally exposed co-located worker if reasonable efforts to account for such people have been made in the facility or facility area emergency plan. For facility accident analyses, the facility worker is defined as an individual located 100 meters (328 feet) downwind of the facility location where an accidental release occurs.

feasibility study A step in the environmental restoration process specified by CERCLA. The objectives are to identify the alternatives for remediation and describe a remedial action that satisfies applicable or relevant appropriate requirements for mitigating confirmed environmental contamination. The feasibility study presents a series of specific engineering or construction alternatives for cleaning up a site; for each alternative presented, there will be a detailed analysis of the costs, effects, engineering feasibility, and environmental impacts. The feasibility study is based on information provided in the remedial investigation. Successful completion of a feasibility study should result in a decision (Record of Decision) selecting a remedial action alternative and the subsequent development of a remedial design for implementation of the selected remedial action.

Federal Facility Compliance Act (FFCA) Federal law signed in October 1992 amending RCRA. The objective of the FFCAct is to bring all Federal facilities into compliance with applicable Federal and State hazardous waste laws, to waive Federal sovereign immunity under those laws, and to allow the imposition of fines and penalties. The law also requires DOE to submit an inventory of all its mixed waste and to develop a treatment plan for mixed wastes.

Federal Facility Agreement and Consent Order A binding agreement, negotiated pursuant to Section 120 of CERCLA, signed by DOE, EPA Region X, and the State of Idaho, to coordinate cleanup activities at the INEEL. The Federal Facility Agreement and Consent Order and its Action Plan outline the remedial action process that will encompass all investigation of hazardous substance release sites. The Federal Facility Agreement and Consent Order superseded the Consent Order and Compliance Agreement.

Federal land manager The Secretary of the Federal department with authority over any Federal lands in the United States.

field offices An administrative division of the DOE that operates facilities that are in its jurisdiction.

fiscal year (FY) The time frame specified by any public or private entity to separate one year's financial (fiscal) activities from the next year's. The 1998 Federal Fiscal Year (FY 1998) began on October 1, 1997, and ended on September 30, 1998.

fissile material Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning; namely, any material fissionable by thermal (slow) neutrons. The three primarily fissile materials are uranium-233, uranium-235, and plutonium-239.

fission The splitting of a nucleus into at least two other nuclei and the release of a relatively large amount of energy. Two or three neutrons are usually released during this type of transformation.

fission products The nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by the fission fragments' radioactive decay.

fissionable material Commonly used as a synonym for fissile material, the meaning of this term has been extended to include material that can be fissioned by fast neutrons, such as uranium-238.

fluorides Gaseous or solid compounds containing fluorine emitted into the air from a number of industrial processes.

free liquid Liquid that is not absorbed into host material such that it could readily separate from the solid portion of a waste under ambient temperature and pressure and spill or drain from its container.

fugitive dust Dust that is stirred up and released into the atmosphere during construction activities. Fugitive emissions composed of particulate matter.

fugitive emissions Those emissions that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.

gamma-emitter A radioactive substance that decays by releasing gamma radiation.

gamma ray (gamma radiation) High-energy, short wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead or uranium. Gamma rays are similar to X-rays, but are usually more energetic.

generator (generation) Organizations of the DOE that produce waste.

geologic repository A system that is intended to be used for, or may be used for, the disposal of radioactive waste or spent nuclear fuel in excavated geologic media. A geologic repository includes (a) the geologic repository operations area, and (b) the portion of the geologic setting that provides isolation. A near-surface disposal area is not a geologic repository.

geothermal energy The energy available from natural sources of heat, such as hot springs and near-surface heat sources in volcanically active areas.

graded approach A process by which the level of analysis, documentation, and actions necessary to comply with a requirement are commensurate with (a) the relative importance to safety, safeguards, and security; (b) the magnitude of any hazard involved; (c) the life-cycle stage of a facility; (d) the programmatic mission of a facility; (e) the particular characteristics of a facility; and (f) any other relevant factor.

graphite fuel Fuel that consists of small pellets of highly enriched uranium (HEU)-carbide fuel surrounded by protective layers of other carbide compounds. These pellets are dispersed in much larger graphite structures for handling and neutron moderation.

greater-than-Class-C waste Low-level radioactive waste that exceeds NRC concentration limits specified in 10 CFR 61. The DOE is responsible for the disposal of greater-than-Class-C wastes from DOE nondefense programs.

groundwater Generally, all water contained in the ground. Water held below the water table available to freely enter wells.

grouting Grouting is the process of immobilizing or fixing solid forms of waste so they can be more safely stored or disposed.

half-life The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

hazard classification A safety classification based on potential onsite consequences. Criteria for this classification are discussed in DOE Order 5480.23 (Nuclear Safety Analysis Reports).

hazard index An indicator of the potential toxicological hazard from exposure to a particular substance. The hazard index is equal to an individual's estimated exposure divided by EPA's substance-specific reference dose.

hazardous air pollutant Any air pollutant subject to a standard promulgated under 42 U.S.C. Section 7412 or other requirements established under 42 U.S.C. Section 7412 of *the Clean Air Act*, including 42 U.S.C. Section 7412(g), (j), and (r) of the *Clean Air Act*.

hazardous chemical A term defined under the *Occupational Safety and Health Act* and the *Emergency Planning and Community Right to Know Act* as any chemical that is a physical hazard or a health hazard.

hazardous material A substance or material, including a hazardous substance, which has been determined by the U.S. Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

hazardous substance Any substance that when released to the environment in an uncontrolled or unpermitted fashion becomes subject to the reporting and possible response provisions of the *Clean Water Act* and CERCLA.

hazardous waste Under RCRA, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and byproduct material, as defined by the *Atomic Energy Act*, are specifically excluded from the definition of solid waste.

hazardous waste landfill A disposal facility or part of a facility where hazardous waste is placed in or on land and which is not a pile, a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, or a cave.

heavy metals Metallic elements with high atomic weights (for example, mercury, chromium, cadmium, arsenic, and lead) that can damage living things at low concentrations and tend to accumulate in the food chain.

heterogeneous Pertaining to a substance having different characteristics in different locations. A synonym is nonuniform.

high-efficiency particulate air (HEPA) filter A filter with an efficiency of at least 99.95 percent used to separate particles from air exhaust streams prior to releasing that air to the atmosphere.

high-level waste The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the NRC, consistent with existing law, determines by rule requires permanent isolation.

Holocene In the geological scale of time, the more recent of the two epochs of the Quaternary period (10,000 years ago to the present); that period of time since the last ice age.

hot cell/hot cell facility A heavily shielded enclosure for handling and processing (by remote means or automatically) or storing highly radioactive materials.

hydraulic conductivity Capacity of a porous media to transport water.

hydraulic gradient The slope of the water table per unit of distance, resulting in groundwater movement.

hydrogeochemistry The study of the chemical interactions between the earth's components, including rocks, minerals, and water.

hydrogeology The study of the geological factors relating to water.

hydrology The study of water, including groundwater, surface water, and rainfall.

infiltrate Water passing from the land surface through the vadose zone into the aquifer.

intermittent surface water A stream, creek, or river which does not contain water during part or all of the year.

inadvertent intrusion The inadvertent disturbance of a disposal facility or its immediate environment by a potential future occupant that could result in loss of containment of the waste or exposure of personnel. Inadvertent intrusion is a significant consideration that shall be included either in the design requirements or waste acceptance criteria of a waste disposal facility.

incineration The efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. Incineration of radioactive materials does not destroy the radionuclides but does significantly reduce the volume of these wastes.

industrial commercial waste Material that is not subject to RCRA Subtitle C or *Atomic Energy Act* regulation. It is generated by manufacturing or industrial processes. Industrial commercial waste is also known as solid waste and is regulated by RCRA, Subtitle D.

INEEL industrial waste Industrial commercial waste generated at the INEEL is categorized as INEEL industrial waste.

institutional control The control of waste management facilities by human institutions.

Interagency Agreement See Federal Facility Agreement and Consent Order.

interim status facility See RCRA interim status facility.

interim action (CERCLA) A remedial action undertaken to clean up or contain a potential threat to human health and the environment that can or should be addressed within a short timeframe. The study associated with an interim action may be completed within an "umbrella" remedial investigation/feasibility study. Interim actions are completed on an accelerated schedule and generally deal with well-defined contamination problems that present a significant, although not immediate, threat to human health and the environment.

interim action (NEPA) An action that may be undertaken while work on a required program environmental impact statement (EIS) is in progress and the action is not covered by an existing program statement. An interim action may not be undertaken unless such action: (a) is justified independently of the program; (b) is itself accompanied by an adequate EIS or has undergone other *National Environmental Policy Act* (NEPA) review; and (c) will not prejudice the ultimate decision on the program. Interim action prejudices the ultimate decision on the program when it tends to determine subsequent development or limit alternatives.

internal accidents Accidents that are initiated by man-made energy sources associated with the operation of a given facility. Examples include process explosions, fires, spills, criticalities, and so forth.

inversion In the atmosphere, a condition in which air temperature warms with increasing altitude.

isotope One of two or more atoms with the same number of protons, but different numbers of neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive) (see also radioisotope).

Kjeldahl nitrogen A method of nitrogen analysis designed to measure nitrogen present as part of organic compounds.

lacustrine Pertaining to, produced by, or formed in a lake or lakes; growing in or inhabiting lakes.

Land Disposal Restrictions (LDRs) A RCRA program that restricts land disposal of RCRA hazardous and RCRA mixed wastes and requires treatment to promulgated treatment standards. LDRs identify hazardous wastes that are restricted from land disposal and define those limited circumstances under which an otherwise prohibited waste may continue to be land disposed.

land-use planning A decisionmaking process to determine the future or end use of a parcel of land, considering such factors as current land use, public expectations, cultural considerations, local ecological factors, legal rights and obligations, technical capabilities, and costs.

lapse In the atmosphere, a condition in which air temperature cools with increasing altitude.

less-than-90-day storage The onsite accumulation and/or storage of hazardous waste for a period of less than 90 days by a generator subject to the requirements of 40 CFR 262.34(a).

life cycle The entire time period from generation to permanent disposal or elimination of waste.

liquid metal fast breeder reactor A reactor that operates using a type of fission known as fast fission where the neutrons that are used to split the atoms are not slowed down or moderated, as is usually the case with normal fission. It creates more fissionable material than it consumes and uses liquid metal as a coolant. Liquid sodium is a common metal used to cool this type of reactor.

listed waste Under RCRA, waste listed in 40 CFR 261, Subpart D, as hazardous. Listed hazardous wastes include wastes from specific sources, nonspecific sources, and discarded commercial chemical products. These wastes have not been subjected to the toxicity characterization leaching procedure because the dangers they present are considered self-evident.

loess A homogeneous deposit consisting predominantly of silt, with subordinate amounts of very fine sand and/or clay.

long-term storage The storage of hazardous waste (a) onsite (a generator site) for a period of 90 days or greater, other than in a satellite accumulation area, or (b) offsite in a properly managed treatment, storage, or disposal facility for any period of time.

low-level waste Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic elements is less than 100 nanocuries per gram of waste.

mafic Pertaining to or composed predominantly of the magnesian rock-forming silicates; said of some igneous rocks and their constituent minerals; synonymous with "dark minerals. "

major radionuclides The radioisotopes that together comprise 95 percent of the total curie content of a waste package by volume and have a half-life of at least 1 week. Radionuclides that are important to a facility's radiological performance assessment and/or a safety analysis and are listed in the facility's waste acceptance criteria are considered major radionuclides.

management (of spent nuclear fuel) Emplacing, operating, and administering facilities, transportation systems, and procedures to ensure safe and environmentally responsible handling and storage of spent nuclear fuel pending (and in anticipation of) a decision on ultimate disposition.

maximally exposed individual (MEI) A hypothetical individual defined to allow dose or dosage comparison with numerical criteria for the public. This individual is located at the point on the DOE site boundary nearest to the facility in question. Sometimes called maximally exposed offsite individual.

maximally exposed offsite individual A hypothetical individual defined to allow dose or dosage comparison with numerical criteria for the public. This individual is located at the point on the DOE site boundary nearest to the facility in question. Sometimes called the MEI.

maximum concentration level These are the maximum concentrations of radionuclides in water estimated to correspond to a lifetime cancer risk of 1/10,000, assuming a lifetime daily consumption of 2 liters of water. These concentrations assume radionuclides emit only one type of radiation. For nonradioactive, noncarcinogenic compounds, maximum concentration levels are based on no observable effect levels.

maximum contaminant level (MCL) Under the *Safe Drinking Water Act*, the maximum permissible concentrations of specific constituents in drinking water that are delivered to any user of a public water system that serves 15 or more connections and 25 or more people. The standards set as maximum contaminant levels take into account the feasibility and cost of attaining the standard.

meteorological classifications Categories defining various states of atmospheric turbulence (dispersion and dilution) that are used to estimate diffusion of radioactive material concentrations for accident scenarios. The criteria consider the relationship of wind speed, insolation (amount of incoming solar radiation), and cloudiness (see Brenk et al. 1983).

> **Average (50 percent) meteorology:** Average meteorological dispersion conditions; more favorable and less favorable to dispersion conditions will each occur 50 percent of the time.
>
> **Conservative (95 percent) meteorology:** Adverse meteorological dispersion conditions (unfavorable to dispersion) which will not occur more than 5 percent of the time.
>
> **Neutral meteorology:** Pasquill Stability Class D, conditions which neither enhance nor inhibit vertical diffusion in the atmosphere.
>
> **Stable meteorology:** Pasquill Stability Class F, moderately stable conditions; the atmospheric condition existing when the temperature of the air rises rather than falls with altitude. It allows for little or no vertical air movement.

millirem One thousandth of a rem (see rem).

mitigation Those actions that avoid impacts altogether, minimize impacts, rectify impacts, reduce or eliminate impacts, or compensate for the impact.

mixed waste Waste that contains both hazardous waste under RCRA and source, special nuclear, or by-product material subject to the *Atomic Energy Act* of 1954.

mixing depth The height to which pollutants can freely disperse, above which inversion conditions exist.

moment magnitude A measure of earthquake size. The rigidity of the rock times the area of faulting times the amount of slip.

M_S Surface wave magnitude; motion is restricted to near the ground surface. Such waves correspond to ripples of water that travel across a lake. Most of the wave motion is located at the outside surface itself; and, as the depth below this surface increases, wave displacements become less and less.

nanocurie One billionth of a curie (see curie).

***National Environmental Policy Act* of 1969 (NEPA)** A law that requires Federal agencies to include in their decisionmaking processes appropriate and careful consideration of all potential environmental effects of proposed actions, analyses of their alternatives, and measures to avoid or minimize adverse effects of a proposed action that have the potential for significantly affecting the environment. These analyses are presented in either an environmental

assessment or in an EIS.

National Oceanic and Atmospheric Administration A Federal agency that collects and analyzes information on the weather. The National Oceanic and Atmospheric Administration has an office at INEEL for collecting weather information. The National Oceanic and Atmospheric Administration also is involved with the environmental monitoring programs at INEEL.

National Priorities List A formal listing of the nation's worst hazardous waste sites, as established by CERCLA, that have been identified for remediation.

natural phenomena accidents Accidents that are initiated by phenomena such as earthquakes, tornadoes, floods, and so forth.

near-surface disposal Disposal in the uppermost portion of the earth, approximately 30 meters. Near-surface disposal includes disposal in engineered facilities that may be built totally or partially above-grade provided that such facilities have protective earthen covers. A near-surface disposal facility is not considered a geologic repository.

nearest public access For facility accident analyses, the location of the nearest public highway where members of the public could be present.

new facilities Any facility that is not an existing facility or an existing hazardous waste management facility.

nitrogen oxides (NO_x) Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; a criteria air pollutant. Two major nitrogen oxides, nitric oxide (NO) and nitrogen dioxide (NO_2), are important airborne contaminants. Oxides of nitrogen are considered precursor to the formation of ozone (photochemical smog).

nonattainment area Any area that has been designated as not meeting (or contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.

noncertifiable waste Waste that is not able to meet the waste acceptance criteria for the intended treatment, storage, or disposal facility; transportation requirements; or waste that may be too difficult to characterize adequately to prove that it meets the applicable criteria.

nonreactor nuclear facility Those activities or operations that involve radioactive and/or fissionable materials in such form and quantity that a nuclear hazard potentially exists to the employees or to the general public. These activities or operations include producing, processing, or storing radioactive liquid or solid waste, fissionable materials, or tritium; conducting separation operations; conducting inspections of irradiated materials, fuel fabrication, decontamination, or recovery operations; conducting fuel enrichment operations; or performing environmental remediation or waste management activities involving radioactive materials.

nonhazardous Waste that does not pose risks to human health and the environment. Industrial/ commercial waste is an example (see hazardous waste).

normal conditions All activities associated with a facility mission, whether operation, maintenance, storage, and so forth, which are carried out within a defined envelope. This envelope can be design process conditions, performance in accordance with procedure, and so forth.

normal operation All normal conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency greater than 0.1 events per year.

NO_x A generic term used to describe the oxides of nitrogen (see nitrogen oxides).

nuclear criticality A self-sustaining chain reaction that releases neutrons and energy and generates radioactive by-product material.

nuclear fuel Materials that are fissionable and can be used in nuclear reactors to make energy.

nuclide A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements.

off-link doses Doses to members of the public within 800 meters (2,625 feet) of a road or railway.

offsite facility A facility located at a different site or location than the shipper.

offsite population For facility accident analyses, the collective sum of individuals located within an 80-kilometer (50-mile) radius of the INEEL facility and within the path of the plume with the wind blowing in the most populous direction. For routine radionuclide emissions, the collective population residing within an 80-kilometer radius for which an annual dose assessment is performed (includes all directions).

on-link doses Doses to members of the public sharing a road or railway.

onsite The same or geographically contiguous property that may be divided by public or private right-of-way, provided the entrance and exit between the properties is at a cross-roads intersection, and access is by crossing as opposed to going along the right-of-way. Non-contiguous properties owned by the same person but connected by a right-of-way that he/she controls and to which the public does not have access is also considered onsite property.

onsite facilities Buildings and other structures, their functional systems and equipment, and other fixed systems and equipment installed onsite.

operable unit A discrete portion of a Waste Area Group consisting of one or many release sites considered together for assessment and cleanup activities. The primary criteria for placement of release sites into an operable unit include geographic proximity, similarity of waste characteristics and site types, and the possibilities for economy of scale.

operator The organization that operates a facility.

organic compounds Chemicals containing mainly carbon, hydrogen, and oxygen. Petroleum products, petroleum-based solvents, and pesticides are examples of organic compounds. Exposure to some organic compounds can produce toxic effects on body tissues and processes.

orphan wastes Wastes in a classification that currently have no long-term disposal scheduled or anticipated. An example of an orphan waste is low-level mixed waste. Orphan waste is probably not radioactive enough to qualify for disposal at the Waste Isolation Pilot Plant and it cannot be disposed of onsite because it has hazardous components.

orthophosphate The phosphate ions including $(H_2O)_4 \bullet HPO_4^{2-}$ and PO_4^{3-}.

overpack A secondary container placed around a primary container to provide additional protection to or from the contents of a waste package or enclose a damaged primary container.

package The packaging plus its contents.

packaging A receptacle and any other components or materials necessary for the receptacle to perform its required containment function.

particulate matter Any material, except water in uncombined form, that exists as a liquid or a solid at standard conditions (see also PM-10).

passivation The process of making metals inactive or less chemically reactive. For example, to passivate the surface of steel by chemical treatment.

perched water A discontinuous saturated water body above the water table with unsaturated conditions existing both above and below.

perennial surface water A stream, creek, lake, pond, or river that contains water year-round.

performance assessment A systematic analysis of the potential risks posed by waste management systems to the public and environment and a comparison of those risks to established performance objectives.

performance assessment limited waste Special-case waste comparable to greater-than-Class-C waste but generated by the government. This is a low-level waste but has unique characteristics that make it unsuitable for shallow land burial.

performance-assessment-limited alpha waste Any alpha-contaminated waste, not meeting the definition of transuranic waste, that cannot be disposed of by shallow land burial, based on a documented site-specific performance assessment approved by the DOE Operations Office and Headquarters.

performance objectives Parameters within which a facility must perform to be considered acceptable.

permeability The degree of ease with which water can pass through a rock or soil.

person-rem A unit of collective radiation dose applied to populations or groups of individuals (see collective dose).

playa The shallow central basin of a desert plain in which water gathers and then evaporates.

Pleistocene The older of the two epochs of the Quaternary period (2 million to 10,000 years ago).

plume The three-dimensional area containing measurable concentrations of a compound or element that has migrated from its source point.

PM-10 All particulate matter in the ambient air with an aerodynamic diameter less than or equal to a nominal ten (10) micrometers.

pollutant migration The movement of a contaminant away from its initial source.

pollution prevention The use of any process, practice, or product that reduces or eliminates the generation and release of pollutants, hazardous substances, contaminants, and wastes, including those that protect natural resources through conservation or more efficient utilization.

polychlorinated biphenyls (PCBs) A class of chemical substances formerly manufactured as an insulating fluid in electrical equipment that is highly toxic to aquatic life. In the environment, PCBs exhibit many of the characteristics of dichloro diphenyl trichloroethane (DDT); they persist in the environment for a long time and accumulate in animals.

population dose The collective dose to the offsite population (usually within 80 kilometers of the facility being assessed).

porosity (n) Porosity is an index of the relative pore volume. It is the total unit volume of the soil or rock divided into the void volume.

preferential pathways Preferred pathways for fluid flow. They are dependent upon the moisture content of the porous media.

pressurized water reactor A nuclear power reactor that uses water under pressure as a coolant. The water boiled to generate steam is in a separate system.

primary ambient air quality standard That air quality that, allowing an adequate margin of safety, is

requisite to protect the public health. National primary ambient air quality standards have been established for criteria pollutants (particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, and lead).

probable maximum flood The largest flood for which there is any reasonable expectancy in a specific area. The probable maximum flood is normally several times larger than the largest flood of record.

process knowledge The set of information that is used by trained and qualified individuals who are cognizant of the origin, use, and location of waste-generating materials and processes in sufficient detail so as to certify the identity of the waste.

processing (of spent nuclear fuel) Applying a chemical or physical process designed to alter the characteristics of a spent nuclear fuel matrix.

public Anyone outside the DOE site boundary at the time of an accident or during normal operation. With respect to accidents analyzed in this EIS, anyone outside the DOE site boundary at the time of an accident.

quality assurance All those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or components will perform satisfactorily and safely in service. Quality assurance includes quality control, which is all those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements.

quality factor The modifying factor that is used to derive dose equivalent from absorbed dose.

Quaternary The younger of the two geologic periods in the Cenozoic Era (2 million years ago to the present). Quaternary is subdivided into the Pleistocene and Holocene epochs.

rad The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram.

radiation (ionizing radiation) Alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as it is used in this EIS, does not include nonionizing radiation, such as radio waves; microwaves; or visible, infrared, or ultraviolet light.

radiation worker A worker who is occupationally exposed to ionizing radiation and receives specialized training and radiation monitoring devices to work in such circumstances.

radioactive waste Waste that is managed for its radioactive content.

radioactivity The property or characteristic of material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

radioisotope An unstable isotope, of an element, that decays or disintegrates spontaneously, emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified.

radiological survey The evaluation of the radiation hazards accompanying the production, use, or existence of radioactive materials under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes affecting these materials to predict hazards resulting from unexpected or possible changes in materials or equipment.

Radiological and Environmental Sciences Laboratory A facility involved in environmental monitoring of INEEL onsite and offsite radiation and research on its effects.

radionuclide See radioisotope.

RCRA See *Resource Conservation and Recovery Act*.

RCRA accumulation point There are two types of accumulation areas allowed under RCRA:

> Satellite Accumulation Areas: Locations where hazardous waste generators are allowed to accumulate waste at or near the point of generation. Generators may accumulate up to 55 gallons of hazardous waste or one quart of acutely hazardous waste at or near the point of generation. Upon reaching 55 gallons, the generator has 72 hours to move the hazardous waste to either a temporary accumulation area or a permitted facility.
>
> Temporary Accumulation Areas: Under RCRA, the location where hazardous waste may be stored by a generator without a RCRA permit, temporary accumulation areas are limited by the amount of time they can store a hazardous waste. Generators may store hazardous wastes for up to 90 days without a permit if the generator complies with other safety and storage requirements, including a personnel training plan, a contingency plan, and an emergency preparedness and response plan.

RCRA interim status facility Hazardous waste management facilities (that is, treatment, storage, or disposal facilities) subject to RCRA requirements that were in existence on the effective date of regulations are considered to have been issued a permit on an interim basis as long as they have met notification and permit application submission requirements. Such facilities are required to meet interim status standards until they have been issued a final permit or until their interim status is withdrawn.

RCRA storage A facility used to store RCRA hazardous waste for greater than 90 days. To be in compliance with the regulatory requirements of RCRA, the facility must meet both documentation requirements (for example, contingency and waste analysis plans) and physical requirements (for example, specific aisle widths and separation of incompatible wastes).

reclassified low-level waste See alpha low-level waste.

Record of Decision (ROD) A public document that records the final decision(s) concerning a proposed action. The Record of Decision is based in whole or in part on information and technical analysis generated either during the CERCLA process or the NEPA process, both of which take into consideration public comments and community concerns.

recycling Recycling techniques are characterized as use, reuse, and reclamation techniques (resource recovery). Use or reuse involves the return of a potential waste material either to the originating process as a substitute for an input material or to another process as an input material. Reclamation is the recovery of a useful or valuable material from a waste stream. Recycling allows potential waste materials to be put to a beneficial use rather than going to treatment, storage, or disposal.

regulated substances A general term used to refer to materials other than radionuclides that are regulated by Federal, State, (or possibly local) requirements.

release site A location at which a hazardous, radioactive, or mixed waste release has occurred or is suspected to have occurred. It is usually associated with an area where these wastes, or substances contaminated with them, have been used, treated, stored, and/or disposed of.

rem The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of X-ray or gamma-ray exposure.

remedial investigation The CERCLA process of determining the extent of hazardous substance contamination and, as appropriate, conducting treatability investigations. The remedial investigation provides the site-specific information for the feasibility study.

remediation Process of remedying a site where a hazardous substance release has occurred.

remote-handled waste Packaged waste whose external surface dose rate exceeds 200 millirem per hour.

remote handling The handling of wastes from a distance so as to protect human operators from unnecessary exposure.

repository A permanent deep geologic disposal facility for high-level or transuranic wastes and spent nuclear fuel.

representative sample A sample of a universe or whole (for example, waste pile, lagoon, groundwater) that can be expected to exhibit the average properties of the universe or whole.

reprocessing (of spent nuclear fuel) Processing of reactor irradiated nuclear material (primarily spent nuclear fuel) to recover fissile and fertile material, in order to recycle such materials primarily for defense programs. Historically, reprocessing has involved aqueous chemical separations of elements (typically uranium or plutonium) from undesired elements in the fuel.

research reactor A nuclear reactor used for research and development.

Resource Conservation and Recovery Act (RCRA) A Federal law addressing the management of waste. Subtitle C of the law addresses hazardous waste under which a waste must either be "listed" on one of EPA's hazardous waste lists or meet one of EPA's four hazardous characteristics of ignitability, corrosivity, reactivity, or toxicity, as measured using the toxicity characterization leaching procedure. Cradle-to-grave management of wastes classified as RCRA hazardous wastes must meet stringent guidelines for environmental protection as required by the law. These guidelines include regulation of transportation, treatment, storage, and disposal of RCRA-defined hazardous waste. Subtitle D of the law addresses the management of nonhazardous, nonradioactive, solid waste, such as municipal wastes.

retrieval The process of recovering wastes that have been stored or disposed of onsite so they may be appropriately characterized, treated, and disposed of.

rhyolite A very acid volcanic rock that is the lava form of granite.

risk Quantitative expression of possible loss that considers both the probability that a hazard causes harm and the consequences of that event.

roentgen A unit of exposure to ionizing radiation. It is that amount of gamma or X-rays required to produce ions carrying one electrostatic unit of electrical charge in one cubic centimeter of dry air under standard conditions.

safe and secure Storage with design and operational features that maintain the integrity of the fuel cladding, prevent criticalities, preclude diversion, and so forth. Safe and secure storage would generally meet the intent of DOE orders, but waivers may be required and granted for some requirements on a case-by-case basis where warranted.

safety analysis report A report, prepared in accordance with DOE Orders 5481.1B and 5480.23, that summarizes the hazards associated with the operation of a particular facility and defines minimum safety requirements.

safety class structures, systems, and components Those systems, structures, or components whose functioning is necessary to keep maximally exposed offsite individual exposure below a dose of 25 rem or an Emergency Response Planning Guideline-2 dosage for design basis accidents and evaluation basis accidents.

sanitary landfill A facility for the disposal of solid waste where there is no reasonable probability of adverse effects on health or the environment from disposal of the solid waste at the facility. This facility is not an open dump and is not for disposal of hazardous waste.

sanitary waste Liquid or solid wastes that are generated as a result of routine operations of a facility and are not considered hazardous or radioactive.

satellite accumulation area See RCRA accumulation point.

saturated zone That part of the earth's crust in which all naturally occurring voids are filled with water.

scaling factor A multiplier that allows the inference of one radionuclide concentration from another that is more easily measured.

scientific notation A notation adopted by the scientific community to deal with very large and very small numbers. The notation calls for moving the decimal point to the right or left so that only one number above zero is to the left of the decimal point. Scientific notation uses a number times 10 and either a positive or negative exponent to show how many places to the left or right the decimal place has been moved. For example, in scientific notation, 120,000 would be written as 1.2×10^{5}, and 0.000012 would be written as 1.2×10^{-5}. In a variation of scientific notation often used in computer printouts, the multiplication sign and number 10 are replaced by the letter E. The above numbers would be written as 1.2E5 (or 1.2E+05) and 1.2E-5, respectively.

scrubber A device that uses a liquid spray to remove aerosol and gaseous pollutants from an airstream. The gases are removed either by absorption or chemical reaction. Solid and liquid particulates are removed through contact with the spray.

secondary ambient air quality standard That air quality which is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of air pollutants in the ambient air.

secondary emissions Emissions that would occur as a result of the construction, modification, or operation of a stationary source or facility but do not come from the stationary source or facility itself.

sedimentary interbeds Rock layers composed of materials, such as sand or gravel, that are derived from the breakdown of various rocks that are layered between other rock types.

segregation The process of separating (or keeping separate) individual waste types and/or forms in order to facilitate their cost-effective treatment and storage or disposal.

seismicity The phenomenon of earth movements; seismic activity. Seismicity is related to the location, size, and rate of occurrence of earthquakes.

site inspection The CERCLA process to acquire the necessary data to confirm the existence of environmental contamination and to assess the associated potential risks to human health, welfare, and the environment. The data collected must be sufficient to support the decision either for continuing with a remedial investigation/feasibility study or for removing the site from further investigation through a decision document.

site waste management organization The functional organization at a DOE site whose responsibility it is to manage waste generated by that site's operations.

sizing The process of reducing the size of various types of solid wastes by compaction, melting, or mechanical reduction.

small quantity generator A generator who generates less than 1,000 kilograms of hazardous waste in a calendar month.

sodium-bearing waste Liquid radioactive waste generated from decontamination of process equipment and other miscellaneous activities at the Idaho Chemical Processing Plant (now called the Idaho Nuclear Technology and Engineering Center).

sole source aquifer A designation granted by the EPA when groundwater from a specific aquifer supplies more than 50 percent of the drinking water for the area overlying the aquifer. Sole source aquifers have no alternative source or combination of sources that could physically, legally, and economically supply all those who obtain their drinking water from the aquifer. Sole source aquifers are protected from federally financially assisted activities determined to be potentially unhealthy for the aquifer.

solid waste Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges, which are point sources subject to permits under Section 402 of the *Federal Water Pollution Control Act*, as amended, or source, special nuclear, or by-product material as defined by the *Atomic Energy Act* of 1954, as amended (Public Law 94-580, 1004[27] RCRA).

solid waste management units Any site, excluding Land Disposal Units, that received or handled solid waste, whether or not hazardous constituents were involved.

solvents Liquid chemicals, usually organic compounds, that are capable of dissolving another substance. Exposure to some organic solvents can produce toxic effects on body tissues and processes.

source material (a) Uranium, thorium, or any other material that is determined by the NRC pursuant to the provisions of the *Atomic Energy Act* of 1954, Section 61, to be source material; or (b) ores containing one or more of the foregoing materials, in such concentration as the NRC may by regulation determine from time-to-time (*Atomic Energy Act* 11[z]). Source material is exempt from regulation under RCRA.

source term The type and quantity of pollutants emitted to air or other media from a specific source or group of sources.

SO_x A generic term used to describe the oxides of sulfur. Air emission of oxides of sulfur contribute to sulfur dioxide concentrations, for which there is an ambient air quality standard; contributes to the formation of acidic precipitation (see sulfur oxides).

special case waste Special case waste is defined in this EIS as those wastes that are not suitable for direct treatment via the primary AMWTP facility supercompaction, macroencapsulation, incineration, and microencapsulation treatment processes. Special case waste includes wastes that may require additional characterization and/or pretreatment (e.g., neutralization and/or absorption) prior to processing via incineration/microencapsulation or final treatment (e.g., amalgamation to meet land disposal restriction treatment standards) prior to disposal. Some examples of special case waste are containers of liquids (i.e., containerized liquids) removed from the original waste containers and free liquids (i.e., non-containerized liquids) removed from the original waste containers and containerized prior to transfer to the special case waste glovebox.

spent nuclear fuel Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated. For the purposes of this EIS, spent nuclear fuel also includes uranium/neptunium target materials, blanket subassemblies, pieces of fuel, and debris.

stabilized waste (stability) Treatment or packaging of a waste stream that is intended to ensure that the waste does not structurally degrade and affect overall stability of the disposal site through slumping, collapse, or other types of failures that will lead to water infiltration into the waste. Stabilization is also a factor in limiting exposure to an inadvertent intruder since it provides a recognizable and nondispersible waste.

stable (Atmospheric) low potential for vertical mixing. Also, nonradioactive.

stakeholder Any person or organization with an interest in or affected by DOE activities. Stakeholders may include representatives from Federal agencies, State agencies, Congress, Native American Tribes, unions, educational groups, industry, environmental groups, other groups, and members of the general public.

stationary source Any building, structure, emissions unit, or installation that emits or may emit any air pollutant.

storage The collection and containment of waste or spent nuclear fuel in such a manner as not to constitute disposal of the waste or spent nuclear fuel for the purposes of awaiting treatment or disposal capacity (that is, not short-term

accumulation).

storativity Storativity of a saturated aquifer is defined as the volume of water that a unit volume of the aquifer releases from storage under a unit decline in hydraulic head.

sulfur oxides Pungent, colorless gases formed primarily by the combustion of fossil fuels; considered major air pollutants, sulfur oxides may damage the respiratory tract as well as vegetation (see SO_x).

subsurface The area below the land surface (including the vadose zone and aquifers).

superfund The common name used for CERCLA and its amendments.

superfund site Any site that has been listed on the National Priorities List because it has been identified by the EPA as having the potential to harm human health and the environment. Study and cleanup activities at these sites are regulated by the CERCLA. "Superfund" sites at Federal facilities must be cleaned up by the operating agency (lead agency) under the oversight of the EPA and other parties to a Federal Facility Agreement.

surface dose The dose measured at the surface of the container of material. The measurements are sometimes expressed as a measurement on contact and at one meter.

tank A stationary device designed to contain an accumulation of waste, which is constructed primarily of non-earthen materials (for example, wood, concrete, steel, plastic) which provide structural support.

technical safety requirement Those requirements that define the conditions, safe boundaries, and the management or administrative controls necessary to ensure the safe operation of a nuclear facility and reduce the potential risk to the public and co-located workers from uncontrolled release of radioactive materials, radiation exposure due to inadvertent criticality, or uncontrolled release of nonradiological material or energy hazards.

tectonics Geological structural features as a whole, or a branch of geology concerned with the structure of the crust of a planet and especially with the formation of folds and faults in it.

tephra Solid material ejected into the air during a volcanic eruption, including volcanic dust, ash, and cinders.

Tertiary The older of the two geologic periods in the Cenozoic Era (63 to 2 million years ago).

thermal treatment The treatment of hazardous waste in a device that uses elevated temperatures as the primary means to change the chemical, physical, or biological character or composition of the hazardous waste. Examples of thermal treatment processes are incineration, molten salt, pyrolysis, calcination, wet air oxidation, and microwave discharge.

total effective dose equivalent The sum of the external dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

toxic air pollutant Under the Idaho Air Quality Control Regulations, any air pollutant that is determined by the Idaho Department of Health and Welfare to be, by its nature, toxic to human or animal life or vegetation.

toxic air pollutant reasonably available control technology An emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Idaho Department of Health and Welfare, considering technological and economic feasibility.

toxicological hazard Any material defined in 40 CFR 355 Appendix A as an extremely hazardous substance.

Toxic Substances Control Act (TSCA) **of 1976** This Act authorizes the EPA to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to

public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the EPA before they are manufactured for commercial purposes.

transient A change in the reactor coolant system temperature and/or pressure. Transients can be caused by adding or removing neutron poisons, by increasing or decreasing the electrical load on the turbine generator, or by accident conditions.

transmissivity The rate at which water of a prevailing density and viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is a function of properties of the liquid, the porous media, and the thickness of the porous media.

transuranic (TRU) waste Waste containing more than 100 nanocuries per gram of alpha-emitting transuranic isotopes with half-lives greater than 20 years, except for (a) high-level radioactive waste; (b) waste that DOE has determined, with the concurrence of the EPA Administrator, does not need the degree of isolation required by 40 CFR 191; or (c) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

transuranium radionuclide Any radionuclide having an atomic number greater than 92.

treatment Any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to render such waste nonhazardous, safer for transport, amenable for recovery, amenable for storage, or reduced in volume. Such term includes any activity or processing designed to change the physical form or chemical composition of hazardous waste so as to render it nonhazardous.

treatment facility Land area, structures, and/or equipment used for the treatment of waste or spent nuclear fuel.

ultimate disposition The final step in which a material is either processed for some use or disposed of.

United States Geological Survey (USGS) A Federal agency that collects and analyzes information on geology and geological resources including groundwater and surface water.

vadose zone The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

vapor vacuum extraction A technology that applies a vacuum to a well field to remove volatile organic contamination from soils and permeable rock layers in that well field.

vitrification The process of immobilizing waste material that results in a glass-like solid.

volatile organic compound (VOC) Chemical containing mainly carbon, hydrogen, and oxygen that readily evaporates at ambient temperature. Exposure to some organic compounds can produce toxic effects on body tissue and processes. VOCs are regulated as precursors to the criteria air pollutant ozone.

Volcanic Rift Zones (VRZs) Linear belts of basaltic vents marked by open fissures, monoclines, and small normal faults. Volcanic rift zones were produced during the propagation of vertical molten basaltic dikes that fed surface eruptions.

vulnerabilities Conditions or weaknesses that may lead to radiation exposure to the public, unnecessary or increased exposure to the workers, or release of radioactive materials to the environment. For example, some DOE facilities have had leakage from spent fuel storage pools, excessive corrosion of fuel causing increased radiation levels in the pool, or degradation of handling systems. Vulnerabilities are also caused by loss of institutional controls, such as cessation of facility funding or reductions in facility maintenance and control.

waste Any waste defined as solid waste by 40 CFR 261.2. Solid waste excluded from regulation by RCRA is still

considered a waste. This includes wastes of all types (solid, liquid, gaseous, hazardous, radioactive, sanitary, and so forth).

waste acceptance criteria (WAC) The requirements specifying the characteristics of waste and waste packaging acceptable to a waste receiving facility; and, the documents and processes the generator needs to certify that waste meets applicable requirements.

waste acceptance specifications The functions to be performed and the technical requirements for a Waste Acceptance System for accepting spent nuclear fuel and high-level waste into the Civilian Radioactive Waste Management System according to the *Waste Acceptance System Requirements Document* (DOE/RW-0352P, January 1993, Office of Civilian Radioactive Waste Management).

waste analysis plan A plan that specifies the parameters for which each waste will be analyzed. These include a testing and sampling method(s), timing, and the rationale of the generator or the facility operator responsible for treatment, storage, or disposal. It ensures that accurate waste type and composition determinations are made as required by law, regulation, or good judgment.

waste area group Ten groupings of release sites under the INEL Federal Facility Agreement and Consent Order 5. Groupings are for efficiency in managing the assessment and cleanup process. Nine of these waste area groups are associated with specific facilities, and the tenth is associated with the remaining miscellaneous facilities. Each waste area group may be broken down into individual operable units

waste certification A process by which a waste generator certifies that a given waste or waste stream meets the waste acceptance criteria of the facility to which the generator intends to transport waste for treatment, storage, or disposal. Certification is accomplished by a combination of waste characterization, documentation, quality assurance, and periodic audits of the certification program.

waste certification plan A plan or collection of plans used by a generator to specify the means by which waste is prepared and certified to meet applicable waste acceptance and safety criteria; hazardous and radiological waste handling, treatment, transportation, and packaging regulations; and other local or site requirements. Certification plans result in developing the information that the receiving facility needs to confirm the suitability of waste for acceptance.

waste certification program A systematic approach to ensure that waste characterization is conducted in a manner to provide reasonable assurance that the receiving facility's waste acceptance criteria are met. A waste certification program consists of all the functional elements, organizations, and activities necessary to provide reasonable assurance that waste characterization is done with sufficient accuracy to ensure proper handling. These functions can be performed by various organizations.

waste characterization See characterization.

waste container A receptacle for waste, including any liner or shielding material that is intended to accompany the waste in disposal.

waste generation Any waste (after being declared a waste, see "waste") produced during a particular calendar year. This does not include waste produced in previous years that is being repacked, treated, or disposed of in the current calendar year. It does include any secondary waste (for example, clothing, gloves, waste from maintenance operations, and so forth) generated by treatment, storage, or disposal activities of previously generated wastes.

waste generator organization Any organization that is responsible for the individual generators of waste.

Waste Isolation Pilot Plant (WIPP) A facility near Carlsbad, New Mexico, authorized to demonstrate safe disposal of defense-generated transuranic waste in a deep geologic medium.

waste management The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated surveillance and maintenance activities.

waste management facility All contiguous land, structures, other appurtenances, and improvements on the land, used for treating, storing, or disposing of waste or spent nuclear fuel. A facility may consist of several treatment, storage, or disposal operational units (for example, one or more landfills, surface impoundments, or combinations of them).

waste management program A systematic approach to organize, direct, document, and assess activities associated with waste generation, treatment, storage, or disposal. A waste management program consists of all the functional elements, organizations, and activities that comprise the system needed to properly manage waste. These functions and activities can be performed by various organizations.

waste management systems assessment A systems assessment of the entire low-level waste management (or all of waste management) structure/program at a given site that considers treatment, storage, and disposal, as well as onsite and offsite points of generation with an emphasis on optimization of all aspects of the operations, including, but not limited to, protection of human health and the environment, regulatory compliance, and cost effectiveness.

waste minimization An action that economically avoids or reduces the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

waste receiving facility A facility that formally accepts waste from a waste generator organization for treatment, storage, or disposal.

waste segregation The process of separating (or keeping separate) individual waste types and/or forms in order to facilitate their cost-effective treatment and storage or disposal.

waste stream A waste or group of wastes with similar physical form, radiological properties, EPA waste codes, or associated land disposal restriction treatment standards. It may be the result of one or more processes or operations.

waste type The waste types discussed in this EIS are high-level waste, transuranic waste, mixed low-level waste, low-level waste, hazardous waste, or nonhazardous waste.

water table The surface below which is saturated with water (an aquifer) and above which is not saturated with water (the vadose zone).

weathering The process by which rocks are broken down and decomposed by the physical and chemical actions of wind, rain, temperature change, plant colonization, and bacterial activity.

weighting factor (W_T) For an organ or tissue, (W_T) is the proportion of the risk of health effects (cancer fatalities) resulting from irradiation of that organ or tissue to the total risk of health effects (cancer fatalities) when the whole body is irradiated uniformly.

wet storage Storage of spent nuclear fuel in a pool of water, generally for the purposes of cooling and/or shielding.

zone of aeration See vadose zone.

zone of saturation That part of the earth's crust in which all voids are filled with water.

APPENDIX E

TECHNICAL METHODOLOGIES AND KEY DATA

E-1 SOCIOECONOMICS

E-1.1 Methodology and Key Assumptions for Socioeconomics

The socioeconomic impact analysis evaluates both the impacts on regional economic activity, as measured by changes in employment and earnings, and the impacts on communities surrounding Idaho National Engineering and Environmental Laboratory (INEEL), as measured by changes in population and the demand for housing and public services. The study area comprises a seven-county Region of Influence (ROI) and socioeconomic impacts are estimated for each of the proposed Advanced Mixed Waste Treatment Project (AMWTP) alternatives. The methodology employed for the AMWTP Environmental Impact Statement (EIS) is similar to that used in the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Program Final Environmental Impact Statement* (DOE INEL EIS) (DOE 1995), but includes updated data and a revised version of the Regional Input-Output Modeling System (RIMS II).

Socioeconomic impacts are addressed in terms of both direct and indirect impacts. Direct impacts are changes in INEEL employment and earnings expected to take place under each alternative and include both construction and operations phase impacts. Indirect impacts are the effects on regional economic activity that result from changes in U.S. Department of Energy (DOE) purchases of goods and services within the region expected to occur under any of the alternatives. The total economic impact to the ROI is the sum of direct and indirect effects. Both the direct and indirect effects were estimated for the ROI described in Section 4.3, Socioeconomics.

The direct impacts estimated in the socioeconomic analysis are based on project summary data developed by DOE in cooperation with INEEL contractors and their representatives. Direct employment impacts represent actual increases or decreases in INEEL staffing; they do not include changes in staffing due to reassignment of the existing INEEL workforce. Total employment and earnings impacts were estimated using RIMS II multipliers developed specifically for the INEEL ROI by the U.S. Bureau of Economic Analysis (BEA 1997). The construction activities were represented by the New Construction, Maintenance, and Repair Industry, while operations activities were represented by the Industrial Inorganic and Organic Chemicals Industry.

The significance of the actions and their impacts is determined relative to the context of the affected environment. Projected baseline conditions in the ROI, as presented in Section 4.3, Socioeconomics, provides the framework for analyzing the significance of potential socioeconomic impacts that could result from implementation of any of the alternatives. Baseline employment and population represent socioeconomic conditions expected to exist in the ROI through the year 2025. Each alternative, other than the No Action Alternative, is expected to generate short-term increases in employment and income as a result of construction, as well as longer term increases as a result of operations.

E-1.2 Population, Housing, and Community Services

Population changes associated with the projected baseline conditions and the proposed alternatives are an important

determinant of other social economic and environmental impacts. These population changes have three key components: (1) baseline growth, (2) relocation of workers and their dependents, (3) natural increase of population over the long term.

Because of the small size of the workforce associated with each of the AMWTP alternatives, the socioeconomic impact analyses assumed that all jobs could be filled by available workers currently residing in the ROI. The assumption was based on the types and number of jobs that would be required to implement each of the proposed alternatives, the composition of the work force currently residing in the ROI, and projected unemployment rates. Even if a small proportion of the required workforce were to migrate in from other regions, the number would be too small to have an effect on demographics and the housing market. Similarly, there would be no perceptible increase in demand for public services.

E-1.3 Key Assumptions

- The baseline workforce is assumed to be non-construction related.
- Construction and operations employment were assumed to be newly created jobs for all the alternatives.
- Construction staffing was based on project descriptions. Impacts were assessed for the peak year of construction.
- Operations staffing was based on project descriptions and assumed to be per year for the life of the project.
- Operations and construction staffing requirements could be filled by available workforce currently residing in the ROI.
- Wages for operations workers were based on project descriptions. An average wage of $26,286 was assumed for construction employees (Census 1997).
- The projected population trends for the ROI assume continuation of current operations at INEEL. The forecasts assumed a stable workforce through the year 2025.

E-2 GEOLOGY AND WATER

This section describes the methodology used to support the conclusions regarding the geologic hazards at the INEEL and local and regional water resources impacts for the four alternatives evaluated in this EIS. These conclusions resulted from an extensive review of existing documentation characterizing the geologic and hydrological conditions at the INEEL and a compilation of this material into a concise description of the existing conditions and potential impacts. This portion of Appendix E directly supports the summaries presented in Sections 4.6 and 5.6 (Geology) and 4.8 and 5.8 (Water Resources.)

E-2.1 Geology

The evaluation of geology at the INEEL site focused on the geologic hazards that could potentially impact the Radioactive Waste Management Complex (RWMC) and AMWTP project site. The following section discusses the studies used to determine the magnitude and likelihood of the hazards associated with seismicity and volcanism at the AMWTP project site.

E-2.1.1 Seismicity

The INEEL is located on the eastern Snake River Plain. The Snake River Plain extends in a broad arc from the Idaho-Oregon border on the west to the Yellowstone Plateau on the east. The plain varies in width from about 50 to 60 miles and is over 370 miles long (see Figure E-2-1).

The mountains surrounding the eastern Snake River Plain are composed mostly of much older rocks (100 million to 600 million years) that were folded by compression forces about 60 million years ago. Starting about 17 million years ago and continuing today, extensional forces on these same rocks caused faulting (Link et al. 1988 and Pierce and Morgan 1992). The failure produced long north-to-northwest trending mountain ranges that extend both north and south from the margins of the eastern Snake River Plain. Those that extend north (the Lost River, the Lemhi Range, and the Beaverhead Range) are each bounded along their western sides by large active faults that are capable of generating earthquakes of magnitude 7 or slightly greater. The south ends of these faults lie very close to the western and northern boundaries of the INEEL and are the major sources of seismic hazards for INEEL facilities.

The largest recorded earthquake in the vicinity of the INEEL was the 1983 Borah Peak earthquake. This 7.3 earthquake, occurred on the middle portion of the Lost River Fault near the towns of Mackay and Challis, about 50 miles from INEEL. Peak horizontal accelerations ranged from 0.022 to 0.078g at the INEEL site from the Borah Peak earthquake (Jackson 1985). Another large earthquake, the Hebgen Lake earthquake (magnitude 7.5), occurred in 1959 on the Yellowstone Plateau about 125 miles from INEEL. No significant safety-related structural damage to INEEL facilities resulted from either earthquake (Jackson & Boatwright 1987).

Both of these earthquakes occurred within a parabolic zone of historic recorded seismicity and young faults (see Figure E-2-1). This zone passes through the Yellowstone Plateau and flanks the eastern Snake River Plain (Andres et al. 1989). However, the INEEL seismic network and other networks show that the eastern Snake River Plain and adjacent parts of nearby mountain ranges form a zone of seismic inactivity or relatively low seismic activity inside the seismically active parabolic zone. During the 25 or more years of earthquake monitoring by the INEEL seismic network, only a few microearthquakes (magnitude less than 1.5) have occurred on or near the INEEL site (Jackson et al. 1993). Studies of the southern ends of the lost River and Lemhi faults near the towns of Arco and Howe show that earthquakes as large as the Borah Peak earthquake occurred there most recently about 20,000 years age (Woodward-Clyde 1992b,1995)

Figure E-2-1. Geologic features in the region of the INEEL.

For purposes of siting new facilities within the INEEL, a series of seismic hazard maps have been generated (Smith 1995). These maps show the levels of ground motion to be expected at various return periods using contour lines. The seismic hazard maps for return periods of 500 and 2000 years are shown in Figures E-2-2 and E-2-3, respectively. The contoured ground motions can be used for site selection purposes and as a general guide to the level of seismic hazard but not for design of facilities. The design of facilities must incorporate site-specific investigations.

A Site-Specific Probabilistic Seismic Hazard Analyses for the Idaho National Engineering Laboratory (INEL) (Woodward-Clyde 1996) was prepared using the results of the fault studies and other recent geologic and seismologic studies to determine the levels of ground motion to be expected at INEEL facilities (Woodward-Clyde 1996).

Figure E-2-4 shows the contribution of the three main source types to the mean hazard at the RWMC. The volcanic rift zones (VRZs) contribute very little to the total hazard compared to the regional source zones and the fault sources. The relative contributions of the fault sources increase as one considers longer period motions because of the increased effect of magnitudes on ground motion levels at longer periods, resulting in an increased domination of the hazard by larger magnitude events. The fault zones are expected to have higher frequency of large magnitude events and the largest maximum magnitudes compared to the nearby regional source zones.

Figure E-2-5 shows the relative contribution of the three fault sources at the RWMC. The Lost River fault contributes the most hazard because of its proximity and its relatively higher recurrence rates than the other two faults.

Figure E-2-6 shows the contribution to the mean hazard from the volcanic sources at the RWMC. The volcanic sources have minimal contribution to the RWMC site hazard because of their low activity rates and, in the case of the postulated Howe-East Butte zone, the low likelihood that it represents a distinct seismic source. The contribution to the seismic hazard from the various regional source zones at the RWMC is shown in Figure E-2-7. The northern Basin and Range source zone is the controlling regional source zone because of its proximity to the INEEL and its relatively high rate of seismicity compared to the eastern Snake River Plain. The eastern Snake River Plain source contributes to the hazard at very low probability levels.

E-2.1.2 Volcanism

The most significant volcanic hazard to INEEL facilities is basaltic volcanism, since it has occurred more recently, has covered more area, and has the potential to occur nearer INEEL facilities. Geologically young volcanic activity in the INEEL area consists of eruption of basalt lava flows and the building of rhyolite domes (Kuntz et al. 1992). Basalts exposed at the surface of the INEEL range in age from over 1 million years to about 12,000 years. Basalts a few miles away from the INEEL at Hell's Half Acre lava field are about 5,000 years old. At Craters of the Moon National Monument a few miles to the west of the INEEL, the basalts are as young as 2,000 years. The vent areas for basaltic lava flows are not randomly distributed on the eastern Snake River Plain but are concentrated in elongate northwest-trending VRZs and along the Axial Volcanic Zone (see Figure E-2-8). Rhyolite domes occur along the axis of the plain at the Big Southern Butte (30,000 years old), and East Butte (600,000 years old), and probably the Middle Butte (age unknown).

The Axial Volcanic Zone (16,000 year recurrence) provides a bounding value of eruption probability for the INEEL volcanic zones because it has erupted most frequently, and because the southern parts of the Arco-and Lava Ridge-Hell's Half Acre VRZ merge with it (Table E-2-1).

Figure E-2-2. Seismic hazard map for a return period of 500 years.

Figure E-2-3. Seismic hazard map for a return period of 2000 years.

Figure E-2-4. Contributions of the seismic sources to the mean seismic hazard at RWMC.

Figure E-2-5. Contributions of the fault sources to the mean seismic hazard at RWMC.

Figure E-2-6. Contributions of the volcanic sources to the mean seismic hazard at RWMC.

Figure E-2-7. Contributions of the regional source zones to the mean seismic hazard at RWMC.

Figure E-2-8. Map showing volcanic vents and volcanic recurrence intervals for volcanic zones in the INEEL region.

Table E.2-1. Estimated volcanic-recurrence intervals and corresponding annual eruption probabilities (in parentheses) for volcanic zones and boreholes of the INEEL area.

Volcanic zone or borehole	Data sources	Time interval of volcanism	Number of vents fissures or flow groups	Comments	Estimated recurrence interval
Great Rift (25 km southwest of INEEL)	Kuntz et al., 1986, 1988	2,100 - 15,00 yrs (radiocarbon dating)	> 100 vents; 8 Holocene eruptive periods (each lasting a few decades or centuries, and each including multiple flows and cones)	No impact on INEEL; most recently and frequently active of all Eastern Snake River Plain rift zones; thus provides minimum recurrence for entire Eastern Snake River Plain; most probable area of future Eastern Snake River Plain volcanism	2,000 yrs ($5x10^{-4}$ /yr)
Axial Volcanic Zone (southern INEEL)	Kuntz et al., 1986, 1994	5,000 - 730,000 yrs K-Ar dating; radiocarbon; paleomagnetic data)	73 vents & fissure sets; Holocene lava fields, 3 of them shared by VRZs. 45 cogenetic vent/fiss gps	Could affect much of southern INEEL; most recently and frequently active of all volcanic zones that could impact INEEL	16,000 yrs ($6.2x10^{-5}$ /yr)
Arco VRZ (southwestern INEEL)	Kuntz, 1978; Smith et al., 1989; Kuntz	10,000 - 600,000 yrs (radiocarbon, K-Ar and TL dating;	83 vents & fissure sets; 2 Holocene lava fields. 35 cogenetic vent/fiss gps	Volcanism could affect southwestern INEEL	17,000 yrs ($5.9x10^{-5}$

	et al., 1994	paleomagnetic data)			/yr)
Lava Ridge-Hells Half Acre VRZ (Includes Circ Butte/kettle Butte volc rift zone) (north & eastern INEEL)	Kuntz et al., 1986, 1994	5,000 - 1,200,000 yrs (K-Ar dating; radiocarbon; paleomagnetic data)	48 vents & fissure sets; 1 Holocene lava field: Hells Half Acre. 30 cogenetic vent/fiss gps	Could affect northern & eastern INEEL; extremely long eruptive history; includes oldest and youngest basalts in the INEEL area	40,000 yrs ($2.5x10^{-5}$ /yr)
Howe-East Butte Volcanic Rift Zone (central INEEL)	Kuntz, 1978, 1992; Golder Associates, 1992	230,000 - 730,000 yrs (K-Ar dating; paleomagnetic data)	7 vents & fissure sets; no Holocene features. 5 cogenetic vent/fissure groups	Old, poorly exposed and sediment-covered; identified in part by subsurface geophysical anomalies	100,000 yrs ($1.0x10^{-5}$ /yr)
Borehole NPR SITE E (south-central INEEL)	Champion et al., 1988	230,000 - 640,000 yrs (K-Ar dating; paleomagnetic data)	9 lava-flow groups (each group contains multiple flows, erupted over a short time)	Dates from 600-foot interval of subsurface lavas give recurrence estimate consistent with surficial geology of the area	45,000 yrs ($2.2x10^{-5}$ /yr)
Borehole RWMC 77-1 (southwestern INEEL)	Kuntz, 1978; Anderson & Lewis, 1989	100,000 - 565,000 yrs (K-Ar and TL dating; palemagnetic data)	11 lava-flow groups (each group contains multiple flows, erupted over a short time)	Dates from 600-foot interval of subsurface lava give longer recurrence interval than nearby Arco & Axial zones, reflecting flow-group (sub-surface) vs. vent-counting (surface geology) approaches	45,000 yrs ($2.2x10^{-5}$ /yr)
Source: Woodward-Clyde 1996.					

Specific sites of future eruptions cannot be forecast, however, as estimate of the probability of future lava flows inundating a random site within a VRZ can be constructed. Hackett and Smith (1994) estimated the general probability for lava flow inundation within each of the INEEL volcanic zones. They assumed that every eruption would produce a lava flow of average dimensions, and terrain factors were ignored. The average INEEL lava flow of the past 40,000 years is 5 miles long and covers 18 square miles. The annual probability of a 18 square miles lava flow inundating a random site within the Axial Volcanic Zone (386 square miles area) is $2.9x10^{-6}$ per year. The Arco VRZ has erupted about as frequently as the Axial Volcanic Zone, and it covers about 115 square miles. The annual probability for the Arco Volcanic Zone is approximately $9.3x10^{-6}$ per year. For a random site within the Lava Ridge-Hell's Half Acre VRZ (193 square miles area), the probability is about $2.4x10^{-6}$ per year.

It is important to emphasize that these probabilities are not equivalent to site-specific risk assessments, because only source terms were considered within the context of several simplifying assumptions. Site-specific assessments must incorporate other factors including distance from the source zone(s), the influence of local terrain upon lava paths, the consequences of volcanic effects, and the potential success of mitigation measures (e.g., construction of barriers or removal of property).

Other hazardous phenomena (i.e., tephra fall, volcanic-gas emissions, and magma-induced ground deformation) are expected to accompany virtually all basaltic volcanic eruptions, however, the affected areas are assessed to be smaller than the areas inundated by lava flows (Hackett & Smith 1994).

E-2.2 Water Resources

The evaluation of potential consequences to water resources at the INEEL, particularly the RWMC, focused on flooding potential, water quality and water use. The following sections discuss the methods and references used to determine impacts resulting from the implementation of the waste management activities for the proposed alternatives.

DOE conducted an extensive review of the INEEL's potential environmental consequences to water resources for the alternatives (DOE INEL EIS Sections 4.8, 5.8 and Appendix Section F.2.2). In lieu of duplication of that discussion in this EIS, the applicable sections of the DOE INEL EIS Volume 2 (Appendix Section F.2.2) for surface and subsurface water, and water use are referenced, and new information and data applicable to water resources are provided.

E-2.2.1 Surface Water

Surface water studies and data were reviewed during a literature search performed for this EIS. This section presents the methodology used for the analyses of potential impacts of the AMWTP alternatives to natural and artificial (manmade) surface waters on and in the vicinity of the RWMC. These methods were used to determine existing surface water quality and flood potential.

The U.S. Geological Survey (USGS) has been compiling surface water quality data for many years at the INEEL. Many potential sources of surface water contamination are identified also in the Federal Facility Consent Order. All potential contamination sources were evaluated, including facility-specific activities, material inventory, past spills and leaks, nonpoint source water discharge, and existing storm water monitoring data (DOE INEL EIS, Appendix Section F.2.2.1.1).

Under the *Clean Water Act*, two National Pollutant Discharge Elimination System (NPDES) General Permits for Storm Water Discharges were issued for the INEEL; one for industrial activities and one for construction activities. The permit requirements for both of these activities specify the development of a Site-Wide Storm Water Pollution Prevention Plan. Any facility at the INEEL having the potential to discharge storm water to the Big Lost River System associated with industrial or construction activities is subject to the monitoring and reporting requirements of the INEEL.

Water samples are collected during each quarter when sufficient rain falls or snow melts to produce enough runoff from the Transuranic Storage Area (TSA) asphalt pads and in the Subsurface Disposal Area (SDA) gate ditch. One sample is collected from the outfall that drains off of the TSA asphalt pads. In addition, a sample is taken at the point of discharge from the SDA near the sump pump. A control sample is collected to determine background concentrations of the radionuclides of interest at a location unaffected by facility operations upgradient of the SDA (LMITCO 1996). Results of the sampling are discussed in Section 4.8, Water Resources.

In addition, several USGS and INEEL studies have been conducted concerning flood potential at the INEEL. The USGS estimated peak flow and flow volume from the Big Lost River for a 100-year flood event. The estimated peak flow was 7,260 cubic feet per second. The estimated volume of flow for a 60-day period from a flood event likely to occur once in 100 years (100-year flood event) was 390,000 acre-feet for the entire INEEL (DOE-ID 1997c) (Kjelstrom and Berenbrock 1996). Acre-feet is the unit of measure in which one foot of water would cover one acre.

Dames and Moore (1993) conducted a flood design evaluation for the RWMC. The scope of work included hydrologic analyses including the development of 100-, 500-, 1,000-, and 10,000-year storm event, 1/2 probable maximum flood, and probable maximum flood hydrographs for subbasins contributing surface runoff to the Main Channel Flow System and East Channel Flow System at the RWMC. The work also included preparation of 100-year flood and probable maximum flood inundation map, development of alternative 100-, 500-, and 1,000-year rain-on-snow scenarios, and computation of revised flood elevations, along with surface runoff hydrographs for two specific cases. The utilized methodology divided the RWMC watershed basin into 21 separate drainage catchments (subbasins) for purposes of hydrologic analysis. The analysis was based on the probable maximum precipitation for each of the storm events analyzed. Subbasins were determined by delineating natural watershed boundaries for each catchment that is a tributary to the RWMC. Estimation of precipitation losses, times of concentration, and lag times were defined using a minimum of four different methods, respectively. These methods were analyzed through the U.S. Army Corps of Engineers flood hydrograph package modeling programs, Hydrologic Engineering Center (HEC)-1 for peak discharges and HEC-2 for

water surface profiles, for the Main and East Channel Flow Systems to Big Lost River (Dames and Moore 1993). Based on the current drainage engineered structures (culverts and ditches), the study indicates that no flooding would occur for the 100-, 500-, 1,000- and 10,000-year storm event for the RWMC, specifically within the SDA. For the 1/2 probable maximum flood and probable maximum flood, overtopping of the culvert on Adams Boulevard would occur for the box culvert. The 100-year flood inundation map is presented in the report (Dames and Moore 1993).

In addition to the Dames and Moore report, the USGS plans to determine the extent of the 100-year floodplain for the Big Lost River and Birch Creek at the INEEL. A simulated 100-year peak flow, using a computer model, will be routed downstream to spreading areas and playas on the INEEL (DOE-ID 1997c). This modeling effort methodology will be similar to the study conducted by Dames and Moore in 1993 (Dames and Moore 1993).

E-2.2.2 Subsurface Water

The Snake River Plain Aquifer arcs approximately 220 miles through eastern Idaho's subsurface and varies in width from 50 to 70 miles (Becker et al. 1996). Total area of the Snake River Plain Aquifer is estimated at 9,600 square miles. Depth to groundwater at the INEEL ranges from approximately 200 feet below land surface in the north to over 900 feet in the south (Becker et al. 1996). The Snake River Plain Aquifer has been estimated to hold 2.5×10^{12} cubic meters of water, which is approximately equivalent to the amount of water contained in Lake Erie, or enough water to cover the entire State of Idaho to a depth of 4 feet (Becker et al. 1996). Water is pumped from the aquifer primarily for human consumption and irrigation. The INEEL's use of the aquifer is minor (Becker et al. 1996).

Groundwater parameters reviewed for this EIS were aquifer permeability, recharge and discharge areas, groundwater flow, and groundwater quality and use.

Improvement in management practices since 1952 at the RWMC have resulted in differences in soil covers, thickness, land contours, vegetation types, and proximity of buried waste to roads and ditches. Each of these factors influences soil moisture dynamics in the protective soil caps. Since 1988, the Environmental Science and Research Foundation has measured soil moisture on eight study sites within the RWMC, mostly during the late winter, early summer, and fall. Throughout that period, precipitation during the non-growing season ranged from 46.6 to 135.5 percent of normal (DOE-ID 1997c). Soil moisture recharge was generally less than 16 inches deep for all areas and years except for 1989, 1993 and 1995. During those years maximum infiltration was recorded at depths of up to 4.5 feet (DOE-ID 1997c).

Infiltration rate studies have been conducted at the RWMC and ranged from 0.14 inches per year in undisturbed sediments to 6.9 feet per day inside the SDA (i.e., disturbed sediments) within the RWMC (Becker et al. 1996). The basalt takes from 0.016 feet per day under normal infiltration conditions (i.e., undisturbed basalt under natural flow conditions) to 16.9 feet per day through fractured basalt during the aquifer pumping and infiltration test (i.e., pumping from a well) near the RWMC (Becker et al. 1996).

The Snake River Plain Aquifer is primarily recharged by infiltration from rain and snowfall that occurs within the drainage basin surrounding the Eastern Snake River Plain and from deep percolation of irrigation water and stream flow from rivers that lose water along their flowpaths. All rivers contribute to recharging the Snake River Plain Aquifer (Becker et al. 1996). If streamflow exists on the INEEL, it is lost to the ground and eventually recharges the Snake River Plain Aquifier (Becker et al. 1996).

Aquifer permeability is controlled by the distribution of highly fractured basalt flow tops, interflow zones, lava tubes, fractures, vesicles, and intergranular pore spaces. The variety and degree of interconnected water-bearing zones complicates the direction of groundwater movement locally throughout the aquifer (Becker et al. 1996). The permeability of the aquifer varies considerably over short distances, but generally, a series of basalt flows will include several excellent water-bearing zones. Estimates of flow velocities within the Snake River Plain Aquifer range between 5 and 20 feet per day. Transmissivity values range from 1.1×10^{0} to 1.2×10^{7} square feet per day (Becker et al. 1996). Depth to groundwater near the RWMC is approximately 590 ft (Becker et al. 1996).

Discharge areas occur at springs and from pumping wells for water consumption. Major springs and seepages that flow from the aquifer on a regional scale are located near the American Falls Reservoir (southwest of Pocatello), the Thousand Springs area between Millner Dam and King Hill (near Twin Falls), and between Lorenzo and Lewisville, along the Snake River (DOE INEL EIS, Section 4.8.2.1).

Groundwater chemistry data was obtained by water sampling and chemical analysis. Sampled monitoring wells are purged until field parameters (pH, temperature, and specific conductivity) stabilize. This ensures that the sampled water is formation water and not residual water that has been chemically altered in the well. The USGS has been routinely monitoring wells at the INEEL since 1949 and uses these methods of sampling. Analytical techniques used to determine concentrations of solutes include liquid scintillation and alpha, beta, and gamma testing for radionuclides; atomic adsorption for metals and anions; and gas chromatography/mass spectrometry for volatile organic compounds. Recently, studies have used inductively coupled plasma-mass spectrometry for chemical analysis of cations, which offers lower detection limits and an expanded analyzed list (DOE-ID 1997c). In 1996, the USGS routine groundwater surveillance program included collection of 374 samples for radionuclides and inorganic constituents including trace elements and 66 purgeable organic compounds on the INEEL.

Fate and transport modeling for the INEEL has been conducted previously and is discussed thoroughly in the DOE INEL EIS (Sections 5.8.1, 5.8.2.2, and Appendix Section F.2.2.2.3). Recent modeling activities include the fate and transport of volatile organic compounds for the SDA within the RWMC. The computer code used was PORFLOW^{TM} and the analysis was conducted by Lockheed Idaho Technologies Company, Buried Waste and Landfill Department (Becker et al. 1996). This numerical simulation was conducted after installment of the vapor vacuum extraction wells. The wells were installed as part of a Record of Decision (ROD) between DOE, U.S. Environmental Protection Agency (EPA) and the State of Idaho to use the vapor vacuum extraction with treatment. Future modeling of the SDA for the proposed remedial investigation/feasibility study of Operable Unit 7-13/14 is planned for the future (Becker et al. 1996).

E-3 Air Resources

The characterization of air resources and assessment of impacts of alternative courses of action required (1) the performance of air dispersion modeling, and (2) the evaluation of results in terms of regulatory criteria developed to protect public health and welfare. Appendix Section E-3 presents background information related to these topics. The information presented herein supports the summary results presented in Sections 4.7 and 5.7 (Air Resources) and Sections 4.3 and 5.3 (Visual and Aesthetic Resources) of this EIS, which respectively describe the affected environment and consequences of alternatives on air quality.

The air resource assessments performed in support of this EIS utilized independent analyses performed by specialists from contractor organizations, as well as tiering from the DOE INEL EIS. Documents which are considered key references, their contents, and the manner in which they were used in the air resources assessments are summarized as follows:

- Applications for a State of Idaho Permit to Construct (BNFL 1998b and c) and a National Emission Standard for Hazardous Air Pollutants (NESHAP) analysis for radiological impacts (BNFL 1998a). These documents provide data on facility location, design and projected emission rates.
- Material and energy balance calculations which were prepared to support permitting of the proposed AMWTP (BNFL 1998d). This document is also cited in the above-mentioned permit applications in support of emission calculations for criteria and selected toxic air pollutants.
- INEEL radiological NESHAP Reports for the calendar years 1995 and 1996 (DOE-ID 1996d, 1997b) were used to establish the existing radiological conditions in terms of airborne radionuclide emissions and highest dose to an offsite receptor.
- INEEL air emissions inventory for the years 1995 and 1996 (DOE-ID 1996b, 1997a) were used to update the criteria pollutant emission rates from existing INEEL facilities. These were compared with the emission rates which were used in the DOE INEL EIS to ensure that the current rates are within the bounds of those used in the DOE INEL EIS as a basis for characterizing existing conditions through atmospheric dispersion modeling.

Appendix Section E-3 attempts to integrate the descriptions of methods, assumptions, and other key information from the analyses cited above into a single source. The remainder of this section is organized as follows:

- Appendix Section E-3.1 presents background environmental information on the INEEL.
- Appendix Section E-3.2 contains a description of air quality standards and regulations, and a discussion of how they apply to sources at the INEEL. This section also details the controls incorporated into the proposed AMWTP to minimize air quality impacts and ensure regulatory compliance.
- Appendix Section E-3.3 provides supplemental information on the methods and assumptions used to estimate emissions and assess baseline conditions and impacts of releases of radiological and nonradiological pollutants.

E-3.1 The Idaho National Engineering and Environmental Laboratory Environment

This section describes background levels of radiation, airborne radioactivity, and nonradiological air quality in the environs of the INEEL.

E-3.1.1 Radiation and Airborne Radioactivity

The population of the Eastern Snake River Plain is exposed to environmental radiation from both natural and other sources of human origin. The predominant source of radiation in the region is the natural radiation background, a term that refers to natural sources of radiation to which humans are continuously exposed. Background radiation includes sources such as cosmic rays; radioactivity naturally present in soil, rocks, and the human body; and airborne radionuclides of natural origin (such as radon). The dose from background radiation results from sources that can be either external (outside the body) or internal (within the body). External sources consist primarily of cosmic rays and radioactivity within soil and rocks. Internal sources include radioactivity naturally present within the human body and airborne radioactivity of natural origin that can deposit in the lungs when inhaled. The natural background dose for residents of the Eastern Snake River Plain is estimated at about 360 millirem per year, with more than half (about 200 millirem per year) caused by the inhalation of radioactive particles formed by the decay of radon (DOE-ID 1997c).

In addition to natural background sources, residents of the Eastern Snake River Plain receive exposure from other sources of human origin, including medical X-rays, nuclear medicine diagnostic procedures, consumer products (such as televisions, smoke detectors, or self-luminous products), and radioactivity remaining in the environment as a result of worldwide atmospheric testing of nuclear weapons. Collectively, these result in an annual dose of about 68 millirem to the average U.S. population member, with most of this dose (about 54 millirem per year) resulting from the medical use of radiation (NCRP 1987). This dose does not include the contribution from radioactivity in tobacco products, which results in a substantial radiation dose (several rem per year) to the lungs of smokers. Additional information related to radiological conditions (including monitoring results and airborne radioactivity associated with existing INEEL facilities) is presented in the site environmental report (DOE-ID 1997c).

E-3.1.2 Background Nonradiological Air Quality

As used here, the term background air quality refers to the levels of nonradiological air pollutants in ambient air that are not attributable to INEEL activities. Regional ambient air monitoring data is sparse; however, it is recognized that air quality in the area is good. Some data have been collected by the National Park Service (NPS) at Craters of the Moon National Monument. That monitoring program has shown no exceedances of the primary ozone standard, low levels of sulfur dioxide (although there was one exceedance for the 24-hour maximum standard in 1985), and total suspended particulate matter within the applicable standards. The NPS has concluded that available data do not currently indicate a significant threat to Craters of the Moon from gaseous pollutants (DOI 1994, Section IV.B.3.a.iii). More recently the NPS has upgraded this program to include aerosols and fine particulates, as described later in this section. The NPS also monitors parameters related to the estimation of background visual range, which they have estimated to be 144 miles annual average (Notar 1998a).

Nitrogen dioxide is monitored at two locations on the INEEL: The Van Buren location is near the intersection of Van Buren Avenue and Highway 20/26, while the Experimental Field Station (EFS) is about 3 miles northeast of the Idaho Chemical Processing Plant. Sulfur dioxide is also monitored at the Van Buren location. Pollutant levels measured at Van Buren are considered "ambient," since they occur along a public road used by the general public. The EFS station, however, is located in a restricted area in the central portion of INEEL, and levels at that location are not representative of "ambient" conditions. Table E-3-1 summarizes the nitrogen dioxide and sulfur dioxide monitoring results for these stations.

Table E-3-1. Measured levels of nitrogen dioxide and sulfur dioxide on the INEEL during 1996.

INEEL Location	Pollutant	Averaging Time	Measured concentration (ug/m^3)	Ambient Air Quality Standard [a] (ug/m^3)
Van Buren Avenue	Nitrogen dioxide	Annual	3.1	100
	Sulfur dioxide	3-hour	24.0	1,300
		24-hour	20.7	363
		Annual	4.0	80
Experimental Field Station	Nitrogen dioxide	Annual	8.1	100

Source: DOE-ID 1997c.

a. Ambient air quality standard specified in IDHW 1997.

The average nitrogen dioxide concentration measured during 1996 at the Van Buren station was 3.1 micrograms per cubic meter. This is a small fraction of the Idaho Ambient Air Quality Standard (AAQS) for annual average nitrogen dioxide, which is 100 micrograms per cubic meter. At EFS, the quarterly samples ranged from 2.1 to 19.2 micrograms per cubic meter. The latter value was measured during the third quarter, and the above-normal concentrations were likely influenced by brush fires that occurred in the region during the late summer. For the year, the EFS mean was 8.1 micrograms per cubic meter. The New Waste Calcining Facility (NWCF), which is the largest source of nitrogen dioxide emissions at the INEEL, did not operate during 1996. Levels of nitrogen dioxide measured at EFS can increase significantly while this facility is operating. The highest concentration of this pollutant measured at EFS during periods of NWCF operation was 50 micrograms per cubic meter, which occurred during 1993 (DOE-ID 1997c).

Sulfur dioxide levels are measured at Van Buren for 3-hour, 24-hour, and annual periods, which correspond to the averaging times specified by the AAQS. The mean level of sulfur dioxide measured at Van Buren during 1996 was 4.0 micrograms per cubic meter (DOE-ID 1997c), which is well below the Idaho AAQS of 80 micrograms per cubic meter. The highest 3-hour and 24-hour levels were also well below their respective standards.

Until recently, the State of Idaho had an air quality standard for total suspended particulate matter, and levels of this pollutant form were monitored at various locations in the INEEL region. Table E-3-2 gives a ten-year summary of total particulate matter concentrations, which indicates that total particulate levels on the INEEL are generally lower than levels at proximal or distant locations. Since 1987, however, EPA began using a standard for fine particulate matter (that is, particles less than or equal to 10 microns in diameter, or PM_{10}). This "respirable" form of particulate matter is considered more indicative of potential effects on human health. The State of Idaho has now discontinued its standard for total particulate matter, and instead specifies one for PM_{10}. The standard for annual average fine particulate matter is 50 micrograms per cubic meter, while the 24-hour standard is 150 micrograms per cubic meter (IDHW 1997). Only limited monitoring data are available for this form of airborne particulate matter. A monitor in Rexburg recorded a mean level of 23 ± 3 micrograms per cubic meter during late 1996, while a sampler in Blackfoot recorded a mean level of 14 ± 10 micrograms per cubic meter (DOE-ID 1997c). It should be noted that these values do not represent annual averages since they began operating only during the latter part of the year.

Recent analyses of health impacts associated with particulate matter has prompted the EPA to develop a standard that applies to very fine particulate matter (that is, with particle diameter less than 2.5 microns, or $PM_{2.5}$). This form of particulate matter is also the type most commonly associated with visibility impairment. Since 1992, samplers have

been operating at Craters of the Moon National Monument and the INEEL Central Facilities Area under the Interagency Monitoring of Protected Visual Environment (IMPROVE) program. The most recent data available are through February 1996. At Craters of the Moon, $PM_{2.5}$ levels over this period have ranged from 0.4 to 25 micrograms per cubic meter, with a mean of 3.6 micrograms per cubic meter. Concentrations at Central Facilities Area over the same period ranged from 0.5 to 28 micrograms per cubic meter, with a mean of 4.5 micrograms per cubic meter. The highest levels observed correspond to periods when smoke from western forest fires covered the Snake River Plain, and during a wintertime temperature inversion condition (DOE-ID 1997c).

Table E-3-2. Ten-year summary of total particulate matter sampling results in the INEEL region.

	Group mean concentration (ug/m^3) [a]		
Year	Distant group [b]	INEEL boundary group [c]	INEEL (onsite) group [d]
1987	45 +/- 16	34 +/- 8	28 +/- 8
1988	50 +/- 20	35 +/- 9	32 +/- 13
1989	40 +/- 14	30 +/- 7	17 +/- 2
1990	36 +/- 12	32 +/- 8	20 +/- 9
1991	30 +/- 20	28 +/- 12	18 +/- 3
1992	26 +/- 19	23 +/- 10	13 +/- 2
1993	21 +/- 21	18 +/- 8	13 +/- 3
1994	28 +/- 28	23 +/- 7	25 +/- 4
1995	32 +/- 30	28 +/- 13	20 +/- 7
1996 (ESRF Data)	24 +/- 10	22 +/- 5	9 +/- 1
1996 (LMITCO Data)	25 +/- 10	-	10 +/- 2

Source: DOE-ID 1997c.

a. Values given are the arithmetic mean with the 95% confidence limit for the mean

b. Sampler locations include Craters of the Moon, Blackfoot, Idaho Falls, Mountain View, and Rexburg.

c. Sampler locations include Arco, Atomic City, FAA Tower, Howe, Monteview, Mud Lake and Reno Ranch.

d. Includes samplers at three locations monitored by the Environmental Science and Research Foundation (ESRF), and locations monitored by LMITCO.

E-3.2 Air Quality and Environmental Protection

Standards and Regulations

Air quality regulations have been established by Federal and State agencies to protect the public from potential harmful effects of air pollution. The Federal *Clean Air Act* (CAA) establishes the framework to protect the nation's air resources and public health and welfare. EPA and the State of Idaho are jointly responsible for establishing and implementing programs that meet the requirements of the CAA. These regulations are based on an overall strategy that incorporates the following principal elements:

- Designation of acceptable levels of pollution in ambient air to protect public health and welfare;

- Implementation of a permitting program to regulate (control) emissions from stationary (nonvehicular) sources of air pollution; and

- Issuance of prohibitory rules, such as rules prohibiting open burning.

Facilities planned or currently operating at the INEEL are subject to air quality regulations and standards established under the CAA and by the Idaho Department of Health and Welfare (IDHW), Division of Environmental Quality, and to internal policies and requirements developed by DOE for the protection of the environment and health. At the INEEL, programs have been developed and implemented to ensure compliance with air quality regulations by (1) identifying sources of air pollutants and obtaining necessary State and Federal permits, (2) providing adequate control of emission of air pollutants, (3) monitoring emissions sources and ambient levels of air pollutants to ensure compliance with air quality standards, (4) operating within permit conditions, and (5) obeying prohibitory rules. Air quality standards and programs applicable to INEEL operations are summarized in Figure E-3-1 and are described in further detail below. This section also provides information on project design features to mitigate air quality impacts and operate within the bounds of regulatory requirements.

E-3.2.1 Ambient Air Quality Standards

The CAA establishes National Ambient Air Quality Standards (NAAQS) to protect public health and welfare. Primary standards define the ambient concentration of an air pollutant below which no adverse impact to human health is expected. A second category of standards (called secondary standards) has been established to prevent adverse impacts on public welfare, including aesthetics, property, and vegetation. Certain standards apply to long-term (annual average) conditions; others are short-term, applying to conditions that persist for periods ranging from one hour to three months, depending on the toxic properties of the pollutant in question. Ambient standards have been developed for only a few specific contaminants, namely respirable particulate matter (particles not larger than 10 micrometers in diameter, which tend to remain in the lung when inhaled), sulfur dioxide, nitrogen dioxide, carbon monoxide, lead, and ozone. In addition to adopting the NAAQS as State AAQS, Idaho has also established an additional State ambient air quality standard for fluorides in vegetation.[1] These ambient air quality standards are used in Section 5.7, Air Resources, in the regulatory compliance evaluations of projected AMWTP emissions (see Table 5.7- 6). The EPA and the State of Idaho have used monitored ambient air quality data in an attempt to define areas as either attainment (that is, the standard in question is not exceeded), or nonattainment of each ambient air quality standard, although many areas are unclassified due to a

Clean Air Act

Federal Program	**State of Idaho Administration Program**	**DOE Compliance Program**
National Ambient Air Quality Standards (NAAQSs) • Set limits on ambient air concentrations of sulfur dioxide, nitrogen dioxide, respirable particulate matter, carbon monoxide, lead, and ozone (criteria pollutants). • Primary standards for protection of public health; secondary standards for protection of public welfare. **Prevention of Significant Deterioration (PSD)** • Limits deterioration of air quality and	**Rules for the Control of Air Pollution in Idaho** Current Regulations of the State of Idaho Department of Health and Welfare (IDHW 1997) include: • **Idaho Ambient Air Quality Standards** - Similar to NAAQSs but also include standards for total fluorides. • **New Source Program** -	Policy to comply with applicable regulations and maintain emissions at levels as low as reasonably achievable. Policy implemented through DOE orders. • DOE (Headquarters) orders apply to all DOE and DOE-contractor operations. • DOE-Idaho Operations Office (DOE-ID) supplemental directives provide direction and guidance specific to the INEEL.

visibility in areas that are better than the NAAQSs.
- Requires Best Available Control Technology on major sources in attainment areas.

New Source Performance Standards

- Regulate emissions from specific types of industrial facilities (for example, fossil fuel-fired steam generators and incinerators).

National Emission Standards for

Hazardous Air Pollutants (NESHAP)

- Control airborne emissions of specific substances harmful to human health.
- Specific provisions regulate hazardous air pollutants and limit radionuclide dose to a member of the public to 10 millirem/year.
- Proposed regulation will control emission of hazardous air pollutants from combustion of hazardous waste.

Clean Air Act **(CAA) Amendments of 1990**

- Sweeping changes to the CAA, primarily to address acid rain, nonattainment of NAAQSs, operating permits, hazardous air pollutants, potential catastrophic releases of acutely hazardous materials, and stratospheric ozone depletion.
- Specific rules and policies not yet fully developed and implemented in all areas (for example, hazardous air pollutants).

Permit to construct is required for essentially any construction or modification of a facility that emits an air pollutant; Major facilities require PSD analysis and permit to construct.

- **Carcinogenic and Noncarcinogenic Toxic Air Pollutant Increments -** Defines acceptable ambient concentrations for many specific toxic air pollutants associated with sources constructed or modified after May 1, 1994; Requires demonstration of preconstruction compliance with toxic air pollutant increments.

- **Operating Permits -** Required for nonexempt sources of air pollutants; Define operating conditions and emissions limitations, as well as monitoring and reporting requirements.

Rules and Standards for Hazardous Waste

- Includes standards for hazardous waste treatment facilities, including limits on emissions.
- Consistent with federal standards.

The most relevant DOE orders and their DOE-ID supplemental directives are:

- **DOE Order 5400.1** establishes general environmental protection program requirements and assigns responsibilities for ensuring compliance with applicable laws, regulations, and DOE policy.
- **DOE Order 5400.5** provides guidelines and requirements for radiation protection of the public.
- **DOE Order 5480.1B** establishes the Environment, Safety, and Health (ES&H) Program for DOE operations (implemented via DOE-ID Supplemental Directive 5480.1).
- **DOE Order 5480.4** prescribes the application of mandatory ES&H standards that shall be used by all DOE and DOE-contractor operations (implemented via DOE-ID Supplemental Directive 5480.4).
- **DOE Order 5480.19** provides guidelines and requirements for plans and procedures in conducting operations at DOE facilities (implemented via DOE-ID Supplemental Directive 5480.19).

Figure E-3-1. Overview of Federal, State, and DOE programs for air quality management.

lack of regional monitoring data. The attainment status is specific to each pollutant and averaging time.

Designation as either attainment or nonattainment not only indicates the quality of the air resource but also dictates the elements that must be included in local air quality regulatory control programs. The elements required in nonattainment areas are more comprehensive (or stricter) than in attainment areas. Unclassified areas are generally treated as being in attainment. The region that encompasses the environs of the INEEL has been classified as attainment or unclassified for all NAAQS, meaning that air pollution levels are considered healthful. The nearest nonattainment area lies some 50 miles south of the INEEL in Power and Bannock Counties. This area has been designated as nonattainment for the standards related to respirable particulate matter.

E-3.2.2 Prevention of Significant Deterioration

The CAA contains requirements to prevent the deterioration of air quality in areas designated as attainment of the AAQSs. These requirements are contained in the Prevention of Significant Deterioration (PSD) amendments and are administered through a program that limits the increase in specific air pollutants above the levels that existed in what has been termed a baseline (or starting) year. The amendments specify maximum allowable ambient pollutant concentration increases, or increments. Increment limits are specified for the nation as a whole (designated as Class II areas), and more stringent increment limits (as well as ceilings) are prescribed for designated national resources, such as national forests, parks, and monuments (designated as Class I areas). In Southeastern Idaho, the Craters of the Moon Wilderness Area is the only Class I area. Increment values applicable to the INEEL and Craters of the Moon are presented in Section 4.7.

The IDHW, Division of Environmental Quality, administers the PSD Program. Proposed new sources of emissions at the INEEL and modifications are evaluated to determine the expected level of emissions of all pollutants. The INEEL is considered a major source, since facility-wide emissions of some air contaminants exceed 250 tons per year. As

such, a PSD analysis must be performed whenever any modification would result in a significant net increase of any air pollutant. Levels of significance range from very small quantities (less than one pound) to over 100 tons per year, depending on the toxic nature of the substance. For radionuclides, significance levels range from any increase in emissions to that which would result in an offsite dose of 0.1 millirem per year or greater, depending on total facility emissions. If an INEEL facility requires a PSD permit, it must be demonstrated that the source:

- Will be constructed using best available control technology (a level of control which is technologically feasible and considered cost-effective) to reduce air emissions;
- Will operate in compliance with all prohibitory rules;
- Will not cause a detriment to ambient air quality at the nearby Craters of the Moon Wilderness Area, a PSD Class I area; and
- Will not result in an exceedance of an ambient air quality standard.

The evaluation also includes an assessment of potential growth and associated impacts to air quality-related values–visibility, vegetation, and soils. Generally, all PSD projects must go through a public comment period with an opportunity for public review. The INEEL has been granted more than 20 PSD permits by the Division of Environmental Quality.

E-3.2.3 National Emission Standards for Hazardous Air Pollutants

In addition to ambient air quality standards and PSD requirements, the CAA designates requirements for sources that emit substances designated as hazardous air pollutants. These requirements are specified in a program termed NESHAP. This program was substantially amended in 1990 and has yet to be fully implemented. However, one section of the NESHAP program that currently applies to INEEL operations is contained in Title 40 of the Code of Federal Regulations (CFR) Part 61, Subpart H, *National Emissions Standards for Radionuclides from Department of Energy Facilities*. This regulation establishes a limit to the dose that may be received by a member of the public due to operations at the INEEL. The annual dose limit (10 millirem) applies to the maximally exposed offsite individual and is designed to be protective of human health with an adequate margin of safety. The regulation also establishes requirements for monitoring emissions from facility operations and analysis and reporting of dose.

The INEEL complies with the requirements of the NESHAP through programs to monitor radionuclide emissions, evaluate dose to nearby residences, and report doses annually to the EPA. Proposed new sources of emissions at the INEEL and modifications are evaluated to identify the expected contribution to dose to nearby residents. If specified levels (fractions of the acceptable dose for combined site operations) are exceeded, a NESHAP permit application is prepared for submittal to the EPA. New sources are also evaluated to determine emissions monitoring requirements. The INEEL currently holds more than 25 NESHAP permits granted by the EPA.

In addition to radionuclides, emissions standards have been established under the NESHAP program for several nonradiological hazardous air pollutants, including benzene, asbestos, and others. The INEEL complies with the requirements for evaluation, control, and permitting of nonradiological hazardous air pollutants through programs that are also administered by the EPA. In accordance with Title III of the 1990 Amendments to the CAA, maximum achievable control technology (MACT) will be specified by the EPA for various source categories. Each MACT will require a level of control at least as stringent as the best performing (i.e., best controlled) sources within each designated source category. Sources will be required to implement programs or controls to comply with the MACT by the scheduled implementation date. If the residual risk is above specified acceptable limits, additional controls will be required. Several MACT standards have been promulgated or proposed. Proposed MACT emission standards and work practice requirements associated with combustion of hazardous waste are expected to be issued in final form prior to

the operation of the proposed AMWTP. The proposed AMWTP, has, therefore, been designed to meet or exceed the proposed emissions standards, as well as limit residual risk to levels which will protect the public and occupational workers. Table E-3-3 contains the proposed emission standards (expressed as stack concentrations) and shows the equivalent emission rate limit under anticipated AMWTP stack conditions. For comparison, the emission rates which were assessed for impact are also presented. Cases in which the emission rate assessed for impacts is greater than the emission rate limit reflect the use of conservative assumptions. Actual emission rates are expected to be well below the limits in all cases, and the AMWTP would have to conduct trial burns to demonstrate the ability to meet these limits before an operating permit would be issued by the State of Idaho. The MACT rule will also require a vigilant program of monitoring, recordkeeping, and periodic reporting to EPA and/or the State of Idaho to document and certify operational compliance.

It is also expected that other INEEL air emissions sources will be assigned MACT requirements as standards are promulgated for additional source categories, including (but not limited to) waste treatment, storage and disposal facilities, research and development activities, industrial boilers, process heaters, stationary internal combustion engines, other hazardous waste incinerators, and site remediation activities.

Table E-3-3. Proposed MACT concentration standards for combustion of hazardous waste and associated AMWTP emission rates.

Hazardous air pollutant or surrogate and units	Proposed standard [a]	Equivalent AMWTP incinerator emission rate [b] (g/hr)	AMWTP incinerator emission rate assessed for impact [c] (g/hr)
Dioxins and furans (nanograms per dry standard cubic meter, as 2,3,7,8-TCDD equivalent)	0.20	2.4E-07	2.4E-07 [d]
Mercury (micrograms per dry standard cubic meter)	40	0.047	0.13 [e]
Particulate matter [f] (micrograms per dry standard cubic meter)	0.015	0.000018	1.2E-08
Hydrogen chloride and chlorine (parts per million by volume as hydrogen chloride equivalents)	75	130	280 [g]
Semi-volatile metals (total lead and cadmium, micrograms per dry standard cubic meter)	100	0.12	7.0E-08
Low-volatile metals (total antimony, arsenic, beryllium and chromium, micrograms per dry standard cubic meter)	55	0.065	5.5E-09
Carbon monoxide [h] (parts per million by volume)	100	140	100

Hydrocarbons [h] (parts per million by volume, as propane)	10	21	11

a. All MACT standard concentrations are based on dry, standard conditions corrected to 7 percent oxygen; the AMWTP incinerator offgas is assumed to be 4.5 percent oxygen.
b. Emission rate that corresponds to MACT concentration limit, assuming an incinerator flue volumetric flow rate of 839 actual cubic feet per minute and 4.5 percent oxygen (per 40 CFR 264.343).
c. Maximum hourly emission rates listed for incineration in Table E-3-8. These emission rates do not represent expected levels in the incinerator offgas, but rather reflect the application of conservative assumptions to ensure that maximum potential impacts on air quality have been identified by the impact analysis.
d. The dioxin/furans emission rate analyzed for impact is that rate that corresponds to the proposed MACT limit. The incinerator air pollution control system includes a rapid water quench which is designed to control emissions of dioxin/furans (which are not constituents of the waste to be treated but are byproducts of incomplete combustion) to levels below the proposed MACT limit. Trial burns would be required to establish that the MACT-prescribed concentration will not be exceeded.
e. The mercury emission rate analyzed for impacts is based on the conservative assumption that the waste feed contains 1 percent mercury. Preliminary waste characterization indicates the actual mercury content of waste to be incinerated is much less than 1 percent. Feed limits and other requirements (including the monitoring of mercury concentrations in the offgas) would be imposed as conditions of the permit to ensure the stack concentration is below the applicable MACT standard.
f. Particulate matter is specified as a surrogate for control of non-mercury metals.
g. The hydrogen chloride and chlorine emission rates analyzed for impacts are based on conservative assumptions for waste feed content (47% chlorinated compounds) and air pollution control system removal efficiency.
h. Pollutants are specified as surrogate indicators of good combustion control.

E-3.2.4 State of Idaho Permit Programs

The Idaho Air Pollution Control Program, administered by the Division of Environmental Quality, requires that permits be obtained for potential sources of air pollutants. Unless the source is specifically exempt from permitting requirements, Permits to Construct and Operate must be obtained before a source can be constructed or operated. The permits specify source requirements, such as monitoring, reporting and record keeping, or limitations on operating conditions, such as emission limits. The list of equipment or operations which are exempt from permit requirements is very specific and limited; most new INEEL sources and modifications to existing sources are subject to permit requirements.

In addition to individual source permits, the INEEL is also required to obtain a Sitewide "Title V" Operating Permit, as stipulated under the 1990 CAA Amendments, which must be renewed periodically. The INEEL submitted an application for a Title V Operating Permit in July 1995. Permits are typically issued with specific emissions limits and conditions for operation. This formal permitting process allows the State to determine that emissions will be adequately controlled, the source will comply with all emission standards and regulations, and public health and safety will be adequately protected. Generally, Operating Permit reviews must go through a public review period with an opportunity for public comment. The MACT program (Title III of the 1990 CAA Amendments which is discussed above) will be administered under the Title V program and also allow for public review and comment.

E-3.2.5 New Source Performance Standards

New Source Performance Standards represent a part of the regulatory framework that has been in place since before the CAA Amendments of 1990. These standards require the use of best demonstrated technology when major sources are constructed or modified. Rules for the Control of Air Pollution in Idaho (IDAPA 16.01.01.590) specify that the modified stationary sources in Idaho shall comply with applicable requirements of the New Source Performance Standards prescribed by 40 CFR Part 60. These standards apply to major modified sources, and it is not clear whether the proposed AMWTP meets this definition. Nevertheless, compliance with other regulations (such as the expected MACT Rule) will likely require that the design features of the proposed AMWTP waste treatment systems be at least as restrictive as any that would be required under New Source Performance Standards.

E-3.2.6 State of Idaho Rules for Toxic Air Pollutants

The Idaho Division of Environmental Quality has promulgated rules and methodologies to estimate and control the potential human health impacts of toxic air pollutants (pollutants which by their nature are toxic to human or animal life or vegetation) from new or modified sources.[1] These rules are contained in Title 1, Chapter 1, Sections 585 and 586 of the Rules for the Control of Air Pollution in Idaho (IDHW 1997) and are implemented through the air quality permit program described above. Emission levels of significance have been established for about 700 toxic air pollutants, based on the known or suspected toxicity of these substances. Expected (uncontrolled) emission rates above administrative screening levels must be evaluated using standard air dispersion modeling techniques and risk assessment methodologies to assess potential impacts. The State has defined acceptable ambient concentration levels for many toxic air pollutants, including both carcinogenic and noncarcinogenic contaminants. These levels are increments over existing levels and apply only to sources that became operational after May 1, 1994.

For contaminants known or suspected to cause cancer in humans, this level has been defined as the acceptable ambient concentration for a carcinogen (AACC). The AACC is based on risk and corresponds to that concentration at which the probability of contracting cancer is one in a million, assuming continuous exposure over a 70-year lifetime.[2] The AACC differs for each carcinogenic substance due to its carcinogenic potency, as defined by the EPA. The State will grant a permit if the calculated incremental risk due to project emissions does not exceed the AACC (that is, does not result in an individual excess cancer risk greater than one in a million). If this level is expected to be exceeded, a permit may still be granted if (a) the calculated risk does not exceed ten in a million and (b) toxic reasonably achievable control technology (which is similar to best available control technology, or BACT) is employed to limit emissions of carcinogenic substances. A facility will not be granted a permit unless it can be shown that the emissions will comply with all applicable toxic air pollutant increments for carcinogenic (cancer-causing) and noncarcinogenic substances (IDHW 1997). As part of the permit evaluation process, requirements related to toxic air pollution control equipment, facility modifications, and materials substitutions may be specified to limit ambient levels of toxic air pollutants.

Many air contaminants do not cause cancer but may contribute to other health impacts, such as respiratory or eye irritants, or impacts to the cardiovascular, reproductive, central nervous or other body systems. Levels of significance for noncarcinogenic substances are called acceptable ambient concentrations (AAC). The AAC is based on acceptable exposure limits for occupational workers and other reference sources of information for the contaminant in question. For an added margin of safety, the State generally sets the AAC at one-hundredth of the acceptable occupational exposure level. Permits are granted if incremental emissions from the new or modified source are expected to result in annual average concentrations below the AAC. However, if the AAC is expected to be exceeded, a permit may still be granted based on consideration of other factors, such as the toxicity of the substance and anticipated level of exposure.

E-3.2.7 Standards for Hazardous Waste and Toxic Substance Control

In addition to regulations designed specifically for air resource protection, projects which include handling or treatment of hazardous substances are required to comply with various Federal and State environmental regulatory programs which incorporate certain requirements on releases to air. Among the most important requirements for hazardous waste incineration are the standards for the destruction of organic hazardous constituents in solid wastes prescribed by EPA and *Idaho Administrative Procedures Act* (IDAPA) 16.01.05.008 (40 CFR 264 Subpart O). Polychlorinated biphenyls (PCB) incineration must achieve the minimum 99.9999 percent destruction and removal efficiency of the *Toxic Substances Control Act* (TSCA), while incineration of other difficult-to-destroy compounds, such as chlorobenzene and carbon tetrachloride, must achieve a minimum 99.99 percent destruction and removal efficiency.*Resource Conservation and Recovery Act* (RCRA) performance standards for hydrogen chloride emissions in IDAPA 16.01.05.008 require either 99 percent hydrogen chloride removal or less than 4 pounds per hour hydrogen chloride during the incineration of chlorinated wastes.

E-3.2.8 Department of Energy Orders and Guides

The DOE has developed and issued a series of orders and guides to ensure that all operations comply with applicable

environment, safety, and health (ES&H) regulations and DOE internal policies, including the concept of maintaining emissions and exposures to the public and workers at levels that are as low as reasonably achievable (ALARA). The ALARA concept is employed in the design and operation of all facilities and applies to all types of air pollutants (for example, radionuclides, carcinogens, toxic and criteria air pollutants). Orders specifically designed for protection of ES&H are summarized in Appendix Section F-3.3.2 of the DOE INEL EIS.

E-3.2.9 Measures to Meet Regulatory Requirements and Minimize Impacts

Specific features have been incorporated into the proposed AMWTP design, which, together with operational controls and practices, will ensure regulatory compliance and reduce environmental impacts of releases of air contaminants. Many mitigation features are required by regulations related to hazardous waste treatment, storage and disposal facilities, and State and Federal Rules for the control of air pollution. Specific regulatory requirements will be incorporated into permit conditions related to proposed AMWTP construction and operation, and compliance with these requirements will be subject to regulatory oversight. Other mitigation features, while not specifically required by regulation, are necessary elements of the ALARA program to ensure protection of the public, workers and the environment.

Mitigation design features related to each of the processes which comprise the AMWTP alternatives (specifically, thermal and/or non-thermal treatment) are discussed below, including the separate air pollution containment and control systems which serve the pretreatment area, incinerator, vitrifier/melter, and evaporator.

E-3.2.9.1 Zone 3 Areas and Gloveboxes. These areas include the pretreatment staging areas, central conveyor system, box lines, drum line, sampling and analytical gloveboxes, special case waste gloveboxes, and non-thermal treatment gloveboxes. These units would apply to the Proposed Action, Non-Thermal Treatment, and Treatment and Storage Alternatives. All uncontained waste would be located in Zone 3 areas–the interior of hot cells, process cells, glove boxes, or other containments for handling highly contaminated materials. A recirculatory self-cleaning reverse jet air filtration system would provide continuous air treatment and reduce dust loading in Zone 3 areas. Containment features would prevent the spread or release of contaminant materials both within the facility and to the environment.

Air extracted from Zone 3 areas will be passed through three stages of high efficiency particulate air (HEPA) filtration before exiting through the facility stack. The first stage of filters would be positioned locally near the areas served. In some cases, the local ducts would then combine upstream of the second and third stage filter banks. Some of the Zone 3 and glovebox areas would also be served by carbon adsorption filters, which would be installed downstream from the first-stage HEPA filters to capture possible organic emissions. In particular, the following Zone 3 and glovebox area exhaust ducts would be equipped with at least one stage of carbon filters:

- Drum line conveyor area (1st floor)
- Drum assay conveyor area (1st floor)
- Drum line area (2nd floor)
- North box line conveyor/drum staging area
- South box line conveyor/drum staging area
- Special case waste glovebox system.

Each bank of HEPA and carbon filters would include a minimum of two filters in parallel.

E-3.2.9.2 Incinerator Design Requirements and Control Features. The proposed AMWTP incinerator has been designed to operate within the specifications of current and proposed regulations for combustion of hazardous waste. In particular, the following design and operational features would mitigate the production and

release of air pollutants:

- Controlled feed streams to the incinerator including limits on hourly feed rate, and maximum chlorine, ash and regulated metals feed rates;
- Controlled combustion with a primary combustion chamber temperature of 1,500 — 1,600° F, and a secondary combustion chamber temperature of 2,200 — 2,400° F to complete the combustion process. Pressure, gas velocity, gas residence time (nominal 2-second), waste feed rate and other combustion parameters would be continuously monitored and controlled as a means to achieve the minimum required destruction and removal efficiency for organic hazardous constituents;
- Independent air pollution control systems (APCS) for the incinerator, vitrifier/melter, non-thermal treatment and ancillary processes;
- Good Engineering Practice stack design to minimize concentrations of contaminants in the building cavity, and provide good dispersion of process effluents (MK 1997);
- Various controls and parameter monitoring and recording to ensure proper system operation and compliance with standards; and
- Trial burn, startup, and testing of incinerator operations which would occur for a period of several months with simulant chemicals and materials that are not regulated as hazardous wastes.

The incinerator system has been designed to function in compliance with current hazardous waste incinerator guidance and performance standards for the destruction of organic hazardous constituents in solid wastes of EPA and IDAPA 16.01.05.008 (40 CFR 264 Subpart O). Since a TSCA permit for PCB incineration would be obtained, the project has been designed to meet the minimum combustion efficiency of TSCA. Trial burns will be conducted to ensure that a 99.9999 percent PCB destruction and removal efficiency is maintained. The facility is also designed to achieve a 99.99 percent destruction and removal efficiency for difficult-to-destroy compounds, such as chlorobenzene and carbon tetrachloride, which will also be confirmed during trial burns. The facility includes a scrubbing system for hydrochloric acid removal which will be operated to comply with the RCRA hydrogen chloride performance standard in IDAPA 16.01.05.008 which requires either 99 percent hydrogen chloride removal or less than 4 pounds per hour hydrogen chloride during the incineration of chlorinated wastes to be demonstrated during the trial burns.

The incinerator and offgas control system has also been designed to function within the framework of the recently proposed emission limits of the hazardous waste combustion MACT rule of Title III, Section 112 of the CAA. The proposed MACT contains emission limitations that will control emissions to a level at least as stringent as the best performing (i.e., best controlled) hazardous waste combustion system. These are listed in Table E-3-3.

In addition, public health and safety will be reevaluated in the project permitting phase through the use of health risk assessments to be conducted in accordance IDAPA 16.01.01.585 and 586. The health risk assessment will incorporate emissions data collected during trial burns and must demonstrate that the IDAPA increments designed for protection of the public from releases of toxic air pollutants are not exceeded. If necessary, additional controls will be placed on the project if required to meet these standards for public health and safety.

E-3.2.9.3 Incinerator Air Pollution Control System. The incinerator APCS is illustrated schematically in Figure E-3-2. This system includes a combination of dry filtration and wet scrubbing subsystems, including the following:

- Saturation quencher
- Venturi scrubber
- Two absorbers in series (one acidic and one neutral to slightly basic)

Figure E-3-2. Simplified schematic of the incinerator air pollution control system (BNFL 1998b).

- Condensing wet electrostatic precipitator
- Offgas reheater
- Redundant first-stage HEPA filtration
- Carbon adsorbers
- Redundant second- and third-stage HEPA filtration
- Associated pumps and blowers, and exhaust flues.

Flue gas from the secondary combustion chamber enters the offgas quencher where it is rapidly cooled and saturated by spraying the gas with a scrub liquid. The saturated and cooled gas then enters the venturi scrubber which removes coarse particulate matter from the gas stream by impaction with atomized scrub liquid droplets. The relatively particulate-free gas would then enter the first (acidic) absorber where it would undergo scrubbing of gas-phase pollutants, mercury, and hydrochloric acid. The acidic absorber contains cooled, recirculating scrub liquid which is uniformly distributed through the entire cross section of the packing. The purpose of the second absorber is to remove sulfur dioxide and the remainder of the hydrochloric acid that passes through the acidic absorber.

Since mercury may be present in the waste streams to be treated by the incinerator, the APCS has been specifically designed to remove mercury from the offgas and scrubber liquids. Mercury would be collected gravimetrically in the low points of the quencher and acidic absorber sumps (no additional mercury removal is expected in the second absorber) and pumped to a mercury hold tank. Elemental mercury would be periodically removed from the hold tank and transferred to the special case waste glovebox for amalgamation.

The condensing wet electrostatic precipitator (WESP) would be located downstream of the second absorber and would function to remove fine scrubber liquid mist droplets and submicron particulate matter entrained in the gas stream. The WESP achieves high efficiency for these droplets and particulates, which extends the functional lifetime of the first-

stage HEPA filters by preventing condensation on these filters. Flue gas is then reheated and passed through two parallel trains consisting of three sets of HEPA filter banks. The first HEPA filter bank contains two roughing filters and a water-repellent glass paper nuclear-grade DOE-certified HEPA filter. The second stage consists of a roughing filter and a water-repellant glass paper nuclear-grade DOE-certified HEPA filter. The third (final) HEPA filter stage would employ a stainless steel or high alloy HEPA filter for durability and to provide protection against any postulated temperature or pressure excursions within the process. The HEPA filters would all have a manufacturer's specified minimum removal efficiency of 99.97% for particles of 0.3 microns (which is the most difficult size for particulate removal). Removal efficiencies for smaller and larger diameter particles would be greater.

A fixed-bed, two-stage carbon-bed adsorber would be located downstream of the first HEPA filter to collect the remainder of the mercury in the offgas stream at this point. Location of this filter downstream of the first HEPA filter stage will keep it relatively free of radioactive contamination, making changeout of carbon simpler and safer. Following the third stage of HEPA filtration, the offgas passes through two parallel exhaust blowers and discharges into the atmosphere through the incinerator offgas exhaust flue within the main stack. The blowers control the draft to maintain negative pressure within the incinerator system and to sustain the movement of the flue gas through the APCS.

E-3.2.9.4 Vitrification Offgas Treatment System. The vitrification process would include a feed system, a melter, the glass form handling system and an APCS. Each vitrification unit would have two discharge chambers each protruding into separate gloveboxes. The inside of the vitrification unit and its separate glovebox is a single continuous containment area with a single common ventilation system maintained at negative pressure with respect to the surrounding process cells.

The melter offgas treatment system (see Figure E-3-3) would include a film cooler, cyclone separator, two parallel trains of high-temperature filters, heat exchangers, three HEPA filters in series, and three parallel main blowers which maintain the melter at a constant negative pressure. The removal efficiency of the cyclone for 10-micron diameter particles is 80 to 85 percent. The high-temperature filter would be designed to collect more than 99 percent of all particles greater than 0.5 microns in diameter, and HEPA filters are 99.97 percent efficient for removal of particles in the 0.3-micron range.

E-3.2.9.5 Brine Evaporator Treatment System. The evaporator would be used to dry the scrubber brine blowdown generated from the incinerator and process non-organic liquid wastes from other areas of the plant. Brine is pumped through a thin film evaporator which disperses the liquid along the inner surface of the vessel, creating a high liquid surface area for efficient drying. Vapors from the evaporator proceed through a condenser where a portion of the vapors are condensed and returned to the condensate tank in the incinerator facility. The remainder of the vapor would be heated, passed through a HEPA filter and charcoal adsorption unit, then directed to the main Zone 3 ventilation system where it would pass through two additional HEPA filter banks and one additional carbon adsorber unit before being discharged to the atmosphere through the exhaust flue.

E-3.3 Air Quality Impact Assessment Methodology

A series of assessments have been performed to evaluate air quality for existing conditions and future actions. These are:

- Radiological air quality assessments, which are performed for radionuclide emissions from stationary sources;
- Nonradiological air quality assessments, which are performed for criteria and toxic air pollutant emissions from stationary (stack and diffuse) operational sources and fugitive dust and combustion product emissions associated with construction activities;
- Degradation of visibility assessments, which are performed for certain criteria emissions from stationary sources; and
- Assessments of criteria pollutant emissions from mobile sources.

This section describes the methodology used in each type of air quality assessment, including the general approach to source term estimation and atmospheric dispersion modeling, as well as specific information on related assumptions, methods, and data used in the analyses.

E-3.3.1 Source Term Estimation

The type and quantity of pollutants emitted to air from a specific source, or group of sources, is often referred to as the source term. The baseline source term was compiled from INEEL emissions inventory reports (DOE-ID 1996b, 1997a) and NESHAP reports (DOE-ID 1996d, 1997b), with projected increases as described in DOE INEL EIS (Section 5-7, and Appendix Section F-3). The source term for each of the proposed AMWTP alternatives was developed using conservative

Figure E-3-3. Simplified schematic of the melter air pollution control system (BNFL 1998c).

engineering and material balance flow calculations, and other information contained in permit applications and project engineering design documents (BNFL 1998a, b, c, and d; MK 1997). The source term for auxiliary equipment (boilers and diesel generators) was estimated using equipment specifications and emission factors from authoritative reference sources, such as the *Compilation of Air Pollution Emission Factors Volume 1* (EPA 1997, Sections 1 and 3).

E-3.3.1.1 Radionuclide Emission Rates. The radionuclide content of the waste to be treated is based on the inventory of the 65,000 cubic meters of waste currently in storage at the TSA (BNFL 1998a). The total activity was scaled upward to account for the fact that an additional 20,000 cubic meters of waste could be treated at the proposed AMWTP. All radionuclides which have a total waste activity of 1 curie or more are included. For each waste handling or treatment process, some fraction of the radionuclides present in the waste are assumed to be released into the process ventilation system, where most would be removed by the various filtration systems. The release fractions and filtration factors used in the release estimation are presented in Table E-3-4. The radionuclide emission rates for each process having the potential for significant emissions are presented in Table E-3-5.

Table E-3-4. Radionuclide release fractions and filtration factors used to estimate emissions from proposed AMWTP systems or areas.

			Applicable filtration factors [a]			
System or area	Sources	Release Fraction [b]	HEPA filters [c]	Venturi scrubber	Wet electrostatic precipitator	Total filtration factor
East Zone 3 non-thermal (pretreatment lines)	Box and drum lines, central conveyor system, special case waste glovebox, supercompaction, macroencapsulation	0.001	3 units @ 0.01 each = 1.0E-06 [d]	-	-	1.0E-06
East (Area 300) Glovebox extract (laboratory)	Analytical laboratory gloveboxes, sample extraction glovebox	0.001	3 units @ 0.01 each = 1.0E-06	-	-	1.0E-06
Incinerator	Incinerator offgas	1.0	3 units @ 0.01 each = 1.0E-06	0.05	0.05	2.5E-09
Vitrifier	Vitrification offgas	1.0 [e]	3 units @ 0.01 each = 1.0E-06	-	-	1.0E-06
West (Area 400) Zone 3	Evaporator offgas	1.0	3 units @ 0.01 each = 1.0E-06	-	-	1.0E-06
West (Area 400) glovebox extract	Microencapsulation glovebox	0.001	3 units @ 0.01 each = 1.0E-06	-	-	1.0E-06

Source: Based on BNFL1998a and other design information.

a. Filtration factor is the fraction of particulate radioactivity that passes through the filtration system.
b. Release fraction is the fraction of radioactivity entering the process that is assumed to be released to the offgas. Exceptions apply to H-3, C-14 and Kr-85, which are assumed to be completely released in the Area 300 pretreatment area.
c. HEPA = High efficiency particulate air filters. HEPA filters are certified for a minimum of 99.97 percent efficiency; however, 99 percent efficiency is used for particulate radionuclides as prescribed by 40 CFR 61, Appendix D.
d. A filtration factor of 1.0 is used for H-3, C-14 and Kr-85.
e. Includes the conservative assumption that 10 percent of activity entering incinerator remains in the ash and enters the vitrifier, whereupon all is released to the vitrification offgas.

Table E-3-5. Unabated and abated radionuclide emission rates for individual sources (curies per year).

	East Zone 3 Non-Thermal	East Non-Thermal	Incinerator	Vitrifier	Evaporator	Microencapsulation

	(pretreatment lines)		glovebox (Lab)								glovebox	
Radionuclide	Unabated	Abated	Unabated	Abated	Unabated	Abated	Unabated	Abated	Unabated	Abated	Unabated	Abated
Americium-241	1.5E+01 b	1.5E-05	7.2E-02	7.2E-08	5.4E+03	1.4E-05	5.4E+02	5.4E-04	1.4E+02	1.4E-04	5.4E+00	5.4E-06
Barium-137m	2.8E-01	2.8E-07	1.3E-03	1.3E-09	1.0E+02	2.5E-07	1.0E+02	1.0E-04	2.5E+00	2.5E-06	1.0E-01	1.0E-07
Bismuth-212	3.3E-03	3.3E-09	1.6E-05	1.6E-11	1.2E+00	3.0E-09	1.2E-01	1.2E-07	2.9E-02	2.9E-08	1.2E-01	1.2E-07
Carbon-14	3.0E-04	3.0E-04	-	-	-	-	-	-	-	-	-	-
Cerium-144	3.4E-03	3.4E-09	1.6E-05	1.6E-11	1.2E+00	3.0E-09	1.2E-01	1.2E-07	3.0E-02	3.0E-08	1.2E-01	1.2E-07
Curium-244	6.7E-02	6.7E-08	3.2E-04	3.2E-10	2.4E+01	6.0E-08	2.4E+00	2.4E-06	6.0E-01	6.0E-07	2.4E-02	2.4E-08
Cobalt-60	1.3E-02	1.3E-08	5.9E-05	5.9E-11	4.4E+00	1.1E-08	4.4E-01	4.4E-07	1.1E-01	1.1E-07	4.4E-03	4.4E-09
Cesium-134	1.4E-02	1.4E-08	6.6E-05	6.6E-11	4.9E+00	1.2E-08	4.9E-01	4.9E-07	1.2E-01	1.2E-07	4.9E-03	4.9E-09
Cesium-137	2.8E-01	2.8E-07	1.3E-03	1.3E-09	1.0E+02	2.5E-07	1.0E+02	1.0E-04	2.5E+00	2.5E-06	1.0E-01	1.0E-07
Iron-55	1.4E-04	1.4E-10	6.7E-07	6.7E-13	5.0E-02	1.3E-10	5.0E-03	5.0E-09	1.3E-03	1.3E-09	5.0E-03	5.0E-09
Hydrogen-3	2.7E+01	2.7E+01	-	-	-	-	-	-	-	-	-	-
Krypton-85	8.6E-04	8.6E-04	-	-	-	-	-	-	-	-	-	-
Nickel-63	4.5E-04	4.5E-10	2.1E-06	2.1E-12	1.6E-01	4.0E-10	1.6E-02	1.6E-08	3.9E-03	3.9E-09	1.6E-02	1.6E-08
Lead-212	3.3E-03	3.3E-09	1.6E-05	1.6E-11	1.2E+00	3.0E-09	1.2E-01	1.2E-07	2.9E-02	2.9E-08	1.2E-01	1.2E-07
Promethium-147	3.4E-03	3.4E-09	1.6E-05	1.6E-11	1.2E+00	3.0E-09	1.2E-01	1.2E-07	3.0E-02	3.0E-08	1.2E-01	1.2E-07
Polonium-216	3.3E-03	3.3E-09	1.6E-05	1.6E-11	1.2E+00	3.0E-09	1.2E-01	1.2E-07	2.9E-02	2.9E-08	1.2E-01	1.2E-07
Praseodymium-144	3.4E-03	3.4E-09	1.6E-05	1.6E-11	1.2E+00	3.0E-09	2.1E-06	2.1E-12	3.0E-02	3.0E-08	1.2E-01	1.2E-07
Plutonium-238	1.5E+01	1.5E-05	6.9E-02	6.9E-08	5.1E+03	1.3E-05	5.1E+02	5.1E-04	1.3E+02	1.3E-04	5.1E+00	5.1E-06
Plutonium-239	8.6E+00	8.6E-06	4.1E-02	4.1E-08	3.0E+03	7.6E-06	3.0E+02	3.0E-04	7.6E+01	7.6E-05	3.0E+00	3.0E-06
Plutonium-240	2.0E+00	2.0E-06	9.4E-03	9.4E-09	7.0E+02	1.8E-06	7.0E+01	7.0E-05	1.8E+01	1.8E-05	7.0E-01	7.0E-07
Plutonium-241	2.0E+01	2.0E-05	9.6E-02	9.6E-08	7.1E+03	1.8E-05	7.1E+02	7.1E-04	1.8E+02	1.8E-04	7.1E+00	7.1E-06
Plutonium-242	1.3E-04	1.3E-10	6.2E-07	6.2E-13	4.6E-02	1.2E-10	4.6E-03	4.6E-09	1.2E-03	1.2E-09	4.6E-05	4.6E-11
Radium-224	3.3E-03	3.3E-09	4.1E-02	4.1E-08	3.0E+03	7.6E-06	3.0E+02	3.0E-04	7.6E+01	7.6E-05	3.0E+00	3.0E-06
Antimony-125	2.1E-04	2.1E-10	9.8E-07	9.8E-13	7.3E-02	1.8E-10	2.1E-06	2.1E-12	1.8E-03	1.8E-09	7.3E-03	7.3E-09
Strontium-90	2.5E-01	2.5E-07	1.2E-03	1.2E-09	8.9E+01	2.2E-07	8.9E+00	8.9E-06	2.2E+00	2.2E-06	8.9E-02	8.9E-08
Thorium-228	3.3E-03	3.3E-09	9.4E-03	9.4E-09	7.0E+02	1.8E-06	7.0E+01	7.0E-05	1.8E+01	1.8E-05	7.0E-01	7.0E-07
Thorium-232	9.1E-04	9.1E-10	4.3E-05	4.3E-11	3.2E-01	8.1E-10	3.2E-02	3.2E-08	8.1E-03	8.1E-09	3.2E-02	3.2E-08
Thallium-208	1.2E-03	1.2E-09	5.7E-06	5.7E-12	4.2E-01	1.1E-09	4.2E-02	4.2E-08	1.1E-02	1.1E-08	4.2E-02	4.2E-08
Uranium-232	3.2E-03	3.2E-09	1.5E-05	1.5E-11	1.2E+00	2.9E-09	1.2E-01	1.2E-07	2.9E-02	2.9E-08	1.2E-01	1.2E-07
Uranium-233	1.3E-01	1.3E-07	6.1E-04	6.1E-10	4.5E+01	1.1E-07	4.5E+00	4.5E-06	1.1E+00	1.1E-06	4.5E-02	4.5E-08
Uranium-234	7.2E-04	7.2E-10	3.4E-06	3.4E-12	2.6E-01	6.4E-10	2.6E-02	2.6E-08	6.4E-03	6.4E-09	2.6E-02	2.6E-08
Yttrium-90	7.2E-04	7.2E-10	3.4E-06	3.4E-12	2.6E-01	6.4E-10	2.6E-02	2.6E-08	6.4E-03	6.4E-09	2.6E-02	2.6E-08

Source: BNFL 1998a.

E-3.3.1.2 Nonradiological Pollutant Emission Rates. Nonradiological pollutant emission rates were estimated either from anticipated mass and energy balance evaluations, with fuel consumption, waste feed content, destruction and removal efficiencies, and other factors taken into account. These emission rate estimates and their bases are documented in detail in BNFL 1998b and are summarized here.

For the waste handling and treatment processes, somewhat different approaches were used to estimate criteria pollutants, and organic and inorganic toxic air pollutants. The criteria pollutants nitrogen dioxide, sulfur dioxide and carbon monoxide are estimated primarily on the basis of anticipated fuel usage and combustion reactions. Volatile organic compound (VOC) emissions are also accounted for in areas where waste containers which house organic-bearing wastes may not be tightly closed. Particulate matter is assumed to be released by mechanical disturbance (dumping, sorting, sizing, drilling, etc.), as well as from thermal treatment. The criteria pollutant emission rates for the process boilers, heating boilers and hot water heater are estimated using anticipated fuel usage and EPA-recommended emission factors (EPA 1997). Diesel generator emissions are estimated assuming a usage rate of 52 hours per year and emission factors that have been used in compiling the annual INEEL air emissions inventory (DOE-ID 1996b), and which were also used in the DOE INEL EIS (DOE 1995).

Organic toxic air pollutant release estimates for the incinerator are made on the basis of a maximum feed rate and an

estimated destruction and removal efficiency. These estimates, shown in Table E-3-6, do not take credit for removal of organics in the offgas by the carbon adsorption filters. Releases of inorganic toxic substances from the incinerator are based on:

- the maximum expected content of the substance in the waste to be treated,
- a partitioning factor which describes the fraction of the substance that leaves the incinerator in the offgas,
- a filtration factor which accounts for removal by the various air pollution control systems.

The values used for these factors are shown in Table E-3-7. The resultant incinerator emission rates are shown in Table E-3-8, which also presents nonradiological emission rate estimates for other waste treatment processes and ancillary equipment.

Table E-3-6. Projected emission rates for toxic organic substances from the proposed AMWTP incinerator.

	Maximum	Destruction	Emission rates [a]			
	content in feed	and removal efficiency	Maximum hourly [b]		Annual average [c]	
Substance	(%)	(%)	(lb/hr)	(g/hr)	(tons/yr)	(kg/yr)
Carcinogens						
Benzene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Carbon tetrachloride	5%	99.99%	3.2E-03	1.5E+00	1.4E-02	1.3E+01
Chloroform	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
1,2-Dichloroethane (Ethylene dichloride)	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
1,1-Dichloroethylene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Dioxin/furans (2,3,7,8 TCDD equivalent) [d]	N.A.	99.9999%	5.3E-10	2.4E-07	2.3E-09	2.1E-06
Methylene chloride	0.07%	99.99%	4.5E-05	2.1E-02	2.0E-04	1.8E-01
PCBs (Arochlor)	15%	99.9999%	9.8E-05	4.4E-02	4.3E-04	3.9E-01
Tetrachloroethylene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
1,1,2-Trichloroethane	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Trichloroethylene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Noncarcinogens						
Acetone	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Butyl alcohol	0.001%	99.99%	6.5E-07	3.0E-04	2.8E-06	2.6E-03
Chlorobenzene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Cyanide	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Cyclohexane	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
2-Ethoxyethanol	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Ethyl benzene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00

Methanol	0.003%	99.99%	1.9E-06	8.9E-04	8.5E-06	7.8E-03
Methyl ethyl ketone	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Nitrobenzene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
Toluene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
1,1,1-Trichloroethane	15%	99.99%	9.7E-03	4.4E+00	4.3E-02	3.9E+01
Trichloroethylene	1%	99.99%	6.5E-04	3.0E-01	2.8E-03	2.6E+00
1,1,2-Trichloro-1,2,2-trifluoroethane	5%	99.99%	3.2E-03	1.5E+00	1.4E-02	1.3E+01
Xylene	0.005%	99.99%	3.2E-06	1.5E-03	1.4E-05	1.3E-02
Total VOCs	39%	99.99%	2.6E-02	1.2E+01	1.1E-01	9.2E+01

Source: BNFL 1998b.

a. Emission rates are based on the maximum waste feed rate to the incinerator of 650 lb/hr.
b. Impacts of non-carcinogens are evaluated using the maximum hourly emission rate.
c. Impacts of carcinogens are evaluated using the annual average emission rate which is based on a conservative operating rate of 365 days per year.
d. The dioxin/furans emission rate is based on the proposed MACT limit (see Table E-3-1 for explanation).

Table E-3-7. Factors used in estimating inorganic toxic air pollutant emission rates from the proposed AMWTP incinerator.

	Maximum		Air pollution control system removal efficiency										Combined
	content in	Partition to	Quench	Venturi	Absorber	Absorber	Wet	HEPA	Carbon	Carbon	HEPA	HEPA	Release
Substance	feed	offgas	tower	scrubber	#1	#2	ESP	Filter #1 a	Adsorb. #1	Adsorb. #2	Filter #2 a	Filter #3 a	fraction b
Carcinogens													
Arsenic	0.15%	100%	0%	20%	40%	50%	95%	99.9%	0%	0%	99.9%	99.9%	1.2E-11
Beryllium	0.15%	5%	0.0%	90%	50%	50%	97%	99.9%	0%	0%	99.9%	99.9%	7.5E-13
Cadmium	1%	100%	0%	20%	40%	50%	95%	99.9%	0%	0%	99.9%	99.9%	1.2E-11
Chromium (hexavalent)	0.005%	5%	0.0%	90%	50%	50%	96%	99.9%	0%	0%	99.9%	99.9%	1.0E-12
Nickel	0.15%	100%	0.0%	20%	40%	50%	95%	99.9%	0%	0%	99.9%	99.9%	1.2E-11
Noncarcinogens													
Barium	0.15%	100%	0.0%	90%	50%	50%	97%	99.9%	0%	0%	99.9%	99.9%	7.5E-13
Chlorine	0.77%	100%	0%	0%	80%	80%	0%	0%	0%	0%	0%	0%	4.0E-02
Chromium (trivalent)	0.15%	5%	0.0%	90%	50%	50%	96%	99.9%	0%	0%	99.9%	99.9%	1.0E-12
Hydrogen chloride	31%	100%	30%	40%	90%	95%	0%	0%	0%	0%	0%	0%	2.1E-03
Hydrogen fluoride	0.001%	100%	30%	40%	90%	95%	0%	0%	0%	0%	0%	0%	2.1E-03
Lead	1%	100%	0%	20%	40%	50%	95%	99.9%	0%	0%	99.9%	99.9%	1.2E-11
Mercury	1%	100%	0%	20%	80%	30%	60%	0%	98%	95%	0%	0%	4.5E-05
Selenium	0.077%	100%	0%	20%	40%	50%	95%	99.9%	0%	0%	99.9%	99.9%	1.2E-11
Silver	0.077%	100%	0.0%	90%	50%	50%	97%	99.9%	0%	0%	99.9%	99.9%	7.5E-13

Source: BNFL 1998b.

a. High-efficiency air particulate filters are certified for a minimum of 99.97% efficiency; 99.9% is used for conservatism.
b. The fraction of the pollutant in the offgas that is released to the outside environment. The release rate (in lb/hr) is estimated as the product of the waste feed rate (650 lb/hr), the fractional content of the substance in the waste, the fractional partition to the offgas system and the combined release fraction.

Table E-3-8. Projected nonradiological emission rates for the proposed AMWTP and support equipment.[a]

	Totals by process									
	Pretreatment and		Thermal treatment[b]							
Process included in Alternative	Non-Thermal treatment		Evaporation		Incineration		Melter		Summation	
Proposed Action (with microencapsulation) Ⓟ	x	x	x	x	x	x			x	
Proposed Action (with vitrification) Ⓟ	x	x	x	x	x	x	x	x	x	
Non-Thermal Treatment Alternative Ⓟ	x	x								
	Maximum	Annual	Maximum	Annual	Maximum	Annual	Maximum	Annual	Maximum	Annual
	hourly[c]	average[d]	hourly	average	hourly	average	hourly	average	hourly	average
Substance	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr
Criteria Pollutants										
Carbon Monoxide	-[e]	-	-	-	1.0E+02	9.1E+02	-	-	1.0E+02	9.1E+02
Oxides of Nitrogen	-	-	-	-	2.0E+03	1.7E+04	-	-	2.0E+03	1.7E+04
Sulfur Dioxide	-	-	-	-	2.8E-01	2.5E+00	-	-	2.8E-01	2.5E+00
Particulate Matter (PM-10)	9.8E-06	8.9E-05	7.6E-06	6.7E-05	1.2E-08	1.1E-07	-	-	1.7E-05	1.6E-04
Particulate Matter (Fugitive)	-	-	-	-	-	-	-	-	-	-
Volatile Organic Compounds	3.0E+00	2.7E+01	5.9E-01	5.2E+00	1.2E+01	1.0E+02	-	-	1.5E+01	1.3E+02
Lead	2.0E-06	1.7E-05	1.5E-07	1.3E-06	3.5E-08	3.1E-07	-	-	2.2E-06	1.9E-05
Carcinogens										
Arsenic (as carcinogen)	1.0E-07	8.9E-07	4.5E-07	3.9E-06	5.4E-09	4.8E-08	-	-	5.6E-07	4.9E-06
Asbestos	3.5E-06	3.1E-05	-	-	-[f]	-	-	-	3.5E-06	3.1E-05
Benzene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00
Beryllium	1.0E-07	8.9E-07	1.2E-09	1.0E-08	1.7E-11	1.5E-10	6.2E-06	5.4E-05	1.0E-07	9.0E-07
Cadmium	1.0E-07	8.9E-07	1.5E-07	1.3E-06	3.5E-08	3.1E-07	-	-	2.8E-07	2.5E-06
Carbon tetrachloride	1.5E-01	1.4E+00	7.4E-02	6.4E-01	1.5E+00	1.3E+01	-	-	1.7E+00	1.5E+01
Chloroform	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00
Chromium (hexavalent)	3.1E-09	2.7E-08	3.5E-11	3.0E-10	6.8E-13	6.0E-12	1.9E-07	1.6E-06	3.1E-09	2.7E-08
1,2-Dichloroethane (Ethylene dichloride)	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00
1,1-Dichloroethylene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00
Dioxin/furans (2,3,7,8 TCDD equivalent)	-	-	-	-	2.4E-07[g]	2.1E-06	-	-	2.4E-07	2.1E-06
Formaldehyde	-	-	-	-	-	-	-	-	-	-
Methylene chloride	2.2E-03	1.9E-02	1.0E-03	9.0E-03	2.1E-02	1.8E-01	-	-	2.4E-02	2.1E-01
Nickel	2.3E-08	2.0E-07	6.7E-08	5.9E-07	5.4E-09	4.8E-08	-	-	9.6E-08	8.4E-07
Polychlorinated Biphenyls (Arochlor)	4.2E-07	3.7E-06	4.4E-02	3.9E-01	4.4E-02	3.9E-01	-	-	8.9E-02	7.8E-01
Tetrachloroethylene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00
1,1,2-Trichloroethane	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00
Trichloroethylene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00

Table E-3-8. Projected nonradiological emission rates for the proposed AMWTP and support equipment[a] (continued).

	Totals by process											
	Pretreatment and		Thermal treatment									
Process included in Alternative	Non-Thermal treatment		Evaporation		Incineration		Melter		Summation			
Proposed Action (with microencapsulation) ®	x	x	x	x	x	x			x			
Proposed Action (with vitrification) ®	x	x	x	x	x	x	x	x	x			
Non-Thermal Treatment Alternative ®	x	x										
	Maximum	Annual	Maximum	Annual	Maximum	Annual	Maximum	Annual	Maximum	Annual		
	hourly	average	hourly	average	hourly	average	hourly	average	hourly	average		
Substance	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr		
Noncarcinogens												
Acetone	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
Barium	9.8E-08	8.6E-07	4.5E-07	4.0E-06	3.4E-10	3.0E-09	-	-	5.5E-07	4.8E-06		
Butyl alcohol	3.0E-05	2.7E-04	1.5E-05	1.3E-04	3.0E-04	2.6E-03	-	-	3.4E-04	3.0E-03		
Chlorine	-	-	-	-	9.1E+01	8.0E+02	-	-	9.1E+01	8.0E+02		
Chlorobenzene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
Chromium (trivalent)	1.0E-07	8.7E-07	1.1E-09	9.8E-09	2.2E-11	1.9E-10	6.0E-06	5.3E-05	1.0E-07	8.8E-07		
Cyanide	2.3E-08	2.0E-07	2.9E-01	2.6E+00	3.0E-01	2.6E+00	-	-	5.9E-01	5.2E+00		
Cyclohexane	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
2-Ethoxyethanol	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
Ethyl benzene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
Hydrogen chloride	-	-	-	-	1.9E+02	1.7E+03	-	-	1.9E+02	1.7E+03		
Hydrogen fluoride	-	-	-	-	7.8E-03	6.9E-02	-	-	7.8E-03	6.9E-02		
Lead	2.0E-06	1.7E-05	1.5E-07	1.3E-06	3.5E-08	3.1E-07	-	-	2.2E-06	1.9E-05		
Mercury	1.4E-07	1.2E-06	2.8E+00	2.5E+01	1.3E-01	1.2E+00	-	-	2.9E+00	2.6E+01		
Methanol	9.3E-05	8.1E-04	4.4E-05	3.9E-04	8.9E-04	7.8E-03	-	-	1.0E-03	9.0E-03		
Methyl ethyl ketone	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
Nitrobenzene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
Selenium	1.0E-07	8.9E-07	2.2E-07	2.0E-06	2.7E-09	2.4E-08	-	-	3.3E-07	2.9E-06		
Silver	1.0E-07	8.9E-07	3.4E-08	3.0E-07	1.7E-10	1.5E-09	-	-	1.4E-07	1.2E-06		
Toluene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
1,1,1-Trichloroethane	4.6E-01	4.0E+00	2.2E-01	1.9E+00	4.4E+00	3.9E+01	-	-	5.1E+00	4.5E+01		
Trichloroethylene	3.0E-02	2.7E-01	1.5E-02	1.3E-01	3.0E-01	2.6E+00	-	-	3.4E-01	3.0E+00		
1,1,2-Trichloro-1,2,2-trifluoroethane	1.5E-01	1.4E+00	7.3E-02	6.4E-01	1.5E+00	1.3E+01	-	-	1.7E+00	1.5E+01		
Xylene	1.5E-04	1.4E-03	7.3E-05	6.4E-04	1.5E-03	1.3E-02	-	-	1.7E-03	1.5E-02		

Table E-3-8. Projected nonradiological emission rates for the proposed AMWTP and support equipment[a] (continued).

	Totals by process

	Boilers/Heaters [h,I]				Diesel generators[i,j]				Grout preparation			
Process included in Alternative	2 Steam/2 Water/1 Htr		2 Water/1 Htr		2 Generators		1 Generator		Macroencapsulation		Microencapsulation	
Proposed Action (with microencapsulation) ®	**x**	**x**			**x**	**x**			**x**	**x**	**x**	**x**
Proposed Action (with vitrification) ®	**x**	**x**			**x**	**x**			**x**	**x**		
Non-Thermal Treatment Alternative ®			**x**	**x**			**x**	**x**	**x**	**x**		
	Maximum	Annual	Maximum	Annual	Maximum	Annual	Maximum	Annual	Maximum	Annual	Maximum	Annual
	hourly	average	hourly	average	hourly	average	hourly	average	hourly	average	hourly	average
Substance	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr	g/hr	kg/yr
Criteria Pollutants												
Carbon Monoxide	3.3E+02	7.3E+02	1.3E+02	1.7E+02	8.1E+03	4.2E+02	4.1E+03	2.1E+02	-	-	-	-
Oxides of Nitrogen	2.4E+03	5.3E+03	9.0E+02	1.2E+03	3.8E+04	2.0E+03	1.9E+04	9.8E+02	-	-	-	-
Sulfur Dioxide	2.5E+02	5.7E+02	1.0E+02	1.3E+02	2.5E+03	1.3E+02	1.3E+03	6.5E+01	-	-	-	-
Particulate Matter (PM-10)	6.8E+01	1.5E+02	2.6E+01	3.5E+01	2.7E+03	1.4E+02	1.3E+03	7.0E+01	-	-	-	-
Particulate Matter (Fugitive)	-	-	-	-	-	-	-	-	2.3E+00	2.0E+01	9.5E-01	8.4E+00
Volatile Organic Compounds	8.3E+01	1.9E+02	3.3E+01	4.4E+01	3.0E+03	1.6E+02	1.5E+03	7.8E+01	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Carcinogens												
Arsenic (as carcinogen)	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	1.2E+02	6.2E+00	6.0E+01	3.1E+00	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-
Carbon tetrachloride	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (hexavalent)	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane (Ethylene dichloride)	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-
Dioxin/furans (2,3,7,8 TCDD equivalent)	-	-	-	-	-	-	-	-	-	-	-	-
Formaldehyde	-	-	-	-	2.3E+02	1.2E+01	1.2E+02	6.0E+00	-	-	-	-
Methylene chloride	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls (Arochlor)	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	-	-	-	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-

Table E-3-8. Projected nonradiological emission rates for the proposed AMWTP and support equipment[a] (continued).

a. Based on BNFL 1998b and c.
b. Thermal treatment assumes a feed rate of 650 lb/hr for the incinerator and 289 lb/hr for the vitrifier.
c. Short-term impacts (e.g., noncarcinogenic toxic air pollutants, carbon monoxide, etc.) are evaluated using maximum hourly emission rates.
d. Long-term impacts (e.g., carcinogens and criteria pollutant annual average concentrations) are evaluated using the annual average emission rate which is based on an operating schedule of 365 days per year.
e. Dash indicates that substance is not emitted in significant amounts by this process or equipment.
f. Asbestos-containing waste would not be treated in the incinerator.
g. Dioxin and furans emissions are limited in accordance with the proposed MACT standard for combustion of hazardous waste, and have been set equal to that limit. They are expressed in terms of equivalency to the compound, 2,3,7,8 TCDD.
h. Under the Proposed Action or Treatment and Storage Alternative, there would be two process steam boilers, two heating boilers and one water heater operating concurrently. Under the Non-Thermal Treatment Alternative, two heating boilers (but no process boilers) and one hot water heater would operate concurrently.
i. There are no significant emissions of non-carcinogenic toxic air pollutants from these processes.
j. Diesel generators are assumed to operate for 52 hours per year. Two generators would be used under the Proposed Action or Treatment and Storage Alternative, while only one would operate under the Non-Thermal Treatment Alternative.

E-3.3.2 Radiological Assessment Methodology

This section summarizes information on the data and methods used to assess radiological conditions and dose to individuals at onsite and offsite locations due to routine emissions of radionuclides from existing and proposed INEEL facilities.

E-3.3.2.1 Model Selection and Application. The computer program GENII (Napier et al. 1988) was used to calculate doses from all pathways and modes of exposure likely to contribute significantly to the total dose from airborne releases. These are:

- External radiation dose from radionuclides in air
- External dose from radionuclides deposited on ground surfaces
- Internal dose from inhalation of airborne radionuclides
- Internal dose from ingestion of contaminated food products.

GENII incorporates algorithms, data, and methods for calculating doses to various tissues and organs and for determination of effective dose equivalent, based on the recommendations of the International Commission on Radiological Protection (ICRP), as contained in Publications 26 and 30 (ICRP 1977, 1979). This model has several technical advantages over other available methods, including the ability to assess dose from many different release scenarios and exposure pathways. In addition, it conforms to the strict quality assurance requirements of NQA-1, Basic Requirement 3 (Design Control) and Supplementary Requirement 3S-1 (Supplementary Requirements of Design Control), which includes requirements for verification and validation of computer codes.

E-3.3.2.2 Release Modeling. Releases from stacks or vents may be modeled as either elevated or ground-level releases. For this EIS, the decision whether to model a given emission point as a stack or ground-level release was based on guidelines issued by the EPA (EPA 1995a) and the National Council on Radiation Protection and Measurements (NCRP 1986). In general, if the height of the release point is less than or equal to 2.5 times the height of attached or nearby buildings, turbulent (wake and downwash) effects are assumed to influence the release, effectively lowering the release height to ground level. For the baseline radiation dose assessment, stacks at existing facilities were modeled either as individual release points, or sources were grouped together and treated as a single release point. For example, elevated sources at the Power Burst Facility (the Waste Experimental Reduction Facility (WERF) North and South Stacks, and the Power Burst Facility Stack) were modeled as individual elevated releases. Conversely, effluents from various vents at the Naval Reactors Facility were summed and treated as a single ground-level release. (See DOE-ID 1996d and 1997b for listings of sources for which doses are assessed separately and collectively.)

The proposed AMWTP main stack is about 1.5 times the height of the building. While this does not strictly meet the general guideline of 2.5 times the building height to characterize the release as elevated, various additional factors were considered, which together indicated that the release is more appropriately characterized as elevated. They include: (1) the actual stack height of 90 feet is well above ground level, (2) the combined effects of discharge velocity (20 meters/second) and thermal induced buoyancy of the offgas, which tend to increase the effective stack height, and (3) design analyses which resulted in an optimization of stack height based on good engineering practice to minimize building-induced cavity effects.

E-3.3.2.3 Meteorological Data. The atmospheric transport modeling performed as part of these radiological assessments was based on actual meteorological conditions measured at eight different locations at the INEEL. Baseline worker and population doses used data files prepared from observations at INEEL weather stations over the period 1987 through 1991 (DOE 1995). The baseline dose for maximally exposed offsite individual is based on meteorological data measured during 1996 (DOE 1997b). In each baseline case, individual or grouped sources are modeled using either ground-level or elevated data, as appropriate, from the monitoring station closest to the source or source group assessed. For the AMWTP assessments, radionuclide emissions from the proposed facility main stack were modeled using meteorological data for 1987-91 from the 200-foot level of the Grid III monitoring station, which is located about 8 miles northeast of the proposed AMWTP site. This 5-year data set was used directly by GENII in the assessment of population dose. In the case of offsite and onsite MEI, the ISC-3 code and hourly meteorological data from the Grid III 200-foot level were used to generate dispersion factors, which were then input to GENII for the dose calculation (see Section E.3.3.3.4).

E-3.3.2.4 Receptor Locations. Doses were assessed for individuals located at the onsite and offsite locations of highest predicted dose and for the surrounding population, as described below.

Maximally Exposed Individual. The offsite individual whose assumed location and habits are likely to result in the highest dose is referred to as the maximally exposed individual (MEI). The location of the MEI was identified on the basis of the source-receptor distance and direction combination that yielded the highest predicted offsite dose. In the DOE INEL EIS, radiation dose was calculated for the minimum distance from each of the major INEEL source areas to the site boundary for each of the 16 compass directions. Since this location was assessed separately for emissions from each of the INEEL areas, the MEI receptor locations are merely points on the INEEL boundary and do not correspond to any actual residences or quarters. These maximum impacts were conservatively summed to derive cumulative impacts, although they occur at spatially distant locations. (The actual MEI locations for five of the major INEEL facilities are all located along a segment of the southern boundary, southwest of the facilities in question.) Although unrealistic, this cumulative MEI assessment process serves to establish the upper-bounding dose. Despite the inherent conservatism, the results obtained were low, and further resolution of the actual MEI location and dose was not necessary.

In this EIS, the dose to the MEI from existing facilities is taken from the annual NESHAP compliance evaluations (DOE-ID 1996d, 1997b). The highest of the most recent two years is used. The MEI dose estimated for the Preferred Alternative from the DOE INEL EIS is assumed to represent projected increases to the current dose. The MEI dose from proposed AMWTP emissions was modeled using GENII and then added to the baseline dose and projected increases to determine the cumulative offsite individual dose.

Population Dose. In the DOE INEL EIS, dose was assessed for the collective population residing in a circular area defined by a radius of 80 kilometers extending out from each major INEEL facility. Population data used were based on 1990 census data provided by the U.S. Census Bureau. For projects associated with DOE INEL EIS alternatives and for projects expected to become operational before June 1, 1995, growth projections for the counties surrounding INEEL were applied. These growth estimates are approximately 10 percent per decade. The period covered by the DOE INEL EIS analysis extends to the year 2005, and the population doses reported in Section 5.7, Air Resources, of Volume 2 of this EIS are the highest obtained for any year throughout this period.

For this EIS, the population dose assessment applies only to the population residing within 80 kilometers of the RWMC, which is the proposed AMWTP location. The data used in the GENII dose calculation is based on 1990 census data, and these results were corrected to account for future population growth. The underlying assumption is

that the population will increase according to the projections presented in Table 4.3-2. The maximum annual population dose uses a correction factor of 1.37, which corresponds to the amount of growth projected between 1990 and 2015 (i.e., from 72,837 to about 100,000 people). The average population assumed for a 13-year operating life of the AMWTP is 95,000, while 109,000 is assumed for the average over a 30-year operating life.

INEEL Worker. INEEL workers may be exposed to radiation attributable to INEEL sources both as a direct result of job performance (such as work within a radiologically controlled area) and incidentally (such as from airborne releases from facilities within their work area, as well as more distant sources within the INEEL). Incidental exposure due to onsite concentrations of radionuclides were assessed in the DOE INEL EIS (for existing sources and future projects) and in this EIS (for the proposed AMWTP). (Direct, job-related occupational exposure is discussed in Sections 4.12 and 5.12, Occupational and Public Health and Safety, of this EIS and Volume 2, Part A of the DOE INEL EIS.) An individual who would receive the highest dose due to incidental exposures is termed the maximally exposed worker. The dose to the maximally exposed worker was assessed using the general methodology described in previous sections, with the following exceptions:

- The worker dose calculations do not include the food ingestion pathway, since workers do not consume food products grown onsite.
- It is assumed that the worker is exposed for only 2,000 hours per year (as opposed to 8,760 hours for year for the offsite cases).
- The inhalation rate for the worker is assumed to be 1.2 cubic meters per hour (as opposed to 0.96 cubic meters per hour for the offsite cases).

Also, although both EIS onsite dose assessments used the GENII code, the methodology used for this EIS differed somewhat from the DOE INEL EIS assessments. The proposed AMWTP dose assessment was performed by first generating an atmospheric dispersion factor using the Industrial Source Complex (ISC-3) code described in Appendix Section E-3.3.3.1. A finely spaced receptor grid (50-meter spacing) was used to identify the area of highest predicted onsite dose. The dispersion factor for that receptor location was manually entered as input to GENII, which was then executed to calculate dose. This level of refinement was not possible in the DOE INEL EIS, because of the large number of sources involved, the large areas over which the sources were distributed, and the lack of detailed facility descriptions for many of the proposed future sources.

E-3.3.2.5 GENII Input Data and Options. The input data and code options that were used in the GENII code runs performed for this EIS are summarized in Annex 1 to this appendix section. Unless otherwise noted, the data used for exposure parameters (exposure times, food production and consumption rates, etc.) are the defaults from the GENII maximum (used for MEI) or average (used for population case) data sets. Table E-3-9 describes the stack characteristics of the individual sources modeled, and gives the atmospheric dispersion factors that were used for the offsite MEI and worker dose assessments.

Table E-3-9. AMWTP stack parameters and atmospheric dispersion factors used in GENII modeling.

		Stack exit conditions				ISC-generated Chi/Q (sec./cubic meter)	
Flue	Emission sources	Height (feet)	Velocity (feet/min.)	Diameter (inches)	Temp. (° C)	Offsite MEI	Worker at RWMC
Incinerator	Incinerator offgas	90	4000	6.0	180	4.0E-07	5.2E-

							06
Melter (vitrifier)	Melter offgas	90	4000	2.5	120	3.3E-07	9.1E-06
East (Area 300) Zone 3 extract	Box lines Central conveyor system Drum line Drum staging areas Special case waste glovebox Supercompaction Macroencapsulation	90	4000	37.1	72	3.0E-07	2.0E-06
East (Area 300) glovebox extract	Analytical laboratory Sample extraction gloveboxes	90	4000	9.6	72	4.0E-07	4.5E-06
West (Area 400) Zone 3 extract	Evaporator offgas	90	4000	13.5	85	3.9E-07	3.9E-06
West (Area 400) glovebox extract	Microencapsulation	90	4000	9.6	72	4.0E-07	4.5E-06
Sources: BNFL 1998a and c.							

E-3.3.3 Nonradiological Assessment Methodology

Air pollutant levels have been estimated by application of air dispersion computer models that incorporate mathematical functions to simulate transport of pollutants in the atmosphere. The modeling methodology conforms to that recommended by the EPA (EPA 1995a) and the State of Idaho (IDHW 1997) for such applications. The models and application methodology are designed to be conservative; that is, they employ data and algorithms designed to prevent underestimating the pollutant concentrations that would actually exist. In general, the methods used to assess consequences of proposed actions were identical to those used in the baseline assessments. Minor exceptions (such as the use of refined versus screening-level modeling) will be noted where applicable. The primary objective of the assessments is to estimate nonradiological pollutant concentrations and other impacts in a manner that facilitates comparison between alternative courses of action, while also providing an indication of compliance with applicable standards or guidelines.

The types of pollutants assessed include the criteria pollutants and certain types of toxic air pollutants. Criteria pollutant concentrations were estimated for locations and over periods of time corresponding to State of Idaho and NAAQS. Since these standards apply only to ambient air (that is, locations to which the general public has access), criteria pollutant concentrations were assessed for offsite locations and public roads traversing the INEEL. The nonradiological assessment did not quantitatively assess impacts related to ozone formation because (1) VOC emission levels are below the significance level designated by the State of Idaho; (2) no simple, well-defined method exists to assess ozone formation potential (Wilson 1993); and (3) while the Idaho Division of Environmental Quality has no ozone monitoring data from the vicinity, it is not aware of problematic ozone levels in the area (Andrus 1994). This is confirmed by recent data collected by the NPS at Craters of the Moon Wilderness Area where no exceedances of the primary ozone standard have been reported (DOI 1994).

Offsite levels of carcinogenic and noncarcinogenic toxic air pollutants were evaluated on the basis of annual average and maximum hourly emission rates, respectively. Annual average levels of carcinogenic pollutants and maximum 24-hour levels of noncarcinogenic toxics were compared to the applicable concentration (increment) standards prescribed by the State of Idaho (IDAPA 16.01.01.585 and 586). Toxic air pollutants were also assessed for onsite locations because of potential exposure of workers to these hazardous substances. Onsite levels of specific toxins were calculated using maximum hourly emission rates and compared to occupational exposure limits set for these substances by either the Occupational Safety and Health Administration (OSHA) or the American Conference of Governmental Industrial Hygienists (ACGIH) (the more limiting of the two values is used).

E-3.3.3.1 Model Description and Application. The EPA ISC-3 (short-term version) computer code (EPA 1995b) was used to evaluate AMWTP alternatives. The ISC-3 model incorporates site-specific data (such as meteorological observations from INEEL weather stations), and takes into account effects such as stack tip downwash and turbulence induced by the presence of nearby structures. In addition, the model accommodates multiple sources and calculates concentrations for user-specified receptor locations. Concentrations were calculated over a range of durations, from one-hour maximum values to annual averages. In summary, dispersion modeling using ISC-3 allows for a reasonable prediction of the impacts of proposed facilities and, therefore, is ideally suited for use in the EIS process.

The analyses performed for the DOE INEL EIS which served to establish the baseline used for this AMWTP EIS made use of some additional models as described in Appendix Section F-3 of the DOE INEL EIS. These models are comprised of: (1) the earlier version of ISC (ISC-2); (2) SCREEN, a screening-level model was used in many cases where a source's contribution to toxic air pollutant concentrations was expected to be minimal (that is, well below acceptable standards); and (3) the EPA-recommended Fugitive Dust Model (Winges 1991), which was used to assess fugitive dust impacts. SCREEN and the Fugitive Dust Model are not used in this EIS (except by reference to results in the DOE INEL EIS).

E-3.3.3.2 ISC-3 Input Data and Options. The input data and code options that were used in the ISC-3 code runs performed for this EIS are presented in annotated format in Annex 2 to this appendix section.

E-3.3.3.3 Emission Parameters. The use of air dispersion models requires emission parameters, such as stack height and diameter and exhaust gas temperature and flow rate; size of area (for example, disturbed areas related to construction sources); and pollutant emission rates. The DOE INEL EIS analysis obtained emission parameter data from the INEEL air emissions inventories discussed above, as well as from project design documents. There are several distinct sources of air emissions at the proposed AMWTP, and the impacts of each source were modeled separately using the emission parameters described below.

The principal source of emissions at the proposed AMWTP will be the main stack, which is actually an assemblage of several individual smaller stacks (or flues) shrouded by a wind screen. The offgas streams from the incinerator, vitrifier/melter, glovebox and containment areas, and process area heating, ventilation and air conditioning (HVAC) systems each pass through separate APCSs and are then exhausted through separate flues. These flues vary in diameter, but each extends to the top of the 27.5 meter (90-foot) main stack, which is located on the south end of the facility. A diagram of the main stack showing these emission points is presented in Figure E-3-4. This figure is based on the configuration that would be used for the Proposed Action or Treatment and Storage Alternative with vitrification of ash. For the Proposed Action or Treatment and Storage Alternative with microencapsulation of ash, the 2.7-inch diameter melter flue would be replaced by a 9.6-inch diameter microencapsulation offgas flue.

In addition to the main stack, for the Proposed Action and Treatment and Storage Alternatives, nonradiological pollutants will be emitted from six propane-fueled water boilers (four of which could operate at any one time), one hot water heater, and two diesel-fueled emergency generators. With the Non-Thermal Treatment Alternative, nonradiological pollutants will be emitted from three propane-fueled water boilers (only two would operate at any one time), one hot water heater, and one diesel-fueled emergency generator. The boiler and heater stacks would be located in a utility building attached to the south end of the AMWTP main building. The generators will be located near the southeast and southwest corners of the main building. The parameter values used for the proposed AMWTP main stack are provided in Table E-3-9. Parameter values for the boiler, heater, and emergency generator stacks are provided in Table E-3-10.

Table E-3-10. Stack parameter values for boilers, heaters and diesel generators.

	Stack exit conditions				
	Height	Velocity	Diameter	Temp.	Flowrate
Stack name	(ft)	(ft/min)	(inches)	(° C)	(ACFM)
Steam Boiler # 1 Exhaust	50	1,920	20	232	4,200

Steam Boiler #2 Exhaust	50	1,920	20	232	4,200
HVAC Boiler #1 Exhaust	50	1,722	16.0	232	2,400
HVAC Boiler #2 Exhaust	50	1,722	16.0	232	2,400
Potable Hot Water Heater Exhaust	36	582	12.0	204	460
Diesel Generator #1	16	6,888	6.0	934	1,352
Diesel Generator #2	16	6,888	6.0	934	1,352
Sources: MK 1997; BNFL 1998b.					

E-3.3.3.4 Meteorological Data. Emissions from the proposed AMWTP main stack were modeled using meteorological data from the 200-foot level of the Grid III monitoring station, which is located about 8 miles northeast of the proposed AMWTP site. Emissions from the diesel generators and boilers were modeled using data from the 33-foot level of the Grid III monitoring station. The meteorological data used contained hourly observations of wind speed, direction, temperature, and stability class for the years 1991 and 1992.

The baseline assessment that is reported in the DOE INEL EIS used surface meteorological data from three different monitoring locations. However, it was not feasible to use data from different elevations due to the large number of sources and pollutants modeled, as well as the spatial distribution of the sources and receptors. In this EIS, however, the baseline PSD increment consumption analyses were re-assessed to provide an updated estimate of increment consumption from existing sources in the south-central portion of the INEEL (i.e., in the Grid III wind regime). These updated analyses were performed using meteorological data from either the 33-feet or 200-feet level. The level closest to the effective stack height of each source was used in the evaluation of that source.

Data required for the calculation of mixing height are currently being collected at the INEEL but are not available for these periods. Therefore, default mixing heights were used. For short-term assessments, a value of 150 meters, which represents the lowest value measured at the INEEL, was used. For annual average evaluations, 800 meters was used. This value has been calculated by the National Oceanic and Atmospheric Administration and is recommended for use in dispersion modeling assessments (Sagendorf 1991). Each case was assessed separately using data from these years, and the highest of the predicted concentrations was selected.

Figure E-3-4. Diagram of AMWTP main stack flues based on vitrification of ash. (MK 1997)

E-3.3.3.5 Receptor Locations. The ISC-3 Model is capable of determining air quality impacts at receptor locations using either a grid layout pattern or user-specified receptor points. Based on modeling efforts performed previously (including in support of the DOE INEL EIS), maximum impacts at ambient receptor locations are expected to occur either (1) along public roads that traverse the INEEL or (2) in the region beyond the INEEL boundary. No points of maximum impact are expected to occur at locations well beyond the INEEL boundary. Thus, only discrete receptors (as opposed to a gridded array) have been used for regulatory air assessments at those locations and at Craters of the Moon Wilderness Area. (Gridded arrays were used, however, in modeling performed to identify the areas where maximum impacts were likely to occur and where fine spacing of discrete receptors points is necessary.)

The receptor locations for the AMWTP dispersion modeling were based on the receptor array developed for the DOE INEL EIS (described in Appendix Section F-3 of that document). This array was modified to include additional receptor locations and eliminate those receptor locations that are clearly beyond the range of maximum impact (e.g., around test Area North or Argonne National Laboratory — West). Also, the elevation of each receptor location was added.

Concentrations of pollutants of each type (criteria pollutants, carcinogenic and non- carcinogenic toxic air pollutants) were calculated for each location specified in the receptor array; however, the regulatory compliance evaluations for

carcinogenic toxic air pollutants were performed only for site boundary locations (and not transportation corridors). This is allowed by IDAPA 210.036 (IDHW 1997) to account for the fact that carcinogenic standards are based on continuous, full-time exposure, and that potential does not exist along road locations.

Criteria and noncarcinogenic toxic air pollutants were assessed at all ambient air locations. PSD increment consumption was also assessed for ambient air locations around the INEEL and at Craters of the Moon Wilderness Area, the Class I area nearest the INEEL. Class I area increments were assessed at discrete receptor locations along the eastern and northern boundaries at intervals of 500 meters.

Concentrations of toxic air pollutants for which occupational exposure standards exist were assessed at locations within the RWMC to characterize potential levels to which workers may be subjected. For these assessments, a grid centered on the proposed AMWTP main stack and extending to the boundary of the RWMC area was developed. This grid uses 50-meter spacing in order to identify the onsite location of highest impact.

E-3.3.3.6 Impacts on Visibility. Atmospheric visibility has been specifically designated as an air quality-related value under the 1977 PSD Amendments to the CAA. Therefore, in the assessment of proposed projects that invoke PSD review (see Appendix Section E-3.2.2), potential impacts to visibility must be evaluated and shown to be acceptable in designated Class I areas and associated integral vistas. Craters of the Moon Wilderness Area, located approximately 12 miles southwest of the INEEL, is the only Class I area in the Eastern Snake River Plain. However, recognizing the importance of the scenic views in and around the Fort Hall Indian Reservation, additional analyses were performed for this location.

The EPA has designed methodologies and developed computer codes to estimate potential visual impacts due to emissions of proposed sources. The methodologies include three levels of sophistication. Level-1 is designed to be very conservative; it uses assumptions and simplifying methodologies that will predict plume visual impacts larger than those calculated with more realistic input and modeling assumptions. This conservatism is achieved by the use of worst-case meteorological conditions, including extremely stable (Class F) conditions coupled with a very low wind speed (3 feet per second) persisting for 12 hours, with a wind direction that would transport the plume directly adjacent to a hypothetical observer in the Class I or scenic area. The Level-1 analysis is implemented using the computer code VISCREEN to calculate the potential visual impact of a plume of specified emissions for specific transport and dispersion conditions. If screening calculations using VISCREEN demonstrate that during worst-case meteorological conditions a plume is either imperceptible or, if perceptible, is not likely to be considered objectionable, further analysis of plume visual impact would not be required (EPA 1992). Level-2 visual impact modeling employs more site-specific information than that of Level-1. It is still conservative and designed to overestimate potential visibility deterioration. Level-3 visual impact modeling is more intensive in scope and designed to provide a more realistic treatment of plume visual impacts. In both the DOE INEL EIS and this EIS, the Level-1 VISCREEN analyses were performed to ensure conservatism.

Because within a range of wavelengths, a measure of contrast must recognize both intensity, and perceived color, the VISCREEN model determines whether a plume is visible by calculating contrast (brightness) and color contrast. Contrast is calculated at three visual wavelengths to characterize blue, green, and red regions of the visual spectrum to determine if a plume will be brighter, darker, or discolored compared to its viewing background. If plume contrast is positive, the plume is brighter than its viewing background; if negative, the plume is darker. To address the dimension of color as well as brightness, the color contrast parameter, termed "delta E", is used as the primary basis for determining the perceptibility of plume visual impacts in screening analyses. Delta E provides a single measure of the difference between two arbitrary colors as perceived by humans. If contrasts are different at different wavelengths, the plume is discolored. If contrasts are all zero, the plume is indistinguishable from its background.

In order to determine whether a plume has the potential to be perceptible to observers under reasonable worst-case conditions, the VISCREEN model calculates both delta E and contrast for two assumed plume-viewing backgrounds: the horizon sky and a dark terrain object. Results are provided for two assumed worst-case sun angles (to simulate forward and backward scattering of light), with the sun in front and behind the observer, respectively. If either of two screening criteria is exceeded, more comprehensive and realistic analyses should be carried out. The first criterion is a delta E value of 2.0; the second is a green contrast value of 0.05. Regional haze, which is caused by multiple sources

throughout a region, is not calculated or estimated with the VISCREEN model.

The EPA recommends default values for various model parameters. In this analysis, default values were used for all parameters with the exception of background ozone concentration. A value of 0.051 parts per million was assigned as a representative regional value (DOI 1994, Notar 1998b). A site-specific annual average background visual range, estimated to be 144 miles based on monitoring programs conducted by the NPS at Craters of the Moon Wilderness Area (Notar 1998a), was also used.

The VISCREEN analyses evaluated the potential impacts of emissions of particulate matter and oxides of nitrogen associated with AMWTP alternatives using maximum short-term (hourly) emission rates and minimum and maximum distances from the source to the Class I area and Reservation. All emission sources were included except construction emissions and emergency diesel generators, which are not evaluated in a PSD assessment. The results of the VISCREEN analyses for AMWTP treatment alternatives are presented in Table E-3-11. All color shift and contrast values are well below screening criteria, with the highest value obtained for the color shift parameter (0.288 compared to the screening criterion of 2.0) for views within Craters of the Moon. These results include the effects of current operations (that is, the effects of current emission levels are included in the visibility monitored at Craters of the Moon Wilderness Area, and are represented in the 144-mile value for annual average visual range used in the analyses). However, these results do not include the combined effects of AMWTP and other future projects, such as those associated with the DOE INEL EIS Preferred Alternative.

Table E-3-11. VISCREEN analysis results for proposed AMWTP treatment alternatives.

	Color shift (delta E) parameter [a]				Contrast parameter [a]			
	Sky		Terrain		Sky		Terrain	
Case	View 1	View 2	View 1	View 2	View 1	View 2	View 1	View 2
Maximum acceptable screening value	**2.0**	**2.0**	**2.0**	**2.0**	**0.05**	**0.05**	**0.05**	**0.05**
Views Within Craters of the Moon Wilderness Area								
Proposed Action (with microencapsulation)	0.288	0.205	0.071	0.043	-0.001	-0.002	0.000	0.000
Proposed Action (with vitrification)	0.288	0.205	0.071	0.043	-0.001	-0.002	0.000	0.000
Treatment and Storage Alt. (with microencapsulation)	0.288	0.205	0.071	0.043	-0.001	-0.002	0.000	0.000
Treatment and Storage Alt. (with vitrification)	0.288	0.205	0.071	0.043	-0.001	-0.002	0.000	0.000
Non-thermal Treatment Alternative	0.060	0.043	0.024	0.009	0.000	0.000	0.000	0.000
Views Within Fort Hall Indian Reservation								
Proposed Action (with microencapsulation)	0.100	0.072	0.031	0.023	0.000	-0.001	0.000	0.000
Proposed Action (with vitrification)	0.100	0.072	0.031	0.023	0.000	-0.001	0.000	0.000
Treatment and Storage Alt. (with microencapsulation)	0.100	0.072	0.031	0.023	0.000	-0.001	0.000	0.000
Treatment and Storage Alt. (with vitrification)	0.100	0.072	0.031	0.023	0.000	-0.001	0.000	0.000
Non-thermal Treatment Alternative	0.021	0.015	0.009	0.005	0.000	0.000	0.000	0.000
a. See text for description of parameters.								

Annex 1. Summary Of Code Options and Exposure Data Used in GENII Modeling of AMWTP Cases

Case: Offsite MEI

GENII data set - maximum individual data set

Far-field release scenario (infinite plume model)

Air transport with following exposure pathway options:

External exposure - infinite plume model

External exposure – contaminated ground

Inhalation uptake

Ingestion - terrestrial foods

Ingestion – animal products

Ingestion – soil (inadvertent)

Radionuclide inventory - Per Table E-3-4

Radionuclide intakes

Intake ends after 50 yr

Dose calculation ends after 50 yr

Release ends after 1 yr

Air deposition prior to the intake period – 0 yr

Irrigation water deposition prior to the intake period – 0 yr

Air transport options

Stack release (parameter values and Chi/Q per Table E-3-9)

Distance – 5300 m (not used by GENII)

Direction – SSW (not used by GENII)

Exposure Data

External exposure time – 8766 hr

Soil contamination exposure time – 2920 hr

Inhalation time – 8766 hr

Resuspension method – mass loading

Mass loading factor – 0.0001 g/m^3

Food product production and consumption

Food production and receptor are co-located

Food not exported out of region

Grow --Consumption--

Food Time Yield Holdup Rate

Type (days) (kg/m^2) (days) (kg/yr)

----- ----- ----- ----- -------

Leafy veg. 90.00 1.5 1.0 30.0

Root veg. 90.00 4.0 5.0 220.0

Fruit 90.00 2.0 5.0 330.0

Grain 90.00 0.8 180.0 80.0

Animal product production and consumption

---Human---- -----------Stored Feed-----------

Consumption Grow Storage

Food Rate Holdup Fraction Time Yield Time

Type (kg/yr) (days) of diet (days) (kg/m^2) (days)

Beef 80.0 15.0 0.25 90.0 0.80 180.0

Poultry 18.5 1.0 1.00 90.0 0.80 180.0

Milk 270.0 1.0 0.25 45.0 2.00 100.0

Egg 30.0 1.0 1.00 90.0 0.80 180.0

----------Fresh Forage----------

Beef 0.75 45.0 2.00 100.0

Milk 0.75 30.0 1.50 0.0

(Cont.)

Case: Surrounding population

(Note: Only options and data that are different from Offsite MEI case are listed)

GENII data set - average individual data set

Population grid in file POP.IN

Air transport options

Stack release (parameter values per Table E-3-9)

Joint frequency data from GRID III station, 200-foot level (1987-1991)

Exposure Data

External exposure time – 8766 hr

Soil contamination exposure time – 2920 hr

Inhalation time – 8766 hr

Resuspension method – mass loading

Mass loading factor – 0.0001 g/m^3

Food product production and consumption

Food production and receptor are co-located

Food not exported out of region

Grow --Consumption--

Food Time Yield Holdup Rate

Type (days) (kg/m^2) (days) (kg/yr)

Leafy veg. 90.00 1.5 14.0 15.0

Root veg. 90.00 4.0 14.0 140.0

Fruit 90.00 2.0 14.0 64.0

Grain 90.00 0.8 180.0 72.0

Animal product production and consumption

---Human---- ----------Stored Feed----------

Consumption Grow Storage

Food Rate Holdup Fraction Time Yield Time

Type (kg/yr) (days) of diet (days) (kg/m^2) (days)

Beef 70.0 34.0 0.25 90.0 0.80 180.0

Poultry 8.5 34.0 1.00 90.0 0.80 180.0

Milk 230.0 4.0 0.25 45.0 2.00 100.0

Egg 20.0 18.0 1.00 90.0 0.80 180.0

----------Fresh Forage----------

Beef 0.75 45.0 2.00 100.0

Milk 0.75 30.0 1.50 0.0

(Cont.)

Case: Onsite Worker

(Note: Only options and data that are different from Offsite MEI case are listed)

GENII data set - average individual data set

Air transport with following exposure pathway options:

External exposure - infinite plume model

External exposure – contaminated ground

Inhalation uptake

Air transport options

Stack release (parameter values and Chi/Q per Table E-3-9)

Distance – Stack dependent (130 - 250 m) (not used by GENII)

Direction – Stack dependent (SSW for melter stack; NE for all others) (not used by GENII)

Exposure Data

External exposure time – 2000 hr

Soil contamination exposure time – 2000 hr

Inhalation time – 2500 hr (Note: Based on inhalation time of 2000 hours per year with correction factor of 1.2/0.96 to account for higher breathing rate of worker)

Food product production and consumption – none

Animal product production and consumption – none

Annex 2. Annotated ISC-3 Input/Output File

8-Hour ISC-3 Model Input/Output Data Files (Annotated):

These files are for a unit (1 gram/sec) emission rate from the incinerator exhaust stack, with impacts evaluated at occupational worker receptor locations within the Radioactive Waste Management Complex (in which the AMWTP would be located). This model run uses 1991 elevated meteorological data from the GRD-III station and an evaluation period of eight(8) hours.

Items which might vary from this input file to those for other cases evaluated in this EIS evaluation are:

1. Meteorological Data – This will be either 1991 or 1992 meteorological data, elevated (anemometer height of 61 meters) or ground (anemometer height of 10 meters), and a mixing height of either 150 or 800 meters.
2. Source or Emission Point – This will be one of the identified sources in the EIS, and it's associated source information such as height, diameter, exit velocity, temperature, location coordinates, and elevation.

3. Evaluation period: 1 hour, 3 hour, 8 hour, 24 hour, monthly or annual, depending on the averaging time of the standard or guideline against which the results are evaluated.

4. The receptor grids used in the evaluations are for ambient locations (INEEL site boundary, public roadways, Fort Hall Indian Reservation, Craters of the Moon Wilderness Area, and the Big Southern Butte) or for occupational exposures to INEEL workers (as identified in this input file).

These items notwithstanding, the model options indicated on the input were used for all ISC-3 runs performed for this EIS.

BEE-Line Software: Standard ISCST3 data input file

Date: 10/28/98 Time: 0:29

```
BEE-Line ISCST3 "BEEST" Version 3.3
Input File - C:\DOE\M2IN8O2.DTA
Output File - C:\DOE\M2IN8O2.LST
Met File - C:\BEE\MET\GRDTM92.ASC
*** 8 HOUR - INCINERATOR - AMWTP - OCCUPATIONAL WORKER GRID ***
*** 1992 MET YEAR DATA - GRD III ELEVATED RELEASE ***
*** MODEL SETUP OPTIONS SUMMARY ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
**Intermediate Terrain Processing is Selected
**Model Is Setup For Calculation of Average CONCentration Values.
-- SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION. DDPLETE = F
**Model Uses NO WET DEPLETION. WDPLETE = F
**NO WET SCAVENGING Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations
**Model Uses RURAL Dispersion.
**Model Uses Regulatory DEFAULT Options:
1. Final Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Use Calms Processing Routine.
5. Not Use Missing Data Processing Routine.
6. Default Wind Profile Exponents.
7. Default Vertical Potential Temperature Gradients.
8. "Upper Bound" Values for Supersquat Buildings.
9. No Exponential Decay for RURAL Mode
**Model Accepts Receptors on ELEV Terrain.
**Model Assumes No FLAGPOLE Receptor Heights.
**Model Calculates 1 Short Term Average(s) of: 8-HR
**This Run Includes: 1 Source(s); 1 Source Group(s); and 279 Receptor(s)
**The Model Assumes A Pollutant Type of: OTHER
**Model Set To Continue RUNning After the Setup Testing.
**Output Options Selected:
Model Outputs Tables of Highest Short Term Values by Receptor RECTABLE Keyword)
Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)
**NOTE: The Following Flags May Appear Following CONC Values:
c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours
**Misc. Inputs: Anem. Hgt. (m) = 61.00 ; Decay Coef. = 0.0000 ; Rot. Angle = 0.0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = 0.10000E+07
Output Units = MICROGRAMS/M**3
**Input Runstream File: C:\DOE\M2IN8O2.DTA ; **Output Print File: C:\DOE\M2IN8O2.LST
*** POINT SOURCE DATA ***
SOURCE NUMBER EMISSION RATE BASE STACK STACK STACK STACK BUILDING EMISSION RATE
ID PART. (GRAMS/SEC) X Y ELEV. HEIGHT TEMP. EXIT VEL. DIAMETER EXISTS SCALAR VARY
CATS. (METERS) (METERS) (METERS) (METERS) (DEG.K) (M/SEC) (METERS) BY
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - -
INCI 0 0.10000E+01 335322.4 4817778.0 1526.0 27.43 355.37 20.32 0.15 YES
*** SOURCE IDs DEFINING SOURCE GROUPS ***
GROUP ID SOURCE Ids
```

ALL INCI ,

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: INCI

IFV BH BW WAK IFV BH BW WAK IFV BH BW WAK IFV BH BW WAK IFV BH BW WAK IFV BH BW WAK

1 18.3, 42.6, 0 2 18.3, 54.7, 0 3 18.3, 65.0, 0 4 18.3, 73.4, 0 5 18.3, 79.6, 0 6 18.3, 83.3, 0

7 18.3, 84.5, 0 8 18.3, 83.2, 0 9 12.3, 87.8, 0 10 18.3, 83.2, 0 11 18.3, 84.5, 0 12 18.3, 83.3, 0

13 18.3, 79.6, 0 14 18.3, 73.4, 0 15 18.3, 65.0, 0 16 18.3, 54.7, 0 17 18.3, 42.6, 0 18 18.3, 29.3, 0

19 18.3, 42.6, 0 20 18.3, 54.7, 0 21 18.3, 65.0, 0 22 18.3, 73.4, 0 23 18.3, 79.6, 0 24 18.3, 83.3, 0

25 18.3, 84.5, 0 26 18.3, 83.2, 0 27 12.3, 87.8, 0 28 18.3, 83.2, 0 29 18.3, 84.5, 0 30 18.3, 83.3, 0

31 18.3, 79.6, 0 32 18.3, 73.4, 0 33 18.3, 65.0, 0 34 18.3, 54.7, 0 35 18.3, 42.6, 0 36 18.3, 29.3, 0

*** DISCRETE CARTESIAN RECEPTORS ***

(X-COORD, Y-COORD, ZELEV, ZFLAG)

(METERS)

(335500.0, 4817550.0, 1526.0, 0.0); (335500.0, 4817600.0, 1526.0, 0.0); (335500.0, 4817650.0, 1526.0, 0.0);

(335500.0, 4817700.0, 1526.0, 0.0); (335500.0, 4817750.0, 1526.0, 0.0); (335500.0, 4817800.0, 1526.0, 0.0);

(335500.0, 4817850.0, 1526.0, 0.0); (335500.0, 4817900.0, 1526.0, 0.0); (335500.0, 4817950.0, 1526.0, 0.0);

(335500.0, 4818000.0, 1526.0, 0.0); (335500.0, 4818050.0, 1526.0, 0.0); (335500.0, 4818100.0, 1526.0, 0.0);

(335500.0, 4818150.0, 1526.0, 0.0); (335450.0, 4817600.0, 1526.0, 0.0); (335450.0, 4817650.0, 1526.0, 0.0);

(335450.0, 4817700.0, 1526.0, 0.0); (335450.0, 4817750.0, 1526.0, 0.0); (335450.0, 4817800.0, 1526.0, 0.0);

(335450.0, 4817850.0, 1526.0, 0.0); (335450.0, 4817900.0, 1526.0, 0.0); (335450.0, 4817950.0, 1526.0, 0.0);

(335450.0, 4818000.0, 1526.0, 0.0); (335450.0, 4818050.0, 1526.0, 0.0); (335450.0, 4818100.0, 1526.0, 0.0);

(335450.0, 4818150.0, 1526.0, 0.0); (335400.0, 4817600.0, 1526.0, 0.0); (335400.0, 4817650.0, 1526.0, 0.0);

*** DISCRETE CARTESIAN RECEPTORS ***

(Cont.) (X-COORD, Y-COORD, ZELEV, ZFLAG)

(METERS)

(335400.0, 4817700.0, 1526.0, 0.0); (335400.0, 4817750.0, 1526.0, 0.0); (335400.0, 4817800.0, 1526.0, 0.0);

(335400.0, 4817850.0, 1526.0, 0.0); (335400.0, 4817900.0, 1526.0, 0.0); (335400.0, 4817950.0, 1526.0, 0.0);

(335400.0, 4818000.0, 1526.0, 0.0); (335400.0, 4818050.0, 1526.0, 0.0); (335400.0, 4818100.0, 1526.0, 0.0);

(335400.0, 4818150.0, 1526.0, 0.0); (335350.0, 4817650.0, 1526.0, 0.0); (335350.0, 4817700.0, 1526.0, 0.0);

(335350.0, 4817750.0, 1526.0, 0.0); (335350.0, 4817800.0, 1526.0, 0.0); (335350.0, 4817850.0, 1526.0, 0.0);

(335350.0, 4817900.0, 1526.0, 0.0); (335350.0, 4817950.0, 1526.0, 0.0); (335350.0, 4818000.0, 1526.0, 0.0);

(335350.0, 4818050.0, 1526.0, 0.0); (335350.0, 4818100.0, 1526.0, 0.0); (335350.0, 4818150.0, 1526.0, 0.0);

(335300.0, 4817650.0, 1526.0, 0.0); (335300.0, 4817700.0, 1526.0, 0.0); (335300.0, 4817750.0, 1526.0, 0.0);

(335300.0, 4817800.0, 1526.0, 0.0); (335300.0, 4817850.0, 1526.0, 0.0); (335300.0, 4817900.0, 1526.0, 0.0);

(335300.0, 4817950.0, 1526.0, 0.0); (335300.0, 4818000.0, 1526.0, 0.0); (335300.0, 4818050.0, 1526.0, 0.0);

(335300.0, 4818100.0, 1526.0, 0.0); (335300.0, 4818150.0, 1526.0, 0.0); (335250.0, 4817700.0, 1526.0, 0.0);

(335250.0, 4817750.0, 1526.0, 0.0); (335250.0, 4817800.0, 1526.0, 0.0); (335250.0, 4817850.0, 1526.0, 0.0);

(335250.0, 4817900.0, 1526.0, 0.0); (335250.0, 4817950.0, 1526.0, 0.0); (335250.0, 4818000.0, 1526.0, 0.0);

(335250.0, 4818050.0, 1526.0, 0.0); (335250.0, 4818100.0, 1526.0, 0.0); (335250.0, 4818150.0, 1526.0, 0.0);

(335200.0, 4817700.0, 1526.0, 0.0); (335200.0, 4817750.0, 1526.0, 0.0); (335200.0, 4817800.0, 1526.0, 0.0);

(335200.0, 4817850.0, 1526.0, 0.0); (335200.0, 4817900.0, 1526.0, 0.0); (335200.0, 4817950.0, 1526.0, 0.0);

(335200.0, 4818000.0, 1526.0, 0.0); (335200.0, 4818050.0, 1526.0, 0.0); (335200.0, 4818100.0, 1526.0, 0.0);

(335200.0, 4818150.0, 1526.0, 0.0); (335150.0, 4817700.0, 1526.0, 0.0); (335150.0, 4817750.0, 1526.0, 0.0);

(335150.0, 4817800.0, 1526.0, 0.0); (335150.0, 4817850.0, 1526.0, 0.0); (335150.0, 4817900.0, 1526.0, 0.0);

(335150.0, 4817950.0, 1526.0, 0.0); (335150.0, 4818000.0, 1526.0, 0.0); (335150.0, 4818050.0, 1526.0, 0.0);

(335150.0, 4818100.0, 1526.0, 0.0); (335150.0, 4818150.0, 1526.0, 0.0); (335100.0, 4817750.0, 1526.0, 0.0);

(335100.0, 4817800.0, 1526.0, 0.0); (335100.0, 4817850.0, 1526.0, 0.0); (335100.0, 4817900.0, 1526.0, 0.0);

(335100.0, 4817950.0, 1526.0, 0.0); (335100.0, 4818000.0, 1526.0, 0.0); (335100.0, 4818050.0, 1526.0, 0.0);

(335100.0, 4818100.0, 1526.0, 0.0); (335100.0, 4818150.0, 1526.0, 0.0); (335100.0, 4818300.0, 1526.0, 0.0);

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(335050.0, 4817900.0, 1526.0, 0.0); (335050.0, 4817950.0, 1526.0, 0.0); (335050.0, 4818000.0, 1526.0, 0.0);

(335050.0, 4818050.0, 1526.0, 0.0); (335050.0, 4818100.0, 1526.0, 0.0); (335050.0, 4818150.0, 1526.0, 0.0);
(335050.0, 4818200.0, 1526.0, 0.0); (335050.0, 4818250.0, 1526.0, 0.0); (335050.0, 4818300.0, 1526.0, 0.0);
(335050.0, 4818350.0, 1526.0, 0.0); (335000.0, 4817800.0, 1526.0, 0.0); (335000.0, 4817850.0, 1526.0, 0.0);
(335000.0, 4817900.0, 1526.0, 0.0); (335000.0, 4817950.0, 1526.0, 0.0); (335000.0, 4818000.0, 1526.0, 0.0);
(335000.0, 4818050.0, 1526.0, 0.0); (335000.0, 4818100.0, 1526.0, 0.0); (335000.0, 4818150.0, 1526.0, 0.0);
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(334950.0, 4817900.0, 1526.0, 0.0); (334950.0, 4817950.0, 1526.0, 0.0); (334950.0, 4818000.0, 1526.0, 0.0);
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(334950.0, 4818350.0, 1526.0, 0.0); (334900.0, 4817800.0, 1526.0, 0.0); (334900.0, 4817850.0, 1526.0, 0.0);
(334900.0, 4817900.0, 1526.0, 0.0); (334900.0, 4817950.0, 1526.0, 0.0); (334900.0, 4818000.0, 1526.0, 0.0);
(334900.0, 4818050.0, 1526.0, 0.0); (334900.0, 4818100.0, 1526.0, 0.0); (334900.0, 4818150.0, 1526.0, 0.0);
(334900.0, 4818200.0, 1526.0, 0.0); (334900.0, 4818250.0, 1526.0, 0.0); (334900.0, 4818300.0, 1526.0, 0.0);
(334900.0, 4818350.0, 1526.0, 0.0); (334850.0, 4817850.0, 1526.0, 0.0); (334850.0, 4817900.0, 1526.0, 0.0);
(334850.0, 4817950.0, 1526.0, 0.0); (334850.0, 4818000.0, 1526.0, 0.0); (334850.0, 4818050.0, 1526.0, 0.0);
(334850.0, 4818100.0, 1526.0, 0.0); (334850.0, 4818150.0, 1526.0, 0.0); (334850.0, 4818200.0, 1526.0, 0.0);
(334850.0, 4818250.0, 1526.0, 0.0); (334850.0, 4818300.0, 1526.0, 0.0); (334850.0, 4818350.0, 1526.0, 0.0);
(334800.0, 4817850.0, 1526.0, 0.0); (334800.0, 4817900.0, 1526.0, 0.0); (334800.0, 4817950.0, 1526.0, 0.0);
(334800.0, 4818000.0, 1526.0, 0.0); (334800.0, 4818050.0, 1526.0, 0.0); (334800.0, 4818100.0, 1526.0, 0.0);
(334800.0, 4818150.0, 1526.0, 0.0); (334800.0, 4818200.0, 1526.0, 0.0); (334800.0, 4818250.0, 1526.0, 0.0);
(334800.0, 4818300.0, 1526.0, 0.0); (334800.0, 4818350.0, 1526.0, 0.0); (334750.0, 4817900.0, 1526.0, 0.0);
*** DISCRETE CARTESIAN RECEPTORS ***
(Cont.) (X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)
(334750.0, 4817950.0, 1526.0, 0.0); (334750.0, 4818000.0, 1526.0, 0.0); (334750.0, 4818050.0, 1526.0, 0.0);
(334750.0, 4818100.0, 1526.0, 0.0); (334750.0, 4818150.0, 1526.0, 0.0); (334750.0, 4818200.0, 1526.0, 0.0);
(334750.0, 4818250.0, 1526.0, 0.0); (334750.0, 4818300.0, 1526.0, 0.0); (334750.0, 4818350.0, 1526.0, 0.0);
(334700.0, 4817900.0, 1526.0, 0.0); (334700.0, 4817950.0, 1526.0, 0.0); (334700.0, 4818000.0, 1526.0, 0.0);
(334700.0, 4818050.0, 1526.0, 0.0); (334700.0, 4818100.0, 1526.0, 0.0); (334700.0, 4818150.0, 1526.0, 0.0);
(334700.0, 4818200.0, 1526.0, 0.0); (334700.0, 4818250.0, 1526.0, 0.0); (334700.0, 4818300.0, 1526.0, 0.0);
(334700.0, 4818350.0, 1526.0, 0.0); (334650.0, 4817950.0, 1526.0, 0.0); (334650.0, 4818000.0, 1526.0, 0.0);
(334650.0, 4818050.0, 1526.0, 0.0); (334650.0, 4818100.0, 1526.0, 0.0); (334650.0, 4818150.0, 1526.0, 0.0);
(334650.0, 4818200.0, 1526.0, 0.0); (334650.0, 4818250.0, 1526.0, 0.0); (334650.0, 4818300.0, 1526.0, 0.0);
(334650.0, 4818350.0, 1526.0, 0.0); (334600.0, 4817950.0, 1526.0, 0.0); (334600.0, 4818000.0, 1526.0, 0.0);
(334600.0, 4818050.0, 1526.0, 0.0); (334600.0, 4818100.0, 1526.0, 0.0); (334600.0, 4818150.0, 1526.0, 0.0);
(334600.0, 4818200.0, 1526.0, 0.0); (334600.0, 4818250.0, 1526.0, 0.0); (334600.0, 4818300.0, 1526.0, 0.0);
(334600.0, 4818350.0, 1526.0, 0.0); (334550.0, 4817950.0, 1526.0, 0.0); (334550.0, 4818000.0, 1526.0, 0.0);
(334550.0, 4818050.0, 1526.0, 0.0); (334550.0, 4818100.0, 1526.0, 0.0); (334550.0, 4818150.0, 1526.0, 0.0);
(334550.0, 4818200.0, 1526.0, 0.0); (334550.0, 4818250.0, 1526.0, 0.0); (334550.0, 4818300.0, 1526.0, 0.0);
(334550.0, 4818350.0, 1526.0, 0.0); (334500.0, 4818000.0, 1526.0, 0.0); (334500.0, 4818050.0, 1526.0, 0.0);
(334500.0, 4818100.0, 1526.0, 0.0); (334500.0, 4818150.0, 1526.0, 0.0); (334500.0, 4818200.0, 1526.0, 0.0);
(334500.0, 4818250.0, 1526.0, 0.0); (334500.0, 4818300.0, 1526.0, 0.0); (334500.0, 4818350.0, 1526.0, 0.0);
(334450.0, 4818000.0, 1526.0, 0.0); (334450.0, 4818050.0, 1526.0, 0.0); (334450.0, 4818100.0, 1526.0, 0.0);
(334450.0, 4818150.0, 1526.0, 0.0); (334450.0, 4818200.0, 1526.0, 0.0); (334450.0, 4818250.0, 1526.0, 0.0);
(334450.0, 4818300.0, 1526.0, 0.0); (334450.0, 4818350.0, 1526.0, 0.0); (334400.0, 4818000.0, 1526.0, 0.0);
(334400.0, 4818050.0, 1526.0, 0.0); (334400.0, 4818100.0, 1526.0, 0.0); (334400.0, 4818150.0, 1526.0, 0.0);
(334400.0, 4818200.0, 1526.0, 0.0); (334400.0, 4818250.0, 1526.0, 0.0); (334400.0, 4818300.0, 1526.0, 0.0);
(334400.0, 4818350.0, 1526.0, 0.0); (334350.0, 4818050.0, 1526.0, 0.0); (334350.0, 4818100.0, 1526.0, 0.0);
(334350.0, 4818150.0, 1526.0, 0.0); (334350.0, 4818200.0, 1526.0, 0.0); (334350.0, 4818250.0, 1526.0, 0.0);
(334350.0, 4818300.0, 1526.0, 0.0); (334300.0, 4818050.0, 1526.0, 0.0); (334300.0, 4818100.0, 1526.0, 0.0);

(334300.0, 4818150.0, 1526.0, 0.0); (334300.0, 4818200.0, 1526.0, 0.0); (334300.0, 4818250.0, 1526.0, 0.0);

(334300.0, 4818300.0, 1526.0, 0.0); (334250.0, 4818100.0, 1526.0, 0.0); (334250.0, 4818150.0, 1526.0, 0.0);

(334250.0, 4818200.0, 1526.0, 0.0); (334250.0, 4818250.0, 1526.0, 0.0); (334250.0, 4818300.0, 1526.0, 0.0);

(334200.0, 4818100.0, 1526.0, 0.0); (334200.0, 4818150.0, 1526.0, 0.0); (334200.0, 4818200.0, 1526.0, 0.0);

(334200.0, 4818250.0, 1526.0, 0.0); (334200.0, 4818300.0, 1526.0, 0.0); (334150.0, 4818150.0, 1526.0, 0.0);

(334150.0, 4818200.0, 1526.0, 0.0); (334150.0, 4818250.0, 1526.0, 0.0); (334150.0, 4818300.0, 1526.0, 0.0);

(334100.0, 4818150.0, 1526.0, 0.0); (334100.0, 4818200.0, 1526.0, 0.0); (334100.0, 4818250.0, 1526.0, 0.0);

(334100.0, 4818300.0, 1526.0, 0.0); (334050.0, 4818150.0, 1526.0, 0.0); (334050.0, 4818200.0, 1526.0, 0.0);

(334050.0, 4818250.0, 1526.0, 0.0); (334050.0, 4818300.0, 1526.0, 0.0); (334000.0, 4818150.0, 1526.0, 0.0);

(334000.0, 4818200.0, 1526.0, 0.0); (334000.0, 4818250.0, 1526.0, 0.0); (334000.0, 4818300.0, 1526.0, 0.0);

* SOURCE-RECEPTOR COMBINATIONS FOR WHICH CALCULATIONS MAY NOT BE PERFORMED *

LESS THAN 1.0 METER OR 3*ZLB IN DISTANCE, OR WITHIN OPEN PIT SOURCE

SOURCE - - RECEPTOR LOCATION - - DISTANCE

ID XR (METERS) YR (METERS) (METERS)

- -

INCI 335350.0 4817750.0 39.31

INCI 335350.0 4817800.0 35.29

INCI 335300.0 4817750.0 35.86

INCI 335300.0 4817800.0 31.40

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***

(1=YES; 0=NO)

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1

1 1 1 1 1 1

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***

(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY WIND SPEED CATEGORY

CATEGORY 1 2 3 4 5 6

A .70000E-01 .70000E-01 .70000E-01 .70000E-01 .70000E-01 .70000E-01

B .70000E-01 .70000E-01 .70000E-01 .70000E-01 .70000E-01 .70000E-01

C .10000E+00 .10000E+00 .10000E+00 .10000E+00 .10000E+00 .10000E+00

D .15000E+00 .15000E+00 .15000E+00 .15000E+00 .15000E+00 .15000E+00

E .35000E+00 .35000E+00 .35000E+00 .35000E+00 .35000E+00 .35000E+00

F .55000E+00 .55000E+00 .55000E+00 .55000E+00 .55000E+00 .55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***

(DEGREES KELVIN PER METER)

STABILITY WIND SPEED CATEGORY

CATEGORY 1 2 3 4 5 6

A .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00

B .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00

C .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00

D .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00 .00000E+00

E .20000E-01 .20000E-01 .20000E-01 .20000E-01 .20000E-01 .20000E-01

F .35000E-01 .35000E-01 .35000E-01 .35000E-01 .35000E-01 .35000E-01

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE:C:\BEE\MET\GRDTM92.ASC; FORMAT: FREE; SURFACE STATION NO.:0; UPPER AIR STATION NO.: 0

NAME: GRD NAME: GRD

YEAR: 1992 YEAR: 1992

FLOW SPEED TEMP STAB MIXING HEIGHT USTAR M-O Z-0 IPCODE PRATE

YEAR MONTH DAY HOUR VECTOR (M/S) (K) CLASS RURAL URBAN LENGTH

(M/S) (M) (M) (mm/HR)

- -

92 1 1 1 217.0 1.53 265.3 6 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 2 198.0 1.31 265.5 5 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 3 232.0 1.00 265.4 6 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 4 234.0 1.00 265.6 6 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 5 165.0 1.00 265.2 5 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 6 128.0 1.00 265.2 4 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 7 98.0 1.00 265.5 4 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 8 95.0 1.00 265.7 5 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 9 49.0 1.00 265.6 4 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 10 90.0 1.00 265.8 3 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 11 288.0 1.00 266.3 2 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 12 12.0 1.00 266.9 3 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 13 36.0 1.00 267.7 3 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 14 14.0 1.14 268.1 4 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 15 4.0 1.11 268.2 3 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 16 13.0 1.00 268.3 2 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 17 289.0 1.00 268.3 3 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 18 180.0 1.00 268.3 4 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 19 178.0 1.00 268.4 4 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 20 162.0 1.00 268.7 4 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 21 174.0 1.00 268.7 5 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 22 203.0 1.00 268.4 6 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 23 203.0 1.52 268.0 6 150.0 150.0 0.0000 0.0 0.0000 0 0.00

92 1 1 24 247.0 1.48 268.3 6 150.0 150.0 0.0000 0.0 0.0000 0 0.00

NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.

FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

8 Hour ISC Model Output Results: This output file is the result of the model run using the input data listed above.

Due to the size of the highest average concentration files, only the "1st highest" 8-hour average concentration file is shown. (The 1st highest average concentration file is used to determine the maximum impact identified in the EIS).

*** 8 HOUR - INCINERATOR - AMWTP - OCCUPATIONAL WORKER GRID *** 10/28/98

*** 1992 MET YEAR DATA-ELEVATED RELEASE *** 01:51:11

*** THE 1ST HIGHEST 8-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***

INCLUDING SOURCE(S): INCI ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH)

. -

335500.00 4817550.00 25.36453 (92012716) 335500.00 4817600.00 24.64047 (92121916) 335500.00 4817650.00 27.26078 (92052616)
335500.00 4817700.00 28.02447 (92121916) 335500.00 4817750.00 26.64979 (92021716) 335500.00 4817800.00 25.71998 (92022716)

335500.00 4817850.00 41.64617 (92011316) 335500.00 4817900.00 57.02593 (92021116) 335500.00 4817950.00 47.32745 (92021116)

335500.00 4818000.00 47.89825 (92031124) 335500.00 4818050.00 38.66580 (92010816) 335500.00 4818100.00 41.36114 (92010816)

335500.00 4818150.00 32.40591 (92112424) 335450.00 4817600.00 30.31480 (92012716) 335450.00 4817650.00 34.54274 (92052616)
335450.00 4817700.00 30.53099 (92052616) 335450.00 4817750.00 25.44897 (92021716) 335450.00 4817800.00 28.60785 (92011316)

335450.00 4817850.00 36.19343 (92110924) 335450.00 4817900.00 50.51545 (92021116) 335450.00 4817950.00 41.18807 (92031124)
335450.00 4818000.00 44.88165 (92010816) 335450.00 4818050.00 35.51377 (92112424) 335450.00 4818100.00 35.11222 (92092608)

335450.00 4818150.00 33.35476 (92010116) 335400.00 4817600.00 29.59212 (92121816) 335400.00 4817650.00 23.61026 (92121816)
335400.00 4817700.00 31.22176 (92052616) 335400.00 4817750.00 8.51756 (92071216) 335400.00 4817800.00 14.60138 (92011316)

335400.00 4817850.00 31.25675 (92021116) 335400.00 4817900.00 39.93450 (92031116) 335400.00 4817950.00 42.18863 (92022124)
335400.00 4818000.00 37.20565 (92010116) 335400.00 4818050.00 56.73483 (92010116) 335400.00 4818100.00 63.68458 (92010116)

335400.00 4818150.00 60.58238 (92010116) 335350.00 4817650.00 24.16610 (92022224) 335350.00 4817700.00 14.61367 (92092524)
335350.00 4817750.00 0.00010 (92092516) 335350.00 4817800.00 0.00000 (92052524) 335350.00 4817850.00 14.90395 (92022124)

335350.00 4817900.00 32.31974 (92031116) 335350.00 4817950.00 42.42368 (92010116) 335350.00 4818000.00 52.53162 (92010116)
335350.00 4818050.00 51.23130 (92010116) 335350.00 4818100.00 45.66654 (92010116) 335350.00 4818150.00 39.30067 (92010116)

335300.00 4817650.00 44.00222 (92012116) 335300.00 4817700.00 20.26916 (92020108) 335300.00 4817750.00 0.00000 (92050416)
335300.00 4817800.00 0.00000 (92081824) 335300.00 4817850.00 8.68079 (92060124) 335300.00 4817900.00 28.97097 (92052224)

335300.00 4817950.00 35.59404 (92022616) 335300.00 4818000.00 33.46711 (92022616) 335300.00 4818050.00 28.07187 (92022616)
335300.00 4818100.00 23.83860 (92041416) 335300.00 4818150.00 23.22237 (92012108) 335250.00 4817700.00 32.42300 (92050716)

335250.00 4817750.00 15.76675 (92022516) 335250.00 4817800.00 10.25017 (92060516) 335250.00 4817850.00 21.07568 (92032316)
335250.00 4817900.00 27.00755 (92050424) 335250.00 4817950.00 30.39252 (92042524) 335250.00 4818000.00 23.85324 (92010908)

335250.00 4818050.00 26.57633 (92010908) 335250.00 4818100.00 32.10378 (92052224) 335250.00 4818150.00 31.93081 (92052224)
335200.00 4817700.00 39.22266 (92022516) 335200.00 4817750.00 41.26678 (92022516) 335200.00 4817800.00 30.07127 (92031916)

X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH)

(Cont.) -

335200.00 4817850.00 33.02909 (92060516) 335200.00 4817900.00 33.05015 (92032524) 335200.00 4817950.00 35.53063 (92031324)
335200.00 4818000.00 22.76532 (92062408) 335200.00 4818050.00 26.50412 (92022524) 335200.00 4818100.00 23.17013 (92041508)

335200.00 4818150.00 29.18651 (92010908) 335150.00 4817700.00 55.28301 (92061724) 335150.00 4817750.00 36.59818 (92022516)
335150.00 4817800.00 36.10882 (92031916) 335150.00 4817850.00 34.87624 (92031916) 335150.00 4817900.00 32.30836 (92032524)

335150.00 4817950.00 28.97903 (92072908) 335150.00 4818000.00 29.44152 (92031324) 335150.00 4818050.00 25.57178 (92062408)
335150.00 4818100.00 24.99066 (92080408) 335150.00 4818150.00 24.40964 (92080408) 335100.00 4817750.00 32.77893 (92040116)

335100.00 4817800.00 38.15358 (92042008) 335100.00 4817850.00 34.19284 (92031916) 335100.00 4817900.00 30.91980 (92031916)
335100.00 4817950.00 28.32658 (92032524) 335100.00 4818000.00 23.95377 (92072908) 335100.00 4818050.00 21.45940 (92072908)

335100.00 4818100.00 21.73577 (92090108) 335100.00 4818150.00 24.75002 (92062408) 335100.00 4818300.00 21.68929 (92111908)
335050.00 4817750.00 33.22020 (92011124) 335050.00 4817800.00 35.41227 (92042008) 335050.00 4817850.00 28.40465 (92031916)

335050.00 4817900.00 32.53730 (92031916) 335050.00 4817950.00 35.41022 (92062108) 335050.00 4818000.00 22.61038 (92032524)

335050.00 4818050.00 19.80598 (92072908) 335050.00 4818100.00 19.76751 (92072908) 335050.00 4818150.00 22.91106 (92031324)

335050.00 4818200.00 21.00553 (92062408) 335050.00 4818250.00 21.39648 (92062408) 335050.00 4818300.00 25.97098 (92080408)
335050.00 4818350.00 25.69055 (92080408) 335000.00 4817800.00 31.48153 (92042008) 335000.00 4817850.00 25.49117 (92042008)

335000.00 4817900.00 26.30241 (92031916) 335000.00 4817950.00 26.11005 (92031916) 335000.00 4818000.00 24.52972 (92062108)
335000.00 4818050.00 18.08410 (92112816) 335000.00 4818100.00 16.53718 (92072908) 335000.00 4818150.00 17.68646 (92072908)

335000.00 4818200.00 21.02330 (92060208) 335000.00 4818250.00 19.83995 (92090108) 335000.00 4818300.00 20.37290 (92062408)
335000.00 4818350.00 17.50289 (92062408) 334950.00 4817800.00 27.63984 (92042008) 334950.00 4817850.00 29.53696 (92042008)

334950.00 4817900.00 20.66318 (92083008) 334950.00 4817950.00 24.33643 (92031916) 334950.00 4818000.00 35.36322 (92062108)
334950.00 4818050.00 17.10193 (92062108) 334950.00 4818100.00 15.60452 (92021816) 334950.00 4818150.00 14.59637 (92121208)

334950.00 4818200.00 15.75989 (92072908) 334950.00 4818250.00 18.23430 (92060208) 334950.00 4818300.00 19.48079 (92031324)
334950.00 4818350.00 17.17760 (92090108) 334900.00 4817800.00 24.20467 (92042008) 334900.00 4817850.00 32.31117 (92042008)

334900.00 4817900.00 23.77029 (92110408) 334900.00 4817950.00 21.07441 (92100708) 334900.00 4818000.00 21.30617 (92122824)
334900.00 4818050.00 31.87780 (92062108) 334900.00 4818100.00 15.58509 (92050708) 334900.00 4818150.00 13.27316 (92021816)

334900.00 4818200.00 13.34976 (92121208) 334900.00 4818250.00 14.65237 (92021024) 334900.00 4818300.00 14.62760 (92060208)
334900.00 4818350.00 19.73738 (92031324) 334850.00 4817850.00 33.71592 (92042008) 334850.00 4817900.00 21.75381 (92110408)

334850.00 4817950.00 22.71363 (92083008) 334850.00 4818000.00 20.26317 (92051524) 334850.00 4818050.00 28.79303 (92062108)
334850.00 4818100.00 23.05839 (92062108) 334850.00 4818150.00 15.10208 (92101908) 334850.00 4818200.00 12.66040 (92080108)

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334800.00 4817850.00 33.93483 (92042008) 334800.00 4817900.00 16.87444 (92083008) 334800.00 4817950.00 20.01455 (92083008)

X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH)

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334800.00 4818000.00 18.19225 (92051524) 334800.00 4818050.00 19.47833 (92122824) 334800.00 4818100.00 32.03354 (92062108)
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334750.00 4817950.00 21.61788 (92110408) 334750.00 4818000.00 19.09131 (92100708) 334750.00 4818050.00 17.33255 (92122824)

334750.00 4818100.00 22.46751 (92062108) 334750.00 4818150.00 26.19909 (92062108) 334750.00 4818200.00 14.27907 (92050708)
334750.00 4818250.00 13.56340 (92030208) 334750.00 4818300.00 13.63404 (92080108) 334750.00 4818350.00 12.07564 (92122408)

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334700.00 4818050.00 16.31819 (92121724) 334700.00 4818100.00 17.23847 (92122824) 334700.00 4818150.00 28.46537 (92062108)

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334700.00 4818350.00 13.62881 (92080108) 334650.00 4817950.00 20.66301 (92110408) 334650.00 4818000.00 19.34044 (92083008)

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334600.00 4818050.00 18.82264 (92083008) 334600.00 4818100.00 16.20702 (92121724) 334600.00 4818150.00 15.10155 (92122824)

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334550.00 4818200.00 13.89895 (92062108) 334550.00 4818250.00 24.94388 (92062108) 334550.00 4818300.00 16.51624 (92062108)

334550.00 4818350.00 13.59899 (92112224) 334500.00 4818000.00 22.23713 (92110408) 334500.00 4818050.00 18.55313 (92083008)
334500.00 4818100.00 16.05041 (92121724) 334500.00 4818150.00 16.02076 (92121724) 334500.00 4818200.00 13.39147 (92122824)

334500.00 4818250.00 19.96514 (92062108) 334500.00 4818300.00 22.03448 (92062108) 334500.00 4818350.00 12.78830 (92062108)
334450.00 4818000.00 19.47253 (92110408) 334450.00 4818050.00 16.55751 (92110408) 334450.00 4818100.00 18.50666 (92083008)

334450.00 4818150.00 15.94215 (92121724) 334450.00 4818200.00 13.80350 (92111008) 334450.00 4818250.00 11.65070 (92122824)
334450.00 4818300.00 22.54102 (92062108) 334450.00 4818350.00 17.81114 (92062108) 334400.00 4818000.00 16.25645 (92121724)

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334350.00 4818300.00 11.15879 (92042224) 334300.00 4818050.00 20.54356 (92110408) 334300.00 4818100.00 14.61496 (92110408)
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X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH) X-COORD(M) Y-COORD(M) CONC (YYMMDDHH)

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334300.00 4818300.00 11.81239 (92111008) 334250.00 4818100.00 17.58365 (92110408) 334250.00 4818150.00 18.48921 (92083008)
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334200.00 4818100.00 19.49151 (92110408) 334200.00 4818150.00 16.73877 (92083008) 334200.00 4818200.00 15.20234 (92083008)
334200.00 4818250.00 14.70318 (92121724) 334200.00 4818300.00 14.79419 (92121724) 334150.00 4818150.00 13.66795 (92083008)

334150.00 4818200.00 17.19105 (92083008) 334150.00 4818250.00 14.30505 (92121724) 334150.00 4818300.00 14.97188 (92121724)
334100.00 4818150.00 15.52132 (92110408) 334100.00 4818200.00 17.39656 (92083008) 334100.00 4818250.00 13.66381 (92121724)

334100.00 4818300.00 14.28999 (92121724) 334050.00 4818150.00 17.49301 (92110408) 334050.00 4818200.00 15.81866 (92083008)
334050.00 4818250.00 14.92852 (92083008) 334050.00 4818300.00 13.46414 (92121724) 334000.00 4818150.00 18.47131 (92110408)

334000.00 4818200.00 13.19211 (92083008) 334000.00 4818250.00 16.38382 (92083008) 334000.00 4818300.00 13.00994 (92121724)

*** THE SUMMARY OF HIGHEST 8-HR RESULTS ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

DATE NETWORK

GROUP ID AVERAGE CONC (YYMMDDHH) RECEPTOR (XR, YR, ZELEV, ZFLAG) OF TYPE GRID-ID

- -

ALL HIGH 1ST HIGH VALUE IS 63.68458 ON 92010116: AT (335400.00, 4818100.00, 1526.00, 0.00) DC NA

HIGH 2ND HIGH VALUE IS 42.86311 ON 92061608: AT (335500.00, 4817900.00, 1526.00, 0.00) DC NA

*** RECEPTOR TYPES: GC = GRIDCART

GP = GRIDPOLR

DC = DISCCART

DP = DISCPOLR

BD = BOUNDARY

*** Message Summary : ISCST3 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)

A Total of 0 Warning Message(s)

A Total of 0 Informational Message(s)

E-4 OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

This appendix section describes the method used and presents the key data required for evaluating the health effects reported in this EIS. The methods presented here are organized under two broad categories: (1) health impacts from effluent releases and (2) normal workplace hazards. The first category includes effluent releases of radioactivity to air and water and addresses health effects to both the public and workers. Sufficient detail on health effects of carcinogenic and toxic chemicals is provided in Section 5.12, Occupational and Public Health and Safety, and additional detail is not provided in this appendix section. The second category includes radiological and nonradiological hazards to workers at the AMWTP facility in the normal conduct of their jobs.

E-4.1 Radiological Health and Safety

Estimated health effects from radionuclides are based on the 1990 recommendations of the ICRP (ICRP 1991). These risk factors are presented in Table E-4-1.

In the interest of clear and consistent presentation and to allow ready comparison with health impacts from other sources, such as chemical carcinogens, the measure of impact used for evaluation of potential radiation exposures in this EIS is risk of fatal cancer. Population effects are reported as collective radiation dose (in person-rem) and the estimated number of fatal cancers in the affected population. The maximum individual effects are reported as individual radiation dose (in rem) and the estimated lifetime probability of fatal cancer. Other effects, such as nonfatal cancer and genetic effects, are presented in Table E-4-1 for informational purposes.

As indicated in Table E-4-1, the risk per unit of radiation exposure is slightly smaller for workers than for the general public. This is because the working population is made up of a narrow age group that excludes infants, children, and the elderly. Similarities in risks of genetic and non-fatal cancers are coincidental artifacts of rounding of reported numbers.

Table E-4-1. Risk of fatal cancer and other health effects from exposure to radiation.[a]

Receptor	Fatal cancer	Nonfatal cancer	Genetic effects	Total detriment
Worker	4.0E-04	8.0E-05	8.0E-05	5.6E-04
General public	5.0E-04	1.0E-04	1.3E-04	7.3E-04

a. Units when applied to an individual are "lifetime probability of cancer per rem of radiation dose." Units when applied to a population of individuals are "excess number of cancer per person-rem of radiation dose." Genetic effects apply to population, not individuals.

Human health effects associated with radionuclide emissions from the AMWTP have been calculated for (1) a worker at the location of highest predicted radioactivity level, (2) the MEI at an offsite location, and (3) the entire population (adjusted for future growth) within an 80-kilometer radius of each source of emission within the INEEL. Doses and associated human health effects are assessed for AMWTP emissions under each proposed alternative and are added to current (baseline) doses and human health impacts and projected increases as a result of other future INEEL facilities to determine cumulative radiological impacts. Projected increases are assumed to be represented by dose and human health impact estimates for the DOE INEL EIS (DOE 1995a) Preferred Alternative. However, some modification to the baseline and foreseeable dose and human health impacts were necessary (see Appendix Section E-3, Air Resources) to remove contributions from facilities that would not operate under the proposed alternatives. Tables E-4-2 and E-4-3 present these annual and operating lifetime doses and associated human health impacts, respectively.

The principal pathway by which the public may be exposed to radioactivity is through releases to the atmosphere.

Radiation doses to members of the public from airborne releases at INEEL are calculated annually using information from the Radioactive Waste Management Information System database (DOE-ID 1996d, 1997c). Table E-4-4 presents data for 1995 and 1996. As Table E-4-4 indicates, the offsite radiation dose to any member of the public from normal operations is substantially less than 1 millirem per year for both periods. Current regulations limit releases of airborne radioactivity from DOE facilities to concentrations that would result in a dose of no more than 10 millirem per year to any member of the public.

Table E-4-2. Summary of radiation dose and human health impacts associated with airborne emissions from the AMWTP.

	Baseline		Projected		AMWTP		Cumulative	
Receptor	Dose millirem	Risk [a] (fatality)	Dose millirem	Risk [a] (fatality)	Dose millirem	Risk [a] (fatality)	Dose millirem	Risk [a] (fatality)
No Action Alternative								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	-	-	0.23	9.32E-08
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	-	-	0.14	7.00E-08
Population [b]	0.085	4.25E-05	0.41	2.05E-04	-	-	0.50	2.48E-04
Proposed Action - with microencapsulation								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.058	2.32E-08	0.29	1.16E-07
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.022	1.10E-08	0.16	8.15E-08
Population [b]	0.085	4.25E-05	0.41	2.05E-04	0.0089	4.45E-06	0.50	2.52E-04
Proposed Action - with vitrification								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.36	1.44E-07	0.59	2.37E-07
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.09	4.50E-08	0.23	1.16E-07
Population [b]	0.085	4.25E-05	0.41	2.05E-04	0.048	2.40E-05	0.54	2.72E-04
Non-Thermal Treatment Alternative								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.003	1.20E-09	0.24	9.44E-08
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.0031	1.55E-09	0.14	7.21E-08
Population [b]	0.085	4.25E-05	0.41	2.05E-04	0.00085	4.25E-07	0.50	2.48E-04
Treatment and Storage Alternative - with microencapsulation								

MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.058	2.32E-08	0.29	1.16E-07
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.022	1.10E-08	0.16	8.15E-08
Population b	0.085	4.25E-05	0.41	2.05E-04	0.0089	4.45E-06	0.50	2.52E-04
Treatment and Storage Alternative - with vitrification								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.36	1.44E-07	0.59	2.37E-07
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.09	4.50E-08	0.23	1.16E-07
Population b	0.085	4.25E-05	0.41	2.05E-04	0.048	2.40E-05	0.54	2.72E-04

a. The fatal cancer risk for the onsite and offsite MEI is based on maximum annual dose to one individual; the population risk is based on annual dose and collective population of 82,000 within 80 kilometer of the site.
b. The population dose is in person-rem per year and represents the collective dose to 100,000 people, which is the projected population within 80 kilometer of the AMWTP during the year 2015.

Based on the nature of the work at the INEEL, occupational radiation exposure for some workers will inevitably be above background levels. Natural background radiation dose in the vicinity of INEEL site, Snake River Plain (DOE-ID 1991a), are presented in Table E-4-5. More recent background radiation levels of approximately 360 mrem/year have been reported (see Section 4.7, Air Resources). The radiation protection program required by regulation and DOE orders is designed to ensure that no worker receives doses larger than the applicable limits and that worker doses are kept ALARA.

Table E-4-3. Summary of radiation dose and human health impacts associated with airborne emissions over the projected operating lifetime of the AMWTP.[a]

	13-year facility lifetime		30-year facility lifetime	
Receptor	Dose	Risk (fatality)	Dose	Risk (fatality)
Proposed Action - with microencapsulation				
MEI Onsite	0.76 millirem	3.04E-07	1.75 millirem	7.00E-07
MEI Offsite	0.29 millirem	1.45E-07	0.67 millirem	3.35E-07
Population	0.11 person-rem b	5.50E-05	0.29 person-rem c	1.45E-04
Proposed Action - with vitrification				
MEI Onsite	4.63 millirem	1.85E-06	10.70 millirem	4.28E-06
MEI Offsite	1.17 millirem	5.85E-07	2.70 millirem	1.35E-06
Population	0.60 person-rem b	3.00E-04	1.60 person-rem c	8.00E-04

Non-Thermal Treatment Alternative				
MEI Onsite	0.039 millirem	1.56E-08	d	d
MEI Offsite	0.040 millirem	2.00E-08	d	d
Population	0.011 person-rem [b]	5.50E-06	d	d
Treatment and Storage Alternative - with microencapsulation				
MEI Onsite	0.76 millirem	3.04E-07	1.75 millirem	7.00E-07
MEI Offsite	0.29 millirem	1.45E-07	0.67 millirem	3.35E-07
Population	0.11 person-rem [b]	5.50E-05	0.29 person-rem [c]	1.45E-04
Treatment and Storage Alternative - with vitrification				
MEI Onsite	4.63 millirem	1.85E-06	10.70 millirem	4.28E-06
MEI Offsite	1.17 millirem	5.85E-07	2.70 millirem	1.35E-06
Population	0.60 person-rem [b]	3.00E-04	1.60 person-rem [c]	8.00E-04

a. Data for dose and lifetime from Table 5.7-4 and Table 5.7-5 of Section 5.7, Air Resources.

b. The population dose and risk is based on total population of 82,000.

c. The population dose and risk is based on total population of 100,000.

d. AMWTP would not operate beyond 13 years under this alternative.

Table E-4-4. Estimated doses to members of the public from INEEL airborne releases for years 1995 and 1996.

Year	Maximally exposed individual (millirem)	Population dose (person-rem)[a]
1995	0.018	0.3
1996	0.031	NA[b]

a. Population dose from DOE 1995a.
b. NA = Not available.

Workers at the RWMC may be exposed either internally or externally to radiation. Internal exposure occurs when radioactive materials are deposited in the body through inhalation, ingestion, or absorption through intact skin or wounds in the skin. External exposures in the workplace are those received from radiation-emitting sources outside the body. Table E-4-6 presents the collective total effective dose equivalent (which includes both internal and external doses) for individual workers with measurable dose for the DOE Complex, including contractor and government workers, the INEEL, and the RWMC. The statistics for the DOE Complex and INEEL are from the DOE Occupational Radiation Exposure report (DOE 1996b). The 1995 information regarding the RWMC is from Parrish (1998).

Table E-4-5. Estimated natural background radiation dose for the Snake River Plain.

Source	Annual effective dose equivalent (millirem)
External	
Terrestrial	75
Cosmic	39
Subtotal	114
Internal	
K-40 and others	40
Inhaled nuclides [a]	200
Subtotal	240
Total	354

Source: DOE-ID 1991a.

a. The dose from inhaled radionuclides is due primarily to short-lived decay products from radon and varies widely with geographic location. The value represents the United States population average.

Table E-4-6. Collective total effective dose equivalent (TEDE) of individuals with measurable dose for the DOE Complex, INEEL, and RWMC.

Year	Site	Total workers, DOE and contractors	Total monitored workers	Total monitored with measurable dose	Collective dose (person-rem)	Average measurable dose (rem)
1991	DOE	183,546	119,770	31,326	2,574	0.082
	INEEL	-[a]	-	-	162	-
	RWMC	-	-	-	-	-
1992	DOE	191,036	123,711	29,414	2,295	0.078
	INEEL	-	-	1,004	87	0.082
	RWMC	-	-	15	0.87	0.058
1993	DOE	194,547	127,042	25,095	1,644	0.066
	INEEL	-	-	1,175	235.5	0.200
	RWMC	-	-	33	2.03	0.062
1994	DOE	184,073	116,511	25,390	1,643	0.065
	INEEL	-	-	1,659	236.8	0.143

	RWMC	-	-	56	7.1	0.127
1995	DOE	172,178	127,276	23,613	1,840	0.078
	INEEL	-	-	1,501	284	0.189
	RWMC	-	-	51	6.4	0.125

a. "-" represents no data available.

Reported doses resulting from normal operations for a recent four-year (1992-1995) period averaged to 72, 154, and 93 millirem for the DOE Complex, INEEL, and RWMC, respectively. The average doses for RWMC changed to 81 millirem when years 1996 and 1997 were included in the statistics. Table E-4-7 presents the total measured dose and the number of radiation workers.

Table E-4-7. RWMC total measured dose.[a]

Year	Number of radiation workers	Total dose (rem)	Average dose (rem)
1992[b]	15	0.874	0.058
1993[b]	33	2.030	0.062
1994[b]	56	7.135	0.127
1995	51	6.353	0.125
1996	78	4.439	0.057
1997	66	3.777	0.057

a. Data from INEEL radiation dosimetry system area radiation dose report.

b. For all years, the total dose includes all Environmental Restoration and Waste Management facilities, which are RWMC, WERF, and Waste Reduction Operation Complex.

E-4.2 Nonradiological Hazards

The primary source of information on nonradiological hazards to the workers at the INEEL are reports of occupational injuries. Statistics regarding the injury, illness, and fatality rates for the entire DOE Complex, INEEL, and RWMC are presented in Table E-4-8. The information for the DOE Complex and INEEL are from the DOE Office of Environment, Safety and Health, Technical Information System web site [http://tis.eh.doe.gov/docs/oipds/oipds964/]. Statistics for the RWMC were obtained from an INEEL occupational health representative (Kavaran 1998). These data include construction workers in addition to operation and maintenance workers.

The calculated rates from Table E-4-8 are used to estimate the annual average injury/illness and fatalities based on the annual average number workers assuming 200,000 hours worked. The rate calculation is based on the approach used in DOE reports. The complete methodology can be found at the following web site [http://tis.eh.doe.gov/systems/doe_injury/rates.html]. The equations for calculating the incidence and fatality rates are as follows:

$$\text{Incidence Rate per 200,000 hours} = (\text{Number of Injuries and Illnesses} \times 200{,}000 \text{ hours})/(\text{Employee Hours Worked})$$

Fatality Rate per 200,000 hours = (Number of Fatalities x 200,000 hours)/(Total Hours Worked).

Table E-4-8. DOE Complex, INEEL, and RWMC injury, illness, and fatality statistics.

Year	Site	Total employees	Total work hours	Recordable cases	Recordable case rate	Total fatalities	Lost workday cases	Lost workday case rate[a]	Lost workdays	Lost workday rate[a]
1992	DOE	190,748	3.63E+08	6,858	3.8	10	3,209	1.8	97,827	54.0
	INEEL	9,544	1.76E+07	324	3.7	0	156	1.8	3,090	35.2
	RWMC	-[b]	-	1	-	0	-	-	1	-
1994	DOE	183,574	3.49E+08	6,282	3.6	12	3,008	1.7	88,111	50.5
	INEEL	8,384	1.59E+07	250	3.1	0	110	1.4	1,823	22.9
	RWMC	-	-	4	-	0	-	-	19	-
1995	DOE	169,679	3.22E+08	5,714	3.5	3	2,784	1.7	80,191	49.7
	INEEL	7,094	1.35E+07	237	3.5	0	114	1.7	1,620	24.0
	RWMC	-	-	15	-	0	-	-	22	-
1996	DOE	157,003	2.98E+08	5,195	3.5	2	2,371	1.6	61,568	41.3
	INEEL	6,645	1.26E+07	192	3.0	1	78	1.2	1,100	17.4
	RWMC	-	-	13	-	1	-	-	8	-

a. Rates are per 200,000 hours worked (based on the format of available data).

b. "-" represents no data available.

E-5 facility accidents

E-5.1 Introduction

Appendix Section E-5 provides background information for Section 5.14, Facility Accidents. A facility accident is an unplanned sequence of events that results in undesirable consequences. This section describes the process used to identify accident scenarios, the basis for evaluating selected scenarios, and the modeling methods and assumptions used to estimate health effects consequences. (Note: accident scenarios describe those actions or occurrences leading up to, including, and following an accident, e.g., the design basis scenario for a design basis accident.) The analysis of accidents is intended to be conservative in the sense that where uncertainties exist, assumptions that bound the potential for credible consequences are used. Because of the importance of this topic and because of the need to ensure consistency with regard to source information, much of this appendix section has been taken verbatim from the latest publication of the AMWTP Preliminary Safety Analysis Report (PSAR) (BNFL 1998d), which was produced by the BNFL Inc. design team. Note that data on the vitrifier alternative for ash treatment, although not present in the current PSAR, was taken from developmental (April 1998) drafts of the current PSAR document (BNFL 1998d).

E-5.2 Methodology

E-5.2.1 Selection of Accident Scenarios

Hazard identification and evaluation were performed for the AMWTP to derive the bounding accidents for the facility. The analysis provides a thorough, predominately qualitative, evaluation of the spectrum of risks to the public, workers, and environment (risk is defined as a quantitative expression of possible loss considering both the probability that a hazard causes harm and the consequences of that event). The hazard evaluation ranking qualitatively evaluates the frequency and consequence of an accident using four frequency bins and four consequence bins as described in Table E-5-1. The risk associated with each accident is the product of frequency and consequence.

Table E-5-1. Frequencies and consequences of hazards evaluated.

Frequency	Description	Consequence	Description
Anticipated (>1.0E-02/yr)	Incidents that may occur several times during the lifetime of the facility	None	Negligible onsite and offsite impacts on people or the environment
Unlikely (1.0E-04/yr to 1.0E-02/yr)	Accidents not anticipated to occur during the lifetime of the facility	Low	Minor onsite and negligible offsite impacts on people or the environment
Extremely unlikely (1.0E-06/yr to 1.0E-04/yr)	Accidents that probably do not occur during the life cycle of the facility	Moderate	Considerable onsite impact on people or the environment; only minor offsite impact
Beyond extremely unlikely (<1.0E-06/yr)	All other accidents	High	Considerable onsite and offsite impacts on people or the environment

Source: INEEL 1997.

The selection of the risk-dominant accident scenarios (those scenarios having the greatest risk) relies on previous safety analysis reports (SARs) for the RWMC (EG&G 1986, INEEL 1997) and on the draft PSAR for the AMWTP (BNFL 1998d). In general, the approach is to select the scenarios with the highest consequence within each frequency category.

To perform the analysis, one first examines the scenarios that have a frequency category of "anticipated." All of the scenarios in this category have a low consequence with the exception of one scenario that has a moderate consequence. Because of its high frequency, the scenario is a significant contributor to risk even though there are higher-consequence events that have lower frequencies. The next step is to examine the scenarios that have a frequency category of "unlikely." Five scenarios were identified with a moderate-to-high consequence within this frequency category. The final step is to examine the "extremely unlikely" frequency category for scenarios that could have a consequence higher than the consequences of the four "unlikely" scenarios already selected. Two design basis scenarios were identified that could have higher consequences. The list of potentially risk-dominant design basis accident scenarios for the AMWTP, in addition to a vitrifier explosion scenario, is presented in Table E-5-2. The following subsections describe the design basis accident scenarios in more detail.

Evaluation guidelines are applied to each scenario twice. The first application is to each of the dominant scenarios, and is represented in Table E-5-2 and Table E-5-4. In more refined analyses, accident scenario frequencies are subsequently reduced to the "extremely unlikely" frequency category for all scenarios except the "Loss of all AC power". A description of this frequency categorization process for each scenario is provided in this section.

Table E-5-2. Design basis accident scenarios for the AMWTP.

Accident description	Frequency category	Consequence
Fire involving waste in the box line	Anticipated	Low
Fire involving waste in the drum line	Anticipated	Low
Loss of all AC power	Anticipated	Low
Dropped waste box outdoors during transfer	Anticipated	Moderate
Fire in TRU waste in the TSA RE	Unlikely	Moderate
Incinerator explosion	Unlikely	High
Wind-borne missile breach of AMWTP facility	Unlikely	Low
Fire involving waste transfer vehicle	Unlikely	High
Design basis seismic event	Unlikely	Moderate
Nuclear criticality in a microencapsulation ash drum	Unlikely	Moderate
Vitrifier explosion	Extremely unlikely	High
Type II module fire	Extremely unlikely	High
Propane-fueled fires	Extremely unlikely	High

E-5.2.1.1 Fire Involving Waste in the Box Line. TRU waste is removed from containers and sorted for further treatment in the AMWTP facility box and drum lines. A fire is postulated to start in waste within the box line confinement cell. A fire could be initiated by sparking from remotely operated power tools used in the cell to open containers or from within the waste itself via spontaneous combustion or undetected pyrophoric constituents. The fire then spreads to involve uncontained and contained waste within the cell.

The box lines are Zone 3 confinement cells with ventilation that is part of the AMWTP facility cascade system. The fire is postulated to increase the temperature in the cell and increase particulate loading on the ventilation system HEPA filters that then fail. The pressure in the cell increases, resulting in a release of radioactivity to Zone 2 areas. No credit is given to either manual or automatic fire detection and suppression system (unmitigated).

The probability of a fire in the box line is estimated to be in the anticipated frequency category. The likelihood of an unmitigated fire is actually much lower because operators are working on the waste boxes with manipulators and would immediately notice and manually extinguish a small fire. The automatic fire suppression system would activate in the event of a severe fire. The likelihood of a fire is estimated to be in the extremely unlikely frequency category for the unmitigated case with bounding radioactive and hazardous material source terms as analyzed below.

E-5.2.1.2 Fire Involving Waste in the Drum Line. TRU waste is removed from containers and sorted for further treatment in the AMWTP facility box and drum lines. A fire is postulated to start in waste within the drum line confinement cell. A fire could be initiated by sparking from remotely operated power tools used in the cell to open containers or from within the waste itself via spontaneous combustion or undetected pyrophoric constituents. The fire then spreads to involve other wastes within the cell.

The drum line is within Zone 3 confinement cells and its ventilation is part of the AMWTP facility cascade system. The fire is postulated to increase the temperature in the cell and to increase the particulate loading on the ventilation system HEPA filters that then fail. No credit is given to either manual or automatic fire detection and suppression systems (unmitigated).

The probability of a fire in the drum line is estimated to be in the anticipated frequency category. The likelihood of an unmitigated fire is actually much lower because operators are working on the waste drums with manipulators and would immediately notice and manually extinguish a small fire. The automatic fire suppression system would activate in the event of a severe fire. The likelihood of a fire is estimated to be in the extremely unlikely frequency category for the unmitigated case with bounding radioactive and hazardous material source terms as analyzed below.

E-5.2.1.3 Loss of All AC Power. A loss of electrical power is postulated and all backup/ emergency diesel generators fail to start or fail to run. Initial efforts to restart backup alternating current (AC) power system fail resulting in a complete loss of AC for 1 hour. During this time, the pressure differential between the various confinement zones is not maintained, resulting in the spread of contamination. The accident sequence and release calculations for loss of AC power are provided in Appendix Section E-5.4.1.3.

Interruptions of offsite power occur up to several times per year at the RWMC, usually for less than a few minutes. On the basis of industry statistics for backup diesel generators, the combined likelihood of failure to start, pick up the electrical load, and continue to run is about 0.01 failures per demand. Given several demands per year, the frequency of occurrence of the postulated accident is in the low end of the anticipated frequency category.

E-5.2.1.4 Dropped Waste Box Outdoors During Transfer. TRU waste in waste boxes is transferred by flatbed truck within the TSA. For each box retrieved from the TSA-RE, transfers between facilities occur as follows:

1. From TSA-RE to Type I module

2. From Type I module to Type II module

3. From Type II module to proposed AMWTP facility.

Each transfer includes loading/unloading, some of which occurs outdoors. It is postulated that a waste box could either be dropped during loading/unloading or fall off a truck during transfer. The dropped waste box is assumed to crack or break open, releasing radioactive and toxic materials to the atmosphere.

Without controls, the probability of the postulated accident is estimated to be in the anticipated frequency category. The actual probability for an accident involving maximum material at risk boxes, however, is in the extremely unlikely frequency category because of the small number of boxes in a waste stream that defines the maximum MAR. The analysis of the unmitigated accident described below does not take credit for container tiedowns or technical safety requirements governing waste transport.

E-5.2.1.5 Fire in TRU Waste in the TSA-RE. Since 1970, TRU waste has been stored in containers on ground-level asphalt pads within the TSA. Waste containers were stacked and covered with plywood cover, fabric, and 3 to 4 feet of soil (TSA-RE pad is covered with fabric only). Some containers are expected to have deteriorated during storage, and waste probably will occasionally be exposed during retrieval operations. Exposed waste is postulated to ignite by chemical reaction, electrical discharge, spontaneous combustion, interaction with retrieval equipment, or ignition of pyrophoric materials. The spread of the fire would be limited by the lack of combustible fuel and by container integrity. Most boxes are metal or have been treated with a fire retardant. The fire is assumed to destroy HEPA filters in the ventilation system.

From the hazards assessment, the probability of a fire in the TSA-RE was estimated to be in the unlikely frequency category. For an unmitigated fire involving the bounding source terms as analyzed below, the probability is estimated to be in the extremely unlikely frequency category.

E-5.2.1.6 Incinerator Explosion. Feed to the incinerator process is inorganic homogeneous solids, organic homogeneous solids, and soil. The postulated accident involves a flameout in the incinerator, buildup of excess volatiles and/or propane in the system, and subsequent ignition and explosion. This accident is representative and bounding of other possible incinerator accidents, such as explosions caused by incompatible materials. The explosion causes breach of the incinerator, the Zone 3 confinement cell (Room 156), and the roof and/or the adjacent access corridors (Rooms 160 and 240) to the outside. The explosion overpressurizes the incinerator offgas treatment system and fails the HEPA filters.

The probability of an incinerator explosion is estimated to be in the unlikely frequency category. The probability for the analyzed case involving an explosion with bounding waste quantities that is powerful enough to break the cell boundaries resulting in an unmitigated release is estimated to be in the extremely unlikely frequency category. No credit was taken in the assessment for fire suppression systems, nitrogen inerting in the incinerator feed auger, or ventilation systems (unmitigated).

E-5.2.1.7 Wind-Borne Missile Breach of AMWTP Facility. TRU waste in drums and waste boxes is received and staged for treatment in Room 134 at the east-central portion of the AMWTP facility. A missile such as a pipe or piece of lumber driven by high wind is postulated to penetrate the wall of the AMWTP facility and is assumed to crack or break open a waste container, releasing radioactive and toxic materials to the atmosphere. High winds are also postulated to disrupt the AC power distribution system to the cascade ventilation system.

The probability of a wind-blown missile penetrating a waste container is estimated to be in the unlikely frequency category. The probability would be in the extremely unlikely frequency category for an unmitigated case involving loss of power and a bounding-case source term as analyzed below.

E-5.2.1.8 Fire Involving Waste Transfer Vehicle. TRU waste in standard waste boxes and drums is transferred by truck within the TRU storage area. For each waste container retrieved from the TSA-RE, transfers between facilities occur as follows (see Figure 2.5-1 of Chapter 2 of the PSAR [BNFL 1998d]):

1. From the TSA-RE to the Type I module

2. From the Type I module to a Type II module

3. From a Type II module to the proposed AMWTP facility.

During a waste transfer, a vehicle accident is postulated to occur because of mechanical failure or human error. The vehicle is assumed to transport a maximum of ten 4 x 4 x 7 feet waste boxes. The accident initiates a fire that spreads to involve the waste contents of the truck. The analysis of the unmitigated accident gives no credit for any type of secondary containment the truck may provide, manual fire suppression, or support from the DOE fire department.

The probability of the transport truck fire is estimated to be in the unlikely frequency category. The likelihood of an unmitigated fire involving the 10 most radioactive or 10 most hazardous combustible boxes as analyzed below is estimated to be in the extremely unlikely frequency category.

E-5.2.1.9 Design Basis Seismic Event. AMWTP structures are Hazard Category 2 facilities and are designed to withstand a seismic event with a peak horizontal ground acceleration of 0.16 grams (nominal return period of 2,000 years). The hazard analysis identified various losses of confinement and fires that could be initiated by a seismic event. Stacked drums and boxes could fall into disarray during retrieval (at the dig face), transportation (including loading and unloading), characterization, storage, waste processing, product certification, or TRUPACT II loading. Toppling during transport would dominate the others because there are no physical barriers or ventilation systems to contain or mitigate the release.

The overall AMWTP facility structure would be expected to withstand accelerations of a design basis earthquake. Concrete walls in confinement cells, however, could crack, causing a partial loss of confinement. Other identified contributors to a seismic event include potential releases through airlocks, bagless transfer ports, and loss of confinement in the incinerator, supercompactor, and encapsulation process areas. A total loss of electric power is assumed to accompany the design basis seismic event, resulting in a failure of the ventilation systems. The net result would be a spread of radioactive and hazardous materials at ground level.

In addition to the ground-level releases just described, a seismic event could be the initiator of a fire with an elevated release. The propane-fueled incinerator in the AMWTP facility is assumed to fail and initiate a fire. The fire destroys the incinerator, feed augers and shredders and fails the Zone 3 confinement cell (Room 156), the roof, and/or the adjacent access corridors to the outside. Finally, the fire is assumed to overheat the incinerator offgas treatment system and fail the HEPA filters.

A design basis earthquake with a return period of 2,000 years is in the unlikely frequency category. For the unmitigated seismic event analyzed below, which couples the seismic event with wastes containing the highest concentrations of radioactive and hazardous materials, the scenario is estimated to be in the extremely unlikely frequency category.

E-5.2.1.10 Nuclear Criticality in a Microencapsulation Ash Drum. The hazard analysis found that risks during retrieval, characterization, storage, and processing were dominated by potential inhalation or ingestion of radiological or hazardous contaminants present in the wastes, but it also identified a potential for a nuclear criticality as a concern. The overall fissile mass content of the waste stream is nominally about 0.25 percent, or on average, less than 3 grams per drum equivalent. The wastes are non-homogeneous within the waste stream and treatment processes will further concentrate fissile mass through volume reduction. Furthermore, the treatment processes have the potential for accumulating fissile mass.

In the microencapsulation process, a drum is charged with water and a sacrificial mixing paddle before entering the process area and being docked to the microencapsulation glovebox. A measured charge of incinerator ash is added to the drum, and the ash-water mixture is stirred by the paddle before the dry concrete mix is added. A criticality is postulated to occur in the ash-water mixture, resulting in prompt neutron and gamma radiation exposure to workers and release of gaseous fission products to the cascade ventilation system, through the stack, and to the atmosphere.

Without controls (unmitigated), the probability of a nuclear criticality was estimated to be in the unlikely frequency category during the hazard assessment. BNFL Inc.'s objective is to ensure sufficient controls are in place to make a nuclear criticality incredible.

E-5.2.1.11 Vitrifier Explosion. Feed to the vitrification process is ash material from the incinerator system, particulate from the atmospheric protection system, and certain secondary waste. Glass-forming additives are continuously fed with the waste to enhance the glass quality of the final waste product drums. Waste and glass feed to the vitrifier is not flammable or explosive. The postulated accident involves a significant water incursion to the vitrifier and subsequent steam explosion. Water incursion could occur due to a severe breach of the vitrifier cooling water jacket, or by initiation of the fire suppression system and accidental flow down a feed, offgas, or bubbler path into the vitrifier chamber.

The explosion causes breach of the vitrifier, the Zone 2 confinement cell, and the roof and/or adjacent building doors. The MAR involves the glass and "cold cap" in the vitrifier. The probability of an explosion in the vitrifier is estimated to be extremely unlikely.

E-5.2.1.12 Type II Module Fire. TRU waste is stored in boxes and drums in the Type II modules (WMF-628 through 634) (see Figure 2.4-4 of Chapter 2 of the PSAR [BNFL 1998d]). A severe fire is postulated to involve a significant fraction of the contents of one Type II module. A severe fire could be initiated by an unsuccessfully controlled range fire that spreads into the TRU waste storage area. Other potential initiators are an accident involving a propane delivery truck near a Type II module or an internal fire that is not detected or suppressed by the fire protection systems.

Because the waste is not readily ignitable and there is not a continuity of combustibles, the probability of a Type II module fire with the bounding source terms is estimated to be in the extremely unlikely frequency category. The analysis of the unmitigated accident discussed below does not take credit for the building structure or the fire detection and suppression systems.

E-5.2.1.13 Propane-Fueled Fires. The possibility of a boiling liquid-expanding vapor explosion (BLEVE) at RWMC has previously been evaluated and found incredible (BNFL 1998d). Following installation of flow-limiting orifices in the existing propane system, propane fuel—air explosions in the air-support buildings have been shown to be "incredible" (BNFL 1998d). Propane is not supplied to the Type II modules, so there are no credible fuel-air explosions or fires in these buildings that have the largest waste inventories and propane is not used in the TRUPACT II Loading Facility. Propane is used for heating in the TSA-RE, but no credible fuel-air explosions have been identified (BNFL 1998d). Waste inventories in the Type I module are small compared with those in the Type II modules, so the consequences of the Type II module fire bound all propane-fueled fires and explosions in the Type I module.

A new propane system is to be designed and installed for the AMWTP facility. Propane will be used in Utility Room 102 at the southern end of the building for firing hot water and steam boilers. The utility area is separated from waste processing areas by offices and maintenance areas on the first floor and change rooms and the control room on the second floor. Two 1-hour firewalls and one 2-hour firewall separate the utility room from waste processing areas. A propane fire or explosion in the utility room would vent through the ceiling or southern wall and would have no impact on the waste processing areas.

The new propane system will also be used to fire the incinerator. A propane explosion in the incinerator bounds any foreseeable propane-fueled fire in the AMWTP facility. In addition, a propane-fueled fire was considered as part of the design basis seismic event. Because of the much lower waste inventories, there are no credible propane-fueled fires in the AMWTP facility with consequences as large as the Type II module fire.

Because the accidents for the incinerator explosion, the Type II module fire, and the seismic event bound the propane-fueled fires and explosions, no specific scenario is analyzed. Safety assessments of the utility room and incinerator propane delivery systems will be developed following detailed design.

E-5.2.2 Computer Modeling to Estimate Radiation Doses

Radiological consequences to downwind receptors (co-located workers and public) were estimated using the Radiological Safety Analysis Computer Program (RSAC-5) (Wenzel 1993). The RSAC-5 computer program was developed for the DOE-ID by Westinghouse Idaho Nuclear Co., Inc. and is in the public domain. Slaughterbeck et al.

(1995) presents a rationale for use of RSAC-5 and comparison with other codes, along with the conclusion that RSAC-5's use is appropriate.

RSAC-5 simulates potential radiation doses to MEIs or population groups from accidental airborne releases of radionuclides to the environment. From a specified source term, users can calculate the environmental transfer, uptake, and human exposure. Individual doses are determined at specific distances onsite, at the site boundaries, and away from the site via airborne plume immersion, ground surface contamination, inhalation, and ingestion. The ingestion pathway applies only where food is raised locally and potentially consumed there.

For comparison with accident evaluation guidelines, the radiological and toxicological consequences of accidents are calculated at receptor locations where hypothetical onsite and offsite individuals would be maximally exposed. These locations are defined as follows:

- *Onsite Individual*—The hypothetical onsite receptor is located at a distance of 100 meters directly downwind from the point of release. This receptor represents the onsite worker (or co-located worker) for the purpose of reporting the consequences of postulated accidents.

- *Offsite Individual*—The hypothetical receptor is located at the nearest INEEL Site boundary directly downwind from the point of release. This receptor is assumed to live at the site boundary and consume agricultural products grown in the area. The offsite individual represents the public for the purpose of reporting the consequences of postulated accidents.

Because members of the public have seasonal access to a nearby National Historic Landmark, the Engineering Breeder Reactor-I (EBR-I), chemical and radiological exposures to an individual are also calculated for this location. Likewise, exposures are calculated for an individual at a rest area near the crossing of U.S. Highway 20/26 and the Big Lost River.

The RSAC-5 program uses a two-dimensional Gaussian atmospheric-dispersion model to estimate the dispersion of the radioactive-material plume at various distances downwind from the point of release. INEEL-specific values of these dispersion coefficients are built into RSAC-5 for calculation of dispersion factors (c /Qs). The meteorological capabilities of RSAC-5 include Pasquill-Gifford, Hilsmeier-Gifford, and Markee models for Gaussian plume diffusion.

RSAC-5 uses weighting factors for various body organs to calculate a committed effective dose equivalent (CEDE) from radioactivity deposited inside the body by inhalation or ingestion. RSAC-5 calculates an effective dose equivalent (EDE) for the external exposure pathways (immersion in plume, exposure from ground surface contamination) and a 50-year CEDE for the internal exposure pathways (inhalation, ingestion). The sum of the EDE from external pathways and the CEDE from internal pathways is called the TEDE.

E-5.2.3 Modeling for Hazardous Chemical Releases

E-5.2.3.1 Modeling for Hazardous Chemical Releases for the No Action Alternative. The determination of hazardous chemical exposures for various accident scenarios uses the same release times and dispersion coefficients (c /Qs) as those used for the radiological consequences. The toxicological evaluation guidelines are in terms of air concentration in units of milligrams per cubic meter (mg/m^3). Because Emergency Response Planning Guidelines (ERPGs) do not exist for the hazardous chemical constituents of the retrievable stored waste at RWMC to be processed at the AMWTP, the most restrictive criterion is used based on the following:

- For TOX-1,

    - Permissible exposure limit-time-weighted average (PEL-TWA)

    - Threshold limit value-time-weighted average (TLV-TWA)

- For TOX-2,

- Emergency exposure guidance level (EEGL) (60 min)

- 10 percent of immediately dangerous to life or health (IDLH)

For anticipated events, the offsite consequences should be less than the PEL-TWA or the TLV-TWA, whichever is more restrictive. TOX-1 is the applicable evaluation guideline for unlikely events and TOX-2 is applied for extremely unlikely events.

Table E-5-3 shows the basic toxicological criteria used in the derivation of the toxicological evaluation guidelines. The TLVs have been defined to include various levels of exposure to worker populations. TLVs are published by the ACGIH. The population that comprises the general public differs from the population defined for TLVs in that the general public includes additional groups such as children, elderly persons, and hospitalized patients. The two thresholds used here are:

- TLV-TWA: The threshold limit value-time-weighted average for a specific substance defines the limit of acceptable concentration to which most workers can be exposed for up to a normal 8-hour day and a 40-hour week without adverse effect.

- TLV-STEL: The threshold limit value-short term exposure limit is a TWA concentration to which workers should not be exposed for longer than 15 minutes and which should not be repeated more than four times per day, with at least 60 minutes between successive exposures. Whereas the TLV-TWA is useful for chronic exposure effects, the threshold limit value-short term exposure limit (TLV-STEL) addresses acute effects of short-term, high-level exposures.

The PELs have been developed by OSHA as a measure for safe and healthful working conditions for men and women employed in any business engaged in commerce in the United States. As with other exposure limits developed for industrial applications, limitations exist with respect to applicability to the general population.

The IDLH levels have been developed to define concentrations of materials from which workers should evacuate within 30 minutes without escape-impairing symptoms or any irreversible health effect. As IDLH values were developed by the National Institute for Occupational Safety and Health for industrial application, their usefulness for application to the general population is limited.

Table E-5-3. Basic toxicological criteria for derivation of TOX-1 and TOX-2.

	ACGIH TLVs			OSHA PELs			
Substance	TWA (mg/m^3)	STEL/C (mg/m^3)		TWA (mg/m^3)	STEL/C (mg/m^3)	IDLH (mg/m^3)	EEGL (mg/m^3)
Solids							
Asbestos[a]	2 f/cc	–		0.1 f/cc	1 f/cc (30 min)	–	–
Beryllium	0.002	0.006[b]		0.002	C0.005	4	–
Cadmium	0.002	0.006[b]		0.005	–	9	–
Lead	0.15	0.45[b]		0.05	–	100	–
Lithium chromate[c]	0.05	0.15		–	C0.1	15	15
Nitrates[d]	–	–		–	–	–	–
Liquids							
n-Butyl alcohol	–	C152		300	–	4,236	–

Carbon tetrachloride	31	63		63	C158	1,258	–
Mercury	0.05	0.15[b]		0.05	C0.1	10	0.2 (24 h)
Methyl alcohol	262	328		260	310	7,861	262
Methylene chloride	174	522[b]		1,740	C3,480	7,970	–
Nitric acid	5.2	10		5	10	64	–
Polychlorinated byphenyls	0.5	1.5[b]		0.5	–	5	–
Perchloroethylene	170	678		685	C1,370	1,015	–
1,1,1-trichloroethane	1,910	2,460		1,900	2,450	3,811	–
1,1,2-trichloro-1,2,2-trifluoroethane	7,670	9,590		7,600	9,500	15,298	11,505
Trichloroethylene	269	537		540	C1,080	5,363	–
Xylene	434	651		435	655	3,901	868

Source: INEEL 1997.

a. The density of chrysotile is 1.55 g/cc (1.55E+09 mg/m^3). Fibers of respirable size would be approximately 10 microns long and 3.3 microns in diameter with a mass of 1.3E-07 mg per fiber. Using the concentration is mg/m^3 at each receptor and converting to fibers/cc allows a comparison of the asbestos released to the appropriate TLV or PEL.

b. No STEL/C is established for these substances. Values listed are 3´ the specific TWA values, as specified by DOE Standard 3005.

c. For purposes of establishing toxicological limits, chromium is used.

d. Nitrates are primarily sodium or potassium nitrates. There are no toxicological limits for these compounds.

An EEGL is a concentration of a substance in air judged by the Department of Defense to be acceptable for the performance of specific tasks by military personnel during emergency conditions lasting 1 to 24 hours. EEGL dosages may produce transient central nervous system effects and eye or respiratory irritation, but none serious enough to prevent response to emergency conditions.

E-5.2.3.2 Modeling for Hazardous Chemical Releases for the Preferred Alternative. In addition to the radioactive constituents of the waste stream to be processed in the AMWTP, there exist significant quantities of hazardous chemical constituents. These hazardous materials could be released during an accident and expose workers, expose members of the public, or cause environmental damage. For accident scenarios involving fires, products-of-combustion are generated that can also be hazardous.

The methods used to calculate toxicological exposures parallels the methods used to calculate radiological exposures. EPIcode™ is the computer code chosen for estimating airborne concentrations resulting from releases of hazardous chemicals. EPIcode™ has been independently verified and uses the well-established Gaussian plume model to calculate the airborne hazardous chemical concentrations. The EPIcode™ library contains information on hazardous substances listed in AIHA (1995). EPIcode™ calculation methods for AMWTP, including verification calculations of standard problems, are documented in Hall (1998).

The evaluation of toxic exposures is considered more uncertain than the evaluation of radiological exposures. The AMWTP source terms have multiple toxic components, and people could be exposed to several chemicals from a single accident. Human health effects from exposures to multiple chemicals are scenario-dependent and in some instances not well understood. Multiple chemical exposures may or may not have additive impacts or even have synergistic effects. Depending on the accident scenario, chemicals could either be combined or be destroyed before reaching people. Neither EPIcode™ nor other toxic transport models fully account for these uncertainties. In the present analysis, such effects are considered qualitatively.

The toxic chemical concentrations at receptor locations are compared with the accident evaluation guidelines, which are in terms of the TLV- TWA and ERPGs. TLV-TWA values are time-weighted average concentrations for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse health effects. ERPG values are estimates of airborne concentration thresholds above which one can reasonably expect to observe adverse effects (BNFL 1998d). ERPG concentrations are specific for each substance, and are derived for each of three general severity levels:

- *ERPG-1*—The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- *ERPG-2*—The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- *ERPG-3*—The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life- threatening health effects.

Table E-5-4 provides evaluation guidelines for nonradiological releases.

Table E-5-4. Evaluation guidelines for nonradiological releases.[a]

		Chemical release[b]	
Event frequency category	Event frequency (per yr)	Onsite	Offsite
Anticipated	> 1E-02 to £ 1E-01	ERPG -1	TLV-TWA
Unlikely	> 1E-04 to £ 1E-02	ERPG-2	ERPG-1
Extremely unlikely	> 1E-06 to £ 1E-04	ERPG-3	ERPG-2

a. ERPG- Emergency Response Planning Guide; TLV-TWA- threshold limit value-time weighted average.

b. ERPG values from American Industrial Hygiene Association (AIHA 1995). Where ERPG values have not been established, concentrations of hazardous chemicals causing potential health effects similar to ERPG levels are used (e.g., TLV, IDLH).

Possible health effects associated with exceeding an ERPG-2 or -3 are specific for each substance of concern and must

be characterized in that context. ERPG values are based upon a 1- hour exposure of a member of the general population. In this analysis, ERPG values are applied only to time-averaged exposures of 1 hour or less in duration. This approach provides an additional element of conservatism in the evaluation of accidents with releases that are significantly less than 1 hour. As recommended by DOE's Subcommittee on Consequence Assessment and Protective Actions group, temporary emergency exposure limits are substituted for ERPGs for chemicals without established ERPG values (BNFL 1998d). Temporary emergency exposure limits are temporary or equivalent exposure limits for which official ERPGs have not yet been developed or finalized.

E-5.3 Inventory of Radioactive and Hazardous Materials

The retrievably stored TRU waste at the RWMC is in the TSA. The source of information for the inventories in this area is the Radioactive Waste Management Information System. It is the official INEEL record for stored solid radioactive waste (TRU and mixed waste), disposed low-level waste , and processed waste (TRU, low-level waste, and mixed). The inventory in the TSA is what the AMWTP facility will treat prior to offsite shipment and disposal.

The TSA was established in November 1970 as a storage area for retrievable waste contaminated with greater than 10 nCi/g of TRU activity. The definition of TRU waste was finalized in 1982 to read "greater than 100 nCi/g,"in accordance with DOE Order 5820.2. Contact-handled (CH) TRU waste is stored aboveground on asphalt pads designated TSA-1, -2, -3, and -R. The waste currently stored on these pads is being transferred to RCRA-approved temporary storage in the Waste Storage Facilities (WSFs) Type I and Type II storage modules. Remote-handled (RH) TRU waste is stored in the Intermediate-Level Transuranic Storage Facility (ILTSF), established in 1976. This waste is stored above grade and is designated as retrievably stored. The ILTSF comprises two pads containing storage vaults.

The volume and curie inventory are presented in Table E-5-5. CH TRU waste is the major inventory class of radionuclides within the TSA. The volume of CH TRU waste is approximately 65,000 cubic meters. This volume of waste is stored in approximately 140,000 waste containers. The volume of RH TRU waste stored at the ILTSF is approximately 77 cubic meters. The ILTSF waste is contained in approximately 619 waste containers. The ILTSF waste is also contaminated with TRU nuclides. However, the ILTSF waste is primarily composed of beta/gamma-emitters. The decay-corrected activity of the ILTSF waste is approximately 11.0 Ci/m^3. The dominant radionuclides found in the TSA waste are Pu-241, Pu-238, Pu-239, and Am-241. The average decay-corrected activity of TSA waste is approximately 5.65 Ci/m^3. The concentration of radionuclides typically present in TSA waste is presented in Table E-5-6. Table E-5-7 is the inventory of radionuclides in the 65,000 cubic meters of TSA waste (including the additional 20,000 cubic meters, per design requirements, to be treated at the AMWTP facility) and the calculated partitioning of radionuclides between the two primary waste streams, non-debris and debris. The breakdown of the various container types for waste stored at the TSA is presented in Table E-5-8.

The hazardous chemicals inventory found in the retrievably stored waste at the TSA is provided in Table E-5-9. These hazardous chemical quantities are derived primarily from the waste generator and process knowledge of the incoming waste. The hazardous source term was developed with a conservative philosophy. Therefore, the weight fractions of hazardous substances actually present in the stored waste are judged to be lower than estimated. The release of hazardous substances, regulated pollutants, or oil not permitted by Federal regulations requires that the occurrence be reported. Reportable quantities are listed in 40 CFR Part 302, Table 302.4. Hazardous substances and materials released in quantities greater than the reportable quantities are subject to reporting to the National Response Center as required by DOE Order 232.1-1. Sodium chromate, hydrochloric acid, nitrobenzene, and ether appear in the source documents of incoming wastes, and, if present at all, they are present in only trace amounts.

Table E-5-5. Volume and decayed activity in waste stored at the TSA.

Location[a]	Volume (m^3)	February 17, 1993 activity[b] (Ci)
TSA		
TRU		200,500

Non-TRU		
Total	64,691.2	
ILTSF		
TRU		100.3
Non-TRU		8,388
Total	77.2	8,489

Source: INEEL 1997.

a. In this table, the designation TSA means all of the Transuranic Storage Area except the ILTSF.

b. The activities are rounded off to four significant digits.

Table E-5-6. General concentration distribution of waste in the TSA.

	Concentration	
Radionuclide distribution	(Ci/m^3)	(Ci/ft^3)
44.3% Pu-241	2.5E+00	7.1E-02
24.3% Am-241	1.4E+00	3.9E-02
16.8% Pu-238	9.7E-01	2.7E-02
11.3% Pu-239	6.3E-01	1.8E-02
2.7% Pu-240	1.5E-01	4.3E-03
0.2% U-233	1.4E-02	3.9E-04
0.2% Cm-244	0.8E-02	2.4E-04

Source: INEEL 1997.

Table E-5-7. Radionuclide inventory for TSA waste and scaled for the AMWTP facility.

Radionuclide[a]	Best estimate activity[b] (Ci)	Scaled best estimate activity[c] (Ci)	Scaled activity non-debris[d]	Scaled activity debris[e] (Ci)	Activity concentration non-debris[f] (Ci/kg)	Activity concentration debris[g] (Ci/kg)

			(Ci)			
Am-241	1.22E+05	1.60E+05	7.02E+04	8.93E+04	4.40E-03	4.49E-03
Pu-238	1.16E+05	1.52E+05	6.67E+04	8.49E+04	4.19E-03	4.27E-03
Pu-239	6.87E+04	8.98E+04	3.95E+04	5.03E+04	2.48E-03	2.53E-03
Pu-240	1.59E+04	2.08E+04	9.15E+03	1.16E+04	5.74E-04	5.86E-04
Pu-242	1.04E+00	1.36E+00	5.98E-01	7.62E-01	3.75E-08	3.83E-08
Pu-241	1.61E+05	2.11E+05	9.26E+04	1.18E+05	5.81E-03	5.93E-03
Ba-137m	2.25E+03	2.94E+03	1.29E+03	1.65E+03	8.12E-05	8.29E-05
Cs-137	2.26E+03	2.96E+03	1.30E+03	1.66E+03	8.16E-05	8.33E-05
Sr-90	2.02E+03	2.64E+03	1.16E+03	1.48E+03	7.29E-05	7.44E-05
Y-90	2.02E+03	2.64E+03	1.16E+03	1.48E+03	7.29E-05	7.44E-05
U-233	1.02E+03	1.33E+03	5.87E+02	7.47E+02	3.68E-05	3.76E-05
Cm-244	5.39E+02	7.05E+02	3.10E+02	3.95E+02	1.95E-05	1.99E-05
H-3	2.64E+02	3.45E+02	1.52E+02	1.93E+02	9.53E-06	9.72E-06
Cs-134	1.11E+02	1.45E+02	6.39E+01	8.13E+01	4.01E-06	4.09E-06
Co-60	1.00E+02	1.31E+02	5.75E+01	7.32E+01	3.61E-06	3.68E-06
Total (primary)	4.94E+05	6.46E+05				
Minor radionuclides (present in TSA waste at between 1 and 100 Ci)						
Bi-212	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
C-14	2.38E+00	3.11E+00	1.37E+00	1.74E+00	8.59E-08	8.77E-08
Ce-144	2.71E+01	3.54E+01	1.56E+01	1.98E+01	9.78E-07	9.98E-07
Fe-55	1.13E+00	1.48E+00	6.50E-01	8.28E-01	4.08E-08	4.16E-08
Kr-85	6.86E+00	8.97E+00	3.95E+00	5.02E+00	2.48E-07	2.53E-07
Ni-63	3.57E+00	4.67E+00	2.05E+00	2.61E+00	1.29E-07	1.32E-07
Pb-212	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Pm-147	2.73E+01	3.57E+01	1.57E+01	2.00E+01	9.86E-07	1.01E-06
Po-212	1.70E+01	2.22E+01	9.78E+00	1.24E+01	6.14E-07	6.26E-07
Po-216	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Pr-144	2.72E+01	3.56E+01	1.57E+01	1.99E+01	9.82E-07	1.00E-06
Ra-224	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Sb-125	1.65E+00	2.16E+00	9.49E-01	1.21E+00	5.96E-08	6.08E-08
Th-228	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Th-232	7.31E+00	9.56E+00	4.21E+00	5.35E+00	2.64E-07	2.69E-07
Tl-208	9.54E+00	1.25E+01	5.49E+00	6.99E+00	3.44E-07	3.51E-07
U-232	2.60E+01	3.40E+01	1.50E+01	1.90E+01	9.39E-07	9.58E-07
U-234	5.78E+00	7.56E+00	3.33E+00	4.23E+00	2.09E-07	2.13E-07
Total (minor)	2.96E+02	3.87E+02				

a. Radionuclides as referred to in BNFL (1998d); radon (Rn-220) not included per CFR reference given in BNFL (1998d).

b. Best estimate activities as referred to in BNFL (1998d).

c. Scaling factor is 85,000 m^3 / 65,000 m^3. Scaling factor is based on 65,000 cubic meters plus 20,000 cubic meters (per design requirements) divided by 65,000 m^3 for the TSA waste. Assumption is total activity is proportional to TSA waste activity.

d. Non-debris mass is 44.49 percent (44 percent) of total waste mass.

e. Debris mass is 55.51 percent (56 percent) of total waste mass.

f. Based on total non-debris mass of 15,936,396 kg (process flow sheet node 23, BNFL [1998d]).

g. Based on total debris mass of 19,879,854 kg (process flow sheet nodes 24, 25, 26 and 4D, BNFL [1998d]).

Table E-5-8. Breakdown of TSA waste by container type.

Container type	Number
Bin	550
BLM[a]	127,690
BXC[b]	1
BXW[c]	8,800
BXM[d]	2,356
O[e]	27
Total container	139,424

Source: INEEL 1997.

a. BLM: Metal barrel (drum).

b. BXC: Cardboard box.

c BXW: Wooden box (fiberglass reinforced polyester and Plywood).

d. BXM: Metal box.

e. O: Other.

It is possible that because of previous use, mixing, contamination, and long-term radioactive effects, certain radioactive mixed waste may become more hazardous. Furthermore, other hazardous substances could conceivably be created by the addition of thermal energy and chemical recombinations. The number of substances created and the extent to which they are created are a function of numerous variables (e.g., oxygen availability, temperature, composition of the involved wastes).

Several articles have appeared in technical journals regarding the products from thermal stressing of chlorinated organics. These articles support the fact that halogenated hydrocarbons in the TSA wastes can form dangerous decomposition products such as phosgene ($COCl_2$), chlorine gas (Cl_2), hydrochloric acid (HCl), carbon dioxide (CO_2), and carbon monoxide (CO). However, the formation of these products requires high temperatures not normally present. Under oxygen-rich conditions, essentially all chlorinated organics from elemental Cl_2, with no HCl or phosgene production. Conversely, for oxygen-lean reactions, HCl is the favored product with possibly a small amount of phosgene. Under no conditions is phosgene a favored end product. It only occurs as a trace material under oxygen-lean conditions. As temperatures are increased, phosgene decomposes to HCl or Cl_2. At very high temperatures (e.g., >1900°C), all the chlorine compounds begin to decompose and form ionized species such as Cl- and/or H+

Radiological decomposition of complex hydrocarbons has been found to occur in limited amounts whenever hydrocarbons are held in close proximity with radioactive materials. The precise products of such decomposition are not predictable given the variety of synthetic rubber and plastic materials stored in containers at RWMC. The concentration of such decomposition products may be estimated, however, based on the energy spectra of the dominant radioactive isotopes in the waste, and the size of the source term they represent. The AMWTP project team has carefully considered waste component reactivity in the SAR and the Application for an Air Quality Permit to Construct. The conclusion of these analyses is that no credible potential exists for a mix of chemical and nuclear materials derived from AMWTP waste to produce a chemical explosion or a nuclear reaction. Gas which has

accumulated in stored drums will be vented, sampled, and treated prior to accumulation of waste for treatment at AMWTP. The relatively short storage times which the waste encounters between residence in the Type II modules and ultimate treatment will minimize the formation of uncharacterized radiological decomposition products.

Table E-5-9. Hazardous chemical inventory for waste stored at the TSA.

Chemical	Average weight fraction of stored waste	Maximum weight fraction of any waste container	Estimated stored waste quantity (kg)	Reportable quantity (kg)
Asbestos	2.74E-03	4.5E-01	71,328	0.454
Barium[a]	0.0	0.0	0.0	None
Beryllium	2.1E-04	9.5E-01	5392	4.54
Cadmium	3.0E-06	1.0E-05	78	4.54
Carbon tetrachloride	6.27E-03	5.0E-02	163,255	4.54
Chromium[a]	0.0	0.0	0.0	2270
n-Butyl alcohol	3.0E-06	1.0E-05	81	2270
Ether[a]	0.0	0.0	0.0	–
Lead	8.26E-03	6.0E-01	215,180	0.454
Hydrochloric acid[a]	0.0	0.0	0.0	2270
Lithium chromate	1.77E-03	2.0E-01	46,032	4.54
Mercury	3.54E-03	2.0E-01	92,211	0.454
Methyl alcohol	8.0E-06	2.5E-05	200	2270
Methylene chloride	4.0E-04	1.0E-03	10,298	454
Nitric acid	1.9E-03	5.05E-01	49,502	454
Nitrates[b]	3.7E-03	9.0E-01	9,655	(c)
Nitrobenzene[a]	0.0	0.0	0.0	454
PCB	8.54E-03	5.56E-01	222,472	0.454
Selenium[a]	0.0	0.0	0.0	45.4
Silver[a]	0.0	0.0	0.0	454
Perchloroethylene	6.2E-04	5.0E-02	16,275	45.4
Sodium chromate[a]	0.0	0.0	0.0	4.54
1,1,1-trichloroethane	5.81E-03	1.5E-01	151,434	454
Trichloroethylene	3.92E-03	1.5E-01	102,097	45.4
1,1,2-trichloro-1,2,2-trifluoroethane	3.71E-03	5.0E-02	96,677	–
Xylene	2.0E-05	5.0E-05	399	454

Source: INEEL 1997.

a. Any 0.0 entry indicates that trace quantities may exist.

b. Nitrates are classified as evaporator salts comprised of sodium nitrate and potassium nitrate.

Analysis of the reactions necessary to produce phosgene from PCB reveals that such production is extremely unlikely because of the stable nature of the PCB benzene ring and the sequential steps necessary. Production of free chlorine is also unlikely. Likewise, production of phosgene from freons is extremely unlikely because of the strength of the carbon-fluorine bond and the sequential steps necessary. An unlikely end product would be carbonyl fluoride which immediately hydrolyses in the presence of moisture to form carbon dioxide and hydrofluoric acid.

The substance of greatest concern is methylene chloride. Radiolytic action in methylene chloride can produce phosgene by sequential steps. This reaction can occur at quite low energy levels and can be caused by drums heating in sunlight, as well as by ultraviolet radiation from the sun. In the presence of moisture, however, the phosgene hydrolyses over time to form hydrochloric acid and carbon dioxide. Radiolytic action can occur only where relatively high specific radioactivity exists.

Based on the absence of high processing temperatures and the stable nature of the waste materials, it is considered unlikely that sufficient hazardous substances could be created through chemical recombinations to cause injury to the worker or the public.

During accident scenarios involving fires and explosions, phosgene and hydrochloric acid are potential combustion products of chlorinated hydrocarbons and therefore they are accounted for in the accident source terms.

E-5.4 Accident Consequence Assessment

E-5.4.1 Source Terms and Accident Consequences

To calculate the downwind consequences, a source term (ST) was determined. The ST is the amount of radioactive material released during a specific accident scenario. The STs for each accident scenario are determined using the following equation:

ST = MAR ´ DR ´ ARF ´ RF ´ LPF

where

ST = source term (g)

MAR = material at risk (g)

DR = damage ratio

ARF = airborne release fraction

RF = respirable fraction

LPF = leak path fraction.

Material at Risk. The material at risk (MAR) is the total waste inventory impacted for a given accident scenario and is expressed in terms of total mass at risk (g).

Damage Ratio. The damage ratio (DR) represents the fraction of the MAR that could be affected by the postulated accident and is a function of the accident initiator and the operational event being evaluated. The DRs are presented in

two ways: a percentage of the total inventory or a finite portion of the total inventory. Percentage of the total inventory is used for accident scenarios such as earthquakes or fires. A finite portion of the total inventory is used for operational accidents in which the actual number of drums or boxes is known.

Airborne Release Fraction. The Airborne Release Fraction (ARF) is that fraction of total radioactive or hazardous chemical material used in a process or contained in storage that is assumed released from its primary confinement in a dispersible form by a postulated accident.

Respirable Fraction. The respirable fraction (RF) represents the fraction of the material with an aerodynamic equivalent diameter less than 10 m m. RF on particles made airborne under accident conditions are correlated to the stresses induced. Estimates for RF for mechanical releases range from 1.0 to 1.0E-03 based on the amount, type, and dispersability of the powder present.

Leak Path Fraction. The leak path fraction (LPF) is that fraction of total radioactive or hazardous chemical material released from its primary confinement that is assumed released from its secondary confinement in a dispersible form by a postulated accident.

E-5.4.1.1 Fire Involving Waste in the Box Line.

E-5.4.1.1.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. The MAR consists of the radioactive and hazardous constituents within three 3.2-cubic-meter standard waste boxes, one sorted into export drums, one being sorted, and one staged for sorting.

The radioactive MAR is based on the selection of three boxes of combustible waste that results in the highest exposure (BNFL 1998b). Examination of the waste descriptions for the boxes resulting from this selection suggests that radionuclides in the dominant waste stream (BNFL 1998b) are cemented inside a steel pipe that can be characterized as a solid. For the remainder of the waste streams, about a third of the material is solids (tanks, piping ducting, motors, pumps, and other used equipment), about a third of the material is contained (wastes in cans, cartons, small boxes, and drums), and about a third of the material when opened in the box line would be classified as uncontained. In addition to the boxes, the fire is assumed to damage the HEPA filters and release contaminates from the ventilation system. The inventory of radioactive materials in the filters and ventilation system was conservatively represented by 500 grams of Pu-239.

Multiple MARs are developed for hazardous constituents based on the selection of three combustible boxes containing the highest concentration of each hazardous material (BNFL 1998b). The resulting MARs bound all combinations of combustible waste boxes for each hazardous material.

When exposed to heat and flame, halogenated compounds produce small quantities of phosgene compounds, and chlorinated hydrocarbons produce small quantities of halogenated acids. The analysis assumes that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire and that 10 percent of the chlorinated hydrocarbons in the MAR decompose to hydrochloric acid and 1 percent of the halogenated compounds convert to phosgene gas with a molecular conversion ratio of 1.19 (BNFL 1998b).

Damage Ratio. Contained and uncontained waste is assumed to be located in various areas within the process cell, and some waste is in transfer drums below the elevation of the floor. Only portions of the waste are expected to be involved in a fire because of a lack of continuity of combustibles. To bound the assessment, however, a DR of 1.0 is assumed. To incorporate the assumption that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire, the DR for halogenated compounds and chlorinated hydrocarbons is multiplied by 0.89 (BNFL 1998b).

Airborne Release Fraction. As discussed above, with the exception of one waste stream (BNFL 1998b) that is characterized as a solid, about one-third of the remaining waste is solids, about third is contained (within drums or other containers inside the box) and about one-third is expected to be uncontained (loose on the sorting tables). The

ARFs for combustible, surface-contaminated waste exposed to fire are 6.0E-03 for solid waste (BNFL 1998b), 5.0E-04 for contained waste (BNFL 1998b), and 0.01 for uncontained waste (BNFL 1998b). For the combination of solid, contained, and uncontained waste, the average ARF is (0.33 x 6.0E-03) + (0.33 x 5.0E-04) + (0.33 x 0.01) = 5.5E-03.

For the release from the ventilation system and HEPA filters, half of the contamination is assumed to reside in the duct work, dampers, and plenums and the other half is in the HEPA filters. The ARF from the ductwork is 4.0E-05 (BNFL 1998b), and the ARF from HEPA failure is 5.0E-04 (BNFL 1998b).

The ARF for contained hazardous materials exposed to fire is 5.0E-04 (BNFL 1998b).

Respirable Fraction. The RFs for combustible surface- contaminated waste exposed to fire are 0.01 for solid waste (BNFL 1998b), 1.0 for contained waste (BNFL 1998b), and 1.0 for uncontained waste (BNFL 1998b). For the combination of solid, contained, and uncontained waste, the average RF is (0.33 x 0.01) + (0.33 x 1.0) + (0.33 x 1.0) = 0.67.

The RF for releases from the ductwork is 1.0 (BNFL 1998b) and the RF for releases from HEPA failure is 1.0 (BNFL 1998b).

For hazardous material releases, the RF for contained hazardous materials exposed to fire is conservatively assigned a value of 1.0 (BNFL 1998b)

Leakpath Factor. The fire is assumed to heat the atmosphere in the cell and damage HEPA filters in the ventilation system, resulting in a LPF of 1.0.

Using the above factors, bounding source terms were developed for radiological and hazardous constituents as shown in Table E-5-10. (BNFL 1998b). The source terms were applied to the unit- gram dose model for 50 percent and 95 percent meteorological conditions (BNFL 1998b) corresponding to a stack release. The consequences reported below select the higher exposures for the 50 percent and 95 percent meteorological conditions.

Table E-5-10. Source term–fire involving waste in the box line.[a]

Waste stream code[b]	Nuclide or hazardous material	MAR(g)	DR	ARF	RF	LPF	Source term (g)
Radionuclides							
ID-INL-152TN	Pu-238	1.37E+02	1	6.0E-03	0.01	1	8.25E-03
ID-MDO-824T	Pu-238	1.54E+01	1	0.0055	0.67	1	5.68E-02
ID-INL-152TN	Pu-239	1.72E+02	1	6.0E-03	0.01	1	1.03E-02
ID-MDO-824T	Pu-239	2.07E+01	1	0.0055	0.67	1	7.62E-02
Ductwork	Pu-239	2.50E+02	1	4.0E-05	1	1	1.00E-02
HEPA filters	Pu-239	2.50E+02	1	5.0E-04	1	1	1.25E-01
ID-INL-152TN	Pu-240	9.06E+01	1	6.0E-03	0.01	1	5.44E-03
ID-MDO-824T	Pu-83	1.47E-01	1	0.0055	0.67	1	5.43E-04
Hazardous materials							
ID-AEO-110T	Acetone	1.03E+04	1	5.00E-04	1	1	5.15E+00
ID-RFO-337	Acetone	1.90E+04	1	5.00E-04	1	1	9.50E+00
ID-AEO-110T	Arsenic (organic compounds as As)	1.03E+04	1	5.00E-04	1	1	5.15E+00
ID-RFO-338T	Asbestos	1.66E+06	1	5.00E-04	1	1	8.28E+02

ID-MDO-824T	Barium	3.45E+04	1	5.00E-04	1	1	1.73E+01
ID-RFO-337	Benzene	2.85E+04	1	5.00E-04	1	1	1.43E+01
ID-RFO-000T	Beryllium	2.55E+04	1	5.00E-04	1	1	1.28E+01
ID-CPP-156	Butyl alcohol, n-	3.67E+04	1	5.00E-04	1	1	1.83E+01
ID-MDO-824T	Cadmium & compounds (as Cd)	3.45E+04	1	5.00E-04	1	1	1.73E+01
ID-CPP-156	Carbon tetrachloride	3.67E+05	0.89	5.00E-04	1	1	1.63E+02
ID-RFO-337	Chloroform	2.85E+04	0.89	5.00E-04	1	1	1.27E+01
ID-RFO-337	Ethyl benzene	2.85E+04	1	5.00E-04	1	1	1.43E+01
ID-AEO-100T	Ethyl ether	2.91E+04	1	5.00E-04	1	1	1.46E+01
ID-RFO-338T	Ethylene dichloride	2.76E+04	0.89	5.00E-04	1	1	1.23E+01
ID-RFO-302T	Lead	2.38E+06	1	5.00E-04	1	1	1.19E+03
ID-MDO-826	Mercury (elemental & inorganic)	3.22E+02	1	5.00E-04	1	1	1.61E-01
ID-CPP-156	Methyl alcohol	3.67E+04	1	5.00E-04	1	1	1.83E+01
ID-RFO-376	Methylene chloride	3.90E+04	0.89	5.00E-04	1	1	1.74E+01
ID-RFO-116T	Methylene chloride	1.46E+04	0.89	5.00E-04	1	1	6.50E+00
ID-CPP-156	Nitric acid	3.67E+04	1	5.00E-04	1	1	1.83E+01
ID-RFO-337	Perchloroethylene	2.85E+04	0.89	5.00E-04	1	1	1.27E+01
ID-RFO-000T	Polychlorinated biphenyl	2.14E+03	0.89	5.00E-04	1	1	9.54E-01
ID-MDO-824T	Selenium	3.45E+04	1	5.00E-04	1	1	1.73E+01
ID-MDO-824T	Silver	3.45E+04	1	5.00E-04	1	1	1.73E+01
ID-RFO-337	Toluene	2.85E+04	1	5.00E-04	1	1	1.43E+01
ID-RFO-302T	Trichloroethane, 1,1,1-	5.95E+04	0.89	5.00E-04	1	1	2.65E+01
ID-RFO-302T	Trichloroethylene	5.95E+04	0.89	5.00E-04	1	1	2.65E+01
ID-RFO-376	Trichlorotrifluroethane	3.90E+04	0.89	5.00E-04	1	1	1.74E+01
ID-RFO-116	Trichlorotrifluroethane	1.53E+04	0.89	5.00E-04	1	1	6.81E+00
ID-RFO-337	Vinylidene chloride	2.85E+04	0.89	5.00E-04	1	1	1.27E+01
ID-CPP-156	Xylene	3.67E+04	1	5.00E-04	1	1	1.83E+01

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d), HEPA—high-efficiency particulate air; DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility. Also evaluated were combustion by-products phosgene and hydrochloric acid (BNFL 1998d).

b. From BNFL (1998d).

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E-5.4.1.1.2 Consequence Analysis¾ Accident consequences are summarized in Table E-5-11. Examination of the radiological consequences by radionuclide (BNFL 1998d) illustrates that nearly all the consequences result from exposure to Pu-238 by way of the inhalation pathway. Pu-238 exists in less than 2 percent of the waste boxes (BNFL 1998d). The six most limiting hazardous materials (in terms of a fraction of the ERPG value) are reported in Table E-5-11 (BNFL 1998b).

E-5.4.1.1.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-11. Evaluation guidelines for an extremely unlikely event are not exceeded.

E.5.4.1.1.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Safety-Class and Safety Significant Structures, Systems, and Components. Evaluation guidelines at the

INEEL boundary are not exceeded, and no safety-class structures, systems, and components are required. Involved workers rely on the following safety- significant structures, systems, and components to mitigate the consequences of this accident:

- Workplace radiation monitoring systems
- Respiratory protection equipment
- Radiological assay and tracking system.

Technical Safety Requirement Controls. The analysis identified a need for technical safety requirement controls to limit the fissile mass in the pretreatment and treatment areas of the plant, which will be developed for the Final SAR. Surveillance of fissile mass in the process is via the plant data management system.

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of a box line fire include the following:

- Fire detection, manual and automatic suppression systems
- Box line Zone 3 confinement cell boundary
- Cascade ventilation system
- Box line qualified operators and training
- Waste characterization
- Fire protection programs
- DOE fire department
- Personal protective equipment.

Table E-5-11. Accident consequences–fire involving waste in the box line.[a]

	Locations			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guideline, rem	100	b	b	25
Calculated TEDE, rem	1.25E-04	0.514	0.170	0.220

Chemical exposure				
Evaluation guideline	ERPG-3	b	b	ERPG-2
Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	9.1E-08	0.0006	0.00022	0.00027
Beryllium				
Evaluation guideline mg/m^3	0.1	7.3E-03	7.3E-03	7.3E-03
Calculated mg/m^3	1.4E-09	9.2E-06	3.4E-06	4.2E-06
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	1.9E-09	2.5E-04	4.7E-06	5.7E-06
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25
Calculated mg/m^3	1.3E-07	8.6E-04	3.2E-04	3.9E-04
Mercury				
Evaluation guideline mg/m^3 [c]	10.0	0.1	0.1	0.1
Calculated mg/m^3	1.8E-11	1.3E-07	5.0E-08	6.1E-08
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	1.1E-10	7.4E-07	3.0E-07	3.6E-07

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a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

a. b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c. As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

E-5.4.1.2 Fire Involving Waste in the Drum Line.

E-5.4.1.2.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. The MAR consists of the radioactive and hazardous constituents within twelve 55-gallon drums, four in sorted export drums, and eight in various stages of opening and sorting.

The radioactive MAR is based on the selection of 12 drums of combustible waste that results in the highest exposure (BNFL 1998d). Examination of the waste descriptions for the drums resulting from this selection suggest that materials from one waste stream (BNFL 1998d) are solids (wastes sealed in pipes) and wastes in the balance are spent HEPA filters. In addition to the radionuclides in the drums, the fire is assumed to damage the HEPA filters and release contaminates from the ventilation system. The inventory of radioactive materials in the filters and ventilation system was conservatively represented by 500 grams of Pu-239.

Multiple MARs are developed for hazardous constituents based on the selection of 12 combustible drums containing the highest concentration of each hazardous material (BNFL 1998d). The resulting MARs bound all combinations of combustible waste drums for each hazardous material. Examination of the hazardous waste descriptions for the drum sets suggests that the hazardous materials are typically in cans, cartons, bottles, or other enclosures and can be characterized as contained waste.

When exposed to heat and flame, halogenated compounds produce small quantities of phosgene compounds, and chlorinated hydrocarbons produce small quantities of halogenated acids. The analysis assumes that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire and that 10 percent of the chlorinated hydrocarbons in the MAR decompose to hydrochloric acid and 1 percent of the halogenated compounds convert to phosgene gas with a molecular conversion ratio of 1.19 (BNFL 1998d).

Damage Ratio. Contained and uncontained waste is assumed to be located in various areas within the process cell, and some waste is in export drums below the elevation of the floor. Only portions of the waste are expected to be involved in a fire because of a lack of continuity of combustibles. However, to bound the assessment, a DR of 1.0 is assumed. To incorporate the assumption that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire, the DR for halogenated compounds and chlorinated hydrocarbons is multiplied by 0.89 (BNFL 1998d).

Airborne Release Fraction. As discussed above, wastes are characterized as solids and spent HEPA filters. The ARF for combustible, surface-contaminated solid wastes exposed to fire are 6.0E-03 (BNFL 1998d), and 1.0E-04 (BNFL 1998d) for spent HEPA filters exposed to fire.

For the release from the ventilation system and HEPA filters, it was assumed that half of the contamination resides in the ductwork, dampers, and plenums and the other half is in the HEPA filters. The ARF from the ductwork is 4.0E-05 (BNFL 1998d) and the ARF from HEPA failure is 5.0E-04 (BNFL 1998d).

The ARF for contained hazardous materials exposed to fire is 5.0E-04 (BNFL 1998d).

Respirable Fraction. The RFs for combustible surface-contaminated waste exposed to fire are 0.01 for solid waste (BNFL 1998d) and 1.0 for loaded HEPA filters (BNFL 1998d).

The RF for releases from the ductwork is 1.0 (BNFL 1998d) and the RF for releases from HEPA failure is 1.0 (BNFL 1998d).

For hazardous material releases, the RF for contained hazardous materials exposed to fire is conservatively assigned a value of 1.0 (BNFL 1998d).

Leakpath Factor. The fire is assumed to heat the atmosphere in the cell and damage HEPA filters in the ventilation system, resulting in a LPF of 1.0.

Using the above factors, bounding source terms were developed for radiological and hazardous constituents as shown in Table E-5-12 (BNFL 1998d). The source terms were applied to the unit- gram dose model for 50 percent and 95 percent meteorological conditions (BNFL 1998d) corresponding to a stack release. The consequences reported below select the higher exposures for the 50 percent and 95 percent meteorological conditions.

Table E-5-12. Source term–fire involving waste in the drum line.[a]

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radioactive materials							
ID-INL-152TN	Pu-238	2.50E+01	1	6.00E-03	0.01	1	1.50E-03
ID-MDO-813T	Pu-238	8.55E+01	1	1.00E-04	1	1	8.55E-03
ID-INL-152TN	Pu-239	3.13E+01	1	6.00E-03	0.01	1	1.88E-03
ID-MDO-813T	Pu-239	2.10E+02	1	1.00E-04	1	1	2.10E-02
Ductwork	Pu-239	2.50E+02	1	4.00E-05	1	1	1.00E-02
HEPA filters	Pu-239	2.50E+02	1	5.00E-04	1	1	1.25E-01
ID-INL-152TN	Pu-240	1.65E+01	1	6.00E-03	0.01	1	9.88E-04
Hazardous materials							
ID-RFO-339T	Acetone	1.81E+04	1	5.00E-04	1	1	9.04E+00
ID-AEO-110T	Arsenic	3.00E+03	1	5.00E-04	1	1	1.50E+00
ID-AEO-120T	Arsenic	1.50E+03	1	5.00E-04	1	1	7.50E-01
ID-RFO-338	Asbestos	5.56E+05	1	5.00E-04	1	1	2.78E+02
ID-RFO-339T	Benzene	1.81E+04	1	5.00E-04	1	1	9.04E+00
ID-RFO-9999	Beryllium	1.24E+04	1	5.00E-04	1	1	6.22E+00
ID-MDO-838	Butyl alcohol, n-	1.50E+03	1	5.00E-04	1	1	7.50E-01
ID-INL-155	Butyl alcohol, n-	7.60E+03	1	5.00E-04	1	1	3.80E+00
ID-MDO-847	Butyl alcohol, n-	1.41E+04	1	5.00E-04	1	1	7.05E+00
ID-AEO-110T	Cadmium & compounds	3.00E+03	1	5.00E-04	1	1	1.50E+00
ID-RFO-9999	Cadmium & compounds	1.24E+04	1	5.00E-04	1	1	6.22E+00
ID-MDO-838	Carbon tetrachloride	1.50E+04	0.89	5.00E-04	1	1	6.68E+00
ID-INL-155	Carbon tetrachloride	7.60E+04	0.89	5.00E-04	1	1	3.38E+01
ID-MDO-847	Carbon tetrachloride	1.41E+05	0.89	5.00E-04	1	1	6.27E+01
ID-RFO-339T	Chloroform	1.81E+04	0.89	5.00E-04	1	1	8.05E+00
ID-RFO-339T	Ethyl benzene	1.81E+04	1	5.00E-04	1	1	9.04E+00
ID-AEO-100T	Ethyl ether	1.20E+03	1	5.00E-04	1	1	6.00E-01
ID-RFO-339T	Ethylene dichloride	1.81E+04	0.89	5.00E-04	1	1	8.05E+00
ID-RFO-463T	Lead	1.26E+06	1	5.00E-04	1	1	6.29E+02
ID-MDO-826T	Mercury (elemental & inorganic)	3.97E+01	1	5.00E-04	1	1	1.99E-02
ID-MDO-826	Mercury (elemental & inorganic)	2.58E+01	1	5.00E-04	1	1	1.29E-02
ID-MDO-827T	Mercury (elemental & inorganic)	1.02E+02	1	5.00E-04	1	1	5.09E-02
ID-MDO-838	Methyl alcohol;	1.50E+03	1	5.00E-04	1	1	7.50E-01
ID-INL-155	Methyl alcohol;	7.60E+03	1	5.00E-04	1	1	3.80E+00

Table E-5-12. Source term–fire involving waste in the drum line (continued)[a].

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-MDO-847	Methyl alcohol;	1.41E+04	1	5.00E-04	1	1	7.05E+00
ID-RFO-460T	Methylene chloride	1.30E+04	0.89	5.00E-04	1	1	5.79E+00
ID-RFO-116T	Methylene chloride	6.10E+03	0.89	5.00E-04	1	1	2.71E+00
ID-RFO-463T	Methylene chloride	2.10E+04	0.89	5.00E-04	1	1	9.32E+00
ID-MDO-838	Nitric acid	1.50E+03	1	5.00E-04	1	1	7.50E-01
ID-INL-155	Nitric acid	7.60E+03	1	5.00E-04	1	1	3.80E+00
ID-MDO-847	Nitric acid	1.41E+04	1	5.00E-04	1	1	7.05E+00
ID-RFO-9999	Perchloroethylene	1.24E+04	0.89	5.00E-04	1	1	5.54E+00
ID-RFO-000T	Polychlorinated biphenyl	9.55E+02	0.89	5.00E-04	1	1	4.25E-01
ID-RFO-339T	Toluene	1.81E+04	1	5.00E-04	1	1	9.04E+00
ID-RFO-460T	Trichloroethane, 1,1,1-	1.30E+04	0.89	5.00E-04	1	1	5.79E+00
ID-RFO-116T	Trichloroethane, 1,1,1-	6.10E+03	0.89	5.00E-04	1	1	2.71E+00
ID-RFO-463T	Trichloroethane, 1,1,1-	2.10E+04	0.89	5.00E-04	1	1	9.32E+00
ID-RFO-116T	Trichloroethylene	6.10E+03	0.89	5.00E-04	1	1	2.71E+00
ID-RFO-463T	Trichloroethylene	2.10E+04	0.89	5.00E-04	1	1	9.32E+00
ID-RFO-460T	Trichlorotrifluroethane	1.30E+04	0.89	5.00E-04	1	1	5.79E+00
ID-RFO-116T	Trichlorotrifluroethane	6.10E+03	0.89	5.00E-04	1	1	2.71E+00
ID-RFO-116	Trichlorotrifluroethane	1.56E+03	0.89	5.00E-04	1	1	6.94E-01
ID-RFO-339T	Trichlorotrifluroethane	1.81E+04	0.89	5.00E-04	1	1	8.05E+00
ID-RFO-339T	Vinylidene chloride	1.81E+04	0.89	5.00E-04	1	1	8.05E+00
ID-RFO-241	Xylene	2.00E+04	1	5.00E-04	1	1	1.00E+01

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d), HEPA-high-efficiency particulate air; DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility. Also evaluated were combustion by-products phosgene and hydrochloric acid (BNFL 1998d).

b. From BNFL (1998d).

E-5.4.1.2.2 Consequence Analysis¾ Accident consequences are summarized in Table E-5-13. Examination of the radiological consequences by radionuclide (BNFL 1998d) illustrates that nearly all the consequences result from exposure to Pu-238 by way of the inhalation pathway. Pu-238 exists in less than 2 percent of the waste drums (BNFL 1998d). The six most limiting hazardous materials (in terms of a fraction of the ERPG value) are reported in Table E-5-13 (see BNFL [1998d] for all 33 materials analyzed).

E-5.4.1.2.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-13. Evaluation guidelines for an extremely unlikely event are not exceeded.

E-5.4.1.2.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Table E-5-13. Accident consequences–fire involving waste in the drum line.[a]

	Locations

	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	2.01E-05	0.0828	0.0274	0.0354
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2
Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	3.1E-08	0.0002	7.5E-05	9.2E-05
Beryllium				
Evaluation guideline mg/m^3	0.1	7.3E-03	7.3E-03	7.3E-03
Calculated mg/m^3	6.8E-10	4.5E-06	1.7E-06	2.1E-06
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	8.5E-10	5.6E-06	2.1E-06	2.6E-06
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25
Calculated mg/m^3	6.9E-08	4.5E-04	1.7E-04	2.1E-04
Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	9.2E-12	6.5E-08	2.6E-08	3.2E-08
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005

Calculated mg/m^3	4.7E-11	3.3E-07	1.3E-07	1.6E-07

a. EBR-I — Experimental Breeder Reactor-I; INEEL — Idaho National Engineering and Environmental Laboratory; TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c. As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

Safety-Class and Safety Significant Structures, Systems, and Components. Evaluation guidelines at the INEEL boundary are not exceeded, and no safety-class structures, systems, and components are required. Involved workers rely upon the following safety- significant structures, systems, and components to mitigate the consequences of this accident:

- Workplace radiation monitoring systems
- Respiratory protection equipment
- Radiological assay and tracking system.

Technical Safety Requirement Controls. The analysis identified a need for technical safety requirement controls to place limits on the fissile mass in the pretreatment and treatment areas of the plant. Surveillance of fissile mass in the process is via the plant data management system.

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of a drum line fire include the following:

- Fire detection, manual and automatic suppression systems
- Drum line Zone 3 confinement cell boundary
- Cascade ventilation system
- Drum line qualified operators and training
- Waste characterization
- Fire protection programs
- DOE fire department
- Personal protective equipment.

E-5.4.1.3 Loss of All AC Power.

E-5.4.1.3.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. The MAR is the airborne contamination throughout the AMWTP. The highest concentrations of

airborne contaminates are assumed to be in the following Zone 3 areas of the treatment facility:

- Box line sorting area
- Drum line sorting area
- Incinerator hoppers and shredders
- Supercompactor glovebox
- Ash handling in microencapsulation area.

The estimated MARs are the contents of one opened box in the box line sorting area, five opened drums in the drum line sorting areas, 1 cubic meter of waste in the incinerator hoppers and shredders, one drum and two pucks in the supercompactor area (represented by three drums), and one drum equivalent of incinerator ash in the microencapsulation ash-handling equipment. The radioactive and hazardous MARs in each area are based on the selection of wastes that would result in the highest exposures (BNFL 1998d).

Damage Ratios. The DR is applied to each of the MAR areas identified above and defines the potential amount of the MAR that is involved with airborne contamination. For example, only the top surface layer of ash in a hopper may be open to the atmosphere. The estimated DRs are 0.5 for the contents of one opened box in the box line sorting area, 0.5 for five opened drums in the drum line sorting areas, 0.1 for the 1 cubic meter of waste in the incinerator hoppers and shredders, 0.3 for the drum and two pucks in the supercompactor area, and 0.1 for the drum equivalent of incinerator ash in the microencapsulation ash-handling equipment. When calculating the source term for the incinerator and ash handling, the DR for halogenated compounds and chlorinated hydrocarbons is multiplied by 0.89 (BNFL 1998d) to incorporate the assumption that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose when incinerated.

Airborne Release Fractions. Normal process equipment and handling will cause some of the wastes to become airborne. The estimated ARF are 5.0E-04 for the contents of the opened box and drums in the sorting areas and at the supercompactor (Section 5.2.1.1 of DOE [1994]), and 6.0E-03 for the waste in the incinerator hoppers, shredders and ash handling equipment (Section 4.1 of DOE [1994]).

Respirable Fraction. The estimated RFs are 1.0 for the contents of the opened box and drums in the sorting areas and at the supercompactor (Section 5.2.1.1 of DOE [1994]), and 0.01 for the waste in the incinerator hoppers, shredders and ash-handling equipment (Section 4.1 of DOE [1994]).

Leakpath Factor. Because the treatment facility cascade ventilation systems are inoperable, contamination migrates via natural convection. In many areas, migration is prevented or impeded by airlocks at zone boundaries. The extent of the time-dependent migration is indeterminate. For purposes of this assessment, the following assumptions are made to bound the release from treatment facility:

- Ten percent of the Zone 3 airborne contaminants are transferred to Zone 2 upon loss of power.
- Ten percent of the new Zone 2 contaminants are transferred to Zone 1 upon loss of power.
- Ten percent of the new Zone 1 contaminants are released from the building.

The resulting LPF for release from the treatment facility is 0.001. Using the above factors, a conservative source term for external release can be estimated as shown in Table
E-5-14. The source terms were applied to the unit-gram dose model for 50 percent and 95 percent meteorological conditions (BNFL 1998d) corresponding to a stack release. The consequences reported below select the higher exposures for the 50 percent and 95 percent meteorological conditions.

Table E-5-14. Source term——loss of all alternating current power.[a]

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radioactive material from the box line							
ID-INL-152TN	Pu-238	1.25E+02	0.5	5.00E-04	1	0.001	3.11E-05
ID-INL-152TN	Pu-239	1.56E+02	0.5	5.00E-04	1	0.001	3.90E-05
ID-INL-152TN	Pu-240	8.21E+01	0.5	5.00E-04	1	0.001	2.05E-05
Hazardous materials from the box line							
ID-RFO-442T	Acetone	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-OFS-121T	Arsenic	1.38E+04	0.5	5.00E-04	1	0.001	3.44E-03
ID-RFO-338T	Asbestos	5.52E+05	0.5	5.00E-04	1	0.001	1.38E-01
ID-RFO-001T	Barium	1.68E+04	0.5	5.00E-04	1	0.001	4.21E-03
ID-RFO-442T	Benzene	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-RFO-000T	Beryllium	8.50E+03	0.5	5.00E-04	1	0.001	2.13E-03
ID-TAN-162	Butanone, 2-; (MEK)	0.00E+01	0.5	5.00E-04	1	0.001	0.00E+00
ID-RFO-978T	Butyl alcohol, n-	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-OFS-121T	Cadmium & compounds	1.38E+05	0.5	5.00E-04	1	0.001	3.44E-02
ID-RFO-003	Carbon tetrachloride	1.52E+05	0.5	5.00E-04	1	0.001	3.79E-02
ID-RFO-976	Chloroform	2.05E+04	0.5	5.00E-04	1	0.001	5.13E-03
ID-RFO-978T	Chromium	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-TAN-162	Dichlorobenzene, p-	0.00E+01	0.5	5.00E-04	1	0.001	0.00E+00
ID-RFO-480T	Ethyl benzene	1.44E+04	0.5	5.00E-04	1	0.001	3.59E-03
ID-AEO-100T	Ethyl ether	9.70E+03	0.5	5.00E-04	1	0.001	2.43E-03
ID-RFO-976	Ethylene dichloride	2.05E+04	0.5	5.00E-04	1	0.001	5.13E-03
ID-RFO-302T	Lead	7.93E+05	0.5	5.00E-04	1	0.001	1.98E-01
ID-RFO-118	Mercury	1.93E+02	0.5	5.00E-04	1	0.001	4.83E-05
ID-RFO-978T	Methyl alcohol	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-RFO-117	Methylene chloride	2.64E+04	0.5	5.00E-04	1	0.001	6.59E-03
ID-CPP-156	Nitric acid	1.22E+04	0.5	5.00E-04	1	0.001	3.06E-03
ID-RFO-003	Nitrobenzene	1.52E+04	0.5	5.00E-04	1	0.001	3.79E-03
ID-RFO-978T	Perchloroethylene	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-RFO-003	Polychlorinated biphenyl	7.65E+03	0.5	5.00E-04	1	0.001	1.91E-03
ID-RFO-005	Potassium nitrate	1.66E+06	0.5	5.00E-	1	0.001	4.14E-01

				04			
ID-MDO-842	Selenium	2.08E+04	0.5	5.00E-04	1	0.001	5.19E-03
ID-MDO-842	Silver	2.08E+04	0.5	5.00E-04	1	0.001	5.19E-03
ID-RFO-442T	Toluene	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-RFO-003	Trichloroethane, 1,1,1-	4.55E+05	0.5	5.00E-04	1	0.001	1.14E-01
ID-RFO-978T	Trichloroethylene	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-RFO-003	Trichlorotrifluroethane	1.52E+05	0.5	5.00E-04	1	0.001	3.79E-02
ID-RFO-442T	Vinylidene chloride	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-RFO-978T	Xylene	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
Radioactive materials from the drum line							
ID-MDO-811T	Pu-238	3.90E+01	0.5	5.00E-04	1	0.001	9.75E-06
ID-MDO-813T	Pu-238	9.50E-00	0.5	5.00E-04	1	0.001	2.38E-06
ID-MDO-811T	Pu-239	8.00E+01	0.5	5.00E-04	1	0.001	2.00E-05
ID-MDO-813T	Pu-239	2.33E+01	0.5	5.00E-04	1	0.001	5.83E-06
Hazardous materials from the drum line							
ID-MDO-836T	Acetone	1.44E+04	0.5	5.00E-04	1	0.001	3.61E-03
ID-OFS-111	Arsenic	1.10E+04	0.5	5.00E-04	1	0.001	2.75E-03
ID-RFO-338	Asbestos	2.32E+05	0.5	5.00E-04	1	0.001	5.80E-02
ID-RFO-002	Barium	1.27E+04	0.5	5.00E-04	1	0.001	3.17E-03
ID-RFO-339T	Benzene	7.54E+03	0.5	5.00E-04	1	0.001	1.88E-03

Table E-5-14. Source term——loss of all alternating current power[a] (continued).

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-9999	Beryllium	5.19E+03	0.5	5.00E-04	1	0.001	1.30E-03
ID-TAN-162	Butanone, 2-; (MEK)	1.06E+04	0.5	5.00E-04	1	0.001	2.64E-03
ID-OFS-111	Butyl alcohol, n-	2.20E+04	0.5	5.00E-04	1	0.001	5.51E-03
ID-OFS-111	Cadmium & compounds	2.20E+04	0.5	5.00E-04	1	0.001	5.51E-03
ID-RFO-112T	Carbon tetrachloride	1.24E+05	0.5	5.00E-04	1	0.001	3.09E-02
ID-RFO-112T	Chloroform	1.24E+05	0.5	5.00E-04	1	0.001	3.09E-02
ID-MDO-836T	Chromium	1.44E+04	0.5	5.00E-04	1	0.001	3.61E-03
ID-TAN-162	Dichlorobenzene, p-	1.06E+04	0.5	5.00E-04	1	0.001	2.64E-03
ID-OFS-111T	Ethyl benzene	2.05E+04	0.5	5.00E-04	1	0.001	5.13E-03
ID-AEO-100T	Ethyl ether	1.20E+03	0.5	5.00E-04	1	0.001	3.00E-04
ID-RFO-002	Ethylene dichloride	1.27E+04	0.5	5.00E-04	1	0.001	3.17E-03
ID-RFO-463T	Lead	5.24E+05	0.5	5.00E-04	1	0.001	1.31E-01

ID-RFO-002	Mercury	2.73E+03	0.5	5.00E-04	1	0.001	6.82E-04
ID-RFO-113	Methyl alcohol	1.50E+04	0.5	5.00E-04	1	0.001	3.75E-03
ID-OFS-111	Methylene chloride	2.20E+04	0.5	5.00E-04	1	0.001	5.51E-03
ID-BCO-204	Nitric acid	7.29E+03	0.5	5.00E-04	1	0.001	1.82E-03
ID-MDO-838	Nitric acid	1.50E+03	0.5	5.00E-04	1	0.001	3.75E-04
ID-INL-155	Nitric acid	1.27E+03	0.5	5.00E-04	1	0.001	3.17E-04
ID-RFO-090	Nitrobenzene	1.41E+04	0.5	5.00E-04	1	0.001	3.52E-03
ID-OFS-111	Perchloroethylene	2.20E+04	0.5	5.00E-04	1	0.001	5.51E-03
ID-RFO-003T	Polychlorinated biphenyl	6.06E+03	0.5	5.00E-04	1	0.001	1.51E-03
ID-RFO-005	Potassium nitrate	8.27E+05	0.5	5.00E-04	1	0.001	2.07E-01
ID-MDO-836T	Selenium	1.44E+04	0.5	5.00E-04	1	0.001	3.61E-03
ID-MDO-836T	Silver	1.44E+04	0.5	5.00E-04	1	0.001	3.61E-03
ID-RFO-007T	Toluene	1.11E+04	0.5	5.00E-04	1	0.001	2.78E-03
ID-RFO-003T	Trichloroethane, 1,1,1-	3.60E+05	0.5	5.00E-04	1	0.001	9.00E-02
ID-TAN-162	Trichloroethylene	1.06E+05	0.5	5.00E-04	1	0.001	2.64E-02
ID-RFO-112T	Trichlorotrifluroethane	1.24E+05	0.5	5.00E-04	1	0.001	3.09E-02
ID-TAN-162	Vinylidene chloride	1.06E+04	0.5	5.00E-04	1	0.001	2.64E-03
ID-RFO-112T	Xylene	1.24E+05	0.5	5.00E-04	1	0.001	3.09E-02
Radioactive materials from the incinerator							
ID-MDO-810T	Pu-238	5.28E-00	0.1	6.00E-03	0.01	0.001	3.17E-08
ID-MDO-811T	Pu-238	3.90E+01	0.1	6.00E-03	0.01	0.001	2.34E-07
ID-MDO-810T	Pu-239	1.05E+01	0.1	6.00E-03	0.01	0.001	6.29E-08
ID-MDO-811T	Pu-239	8.00E+01	0.1	6.00E-03	0.01	0.001	4.80E-07
Hazardous materials from the incinerator							
ID-MDO-836T	Acetone	1.36E+04	0.1	6.00E-03	0.01	0.001	8.16E-05
ID-OFS-111	Arsenic	1.04E+04	0.1	6.00E-03	0.01	0.001	6.24E-05
ID-RFO-002	Barium	1.20E+04	0.1	6.00E-03	0.01	0.001	7.18E-05
ID-RFO-442T	Benzene	4.63E+03	0.1	6.00E-03	0.01	0.001	2.78E-05
ID-TAN-162	Butanone, 2-; (MEK)	9.98E+03	0.1	6.00E-03	0.01	0.001	5.99E-05
ID-OFS-111	Butyl alcohol, n-	2.08E+04	0.1	6.00E-03	0.01	0.001	1.25E-04
ID-OFS-111	Cadmium & compounds	2.08E+04	0.1	6.00E-03	0.01	0.001	1.25E-04
ID-RFO-112T	Carbon tetrachloride	1.17E+05	0.089	6.00E-03	0.01	0.001	6.24E-04
ID-RFO-112T	Chloroform	1.17E+05	0.089	6.00E-03	0.01	0.001	6.24E-04
ID-MDO-836T	Chromium	1.36E+04	0.1	6.00E-03	0.01	0.001	8.16E-05

ID-TAN-162	Dichlorobenzene, p-	9.98E+03	0.089	6.00E-03	0.01	0.001	5.33E-05
ID-OFS-111T	Ethyl benzene	1.93E+04	0.1	6.00E-03	0.01	0.001	1.16E-04
ID-RFO-002	Ethylene dichloride	1.20E+04	0.089	6.00E-03	0.01	0.001	6.39E-05
ID-BCO-204T	Lead	2.91E+05	0.1	6.00E-03	0.01	0.001	1.75E-03

Table E-5-14. Source term——loss of all alternating current power[a] (continued).

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-AEO-102T	Lead	2.44E+04	0.1	6.00E-03	0.01	0.001	1.46E-04
ID-RFO-002	Mercury	2.57E+03	0.1	6.00E-03	0.01	0.001	1.54E-05
ID-RFO-113	Methyl alcohol	1.42E+04	0.1	6.00E-03	0.01	0.001	8.49E-05
ID-OFS-111	Methylene chloride	2.08E+04	0.089	6.00E-03	0.01	0.001	1.11E-04
ID-BCO-204	Nitric acid	7.29E+03	0.1	6.00E-03	0.01	0.001	4.37E-05
ID-AEO-102	Nitric acid	1.83E+03	0.1	6.00E-03	0.01	0.001	1.10E-05
ID-RFO-090	Nitrobenzene	1.33E+04	0.1	6.00E-03	0.01	0.001	7.97E-05
ID-OFS-111	Perchloroethylene	2.08E+04	0.089	6.00E-03	0.01	0.001	1.11E-04
ID-RFO-003T	Polychlorinated biphenyl	5.71E+03	0.089	6.00E-03	0.01	0.001	3.05E-05
ID-RFO-005	Potassium nitrate	7.81E+05	0.1	6.00E-03	0.01	0.001	4.68E-03
ID-MDO-836T	Selenium	1.36E+04	0.1	6.00E-03	0.01	0.001	8.16E-05
ID-MDO-836T	Silver	1.36E+04	0.1	6.00E-03	0.01	0.001	8.16E-05
ID-RFO-007T	Toluene	1.05E+04	0.1	6.00E-03	0.01	0.001	6.30E-05
ID-RFO-003T	Trichloroethane, 1,1,1-	3.40E+05	0.089	6.00E-03	0.01	0.001	1.81E-03
ID-TAN-162	Trichloroethylene	9.98E+04	0.089	6.00E-03	0.01	0.001	5.33E-04
ID-RFO-112T	Trichlorotrifluroethane	1.17E+05	0.089	6.00E-03	0.01	0.001	6.24E-04
ID-TAN-162	Vinylidene chloride	9.98E+03	0.089	6.00E-03	0.01	0.001	5.33E-05
ID-RFO-112T	Xylene	1.17E+05	0.1	6.00E-03	0.01	0.001	7.01E-04
Radioactive materials from the supercompactor							
ID-MDO-811T	Pu-238	2.93E+01	0.3	5.00E-04	1	0.001	4.39E-06
ID-MDO-811T	Pu-239	6.00E+01	0.3	5.00E-04	1	0.001	9.00E-06
Hazardous materials from the supercompactor							
ID-MDO-836T	Acetone	8.65E+03	0.3	5.00E-04	1	0.001	1.30E-03
ID-OFS-111	Arsenic	6.61E+03	0.3	5.00E-04	1	0.001	9.92E-04
ID-RFO-338	Asbestos	1.39E+05	0.3	5.00E-04	1	0.001	2.09E-02
ID-RFO-002	Barium	7.62E+03	0.3	5.00E-04	1	0.001	1.14E-03
ID-RFO-339T	Benzene	4.52E+03	0.3	5.00E-04	1	0.001	6.78E-04
ID-RFO-9999	Beryllium	3.11E+03	0.3	5.00E-	1	0.001	4.67E-04

				04			
ID-TAN-162	Butanone, 2-; (MEK)	6.35E+03	0.3	5.00E-04	1	0.001	9.52E-04
ID-OFS-111	Butyl alcohol, n-	1.32E+04	0.3	5.00E-04	1	0.001	1.98E-03
ID-OFS-111	Cadmium & compounds	1.32E+04	0.3	5.00E-04	1	0.001	1.98E-03
ID-RFO-112T	Carbon tetrachloride	7.43E+04	0.3	5.00E-04	1	0.001	1.11E-02
ID-RFO-112T	Chloroform	7.43E+04	0.3	5.00E-04	1	0.001	1.11E-02
ID-MDO-836T	Chromium	8.65E+03	0.3	5.00E-04	1	0.001	1.30E-03
ID-TAN-162	Dichlorobenzene, p-	6.35E+03	0.3	5.00E-04	1	0.001	9.52E-04
ID-OFS-111T	Ethyl benzene	1.23E+04	0.3	5.00E-04	1	0.001	1.85E-03
ID-AEO-100T	Ethyl ether	1.20E+03	0.3	5.00E-04	1	0.001	1.80E-04
ID-RFO-002	Ethylene dichloride	7.62E+03	0.3	5.00E-04	1	0.001	1.14E-03
ID-RFO-463T	Lead	3.14E+05	0.3	5.00E-04	1	0.001	4.71E-02
ID-RFO-002	Mercury	1.64E+03	0.3	5.00E-04	1	0.001	2.45E-04
ID-RFO-113	Methyl alcohol	9.00E+03	0.3	5.00E-04	1	0.001	1.35E-03
ID-OFS-111	Methylene chloride	1.32E+04	0.3	5.00E-04	1	0.001	1.98E-03
ID-BCO-204	Nitric acid	7.29E+03	0.3	5.00E-04	1	0.001	1.09E-03
ID-RFO-090	Nitrobenzene	8.44E+03	0.3	5.00E-04	1	0.001	1.27E-03
ID-OFS-111	Perchloroethylene	1.32E+04	0.3	5.00E-04	1	0.001	1.98E-03
ID-RFO-003T	Polychlorinated biphenyl	3.63E+03	0.3	5.00E-04	1	0.001	5.45E-04
ID-RFO-005	Potassium nitrate	4.96E+05	0.3	5.00E-04	1	0.001	7.45E-02
ID-MDO-836T	Selenium	8.65E+03	0.3	5.00E-04	1	0.001	1.30E-03
ID-MDO-836T	Silver	8.65E+03	0.3	5.00E-04	1	0.001	1.30E-03

Table E-5-14. Source term——loss of all alternating current power[a] (continued).

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-007T	Toluene	6.68E+03	0.3	5.00E-04	1	0.001	1.00E-03
ID-RFO-003T	Trichloroethane, 1,1,1-	2.16E+05	0.3	5.00E-04	1	0.001	3.24E-02
ID-TAN-162	Trichloroethylene	6.35E+04	0.3	5.00E-04	1	0.001	9.52E-03
ID-RFO-112T	Trichlorotrifluroethane	7.43E+04	0.3	5.00E-04	1	0.001	1.11E-02
ID-TAN-162	Vinylidene chloride	6.35E+03	0.3	5.00E-04	1	0.001	9.52E-04
ID-RFO-112T	Xylene	7.43E+04	0.3	5.00E-04	1	0.001	1.11E-02
Radioactive materials from ash handling							
ID-MDO-811T	Pu-238	9.75E-00	0.1	6.00E-03	0.01	0.001	5.85E-08
ID-MDO-811T	Pu-239	2.00E+01	0.1	6.00E-03	0.01	0.001	1.20E-07
Hazardous materials from ash handling							

ID-MDO-836T	Acetone	2.88E+03	0.1	6.00E-03	0.01	0.001	1.73E-05
ID-OFS-111	Arsenic	2.20E+03	0.1	6.00E-03	0.01	0.001	1.32E-05
ID-RFO-002	Barium	2.54E+03	0.1	6.00E-03	0.01	0.001	1.52E-05
ID-RFO-442T	Benzene	9.81E+02	0.1	6.00E-03	0.01	0.001	5.89E-06
ID-TAN-162	Butanone, 2-; (MEK)	2.12E+03	0.1	6.00E-03	0.01	0.001	1.27E-05
ID-OFS-111	Butyl alcohol, n-	4.41E+03	0.1	6.00E-03	0.01	0.001	2.64E-05
ID-OFS-111	Cadmium & compounds	4.41E+03	0.1	6.00E-03	0.01	0.001	2.64E-05
ID-RFO-112T	Carbon tetrachloride	2.48E+04	0.089	6.00E-03	0.01	0.001	1.32E-04
ID-RFO-112T	Chloroform	2.48E+04	0.089	6.00E-03	0.01	0.001	1.32E-04
ID-MDO-836T	Chromium	2.88E+03	0.1	6.00E-03	0.01	0.001	1.73E-05
ID-TAN-162	Dichlorobenzene, p-	2.12E+03	0.089	6.00E-03	0.01	0.001	1.13E-05
ID-OFS-111T	Ethyl benzene	4.10E+03	0.1	6.00E-03	0.01	0.001	2.46E-05
ID-RFO-002	Ethylene dichloride	2.54E+03	0.089	6.00E-03	0.01	0.001	1.36E-05
ID-BCO-204T	Lead	7.28E+04	0.1	6.00E-03	0.01	0.001	4.37E-04
ID-RFO-002	Mercury	5.45E+02	0.1	6.00E-03	0.01	0.001	3.27E-06
ID-RFO-113	Methyl alcohol	3.00E+03	0.1	6.00E-03	0.01	0.001	1.80E-05
ID-OFS-111	Methylene chloride	4.41E+03	0.089	6.00E-03	0.01	0.001	2.35E-05
ID-BCO-204	Nitric acid	2.43E+03	0.1	6.00E-03	0.01	0.001	1.46E-05
ID-RFO-090	Nitrobenzene	2.81E+03	0.1	6.00E-03	0.01	0.001	1.69E-05
ID-OFS-111	Perchloroethylene	4.41E+03	0.089	6.00E-03	0.01	0.001	2.35E-05
ID-RFO-003T	Polychlorinated biphenyl	1.21E+03	0.089	6.00E-03	0.01	0.001	6.47E-06
ID-RFO-005	Potassium nitrate	1.65E+05	0.1	6.00E-03	0.01	0.001	9.93E-04
ID-MDO-836T	Selenium	2.88E+03	0.1	6.00E-03	0.01	0.001	1.73E-05
ID-MDO-836T	Silver	2.88E+03	0.1	6.00E-03	0.01	0.001	1.73E-05
ID-RFO-007T	Toluene	2.23E+03	0.1	6.00E-03	0.01	0.001	1.34E-05
ID-RFO-003T	Trichloroethane, 1,1,1-	7.20E+04	0.089	6.00E-03	0.01	0.001	3.85E-04
ID-TAN-162	Trichloroethylene	2.12E+04	0.089	6.00E-03	0.01	0.001	1.13E-04
ID-RFO-112T	Trichlorotrifluroethane	2.48E+04	0.089	6.00E-03	0.01	0.001	1.32E-04
ID-TAN-162	Vinylidene chloride	2.12E+03	0.089	6.00E-03	0.01	0.001	1.13E-05
ID-RFO-112T	Xylene	2.48E+04	0.1	6.00E-03	0.01	0.001	1.49E-04

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d); DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility.

b. From BNFL (1998d).

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E-5.4.1.3.2 Consequence Analysis¾ The consequences of a total loss of all AC power are summarized in Table E-5-15. The source term is assumed released to the outside at ground level. Involved workers in Zone 1 and 2 areas could be exposed to contaminants unless precautions are taken to evacuate and use respiratory protection equipment.

E-5.4.1.3.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-15. Evaluation guidelines for an anticipated event are not exceeded.

E-5.4.1.3.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ Evaluation guidelines at the INEEL boundary are not exceeded, and no safety-class structures, systems, or components are required. Involved workers rely on the following safety-significant structures, systems, and components to prevent or mitigate the consequences of this accident are as follows:

- Respiratory protection equipment
- Workplace radiation monitoring systems.

Technical Safety Requirement Controls. The analysis identified a need for administrative controls for procedures and training on evacuation and the use of respiratory protection equipment. A Limiting Condition for Operation was identified to have an operating ventilation system during pretreatment and treatment.

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of loss of AC include the following:

- Waste characterization
- Emergency preparedness planning
- Personal protective equipment.

Table E-5-15. Accident consequences–loss of all alternating current power.[a]

	Locations			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	5	b	b	0.5
Calculated TEDE, rem	0.0874	0.00308	0.00131	0.00159
Chemical exposure				
Evaluation guidelines	ERPG-1	b	b	TLV-TWA

Asbestos				
Evaluation guideline mg/m^3 [c]	0.05	0.05	0.05	0.05 [d]
Calculated mg/m^3	5.9E-04	6.5E-07	1.8E-07	2.4E-07
Beryllium				
Evaluation guideline mg/m^3	0.005	0.002	0.002	0.002
Calculated mg/m^3	1.1E-05	1.2E-08	3.2E-09	4.3E-09
Cadmium				
Evaluation guideline mg/m^3 [c]	0.03	0.01	0.01	0.01
Calculated mg/m^3	0.00011	1.3E-07	3.5E-08	4.6E-08
Lead				
Evaluation guideline mg/m^3 [c]	0.15	0.05	0.05	0.05
Calculated mg/m^3	0.0010	1.1E-06	3.1E-07	4.2E-07
Mercury				
Evaluation guideline mg/m^3 [c]	0.10	0.01	0.01	0.01
Calculated mg/m^3	2.3E-05	1.3E-08	5.4E-09	6.5E-09
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	0.003	0.001	0.001	0.001
Calculated mg/m^3	9.2E-05	5.2E-08	2.2E-08	2.6E-08

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a. EBR-I — Experimental Breeder Reactor-I; INEEL — Idaho National Engineering and Environmental Laboratory; TEDE — total effective dose equivalent; ERPG — emergency response planning guideline; TLV-TWA - Threshold limit value, time weighted average; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c. As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

d. National Institute for Occupational Safety and Health Recommended Exposure Limit.

E-5.4.1.4 Dropped Waste Box Outdoors During Transfer.

E-5.4.1.4.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. The MAR consists of the radioactive and hazardous constituents within a 3.2-cubic-meter standard waste box. All boxes of waste destined for the treatment facility are potential candidates for being dropped.

The radioactive MAR is based on using the waste streams that would contribute the maximum dose. The relative radiation dose from each waste stream is ranked from greater doses to lesser doses. Beginning with the waste stream with the greatest dose and proceeding to the waste streams with lesser doses, the waste streams are analyzed to find the waste stream in boxes that would contribute the greatest dose. A single box from the waste stream that would contribute the greatest dose defines the maximum radioactive MAR for the dropped box scenario.

The hazardous MAR is based on using the waste streams that would contribute the maximum quantity of each hazardous material. For each hazardous material identified in BNFL (1998d), the concentration of the chemical in boxes is ranked from greatest to least. Beginning with the waste stream with the greatest concentration and proceeding to the waste streams with lesser concentrations, the waste streams are analyzed to find the waste stream in boxes that has the greatest concentration of each of the 33 hazardous materials.

The resulting radioactive MAR represents bounding quantities of radioactive constituents from dropped boxes; the resulting 33 hazardous MARs represent bounding quantities of hazardous constituents from dropped boxes.

Damage Ratio. Evaluation of the waste descriptions for the waste streams that define the maximum radioactive MAR and the maximum hazardous MARs indicates that the waste inside the box is generally contained in one or two more packaging layers. For example, the description for the waste stream (waste stream code ID-INL-152TN referred to in BNFL [1998d]) that defines the waste stream with the maximum radioactive MAR indicates that "Pu-Be sources packaged in 1975 were placed in a carbon steel pipe, which was cemented and encapsulated into the center of a 55-gallon drum and placed in a box. In 1978, Pu-Be sources were packaged in four 55-gallon drums. Wastes packed in 1980 were wrapped plastic, placed in paraffin lined 15-gallon drums, and then placed in 55-gallon drums. Some individual items may be unbagged" (BNFL 1998d). The description for the waste stream that defines the maximum asbestos MAR indicates that "The waste is generally double-contained in either PE [polyethylene] or PVC [polyvinyl chloride] bags or in 1-gallon PE bottles and single or double bags" (BNFL 1998d). Because of the multiple packaging layers and because a box is most likely not even to break open during a fall, a DR of 0.5 is assumed for both the radioactive and hazardous material packagings.

Airborne Release Fraction. The bounding ARF for packaged waste is 5.0E-04 (Section 5.2.1.1 of DOE [1994]).

Respirable Fraction. The bounding RF for packaged waste is 1.0 (Section 5.3.3.2.2 of DOE [1994]).

Leakpath Factor. The accident is assumed to occur outdoors with confinement provided by the packaging allowing no more than 50 percent leakage of hazardous materials. For the radioactive material that is cemented and encapsulated, no more than 1 percent leakage of radioactive material would be expected. The LPF is therefore 0.01 for radioactive material and 0.5 for hazardous materials.

Using the above factors, bounding source terms were developed for radiological and hazardous constituents as shown in Table E-5-16 (BNFL 1998d). The source terms were applied to the unit- gram dose model for 50 percent and 95 percent meteorological conditions (BNFL 1998d) corresponding to a ground-level release. The consequences reported below select the higher exposures for the 50 percent and 95 percent meteorological conditions.

E-5.4.1.4.2 Consequence Analysis¾ The consequences to co-located workers and the public of a dropped waste box outdoors during transfer are summarized in Table E-5-17. Involved workers depend on procedures, training and personal protection equipment to minimize exposures for drops and spills of containers. Examination of the radiological consequences by radionuclide (BNFL 1998d) illustrates that nearly all the radiological exposure results from Pu-238 by way of the inhalation pathway. Pu-238 exists in less than 2 percent of the waste boxes (BNFL 1998d).

If the dropped box contained the maximum arsenic, beryllium, cadmium or potassium nitrate, co-located workers would be exposed to concentrations near or exceeding ERPG-1 concentrations (shown in BNFL [1998d]). If the dropped box contained the maximum asbestos, lead, or PCBs, co-located workers would be exposed to concentrations near or exceeding ERPG-2 concentrations. Persons exposed to these concentrations would not be impaired from evacuating.

E-5.4.1.4.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-17. Evaluation guidelines for an anticipated event are not exceeded. Exposure to the worker is a significant fraction of the guideline, and for a box loaded with 325 grams of fissile material, exposures would exceed the guideline associated with anticipated events. However, an accident with 325 grams would be in the unlikely frequency category, and the exposure would not exceed the guidelines associated with that category.

E-5.4.1.4.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls. The following paragraphs address the safety structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Safety-Class and Safety Significant Structures, Systems, and Components. Evaluation guidelines are not exceeded, and no safety-class or safety-significant structures, systems, and components are required.

Technical Safety Requirement Controls. The analysis identified a need for administrative controls to provide for appropriate procedures and training for handling and transporting waste. In addition, administrative controls were identified for handling and transporting waste in inclement weather.

Table E-5-16. Source term——dropped waste box outdoors during transfer.[a]

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radioactive materials							
ID-INL-152TN	Pu-238	1.25E+02	0.5	5.00E-04	1	0.01	3.11E-04
ID-INL-152TN	Pu-239	1.56E+02	0.5	5.00E-04	1	0.01	3.90E-04
ID-INL-152TN	Pu-240	8.21E+01	0.5	5.00E-04	1	0.01	2.05E-04
Hazardous materials							
ID-RFO-442T	Acetone	1.47E+04	0.5	5.00E-04	1	0.5	1.83E-00
ID-OFS-121T	Arsenic	1.38E+04	0.5	5.00E-04	1	0.5	1.72E-00
ID-RFO-338T	Asbestos	5.52E+05	0.5	5.00E-04	1	0.5	6.90E+01
ID-RFO-001T	Barium	1.68E+04	0.5	5.00E-04	1	0.5	2.10E-00
ID-RFO-442T	Benzene	1.47E+04	0.5	5.00E-04	1	0.5	1.83E-00
ID-RFO-000T	Beryllium	8.50E+03	0.5	5.00E-04	1	0.5	1.06E-00
ID-TAN-162	Butanone, 2-; (MEK)	0.00E+01	0.5	5.00E-04	1	0.5	0.00E+01
ID-RFO-978T	Butyl alcohol, n-	2.63E+04	0.5	5.00E-04	1	0.5	3.29E-00
ID-OFS-121T	Cadmium & compounds	1.38E+05	0.5	5.00E-04	1	0.5	1.72E+01
ID-RFO-003	Carbon tetrachloride	1.52E+05	0.5	5.00E-04	1	0.5	1.90E+01

ID-RFO-976	Chloroform	2.05E+04	0.5	5.00E-04	1	0.5	2.56E-00
ID-RFO-978T	Chromium	2.63E+04	0.5	5.00E-04	1	0.5	3.29E-00
ID-TAN-162	Dichlorobenzene, p-	0.00E+01	0.5	5.00E-04	1	0.5	0.00E+01
ID-RFO-480T	Ethyl benzene	1.44E+04	0.5	5.00E-04	1	0.5	1.80E-00
ID-AEO-100T	Ethyl ether	9.70E+03	0.5	5.00E-04	1	0.5	1.21E-00
ID-RFO-976	Ethylene dichloride	2.05E+04	0.5	5.00E-04	1	0.5	2.56E-00
ID-RFO-302T	Lead	7.93E+05	0.5	5.00E-04	1	0.5	9.92E+01
ID-RFO-118	Mercury (elemental & inorganic)	1.93E+02	0.5	5.00E-04	1	0.5	2.42E-02
ID-RFO-978T	Methyl alcohol	2.63E+04	0.5	5.00E-04	1	0.5	3.29E-00
ID-RFO-117	Methylene chloride	2.64E+04	0.5	5.00E-04	1	0.5	3.30E-00
ID-CPP-156	Nitric acid	1.22E+04	0.5	5.00E-04	1	0.5	1.53E-00
ID-RFO-003	Nitrobenzene	1.52E+04	0.5	5.00E-04	1	0.5	1.90E-00
ID-RFO-978T	Perchloroethylene	2.63E+04	0.5	5.00E-04	1	0.5	3.29E-00
ID-RFO-003	Polychlorinated biphenyl	7.65E+03	0.5	5.00E-04	1	0.5	9.56E-01
ID-RFO-005	Potassium nitrate	1.66E+06	0.5	5.00E-04	1	0.5	2.07E+02
ID-MDO-842	Selenium	2.08E+04	0.5	5.00E-04	1	0.5	2.60E-00
ID-MDO-842	Silver	2.08E+04	0.5	5.00E-04	1	0.5	2.60E-00
ID-RFO-442T	Toluene	1.47E+04	0.5	5.00E-04	1	0.5	1.83E-00
ID-RFO-003	Trichloroethane, 1,1,1-	4.55E+05	0.5	5.00E-04	1	0.5	5.69E+01
ID-RFO-978T	Trichloroethylene	2.63E+04	0.5	5.00E-04	1	0.5	3.29E-00
ID-RFO-003	Trichlorotrifluroethane	1.52E+05	0.5	5.00E-04	1	0.5	1.90E+01
ID-RFO-442T	Vinylidene chloride	1.47E+04	0.5	5.00E-04	1	0.5	1.83E-00
ID-RFO-978T	Xylene	2.63E+04	0.5	5.00E-04	1	0.5	3.29E-00

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d); DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility.

b. From BNFL (1998d).

Table E-5-17. Accident consequences–dropped waste box outdoors during transfer.[a]

	Locations			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary

Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	0.569	0.0201	0.00853	0.0104
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2
Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	0.19	2.1E-04	5.7E-05	7.6E-05
Beryllium				
Evaluation guideline mg/m^3	0.1	0.025	0.025	0.025
Calculated mg/m^3	0.0029	3.2E-06	8.8E-07	1.2E-06
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	0.046	5.2E-05	1.4E-05	1.9E-05
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25
Calculated mg/m^3	0.27	3.0E-04	8.2E-05	1.1E-04
Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	5.6E-4	3.1E-07	1.3E-07	1.6E-07
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	0.022	1.2E-05	5.2E-06	6.2E-06

a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation

guideline for the nearest INEEL site boundary.

c. As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of a dropped waste box outdoors during transfer include the following:

- Containers inspection for integrity before transfer
- Waste handling by trained and qualified equipment operators
- Waste handling and transfer equipment inspection for safe operation
- Hoisting and rigging procedures
- Technical safety requirements governing transportation at AMWTP
- Emergency preparedness planning
- Personal protective equipment.

E-5.4.1.5 Fire in TRU Waste in the TSA-RE.

E-5.4.1.5.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. Soil removal in the retrieval enclosure will occur in a batch mode and will uncover as much as 200 linear feet of wastes at a time. Exposed wastes are separated by earthen-covered berm fire barriers between cells at about every 100 feet (BNFL 1998d). The cells are typically configured with boxes in a perimeter around stacked drums. For standard waste boxes stacked 3 high and two deep, about 228 boxes would form the perimeter of a cell containing a nominal 10,000 drums. At the retrieval face of a typical cell, about 42 boxes are exposed. The overall MAR is assumed to be 228 boxes and 10,000 drums. The inventory of radioactive materials in the filters and ventilation system was conservatively represented by 500 grams of Pu-239.

The radioactive MAR is based on using the waste streams that would contribute the maximum dose. The relative radiation dose from each waste stream is ranked from greater doses to lesser doses. Beginning with the waste stream with the greatest dose and proceeding to the waste streams with lesser doses, the number of combustible boxes in each contributing waste stream is accumulated until enough waste streams have been accumulated to total 228 boxes. Similarly for drums, the number of drums in each contributing waste stream, either combustible or noncombustible, is accumulated until enough waste streams have been accumulated to total 10,000 drums. The radionuclide mass from each of these waste streams is summed to give the radioactive MAR for the scenario.

The hazardous MAR also consists of a box component and a drum component. The hazardous MAR is based on using the waste streams that would contribute the maximum quantity of each hazardous material. For each hazardous material identified in the PSAR (BNFL 1998d), the chemical concentration for boxes and drums is ranked from greatest to least. Beginning with the waste stream with the greatest concentration and proceeding to the waste streams with lesser concentrations, the number of combustible boxes in each contributing waste stream is accumulated until enough waste streams have been accumulated to total 228 boxes or until the supply of combustible boxes containing the chemical has been exhausted. Similarly for drums, the number of drums in each contributing waste stream, either combustible or noncombustible, is accumulated until enough waste streams have been accumulated to total 10,000 drums. The hazardous material mass from each of these waste streams is summed to give the maximum hazardous MAR for the scenario.

When exposed to heat and flame, halogenated compounds produce small quantities of phosgene compounds, and chlorinated hydrocarbons produce small quantities of halogenated acids. The analysis assumes that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire and that 10 percent of the chlorinated hydrocarbons in the MAR decompose to hydrochloric acid and 1 percent of the halogenated compounds convert to phosgene gas with a molecular conversion ratio of 1.19 (BNFL 1998d).

The resulting MAR represents a bounding case for any potential combination of containers and waste streams in the retrieval area. The likelihood of having the maximum amount of even one constituent in a single cell in the retrieval area is extremely unlikely.

Damage Ratio. Even in a severe fire scenario, it is unreasonable to postulate that all exposed containers in a cell would be involved in a fire. Metal boxes and fiberglass-reinforced boxes treated with fire retardant would be difficult to ignite and would interrupt the continuity of combustibles. While no credit was given to fire detection and suppression, these activities would also limit spread of the fire. To conservatively bound the fire, the equivalent of all the boxes along an entire retrieval face (42 boxes) are assumed ignited and completely consumed by fire. The burning boxes heat the top row of drums along the retrieval face (52 drums). Results of severe fire tests documented in Section 7.3.9.2 of DOE (1994) indicate that only a fraction of drums would be totally breached, some would be only partly breached (lid seal failure) and some would remain intact. From this information, 25 percent of the drums are conservatively estimated to release material.

The resulting DRs are:

- Box DR = 42/228 = 0.18
- Drum DR = 0.25 x 52/10,000 = 0.0013.

A DR of 1.0 is conservatively assumed for materials in the offgas ventilation system and HEPA filters. To incorporate the assumption that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire, the DR for halogenated compounds and chlorinated hydrocarbons is multiplied by 0.89 (BNFL 1998d).

Airborne Release Fraction. The bounding ARF for packaged waste is 5E-04 (Section 5.2.1.1 of DOE [1994]). The ARF is further defined in terms of combustibility. Using the data for individual waste streams allows the material to be identified as either combustible (combustibility index of 1 or 2 in the PSAR [BNFL 1998d]) or noncombustible (combustibility index of 3 in the PSAR [BNFL 1998d]). The boxed waste in the retrieval fire scenario is selected from only combustible waste streams while the drummed waste is selected from both combustible and noncombustible waste streams. The ARF for a fire in contained combustible, surface-contaminated waste is 5.0E-04 (Section 5.2.1.1 of DOE [1994]) and ARF for a fire in noncombustible surface contaminated waste is 6.0E-03 (Section 5.3.1 of DOE [1994]). Thus, for both radioactive and hazardous materials, an ARF of 5.0E-04 is used for combustible waste and an ARF of 6.0E-03 is used for noncombustible waste.

For the release from the ventilation system and HEPA filters, half of the contamination is assumed to reside in the ductwork, dampers, and plenums and the other half in the HEPA filters. The ARF from the ductwork is 4.0E-04 (Section 5.3.4 of DOE [1994]) and the ARF from HEPA failure is 5.0E-04 (Section 5.4.4.1 of DOE [1994]).

Respirable Fraction. Using the data for individual waste streams allows the material to be identified as either combustible (combustibility index of 1 or 2 in the PSAR [BNFL 1998d]) or noncombustible (combustibility index of 3 in the PSAR [BNFL 1998d]). RF for a fire in combustible surface-contaminated waste is 1.0 (Section 5.2.1.1 of DOE [1994]). RF for a fire in noncombustible surface contaminated waste is 0.01 (Section 5.3.1 of DOE [1994]).

Leakpath Factor. The accident occurs inside of the retrieval enclosure. Major failure of the building structure and the HEPA filters is assumed to occur. The LPF is 1.0. No credit is taken for either deposition within the building or fire containment by the fire detection and suppression systems.

Using the above factors, bounding source terms were developed for radiological and hazardous constituents as shown

in Table E-5-18 (BNFL 1998d). The source terms were applied to the unit- gram dose model for 50 percent and 95 percent meteorological conditions (BNFL 1998d). The consequences reported below select the higher exposures for 50 percent and 95 percent meteorological conditions.

E-5.4.1.5.2 Consequence Analysis¾ The source term is assumed released to the environment over one hour. The radiological and toxicological consequences to co-located workers and the public of the fire in the retrieval enclosure are summarized in Table E-5-19. Examination of the radiological consequences by individual radionuclides (BNFL 1998d) illustrates that nearly all of the consequences result from exposure to Pu-238 by way of the inhalation pathway. Pu-238 exists in less than 2 percent of the waste containers (BNFL 1998d). The six most limiting hazardous materials (in terms of a fraction of the ERPG value) are shown in Table E-5-19 (see the PSAR [BNFL 1998d] for all 33 materials analyzed).

E-5.4.1.5.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-19. The evaluation guidelines for an unlikely event are not exceeded.

E-5.4.1.5.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls, and defense in depth measures.

Safety-Class and Safety Significant Structures, Systems, and Components. Evaluation guidelines are not exceeded, and no safety-class structures, systems, or components are required. Exposures to workers inside the retrieval enclosure could occur unless immediate steps are taken to evacuate and wear respiratory protection upon warning from plant radiation monitoring systems or visual observation of the fire. Therefore, the following are safety-significant structures, systems, and components:

- Respiratory protection equipment
- Workplace radiation monitoring systems.

Technical Safety Requirement Controls. The analysis identified a need for an administrative control to provide for appropriate procedures and training for handling waste, and a limiting condition for operation to have the fire suppression system operable during retrieval activities.

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure.[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radioactive material from boxes							
ID-AEO-101T	Am-241	1.00E-01	0.18	5.00E-04	1	1	9.25E-06
ID-AEO-110T	Am-241	3.60E-01	0.18	5.00E-04	1	1	3.31E-05
ID-INL-155T	Am-241	2.33E+01	0.18	5.00E-04	1	1	2.15E-03
ID-RFO-119T	Am-241	4.05E-01	0.18	5.00E-04	1	1	3.73E-05
ID-RFO-335T	Am-241	3.64E-00	0.18	5.00E-04	1	1	3.35E-04
ID-RFO-337T	Am-241	1.33E+01	0.18	5.00E-04	1	1	1.23E-03
ID-RFO-338T	Am-241	5.27E-02	0.18	5.00E-04	1	1	4.85E-06
ID-RFO-339T	Am-241	9.66E-01	0.18	5.00E-	1	1	8.90E-05

				04			
ID-RFO-376T	Am-241	3.55E-00	0.18	5.00E-04	1	1	3.27E-04
ID-AEO-110T	Am-243	2.65E-02	0.18	5.00E-04	1	1	2.44E-06
ID-AEO-101T	Np-237	1.94E+02	0.18	5.00E-04	1	1	1.79E-02
ID-RFO-337T	Np-237	9.12E-01	0.18	5.00E-04	1	1	8.40E-05
ID-INL-152TN	Pu-238	1.37E+02	0.18	5.00E-04	1	1	1.27E-02
ID-INL-155T	Pu-238	1.30E-00	0.18	5.00E-04	1	1	1.20E-04
ID-MDO-824T	Pu-238	9.51E+02	0.18	5.00E-04	1	1	8.76E-02
ID-AEO-101T	Pu-239	7.23E+02	0.18	5.00E-04	1	1	6.66E-02
ID-AEO-110T	Pu-239	2.56E+02	0.18	5.00E-04	1	1	2.36E-02
ID-INL-152TN	Pu-239	1.72E+02	0.18	5.00E-04	1	1	1.59E-02
ID-INL-155T	Pu-239	2.92E+02	0.18	5.00E-04	1	1	2.69E-02
ID-MDO-824T	Pu-239	1.28E+03	0.18	5.00E-04	1	1	1.18E-01
Ductwork	Pu-239	1.25E+02	1	4.00E-05	1	1	5.00E-03
HEPA Filters	Pu-239	1.25E+02	1	5.00E-04	1	1	6.25E-02
ID-AEO-101T	Pu-240	2.35E+03	0.18	5.00E-04	1	1	2.17E-01
ID-INL-152TN	Pu-240	9.06E+01	0.18	5.00E-04	1	1	8.35E-03
ID-INL-155T	Pu-240	5.07E+01	0.18	5.00E-04	1	1	4.67E-03
ID-AEO-101T	Pu-241	4.80E-01	0.18	5.00E-04	1	1	4.42E-05
ID-AEO-110T	Pu-241	1.56E-00	0.18	5.00E-04	1	1	1.44E-04
ID-RFO-337T	Pu-242	2.60E-01	0.18	5.00E-04	1	1	2.40E-05
ID-RFO-119T	Pu-52	8.94E+02	0.18	5.00E-04	1	1	8.24E-02
ID-RFO-311TN	Pu-52	8.14E+02	0.18	5.00E-04	1	1	7.49E-02
ID-RFO-335T	Pu-52	7.78E+02	0.18	5.00E-04	1	1	7.17E-02
ID-RFO-337T	Pu-52	4.29E+02	0.18	5.00E-04	1	1	3.95E-02
ID-RFO-338T	Pu-52	1.71E+03	0.18	5.00E-04	1	1	1.57E-01
ID-RFO-339T	Pu-52	1.60E+03	0.18	5.00E-04	1	1	1.47E-01
ID-RFO-376T	Pu-52	2.98E+03	0.18	5.00E-04	1	1	2.75E-01
ID-MDO-824T	Pu-83	9.09E-00	0.18	5.00E-04	1	1	8.38E-04
ID-INL-155T	Th-232	4.78E+03	0.18	5.00E-04	1	1	4.40E-01
ID-AEO-101T	U-235	1.00E-00	0.18	5.00E-04	1	1	9.21E-05
ID-INL-155T	U-235	1.11E+02	0.18	5.00E-04	1	1	1.02E-02
ID-RFO-119T	U-235	2.84E-00	0.18	5.00E-04	1	1	2.61E-04
ID-RFO-335T	U-235	1.69E+01	0.18	5.00E-04	1	1	1.56E-03

ID-RFO-337T	U-235	1.17E-00	0.18	5.00E-04	1	1	1.08E-04
ID-RFO-376T	U-235	3.03E-00	0.18	5.00E-04	1	1	2.79E-04
ID-AEO-101T	U-238	3.06E+04	0.18	5.00E-04	1	1	2.81E-00
ID-RFO-376T	U-238	9.21E-00	0.18	5.00E-04	1	1	8.49E-04
Radioactive materials from drums							
ID-MDO-802T	Am-241	4.00E-01	0.0013	0.0005	1	1	2.60E-07
ID-MDO-803T	Am-241	1.00E-01	0.0013	0.006	0.01	1	7.80E-09
ID-RFO-001T	Am-241	1.44E+04	0.0013	0.006	0.01	1	1.12E-03
ID-RFO-005T	Am-241	7.20E-00	0.0013	0.006	0.01	1	5.62E-07

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-391TN	Am-241	9.07E+01	0.0013	0.006	0.01	1	7.07E-06
ID-RFO-393TN	Am-241	3.65E-02	0.0013	0.0005	1	1	2.37E-08
ID-RFO-409T	Am-241	2.17E+02	0.0013	0.006	0.01	1	1.69E-05
ID-RFO-414T	Am-241	2.60E-02	0.0013	0.006	0.01	1	2.03E-09
ID-RFO-416TN	Am-241	3.10E+01	0.0013	0.006	0.01	1	2.42E-06
ID-BTO-015TN	Pu-238	4.70E-00	0.0013	0.006	0.01	1	3.67E-07
ID-INL-152TN	Pu-238	7.49E+01	0.0013	0.0005	1	1	4.87E-05
ID-MDO-801T	Pu-238	2.76E+01	0.0013	0.0005	1	1	1.79E-05
ID-MDO-802T	Pu-238	1.47E+02	0.0013	0.0005	1	1	9.57E-05
ID-MDO-803T	Pu-238	1.42E+03	0.0013	0.006	0.01	1	1.11E-04
ID-MDO-804TN	Pu-238	2.73E+02	0.0013	0.0005	1	1	1.78E-04
ID-MDO-805T	Pu-238	2.61E+02	0.0013	0.0005	1	1	1.69E-04
ID-MDO-810T	Pu-238	9.58E+01	0.0013	0.006	0.01	1	7.47E-06
ID-MDO-811T	Pu-238	3.90E+01	0.0013	0.006	0.01	1	3.04E-06
ID-MDO-813T	Pu-238	2.85E+01	0.0013	0.0005	1	1	1.85E-05
ID-MDO-815T	Pu-238	8.00E-01	0.0013	0.006	0.01	1	6.24E-08
ID-MDO-825TN	Pu-238	1.24E+02	0.0013	0.006	0.01	1	9.66E-06
ID-MDO-836T	Pu-238	1.59E+01	0.0013	0.006	0.01	1	1.24E-06
ID-MDO-848T	Pu-238	8.30E-00	0.0013	0.006	0.01	1	6.47E-07
ID-AEO-106T	Pu-239	1.96E+02	0.0013	0.006	0.01	1	1.53E-05
ID-BTO-030	Pu-239	1.56E-01	0.0013	0.006	0.01	1	1.21E-08
ID-INL-152TN	Pu-239	9.40E+01	0.0013	0.0005	1	1	6.11E-05
ID-MDO-802T	Pu-239	2.89E+02	0.0013	0.0005	1	1	1.88E-04
ID-MDO-803T	Pu-239	2.71E+03	0.0013	0.006	0.01	1	2.11E-04
ID-MDO-805T	Pu-239	4.35E+02	0.0013	0.0005	1	1	2.83E-04
ID-MDO-810T	Pu-239	1.90E+02	0.0013	0.006	0.01	1	1.48E-05
ID-MDO-811T	Pu-239	8.00E+01	0.0013	0.006	0.01	1	6.24E-06
ID-MDO-813T	Pu-239	7.00E+01	0.0013	0.0005	1	1	4.55E-05
ID-MDO-814T	Pu-239	1.11E+02	0.0013	0.006	0.01	1	8.66E-06
ID-MDO-825TN	Pu-239	2.01E+02	0.0013	0.006	0.01	1	1.57E-05
ID-MDO-848T	Pu-239	1.00E-00	0.0013	0.006	0.01	1	7.80E-08
Ductwork	Pu-239	1.25E+02	1	4.00E-05	1	1	5.00E-03
HEPA Filters	Pu-239	1.25E+02	1	5.00E-04	1	1	6.25E-02
ID-AEO-106T	Pu-240	1.64E+02	0.0013	0.006	0.01	1	1.28E-05
ID-INL-152TN	Pu-240	4.94E+01	0.0013	0.0005	1	1	3.21E-05
ID-MDO-802T	Pu-240	1.70E+02	0.0013	0.0005	1	1	1.11E-04
ID-MDO-814T	Pu-240	7.00E+01	0.0013	0.006	0.01	1	5.46E-06

ID-MDO-825TN	Pu-240	1.14E+01	0.0013	0.006	0.01	1	8.91E-07
ID-MDO-825TN	Pu-52	3.01E-01	0.0013	0.006	0.01	1	2.35E-08
ID-RFO-001T	Pu-52	3.77E+04	0.0013	0.006	0.01	1	2.94E-03
ID-RFO-005T	Pu-52	5.40E-00	0.0013	0.006	0.01	1	4.21E-07
ID-RFO-361TN	Pu-52	1.99E+02	0.0013	0.006	0.01	1	1.55E-05
ID-RFO-375T	Pu-52	3.07E+02	0.0013	0.006	0.01	1	2.39E-05
ID-RFO-391TN	Pu-52	1.07E+03	0.0013	0.006	0.01	1	8.31E-05
ID-RFO-392TN	Pu-52	1.23E+03	0.0013	0.006	0.01	1	9.62E-05
ID-RFO-393TN	Pu-52	7.00E+03	0.0013	0.0005	1	1	4.55E-03
ID-RFO-409T	Pu-52	4.08E+03	0.0013	0.006	0.01	1	3.18E-04
ID-RFO-411TN	Pu-52	6.36E+02	0.0013	0.006	0.01	1	4.96E-05
ID-RFO-414T	Pu-52	7.66E+02	0.0013	0.006	0.01	1	5.97E-05
ID-RFO-416TN	Pu-52	1.70E+02	0.0013	0.006	0.01	1	1.33E-05
ID-RFO-421TN	Pu-52	1.78E+04	0.0013	0.006	0.01	1	1.39E-03

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-430T	Pu-52	2.72E+03	0.0013	0.0005	1	1	1.77E-03
ID-MDO-801T	Pu-83	4.43E-01	0.0013	0.0005	1	1	2.88E-07
ID-MDO-803T	Pu-83	6.58E+01	0.0013	0.006	0.01	1	5.13E-06
ID-MDO-825TN	Pu-83	1.74E+01	0.0013	0.006	0.01	1	1.35E-06
ID-MDO-836T	Pu-83	5.57E-01	0.0013	0.006	0.01	1	4.34E-08
ID-BTO-030	Th-232	1.07E+06	0.0013	0.006	0.01	1	8.37E-02
ID-BTO-030	U-233	6.14E+03	0.0013	0.006	0.01	1	4.79E-04
Hazardous materials from boxes							
ID-AEO-110T	Acetone	1.03E+04	0.18	5.00E-04	1	1	9.49E-01
ID-RFO-337	Acetone	3.80E+04	0.18	5.00E-04	1	1	3.50E-00
ID-RFO-339T	Acetone	3.50E+04	0.18	5.00E-04	1	1	3.22E-00
ID-RFO-337T	Acetone	5.90E+04	0.18	5.00E-04	1	1	5.43E-00
ID-RFO-336	Acetone	1.80E+05	0.18	5.00E-04	1	1	1.66E+01
ID-RFO-336T	Acetone	1.38E+06	0.18	5.00E-04	1	1	1.27E+02
ID-RFO-335T	Acetone	3.30E+04	0.18	5.00E-04	1	1	3.04E-00
ID-AEO-110T	Arsenic	1.03E+04	0.18	5.00E-04	1	1	9.49E-01
ID-RFO-338T	Asbestos	2.76E+06	0.18	5.00E-04	1	1	2.54E+02
ID-RFO-338	Asbestos	3.92E+07	0.18	5.00E-04	1	1	3.61E+03
ID-RFO-360	Asbestos	5.04E+05	0.18	5.00E-04	1	1	4.64E+01
ID-RFO-490T	Asbestos	6.36E+07	0.18	5.00E-04	1	1	5.86E+03
ID-MDO-824T	Barium	1.35E+06	0.18	5.00E-04	1	1	1.24E+02
ID-RFO-337	Benzene	3.80E+04	0.18	5.00E-04	1	1	3.50E-00
ID-RFO-338T	Benzene	4.60E+04	0.18	5.00E-04	1	1	4.24E-00
ID-RFO-338	Benzene	6.53E+05	0.18	5.00E-04	1	1	6.01E+01
ID-RFO-339T	Benzene	3.50E+04	0.18	5.00E-04	1	1	3.22E-00

ID-RFO-330	Benzene	1.22E+06	0.18	5.00E-04	1	1	1.12E+02
ID-RFO-000T	Beryllium	6.76E+05	0.18	5.00E-04	1	1	6.23E+01
ID-CPP-156	Butyl alcohol, n-	1.10E+05	0.18	5.00E-04	1	1	1.01E+01
ID-RFO-000T	Butyl alcohol, n-	6.76E+05	0.18	5.00E-04	1	1	6.23E+01
ID-BCO-202	Butyl alcohol, n-	2.76E+04	0.18	5.00E-04	1	1	2.54E-00
ID-INL-155	Butyl alcohol, n-	6.80E+02	0.18	5.00E-04	1	1	6.26E-02
ID-MDO-824T	Cadmium & compounds	1.35E+06	0.18	5.00E-04	1	1	1.24E+02
ID-AEO-110T	Cadmium & compounds	1.03E+04	0.18	5.00E-04	1	1	9.49E-01
ID-RFO-000T	Cadmium & compounds	6.76E+05	0.18	5.00E-04	1	1	6.23E+01
ID-CPP-156	Carbon tetrachloride	1.10E+06	0.16	5.00E-04	1	1	9.02E+01
ID-RFO-000T	Carbon tetrachloride	6.76E+06	0.16	5.00E-04	1	1	5.54E+02
ID-BCO-202	Carbon tetrachloride	2.76E+05	0.16	5.00E-04	1	1	2.26E+01
ID-RFO-302T	Carbon tetrachloride	1.19E+05	0.16	5.00E-04	1	1	9.75E-00
ID-RFO-376	Carbon tetrachloride	3.90E+04	0.16	5.00E-04	1	1	3.20E-00
ID-RFO-302	Carbon tetrachloride	2.99E+05	0.16	5.00E-04	1	1	2.45E+01
ID-RFO-116	Carbon tetrachloride	1.69E+06	0.16	5.00E-04	1	1	1.38E+02
ID-RFO-337	Chloroform	3.80E+04	0.16	5.00E-04	1	1	3.12E-00
ID-RFO-338T	Chloroform	4.60E+04	0.16	5.00E-04	1	1	3.77E-00
ID-RFO-338	Chloroform	6.53E+05	0.16	5.00E-04	1	1	5.35E+01
ID-RFO-339T	Chloroform	3.50E+04	0.16	5.00E-04	1	1	2.87E-00
ID-RFO-330	Chloroform	1.22E+06	0.16	5.00E-04	1	1	9.99E+01
ID-MDO-824T	Chromium	1.35E+06	0.18	5.00E-04	1	1	1.24E+02
ID-RFO-337	Ethyl benzene	3.80E+04	0.18	5.00E-04	1	1	3.50E-00
ID-RFO-339T	Ethyl benzene	3.50E+04	0.18	5.00E-04	1	1	3.22E-00
ID-RFO-330	Ethyl benzene	1.89E+06	0.18	5.00E-04	1	1	1.74E+02
ID-AEO-100T	Ethyl ether	2.21E+06	0.18	5.00E-04	1	1	2.04E+02

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-338T	Ethylene dichloride	4.60E+04	0.16	5.00E-04	1	1	3.77E-00
ID-RFO-338	Ethylene dichloride	6.53E+05	0.16	5.00E-04	1	1	5.35E+01
ID-RFO-339T	Ethylene dichloride	3.50E+04	0.16	5.00E-04	1	1	2.87E-00
ID-RFO-335T	Ethylene dichloride	3.30E+04	0.16	5.00E-04	1	1	2.71E-00
ID-RFO-302T	Lead	4.76E+06	0.18	5.00E-04	1	1	4.38E+02

ID-RFO-302	Lead	1.20E+07	0.18	5.00E-04	1	1	1.10E+03
ID-RFO-339T	Lead	2.10E+06	0.18	5.00E-04	1	1	1.93E+02
ID-INL-155T	Lead	1.53E+06	0.18	5.00E-04	1	1	1.41E+02
ID-BCO-202T	Lead	2.07E+05	0.18	5.00E-04	1	1	1.91E+01
ID-AEO-101T	Lead	7.20E+06	0.18	5.00E-04	1	1	6.63E+02
ID-BCO-201T	Lead	1.90E+06	0.18	5.00E-04	1	1	1.75E+02
ID-BCO-201	Lead	2.61E+06	0.18	5.00E-04	1	1	2.40E+02
ID-AEO-104T	Lead	5.60E+05	0.18	5.00E-04	1	1	5.16E+01
ID-AEO-104	Lead	1.10E+05	0.18	5.00E-04	1	1	1.01E+01
ID-AEO-101	Lead	1.04E+06	0.18	5.00E-04	1	1	9.62E+01
ID-RFO-000T	Lead	5.72E+06	0.18	5.00E-04	1	1	5.27E+02
ID-MDO-826	Mercury (elemental & inorganic)	3.22E+02	0.18	5.00E-04	1	1	2.97E-02
ID-MDO-826T	Mercury (elemental & inorganic)	2.69E+03	0.18	5.00E-04	1	1	2.47E-01
ID-MDO-824T	Mercury (elemental & inorganic)	3.76E+02	0.18	5.00E-04	1	1	3.46E-02
ID-CPP-156	Methyl alcohol	1.10E+05	0.18	5.00E-04	1	1	1.01E+01
ID-RFO-337	Methyl alcohol	3.80E+04	0.18	5.00E-04	1	1	3.50E-00
ID-RFO-000T	Methyl alcohol	6.76E+05	0.18	5.00E-04	1	1	6.23E+01
ID-RFO-337T	Methyl alcohol	5.90E+04	0.18	5.00E-04	1	1	5.43E-00
ID-BCO-202	Methyl alcohol	2.76E+04	0.18	5.00E-04	1	1	2.54E-00
ID-INL-155	Methyl alcohol	6.80E+02	0.18	5.00E-04	1	1	6.26E-02
ID-RFO-376	Methylene chloride	3.90E+04	0.16	5.00E-04	1	1	3.20E-00
ID-RFO-116T	Methylene chloride	3.30E+06	0.16	5.00E-04	1	1	2.71E+02
ID-CPP-156	Nitric acid	1.10E+05	0.18	5.00E-04	1	1	1.01E+01
ID-RFO-000T	Nitric acid	6.76E+05	0.18	5.00E-04	1	1	6.23E+01
ID-BCO-202	Nitric acid	2.76E+04	0.18	5.00E-04	1	1	2.54E-00
ID-INL-155	Nitric acid	6.80E+02	0.18	5.00E-04	1	1	6.26E-02
ID-RFO-337	Perchloroethylene	3.80E+04	0.16	5.00E-04	1	1	3.12E-00
ID-RFO-338T	Perchloroethylene	4.60E+04	0.16	5.00E-04	1	1	3.77E-00
ID-RFO-338	Perchloroethylene	6.53E+05	0.16	5.00E-04	1	1	5.35E+01
ID-RFO-330	Perchloroethylene	1.25E+06	0.16	5.00E-04	1	1	1.03E+02
ID-RFO-000T	Polychlorinated biphenyl	5.68E+04	0.16	5.00E-04	1	1	4.66E-00
ID-MDO-824T	Selenium	1.35E+06	0.18	5.00E-04	1	1	1.24E+02
ID-MDO-824T	Silver	1.35E+06	0.18	5.00E-04	1	1	1.24E+02
ID-RFO-337	Toluene	3.80E+04	0.18	5.00E-	1	1	3.50E-00

				04			
ID-RFO-338T	Toluene	4.60E+04	0.18	5.00E-04	1	1	4.24E-00
ID-RFO-338	Toluene	6.53E+05	0.18	5.00E-04	1	1	6.01E+01
ID-RFO-339T	Toluene	3.50E+04	0.18	5.00E-04	1	1	3.22E-00
ID-RFO-330	Toluene	1.22E+06	0.18	5.00E-04	1	1	1.12E+02
ID-RFO-302T	Trichloroethane, 1,1,1-	1.19E+05	0.16	5.00E-04	1	1	9.75E-00
ID-RFO-376	Trichloroethane, 1,1,1-	3.90E+04	0.16	5.00E-04	1	1	3.20E-00
ID-RFO-302	Trichloroethane, 1,1,1-	2.99E+05	0.16	5.00E-04	1	1	2.45E+01
ID-RFO-116	Trichloroethane, 1,1,1-	1.79E+06	0.16	5.00E-04	1	1	1.47E+02
ID-RFO-116T	Trichloroethane, 1,1,1	1.26E+06	0.16	5.00E-04	1	1	1.03E+02
ID-RFO-302T	Trichloroethylene	1.19E+05	0.16	5.00E-04	1	1	9.75E-00
ID-RFO-302	Trichloroethylene	2.99E+05	0.16	5.00E-04	1	1	2.45E+01
ID-RFO-116	Trichloroethylene	1.79E+06	0.16	5.00E-04	1	1	1.47E+02

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-116T	Trichloroethylene	1.29E+06	0.16	5.00E-04	1	1	1.05E+02
ID-RFO-376	Trichlorotrifluroethane	3.90E+04	0.16	5.00E-04	1	1	3.20E-00
ID-RFO-116	Trichlorotrifluroethane	1.79E+06	0.16	5.00E-04	1	1	1.47E+02
ID-RFO-116T	Trichlorotrifluroethane	1.59E+06	0.16	5.00E-04	1	1	1.31E+02
ID-RFO-337	Vinylidene chloride	3.80E+04	0.16	5.00E-04	1	1	3.12E-00
ID-RFO-338T	Vinylidene chloride	4.60E+04	0.16	5.00E-04	1	1	3.77E-00
ID-RFO-338	Vinylidene chloride	6.53E+05	0.16	5.00E-04	1	1	5.35E+01
ID-RFO-339T	Vinylidene chloride	3.50E+04	0.16	5.00E-04	1	1	2.87E-00
ID-RFO-330	Vinylidene chloride	1.22E+06	0.16	5.00E-04	1	1	9.99E+01
ID-CPP-156	Xylene	1.10E+05	0.18	5.00E-04	1	1	1.01E+01
ID-RFO-970T	Xylene	3.30E+05	0.18	5.00E-04	1	1	3.04E+01
ID-RFO-970	Xylene	2.66E+05	0.18	5.00E-04	1	1	2.45E+01
ID-RFO-337	Xylene	3.80E+04	0.18	5.00E-04	1	1	3.50E-00
ID-RFO-339T	Xylene	3.50E+04	0.18	5.00E-04	1	1	3.22E-00
ID-RFO-900	Xylene	5.18E+04	0.18	5.00E-04	1	1	4.77E-00
ID-RFO-330	Xylene	1.23E+06	0.18	5.00E-04	1	1	1.13E+02
Hazardous materials from drums							
ID-MDO-836T	Acetone	7.50E+04	0.0013	0.006	0.01	1	5.85E-03
ID-MDO-836	Acetone	1.19E+07	0.0013	0.006	0.01	1	9.28E-01

ID-TAN-162	Acetone	7.12E+04	0.0013	0.006	0.01	1	5.55E-03
ID-RFO-339T	Acetone	1.05E+06	0.0013	0.0005	1	1	6.82E-01
ID-AEO-110T	Acetone	3.00E+03	0.0013	0.0005	1	1	1.95E-03
ID-RFO-339	Acetone	3.40E+04	0.0013	0.0005	1	1	2.21E-02
ID-RFO-480	Acetone	1.70E+06	0.0013	0.006	0.01	1	1.33E-01
ID-RFO-480T	Acetone	1.10E+06	0.0013	0.006	0.01	1	8.58E-02
ID-RFO-442T	Acetone	5.38E+05	0.0013	0.006	0.01	1	4.19E-02
ID-RFO-336	Acetone	1.72E+06	0.0013	0.0005	1	1	1.12E-00
ID-OFS-111	Arsenic	2.90E+06	0.0013	0.006	0.01	1	2.26E-01
ID-TAN-162	Arsenic	7.12E+04	0.0013	0.006	0.01	1	5.55E-03
ID-OFS-111T	Arsenic	5.35E+06	0.0013	0.006	0.01	1	4.18E-01
ID-AEO-110T	Arsenic	3.00E+03	0.0013	0.0005	1	1	1.95E-03
ID-AEO-120T	Arsenic	1.50E+03	0.0013	0.0005	1	1	9.75E-04
ID-OFS-121	Arsenic	4.40E+02	0.0013	0.006	0.01	1	3.43E-05
ID-RFO-338	Asbestos	2.04E+06	0.0013	0.0005	1	1	1.33E-00
ID-RFO-338T	Asbestos	9.44E+06	0.0013	0.0005	1	1	6.13E-00
ID-RFO-490	Asbestos	3.40E+05	0.0013	0.0005	1	1	2.21E-01
ID-RFO-335	Asbestos	3.30E+06	0.0013	0.0005	1	1	2.15E-00
ID-RFO-490T	Asbestos	2.82E+06	0.0013	0.0005	1	1	1.83E-00
ID-RFO-335T	Asbestos	1.93E+06	0.0013	0.0005	1	1	1.26E-00
ID-RFO-360T	Asbestos	6.24E+05	0.0013	0.0005	1	1	4.06E-01
ID-RFO-360	Asbestos	8.68E+06	0.0013	0.0005	1	1	5.64E-00
ID-RFO-119T	Asbestos	7.86E+06	0.0013	0.0005	1	1	5.11E-00
ID-MDO-805T	Asbestos	1.25E+06	0.0013	0.0005	1	1	8.13E-01
ID-RFO-119	Asbestos	2.85E+06	0.0013	0.0005	1	1	1.85E-00
ID-RFO-376T	Asbestos	1.69E+07	0.0013	0.0005	1	1	1.10E+01
ID-RFO-376	Asbestos	3.20E+06	0.0013	0.0005	1	1	2.08E-00
ID-RFO-002	Barium	4.10E+06	0.0013	0.006	0.01	1	3.20E-01
ID-RFO-003T	Barium	6.23E+06	0.0013	0.006	0.01	1	4.86E-01
ID-RFO-002T	Barium	1.33E+07	0.0013	0.006	0.01	1	1.03E-00
ID-RFO-339T	Benzene	1.05E+06	0.0013	0.0005	1	1	6.82E-01
ID-RFO-339	Benzene	3.40E+04	0.0013	0.0005	1	1	2.21E-02
ID-RFO-300T	Benzene	2.05E+06	0.0013	0.006	0.01	1	1.60E-01

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-480	Benzene	1.70E+06	0.0013	0.006	0.01	1	1.33E-01
ID-RFO-300	Benzene	9.60E+04	0.0013	0.006	0.01	1	7.49E-03
ID-RFO-480T	Benzene	1.10E+06	0.0013	0.006	0.01	1	8.58E-02
ID-RFO-330T	Benzene	8.72E+05	0.0013	0.0005	1	1	5.66E-01
ID-RFO-442T	Benzene	5.38E+05	0.0013	0.006	0.01	1	4.19E-02
ID-RFO-442	Benzene	5.50E+05	0.0013	0.006	0.01	1	4.29E-02
ID-RFO-330	Benzene	2.14E+06	0.0013	0.0005	1	1	1.39E-00
ID-RFO-9999	Beryllium	1.04E+07	0.0013	0.0005	1	1	6.74E-00
ID-TAN-162	Butanone, 2-; (MEK)	7.12E+04	0.0013	0.006	0.01	1	5.55E-03
ID-OFS-111	Butyl alcohol, n-	5.80E+06	0.0013	0.006	0.01	1	4.52E-01
ID-OFS-111T	Butyl alcohol, n-	1.07E+07	0.0013	0.006	0.01	1	8.35E-01
ID-RFO-113	Butyl alcohol, n-	3.60E+04	0.0013	0.006	0.01	1	2.81E-03
ID-RFO-113T	Butyl alcohol, n-	1.97E+05	0.0013	0.006	0.01	1	1.54E-02
ID-RFO-090	Butyl alcohol, n-	3.80E+05	0.0013	0.006	0.01	1	2.96E-02
ID-RFO-004T	Butyl alcohol, n-	2.85E+06	0.0013	0.006	0.01	1	2.23E-01

ID-RFO-004	Butyl alcohol, n-	1.30E+06	0.0013	0.006	0.01	1	1.01E-01
ID-RFO-990	Butyl alcohol, n-	1.20E+06	0.0013	0.006	0.01	1	9.36E-02
ID-RFO-002	Butyl alcohol, n-	4.10E+06	0.0013	0.006	0.01	1	3.20E-01
ID-BCO-204	Butyl alcohol, n-	7.29E+03	0.0013	0.006	0.01	1	5.69E-04
ID-RFO-002T	Butyl alcohol, n-	5.10E+06	0.0013	0.006	0.01	1	3.98E-01
ID-OFS-111	Cadmium & compounds	5.80E+06	0.0013	0.006	0.01	1	4.52E-01
ID-OFS-121	Cadmium & compounds	4.40E+03	0.0013	0.006	0.01	1	3.43E-04
ID-OFS-111T	Cadmium & compounds	1.07E+07	0.0013	0.006	0.01	1	8.35E-01
ID-MDO-836T	Cadmium & compounds	7.50E+04	0.0013	0.006	0.01	1	5.85E-03
ID-MDO-836	Cadmium & compounds	1.19E+07	0.0013	0.006	0.01	1	9.28E-01
ID-RFO-004T	Cadmium & compounds	2.85E+06	0.0013	0.006	0.01	1	2.23E-01
ID-RFO-004	Cadmium & compounds	1.30E+06	0.0013	0.006	0.01	1	1.01E-01
ID-RFO-002	Cadmium & compounds	8.86E+05	0.0013	0.006	0.01	1	6.91E-02
ID-RFO-112T	Carbon tetrachloride	1.92E+07	0.0012	0.006	0.01	1	1.33E-00
ID-BCO-204	Carbon tetrachloride	7.29E+04	0.0012	0.006	0.01	1	5.06E-03
ID-RFO-003T	Carbon tetrachloride	6.23E+07	0.0012	0.006	0.01	1	4.33E-00
ID-RFO-003	Carbon tetrachloride	1.00E+08	0.0012	0.006	0.01	1	6.94E-00
ID-RFO-112	Carbon tetrachloride	4.30E+05	0.0012	0.006	0.01	1	2.99E-02
ID-MDO-838	Carbon tetrachloride	1.50E+04	0.0012	0.0005	1	1	8.68E-03
ID-INL-155	Carbon tetrachloride	7.60E+04	0.0012	0.0005	1	1	4.40E-02
ID-MDO-847	Carbon tetrachloride	8.47E+06	0.0012	0.0005	1	1	4.90E-00
ID-AEO-102	Carbon tetrachloride	5.00E+05	0.0012	0.006	0.01	1	3.47E-02
ID-RFO-9999	Carbon tetrachloride	1.24E+07	0.0012	0.0005	1	1	7.15E-00
ID-RFO-112T	Chloroform	1.92E+07	0.0012	0.006	0.01	1	1.33E-00
ID-RFO-112	Chloroform	4.30E+05	0.0012	0.006	0.01	1	2.99E-02
ID-RFO-700T	Chloroform	2.40E+04	0.0012	0.006	0.01	1	1.67E-03
ID-RFO-002	Chloroform	4.10E+06	0.0012	0.006	0.01	1	2.85E-01
ID-RFO-002T	Chloroform	1.40E+07	0.0012	0.006	0.01	1	9.73E-01
ID-RFO-007T	Chloroform	3.25E+06	0.0012	0.006	0.01	1	2.26E-01
ID-MDO-836T	Chromium	7.50E+04	0.0013	0.006	0.01	1	5.85E-03
ID-MDO-836	Chromium	1.19E+07	0.0013	0.006	0.01	1	9.28E-01
ID-RFO-002	Chromium	4.10E+06	0.0013	0.006	0.01	1	3.20E-01
ID-RFO-002T	Chromium	9.64E+06	0.0013	0.006	0.01	1	7.52E-01
ID-TAN-162	Dichlorobenzene, p-	7.12E+04	0.0012	0.006	0.01	1	4.94E-03
ID-OFS-111T	Ethyl benzene	1.07E+07	0.0013	0.006	0.01	1	8.35E-01

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-OFS-111	Ethyl benzene	2.90E+06	0.0013	0.006	0.01	1	2.26E-01
ID-RFO-339T	Ethyl benzene	1.05E+06	0.0013	0.0005	1	1	6.82E-01
ID-RFO-339	Ethyl benzene	3.40E+04	0.0013	0.0005	1	1	2.21E-02
ID-RFO-480	Ethyl benzene	1.70E+06	0.0013	0.006	0.01	1	1.33E-01
ID-RFO-480T	Ethyl benzene	1.10E+06	0.0013	0.006	0.01	1	8.58E-02
ID-RFO-330T	Ethyl benzene	8.72E+05	0.0013	0.0005	1	1	5.66E-01
ID-RFO-330	Ethyl benzene	1.53E+06	0.0013	0.0005	1	1	9.96E-01
ID-AEO-100T	Ethyl ether	1.20E+03	0.0013	0.0005	1	1	7.80E-04
ID-RFO-002	Ethylene dichloride	4.10E+06	0.0012	0.006	0.01	1	2.85E-01
ID-RFO-002T	Ethylene dichloride	1.40E+07	0.0012	0.006	0.01	1	9.73E-01
ID-RFO-007T	Ethylene dichloride	4.82E+06	0.0012	0.006	0.01	1	3.35E-01
ID-OFS-111	Ethylene dichloride	2.25E+05	0.0012	0.006	0.01	1	1.56E-02
ID-RFO-463T	Lead	5.03E+06	0.0013	0.0005	1	1	3.27E-00
ID-RFO-339T	Lead	6.29E+07	0.0013	0.0005	1	1	4.09E+01
ID-RFO-339	Lead	2.04E+06	0.0013	0.0005	1	1	1.33E-00

ID-BCO-204T	Lead	2.91E+05	0.0013	0.006	0.01	1	2.27E-02
ID-RFO-463	Lead	2.82E+05	0.0013	0.0005	1	1	1.83E-01
ID-RFO-464	Lead	9.60E+05	0.0013	0.0005	1	1	6.24E-01
ID-RFO-302	Lead	3.36E+05	0.0013	0.0005	1	1	2.18E-01
ID-RFO-464T	Lead	1.32E+06	0.0013	0.0005	1	1	8.61E-01
ID-RFO-302T	Lead	6.26E+05	0.0013	0.0005	1	1	4.07E-01
ID-INL-155T	Lead	3.42E+05	0.0013	0.0005	1	1	2.22E-01
ID-MDO-847T	Lead	6.90E+05	0.0013	0.0005	1	1	4.49E-01
ID-AEO-102T	Lead	1.97E+06	0.0013	0.006	0.01	1	1.54E-01
ID-MDO-848T	Lead	1.74E+05	0.0013	0.006	0.01	1	1.36E-02
ID-BCO-202T	Lead	6.90E+04	0.0013	0.0005	1	1	4.49E-02
ID-BCO-201T	Lead	6.01E+05	0.0013	0.0005	1	1	3.91E-01
ID-RFO-481T	Lead	9.49E+06	0.0013	0.006	0.01	1	7.40E-01
ID-RFO-320	Lead	1.70E+06	0.0013	0.006	0.01	1	1.33E-01
ID-RFO-481	Lead	2.40E+06	0.0013	0.006	0.01	1	1.87E-01
ID-RFO-123T	Lead	3.69E+06	0.0013	0.0005	1	1	2.40E-00
ID-RFO-117	Lead	4.30E+05	0.0013	0.006	0.01	1	3.35E-02
ID-RFO-480	Lead	1.70E+07	0.0013	0.006	0.01	1	1.33E-00
ID-RFO-123	Lead	1.20E+05	0.0013	0.0005	1	1	7.80E-02
ID-RFO-480T	Lead	1.10E+07	0.0013	0.006	0.01	1	8.58E-01
ID-RFO-9999	Lead	5.27E+07	0.0013	0.0005	1	1	3.43E+01
ID-RFO-002	Mercury (elemental & inorganic)	8.81E+05	0.0013	0.006	0.01	1	6.87E-02
ID-RFO-002T	Mercury (elemental & inorganic)	3.01E+06	0.0013	0.006	0.01	1	2.35E-01
ID-OFS-111	Mercury (elemental & inorganic)	6.23E+04	0.0013	0.006	0.01	1	4.86E-03
ID-OFS-111T	Mercury (elemental & inorganic)	4.19E+04	0.0013	0.006	0.01	1	3.27E-03
ID-RFO-113	Methyl alcohol	3.60E+04	0.0013	0.006	0.01	1	2.81E-03
ID-RFO-113T	Methyl alcohol	1.97E+05	0.0013	0.006	0.01	1	1.54E-02
ID-MDO-836T	Methyl alcohol	7.50E+04	0.0013	0.006	0.01	1	5.85E-03
ID-MDO-836	Methyl alcohol	1.19E+07	0.0013	0.006	0.01	1	9.28E-01
ID-RFO-090	Methyl alcohol	3.80E+05	0.0013	0.006	0.01	1	2.96E-02
ID-RFO-004T	Methyl alcohol	2.85E+06	0.0013	0.006	0.01	1	2.23E-01
ID-RFO-004	Methyl alcohol	1.30E+06	0.0013	0.006	0.01	1	1.01E-01
ID-RFO-990	Methyl alcohol	1.20E+06	0.0013	0.006	0.01	1	9.36E-02
ID-RFO-002	Methyl alcohol	4.10E+06	0.0013	0.006	0.01	1	3.20E-01
ID-BCO-204	Methyl alcohol	7.29E+03	0.0013	0.006	0.01	1	5.69E-04

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-002T	Methyl alcohol	4.52E+06	0.0013	0.006	0.01	1	3.53E-01
ID-OFS-111	Methylene chloride	5.80E+06	0.0012	0.006	0.01	1	4.03E-01
ID-OFS-111T	Methylene chloride	1.07E+07	0.0012	0.006	0.01	1	7.43E-01
ID-RFO-090	Methylene chloride	3.80E+05	0.0012	0.006	0.01	1	2.64E-02
ID-BTO-030	Methylene chloride	5.60E+03	0.0012	0.006	0.01	1	3.89E-04
ID-RFO-004T	Methylene chloride	2.85E+06	0.0012	0.006	0.01	1	1.98E-01
ID-RFO-004	Methylene chloride	1.30E+06	0.0012	0.006	0.01	1	9.02E-02
ID-RFO-990	Methylene chloride	1.20E+06	0.0012	0.006	0.01	1	8.33E-02
ID-RFO-002	Methylene chloride	4.10E+06	0.0012	0.006	0.01	1	2.85E-01
ID-BCO-204	Methylene chloride	7.29E+03	0.0012	0.006	0.01	1	5.06E-04
ID-RFO-003T	Methylene chloride	5.53E+06	0.0012	0.006	0.01	1	3.84E-01
ID-BCO-204	Nitric acid	7.29E+03	0.0013	0.006	0.01	1	5.69E-04

ID-MDO-838	Nitric acid	1.50E+03	0.0013	0.0005	1	1	9.75E-04
ID-INL-155	Nitric acid	7.60E+03	0.0013	0.0005	1	1	4.94E-03
ID-MDO-847	Nitric acid	8.47E+05	0.0013	0.0005	1	1	5.51E-01
ID-AEO-102	Nitric acid	5.00E+04	0.0013	0.006	0.01	1	3.90E-03
ID-RFO-9999	Nitric acid	9.56E+06	0.0013	0.0005	1	1	6.22E-00
ID-RFO-090	Nitrobenzene	3.80E+05	0.0013	0.006	0.01	1	2.96E-02
ID-RFO-990	Nitrobenzene	1.20E+06	0.0013	0.006	0.01	1	9.36E-02
ID-RFO-003T	Nitrobenzene	6.23E+06	0.0013	0.006	0.01	1	4.86E-01
ID-RFO-003	Nitrobenzene	1.00E+07	0.0013	0.006	0.01	1	7.80E-01
ID-RFO-374	Nitrobenzene	2.00E+06	0.0013	0.006	0.01	1	1.56E-01
ID-RFO-374T	Nitrobenzene	2.09E+05	0.0013	0.006	0.01	1	1.63E-02
ID-OFS-111	Perchloroethylene	5.80E+06	0.0012	0.006	0.01	1	4.03E-01
ID-OFS-111T	Perchloroethylene	1.07E+07	0.0012	0.006	0.01	1	7.43E-01
ID-RFO-090	Perchloroethylene	3.80E+05	0.0012	0.006	0.01	1	2.64E-02
ID-RFO-990	Perchloroethylene	1.20E+06	0.0012	0.006	0.01	1	8.33E-02
ID-RFO-002	Perchloroethylene	4.10E+06	0.0012	0.006	0.01	1	2.85E-01
ID-RFO-003T	Perchloroethylene	6.23E+06	0.0012	0.006	0.01	1	4.33E-01
ID-RFO-002T	Perchloroethylene	2.88E+06	0.0012	0.006	0.01	1	2.00E-01
ID-RFO-003T	Polychlorinated biphenyl	3.14E+06	0.0012	0.006	0.01	1	2.18E-01
ID-RFO-003	Polychlorinated biphenyl	5.04E+06	0.0012	0.006	0.01	1	3.50E-01
ID-RFO-000T	Polychlorinated biphenyl	2.20E+05	0.0012	0.0005	1	1	1.27E-01
ID-RFO-005	Potassium nitrate	8.11E+06	0.0013	0.006	0.01	1	6.33E-01
ID-RFO-005T	Potassium nitrate	4.95E+05	0.0013	0.006	0.01	1	3.86E-02
ID-MDO-836T	Selenium	7.50E+04	0.0013	0.006	0.01	1	5.85E-03
ID-MDO-836	Selenium	1.19E+07	0.0013	0.006	0.01	1	9.28E-01
ID-TAN-162	Selenium	7.12E+04	0.0013	0.006	0.01	1	5.55E-03
ID-MDO-836T	Silver	7.50E+04	0.0013	0.006	0.01	1	5.85E-03
ID-MDO-836	Silver	1.19E+07	0.0013	0.006	0.01	1	9.28E-01
ID-RFO-002	Silver	4.10E+06	0.0013	0.006	0.01	1	3.20E-01
ID-RFO-003T	Silver	6.23E+06	0.0013	0.006	0.01	1	4.86E-01
ID-RFO-002T	Silver	3.69E+06	0.0013	0.006	0.01	1	2.88E-01
ID-RFO-007T	Toluene	4.82E+06	0.0013	0.006	0.01	1	3.76E-01
ID-OFS-111	Toluene	2.90E+06	0.0013	0.006	0.01	1	2.26E-01
ID-RFO-007	Toluene	4.80E+06	0.0013	0.006	0.01	1	3.74E-01
ID-OFS-111T	Toluene	5.35E+06	0.0013	0.006	0.01	1	4.18E-01
ID-RFO-339T	Toluene	1.05E+06	0.0013	0.0005	1	1	6.82E-01
ID-RFO-339	Toluene	3.40E+04	0.0013	0.0005	1	1	2.21E-02
ID-RFO-481T	Toluene	9.49E+05	0.0013	0.006	0.01	1	7.40E-02
ID-RFO-481	Toluene	2.40E+05	0.0013	0.006	0.01	1	1.87E-02

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-300T	Toluene	1.17E+05	0.0013	0.006	0.01	1	9.16E-03
ID-RFO-003T	Trichloroethane, 1,1,1-	1.87E+08	0.0012	0.006	0.01	1	1.30E+01
ID-RFO-003	Trichloroethane, 1,1,1-	3.00E+08	0.0012	0.006	0.01	1	2.08E+01
ID-RFO-112T	Trichloroethane, 1,1,1-	1.92E+07	0.0012	0.006	0.01	1	1.33E-00
ID-RFO-112	Trichloroethane, 1,1,1-	4.30E+05	0.0012	0.006	0.01	1	2.99E-02
ID-OFS-111	Trichloroethane, 1,1,1-	5.80E+06	0.0012	0.006	0.01	1	4.03E-01
ID-OFS-111T	Trichloroethane, 1,1,1-	2.68E+06	0.0012	0.006	0.01	1	1.86E-01
ID-TAN-162	Trichloroethylene	7.12E+05	0.0012	0.006	0.01	1	4.94E-02
ID-OFS-111	Trichloroethylene	5.80E+06	0.0012	0.006	0.01	1	4.03E-01
ID-OFS-111T	Trichloroethylene	1.07E+07	0.0012	0.006	0.01	1	7.43E-01

ID-MDO-836T	Trichloroethylene	7.50E+04	0.0012	0.006	0.01	1	5.21E-03
ID-MDO-836	Trichloroethylene	1.19E+07	0.0012	0.006	0.01	1	8.26E-01
ID-RFO-090	Trichloroethylene	3.80E+05	0.0012	0.006	0.01	1	2.64E-02
ID-RFO-004T	Trichloroethylene	2.85E+06	0.0012	0.006	0.01	1	1.98E-01
ID-RFO-004	Trichloroethylene	1.30E+06	0.0012	0.006	0.01	1	9.02E-02
ID-RFO-990	Trichloroethylene	4.63E+05	0.0012	0.006	0.01	1	3.21E-02
ID-RFO-112T	Trichlorotrifluroethane	1.92E+07	0.0012	0.006	0.01	1	1.33E-00
ID-RFO-003T	Trichlorotrifluroethane	6.23E+07	0.0012	0.006	0.01	1	4.33E-00
ID-RFO-003	Trichlorotrifluroethane	1.00E+08	0.0012	0.006	0.01	1	6.94E-00
ID-RFO-112	Trichlorotrifluroethane	4.30E+05	0.0012	0.006	0.01	1	2.99E-02
ID-OFS-111	Trichlorotrifluroethane	5.80E+06	0.0012	0.006	0.01	1	4.03E-01
ID-OFS-111T	Trichlorotrifluroethane	2.68E+06	0.0012	0.006	0.01	1	1.86E-01
ID-TAN-162	Vinylidene chloride	7.12E+04	0.0012	0.006	0.01	1	4.94E-03
ID-RFO-339T	Vinylidene chloride	1.05E+06	0.0012	0.0005	1	1	6.07E-01
ID-RFO-339	Vinylidene chloride	3.40E+04	0.0012	0.0005	1	1	1.97E-02
ID-RFO-480	Vinylidene chloride	1.70E+06	0.0012	0.006	0.01	1	1.18E-01
ID-RFO-480T	Vinylidene chloride	1.10E+06	0.0012	0.006	0.01	1	7.63E-02
ID-RFO-440	Vinylidene chloride	4.80E+05	0.0012	0.006	0.01	1	3.33E-02
ID-RFO-440T	Vinylidene chloride	9.61E+05	0.0012	0.006	0.01	1	6.67E-02
ID-RFO-330T	Vinylidene chloride	8.72E+05	0.0012	0.0005	1	1	5.04E-01
ID-RFO-442T	Vinylidene chloride	5.38E+05	0.0012	0.006	0.01	1	3.73E-02
ID-RFO-442	Vinylidene chloride	5.50E+05	0.0012	0.006	0.01	1	3.82E-02
ID-RFO-330	Vinylidene chloride	2.52E+06	0.0012	0.0005	1	1	1.46E-00
ID-RFO-112T	Xylene	1.92E+07	0.0013	0.006	0.01	1	1.49E-00
ID-RFO-112	Xylene	4.30E+05	0.0013	0.006	0.01	1	3.35E-02
ID-OFS-111	Xylene	5.80E+06	0.0013	0.006	0.01	1	4.52E-01
ID-OFS-111T	Xylene	1.07E+07	0.0013	0.006	0.01	1	8.35E-01
ID-RFO-113	Xylene	3.60E+04	0.0013	0.006	0.01	1	2.81E-03
ID-RFO-113T	Xylene	1.97E+05	0.0013	0.006	0.01	1	1.54E-02
ID-RFO-090	Xylene	3.80E+05	0.0013	0.006	0.01	1	2.96E-02
ID-RFO-004T	Xylene	2.85E+06	0.0013	0.006	0.01	1	2.23E-01
ID-RFO-700T	Xylene	2.40E+04	0.0013	0.006	0.01	1	1.87E-03
ID-RFO-004	Xylene	1.30E+06	0.0013	0.006	0.01	1	1.01E-01
ID-RFO-990	Xylene	1.20E+06	0.0013	0.006	0.01	1	9.36E-02
ID-RFO-002	Xylene	4.10E+06	0.0013	0.006	0.01	1	3.20E-01
ID-BCO-204	Xylene	7.29E+03	0.0013	0.006	0.01	1	5.69E-04
ID-RFO-002T	Xylene	3.25E+06	0.0013	0.006	0.01	1	2.54E-01

Table E-5-18. Source term——fire in transuranic waste in the retrieval enclosure[a] (continued).

a. MAR—materials at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d), HEPA–high-efficiency particulate air; DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility. Also evaluated were combustion by-products phosgene and hydrochloric acid (BNFL 1998d).

b. From BFNL (1998d).

c. Some plutonium listings in this column show metallurgical codes for nuclear grade plutonium (i.e., Pu-52, Pu-83) instead of isotopes. These materials are mixtures of plutonium isotopes designated prior to the development of modern analysis techniques which can identify composition of the waste form by isotope.

Table E-5-19. Accident consequences–fire in transuranic waste in the retrieval enclosure.[a]

	Locations			

	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	0.0207	5.83	2.91	3.53
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2
Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	4.6E-05	0.035	0.0098	0.013
Beryllium				
Evaluation guideline mg/m^3	0.1	0.025	0.025	0.025
Calculated mg/m^3	3.2E-07	2.5E-04	6.9E-05	9.0E-05
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	8.9E-07	6.8E-04	6.8E-06	8.9E-06
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25
Calculated mg/m^3	1.8E-05	0.014	6.1E-06	7.9E-05
Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	2.9E-09	3.8E-06	2.2E-06	2.6E-06
Polychlorinated biphenyls (PCBs)				

Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	2.5E-08	3.3E-05	4.3E-06	5.2E-06

a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of a fire in TRU waste in the retrieval enclosure include the following:

- Retrieval enclosure structure
- Ventilation system
- Fire detection and suppression systems
- Containers inspection for integrity before moving
- Waste handling by trained and qualified equipment operators
- Waste retrieval equipment inspection for safe operation
- Hoisting and rigging procedures
- Radiation monitoring of waste retrieval face
- Secondary enclosures within the retrieval enclosure to handle breached containers
- Emergency preparedness planning
- Housekeeping to limit combustible materials
- Personal protective equipment.

E-5.4.1.6. Incinerator Explosion.

E-5.4.1.6.1 Source Term Analysis¾ The following discusses the factors in the source term analysis.

Material at Risk. The MAR includes waste in the two shredders, feed augers, primary and secondary chambers, ash collection system, and offgas ventilation system and HEPA filters. On the basis of the incinerator design, there would likely be less than two cubic meters of waste in the incinerator at any one time but a maximum of six cubic meters of waste is postulated to be in the incinerator system at the time of the explosion. The radioactive MAR is based on selecting waste streams from the organic solids, inorganic solids and soils waste types that results in the highest exposure (BNFL 1998d). In addition, the explosion is assumed to damage the HEPA filters and release contaminates from the offgas ventilation system. The inventory of radioactive materials in the filters and offgas ventilation system was conservatively represented by 500 grams of
Pu-239.

Multiple MARs are developed for hazardous constituents and the MAR is based on selecting from the waste streams for the organic homogeneous solids, inorganic homogeneous solids, and soil waste types containing the highest concentration of each hazardous material (BNFL 1998d). The resulting MAR bounds all combinations of wastes destined for the incinerator for each hazardous material.

Damage Ratio. Because much of the waste is in shredders and conveyance augers, not all the materials would be released from an incinerator explosion. For an explosion severe enough to fail the roof, access corridors, or both (see LPF below), a bounding DR of 0.9 is assumed. A DR of 1.0 is conservatively assumed for materials in the offgas ventilation system and HEPA filters. To incorporate the assumption that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire, the DR for halogenated compounds and chlorinated hydrocarbons is multiplied by 0.89 (BNFL 1998d).

Airborne Release Fraction. Radioactive and hazardous materials were assumed released as ash. The ARF for ash is 6.0×10^{-3} based on Section 4.4.1.1 of DOE (1994). For the release from the ventilation system and HEPA filters, half of the contamination resides is assumed to be in the ductwork, dampers, and plenums and the other half in the HEPA filters. The ARF from the ductwork is 4.0E-05 (Section 5.3.4 of DOE [1994]), and the ARF from HEPA failure is 5.0E-04 (Section 5.4.4.1 of DOE [1994]).

Respirable Fraction. Radioactive and hazardous materials were assumed released as ash with a RF of 0.01 (Section 4.4.1.1 of DOE [1994]). The RF for the release from the ventilation system and HEPA filters is 1.0.

Leakpath Factor. While it is doubtful that an explosion powerful enough to break the cell boundaries (Room 156b) could occur, the analysis conservatively assumes failure of the cell and the roof above the cell and/or the access corridors. A LPF of 1.0 is conservatively assumed, resulting in no credit for holdup or partial holdup of contaminates within the building structure.

Using the above factors, bounding source terms were developed for radiological and hazardous constituents as shown in Table E-5-20 (BNFL 1998d). The source terms were applied to the unit-gram dose model for 50 percent and 95 percent meteorological conditions corresponding to a buoyant plume (BNFL 1998d). The consequences reported below select the higher exposures for the 50 percent and 95 percent meteorological conditions.

E-5.4.1.6.2 Consequence Analysis¾ The source term is assumed released to the environment over one hour. The radiological and toxicological consequences to co-located workers and the public of an incinerator explosion are summarized in Table E-5-21. Examination of the radiological consequences by radionuclide (BNFL 1998d) illustrates that nearly all the consequences result from exposure to Pu-238 by way of the inhalation pathway. Pu-238 exists in less than 2 percent of the waste containers (BNFL 1998d). The four most limiting hazardous materials (in terms of a fraction of the ERPG value) are reported in Table E-5-21 (see BNFL [1998d] for all 33 materials analyzed).

E-5.4.1.6.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-21. Evaluation guidelines for an extremely unlikely event are not exceeded.

Table E-5-20. Source term–incinerator explosion.[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radioactive materials							
ID-RFO-391TN	Am-241	4.66E+01	0.9	6.00E-03	0.01	1	2.54E-03
ID-MDO-810T	Pu-238	9.58E+01	0.9	6.00E-03	0.01	1	5.23E-03
ID-MDO-811T	Pu-238	3.90E+01	0.9	6.00E-03	0.01	1	2.13E-03
ID-MDO-810T	Pu-239	1.90E+02	0.9	6.00E-03	0.01	1	1.04E-02

ID-MDO-811T	Pu-239	8.00E+01	0.9	6.00E-03	0.01	1	4.37E-03
Ductwork	Pu-239	2.50E+02	1	4.00E-05	1	1	1.00E-02
HEPA Filters	Pu-239	2.50E+02	1	5.00E-04	1	1	1.25E-01
ID-RFO-391TN	Pu-52	5.48E+02	0.9	6.00E-03	0.01	1	2.99E-02
Hazardous materials							
ID-MDO-836T	Acetone	7.50E+04	0.9	6.00E-03	0.01	1	4.10E-00
ID-MDO-836	Acetone	6.60E+03	0.9	6.00E-03	0.01	1	3.60E-01
ID-OFS-111	Arsenic	6.24E+04	0.9	6.00E-03	0.01	1	3.41E-00
ID-RFO-002	Barium	7.18E+04	0.9	6.00E-03	0.01	1	3.92E-00
ID-RFO-442T	Benzene	2.78E+04	0.9	6.00E-03	0.01	1	1.52E-00
ID-TAN-162	Butanone, 2-; (MEK)	5.99E+04	0.9	6.00E-03	0.01	1	3.27E-00
ID-OFS-111	Butyl alcohol, n-	1.25E+05	0.9	6.00E-03	0.01	1	6.81E-00
ID-OFS-111	Cadmium & compounds	1.25E+05	0.9	6.00E-03	0.01	1	6.81E-00
ID-RFO-112T	Carbon tetrachloride	7.01E+05	0.8099	6.00E-03	0.01	1	3.40E+01

Table E-5-20. Source term–incinerator explosion (continued)[a].

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-112T	Chloroform	7.01E+05	0.8099	6.00E-03	0.01	1	3.40E+01
ID-MDO-836T	Chromium	7.50E+04	0.9	6.00E-03	0.01	1	4.10E-00
ID-MDO-836	Chromium	6.60E+03	0.9	6.00E-03	0.01	1	3.60E-01
ID-TAN-162	Dichlorobenzene, p-	5.99E+04	0.8099	6.00E-03	0.01	1	2.91E-00
ID-OFS-111T	Ethyl benzene	1.16E+05	0.9	6.00E-03	0.01	1	6.34E-00
ID-RFO-002	Ethylene dichloride	7.18E+04	0.8099	6.00E-03	0.01	1	3.49E-00
ID-BCO-204T	Lead	2.91E+05	0.9	6.00E-03	0.01	1	1.59E+01
ID-AEO-102T	Lead	8.26E+05	0.9	6.00E-03	0.01	1	4.51E+01
ID-RFO-002	Mercury (elemental & inorganic)	1.54E+04	0.9	6.00E-03	0.01	1	8.43E-01
ID-RFO-113	Methyl alcohol	3.60E+04	0.9	6.00E-03	0.01	1	1.97E-00
ID-RFO-113T	Methyl alcohol	4.72E+04	0.9	6.00E-03	0.01	1	2.58E-00
ID-OFS-111	Methylene chloride	1.25E+05	0.8099	6.00E-03	0.01	1	6.06E-00
ID-BCO-204	Nitric acid	7.29E+03	0.9	6.00E-03	0.01	1	3.98E-01
ID-AEO-102	Nitric acid	2.69E+04	0.9	6.00E-03	0.01	1	1.47E-00
ID-RFO-090	Nitrobenzene	7.97E+04	0.9	6.00E-03	0.01	1	4.35E-00
ID-OFS-111	Perchloroethylene	1.25E+05	0.8099	6.00E-03	0.01	1	6.06E-00
ID-RFO-003T	Polychlorinated biphenyl	3.43E+04	0.8099	6.00E-03	0.01	1	1.67E-00
ID-RFO-005	Potassium nitrate	4.68E+06	0.9	6.00E-03	0.01	1	2.56E+02
ID-MDO-836T	Selenium	7.50E+04	0.9	6.00E-03	0.01	1	4.10E-00
ID-MDO-836	Selenium	6.60E+03	0.9	6.00E-03	0.01	1	3.60E-01
ID-MDO-836T	Silver	7.50E+04	0.9	6.00E-03	0.01	1	4.10E-00
ID-MDO-836	Silver	6.60E+03	0.9	6.00E-03	0.01	1	3.60E-01
ID-RFO-007T	Toluene	6.30E+04	0.9	6.00E-03	0.01	1	3.44E-00
ID-RFO-003T	Trichloroethane, 1,1,1-	2.04E+06	0.8099	6.00E-03	0.01	1	9.91E+01
ID-TAN-162	Trichloroethylene	5.99E+05	0.8099	6.00E-03	0.01	1	2.91E+01
ID-RFO-112T	Trichlorotrifluroethane	7.01E+05	0.8099	6.00E-03	0.01	1	3.40E+01
ID-TAN-162	Vinylidene chloride	5.99E+04	0.8099	6.00E-03	0.01	1	2.91E-00
ID-RFO-112T	Xylene	7.01E+05	0.9	6.00E-03	0.01	1	3.83E+01

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d), HEPA–high-efficiency particulate air; DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility. Also evaluated were combustion by-products phosgene and hydrochloric acid (BNFL 1998d).

b. From BNFL (1998d).

c. Some plutonium listings in this column show metallurgical codes for nuclear grade plutonium (i.e., Pu-52) instead of isotopes. These materials are mixtures of plutonium isotopes designated prior to the development of modern analysis techniques which can identify composition of the waste form by isotope.

Table E-5-21. Accident consequences–incinerator explosion.[a]

	Locations			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	0.00143	0.412	0.201	0.238
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2
Asbestos (not expected in organic and inorganic solids going to incinerator)				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	0	0	0	0
Beryllium (not expected in organic and inorganic solids going to incinerator)				
Evaluation guideline mg/m^3	0.1	0.025	0.025	0.025
Calculated mg/m^3	0	0	0	0
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	3.3E-08	2.5E-05	6.8E-06	8.9E-06
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25

Calculated mg/m^3	3.0E-07	2.3E-04	6.1E-06	7.9E-05
Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	4.1E-09	5.3E-06	2.2E-06	2.6E-06
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	8.2E-09	1.1E-05	4.3E-06	5.2E-06

a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

E-5.4.1.6.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirements; and defense in depth measures.

Safety-Class and Safety Significant Structures, Systems, and Components. Evaluation guidelines are not exceeded, and no safety-class or safety-significant structures, systems, and components are required.

Technical Safety Requirement Controls. Technical safety requirement controls to limit the total quantity of fissile material in the incinerator were identified by the assessment. Administrative controls were identified that govern incinerator restart and personnel entry following flameout, i.e., verify propane feed is off, run ventilation system for several minutes before attempting to restart the flame. These controls will be developed for the Final SAR.

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of an incinerator explosion include the following:

- The incinerator primary chamber
- Flame detection system
- Propane cutoff system
- Offgas system
- The building structure

Emergency procedures

- Incineration system control logic
- Incinerator operating and restart procedures
- Monitoring of incineration system fissile content
- Personal protective equipment.

E-5.4.1.7 Wind-Borne Missile Breach of Treatment Facility.

E-5.4.1.7.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. All containers of waste destined for the treatment facility are potential candidates for being penetrated by an airborne missile. The MAR consists of the radioactive and hazardous constituents within a drum or waste box.

The radioactive MAR is based on using the waste streams that would contribute the maximum dose. The relative radiation dose from each waste stream is ranked from greater doses to lesser doses. Beginning with the waste stream with the greatest dose and proceeding to the waste streams with lesser doses, the waste streams are analyzed to find the waste stream in containers that would contribute the greatest dose. A single box from the waste stream that would contribute the greatest dose defines the maximum radioactive MAR for the wind-blown missile scenario.

The hazardous MARs are based on using the waste streams that would contribute the maximum quantity of each hazardous material. For each hazardous material identified in the PSAR (BNFL 1998d), the concentration of the chemical in boxes is ranked from greatest to least. Beginning with the waste stream with the greatest concentration and proceeding to the waste streams with lesser concentrations, the waste streams are analyzed to find the waste stream in containers that has the greatest concentration of each of the 33 hazardous materials.

The resulting radioactive MAR represents bounding quantities of radioactive constituents from penetrated containers; the resulting 33 hazardous MARs represent bounding quantities of the hazardous constituents from containers penetrated by a wind-blown missile.

Damage Ratio. Because of the multiple packaging layers within waste containers, a DR of 0.5 is assumed for both the radioactive and hazardous material packagings.

Airborne Release Fraction. The bounding ARF for packaged waste is 5.0E-04 (Section 5.2.1.1 of DOE [1994]).

Respirable Fraction. The bounding RF for packaged waste is 1.0 (Section 5.3.3.2.2 of DOE [1994]).

Leakpath Factor. The accident occurs within the breached confinement of Room 134. During the accident, cascade ventilation is assumed to discontinue functioning. The airborne missile is assumed to penetrate the box and release 1 percent of the waste to Room 134. Wind-related differential pressures are assumed to cause 10 percent of the material that becomes airborne in the room to be released to the environment. The resulting LPF is 0.001 (0.01 x 0.1).

Using the above factors, a conservative source term is estimated as shown in Table E-5-22 (BNFL 1998d). Consistent with the wind scenario, the source terms is applied to the unit-gram dose model for the 50 percent meteorological conditions (BNFL 1998d).

E-5.4.1.7.2 Consequence Analysis¾ The consequences of a wind-borne missile breach of the treatment facility are summarized in Table E-5-23. The consequences were conservatively calculated assuming average meteorological conditions. Actual dispersion would be much higher because of the high winds required to cause a wind-borne missile. Examination of the radiological consequences by radionuclide (BNFL 1998d) illustrates that nearly all the consequences result from exposure to Pu-238 by way of the inhalation pathway. Pu-238 exists in less than 2 percent of

the waste drums (BNFL 1998d). The six most limiting hazardous materials (in terms of a fraction of the ERPG value) are reported in Table E-5-23 (see the PSAR [BNFL 1998d] for all 33 materials analyzed).

E-5.4.1.7.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-23. Evaluation guidelines for an unlikely event are not exceeded. The wind-blown missile consequences are well below the threshold where the building shell would have to be designed as Performance Category 3 equipment based on the DOE standard referenced in BNFL (1998d).

E-5.4.1.7.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Table E-5-22. Source term——wind-borne missile breach of treatment facility.[a]

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radioactive materials							
ID-INL-152TN	Pu-238	1.25E+02	0.5	5.00E-04	1	0.001	3.11E-05
ID-INL-152TN	Pu-239	1.56E+02	0.5	5.00E-04	1	0.001	3.90E-05
ID-INL-152TN	Pu-240	8.21E+01	0.5	5.00E-04	1	0.001	2.05E-05
Hazardous materials							
ID-RFO-442T	Acetone	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-OFS-121T	Arsenic	1.38E+04	0.5	5.00E-04	1	0.001	3.44E-03
ID-RFO-338T	Asbestos	5.52E+05	0.5	5.00E-04	1	0.001	1.38E-01
ID-RFO-001T	Barium	1.68E+04	0.5	5.00E-04	1	0.001	4.21E-03
ID-RFO-442T	Benzene	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-RFO-000T	Beryllium	8.50E+03	0.5	5.00E-04	1	0.001	2.13E-03
ID-TAN-162	Butanone, 2-; (MEK)	0.00E+01	0.5	5.00E-04	1	0.001	0.00E+01
ID-RFO-978T	Butyl alcohol, n-	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-OFS-121T	Cadmium & compounds	1.38E+05	0.5	5.00E-04	1	0.001	3.44E-02
ID-RFO-003	Carbon tetrachloride	1.52E+05	0.5	5.00E-04	1	0.001	3.79E-02
ID-RFO-976	Chloroform	2.05E+04	0.5	5.00E-04	1	0.001	5.13E-03
ID-RFO-978T	Chromium	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-TAN-162	Dichlorobenzene, p-	0.00E+01	0.5	5.00E-04	1	0.001	0.00E+01
ID-RFO-480T	Ethyl benzene	1.44E+04	0.5	5.00E-04	1	0.001	3.59E-03
ID-AEO-100T	Ethyl ether	9.70E+03	0.5	5.00E-04	1	0.001	2.43E-03
ID-RFO-976	Ethylene dichloride	2.05E+04	0.5	5.00E-04	1	0.001	5.13E-03
ID-RFO-302T	Lead	7.93E+05	0.5	5.00E-04	1	0.001	1.98E-01

ID-RFO-118	Mercury (elemental & inorganic)	1.93E+02	0.5	5.00E-04	1	0.001	4.83E-05
ID-RFO-978T	Methyl alcohol	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-RFO-117	Methylene chloride	2.64E+04	0.5	5.00E-04	1	0.001	6.59E-03
ID-CPP-156	Nitric acid	1.22E+04	0.5	5.00E-04	1	0.001	3.06E-03
ID-RFO-003	Nitrobenzene	1.52E+04	0.5	5.00E-04	1	0.001	3.79E-03
ID-RFO-978T	Perchloroethylene	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-RFO-003	Polychlorinated biphenyl	7.65E+03	0.5	5.00E-04	1	0.001	1.91E-03
ID-RFO-005	Potassium nitrate	1.66E+06	0.5	5.00E-04	1	0.001	4.14E-01
ID-MDO-842	Selenium	2.08E+04	0.5	5.00E-04	1	0.001	5.19E-03
ID-MDO-842	Silver	2.08E+04	0.5	5.00E-04	1	0.001	5.19E-03
ID-RFO-442T	Toluene	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-RFO-003	Trichloroethane, 1,1,1-	4.55E+05	0.5	5.00E-04	1	0.001	1.14E-01
ID-RFO-978T	Trichloroethylene	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03
ID-RFO-003	Trichlorotrifluroethane	1.52E+05	0.5	5.00E-04	1	0.001	3.79E-02
ID-RFO-442T	Vinylidene chloride	1.47E+04	0.5	5.00E-04	1	0.001	3.67E-03
ID-RFO-978T	Xylene	2.63E+04	0.5	5.00E-04	1	0.001	6.58E-03

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d); DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility.

b. From BNFL (1998d).

Table E-5-23. Accident consequences–wind-borne missile breach of the treatment facility.[a]

	Locations			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	0.0477	2.3E-04	7.39E-05	9.6E-05
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2

Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	2.9E-04	1.4E-07	5.0E-08	6.2E-08
Beryllium				
Evaluation guideline mg/m^3	0.1	7.3E-03	7.3E-03	7.3E-03
Calculated mg/m^3	4.5E-06	2.1E-09	7.7E-10	9.6E-10
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	7.2E-05	3.4E-08	1.2E-08	1.6E-08
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25
Calculated mg/m^3	4.2E-04	2.0E-07	7.1E-08	8.9E-08
Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	1.8E-07	6.3E-11	2.3E-11	2.9E-11
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	7.1E-06	2.5E-09	9.2E-10	1.1E-09

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a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for 50 percent meteorological conditions because the wind scenario is inconsistent with 95 percent meteorology.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

Safety-Class and Safety-Significant Structures, Systems, and Components. Evaluation guidelines are not exceeded, and no safety-class or safety-significant structures, systems, or components are required.

Technical Safety Requirement Controls. The analysis identified a need for administrative controls related to area housekeeping and transporting waste in inclement weather.

Defense in Depth. For natural phenomena events, the structure is considered Performance Category 2 equipment. Defense in depth measures to prevent and mitigate the consequences of a wind-borne missile breach of the treatment facility include the following:

- Emergency preparedness planning
- Cascade ventilation system
- External treatment facility building shell
- Radiation monitoring systems
- Housekeeping
- Personal protective equipment.

E-5.4.1.8 Fire Involving Waste Transfer Vehicle.

E-5.4.1.8.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. The inventory of waste within each waste box is 3.2 cubic meters. The radioactive MAR is based on selecting the ten boxes of combustible waste from the entire inventory that would result in the highest radiological exposure (BNFL 1998d). Multiple MARs are developed for hazardous constituents, and they are based on selecting the ten combustible boxes containing the highest concentration of each hazardous material (BNFL 1998d). The resulting MARs bound all combinations of combustible waste codes for each hazardous material.

When exposed to heat and flame, halogenated compounds produce small quantities of phosgene compounds and chlorinated hydrocarbons produce small quantities of halogenated acids. The analysis assumes that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire, that 10 percent of the chlorinated hydrocarbons in the MAR decompose to hydrochloric acid, and 1 percent of the halogenated compounds convert to phosgene gas with a molecular conversion ratio of 1.19 (BNFL 1998d).

Damage Ratio. Even in a severe fire scenario, it is unreasonable to postulate that all containers on the truck would be involved in a fire. Without an external source of fuel, the boxes would be difficult to ignite. Results of severe fire tests with an external source of fuel (documented in Section 7.3.9.2 of DOE [1994]) indicate that only a fraction of containers would be totally breached, some would be only partly breached, and some would remain intact. Although the analysis does not credit manual fire suppression, such activities could also limit spread of the fire. From this information, a bounding DR of 0.25 is estimated. To incorporate the assumption that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire, the DR for halogenated compounds and chlorinated hydrocarbons is multiplied by 0.89 (BNFL 1998d).

Airborne Release Fraction. With the exception of one waste stream (waste stream code ID-INL-152TN in PSAR [BNFL 1998d]) that is characterized as a solid, about one-third of the remaining waste is solids, about one-third is contained (within drums or other containers inside the boxes), and about one-third is expected to be uncontained. The ARF for combustible, surface- contaminated waste exposed to fire are 6.0E-03 for solid waste (Section 4.1 of DOE [1994]),
5.0E-04 for contained waste (Section 5.2.1.1 of DOE [1994]), and 0.01 for uncontained waste (Section 5.2.1.2 of DOE [1994]). For the combination of solid, contained, and uncontained waste, the average ARF is (0.33 x 6.0E-03) + (0.33 x 5.0E-04) + (0.33 x 0.01) = 5.5E-03. The ARF for contained hazardous materials exposed to fire is 5.0E-04

(Section 5.2.1.1 of DOE [1994]).

Respirable Fraction. The RFs for combustible surface-contaminated waste exposed to fire corresponding to solids, contained and uncontained waste forms are 0.01 (Section 4.1 of DOE [1994]), 1.0 (Section 5.2.1.1 of DOE [1994]), and 1.0 (Section 5.2.1.2 of DOE [1994]), respectively. For the combination of solid, contained, and uncontained waste, the average RF is (0.33 x 0.01) + (0.33 x 1.0) + (0.33 x 1.0) = 0.67.

For hazardous material releases, the RF for contained hazardous materials exposed to fire is conservatively assigned a value of 1.0 (Section 5.2.1.1 of DOE [1994])

Leakpath Factor. The accident is assumed to occur outdoors and no credit is taken for confinement in the truck. The LPF is 1.0.

Using the above factors, the source term can be determined as shown in Table E-5-24. The source terms were applied to the unit-gram dose model for 50 percent and 95 percent meteorological conditions (BNFL 1998d). The consequences reported below select the higher exposures for the 50 percent and 95 percent meteorological conditions.

Table E-5-24. Source term——fire involving waste transfer vehicle.[a]

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radioactive materials							
ID-INL-152TN	Pu-238	1.37E+02	0.25	6.00E-03	0.01	1	2.06E-03
ID-MDO-824T	Pu-238	7.23E+01	0.25	0.0055	0.67	1	6.66E-02
ID-INL-152TN	Pu-239	1.72E+02	0.25	6.00E-03	0.01	1	2.59E-03
ID-MDO-824T	Pu-239	9.70E+01	0.25	0.0055	0.67	1	8.94E-02
ID-INL-152TN	Pu-240	9.06E+01	0.25	6.00E-03	0.01	1	1.36E-03
ID-MDO-824T	Pu-83	6.91E-01	0.25	0.0055	0.67	1	6.37E-04
Hazardous materials							
ID-AEO-110T	Acetone	1.03E+04	0.25	5.00E-04	1	1	1.29E-00
ID-RFO-337	Acetone	3.80E+04	0.25	5.00E-04	1	1	4.75E-00
ID-RFO-339T	Acetone	3.50E+04	0.25	5.00E-04	1	1	4.38E-00
ID-RFO-337T	Acetone	8.43E+03	0.25	5.00E-04	1	1	1.05E-00
ID-AEO-110T	Arsenic	1.03E+04	0.25	5.00E-04	1	1	1.29E-00
ID-RFO-338T	Asbestos	2.76E+06	0.25	5.00E-04	1	1	3.45E+02
ID-RFO-338	Asbestos	2.68E+06	0.25	5.00E-04	1	1	3.35E+02
ID-MDO-824T	Barium	1.15E+05	0.25	5.00E-04	1	1	1.44E+01
ID-RFO-337	Benzene	3.80E+04	0.25	5.00E-04	1	1	4.75E-00
ID-RFO-338T	Benzene	4.60E+04	0.25	5.00E-04	1	1	5.75E-00
ID-RFO-338	Benzene	8.95E+03	0.25	5.00E-04	1	1	1.12E-00
ID-RFO-000T	Beryllium	8.50E+04	0.25	5.00E-04	1	1	1.06E+01
ID-CPP-156	Butyl alcohol, n-	1.10E+05	0.25	5.00E-04	1	1	1.38E+01
ID-RFO-000T	Butyl alcohol, n-	8.50E+03	0.25	5.00E-04	1	1	1.06E-00
ID-MDO-824T	Cadmium & compounds	1.15E+05	0.25	5.00E-04	1	1	1.44E+01
ID-CPP-156	Carbon tetrachloride	1.10E+06	0.22	5.00E-04	1	1	1.22E+02
ID-RFO-000T	Carbon tetrachloride	8.50E+04	0.22	5.00E-04	1	1	9.46E-00
ID-RFO-337	Chloroform	3.80E+04	0.22	5.00E-04	1	1	4.23E-00
ID-RFO-338T	Chloroform	4.60E+04	0.22	5.00E-04	1	1	5.12E-00
ID-RFO-338	Chloroform	8.95E+03	0.22	5.00E-04	1	1	9.95E-01
ID-MDO-824T	Chromium	1.15E+05	0.25	5.00E-04	1	1	1.44E+01
ID-RFO-337	Ethyl benzene	3.80E+04	0.25	5.00E-04	1	1	4.75E-00
ID-RFO-339T	Ethyl benzene	3.50E+04	0.25	5.00E-04	1	1	4.38E-00

ID-RFO-330	Ethyl benzene	1.72E+04	0.25	5.00E-04	1	1	2.14E-00
ID-AEO-100T	Ethyl ether	9.70E+04	0.25	5.00E-04	1	1	1.21E+01
ID-RFO-338T	Ethylene dichloride	4.60E+04	0.22	5.00E-04	1	1	5.12E-00
ID-RFO-338	Ethylene dichloride	4.47E+04	0.22	5.00E-04	1	1	4.98E-00
ID-RFO-302T	Lead	4.76E+06	0.25	5.00E-04	1	1	5.95E+02
ID-RFO-302	Lead	2.81E+06	0.25	5.00E-04	1	1	3.52E+02
ID-MDO-826	Mercury (elemental & inorganic)	3.22E+02	0.25	5.00E-04	1	1	4.03E-02
ID-MDO-826T	Mercury (elemental & inorganic)	7.52E+02	0.25	5.00E-04	1	1	9.40E-02
ID-CPP-156	Methyl alcohol	1.10E+05	0.25	5.00E-04	1	1	1.38E+01
ID-RFO-337	Methyl alcohol	9.50E+03	0.25	5.00E-04	1	1	1.19E-00
ID-RFO-376	Methylene chloride	3.90E+04	0.22	5.00E-04	1	1	4.34E-00

Table E-5-24. Source term——fire involving waste transfer vehicle[a] (continued).

Waste stream code[b]	Nuclide or hazardous material	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-116T	Methylene chloride	1.17E+05	0.22	5.00E-04	1	1	1.30E+01
ID-CPP-156	Nitric acid	1.10E+05	0.25	5.00E-04	1	1	1.38E+01
ID-RFO-000T	Nitric acid	8.50E+03	0.25	5.00E-04	1	1	1.06E-00
ID-RFO-337	Perchloroethylene	3.80E+04	0.22	5.00E-04	1	1	4.23E-00
ID-RFO-338T	Perchloroethylene	4.60E+04	0.22	5.00E-04	1	1	5.12E-00
ID-RFO-338	Perchloroethylene	8.95E+03	0.22	5.00E-04	1	1	9.95E-01
ID-RFO-000T	Polychlorinated biphenyl	7.15E+03	0.22	5.00E-04	1	1	7.95E-01
ID-MDO-824T	Selenium	1.15E+05	0.25	5.00E-04	1	1	1.44E+01
ID-MDO-824T	Silver	1.15E+05	0.25	5.00E-04	1	1	1.44E+01
ID-RFO-337	Toluene	3.80E+04	0.25	5.00E-04	1	1	4.75E-00
ID-RFO-338T	Toluene	4.60E+04	0.25	5.00E-04	1	1	5.75E-00
ID-RFO-338	Toluene	8.95E+03	0.25	5.00E-04	1	1	1.12E-00
ID-RFO-302T	Trichloroethane, 1,1,1-	1.19E+05	0.22	5.00E-04	1	1	1.32E+01
ID-RFO-376	Trichloroethane, 1,1,1-	3.90E+04	0.22	5.00E-04	1	1	4.34E-00
ID-RFO-302	Trichloroethane, 1,1,1-	3.52E+04	0.22	5.00E-04	1	1	3.91E-00
ID-RFO-302T	Trichloroethylene	1.19E+05	0.22	5.00E-04	1	1	1.32E+01
ID-RFO-302	Trichloroethylene	7.04E+04	0.22	5.00E-04	1	1	7.83E-00
ID-RFO-376	Trichlorotrifluroethane	3.90E+04	0.22	5.00E-04	1	1	4.34E-00
ID-RFO-116	Trichlorotrifluroethane	1.22E+05	0.22	5.00E-04	1	1	1.36E+01
ID-RFO-337	Vinylidene chloride	3.80E+04	0.22	5.00E-04	1	1	4.23E-00
ID-RFO-338T	Vinylidene chloride	4.60E+04	0.22	5.00E-04	1	1	5.12E-00
ID-RFO-338	Vinylidene chloride	8.95E+03	0.22	5.00E-04	1	1	9.95E-01
ID-CPP-156	Xylene	1.10E+05	0.25	5.00E-04	1	1	1.38E+01
ID-RFO-970T	Xylene	9.71E+03	0.25	5.00E-04	1	1	1.21E-00

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL(1998d); DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility. Also evaluated were combustion by-products phosgene and hydrochloric acid (BNFL 1998d).

b. From BNFL (1998d).

E-5.4.1.8.2 Consequence Analysis¾ The source term is assumed released to the environment over one hour. The consequences to co-located workers and the public of a transfer vehicle fire are summarized in Table E-5-25. Involved

workers depend on procedures, training, and personal protection equipment to minimize exposures for drops and spills of containers.

E-5.4.1.8.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-25. Evaluation guidelines for an unlikely event are not exceeded.

Table E-5-25. Accident consequences–fire involving waste transfer vehicle.[a]

	Locations			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	0.0115	3.31	1.61	1.91
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2
Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	3.3E-06	0.0025	6.8E-04	8.9E-04
Beryllium				
Evaluation guideline mg/m^3	0.1	0.025	0.025	0.025
Calculated mg/m^3	5.2E-08	3.9E-05	1.1E-05	1.4E-05
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	7.1E-08	5.3E-05	1.4E-05	1.9E-05
Lead				
Evaluation guideline	100	0.25	0.25	0.25

mg/m^3 [c]				
Calculated mg/m^3	4.6E-06	0.0035	9.5E-04	0.0012
Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	6.6E-10	8.5E-07	3.5E-07	4.1E-07
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	3.9E-09	5.0E-06	2.1E-06	2.5E-06

a. EBR-I — Experimental Breeder Reactor-I;TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

E-5.4.1.8.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Safety-Class and Safety Significant Structures, Systems, and Components. Evaluation guidelines at the INEEL boundary are not exceeded, and no safety-class structures, system, or components are required. Evaluation guidelines for a worker 100 meters away are not exceeded and no safety-significant structures, systems, or components are required.

Technical Safety Requirement Controls. The analysis identified a need for administrative controls to provide for appropriate procedures and training for handling and transporting waste.

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of a fire during waste transfer include the following:

- Containers are inspected for integrity before transfer
- Waste is transferred only by trained and qualified equipment operators
- Waste transfer equipment is periodically inspected for safe operation
- Hoisting and rigging procedures are followed
- Speed limits are established within the AMWTP area
- Fire protection programs and equipment
- Emergency preparedness planning

- Personal protective equipment.

E-5.4.1.9 Design Basis Seismic Event.

E-5.4.1.9.1 Source Term Analysis¾ To a degree, all wastes in the TSA are at risk during a design basis seismic event. Quantification of the exact damage that would be expected at a given seismic acceleration is neither possible nor necessary. Because the objective is to determine the potential need for safety structures, systems, and components and technical safety requirements, it is sufficient to postulate reasonably bounding releases of radioactive and hazardous constituents. Bounding ground-level and elevated releases are developed for the design basis seismic event below. The assessment conservatively ignores that the bounding waste containers cannot simultaneously exist at all the AMWTP facilities.

For ground-level releases, the total amount of radioactive and hazardous waste is estimated as discussed below in terms of the source term from the unmitigated box spills during transportation discussed in Appendix Section E-5.4.1.4. LPFs for radioactive and hazardous material releases at ground level from inside structures is assumed to be 0.1 because there is no driving force to push them from the structures even with partial losses of confinement barriers and loss of the ventilation systems. See Appendix Section E-5.4.1.3 for a description of the source term for a dropped box.

Taking no credit for fence supports or other devices to stabilize containers after soil removal in the retrieval enclosure, and taking no credit for ventilation and HEPA filtration, the equivalent of the waste from five box spills with a LPF of 0.1 is released to the environment.

Taking no credit for tie-downs or administrative controls on transporting materials, boxes and drums being loaded or in transit among AMWTP facilities are spilled releasing the equivalent of the waste from two box spills with a LPF of 1.0 to the environment.

Taking no credit for administrative controls on handling materials, boxes and drums in the Type I module are assumed to fall or be dropped because of the seismic event. The equivalent of the waste from one box spill with a LPF of 0.1 is released to the environment.

Taking no credit for stabilizing devices in box and drum storage arrays in the Type II modules, boxes and drums inside the buildings are assumed to fall or be dropped because of the seismic event. From these occurrences, the equivalent of the waste from 2 box spills is released to the environment from each of storage modules, or a total of 14 box spills with a LPF of 0.1.

For the treatment facility, releases from the process equipment are assumed to be the equivalent of the waste from five box spills (one from the box line, one from the drum line or the equivalent of 15 drum spills, one from the supercompaction area, and one from each of the encapsulation areas) with a LPF of 0.1.

Taking no credit for the waste being encapsulated, product drums in storage or in the TRUPACT II loading facility are assumed to fall or be dropped because of the seismic event. The equivalent of the waste from one box spill with a LPF of 0.1 is released to the environment.

In addition to these ground-level releases, elevated releases from a fire in the incinerator area are postulated. The MAR includes waste in the two shedders, feed augers, primary and secondary chambers, ash collection system, and offgas ventilation system and HEPA filters. On the basis of the incinerator design, there would likely be less than 2 cubic meters of waste in the incinerator at any one time but following a seismic event a maximum of 6 cubic meters of waste is postulated for the seismically initiated fire. The radioactive MAR is based on selecting drums of organic and inorganic solids that would result in the highest exposure (BNFL 1998d). A LPF of 1.0 is used for the elevated release. In addition, the fire is assumed to damage the HEPA filters and release contaminates from the offgas ventilation system. The inventory of radioactive materials in the filters and offgas ventilation system was conservatively represented by 500 g of Pu-239. The fire portion of the source term is the same as that developed for the incinerator explosion in Appendix Section E-5.4.1.6.

E-5.4.1.9.2 Consequence Analysis¾ The ground-level releases are distributed over the AMWTP facilities so that a co-located worker would not be expected to receive exposures from all the releases. Conservatively assuming a co-located worker received exposures from all ground-level and elevated releases, they would receive a radiological exposure as summarized in Table E-5-26. Involved workers depend on procedures, training, and personal protection equipment to minimize exposures.

E-5.4.1.9.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-26. All radiological and chemical exposures are below the evaluation guidelines.

E-5.4.1.9.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls, and defense in depth measures.

Safety-Class and Safety-Significant Structures, Systems, and Components. Evaluation guidelines are not exceeded, and no safety-class or safety-significant structures, systems, or components are required.

Table E-5-26. Accident consequences–design basis seismic event.[a]

	Locations			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	2.62	0.0931	0.0395	.0482
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2
Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	0.87	9.7E-04	2.6E-04	3.5E-04
Beryllium				
Evaluation guideline mg/m^3	0.1	0.025	0.025	0.025
Calculated mg/m^3	0.013	1.5E-05	4.0E-06	5.5E-06
Cadmium				

Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	0.21	2.6E-4	7.1E-05	9.6E-05
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25
Calculated mg/m^3	1.2	0.0016	3.8E-04	5.9E-04
Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	0.0026	6.7E-06	2.8E-06	3.3E-06
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	0.10	6.6E-05	2.8E-05	3.4E-05

a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent; ERPG - emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c. As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

Technical Safety Requirement Controls. No unique administrative controls were identified for the design basis earthquake. Waste at most risk is in transit or being loaded, and administrative controls to secure waste containers during transport have previously been identified.

Defense in Depth. Defense in depth measures to prevent or mitigate the consequences of a design basis earthquake include the following:

- Seismic facility design and design features
- Ventilation and filtration systems (retrieval enclosure, treatment facility)
- Fire detection and suppression systems including the DOE fire department
- Emergency and evacuation planning.

E-5.4.1.10 Nuclear Criticality in a Microencapsulation Ash Drum.

E-5.4.1.10.1 Source Term Analysis¾ Representative calculations were performed for prompt gamma and neutron exposures using the following algorithms and assuming 1.0E+19 fissions. This high number of fissions was selected to bound more typical excursions on the order of 1.0E+17 fissions where several criticality excursions could occur in one solution. Distances and shielding were selected to represent exposures in the central control room, and a co-located

worker 100 meters from the treatment facility.

The following semi-empirical equations may be used to provide an order-of-magnitude estimate for prompt gamma and neutron doses to personnel (BNFL 1998d).

Prompt gamma dose

$D\text{g} = 2.1E\text{-}20\ N^{d-2}\ e^{-3.4d}$

where:

*D*g = *gamma dose (rem),*

N = number of fissions,

D = distance source (km).

For gamma shielding by concrete, the dose is reduced by a factor of 2.5 for the first 8 inches, a factor of 5.0 for the first foot, and a factor of 5.5 for each additional foot (BNFL 1998d).

Prompt neutron dose

$D\text{h} = 7.0E\text{-}20\ N^{d-2}\ e^{-5.2d}$

where:

*D*h = *neutron dose (rem),*

N = number of fissions,

D = distance source (km).

For neutron shielding by concrete, the dose is reduced by a factor of 2.3 for the first 8 inches, a factor of 4.6 for the first foot, and a factor of 20 for each additional foot (BNFL 1998d).

The distance from the microencapsulation area to the central control room is 59 meters, with 5 intervening concrete walls about 8 inches thick. The source term for gaseous fission products released from the treatment facility stack consists of isotopes of krypton, xenon, and iodine. The inventory is based on guidance from NRC Regulatory Guide 3.35 (BNFL 1998d).

E-5.4.1.10.2 Consequence Analysis¾ Workers are not routinely in the vicinity of the microencapsulation process. If workers were in the microencapsulation room at the time of the criticality, they could receive fatal exposures. Likewise, workers in the microencapsulation cure area, the adjacent electrical room, or in the corridor outside the microencapsulation room at the time of the criticality could receive fatal or near-fatal exposures. Workers in the central control room would receive 0.2 rem. The consequences of a nuclear criticality in microencapsulation to co-located workers and members of the public are summarized in Table E-5-27. Members of the public receive direct neutron and gamma exposures of less than 0.6 m rem.

E-5.4.1.10.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-27. Evaluation guidelines for an unlikely event are not exceeded.

E-5.4.1.10.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Safety-Class and Safety-Significant Structures, Systems, and Components. Evaluation guidelines at the INEEL boundary are not exceeded, and no safety-class structures, systems, and components are required.

Technical Safety Requirement Controls. Technical safety requirements governing the operation of the radiological assay and fissile mass tracking system are discussed in Chapter 5 of the PSAR.

Table E-5-27. Accident consequences–nuclear criticality in a microencapsulation ash drum.[a]

	Location			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	25	b	b	5
Calculated TEDE, rem	20.2	0.0068	0.0024	0.0236[c]

a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent.

b. Evaluation guidelines do not exist for these locations; the exposures can be compared with the evaluation guideline for the nearest INEEL site boundary.

b. Nearest INEEL boundary doses are an order of magnitude higher than those at EBR-I and the rest area because of radionuclide ingestion.

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of a microencapsulation criticality include the following:

- Criticality incident detection system
- Radiation monitoring
- Microencapsulation Zone 3 glovebox and Zone 2 room boundaries
- Cascade ventilation system
- Waste characterization
- Emergency preparedness planning
- Personal protective equipment.

E-5.4.1.11 Vitrifier Explosion.

E-5.4.1.11.1 Source Term Analysis¾ The following factors were included in the computation of the source terms.

Material at Risk. The radionuclide content of the vitrifier is limited by criticality considerations. The MAR assumes that there is one kilogram of Pu-239 equivalent in the 18,000 kg of material in the vitrifier at the time of the explosion. It is assumed that all the radionuclides are present at the average concentration in TRU waste at the TSA. Other MARs that could be released in the explosion (loading on vitrifier offgas system filters, feed auger) is considered insignificant compared to the vitrifier. It is assumed that the majority of significant toxic compounds will have been removed from the MAR in the incineration process.

Damage Ratio. An explosion DR of 0.1 is estimated for the material in the vitrifier.

Airborne Release Fraction. The ARF for molten glass is 6.0E-03 based on DOE-HDBK-3010-94, Subsection 4.2.1.2.2. The ARF for any "cold cap" ash is also 6.0E-03 based on DOE-HDBK-3010-94, Section 4.4.1.1.

Respirable Fraction. The RF is 1.0 based on DOE-HDBK-3010-94, Section 4.2.1.2.2.

Leakpath Factor. The explosion is assumed to cause failure of the vitrifier cell and the cell and the roof above the vitrifier cell and/or the adjacent building doors (electrical equipment access door, northwest fire protection door), A LPF of 1.0 is conservatively assumed.

Using the above factors, the source term can be determined as shown in Table E-5-28.

E-5.4.1.11.2 Consequence Analysis¾ The source term is assumed to be released to the environment over a 1-hour period. The consequences of a vitrifier explosion are summarized in Table E-5-29.

Table E-5-28. Source terms - vitrifier explosion.

Nuclide/chemical	MAR (g)	DR	ARF/RF	LPF	Source (g)
Pu-241	2.88E+00	0.1	6.00E-03	1	1.73E-03
Am-241	5.48E-01	0.1	6.00E-03	1	3.29E-04
Pu-238	6.27E-01	0.1	6.00E-03	1	3.76E-04
Pu-239	9.08E+02	0.1	6.00E-03	1	5.45E-01
Pu-240	1.29E+00	0.1	6.00E-03	1	7.75E-04
U-233	8.67E+01	0.1	6.00E-03	1	5.20E-02
Cm-244	4.91E-04	0.1	6.00E-03	1	2.95E-07
Cs-134	6.33E-05	0.1	6.00E-03	1	3.80E-08

Cs-137	1.92E-02	0.1	6.00E-03	1	1.15E-05
Ba-137m	3.13E-09	0.1	6.00E-03	1	1.88E-12
Sr-90	1.09E-02	0.1	6.00E-03	1	6.54E-06
Y-90	2.76E-06	0.1	6.00E-03	1	1.66E-08
Co-60	6.54E-05	0.1	6.00E-03	1	3.83E-06
H-3	2.01E-05	0.1	6.00E-03	1	1.21E-06

Table E-5-29. Accident consequences - vitrifier explosion.

	Location			
	100 meters	EBR-1	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE[a], rem	0.00048	0.15	0.079	0.089

a. TEDE = Total Effective Dose Equivalent.

b. Evaluation guidelines do not exist at these locations; the exposures are compared to the evaluation guidelines for the nearest INEEL boundary.

E-5.4.1.11.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-29. Evaluation guidelines for an extremely unlikely event are not exceeded.

E-5.4.1.11.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems and components; technical safety requirements; and defense in depth.

Safety-Class and Safety Significant Structures, Systems and Components. Evaluation guidelines are not exceeded, and no safety-class or safety significant SSCs are required. Equipment important to safety include:

- The vitrifier
- The building structure.

Technical Safety Requirement Controls. Administrative controls that limit the total quantity of fissile material in the vitrifier have been identified and are currently under development.

Defense in Depth. Defense in depth to prevent and mitigate the consequences of a vitrifier explosion include:

- Emergency procedures

- Personal protective equipment.

E-5.4.1.12 Type II Module Fire.

E-5.4.1.12.1 Source Term Analysis¾ The following factors were included in the computation of the source term.

Material at Risk. The maximum TRU waste storage capacity of one Type II module is 19,320 drums or 2,640 boxes. The normal storage configuration in each Type II module, however, includes a combination of drums and boxes. An inventory of approximately 90 percent drums (11,040) and 10 percent boxes (1,056) is used based on the average distribution of TRU waste container types.

The MAR consists of a box component and a drum component. Because some boxes are combustible, only boxes with a combustibility index of 1 or 2 as defined in the PSAR (BNFL 1998d) are considered when developing the box MAR.

Wastes with the highest radionuclide inventory and categorized as combustible are preferentially selected for the MAR. The radioactive MAR is based on using the waste streams that would contribute the maximum dose. The relative radiation dose from each waste stream is ranked from greater doses to lesser doses. Beginning with the waste stream with the greatest dose and proceeding to the waste streams with lesser doses, the number of combustible boxes in each contributing waste stream is accumulated until enough waste streams have been accumulated to total 1,056 boxes. Similarly for drums, the number of drums, either combustible or noncombustible, in each contributing waste stream is accumulated until enough waste streams have been accumulated to total 11,040 drums. The radionuclide mass from each of these waste streams is summed to give the radioactive MAR for the scenario.

The hazardous MAR also consists of a box component and a drum component. The hazardous MAR is based on using the waste streams that would contribute the maximum quantity of each hazardous material. For each hazardous material identified in the PSAR (BNFL 1998d), the chemical concentration for boxes and drums is ranked from greatest to least. Beginning with the waste stream with the greatest concentration and proceeding to the waste streams with lesser concentrations, the number of combustible boxes in each contributing waste stream is accumulated until enough waste streams have been accumulated to total 1,056 boxes or until the supply of combustible boxes containing the chemical has been exhausted. Similarly for drums, the number of drums in each contributing waste stream is accumulated until enough waste streams have been accumulated to total 11,040 drums. The hazardous material mass from each of these waste streams is summed to give the maximum hazardous MAR for the scenario.

When exposed to heat and flame, halogenated compounds produce small quantities of phosgene compounds, and chlorinated hydrocarbons produce small quantities of halogenated acids. The analysis assumes that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire and that 10 percent of the chlorinated hydrocarbons in the MAR decompose to hydrochloric acid and that 1 percent of the halogenated compounds convert to phosgene gas with a molecular conversion ratio of 1.19 (BNFL 1998d).

The resulting MAR represents a bounding case for any potential combination of containers and waste streams placed in a Type II module. The likelihood of collecting the maximum amount of even one constituent in a Type II module at any given time is unlikely, and collecting all the postulated waste streams into one Type II module at any give time is extremely unlikely.

Damage Ratio. Combustible materials within the facility are kept at a minimum, and all waste is in containers. Even in a severe fire scenario, it is unreasonable to postulate that all containers in the Type II module would be involved in a fire.

If the fire were to occur in a typical configuration of boxes located between two typical configurations of drums, 88 boxes (2 rows x 4 high x 11 deep) and 230 drums (2 rows x 5 high x 23 deep) are estimated to be involved in the fire. The resulting involved fractions are 0.083 (88/1,056) and 0.021 (233/11,040) for the boxes and drums, respectively.

The fire is conservatively assumed to completely consume 88 boxes. Results of severe fire tests (documented in Section 7.3.9.2 of DOE [1994]) indicate that only a fraction of drums would be totally breached, some would be only

partly breached (lid seal failure) and some would remain intact. From this information, 25 percent of the drums are conservatively estimated to release material.

The resulting DRs for boxes and drums are as follows:

- Box DR = 0.083
- Drum DR = 0.25 x 0.021 = 0.005.

To incorporate the assumption that 89 percent of all halogenated compounds and chlorinated hydrocarbons decompose in the fire, the DR for halogenated compounds and chlorinated hydrocarbons is multiplied by 0.89 (BNFL 1998d).

Airborne Release Fraction. The bounding ARF for packaged waste is 5.0E-04 (Section 5.2.1.1 of DOE [1994]). The ARF is further defined in terms of combustibility. Using the data for individual waste streams allows the waste to be identified as either combustible (combustibility index of 1 or 2 in the PSAR [BNFL 1998d]) or noncombustible (combustibility index of 3 in the PSAR [BNFL 1998d]). The boxed waste in the Type II module scenario is selected from only combustible waste streams while the drummed waste is selected from both combustible and noncombustible waste streams. The ARF for a fire in contained combustible, surface-contaminated waste is 5.0E-04 (Section 5.2.1.1 of DOE [1994]) and the ARF for a fire in noncombustible surface contaminated waste is 6.0E-03 (Section 5.3.1 of DOE [1994]). Thus an ARF of 5.0E-04 is used for combustible waste and an ARF of 6.0E-03 is used for noncombustible waste.

Respirable Fraction. Using the data for individual waste streams allows the wastes to be identified as either combustible (combustibility index of 1 or 2 in the PSAR [BNFL 1998d]) or noncombustible (combustibility index of 3 in the PSAR [BNFL 1998d]). The RF for a fire in combustible uncontained, surface-contaminated waste is 1.0 (Section 5.2.1.1 of DOE [1994]). The RF for a fire in noncombustible surface contaminated waste is 0.01 (Section 5.3.1 of DOE [1994]).

Leakpath Factor. A major failure of the Type II module building structure is assumed to occur. The LPF is 1.0.

Using the above factors, bounding source terms were developed for radiological and hazardous constituents as shown in Table E-5-30 (BNFL 1998d). The source terms were applied to the unit-gram dose model for 50 percent and 95 percent meteorological conditions (BNFL 1998d). The consequences reported below select the higher exposures for the 50 percent and 95 percent meteorological conditions.

E-5.4.1.12.2 Consequence Analysis¾ The source term is assumed released to the environment over 1 hour. The consequences to co-located workers and members of the public of a Type II module fire are summarized in Table E-5-31. Involved workers depend on procedures, training and personal protection equipment to minimize exposures.

Table E-5-30. Source term——Type II module fire.[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Radionuclides from boxes							
ID-AEO-101T	Am-241	1.00E-01	8.30E-02	5.00E-04	1	1	4.17E-06
ID-AEO-110T	Am-241	3.60E-01	8.30E-02	5.00E-04	1	1	1.49E-05
ID-INL-155T	Am-241	2.33E+01	8.30E-02	5.00E-04	1	1	9.67E-04
ID-RFO-000T	Am-241	6.58E+01	8.30E-02	5.00E-04	1	1	2.73E-03
ID-RFO-119T	Am-241	3.88E-00	8.30E-02	5.00E-04	1	1	1.61E-04
ID-RFO-330T	Am-241	1.58E+02	8.30E-02	5.00E-04	1	1	6.57E-03
ID-RFO-335T	Am-241	3.64E-00	8.30E-02	5.00E-04	1	1	1.51E-04
ID-RFO-336T	Am-241	1.37E+02	8.30E-02	5.00E-04	1	1	5.69E-03
ID-RFO-337T	Am-241	1.33E+01	8.30E-02	5.00E-04	1	1	5.52E-04
ID-RFO-338T	Am-241	5.27E-02	8.30E-02	5.00E-04	1	1	2.19E-06
ID-RFO-339T	Am-241	9.66E-01	8.30E-02	5.00E-04	1	1	4.01E-05

ID-RFO-376T	Am-241	3.55E-00	8.30E-02	5.00E-04	1	1	1.47E-04

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-AEO-110T	Am-243	2.65E-02	8.30E-02	5.00E-04	1	1	1.10E-06
ID-AEO-101T	Np-237	1.94E+02	8.30E-02	5.00E-04	1	1	8.06E-03
ID-RFO-337T	Np-237	9.12E-01	8.30E-02	5.00E-04	1	1	3.78E-05
ID-INL-152TN	Pu-238	1.37E+02	8.30E-02	5.00E-04	1	1	5.70E-03
ID-INL-155T	Pu-238	1.30E-00	8.30E-02	5.00E-04	1	1	5.41E-05
ID-MDO-824T	Pu-238	9.51E+02	8.30E-02	5.00E-04	1	1	3.95E-02
ID-RFO-000T	Pu-238	7.30E-01	8.30E-02	5.00E-04	1	1	3.03E-05
ID-AEO-101T	Pu-239	7.23E+02	8.30E-02	5.00E-04	1	1	3.00E-02
ID-AEO-110T	Pu-239	2.56E+02	8.30E-02	5.00E-04	1	1	1.06E-02
ID-INL-152TN	Pu-239	1.72E+02	8.30E-02	5.00E-04	1	1	7.15E-03
ID-INL-155T	Pu-239	2.92E+02	8.30E-02	5.00E-04	1	1	1.21E-02
ID-MDO-824T	Pu-239	1.28E+03	8.30E-02	5.00E-04	1	1	5.30E-02
ID-RFO-000T	Pu-239	1.41E+03	8.30E-02	5.00E-04	1	1	5.84E-02
ID-AEO-101T	Pu-240	2.35E+03	8.30E-02	5.00E-04	1	1	9.76E-02
ID-INL-152TN	Pu-240	9.06E+01	8.30E-02	5.00E-04	1	1	3.76E-03
ID-INL-155T	Pu-240	5.07E+01	8.30E-02	5.00E-04	1	1	2.11E-03
ID-AEO-101T	Pu-241	4.80E-01	8.30E-02	5.00E-04	1	1	1.99E-05
ID-AEO-110T	Pu-241	1.56E-00	8.30E-02	5.00E-04	1	1	6.48E-05
ID-RFO-337T	Pu-242	2.60E-01	8.30E-02	5.00E-04	1	1	1.08E-05
ID-RFO-000T	Pu-52	1.69E+02	8.30E-02	5.00E-04	1	1	7.01E-03
ID-RFO-119T	Pu-52	8.57E+03	8.30E-02	5.00E-04	1	1	3.56E-01
ID-RFO-311TN	Pu-52	8.14E+02	8.30E-02	5.00E-04	1	1	3.38E-02
ID-RFO-330T	Pu-52	1.47E+04	8.30E-02	5.00E-04	1	1	6.12E-01
ID-RFO-335T	Pu-52	7.78E+02	8.30E-02	5.00E-04	1	1	3.23E-02
ID-RFO-336T	Pu-52	6.70E+03	8.30E-02	5.00E-04	1	1	2.78E-01
ID-RFO-337T	Pu-52	4.29E+02	8.30E-02	5.00E-04	1	1	1.78E-02
ID-RFO-338T	Pu-52	1.71E+03	8.30E-02	5.00E-04	1	1	7.10E-02
ID-RFO-339T	Pu-52	1.60E+03	8.30E-02	5.00E-04	1	1	6.65E-02
ID-RFO-376T	Pu-52	2.98E+03	8.30E-02	5.00E-04	1	1	1.24E-01
ID-MDO-824T	Pu-83	9.09E-00	8.30E-02	5.00E-04	1	1	3.77E-04
ID-INL-155T	Th-232	4.78E+03	8.30E-02	5.00E-04	1	1	1.98E-01
ID-AEO-101T	U-235	1.00E-00	8.30E-02	5.00E-04	1	1	4.15E-05
ID-INL-155T	U-235	1.11E+02	8.30E-02	5.00E-04	1	1	4.62E-03
ID-RFO-119T	U-235	2.72E+01	8.30E-02	5.00E-04	1	1	1.13E-03
ID-RFO-330T	U-235	1.73E+03	8.30E-02	5.00E-04	1	1	7.16E-02
ID-RFO-335T	U-235	1.69E+01	8.30E-02	5.00E-04	1	1	7.02E-04
ID-RFO-336T	U-235	2.57E+02	8.30E-02	5.00E-04	1	1	1.07E-02
ID-RFO-337T	U-235	1.17E-00	8.30E-02	5.00E-04	1	1	4.86E-05
ID-RFO-376T	U-235	3.03E-00	8.30E-02	5.00E-04	1	1	1.26E-04
ID-AEO-101T	U-238	3.06E+04	8.30E-02	5.00E-04	1	1	1.27E-00
ID-RFO-330T	U-238	3.62E-01	8.30E-02	5.00E-04	1	1	1.50E-05
ID-RFO-376T	U-238	9.21E-00	8.30E-02	5.00E-04	1	1	3.82E-04
Radionuclides from drums							
ID-MDO-802T	Am-241	4.00E-01	0.005	0.0005	1	1	1.00E-06
ID-MDO-803T	Am-241	1.00E-01	0.005	0.006	0.01	1	3.00E-08

ID-RFO-001T	Am-241	1.61E+04	0.005	0.006	0.01	1	4.83E-03
ID-RFO-005T	Am-241	7.20E-00	0.005	0.006	0.01	1	2.16E-06
ID-RFO-391TN	Am-241	9.07E+01	0.005	0.006	0.01	1	2.72E-05
ID-RFO-393TN	Am-241	3.65E-02	0.005	0.0005	1	1	9.13E-08
ID-RFO-409T	Am-241	2.17E+02	0.005	0.006	0.01	1	6.51E-05

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-414T	Am-241	2.60E-02	0.005	0.006	0.01	1	7.80E-09
ID-RFO-416TN	Am-241	3.10E+01	0.005	0.006	0.01	1	9.30E-06
ID-BTO-015TN	Pu-238	4.70E-00	0.005	0.006	0.01	1	1.41E-06
ID-INL-152TN	Pu-238	7.49E+01	0.005	0.0005	1	1	1.87E-04
ID-MDO-801T	Pu-238	2.76E+01	0.005	0.0005	1	1	6.90E-05
ID-MDO-802T	Pu-238	1.47E+02	0.005	0.0005	1	1	3.68E-04
ID-MDO-803T	Pu-238	1.42E+03	0.005	0.006	0.01	1	4.25E-04
ID-MDO-804TN	Pu-238	2.73E+02	0.005	0.0005	1	1	6.83E-04
ID-MDO-805T	Pu-238	2.61E+02	0.005	0.0005	1	1	6.51E-04
ID-MDO-810T	Pu-238	9.58E+01	0.005	0.006	0.01	1	2.87E-05
ID-MDO-811T	Pu-238	3.90E+01	0.005	0.006	0.01	1	1.17E-05
ID-MDO-813T	Pu-238	2.85E+01	0.005	0.0005	1	1	7.13E-05
ID-MDO-815T	Pu-238	8.00E-01	0.005	0.006	0.01	1	2.40E-07
ID-MDO-825TN	Pu-238	1.24E+02	0.005	0.006	0.01	1	3.72E-05
ID-MDO-836T	Pu-238	1.59E+01	0.005	0.006	0.01	1	4.77E-06
ID-MDO-848T	Pu-238	8.30E-00	0.005	0.006	0.01	1	2.49E-06
ID-AEO-106T	Pu-239	1.96E+02	0.005	0.006	0.01	1	5.88E-05
ID-BTO-030	Pu-239	1.56E-01	0.005	0.006	0.01	1	4.67E-08
ID-INL-152TN	Pu-239	9.40E+01	0.005	0.0005	1	1	2.35E-04
ID-MDO-802T	Pu-239	2.89E+02	0.005	0.0005	1	1	7.23E-04
ID-MDO-803T	Pu-239	2.71E+03	0.005	0.006	0.01	1	8.12E-04
ID-MDO-805T	Pu-239	4.35E+02	0.005	0.0005	1	1	1.09E-03
ID-MDO-810T	Pu-239	1.90E+02	0.005	0.006	0.01	1	5.70E-05
ID-MDO-811T	Pu-239	8.00E+01	0.005	0.006	0.01	1	2.40E-05
ID-MDO-813T	Pu-239	7.00E+01	0.005	0.0005	1	1	1.75E-04
ID-MDO-814T	Pu-239	1.11E+02	0.005	0.006	0.01	1	3.33E-05
ID-MDO-825TN	Pu-239	2.01E+02	0.005	0.006	0.01	1	6.03E-05
ID-MDO-848T	Pu-239	1.00E-00	0.005	0.006	0.01	1	3.00E-07
ID-AEO-106T	Pu-240	1.64E+02	0.005	0.006	0.01	1	4.92E-05
ID-INL-152TN	Pu-240	4.94E+01	0.005	0.0005	1	1	1.23E-04
ID-MDO-802T	Pu-240	1.70E+02	0.005	0.0005	1	1	4.25E-04
ID-MDO-814T	Pu-240	7.00E+01	0.005	0.006	0.01	1	2.10E-05
ID-MDO-825TN	Pu-240	1.14E+01	0.005	0.006	0.01	1	3.43E-06
ID-MDO-825TN	Pu-52	3.01E-01	0.005	0.006	0.01	1	9.04E-08
ID-RFO-001T	Pu-52	4.21E+04	0.005	0.006	0.01	1	1.26E-02
ID-RFO-005T	Pu-52	5.40E-00	0.005	0.006	0.01	1	1.62E-06
ID-RFO-361TN	Pu-52	1.99E+02	0.005	0.006	0.01	1	5.97E-05
ID-RFO-375T	Pu-52	3.07E+02	0.005	0.006	0.01	1	9.21E-05
ID-RFO-391TN	Pu-52	1.07E+03	0.005	0.006	0.01	1	3.20E-04
ID-RFO-392TN	Pu-52	1.23E+03	0.005	0.006	0.01	1	3.70E-04
ID-RFO-393TN	Pu-52	7.00E+03	0.005	0.0005	1	1	1.75E-02
ID-RFO-409T	Pu-52	4.08E+03	0.005	0.006	0.01	1	1.22E-03
ID-RFO-411TN	Pu-52	6.36E+02	0.005	0.006	0.01	1	1.91E-04
ID-RFO-414T	Pu-52	7.66E+02	0.005	0.006	0.01	1	2.30E-04
ID-RFO-416TN	Pu-52	1.70E+02	0.005	0.006	0.01	1	5.10E-05
ID-RFO-421TN	Pu-52	1.78E+04	0.005	0.006	0.01	1	5.33E-03

ID-RFO-430T	Pu-52	2.72E+03	0.005	0.0005	1	1	6.79E-03
ID-MDO-801T	Pu-83	4.43E-01	0.005	0.0005	1	1	1.11E-06
ID-MDO-803T	Pu-83	6.58E+01	0.005	0.006	0.01	1	1.97E-05
ID-MDO-825TN	Pu-83	1.74E+01	0.005	0.006	0.01	1	5.21E-06
ID-MDO-836T	Pu-83	5.57E-01	0.005	0.006	0.01	1	1.67E-07
ID-BTO-030	Th-232	1.07E+06	0.005	0.006	0.01	1	3.22E-01

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
Hazardous materials from boxes							
ID-BTO-030	U-233	6.14E+03	0.005	0.006	0.01	1	1.84E-03
ID-AEO-110T	Acetone	1.03E+04	0.083	5.00E-04	1	1	4.27E-01
ID-RFO-337	Acetone	3.80E+04	0.083	5.00E-04	1	1	1.58E-00
ID-RFO-339T	Acetone	3.50E+04	0.083	5.00E-04	1	1	1.45E-00
ID-RFO-337T	Acetone	5.90E+04	0.083	5.00E-04	1	1	2.45E-00
ID-RFO-336	Acetone	1.80E+05	0.083	5.00E-04	1	1	7.47E-00
ID-RFO-336T	Acetone	1.38E+06	0.083	5.00E-04	1	1	5.72E+01
ID-RFO-335T	Acetone	3.30E+04	0.083	5.00E-04	1	1	1.37E-00
ID-AEO-110T	Arsenic	1.03E+04	0.083	5.00E-04	1	1	4.27E-01
ID-RFO-338T	Asbestos	2.76E+06	0.083	5.00E-04	1	1	1.15E+02
ID-RFO-338	Asbestos	3.92E+07	0.083	5.00E-04	1	1	1.63E+03
ID-RFO-360	Asbestos	5.04E+05	0.083	5.00E-04	1	1	2.09E+01
ID-RFO-490T	Asbestos	3.36E+08	0.083	5.00E-04	1	1	1.40E+04
ID-RFO-490	Asbestos	7.90E+07	0.083	5.00E-04	1	1	3.28E+03
ID-MDO-824T	Barium	1.35E+06	0.083	5.00E-04	1	1	5.59E+01
ID-RFO-337	Benzene	3.80E+04	0.083	5.00E-04	1	1	1.58E-00
ID-RFO-338T	Benzene	4.60E+04	0.083	5.00E-04	1	1	1.91E-00
ID-RFO-338	Benzene	6.53E+05	0.083	5.00E-04	1	1	2.71E+01
ID-RFO-339T	Benzene	3.50E+04	0.083	5.00E-04	1	1	1.45E-00
ID-RFO-330	Benzene	6.10E+06	0.083	5.00E-04	1	1	2.53E+02
ID-RFO-337T	Benzene	5.90E+04	0.083	5.00E-04	1	1	2.45E-00
ID-RFO-330T	Benzene	1.96E+06	0.083	5.00E-04	1	1	8.13E+01
ID-RFO-000T	Beryllium	6.76E+05	0.083	5.00E-04	1	1	2.81E+01
ID-CPP-156	Butyl alcohol, n-	1.10E+05	0.083	5.00E-04	1	1	4.57E-00
ID-RFO-000T	Butyl alcohol, n-	6.76E+05	0.083	5.00E-04	1	1	2.81E+01
ID-BCO-202	Butyl alcohol, n-	2.76E+04	0.083	5.00E-04	1	1	1.15E-00
ID-INL-155	Butyl alcohol, n-	6.80E+02	0.083	5.00E-04	1	1	2.82E-02
ID-MDO-824T	Cadmium & compounds	1.35E+06	0.083	5.00E-04	1	1	5.59E+01
ID-AEO-110T	Cadmium & compounds	1.03E+04	0.083	5.00E-04	1	1	4.27E-01
ID-RFO-000T	Cadmium & compounds	6.76E+05	0.083	5.00E-04	1	1	2.81E+01
ID-CPP-156	Carbon tetrachloride	1.10E+06	0.07387	5.00E-04	1	1	4.06E+01
ID-RFO-000T	Carbon tetrachloride	6.76E+06	0.07387	5.00E-04	1	1	2.50E+02
ID-BCO-202	Carbon tetrachloride	2.76E+05	0.07387	5.00E-04	1	1	1.02E+01
ID-RFO-302T	Carbon tetrachloride	1.19E+05	0.07387	5.00E-04	1	1	4.40E-00
ID-RFO-376	Carbon tetrachloride	3.90E+04	0.07387	5.00E-04	1	1	1.44E-00
ID-RFO-302	Carbon tetrachloride	2.99E+05	0.07387	5.00E-04	1	1	1.10E+01
ID-RFO-116	Carbon tetrachloride	1.79E+06	0.07387	5.00E-04	1	1	6.62E+01
ID-RFO-116T	Carbon tetrachloride	1.20E+07	0.07387	5.00E-04	1	1	4.43E+02
ID-RFO-337	Chloroform	3.80E+04	0.07387	5.00E-04	1	1	1.40E-00
ID-RFO-338T	Chloroform	4.60E+04	0.07387	5.00E-04	1	1	1.70E-00
ID-RFO-338	Chloroform	6.53E+05	0.07387	5.00E-04	1	1	2.41E+01
ID-RFO-339T	Chloroform	3.50E+04	0.07387	5.00E-04	1	1	1.29E-00
ID-RFO-330	Chloroform	6.10E+06	0.07387	5.00E-04	1	1	2.25E+02

ID-RFO-337T	Chloroform	5.90E+04	0.07387	5.00E-04	1	1	2.18E-00
ID-RFO-336	Chloroform	1.80E+05	0.07387	5.00E-04	1	1	6.65E-00
ID-RFO-330T	Chloroform	1.79E+06	0.07387	5.00E-04	1	1	6.61E+01
ID-MDO-824T	Chromium	1.35E+06	0.083	5.00E-04	1	1	5.59E+01
ID-RFO-337	Ethyl benzene	3.80E+04	0.083	5.00E-04	1	1	1.58E-00
ID-RFO-339T	Ethyl benzene	3.50E+04	0.083	5.00E-04	1	1	1.45E-00
ID-RFO-330	Ethyl benzene	6.10E+06	0.083	5.00E-04	1	1	2.53E+02

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-337T	Ethyl benzene	5.90E+04	0.083	5.00E-04	1	1	2.45E-00
ID-RFO-330T	Ethyl benzene	2.57E+06	0.083	5.00E-04	1	1	1.06E+02
ID-AEO-100T	Ethyl ether	2.36E+06	0.083	5.00E-04	1	1	9.77E+01
ID-AEO-100	Ethyl ether	8.58E+05	0.083	5.00E-04	1	1	3.56E+01
ID-RFO-338T	Ethylene dichloride	4.60E+04	0.07387	5.00E-04	1	1	1.70E-00
ID-RFO-338	Ethylene dichloride	6.53E+05	0.07387	5.00E-04	1	1	2.41E+01
ID-RFO-339T	Ethylene dichloride	3.50E+04	0.07387	5.00E-04	1	1	1.29E-00
ID-RFO-335T	Ethylene dichloride	3.30E+04	0.07387	5.00E-04	1	1	1.22E-00
ID-RFO-302T	Lead	4.76E+06	0.083	5.00E-04	1	1	1.98E+02
ID-RFO-302	Lead	1.20E+07	0.083	5.00E-04	1	1	4.96E+02
ID-RFO-339T	Lead	2.10E+06	0.083	5.00E-04	1	1	8.72E+01
ID-INL-155T	Lead	1.53E+06	0.083	5.00E-04	1	1	6.35E+01
ID-BCO-202T	Lead	2.07E+05	0.083	5.00E-04	1	1	8.59E-00
ID-AEO-101T	Lead	7.20E+06	0.083	5.00E-04	1	1	2.99E+02
ID-BCO-201T	Lead	1.90E+06	0.083	5.00E-04	1	1	7.89E+01
ID-BCO-201	Lead	2.61E+06	0.083	5.00E-04	1	1	1.08E+02
ID-AEO-104T	Lead	5.60E+05	0.083	5.00E-04	1	1	2.32E+01
ID-AEO-104	Lead	1.10E+05	0.083	5.00E-04	1	1	4.57E-00
ID-AEO-101	Lead	1.04E+06	0.083	5.00E-04	1	1	4.33E+01
ID-RFO-000T	Lead	6.76E+06	0.083	5.00E-04	1	1	2.81E+02
ID-RFO-116	Lead	1.79E+06	0.083	5.00E-04	1	1	7.43E+01
ID-INL-142T	Lead	6.03E+04	0.083	5.00E-04	1	1	2.50E-00
ID-RFO-116T	Lead	1.02E+07	0.083	5.00E-04	1	1	4.21E+02
ID-MDO-826	Mercury (elemental & inorganic)	3.22E+02	0.083	5.00E-04	1	1	1.34E-02
ID-MDO-826T	Mercury (elemental & inorganic)	2.69E+03	0.083	5.00E-04	1	1	1.11E-01
ID-MDO-824T	Mercury (elemental & inorganic)	3.76E+02	0.083	5.00E-04	1	1	1.56E-02
ID-CPP-156	Methyl alcohol	1.10E+05	0.083	5.00E-04	1	1	4.57E-00
ID-RFO-337	Methyl alcohol	3.80E+04	0.083	5.00E-04	1	1	1.58E-00
ID-RFO-000T	Methyl alcohol	6.76E+05	0.083	5.00E-04	1	1	2.81E+01
ID-RFO-337T	Methyl alcohol	5.90E+04	0.083	5.00E-04	1	1	2.45E-00
ID-BCO-202	Methyl alcohol	2.76E+04	0.083	5.00E-04	1	1	1.15E-00
ID-INL-155	Methyl alcohol	6.80E+02	0.083	5.00E-04	1	1	2.82E-02
ID-RFO-376	Methylene chloride	3.90E+04	0.07387	5.00E-04	1	1	1.44E-00
ID-RFO-116T	Methylene chloride	1.24E+07	0.07387	5.00E-04	1	1	4.59E+02
ID-CPP-156	Methylene chloride	1.10E+05	0.07387	5.00E-04	1	1	4.06E-00
ID-RFO-970T	Methylene chloride	3.30E+05	0.07387	5.00E-04	1	1	1.22E+01
ID-RFO-970	Methylene chloride	2.66E+05	0.07387	5.00E-04	1	1	9.82E-00
ID-RFO-337	Methylene chloride	3.80E+04	0.07387	5.00E-04	1	1	1.40E-00
ID-RFO-338T	Methylene chloride	4.60E+04	0.07387	5.00E-04	1	1	1.70E-00
ID-RFO-338	Methylene chloride	6.53E+05	0.07387	5.00E-04	1	1	2.41E+01
ID-RFO-339T	Methylene chloride	3.50E+04	0.07387	5.00E-04	1	1	1.29E-00
ID-RFO-900	Methylene chloride	5.18E+04	0.07387	5.00E-04	1	1	1.91E-00

ID-RFO-330	Methylene chloride	3.52E+05	0.07387	5.00E-04	1	1	1.30E+01
ID-CPP-156	Nitric acid	1.10E+05	0.083	5.00E-04	1	1	4.57E-00
ID-RFO-000T	Nitric acid	6.76E+05	0.083	5.00E-04	1	1	2.81E+01
ID-BCO-202	Nitric acid	2.76E+04	0.083	5.00E-04	1	1	1.15E-00
ID-INL-155	Nitric acid	6.80E+02	0.083	5.00E-04	1	1	2.82E-02
ID-RFO-337	Perchloroethylene	3.80E+04	0.07387	5.00E-04	1	1	1.40E-00
ID-RFO-338T	Perchloroethylene	4.60E+04	0.07387	5.00E-04	1	1	1.70E-00
ID-RFO-338	Perchloroethylene	6.53E+05	0.07387	5.00E-04	1	1	2.41E+01
ID-RFO-330	Perchloroethylene	6.10E+06	0.07387	5.00E-04	1	1	2.25E+02

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-000T	Perchloroethylene	6.76E+05	0.07387	5.00E-04	1	1	2.50E+01
ID-RFO-337T	Perchloroethylene	5.90E+04	0.07387	5.00E-04	1	1	2.18E-00
ID-RFO-336	Perchloroethylene	1.80E+05	0.07387	5.00E-04	1	1	6.65E-00
ID-RFO-330T	Perchloroethylene	1.20E+06	0.07387	5.00E-04	1	1	4.44E+01
ID-RFO-000T	Polychlorinated biphenyl	5.68E+04	0.07387	5.00E-04	1	1	2.10E-00
ID-MDO-824T	Selenium	1.35E+06	0.083	5.00E-04	1	1	5.59E+01
ID-MDO-824T	Silver	1.35E+06	0.083	5.00E-04	1	1	5.59E+01
ID-RFO-337	Toluene	3.80E+04	0.083	5.00E-04	1	1	1.58E-00
ID-RFO-338T	Toluene	4.60E+04	0.083	5.00E-04	1	1	1.91E-00
ID-RFO-338	Toluene	6.53E+05	0.083	5.00E-04	1	1	2.71E+01
ID-RFO-339T	Toluene	3.50E+04	0.083	5.00E-04	1	1	1.45E-00
ID-RFO-330	Toluene	6.10E+06	0.083	5.00E-04	1	1	2.53E+02
ID-RFO-337T	Toluene	5.90E+04	0.083	5.00E-04	1	1	2.45E-00
ID-RFO-336	Toluene	1.80E+05	0.083	5.00E-04	1	1	7.47E-00
ID-RFO-330T	Toluene	1.79E+06	0.083	5.00E-04	1	1	7.42E+01
ID-RFO-302T	Trichloroethane, 1,1,1-	1.19E+05	0.07387	5.00E-04	1	1	4.40E-00
ID-RFO-376	Trichloroethane, 1,1,1-	3.90E+04	0.07387	5.00E-04	1	1	1.44E-00
ID-RFO-302	Trichloroethane, 1,1,1-	2.99E+05	0.07387	5.00E-04	1	1	1.10E+01
ID-RFO-116	Trichloroethane, 1,1,1-	1.79E+06	0.07387	5.00E-04	1	1	6.62E+01
ID-RFO-116T	Trichloroethane, 1,1,1-	1.24E+07	0.07387	5.00E-04	1	1	4.59E+02
ID-CPP-156	Trichloroethane, 1,1,1-	1.10E+05	0.07387	5.00E-04	1	1	4.06E-00
ID-RFO-970T	Trichloroethane, 1,1,1-	3.30E+05	0.07387	5.00E-04	1	1	1.22E+01
ID-RFO-970	Trichloroethane, 1,1,1	2.00E+05	0.07387	5.00E-04	1	1	7.37E-00
ID-RFO-302T	Trichloroethylene	1.19E+05	0.07387	5.00E-04	1	1	4.40E-00
ID-RFO-302	Trichloroethylene	2.99E+05	0.07387	5.00E-04	1	1	1.10E+01
ID-RFO-116	Trichloroethylene	1.79E+06	0.07387	5.00E-04	1	1	6.62E+01
ID-RFO-116T	Trichloroethylene	1.24E+07	0.07387	5.00E-04	1	1	4.59E+02
ID-RFO-970T	Trichloroethylene	3.30E+05	0.07387	5.00E-04	1	1	1.22E+01
ID-RFO-970	Trichloroethylene	2.66E+05	0.07387	5.00E-04	1	1	9.82E-00
ID-RFO-337	Trichloroethylene	3.80E+04	0.07387	5.00E-04	1	1	1.40E-00
ID-RFO-376	Trichlorotrifluroethane	3.90E+04	0.07387	5.00E-04	1	1	1.44E-00
ID-RFO-116	Trichlorotrifluroethane	1.79E+06	0.07387	5.00E-04	1	1	6.62E+01
ID-RFO-116T	Trichlorotrifluroethane	1.24E+07	0.07387	5.00E-04	1	1	4.59E+02
ID-CPP-156	Trichlorotrifluroethane	1.10E+05	0.07387	5.00E-04	1	1	4.06E-00
ID-RFO-970T	Trichlorotrifluroethane	3.30E+05	0.07387	5.00E-04	1	1	1.22E+01
ID-RFO-970	Trichlorotrifluroethane	2.66E+05	0.07387	5.00E-04	1	1	9.82E-00
ID-RFO-337	Trichlorotrifluroethane	3.80E+04	0.07387	5.00E-04	1	1	1.40E-00
ID-RFO-338T	Trichlorotrifluroethane	4.60E+04	0.07387	5.00E-04	1	1	1.70E-00
ID-RFO-338	Trichlorotrifluroethane	6.26E+04	0.07387	5.00E-04	1	1	2.31E-00
ID-RFO-337	Vinylidene chloride	3.80E+04	0.07387	5.00E-04	1	1	1.40E-00
ID-RFO-338T	Vinylidene chloride	4.60E+04	0.07387	5.00E-04	1	1	1.70E-00

ID-RFO-338	Vinylidene chloride	6.53E+05	0.07387	5.00E-04	1	1	2.41E+01
ID-RFO-339T	Vinylidene chloride	3.50E+04	0.07387	5.00E-04	1	1	1.29E-00
ID-RFO-330	Vinylidene chloride	6.10E+06	0.07387	5.00E-04	1	1	2.25E+02
ID-RFO-337T	Vinylidene chloride	5.90E+04	0.07387	5.00E-04	1	1	2.18E-00
ID-RFO-330T	Vinylidene chloride	1.96E+06	0.07387	5.00E-04	1	1	7.24E+01
ID-CPP-156	Xylene	1.10E+05	0.083	5.00E-04	1	1	4.57E-00
ID-RFO-970T	Xylene	3.30E+05	0.083	5.00E-04	1	1	1.37E+01
ID-RFO-970	Xylene	2.66E+05	0.083	5.00E-04	1	1	1.10E+01
ID-RFO-337	Xylene	3.80E+04	0.083	5.00E-04	1	1	1.58E-00
ID-RFO-339T	Xylene	3.50E+04	0.083	5.00E-04	1	1	1.45E-00

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-900	Xylene	5.18E+04	0.083	5.00E-04	1	1	2.15E-00
ID-RFO-330	Xylene	6.10E+06	0.083	5.00E-04	1	1	2.53E+02
ID-RFO-000T	Xylene	6.76E+05	0.083	5.00E-04	1	1	2.81E+01
ID-RFO-337T	Xylene	5.90E+04	0.083	5.00E-04	1	1	2.45E-00
ID-RFO-336	Xylene	1.80E+05	0.083	5.00E-04	1	1	7.47E-00
ID-RFO-330T	Xylene	1.18E+06	0.083	5.00E-04	1	1	4.89E+01
Hazardous materials from drums							
ID-MDO-836T	Acetone	7.50E+04	0.005	0.006	0.01	1	2.25E-02
ID-MDO-836	Acetone	1.19E+07	0.005	0.006	0.01	1	3.57E-00
ID-TAN-162	Acetone	7.12E+04	0.005	0.006	0.01	1	2.14E-02
ID-RFO-339T	Acetone	1.05E+06	0.005	0.0005	1	1	2.62E-00
ID-AEO-110T	Acetone	3.00E+03	0.005	0.0005	1	1	7.50E-03
ID-RFO-339	Acetone	3.40E+04	0.005	0.0005	1	1	8.50E-02
ID-RFO-480	Acetone	1.70E+06	0.005	0.006	0.01	1	5.10E-01
ID-RFO-480T	Acetone	1.10E+06	0.005	0.006	0.01	1	3.30E-01
ID-RFO-442T	Acetone	5.38E+05	0.005	0.006	0.01	1	1.61E-01
ID-RFO-336	Acetone	2.64E+06	0.005	0.0005	1	1	6.60E-00
ID-OFS-111	Arsenic	2.90E+06	0.005	0.006	0.01	1	8.70E-01
ID-TAN-162	Arsenic	7.12E+04	0.005	0.006	0.01	1	2.14E-02
ID-OFS-111T	Arsenic	5.35E+06	0.005	0.006	0.01	1	1.61E-00
ID-AEO-110T	Arsenic	3.00E+03	0.005	0.0005	1	1	7.50E-03
ID-AEO-120T	Arsenic	1.50E+03	0.005	0.0005	1	1	3.75E-03
ID-OFS-121	Arsenic	4.40E+02	0.005	0.006	0.01	1	1.32E-04
ID-OFS-121T	Arsenic	0.00E+01	0.005	0.006	0.01	1	0.00E+01
ID-RFO-338	Asbestos	2.04E+06	0.005	0.0005	1	1	5.10E-00
ID-RFO-338T	Asbestos	9.44E+06	0.005	0.0005	1	1	2.36E+01
ID-RFO-490	Asbestos	3.40E+05	0.005	0.0005	1	1	8.50E-01
ID-RFO-335	Asbestos	3.30E+06	0.005	0.0005	1	1	8.25E-00
ID-RFO-490T	Asbestos	2.82E+06	0.005	0.0005	1	1	7.05E-00
ID-RFO-335T	Asbestos	1.93E+06	0.005	0.0005	1	1	4.83E-00
ID-RFO-360T	Asbestos	6.24E+05	0.005	0.0005	1	1	1.56E-00
ID-RFO-360	Asbestos	8.68E+06	0.005	0.0005	1	1	2.17E+01
ID-RFO-119T	Asbestos	7.86E+06	0.005	0.0005	1	1	1.96E+01
ID-MDO-805T	Asbestos	1.25E+06	0.005	0.0005	1	1	3.13E-00
ID-RFO-119	Asbestos	2.85E+06	0.005	0.0005	1	1	7.13E-00
ID-RFO-376T	Asbestos	1.69E+07	0.005	0.0005	1	1	4.22E+01
ID-RFO-376	Asbestos	3.20E+06	0.005	0.0005	1	1	8.00E-00
ID-RFO-002	Barium	4.10E+06	0.005	0.006	0.01	1	1.23E-00
ID-RFO-003T	Barium	6.23E+06	0.005	0.006	0.01	1	1.87E-00
ID-RFO-002T	Barium	1.40E+07	0.005	0.006	0.01	1	4.21E-00
ID-OFS-111	Barium	1.57E+06	0.005	0.006	0.01	1	4.71E-01

ID-RFO-339T	Benzene	1.05E+06	0.005	0.0005	1	1	2.62E-00
ID-RFO-339	Benzene	3.40E+04	0.005	0.0005	1	1	8.50E-02
ID-RFO-300T	Benzene	2.05E+06	0.005	0.006	0.01	1	6.14E-01
ID-RFO-480	Benzene	1.70E+06	0.005	0.006	0.01	1	5.10E-01
ID-RFO-300	Benzene	9.60E+04	0.005	0.006	0.01	1	2.88E-02
ID-RFO-480T	Benzene	1.10E+06	0.005	0.006	0.01	1	3.30E-01
ID-RFO-330T	Benzene	8.72E+05	0.005	0.0005	1	1	2.18E-00
ID-RFO-442T	Benzene	5.38E+05	0.005	0.006	0.01	1	1.61E-01
ID-RFO-442	Benzene	5.50E+05	0.005	0.006	0.01	1	1.65E-01
ID-RFO-330	Benzene	2.98E+06	0.005	0.0005	1	1	7.44E-00

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-9999	Beryllium	1.14E+07	0.005	0.0005	1	1	2.86E+01
ID-TAN-162	Butanone, 2-; (MEK)	7.12E+04	0.005	0.006	0.01	1	2.14E-02
ID-OFS-111	Butyl alcohol, n-	5.80E+06	0.005	0.006	0.01	1	1.74E-00
ID-OFS-111T	Butyl alcohol, n-	1.07E+07	0.005	0.006	0.01	1	3.21E-00
ID-RFO-113	Butyl alcohol, n-	3.60E+04	0.005	0.006	0.01	1	1.08E-02
ID-RFO-113T	Butyl alcohol, n-	1.97E+05	0.005	0.006	0.01	1	5.90E-02
ID-RFO-090	Butyl alcohol, n-	3.80E+05	0.005	0.006	0.01	1	1.14E-01
ID-RFO-004T	Butyl alcohol, n-	2.85E+06	0.005	0.006	0.01	1	8.56E-01
ID-RFO-004	Butyl alcohol, n-	1.30E+06	0.005	0.006	0.01	1	3.90E-01
ID-RFO-990	Butyl alcohol, n-	1.20E+06	0.005	0.006	0.01	1	3.60E-01
ID-RFO-002	Butyl alcohol, n-	4.10E+06	0.005	0.006	0.01	1	1.23E-00
ID-BCO-204	Butyl alcohol, n-	7.29E+03	0.005	0.006	0.01	1	2.19E-03
ID-RFO-002T	Butyl alcohol, n-	7.48E+06	0.005	0.006	0.01	1	2.24E-00
ID-OFS-111	Cadmium & compounds	5.80E+06	0.005	0.006	0.01	1	1.74E-00
ID-OFS-121	Cadmium & compounds	4.40E+03	0.005	0.006	0.01	1	1.32E-03
ID-OFS-111T	Cadmium & compounds	1.07E+07	0.005	0.006	0.01	1	3.21E-00
ID-MDO-836T	Cadmium & compounds	7.50E+04	0.005	0.006	0.01	1	2.25E-02
ID-MDO-836	Cadmium & compounds	1.19E+07	0.005	0.006	0.01	1	3.57E-00
ID-RFO-004T	Cadmium & compounds	2.85E+06	0.005	0.006	0.01	1	8.56E-01
ID-RFO-004	Cadmium & compounds	1.30E+06	0.005	0.006	0.01	1	3.90E-01
ID-RFO-002	Cadmium & compounds	3.53E+06	0.005	0.006	0.01	1	1.06E-00
ID-RFO-112T	Carbon tetrachloride	1.92E+07	0.00445	0.006	0.01	1	5.12E-00
ID-BCO-204	Carbon tetrachloride	7.29E+04	0.00445	0.006	0.01	1	1.95E-02
ID-RFO-003T	Carbon tetrachloride	6.23E+07	0.00445	0.006	0.01	1	1.66E+01
ID-RFO-003	Carbon tetrachloride	1.00E+08	0.00445	0.006	0.01	1	2.67E+01
ID-RFO-112	Carbon tetrachloride	4.30E+05	0.00445	0.006	0.01	1	1.15E-01
ID-MDO-838	Carbon tetrachloride	1.50E+04	0.00445	0.0005	1	1	3.34E-02
ID-INL-155	Carbon tetrachloride	7.60E+04	0.00445	0.0005	1	1	1.69E-01
ID-MDO-847	Carbon tetrachloride	8.47E+06	0.00445	0.0005	1	1	1.88E+01
ID-AEO-102	Carbon tetrachloride	5.00E+05	0.00445	0.006	0.01	1	1.34E-01
ID-RFO-9999	Carbon tetrachloride	2.31E+07	0.00445	0.0005	1	1	5.15E+01
ID-RFO-112T	Chloroform	1.92E+07	0.00445	0.006	0.01	1	5.12E-00
ID-RFO-112	Chloroform	4.30E+05	0.00445	0.006	0.01	1	1.15E-01
ID-RFO-700T	Chloroform	2.40E+04	0.00445	0.006	0.01	1	6.41E-03
ID-RFO-002	Chloroform	4.10E+06	0.00445	0.006	0.01	1	1.09E-00
ID-RFO-002T	Chloroform	1.40E+07	0.00445	0.006	0.01	1	3.74E-00

ID-RFO-007T	Chloroform	4.82E+06	0.00445	0.006	0.01	1	1.29E-00
ID-OFS-111	Chloroform	7.38E+05	0.00445	0.006	0.01	1	1.97E-01
ID-MDO-836T	Chromium	7.50E+04	0.005	0.006	0.01	1	2.25E-02
ID-MDO-836	Chromium	1.19E+07	0.005	0.006	0.01	1	3.57E-00
ID-RFO-002	Chromium	4.10E+06	0.005	0.006	0.01	1	1.23E-00
ID-RFO-002T	Chromium	1.20E+07	0.005	0.006	0.01	1	3.61E-00
ID-TAN-162	Dichlorobenzene, p-	7.12E+04	0.00445	0.006	0.01	1	1.90E-02
ID-OFS-111T	Ethyl benzene	1.07E+07	0.005	0.006	0.01	1	3.21E-00
ID-OFS-111	Ethyl benzene	2.90E+06	0.005	0.006	0.01	1	8.70E-01
ID-RFO-339T	Ethyl benzene	1.05E+06	0.005	0.0005	1	1	2.62E-00
ID-RFO-339	Ethyl benzene	3.40E+04	0.005	0.0005	1	1	8.50E-02
ID-RFO-480	Ethyl benzene	1.70E+06	0.005	0.006	0.01	1	5.10E-01

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-480T	Ethyl benzene	1.10E+06	0.005	0.006	0.01	1	3.30E-01
ID-RFO-330T	Ethyl benzene	8.72E+05	0.005	0.0005	1	1	2.18E-00
ID-RFO-330	Ethyl benzene	2.37E+06	0.005	0.0005	1	1	5.92E-00
ID-AEO-100T	Ethyl ether	1.20E+03	0.005	0.0005	1	1	3.00E-03
ID-RFO-002	Ethylene dichloride	4.10E+06	0.00445	0.006	0.01	1	1.09E-00
ID-RFO-002T	Ethylene dichloride	1.40E+07	0.00445	0.006	0.01	1	3.74E-00
ID-RFO-007T	Ethylene dichloride	4.82E+06	0.00445	0.006	0.01	1	1.29E-00
ID-OFS-111	Ethylene dichloride	2.52E+06	0.00445	0.006	0.01	1	6.72E-01
ID-RFO-463T	Lead	5.03E+06	0.005	0.0005	1	1	1.26E+01
ID-RFO-339T	Lead	6.29E+07	0.005	0.0005	1	1	1.57E+02
ID-RFO-339	Lead	2.04E+06	0.005	0.0005	1	1	5.10E-00
ID-BCO-204T	Lead	2.91E+05	0.005	0.006	0.01	1	8.74E-02
ID-RFO-463	Lead	2.82E+05	0.005	0.0005	1	1	7.05E-01
ID-RFO-464	Lead	9.60E+05	0.005	0.0005	1	1	2.40E-00
ID-RFO-302	Lead	3.36E+05	0.005	0.0005	1	1	8.40E-01
ID-RFO-464T	Lead	1.32E+06	0.005	0.0005	1	1	3.31E-00
ID-RFO-302T	Lead	6.26E+05	0.005	0.0005	1	1	1.56E-00
ID-INL-155T	Lead	3.42E+05	0.005	0.0005	1	1	8.55E-01
ID-MDO-847T	Lead	6.90E+05	0.005	0.0005	1	1	1.73E-00
ID-AEO-102T	Lead	1.97E+06	0.005	0.006	0.01	1	5.91E-01
ID-MDO-848T	Lead	1.74E+05	0.005	0.006	0.01	1	5.22E-02
ID-BCO-202T	Lead	6.90E+04	0.005	0.0005	1	1	1.73E-01
ID-BCO-201T	Lead	6.01E+05	0.005	0.0005	1	1	1.50E-00
ID-RFO-481T	Lead	9.49E+06	0.005	0.006	0.01	1	2.85E-00
ID-RFO-320	Lead	1.70E+06	0.005	0.006	0.01	1	5.10E-01
ID-RFO-481	Lead	2.40E+06	0.005	0.006	0.01	1	7.20E-01
ID-RFO-123T	Lead	3.69E+06	0.005	0.0005	1	1	9.23E-00
ID-RFO-117	Lead	4.30E+05	0.005	0.006	0.01	1	1.29E-01
ID-RFO-480	Lead	1.70E+07	0.005	0.006	0.01	1	5.10E-00
ID-RFO-123	Lead	1.20E+05	0.005	0.0005	1	1	3.00E-01
ID-RFO-480T	Lead	1.10E+07	0.005	0.006	0.01	1	3.30E-00
ID-RFO-9999	Lead	6.35E+07	0.005	0.0005	1	1	1.59E+02
ID-RFO-002	Mercury (elemental & inorganic)	8.81E+05	0.005	0.006	0.01	1	2.64E-01
ID-RFO-002T	Mercury (elemental & inorganic)	3.01E+06	0.005	0.006	0.01	1	9.04E-01
ID-OFS-111	Mercury (elemental & inorganic)	6.23E+04	0.005	0.006	0.01	1	1.87E-02
ID-OFS-111T	Mercury (elemental & inorganic)	8.78E+04	0.005	0.006	0.01	1	2.63E-02

ID-RFO-113	Methyl alcohol	3.60E+04	0.005	0.006	0.01	1	1.08E-02
ID-RFO-113T	Methyl alcohol	1.97E+05	0.005	0.006	0.01	1	5.90E-02
ID-MDO-836T	Methyl alcohol	7.50E+04	0.005	0.006	0.01	1	2.25E-02
ID-MDO-836	Methyl alcohol	1.19E+07	0.005	0.006	0.01	1	3.57E-00
ID-RFO-090	Methyl alcohol	3.80E+05	0.005	0.006	0.01	1	1.14E-01
ID-RFO-004T	Methyl alcohol	2.85E+06	0.005	0.006	0.01	1	8.56E-01
ID-RFO-004	Methyl alcohol	1.30E+06	0.005	0.006	0.01	1	3.90E-01
ID-RFO-990	Methyl alcohol	1.20E+06	0.005	0.006	0.01	1	3.60E-01
ID-RFO-002	Methyl alcohol	4.10E+06	0.005	0.006	0.01	1	1.23E-00
ID-BCO-204	Methyl alcohol	7.29E+03	0.005	0.006	0.01	1	2.19E-03
ID-RFO-002T	Methyl alcohol	6.91E+06	0.005	0.006	0.01	1	2.07E-00
ID-OFS-111	Methylene chloride	5.80E+06	0.00445	0.006	0.01	1	1.55E-00

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-OFS-111T	Methylene chloride	1.07E+07	0.00445	0.006	0.01	1	2.86E-00
ID-RFO-090	Methylene chloride	3.80E+05	0.00445	0.006	0.01	1	1.01E-01
ID-BTO-030	Methylene chloride	5.60E+03	0.00445	0.006	0.01	1	1.50E-03
ID-RFO-004T	Methylene chloride	2.85E+06	0.00445	0.006	0.01	1	7.62E-01
ID-RFO-004	Methylene chloride	1.30E+06	0.00445	0.006	0.01	1	3.47E-01
ID-RFO-990	Methylene chloride	1.20E+06	0.00445	0.006	0.01	1	3.20E-01
ID-RFO-002	Methylene chloride	4.10E+06	0.00445	0.006	0.01	1	1.09E-00
ID-BCO-204	Methylene chloride	7.29E+03	0.00445	0.006	0.01	1	1.95E-03
ID-RFO-003T	Methylene chloride	6.23E+06	0.00445	0.006	0.01	1	1.66E-00
ID-RFO-002T	Methylene chloride	1.71E+06	0.00445	0.006	0.01	1	4.57E-01
ID-BCO-204	Nitric acid	7.29E+03	0.005	0.006	0.01	1	2.19E-03
ID-MDO-838	Nitric acid	1.50E+03	0.005	0.0005	1	1	3.75E-03
ID-INL-155	Nitric acid	7.60E+03	0.005	0.0005	1	1	1.90E-02
ID-MDO-847	Nitric acid	8.47E+05	0.005	0.0005	1	1	2.12E-00
ID-AEO-102	Nitric acid	5.00E+04	0.005	0.006	0.01	1	1.50E-02
ID-RFO-9999	Nitric acid	1.06E+07	0.005	0.0005	1	1	2.66E+01
ID-RFO-090	Nitrobenzene	3.80E+05	0.005	0.006	0.01	1	1.14E-01
ID-RFO-990	Nitrobenzene	1.20E+06	0.005	0.006	0.01	1	3.60E-01
ID-RFO-003T	Nitrobenzene	6.23E+06	0.005	0.006	0.01	1	1.87E-00
ID-RFO-003	Nitrobenzene	1.00E+07	0.005	0.006	0.01	1	3.00E-00
ID-RFO-374	Nitrobenzene	2.00E+06	0.005	0.006	0.01	1	6.00E-01
ID-RFO-374T	Nitrobenzene	2.09E+05	0.005	0.006	0.01	1	6.27E-02
ID-OFS-111	Perchloroethylene	5.80E+06	0.00445	0.006	0.01	1	1.55E-00
ID-OFS-111T	Perchloroethylene	1.07E+07	0.00445	0.006	0.01	1	2.86E-00
ID-RFO-090	Perchloroethylene	3.80E+05	0.00445	0.006	0.01	1	1.01E-01
ID-RFO-990	Perchloroethylene	1.20E+06	0.00445	0.006	0.01	1	3.20E-01
ID-RFO-002	Perchloroethylene	4.10E+06	0.00445	0.006	0.01	1	1.09E-00
ID-RFO-003T	Perchloroethylene	6.23E+06	0.00445	0.006	0.01	1	1.66E-00
ID-RFO-002T	Perchloroethylene	5.26E+06	0.00445	0.006	0.01	1	1.41E-00
ID-RFO-003T	Polychlorinated biphenyl	3.14E+06	0.00445	0.006	0.01	1	8.40E-01
ID-RFO-003	Polychlorinated biphenyl	5.04E+06	0.00445	0.006	0.01	1	1.35E-00
ID-RFO-000T	Polychlorinated biphenyl	3.03E+05	0.00445	0.0005	1	1	6.75E-01
ID-RFO-005	Potassium nitrate	8.11E+06	0.005	0.006	0.01	1	2.43E-00
ID-RFO-005T	Potassium nitrate	4.95E+05	0.005	0.006	0.01	1	1.49E-01
ID-MDO-836T	Selenium	7.50E+04	0.005	0.006	0.01	1	2.25E-02
ID-MDO-836	Selenium	1.19E+07	0.005	0.006	0.01	1	3.57E-00

ID-TAN-162	Selenium	7.12E+04	0.005	0.006	0.01	1	2.14E-02
ID-MDO-836T	Silver	7.50E+04	0.005	0.006	0.01	1	2.25E-02
ID-MDO-836	Silver	1.19E+07	0.005	0.006	0.01	1	3.57E-00
ID-RFO-002	Silver	4.10E+06	0.005	0.006	0.01	1	1.23E-00
ID-RFO-003T	Silver	6.23E+06	0.005	0.006	0.01	1	1.87E-00
ID-RFO-002T	Silver	6.08E+06	0.005	0.006	0.01	1	1.82E-00
ID-RFO-007T	Toluene	4.82E+06	0.005	0.006	0.01	1	1.45E-00
ID-OFS-111	Toluene	2.90E+06	0.005	0.006	0.01	1	8.70E-01
ID-RFO-007	Toluene	4.80E+06	0.005	0.006	0.01	1	1.44E-00
ID-OFS-111T	Toluene	5.35E+06	0.005	0.006	0.01	1	1.61E-00
ID-RFO-339T	Toluene	1.05E+06	0.005	0.0005	1	1	2.62E-00
ID-RFO-339	Toluene	3.40E+04	0.005	0.0005	1	1	8.50E-02
ID-RFO-481T	Toluene	9.49E+05	0.005	0.006	0.01	1	2.85E-01
ID-RFO-481	Toluene	2.40E+05	0.005	0.006	0.01	1	7.20E-02

Table E-5-30. Source term——Type II module fire (continued).[a]

Waste stream code[b]	Nuclide or hazardous material[c]	MAR (g)	DR	ARF	RF	LPF	Source term (g)
ID-RFO-300T	Toluene	1.27E+06	0.005	0.006	0.01	1	3.81E-01
ID-RFO-003T	Trichloroethane, 1,1,1-	1.87E+08	0.00445	0.006	0.01	1	4.99E+01
ID-RFO-003	Trichloroethane, 1,1,1-	3.00E+08	0.00445	0.006	0.01	1	8.01E+01
ID-RFO-112T	Trichloroethane, 1,1,1-	1.92E+07	0.00445	0.006	0.01	1	5.12E-00
ID-RFO-112	Trichloroethane, 1,1,1-	4.30E+05	0.00445	0.006	0.01	1	1.15E-01
ID-OFS-111	Trichloroethane, 1,1,1-	5.80E+06	0.00445	0.006	0.01	1	1.55E-00
ID-OFS-111T	Trichloroethane, 1,1,1-	6.95E+06	0.00445	0.006	0.01	1	1.85E-00
ID-TAN-162	Trichloroethylene	7.12E+05	0.00445	0.006	0.01	1	1.90E-01
ID-OFS-111	Trichloroethylene	5.80E+06	0.00445	0.006	0.01	1	1.55E-00
ID-OFS-111T	Trichloroethylene	1.07E+07	0.00445	0.006	0.01	1	2.86E-00
ID-MDO-836T	Trichloroethylene	7.50E+04	0.00445	0.006	0.01	1	2.00E-02
ID-MDO-836	Trichloroethylene	1.19E+07	0.00445	0.006	0.01	1	3.18E-00
ID-RFO-090	Trichloroethylene	3.80E+05	0.00445	0.006	0.01	1	1.01E-01
ID-RFO-004T	Trichloroethylene	2.85E+06	0.00445	0.006	0.01	1	7.62E-01
ID-RFO-004	Trichloroethylene	1.30E+06	0.00445	0.006	0.01	1	3.47E-01
ID-RFO-990	Trichloroethylene	1.20E+06	0.00445	0.006	0.01	1	3.20E-01
ID-RFO-002	Trichloroethylene	1.91E+06	0.00445	0.006	0.01	1	5.09E-01
ID-RFO-112T	Trichlorotrifluroethane	1.92E+07	0.00445	0.006	0.01	1	5.12E-00
ID-RFO-003T	Trichlorotrifluroethane	6.23E+07	0.00445	0.006	0.01	1	1.66E+01
ID-RFO-003	Trichlorotrifluroethane	1.00E+08	0.00445	0.006	0.01	1	2.67E+01
ID-RFO-112	Trichlorotrifluroethane	4.30E+05	0.00445	0.006	0.01	1	1.15E-01
ID-OFS-111	Trichlorotrifluroethane	5.80E+06	0.00445	0.006	0.01	1	1.55E-00
ID-OFS-111T	Trichlorotrifluroethane	6.95E+06	0.00445	0.006	0.01	1	1.85E-00
ID-TAN-162	Vinylidene chloride	7.12E+04	0.00445	0.006	0.01	1	1.90E-02
ID-RFO-339T	Vinylidene chloride	1.05E+06	0.00445	0.0005	1	1	2.33E-00
ID-RFO-339	Vinylidene chloride	3.40E+04	0.00445	0.0005	1	1	7.57E-02
ID-RFO-480	Vinylidene chloride	1.70E+06	0.00445	0.006	0.01	1	4.54E-01
ID-RFO-480T	Vinylidene chloride	1.10E+06	0.00445	0.006	0.01	1	2.94E-01
ID-RFO-440	Vinylidene chloride	4.80E+05	0.00445	0.006	0.01	1	1.28E-01
ID-RFO-440T	Vinylidene chloride	9.61E+05	0.00445	0.006	0.01	1	2.57E-01
ID-RFO-330T	Vinylidene chloride	8.72E+05	0.00445	0.0005	1	1	1.94E-00
ID-RFO-442T	Vinylidene chloride	5.38E+05	0.00445	0.006	0.01	1	1.44E-01

ID-RFO-442	Vinylidene chloride	5.50E+05	0.00445	0.006	0.01	1	1.47E-01
ID-RFO-330	Vinylidene chloride	3.36E+06	0.00445	0.0005	1	1	7.48E-00
ID-RFO-112T	Xylene	1.92E+07	0.005	0.006	0.01	1	5.75E-00
ID-RFO-112	Xylene	4.30E+05	0.005	0.006	0.01	1	1.29E-01
ID-OFS-111	Xylene	5.80E+06	0.005	0.006	0.01	1	1.74E-00
ID-OFS-111T	Xylene	1.07E+07	0.005	0.006	0.01	1	3.21E-00
ID-RFO-113	Xylene	3.60E+04	0.005	0.006	0.01	1	1.08E-02
ID-RFO-113T	Xylene	1.97E+05	0.005	0.006	0.01	1	5.90E-02
ID-RFO-090	Xylene	3.80E+05	0.005	0.006	0.01	1	1.14E-01
ID-RFO-004T	Xylene	2.85E+06	0.005	0.006	0.01	1	8.56E-01
ID-RFO-700T	Xylene	2.40E+04	0.005	0.006	0.01	1	7.20E-03
ID-RFO-004	Xylene	1.30E+06	0.005	0.006	0.01	1	3.90E-01
ID-RFO-990	Xylene	1.20E+06	0.005	0.006	0.01	1	3.60E-01
ID-RFO-002	Xylene	4.10E+06	0.005	0.006	0.01	1	1.23E-00
ID-BCO-204	Xylene	7.29E+03	0.005	0.006	0.01	1	2.19E-03
ID-RFO-002T	Xylene	5.63E+06	0.005	0.006	0.01	1	1.69E-00

Table E-5-30. Source term——Type II module fire (continued).[a]

a. MAR—material at risk; DR—damage ratio; ARF—airborne release fraction; LPF—leak path factor; data from BNFL (1998d); DRs, ARFs and RFs vary depending on waste stream characteristics and combustibility. Also evaluated were combustion by-products phosgene and hydrochloric acid (BNFL 1998d).

b. From BNFL (1998d).

c. Some plutonium listings in this column show metallurgical codes for nuclear grade plutonium (i.e., Pu-52, Pu-83) instead of isotopes. These materials are mixtures of plutonium isotopes designated prior to the development of modern analysis techniques which can identify composition of the waste form by isotope.

E-5.4.1.12.3 Comparison to Guidelines¾ Evaluation guidelines are shown in Table E-5-31. Evaluation guidelines for an extremely unlikely event are not exceeded.

E-5.4.1.12.4 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the safety structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Safety-Class and Safety Significant Structures, Systems, and Components. Evaluation guidelines are not exceeded, and no safety-class or safety-significant structures, systems, or components are required.

Technical Safety Requirement Controls. The analysis identified a need for Type II modules administrative controls to limit free combustibles, to keep brush and grass growth to a minimum, to maintain lightning protection, and to maintain an operable fire suppression system.

Defense in Depth. Defense in depth measures to prevent and mitigate the consequences of a Type II module fire include the following:

- Fire protection programs and equipment
- Emergency preparedness planning
- Periodic inspection of each Type II module
- Housekeeping (including weed control) to limit combustibles

- Personal protective equipment
- DOE fire department.

Table E-5-31. Accident consequences–Type II module fire.[a]

	Location			
	100 m	EBR-I	Highway 20/26 rest area	Nearest INEEL boundary
Radiation exposure				
Evaluation guidelines, rem	100	b	b	25
Calculated TEDE, rem	0.0127	3.64	1.78	2.23
Chemical exposure				
Evaluation guidelines	ERPG-3	b	b	ERPG-2
Asbestos				
Evaluation guideline mg/m^3 [c]	500	0.05	0.05	0.05
Calculated mg/m^3	9.4E-05	0.071[d]	0.019	0.025
Beryllium				
Evaluation guideline mg/m^3	0.1	0.025	0.025	0.025
Calculated mg/m^3	2.8E-07	2.1E-04	5.7E-05	7.4E-05
Cadmium				
Evaluation guideline mg/m^3 [c]	9.0	4.0	4.0	4.0
Calculated mg/m^3	4.7E-07	3.5E-04	9.5E-05	1.2E-04
Lead				
Evaluation guideline mg/m^3 [c]	100	0.25	0.25	0.25
Calculated mg/m^3	1.3E-05	0.0095	0.0026	0.0033

Mercury				
Evaluation guideline mg/m^3 [c]	10	0.1	0.1	0.1
Calculated mg/m^3	6.6E-09	8.5E-06	1.2E-04	4.2E-06
Polychlorinated biphenyls (PCBs)				
Evaluation guideline mg/m^3 [c]	500	0.005	0.005	0.005
Calculated mg/m^3	2.4E-08	3.1E-05	1.3E-05	1.5E-05

a. EBR-I — Experimental Breeder Reactor-I; TEDE — total effective dose equivalent; ERPG — emergency response planning guideline; calculated values are shown for the most limiting meteorological conditions, 50 percent or 95 percent.

b. Evaluation guidelines do not exist for these locations; the exposures are compared with the evaluation guideline for the nearest INEEL site boundary.

c As recommended by DOE Subcommittee on Consequence Assessment and Protective Actions, temporary emergency exposure limits substituted because official ERPGs have yet to be finalized (Craig 1998).

d. Projected one-hour concentration is based on current one-hour asbestos emission source term for Type II Module fire (BNFL 1998d). For perspective, the very conservative assumptions of the release scenario result in an impact of approximately half the exposure of a turnpike toll-booth operator exposed to asbestos from automobile break shoes over a 30-day period. One-time exposure to an asbestos concentration of this magnitude would not be discernible in terms of increased cancer risk.

E-5.4.1.13 Propane fueled fires. Because the accidents for an incinerator explosion, a Type II module fire and a design basis seismic event described previously bound the propane-fueled fires and explosions, no specific scenario is analyzed in this section. Safety assessments of the utility room and incinerator propane delivery systems will be developed following detailed design. The summary of safety structures, systems, and components and technical safety requirement controls below will be updated following the assessment of the detailed design.

E-5.4.1.13.1 Summary of Safety Structures, Systems, and Components and Technical Safety Requirement Controls¾ The following paragraphs address the structures, systems, and components; technical safety requirement controls; and defense in depth measures.

Safety-Class and Safety-Significant Structures, Systems, and Components. Evaluation guidelines are not exceeded for accidents that bound propane-fueled fires and no safety-class or safety-significant structures, systems, or components are required.

Technical Safety Requirement Controls. Administrative controls for propane delivery vehicles and propane tank filling were identified through the assessment. In addition, periodic surveillance and maintenance of the existing and proposed propane storage and distribution systems are required.

Defense in Depth. Defense in depth is achieved by equipment important to propane system safety; pending detailed design this equipment is expected to include the following:

- Propane flow-limiting devices
- Propane leak-detection and alarm
- Propane shut-off valves

- Incinerator control system
- Barriers protecting propane supply tanks
- Barriers protecting risers from underground propane lines.

E-5.4.2 Meteorological Parameters

Meteorological conditions assumed at the time of release impact the calculation by RSAC-5 of diffusion, dispersion, and depletion factors. Except for releases through operable discharge systems such as offgas filtration and ventilation systems, most releases are assumed to be at ground level. The ground-level release assumption is conservative because the slower dispersion compared to elevated releases results in higher ground-level concentrations and, in the case of radiological releases, higher estimates of radiation exposures near the point of release.

The F stability class was selected since it is the conservative stability class which minimizes dispersion, thereby maximizing downwind concentrations. Similarly, a low windspeed of 1.0 meters per second is used for the same reasons. The RSAC-5 program has three different models for diffusion coefficients. For short duration releases (20 minutes or less), the Hilsmeier-Gifford model is used to determine diffusion coefficients as a function of downwind distance. For long duration releases (one hour or longer), the Markee model is used.

Downwind chemical concentrations and radiation exposures are determined at distances of 100 meters, 3,000 meters, and 6,000 meters. The receptor at 100 meters represents a co-located facility worker within the RWMC area. The 3,000 meters receptor represents the distance to the Experimental Breeder Reactor (EBR-I) National Historical Site where members of the public may be present. The receptor at 6,000 meters represents the distance to the nearest site boundary south of the RWMC.

E-5.4.3 Criticality Safety

The purpose of the AMWTP facilities is to retrieve and treat alpha low-level mixed and TRU waste. Fissile materials in these wastes occur as contamination at low concentrations. The fissile nuclides of concern are primarily isotopes of plutonium (Pu-238, Pu-239, Pu-240, and
Pu-241). In addition, small quantities of U-233 are present in a limited number of drums. Most of the waste is held in 55-gallon drums or 4 x 4 x 7 feet (or smaller) boxes.

Because of the large quantities of waste processed in the treatment facility, total quantities of fissile material passing through the facility during its lifetime constitute more than a critical mass. Most of the fissile material in the incoming and outgoing waste streams, however, is dispersed throughout large volumes of the waste material. Thus at any given time, there is a low concentration of fissile material in the processes.

The purpose of this section is to describe the AMWTP nuclear criticality safety program. This program is designed to ensure that sufficient controls are in place to reduce the likelihood of inadvertent nuclear criticality excursions as a result of retrieving waste, transporting waste to the facility, processing waste, and transferring the product from the facility. The AMWTP criticality safety program applies to all AMWTP activities involving fissionable materials.

E-5.4.3.1 Criticality Assessment. The Preliminary Criticality Safety Assessment (Winstanley 1998) addresses criticality concerns for specific areas in the treatment facility and methods for addressing the concerns. The assessment considers the design of the plant and treatment processes, the method of operation, and the materials to be handled. The assessment demonstrates that, under normal operating conditions and potential contingency conditions, a criticality incident is not credible. In some areas of the facility, however, the possibility of a criticality incident is of potential concern. Thus, the facility will be designed and operated to ensure that these concerns are addressed and the potential for a criticality incident is minimized. The Preliminary Criticality Safety Assessment identifies where criticality detection and alarm systems are required to address these concerns and where such systems are judged not to be necessary.

The process areas addressed in the Preliminary Criticality Safety Assessment are (a) retrieval operations at the TSA-

RE, (b) the assay facility, (c) the storage facility, (d) the pretreatment drum and box lines, (e) the central conveying system, (f) the assay and buffer storage area, (g) the supercompaction area, (h) the microencapsulation and macroencapsulation areas, (i) the incineration area, and (j) the special-case waste glovebox.

The waste materials and their fissile contents are described in Appendix Section E-5.3. Generally, drums and boxes of retrieved waste will only contain a few grams of fissile material in the form of contamination, significantly less than the minimum safety subcritical mass. Some containers held in the TSA may contain fissile masses that approach a minimum safety subcritical mass. Analyses presented in the Preliminary Criticality Safety Assessment demonstrate that these containers will remain safely subcritical during retrieval. All drums will be assayed for fissile content before storage and subsequent sorting and treatment.

Calculations were performed using conservative assumptions regarding the waste matrix (particularly its moderating and reflecting properties), the fissile material concentration and geometry, and the isotopic composition of fissile material for single containers and arrays of containers (Winstanley 1998). On the basis of these calculations, a Limiting Condition of Operation of 200 grams fissile material per drum and 325 grams fissile material per box has been established. Analyses in Winstanley (1998) demonstrate that individual containers and planned storage configurations for multiple containers are inherently safe at these levels. Therefore, no limit on the total mass of fissile material has been established for the waste storage facility.

Once waste containers have been opened in the sorting area, and throughout subsequent processing, the geometries of the containers will be altered from that of the initial retrieved containers. Mass limits for fissile materials in the sorting and processing areas will ensure that changes in geometry will not introduce additional criticality concerns. A mass limit of 450 grams of fissile material has been established for the sorting area. Mass limits for fissile materials will be established for other facility areas in the Final SAR. These limits are not available in the PSAR (BNFL 1998d) because facility design is not yet complete and criticality analyses are not finalized.

E-5.4.3.2 Criticality Controls. These criticality control comprise engineering controls, administrative controls, and application of the double contingency principle. Each of these control methods is discussed in the following sections.

E-5.4.3.2.1 Engineering Controls¾ The specific engineering controls implemented for AMWTP processes are based on the results of the criticality safety evaluations and analyses documented in the Preliminary Criticality Safety Assessment (Winstanley 1998). Criticality safety design limits have been developed on the basis of the waste characteristics, fissile content, and container geometries of TSA waste and the design of storage, pretreatment, and treatment processes of the AMWTP. The AMWTP operational configuration control program will maintain configuration control of the equipment used to store, handle, and process fissile material.

Wherever practical, the preferred approach to criticality control is to maintain inherently subcritical geometries. Total fissile mass in each area will also be controlled to meet the double contingency principle. These limits will be developed for the Final SAR.

Engineering controls specific to plant areas are as follows:

- *Retrieval area*–At retrieval, containers undergo visual and contamination checks. Each container is inspected for identification markings and a bar code attached. Inspection, identification, and bar code data are entered into the data management system. This system provides essential information for engineering and administrative criticality controls through all subsequent processes.

- *Assay facility*–Within the assay facility, the contents of the boxes and drums are determined to ensure that these meet the AMWTP acceptance criteria (DOE-ID 1996f). The primary criteria relevant to criticality safety are that each drum must not contain more that 200 grams of Pu-239 (fissile equivalent) and each box must not contain more than 325 grams of Pu-239 (fissile equivalent). Engineering and administrative criticality controls of all subsequent processes are based on these limits. These assay systems meet prescribed levels of integrity and use two independent systems for determining fissile material mass: passive/active neutron counting and gamma spectroscopy. The retrieval radioassay, described in Section 2.7.4, Criticality Protection and Monitoring, of

PSAR (BNFL 1998d), is classified a safety-significant system (see Chapter 4 of the PSAR [BNFL 1998d]).

- *Storage facility*–In the storage facility, the configuration of containers ensures that any combination of containers meeting the AMWTP acceptance criteria (DOE-ID 1996f) will be inherently subcritical.

- *Pretreatment drum and box lines*–As each container enters the pretreatment area, a running total of fissile mass is maintained. Once the fissile mass limit is reached, an interlock is set that prevents introducing another container into the area until existing containers have been sorted and cleared from the lines. The system for tracking fissile mass and operating the interlock is classified as a safety-significant system (see Chapter 4 of the PSAR [BNFL 1998d]). Following sorting, the repackaged containers will be assayed to determine fissile material content of the reconfigured waste using both passive/active neutron counting and gamma spectroscopy as described in Section 2.7.4, Criticality Protection and Monitoring, of the PSAR (BNFL 1998d).

- *Central conveying system, assay area, and buffer storage*–On the basis of calculations reported in the Preliminary Criticality Safety Assessment (Winstanley 1998), an 80-centimeter surface-to-surface distance between containers has been determined to provide a subcritical geometry for pretreated containers. This distance is maintained by engineering controls between drums of sorted material originating from pretreatment areas until assay confirms that the drums contain less than 200 grams of fissile material.

- *Supercompaction and encapsulation areas*–Drums received in the supercompaction area are positively identified and confirmed to have been assayed and to have a fissile content of less than 200 grams. Pucks accumulated for transfer to the macroencapsulation area will be stored in a critically safe geometry (a horizontal one-high array). Before a puck is added to a product container, it will be determined that the new combined fissile mass in the container will remain below the product specification limit (200 grams per drum and 325 grams per box).

- *Incineration area*–Criticality control will be based on (a) design and engineered features that ensure subcritical geometries and (b) the use of subcritical limits and operating limits on the total fissile mass in the incineration area. These two separate systems for control of fissile mass will be used to meet the double contingency principle. The potential for accumulation of fissile material in incineration systems will be minimized by design and engineered controls and monitored by radiological detectors and surveys. Engineering controls and fissile mass limits for the incineration area are under development and will be addressed in the Final SAR. Following incineration and ash mixing, drums of incinerator ash will be assayed using both passive/active neutron counting and gamma spectroscopy as described in Section 2.7.4, Criticality Protection and Monitoring, of the PSAR (BNFL 1998d).

E-5.4.3.2.2 Administrative Controls¾ Administrative controls of moderation, fissile material concentration, and total fissile material will be used in combination with assay systems and engineered safety features to ensure criticality safety. Criticality within the plant will be prevented by administrative controls on the following:

- The introduction of fissile material into the process

- The process via the plant control system

- The fissile material by use of the data management system.

On removal from the TSA-RE, each waste container will have a bar code affixed for unique identification. The bar codes will be read at numerous points throughout the process to identify the location of the container to the tracking system and to enable additional container- specific information to be entered into the data management system.

The data management system includes parallel tracking of fissile material by independent computerized and hard copy databases. The system provides the basis for administrative controls and operational limits for fissile mass by container and process area. The fissile material inventory contained in the data management system provides the information to determine the amount and process area location of "material unaccounted for" (MUF). The specific use of data by the data management system to help ensure criticality safety in the various parts of the plant is discussed in the Preliminary Criticality Safety Assessment (Winstanley 1998).

Assay systems will be used both following the retrieval of waste from the TSA and within the treatment facility to determine the mass of fissile material within a container and to confirm that this is below the relevant safety limit. Specific use of data from the assay system to help ensure criticality safety in the various parts of the plant is considered in the Preliminary Criticality Safety Assessment. The following features of the assay system are relevant to criticality safety:

- The capability to identify a minimum of 12 specific radionuclides, either individually or in combination, including Pu-238, Pu-239, Pu-240, Pu-241, U-233, U-234, U-235, U-238, Am-241, and Np-237
- The capability to determine the quantity and approximate location of radionuclides present
- A bar coding system, capable of reading/writing different bar code styles linked to the data management system
- A passive/active neutron and gamma spectroscopy analysis assay capability
- Appropriate calibration of the assay system
- An appropriate training program for assay system operators.

A nuclear material measurement specialist will evaluate assay uncertainty and bias. Criticality safety limits will be established at levels that ensure that they include the uncertainty in assay measurements at the 95 percent confidence level.

Administrative controls for reviewing and approving changes to process or system configurations are the responsibility of the AMWTP Operations Manager and will be implemented through the AMWTP operational configuration control program.

A probabilistic reliability analysis is being conducted to determine the reliability of the data management system, which is under development. The results of this analysis will be summarized in the Final SAR.

E-5.4.3.2.3 Application of Double Contingency Principle¾ Treatment facility processes are designed to incorporate factors of safety such that two unlikely, independent, and concurrent changes in process conditions must occur before a criticality accident is possible. Standards for nuclear criticality safety in operations with fissionable materials, i.e., ANSI (1983), require the use of the "double contingency principle" to provide redundant control systems for the prevention of criticality. The double contingency principle is satisfied either by controlling two of the independent process parameters or by implementing at least two independent controls on a single process parameter. For all process areas, control will be based on both engineered controls on geometry and total fissile mass limits determined by radioassay and controlled through the data management system.

The design criteria for the incineration system specify that the system be inherently subcritical by geometryand provide for engineered features that ensure that unsafe build up of fissile material cannot occur. Design of this system is not complete and is unavailable for the PSAR but will be addressed in the Final SAR.

Winstanley (1998) presents specific conditions for normal operations and contingency situations for each storage, handling, and process area. Contingency conditions addressed for all retrieval, storage, transfer, and process areas include the potential for excess fissile mass in individual containers, spillage and accumulation of fissile material, the presence of an excess number of containers, the presence of excess moderator, flooding, and fire fighting. For the central conveying system and the assay and buffer storage area, failure to maintain safe separation distance is addressed as an additional contingency condition addressed.

Additional contingency conditions for the incinerator treatment system are under development and will be addressed in the Final SAR.

E-5.4.3.3 Criticality Protection Program. Even though the waste is expected to generally contain only low concentrations of fissile material, AMWTP will maintain a criticality safety program implemented by an AMWTP

Criticality Safety Manual to ensure nuclear criticality safety. The program will incorporate program responsibilities, training, passive and active controls, and self-assessments of the program to promote continued vigilance of criticality safety. The specific features of the program and contents of the AMWTP Criticality Safety Manual will be addressed in the Final SAR.

E-5.4.3.3.1 Criticality Safety Organization¾ The criticality safety program requires that management clearly establish responsibility for all elements of nuclear criticality safety. The AMWTP Operations Manager will be responsible for promoting criticality safety through the control of the operations within the AMWTP and will be assisted in this responsibility by the Environment Safety and Health Manager and the Safety Committee (BNFL 1998d). The criticality safety program is addressed in Section D.2, Nuclear Criticality Controls, of the Environmental Safety and Health Program Operating Plan (ESHPOP) (BNFL 1998f).

E-5.4.3.3.2 Criticality Safety Plans and Procedures¾ All waste treatment operations and routine maintenance activities in the treatment facility will be governed by written procedures. Nonroutine operations will be conducted according to a safe work permit that contains job-specific requirements, with criticality safety being one aspect. The procedures will include instructions for posting nuclear material safety limits, material and operational controls, reviews required for operations, emergency evacuation, and guidelines for fire suppression. The procedures will also document that the process conforms to the double contingency principle. These procedures will incorporate requirements from the AMWTP Criticality Safety Manual as needed. The Criticality Safety Manual will form a comprehensive reference for personnel involved in handling fissionable material at the treatment facility. Specific procedures will be included for each process area. The specific features of the program and contents of the AMWTP Criticality Safety Manual will be addressed in the Final SAR.

E-5.4.3.3.3 Criticality Safety Training¾ To maintain awareness of criticality safety, management will provide time for employee training in criticality safety. General awareness training will be provided for employees, and specific technical training will be provided for personnel who directly handle the waste. Specifically, criticality safety training conforming to ANSI (1991) will be provided for (a) nuclear criticality safety staff, (b) operations support personnel, (c) design personnel, (d) maintenance personnel, (e) emergency response personnel, and (f) managers. Criticality emergency response training and evacuation drills will be conducted annually for all AMWTP personnel. Criticality safety training is addressed in Section D7, Training and Qualification, of the ESHPOP (BNFL 1998f) and Section 12.4, Training Program, of the PSAR (BNFL 1998d).

E-5.4.3.3.4 Determination of Operational Nuclear Criticality Limits¾ Calculations documented in Winstanley (1998) were used to derive operational nuclear criticality limits. Calculations were performed using the Monte Carlo neutronics code MONK7B with the UKNDL Dice Nuclear Data Library, on a SUN Sparc Station 1000E operating under Solaris 2.5. Calculational methods are validated in accordance with ANSI (1983). In all calculations, the safety criterion used was

$$k_{eff} + 3s \leq 0.95,$$

where k_{eff} is the effective neutron multiplication factor and s is the standard deviation of the calculated value of k_{eff}.

The uncertainty in k_{eff} reflects the statistical uncertainty of the code alone and, by itself, does not ensure an adequate calculational margin of error. The calculations reported in the Preliminary Criticality Safety Assessment (Winstanley 1998) address conservative combinations of fissile mass, moderation, and geometry for single containers and arrays of containers using the best available knowledge of TSA waste. These calculations are intended to indicate the margins of safety, rather than to determine specific operational limits. Before establishing operational limits, additional calculations may be performed as more details of the material in the waste streams become available to determine whether an additional margin of safety is required as specified by ANSI (1983).

Specific operational criticality limits for each retrieval, storage, transfer, and process area will be addressed in the Final SAR

The double contingency principle has been used to ensure that a criticality accident is an extremely unlikely event.

Compliance with the double contingency principle requires that two unlikely, independent and concurrent changes in process or system conditions occur before a criticality accident is possible. Credible, potential fault conditions that could impact the criticality safety of the facility have been considered. Contingency conditions considered at this stage of the design safety analysis are documented in Winstanley (1998).

E-5.4.3.3.5 Criticality Safety Inspections and Audits¾ Criticality safety inspections and audits will be conducted according to procedures that will be documented in the AMWTP Criticality Safety Manual. These procedures will be summarized in the Final SAR.

Inspections and audits will be conducted as part of the AMWTP self-assessment program described in Section D.10, Continuous Improvement Process and Response to Internal and External Audits, of the ESHPOP (BNFL 1998f).

Corrective action tracking and closure processes for audit findings are the responsibility of the Project Quality Assurance Manager under the provisions of the AMWTP Project Quality Procedure PQP 3.1, Corrective Action (BNFL 1998g). The Quality Assurance Manager reviews audit findings, initiates corrective action reports, tracks these reports and verifies that corrective action report dispositions are complete.

E-5.4.3.3.6 Criticality Instrumentation¾ Criticality detection and alarm systems will be located in each area of the treatment facility where a criticality incident is of potential concern (BNFL 1998d). These areas will also be equipped with fixed nuclear accident dosimeter units to help evaluate personnel dose. Personnel in these areas are required to wear personal nuclear accident dosimeters.

Winstanley (1998) has determined that criticality detection and alarm systems will be provided for the process areas, including offgas systems, i.e., pretreatment lines, the conveying system, the compactor, the macroencapsulation area, and the incinerator system.

Criticality detection systems will not be required for areas following the macroencapsulation of product containers. Neither will such systems be required for areas before the pretreatment lines. These include areas for the retrieval, assay, and storage of containers before introduction into the treatment facility. Areas containing returned material from the pretreatment lines will need further criticality analysis before a detection and alarm system can be omitted. Nonprocess areas will not require criticality detectors, although they will be covered by the criticality alarms.

APPENDIX F
PROJECT HISTORY AND CHRONOLOGY

Waste History/Description

From 1970 through the early 1980s the Idaho National Engineering and Environmental Laboratory (INEEL) accepted over 65,000 cubic meters of transuranic (TRU) and alpha-contaminated waste from other U.S. Department of Energy (DOE) sites. These wastes were placed in above ground storage at the Radioactive Waste Management Complex (RWMC) on the INEEL. The wastes are primarily laboratory and processing wastes of various solid materials, including paper, cloth, plastics, rubber, glass, graphite, bricks, concrete, metals, nitrate salts, and absorbed liquids. Over 95 percent of the waste was generated at DOE's Rocky Flats Plant in Colorado and transported to the INEEL by rail in bins, boxes, and drums. All 65,000 cubic meters was considered to be TRU waste when it was first stored at the INEEL. The amount of this waste stored at the INEEL is over half of the retrievably stored TRU waste in the DOE Complex, all of which was to be eventually permanently disposed of at Waste Isolation Pilot Plant (WIPP). A detailed description of these wastes follows this section (Table F-9). In addition, a brief history of regulatory drivers, program, and political events leading to the AMWTP is also presented (Table F-10).

The waste was placed on an asphalt pad at the RWMC in its original shipping containers and covered with plywood, sheets of plastic, and soil. This storage location is an earthen covered berm. Eighty percent (or 52,000 cubic meters) of the waste is located in the earthen covered berm while 20 percent was placed in an Air Support Building and since moved to near-by permitted storage buildings.

The waste has been in the berm since the early 1970s. At the time of initial storage, the design life for the containers was 20 years. Some degradation and deterioration of drums and boxes is expected, with associated soil contamination. If the wastes are not removed from the berm, the soil and possibly the surrounding area could become contaminated.

Over 95 percent of the waste has hazardous constituents and is therefore considered to be mixed waste. Mixed waste is regulated under the *Resource Conservation and Recovery Act* (RCRA). The waste also contains materials such as polychlorinated biphenyls (PCBs) which is regulated under the *Toxic Substance and Control Act* (TSCA).

In 1982, DOE Order 5820.1 finalized the definition of TRU waste. The new definition excluded alpha emitting waste less than 100 nCi/g at the time of assay. The INEEL estimated that between 25,000 and 27,000 cubic meters of the stored waste would not meet the revised definition of TRU waste, would have to be managed as low-level mixed waste (LLMW), and could not be disposed of at WIPP. Since all of the waste was initially considered to be TRU, the alpha wastes were co-mingled in the same containers when placed in the earthen covered berm. To separate the wastes, each container would have to be opened and the material sorted and assayed to segregate the alpha from the TRU waste.

In planning a path forward for this waste in the early 1990s, DOE had two environment, safety, and health (ES&H) and regulatory considerations. The first was the potential for further breaching of containers in the berm and subsequent migration of contaminants into the surrounding soil and groundwater. The second was that the interim storage of the waste in the earthen covered berm and temporary buildings did not meet RCRA standards. The waste in interim storage in the temporary buildings was the subject of an U.S. Environmental Protection Agency (EPA) Notice of Noncompliance in 1990. The RCRA Hazardous and Solid Waste amendments require that all hazardous waste be treated to EPA standards before being placed "in or on the land" for disposal. In addition, the only permissible reason to store untreated waste is to accumulate sufficient quantities of hazardous waste as necessary to facilitate proper recovery, treatment, or disposal. This is referred to as the Land Disposal Restriction (LDR) storage prohibition. The INEEL's interim storage of mixed waste did not meet these requirements.

Project Evolution

This section describes the planning and evaluation of options available to DOE in dealing with the stored waste. The initial plans for dealing with these wastes were developed by the INEEL Management and Operating (M&O) contractor in the early 1990's. The plans components included the following:

- Retrieve the wastes from the earthen covered berm, and identify and segregate the alpha waste from the TRU waste;
- Build and operate a two-phase treatment facility. This facility was referred to as the Idaho Waste Processing Facility (IWPF). Phase 1 would treat the alpha mixed waste to allow disposal under RCRA LDR standards, and Phase 2 would repackage the TRU waste into appropriate containers for shipment to WIPP, and thermally treat approximately 25 percent of the waste to meet WIPP waste acceptance criteria (WAC);
- Build a new waste characterization facility to characterize 10 percent of the TRU waste destined for WIPP to assure the WIPP WAC was met;
- Build 11 additional RCRA storage modules for the retrieved and/or treated waste. Seven RCRA storage modules were near completion at the time.

Initial cost estimates for the IWPF exceeded $620 million. DOE and the M&O contractor were concerned about the high cost estimate and began exploring options. In 1992, the M&O performed a Systems Design Study to examine the potential for private sector treatment of alpha mixed waste and in 1993, Dames and Moore was commissioned to prepare studies to examine the subject. These studies (which are part of the Administrative Record for this environmental impact statement [EIS], as are the other studies referenced in this Appendix) concluded that at least $200 million in savings could be achieved and the schedule could be shortened by seven years if the treatment were privatized. At the same time, private industry approached DOE and claimed that commercial LDR treatment of the alpha waste would be more cost effective than if performed by the DOE M&O contractor. Even with the two studies in hand, DOE—Idaho Operations Office (DOE-ID) recognized that current knowledge and funding were insufficient to directly pursue private services for the required treatment.

In December 1993, DOE-ID issued a Scope of Work for a "Feasibility Study of Treatment Services for Alpha-Contaminated Low-Level Mixed Waste." The Scope of Work announced DOE’s intent to procure feasibility studies of private sector solutions for the treatment of alpha LLMW. The Scope of Work encouraged innovative approaches for providing all aspects of treatment services and was the first in a series of steps anticipated to lead to an eventual procurement for production level treatment services.

DOE’s expressed intention in the feasibility study Scope of Work was to obtain industry’s "best thinking" for a private sector approach to cost effective waste treatment. The Scope of Work indicated that teaming arrangements for preparation of the studies were preferred; that partners should have experience in design, construction, and operation of actual waste treatment facilities; and would need to demonstrate the ability to finance such a project.

Assumptions/direction provided in the Scope of Work indicated that the private sector should assume:

- They would own and operate the facility, would be responsible for all licensing and permitting, and would operate within applicable Federal and state rules and regulations. DOE orders were not invoked; rather, the private sector was asked to identify whether they would rather be DOE regulated, or U.S. Nuclear Regulatory Commission (NRC) licensed.
- They would assume risk and liability.
- They could consider using existing facilities on the INEEL or offsite, within Idaho, or in another part of the U.S. (the key was cost effectiveness).
- They needed to provide information on options considered, why options were rejected, and the rationale for their recommended approach.
- They could treat non-INEEL waste (including commercial waste) but residuals would have to be returned to the generator for disposal.

Study deliverables included a Business Plan, with financial approaches, recommendations on the type of contract and contract terms and conditions, cost estimates, pricing to DOE, a schedule for treatment services; Technology Plan; Licensing and Regulatory Plan; Transportation and Waste Transfer Plan; and a Public Acceptance Plan.

Three private sector teams ultimately provided feasibility studies for DOE-ID consideration. The private sector teams (in alphabetical order) were: Lockheed Environmental Systems and Technologies Company (LESAT) (now Lockheed Martin Advanced Environmental Systems); Rust Federal Services, Incorporated; and the Scientific Ecology Group (SEG).

The LESAT team included Mountain States Energy, Incorporated. The Rust Federal Services study team included Science Applications International Corporation (SAIC), Martin Marietta Aerospace and Naval Systems, and Consoer, Townsend and Associates. The SEG study team included British Nuclear Fuels Limited (BNFL Inc.), Raytheon Corporation, and Morrison-Knudsen Corporation.

The focus of the feasibility studies was alpha LLMW stored at the Transuranic Storage Area (TSA) at the RWMC. Optionally it was suggested that treatment of TRU waste stored at the TSA, similar environmental restoration buried wastes at the Subsurface Disposal Area (SDA), and similar wastes from other DOE sites might be considered as expanded waste treatment markets depending upon technologies/services available at the prospective treatment facility.

The Scope of Work for the feasibility studies, and attendant reference reports (EGG-RWMC-11189 and 11190 March 1994), (part of the Administrative Record for this EIS) provided a detailed description of the stored wastes (both alpha LLMW and TRU) at the RWMC TSA. The Scope of Work also described the envisioned treated product WAC in functional performance terms, but did not require a specific type of product. As a minimum the treated product waste materials had to satisfy the requirements for RCRA and TSCA long term storage and disposal, and provide suitable performance properties for passing a DOE radiological disposal site performance assessment. Additional detailed specifications on desired waste form performance properties were supplied in the Scope of Work as a guide, but were not required. The selection of treatment technologies, and resulting products (final waste forms) was left up to those preparing the feasibility studies.

The feasibility studies all centered on primary treatment using forms of thermal processing. Each of the three identified primary treatment technologies appeared to be viable to the DOE evaluation team. The identified plasma technologies were less widely used and potentially require more development prior to full-scale deployment for mixed waste. Recovery of reduced metals (the Rust and SEG study team alternate, molten metal) as a separate stream was viewed as economically advantageous because of cost avoidance associated with storage, certification and transportation to WIPP.

DOE's feasibility study evaluation team recognized the public's concern about, and acceptance of, thermal technologies involving incinerators. The team recognized the importance of monitoring developments in non-thermal treatments as alternatives. The definition of non-thermal treatment is somewhat subjective. This is because some argue that a technology is not thermal or at the very least is not incineration, despite operation at elevated temperatures and off-gas streams consisting of products of combustion. There are a variety of non-thermal treatments in various stages of development, including molten metal, steam reforming, Delphi catalyzed wet oxidation, hydrothermal oxidation (a.k.a. supercritical water oxidation), molten salt, etc. In general these technologies require feed material to be liquid or ground to a fine particle size. They also may require follow-on processes to stabilize residues for disposal. Due to these limitations, these technologies were considered by the DOE review team to be applicable to a narrower range of DOE wastes than the thermal technologies identified in the feasibility studies. The SEG study team did identify alternate technologies advertised as "non-thermal" (molten metal and steam reforming). The disadvantages of pursuing non-thermal options are that less volume reduction would be realized and a greater fraction of the waste would not be treated.

All of the feasibility study suppliers planned to thermally treat from 60 to 90 percent of the waste.

Project Definition Process

As a part of its process in evaluating the feasibility studies to determine a path forward, DOE used interdisciplinary

and systems approaches. A team of systems engineers, technical, regulatory, and business subject matter experts was assembled to conduct the evaluation process. The team's goal was: "Dispose of INEEL mixed waste in a safe and permanent manner." Three objectives to support the goal were defined:

1. Demonstrate progress to the State of Idaho on treatment and disposal of alpha LLMW;
2. Minimize cost with respect to risk sensitivities; and
3. Accomplish the goal in a safe, ethical and legal manner.

The objectives were used in the strategic and tactical phases to evaluate candidate alternatives and subsequent options. The steps that were followed are described below.

Step 1 — Strategic Phase — Formulate Feasible Alternatives

The team developed two sets of alternatives, non-treatment and treatment. Candidate alternatives are briefly described in Table F-1. Note that for this stage, the team took a much broader view of potential actions. Due to actual and anticipated DOE budget cuts, the team wanted to evaluate "no action" types of alternatives to see if there would be cost savings, without increased risk to the environment.

Table F-1. Summary of non-treatment and treatment alternatives.

A. Non-Treatment Alternatives:

	Alternative	Description
A.1	No Action	Leave waste in the earthen covered berm
A.2	Barrier Enhancement	Construct a protective cap over the bermed waste to prevent infiltration and subsequent waste migration
A.3	Retrieval Enclosure Building	Enclose the earthen covered berm in a protective building for indefinite storage
A.4	Retrieval Enclosure Building and Barrier Enhancement	A combination of alternatives A.2 and A.3 above
A.5	Retrieval and Indefinite RCRA Compliant Storage	Retrieve all drums and boxes of alpha LLMW and mixed TRU waste, repackage as necessary, and store in Type II storage buildings for 55 years

B. Treatment Alternatives:

		Alternative	Description
	B.1	IWPF Concept	Retrieve all waste, sort, treat alpha LLMW to LDRs, land dispose of alpha LLMW, treat TRU to WIPP WAC, ship TRU to

			WIPP
	B.2	Private Sector Concept	Retrieve all waste, treat alpha LLMW and TRU together to LDRs, and ship resulting TRU waste to WIPP

To identify feasible alternatives, candidate treatment and non-treatment alternatives were evaluated against the objectives. Non-treatment alternatives A.1, A.2, A.3, and A.4 were rejected by the team due to the lack of demonstrable progress to the State and on legal and ethical grounds. From an ethics perspective, the team agreed that continued storage of earthen covered bermed waste could result in further deterioration in the waste containers which would increase the potential for contaminant migration into the Snake River Plain Aquifer and potential adverse consequences for future generations. Costs associated with the barrier enhancement alternatives (A.2) were not estimated, but construction costs would probably range from $10 million - $20 million with additional costs for continuous monitoring. Costs for construction of the Retrieval/Enclosure Building (Alternative A.3) over the earthen-covered bermed waste, personnel costs, and monitoring for 55 years was estimated to be $1.1 billion.

Alternative A.5 (Retrieval of all mixed waste and Indefinite RCRA Compliant Storage) was also rejected. Although Alternative A.5 would remove the waste from the earthen-covered berm and would thereby demonstrate progress to the State, the risk of migration and exposure was not significantly reduced, i.e., potential for migration and exposure via natural disasters over the 55 year time frame. Furthermore, the estimated cost to DOE for this alternative was $1.4 billion over 55 years (RWMC storage costs, personnel, monitoring, etc.).

Next, the two candidate treatment alternatives were evaluated. The first alternative was the baseline INEEL M&O planned IWPF. This concept involves M&O retrieval of all earthen-covered bermed waste over a period of 5 years, segregating the waste (alpha and TRU) based on radiological assay, treating alpha LLMW to LDRs, treating TRU to WIPP WAC, and shipping all TRU to WIPP. The first alternative of treating alpha and TRU separately was comprised of two variations: 1) M&O retrieval and M&O treatment of alpha LLMW to LDRs; or 2) M&O retrieval and private sector treatment to LDRs. The second alternative was a concept recommended in all three private sector feasibility studies, i.e., treat all waste together to LDRs (treatment renders all waste to TRU) and ship TRU to WIPP. This alternative was also comprised of two variations: 1) M&O retrieval and private sector treatment or 2) private sector retrieval and treatment. Again, these steps are similar with or without private sector involvement.

Step 2 — Evaluate Feasible Alternatives with Respect to Objectives

The following discussion highlights and qualifies the comparison of alternatives relative to each objective. Table F-2 summarizes treatment alternatives with respect to the stated objectives. Life-cycle costs (retrieval, storage, assay, characterization, treatment, and transportation to WIPP) are used.

Table F-2. Treatment alternatives with respect to objectives.

Treatment Alternative	Demonstrate progress to State	Minimize cost w/ respect to risk[a]	Safe, legal, and ethical conduct
M&O IWPF Concept (M&O retrieval & treat alpha & TRU separately)	TRU to WIPP by 2021[b] Alpha disposal site to be determined.	$1.6 billion	
Private Sector (treat alpha only) Concept (M&O retrieval & treat alpha & TRU separately)	TRU to WIPP by 2016	$1.2 billion	

Private Sector Treat-all Concept (treat alpha & TRU together to LDRs) w/ M&O Retrieval	Alpha & TRU waste to WIPP by 2016. Most waste out of Idaho.	$1.2 billion	• Reduced handling and exposure for workers • Increased criticality concerns
Private Sector Treat-all Concept (treat alpha & TRU together to LDRs) w/ Private Sector Retrieval	Alpha & TRU waste to WIPP by 2013. Most waste out of Idaho.	$827 million	• Reduced handling and exposure for workers • Increased criticality concerns

a. Total DOE/INEEL life-cycle costs.

b. Based on operations beginning in 2010; this did not support the 1994 WIPP closing date of 2018.

Objective 1: Demonstrate Progress to State

All four alternatives above demonstrate DOE commitment to retrieving, treating, and disposing of mixed waste. The primary discriminators are: 1) time required to complete retrieval, treatment, and disposal, and 2) the final location for disposition of LDRs treated alpha LLMW.

M&O IWPF Concept — For the baseline alternative, where all work was to be performed by the M&O, it was estimated that all TRU waste would be shipped to WIPP by 2021 (assuming IWPF began treatment by 2010). If there was any remaining alpha low-level waste (waste that does not include a hazardous waste constituent), it could be land disposed (shallow burial) at INEEL or another location to be determined. For the private sector treatment alternative, shipment of TRU waste to WIPP was to be completed by 2016. Similarly, remaining alpha low-level waste was to be land disposed. It was estimated that use of private sector treatment services would reduce the baseline IWPF schedule by four to seven years.

Private Sector Concept — Treating alpha and TRU waste streams together would create significant process efficiencies in sorting, assaying, and characterization. However, many of these efficiencies would be lost due to the M&O's planned retrieval rate that is lower than the private sector's projected treatment capacity; this translates into increased time and costs for the private sector and DOE. Under this scenario, waste shipments to WIPP would be completed by 2016. This alternative removes nearly all TRU contaminated waste from the State of Idaho since all treated alpha becomes TRU waste and is transported to WIPP. Private sector treatment of alpha and TRU waste streams together, combined with private sector retrieval, would allow the private sector to shorten the retrieval period, thereby increasing system efficiency. For this alternative, it is estimated that most mixed TRU and alpha waste would be removed from Idaho and transported to WIPP by 2013. It was estimated that a private sector "turn-key" operation would reduce the baseline IWPF schedule by seven to eight years.

Objective 2: Minimize Cost with Respect to Risk Sensitivities

There was a wide range of costs between treatment alternatives. Total DOE/INEEL life-cycle costs are presented in Table F-2. Looking strictly at costs, the difference between the M&O IWPF concept of treating waste streams

separately and the private sector concept of treating alpha and TRU together, was approximately $800 million ($1.6 billion and $827 million, respectively). However, in addition to bottom line costs, treating all waste together generates other risk reduction benefits for DOE.

1. The amount of assay and characterization required and associated cost is greatly reduced when all waste is treated to LDRs. In order to segregate alpha and TRU waste, assay capabilities must be precise, particularly for waste readings approaching the classification limits. This degree of assay precision is time and work intensive. In contrast, treating alpha and TRU waste together requires only a safety assay to maintain criticality control. Similarly, the amount of characterization required for treated alpha and TRU waste differs markedly in that much less characterization is required for a homogenous treated product.

2. The utility of a consistent and stable final waste form improves system efficiency and safety in transportation, handling, and storage.

3. Volume reduction from treating all waste is significant, lowers transportation costs, simplifies transportation safety-related issues, and may reduce WIPP operational costs (not calculated).

4. All waste is treated, volume reduced, and becomes TRU, eliminating the need for separate land disposal of alpha low-level waste.

The team concluded that treating alpha and TRU wastes together should result in significant cost savings, as well as lessen some of the fundamental risks and uncertainties facing DOE in dealing with mixed waste.

Objective 3: Accomplish the Goal in a Safe, Ethical, and Legal Manner

The primary discriminators in the comparison of the two base alternatives (treating alpha and TRU waste separately or together) involved worker safety and criticality control issues. The team believed that treating all waste streams together with private sector assay and waste characterization would greatly decrease worker exposure to radiation and the hazardous components of the mixed waste. On the other hand, the team felt treating all wastes together would increase criticality concerns. However, the team's radiation experts believed these concerns could be adequately addressed through treatment process controls. Regulatory experts indicated that obtaining a RCRA Part B permit would be similar under either alternative, although it was recognized that the "Treat-all" concept would entail significantly more thermal treatment which is a sensitive public issue. Some of the benefits of treating TRU and alpha LLMW together are fewer shipments to WIPP, a more stable and known waste form, and enhanced public safety. In summary, treating all wastes to LDRs should decrease risks to workers and the public assuming adequate worker protection standards and criticality controls are maintained.

Strategic Decision: Evaluation of the two alternatives, treating waste streams separately versus treating waste streams together, revealed clear advantages (cost, safety, and final disposition) to DOE-ID in treating alpha and TRU mixed wastes with the same treatment process.

Tactical Phase

Once the decision was made to recommend treating alpha and TRU wastes together, the next level of decision making focused on tactical issues, i.e., how the decision should be implemented. This phase of the decision making process involved formulating feasible options and evaluating these options with respect to the objectives. Options evaluated were primarily derived from the private sector feasibility studies.

Step 1 — Formulate Options

A. Private Sector Treatment

1. Sole Source

2. Offsite Location for Treatment Facility

3. M&O Retrieval

4. Private Sector Turn-key (i.e. all work performed by private sector.

B. M&O Treat-all to LDRs

Two potential options, sole source treatment services and siting the private sector treatment facility off the INEEL, were determined to be infeasible.

Sole Source — This option was rejected due to the requirements of the *Competition in Contracting Act* and implementing regulations. The team determined that procurement of waste treatment services does not meet the criteria for a sole source contract, i.e., national emergency, national security, or unique capability. Furthermore, the consensus opinion was that competition would reduce the total cost of the project.

Offsite Treatment Facility Location — This option was rejected due to an evaluation of the advantages and disadvantages of an offsite location. One of the feasibility studies suggested an offsite location for the treatment facility while two of the studies did not consider locations outside the INEEL boundaries.

The one contractor that advocated an offsite location stated that "the conceptual design is totally adaptable to either a privately leased site within the INEEL complex or an offsite location," and listed numerous advantages and disadvantages of siting the treatment facility at the INEEL. Advantages cited include: close proximity to waste, existing site infrastructure, functional facilities (fire department and site security), similar waste management activities and absence of community and state fees. Disadvantages cited include: precedent in siting a private fixed price facility on Federal land, perceived delays with licensing and permitting, uncertainty of *National Environmental Policy Act* (NEPA) requirements, and the burden of DOE orders and oversight.

These concerns were discussed at length by the team members and their opinion was that the disadvantages were more perceived than real. For example, there is a precedent of siting a private facility on Federal land (U.S. Ecology Facility at Hanford). The team felt that all these issues could be adequately addressed but was unsure of the extent that DOE would have to be involved in licensing and permitting an offsite waste treatment facility. Some level of responsibility was assumed because the facility would presumably not be built but for DOE's waste. NEPA requirements are addressed in the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE INEL EIS [DOE 1995a]) and DOE would assume the burden of any supplemental NEPA requirements. Finally, the team determined that a set of "necessary and sufficient" requirements from DOE orders, i.e., ES&H requirements, should be identified. In summary, private sector concerns regarding problems associated with siting a facility at the INEEL were not well substantiated and insignificant relative to the advantages (cost and safety) of siting the treatment facility near the RWMC.

The SEG study team offsite feasibility study option was based on the premise that the scope of treatment services was restricted to alpha waste only. Although not verified, the evaluation team assumed that had the contractor been requested to treat all alpha and TRU waste types, the logistics of transporting large quantities of TRU waste in addition to alpha waste would have eliminated the option of siting the facility off the INEEL.

Once the team decided to recommend all mixed waste be treated to LDRs, an offsite location was determined to be infeasible for the following reasons:

1. Transport and Handling of TRU Wastes — approximately 60 percent of the waste is stored in boxes; these boxes would need to be repackaged prior to transport offsite because there is no approved TRU box transport system. This would require a characterization facility and a repackaging facility with an estimated life-cycle cost of $800 million. Furthermore, transportation of treated TRU waste would have required Transuranic Pact Transporter (TRUPACT) containers. An independent estimate procured by DOE estimated that constructing a private road from the RWMC to a private offsite treatment facility with restricted access would cost $10 million.

2. Site infrastructure and emergency services could be utilized at an onsite location. Impacts to existing site operations was projected to be minimal.

3. Discussions with NRC regarding licensing indicated that their lack of experience in licensing this type of facility would delay the project.

Eliminating the Sole Source and Offsite options resulted in the formulation of three remaining options: (1) Private Sector Turn-key, (2) M&O Retrieval and Private Sector Treatment, and (3) M&O Treat-all to LDRs. The next stage of the decision making process involved evaluating these remaining options against the objectives.

Step 2 — Evaluate Remaining Options with Respect to Objectives

The following discussion highlights and compares the remaining options relative to each objective. Table F-3 summarizes treatment options with respect to the stated objectives. (Note: For the M&O IWPF Option, the facility was assumed to be operational by 2010 with a 20-year operating life. All cost estimates were based on a 2010 starting date).

Table F-3. Evaluation of feasible options with respect to the objectives.

Treatment Alternative	Demonstrate progress to State	Minimize cost w/ respect to risk[a]	Safe, legal, and ethical conduct[b]
M&O IWPF (retrieve and treat-all waste together to LDRs)	TRU to WIPP by 2030	$2.0 billion	See footnote[b]
M&O Retrieval & Private Sector Treatment	TRU to WIPP by 2016	$1.2 billion	Reduced DOE flexibility with private sector involvement
Private Sector Turn-key	All waste to WIPP by 2013. Most waste out of Idaho.	$827 million	Reduced DOE flexibility with private sector involvement

a. Total DOE/INEEL costs.

b. The consensus opinion of the team was that there is no differences in safety, ultimate DOE liability, and real level of DOE control between options.

Objective 1: Demonstrate Progress to State

M&O IWPF Treat-all to LDRs — This option scored the lowest with respect to this objective. Waste treatment and disposal at WIPP would not be completed until 2030.

M&O Retrieval and Private Sector Treatment — This option scored high relative to this objective since treatment

was projected to begin in 1998-2001, with all waste shipped to WIPP by 2016, 14 years sooner than the M&O option.

Private Sector Turn-key — This option scored highest relative to this objective since treatment could begin in 1998-2001, with all waste shipped to WIPP by 2013. An accelerated retrieval schedule matched to the capacity of the treatment facility would result in a three year savings over M&O Retrieval with Private Sector Treatment option, and a 17 year savings over the full M&O option.

Objective 2: Minimize Cost with Respect to Risk

M&O IWPF treat-all to LDRs — This option, estimated at approximately $2 billion, is significantly higher than the two competing options. It is more than twice the estimated cost of the Private Sector Turn-key option. The $2 billion estimate was provided by the LITCO cost-estimating group (this cost estimate is part of the Administrative Record for this EIS). DOE-ID believes it is probably high. It is reasonable to assume that the M&O IWPF alternative to treat all waste to LDRs standards should be slightly less than the $1.6 billion estimate for the baseline case. Under this option all financial risks would be borne by DOE; DOE would provide funding for all capitalization, contract modifications, claims, etc. Budget vulnerabilities increase as a function of time, and this option extends over the longest time period. On the other hand, the relationship between DOE and the M&O may be less adversarial due to traditional performance incentives. Costs of extended WIPP operations are not included in the overall cost estimate.

M&O Retrieval and Private Sector Treatment — It is estimated that this option would cost DOE substantially less than the M&O option but approximately $400 million more than the Private Sector Turn-key option. Financial risk is shared by DOE and the private sector, with the private sector providing capitalization for facilities associated with treatment. The private sector would also provide insurance/surety. Associated WIPP costs may be reduced due to the earlier completion date. Budget uncertainties are somewhat reduced due to the project's lower cost and shorter duration. A major disadvantage of this option is the potential for DOE to incur significant delay and/or disruption claims from the private sector contractor. This would be due to changes in conditions if the M&O fails to provide the private sector contractor retrieved waste in the contractually specified condition and at the specified rate. Also, DOE would be responsible for interim storage of the treated waste.

Private Sector Turn-key — This is the lowest cost option. It avoids the potential problems associated with an interface point between contractors thereby eliminating DOE's responsibility for interim storage. Retrieval can be performed just-in-time to minimize handling and storage. Similarly to the M&O Retrieval and Private Sector Treatment option, financial risk is shared by DOE and the private sector, with the private sector providing capitalization for facilities associated with treatment. The private sector would also provide insurance/surety. Associated WIPP costs may be reduced due to the earlier completion date. Budget uncertainties are further reduced due to even lower cost and shorter duration that under the other two options.

Objective 3: Accomplish the Goal in a Safe, Ethical, and Legal Manner

This objective was the most difficult to quantify. The team discussed safety, ethical, and legal issues at great detail. Ethical DOE conduct involves accomplishing the mission at the lowest cost to the taxpayers, while maintaining safety standards and complying with applicable law. Thus, given the large disparity in cost and schedule between the private sector options and the M&O option, the team was forced to address the following questions:

1. What is DOE gaining from private sector involvement?

versus

2. What is DOE giving up with private sector involvement?

What is DOE gaining? Assuming the private sector can perform the work at the estimated cost within in the estimated time frames, DOE gains tremendous cost savings. In addition, most waste is removed from Idaho up to 17 years sooner than with the M&O option.

What is DOE giving up? DOE traditionally strives to operate in a near risk-free environment, as a result, DOE has an impressive record of safety. Conversely, a near risk-free culture comes at a high price. Privatization and the call for "DOE to function more like a business" essentially entails accepting slightly more risk in anticipation of large cost savings. It was the consensus opinion of the team that DOE would not compromise safety or environmental quality by utilizing private sector services for treatment of mixed waste. Furthermore, use of private sector treatment services would not increase nor limit the risk to DOE of catastrophic liability any more than with the M&O-operated, DOE-owned IWPF. On the other hand, the team recognized the loss of DOE flexibility (not control) in utilizing the private sector under a fixed price contractual arrangement. In the event of budget perturbations or "change conditions," DOE has much less latitude and ability to redirect a fixed-price contractor (without incurring substantial costs) versus the M&O under a cost-plus arrangement. In addition, project budget uncertainty may be reduced since it may be more difficult to remove funding from a fixed-price private sector contract than an M&O. In summary, the consensus opinion of the team was that, given the tremendous potential cost savings, DOE should afford to surrender some flexibility within an acceptable level of environmental, health and safety risk.

Tactical Decision: After careful evaluation of the three options (M&O IWPF Treat-all, M&O Retrieval and Private Sector Treatment, and Private Sector Turn-key), the team recommended that DOE pursue procurement of treatment, assay and characterization services for alpha and TRU mixed waste from the private sector. The contract may include a priced option for private sector retrieval and storage.

DOE Make or Buy Decision

The evaluation team's recommendations were presented to Jill Lytle, DOE Environmental Management (EM) Deputy Assistant Secretary for Waste Management, and Thomas Grumbly, Assistant DOE Secretary for EM. The evaluation team recommended that plans for the M&O constructed and operated IWPF concept be terminated in favor of privatizing the treatment of TRU waste and alpha LLMW to LDRs because of cost effectiveness. In May 1995, Assistant Secretary Grumbly gave oral direction to proceed with a procurement action for privatization.

Link to NEPA Activities

As the feasibility studies were being completed in 1994, information from them was being provided for analysis in the DOE INEL EIS, then in preparation. The project manager had requested a separate EIS to be conducted for this project in 1994; however, a separate EIS was not done because the DOE-ID NEPA Compliance Officer believed this would have the appearance of a "segmentation" action. Therefore the environmental impacts of the project were analyzed with all other environmental restoration and waste management projects in the DOE INEL EIS. Alternatives considered in the feasibility studies were considered broadly in the Alternative A (No Action), Alternative B (Ten Year Plan), and Alternative D (Maximum Treatment, Storage, and Disposal) of the DOE INEL EIS. The information summarized from the DOE INEL EIS with regard to private sector treatment of alpha and TRU mixed waste is described in the Table F-4.

Table F-4. Summary of private sector treatment of alpha LLMW and TRU mixed waste.

Area	Description
Private Sector Alpha LLMW Treatment	Alpha-contaminated, possibly TRU, and small amounts of low-level waste and LLMW and environmental restoration wastes. Treat alpha to LDRs, treatment of TRU sufficient to allow disposal at WIPP. Facility throughput 2,000 cubic meters of alpha and 4,000 cubic meters of TRU. Sort, segregate containers, vent, open, and dump contents for further sorting and processing; physical and chemical processing; thermal treatments (oxidation/combustion and

	stabilization). Analyses include transportation to offsite commercial facility for treatment: 1,022 offsite truck trips per year. Chapter 5 of the EIS, Alt. B, 10 year plan, and D, Maximum Treatment, Storage and Disposal.
RWMC Modifications to Support Private Sector Treatment of Alpha LLMW	Needed to support transport of alpha LLMW and TRU to a privately owned and operated treatment facility. Additional waste retrieval, venting, and examination facilities would be required to be operational by 10/2000 to support the transport of waste offsite for treatment, and receiving it back onsite after treatment -new examination and assay facilities to supplement the Stored Waste Examination Pilot Plan -transportation facilities to stage drums and boxes for transport to the private facility and receive returning drums of treated waste; capacity is 680 drum equivalents per day.
Shipping/Transfer Station	Built to deal with number of offsite shipments required to send waste elsewhere for treatment.

The Record of Decision (ROD) from the DOE INEL EIS (Section 3.2.2.2, TRU Waste) states that the INEEL would construct treatment facilities necessary to comply with the *Federal Facility Compliance Act* (FFCA). Treatment of TRU waste at a minimum will be for the purpose of meeting the WAC for disposal at WIPP and will occur on a schedule to be negotiated with the State of Idaho. The decision also indicates that projects for retrieving, characterizing, and treating TRU waste will prepare the waste for transportation and disposal in a repository or on site. The ROD indicates that decisions regarding the projects shown above (Private Sector Alpha LLMW Treatment, and RWMC Modifications to Support Private Sector Treatment of Alpha Contaminated LLMW, as well as IWPF), will be made in the future pending further project definition, funding priorities, or appropriate review under NEPA.

Current Regulatory Situation

Under RCRA, the FFCA of 1992 required DOE to prepare a plan for developing treatment capacities and technologies for each facility at which DOE generates or stores mixed wastes. The Idaho Department of Health and Welfare (IDHW), Division of Environmental Quality, upon consultation with EPA, issued an order to DOE requiring compliance with the approved plan. This plan, referred to as the Site Treatment Plan (STP) and Consent Order fulfill the requirements contained in the FFCA, applicable RCRA sections, and the Idaho *Hazardous Waste Management Act*. Storage of waste, covered under the STP and Consent Order, at the INEEL, pending development of treatment capacities and technologies and completion of LDR standards pursuant to the STP, are considered to be in compliance.

The STP, originally signed in October 1995, indicates that alpha LLMW is managed along with mixed TRU waste (sections 4.2 and 5.4 of the plan). The plan indicates that DOE has decided to fully pursue private sector treatment of the TRU contaminated stored waste at the INEEL. The STP states that private sector treatment of the TRU contaminated stored wastes is planned, along with limited amounts of LLMW from the INEEL and offsite which may be treated at the same facility. It indicates that for a majority of the TRU contaminated waste at the INEEL, DOE-ID plans to achieve compliance with the requirements of the FFCA by implementing full treatment and then disposing of the treated waste at WIPP (page 5-16). Specific milestones/planning dates in the STP for mixed alpha and TRU wastes are as follows: place contract (complete); initiate construction fourth quarter of FY-99; commence system testing fourth quarter FY-02; commence operations, second quarter of FY-03; and, submit schedule for backlog, fourth

quarter of FY-03.

In addition to the STP, DOE is under a Federal court-ordered 1995 DOE and Navy Settlement Agreement with the State of Idaho to ship all TRU waste from the INEEL. The target date for all waste to leave the State is December 31, 2015, and no later than December 31, 2018. After January 1, 2003, a running average of no fewer than 2,000 cubic meters per year of this waste must be shipped out of the State of Idaho. If DOE fails to meet specified deadlines or requirements, the State will suspend all DOE spent fuel shipments to the INEEL. The agreement states that DOE may treat non-INEEL waste. The waste must be treated within six months of receipt at the facility. Any TRU waste received from another site for treatment at the INEEL must be shipped out of Idaho for storage or disposal within six months following treatment.

Advanced Mixed Waste Treatment Project (AMWTP) Procurement

A draft Request for Proposal (RFP) for the treatment of TRU waste and alpha LLMW was issued for industry comment in July 1995. A final RFP was issued in January 1996. DOE requested that retrieval and other support activities to treatment be priced separately, since a decision to buy treatment with all services had not yet been made. Additionally, DOE did not mandate the facility location, but was open to onsite or offsite facilities.

The overall vision expressed in the RFP was for the project to treat waste for final disposal by a process that provided the greatest value to the Government. This was envisioned to be accomplished through a private sector treatment facility that had the capability to treat INEEL waste streams with the flexibility to treat other INEEL and DOE regional and national waste streams. The services were to: (1) treat waste to meet the most current WIPP WAC, RCRA LDR standards, and TSCA standards; (2) reduce waste volume and life-cycle cost to DOE, and (3) be performed in a safe and environmentally compliant manner.

Bids were received from four teams; three teams were in the competitive range. The teams were Foster Wheeler and the SEG, Lockheed Martin Advanced Environmental Systems, and BNFL Inc. who teamed with Morrison Knudsen, SAIC, Duratek, and BEL. All proposed onsite facilities and DOE regulation.

BNFL Inc. was selected in December 1996.

AMWTP Contract

The contract includes treatment and supporting services of retrieval, sorting, characterization, storage, and certifying, packaging, and loading the final waste product for disposal for 65,000 cubic meters of waste.

The contract contains performance specifications that include: a schedule that conforms to the Settlement Agreement; the final waste form must meet RCRA LDR standards, treatment standards and the WIPP WAC Rev. 5; the waste must contain greater than 100 nCi/g TRU, or the contractor receives a payment penalty; and the contractor must also achieve 65 percent volume reduction or receive a payment penalty.

A specific final waste form (such as glass or concrete), or specific technology to be used to treat the waste, was not included in the performance specifications of the contract.

The contract has three phases and two options. Phase I is permitting, submission of data for DOE's NEPA analysis, and an ES&H authorization process. Phase II is construction and operational testing; Phase III is operations, RCRA closure and decontamination and decommission (D&D). There is a go/no go between Phase I and Phase II. Before the contractor can proceed to Phase II, Phase I must be completed and DOE must complete its NEPA review. If the decision under NEPA is unfavorable to moving forward with Phases II and III of the project, then the contact will be terminated for the convenience of the government. The contact has an option to treat an additional 120,000 cubic meters of waste in 20,000 cubic meters increments. The contract specifies that only DOE waste can be treated at the facility.

For Phase I of the project, BNFL Inc. will be paid a total of $16.3 million. Payments are made only for specific deliverables accepted by DOE. For Phase II, the construction and operational testing phase, no payments will be made.

This is entirely financed by BNFL Inc. Once treatment begins in 2003, BNFL Inc. will be paid per cubic meter of waste treated and accepted by DOE. BNFL Inc. will amortize the cost of the facility over the first 25,000 cubic meters of waste treated. For treatment of the 65,000 cubic meters of waste plus RCRA closure of the facility, BNFL Inc. will be paid $859.8 million. The price of the contract for all three phases and all services for the treatment of 65,000 cubic meters is $876 million.

AMWTP Cost Savings/Cost Avoidance over M&O Plans

In looking at potential cost savings based on the feasibility studies, DOE estimated an average of $820 million could be saved by privatizing treatment and all supporting services. After the contract was awarded, cost savings estimates were recalculated using the contract price plus DOE and M&O contractor supporting services.

For the recalculation, dollars were adjusted from FY-1994 to FY-1996 using DOE guidance from the Office of Management and Budget, construction dollars spent in 1995 and 1996 were treated as sunk costs, remaining costs and facility start-ups from the M&O baseline plan were delayed two years, and transportation costs were reduced to eliminate the operating cost of the TRU transporters for comparability with the awarded contract, which excluded transportation. Information is summarized in the Table F-5.

Table F-5. Summary of adjusted transportation costs to 1996 dollars.

1994 M&O Alternative	1994 estimate ($FY-94)	Escalated to 1996 ($FY-96)	M&O adjusted 1996 ($FY-96)
Baseline plan[a]	$1,647	$1,763	$1,679
Treat all to LDRs	$2,000	$2,141	$2,067
Treat all to WIPP WAC [b]	$1,595	$1,707	$1,611
	BNFL Inc. Contract plus DOE/M&O Support Costs	M&O Baseline Plan Adjusted 1996 ($FY-96)	Savings/Cost Avoidance
Total costs ($'96)	$1,009	$1,679	$670
Total escalated cost @ 2.7 percent in EM 2006 Plan	$1,173	$2,524	$1,351

a. Baseline plan was treat TRU to WIPP WAC and treat alpha to RCRA LDR standards.

b. This alternative would require a change to the *Land Withdrawal Act* to accept alpha mixed waste.

When the contract price of $827 million is added to the DOE and M&O supporting costs, the cost is $1.009 billion. As reflected in the table, this saves or avoids costs of $670 million in 1996 constant dollars over the M&O baseline plan described in the feasibility study evaluation.

Treatment Drivers

During the feasibility study stage, treatment needs for the waste were discussed extensively. Treatment of the alpha mixed waste to meet RCRA LDR standards was never debated. The level of TRU waste treatment was examined from a technical and cost perspective. The feasibility studies bore out that treating both waste streams together resulted in substantial cost savings over dealing with them separately. In addition, volume reduction lowered INEEL storage costs.

The feasibility studies indicated that volume reduction would also lead to further savings in transportation of the waste to WIPP. However, further examination after contract award has shown that due to weight loading limits of the TRUPACT II container, these cost savings would be minimal. They were eliminated from the cost savings calculations; the cost savings of $670 million does not include transportation costs.

Since the feasibility studies and the award of the contract, the issue of treatment vs. no treatment is still a topic of interest to some stakeholders. For that reason, the following information is provided in this section.

Treatment as defined in RCRA 40 CFR Part 260, Subpart B, 260.10, "means any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduce in volume." Using this definition, the INEEL has viewed that repackaging boxed waste so that it can legally be transported, and sizing, and compaction of waste for volume reduction meets the definition of treatment.

Some stakeholders do not understand that while waste being disposed of at WIPP is exempted from RCRA LDR standards, there are still strict characterization, transportation, and disposal requirements, which are part of the WIPP WAC.

- WIPP and its regulatory agencies require that waste be characterized sufficient to meet its WAC;
- The only approved transport system approved for moving TRU waste to WIPP is the TRUPACT II's. The TRUPACT II has restrictions on types of containers that can be placed in it, the weight of individual containers and total load weight, hydrogen generation within containers, and liquids volume within the containers.

- Not all categories of hazardous and toxic wastes can be disposed of at WIPP, and;
- WIPP's ability to handle various containers types and sizes for disposal is limited.

Table F-6 illustrates some of these points.

Table F-6. Summary of WIPP WAC characterization, transportation, and disposal requirements.

WIPP requirements	INEEL wastes	INEEL action to meet WIPP WAC
Only standard waste boxes or Type A 55 gallon drums can be shipped in the TRUPACT II and disposed of at WIPP	38,000 cubic meters (60 percent) of the INEEL stored waste is in nonstandard waste boxes; 24,000 cubic meters, or 6,600 boxes, of this waste is TRU waste	Repackage all of the boxes into drums and/or standard waste boxes
Waste with radionuclides below 100nCi/g cannot be disposed at WIPP	25,000 cubic meters of waste is expected to be below 100 nCi/g	Treat waste through thermal and/or mechanical processes to maximize that $\geq$ 100 nCi/g and can be disposed of at WIPP

WIPP will not accept wastes with PCBs above 50 ppm	1,560 cubic meters of waste has been identified as potentially having PCBs above the limit; 12,662 cubic meters is suspect for PCBs	Thermal treatment of PCBs is required by TSCA
No liquids over 1 percent volume	8,450 cubic meters of waste with excess liquids	Excess liquids will be absorbed or incinerated
No ignitable wastes	3,900 cubic meters exhibit the ignitable characteristic	Ignitable waste will be incinerated

Considering all of the above categories, a total of 90 percent of the INEEL stored waste requires repackaging or other treatment to meet all regulatory requirements for transportation and disposal. Under current plans, BNFL Inc. will incinerate approximately 22 percent of the waste. For NEPA analyses 25 percent of the waste was considered to be incinerated. Wastes to be incinerated include PCBs, soils, and organic and inorganic solids.

In response to comments received from the public at RCRA pre-application meetings and NEPA EIS scoping meetings, BNFL Inc. made changes to their treatment process flow sheets to minimize the amount of thermal treatment to be performed. They originally proposed thermal treatment for more than 50 percent of the waste. This change appears to have gained the approval of a number of members of the public as reasonable and environmentally more acceptable.

The purpose of this AMWTP WAC document is to define the requirements for accepting waste for treatment at the AMWTP facility. These requirements are based on the presently proposed and evaluated design capability of the treatment process described in the Technical Proposal. Wastes which do not meet the criteria stated in the AMWTP WAC may be accepted for treatment, but only following a detailed case-by-case evaluation of the specific waste characteristics, and special authorization from the AMWTP General Manager.

Table F-7 presents a summary of the AMWTP WAC for INEEL wastes required to be treated in the AMWTP.

Table F-8 presents a summary of the AMWTP WAC for non-INEEL wastes which could be received for treatment in the AMWTP. The WAC for non-INEEL wastes contains additional requirements which ensure that waste received is similar to the existing INEEL wastes.

Please note that the AMWTP WAC proposed in this section are for receipt of wastes for treatment, and not for outgoing, treated wastes. Treated wastes will meet the WAC for the respective disposal site. Also note that the AMWTP WAC presented in this section is subject to change as more is learned about the specific physical, chemical, and radiological characteristics of the INEEL stored wastes, and the needs of other potential INEEL and non-INEEL customers.

Table F-7. Summary of AMWTP WAC for INEEL wastes.

Criteria	Requirement
General	1. Waste must be characterized for identity and quantity of radionuclides, organic and inorganic constituents, and metals 2. Waste must not contain classified materials
Container and Physical Properties	
Size	1. Waste must be packaged in a;

	1. 55 gallon drum, or 2. Over pack drum no larger than 83 gallons, or 3. Standard Waste Box, or 4. Overpacked Standard Waste Box, or 5. 4'x4'x7' box 1. Other sized boxes may be considered on a case-by-case basis, and are limited only by the physical dimensions of the receipt, opening and content removal capacity of the AMWTP
Containment	• Waste must be confined in at lease two levels of containment • All containers must be vented (filtered vent) • Containers must not contain shielded radioactive material (case-by-case evaluation)
Marking/Labeling	• Containers must be uniquely numbered or coded for tracking purposes
Package Weight	• Drum gross weight must not exceed 1,000 lb • Box gross weight must not exceed 8,000 lb
Free Liquids	• Quantity and composition of free liquids must be identified in the characterization information
Particulates	No restrictions
Chemical Properties	
Metals	• Separable or contained beryllium metals, mercury and lead must be identified in the characterization information • Beryllium-contaminated waste from foundries, extraction plants, ceramic plants and propellant plants are prohibited • Mercury-contaminated waste must not exceed 1,000 ppm
Corrosives	• Waste must not contain corrosive materials (<2 or >12.5 pH)
Explosives, Pyrophorics, Reactives, and Compressed Gases	• Waste must not contain explosive or pyrophoric material, except for pyrophoric forms of radionuclides • Waste must not contain DOT Class 1 explosives • Waste must not contain reactive metals or forbidden materials per 49 CFR 173.21. • Waste must not contain compressed gases. Pressurized containers must be vented and

	drained
Mixed/TSCA Waste	• Mixed waste is acceptable except as restricted in other parts of this WAC (see general topic above) • Liquid PCB waste must not exceed 50 ppm

Table F-7. Summary of AMWTP WAC for INEEL wastes (continued).

Criteria	Requirements
Nuclear Properties	
Fissile Mass	• Drums must not contain more that 200 grams of Pu-239 fissile-gram equivalent (FGE) • Boxes must not contain more than 325 grams (FGE) • Waste containers with more than 15 grams of non-TRU fissile material (e.g. U-235) must be reviewed and approved on a case-by-case basis
Pu-239 Equivalent Activity (PE-Ci)	• Waste containers must not contain more than 1,000 PE-Ci
Non-Fissile Radionuclides	• Waste containers must not contain more than 1 Ci of non-TRU betagamma emitting radionuclides
Dose Rate	1. Contact dose rate (beta + gamma + neutron) at any point on the surface of a container must not exceed 200 mrem/hr 2. Dose rate (gamma + neutron) at two meters from the surface of a container must not exceed 10 mrem/hr 3. Neutron contributions (at contact) greater than 20 mrem/hr must be documented in the characterization information
Surface Contamination	• Removable contamination shat not exceed 200 dpm/100cm^2 beta gamma activity, or 20 dpm/100 cm^2 of alpha activity
Thermal Power	• Containers with thermal power greater than 0.1 watt/ft^2 must be identified and quantified in the characterization information

Table F-8. Summary of WAC for wastes received from non-INEEL sites.

Criteria	Requirement
General	

	Generators must receive approval from the BNFL Inc. Team prior to shipping waste to the AMWTP facility • Waste must be characterized for identity and quantity of radionuclides, organic and inorganic constituents, and metals • Waste must not contain classified materials • Each waste container must be accompanied by a data package
Container and Physical Properties	
Size	• Waste must be packaged in one of the following DOT-approved containers; 1. 55 gallon drum, or 2. Overpack drum no larger than 83 gallons, or 3. Standard Waste Box, or 4. Overpacked Standard Waste Box, or 5. 4'x4'x7' box 6. Other sized boxes may be considered on a case-by-case basis, and are limited only by the physical dimensions of the receipt, opening and content removal capacity of the AMWTP
Containment	• Waste must be confined in at lease two levels of containment • All containers must be vented (filtered vent) • Containers must not contain shielded radioactive material (case-by-case evaluation)
Marking/Labeling	• Containers must be uniquely numbered or coded for tracking purposes • Waste packages must have DOT labels, RCRA labels, container number, gross weight, and other appropriate DOE markings and labels.
Package Weight	• Drum gross weight must not exceed 1,000 lb • Box gross weight must not exceed 8,000 lb
Free Liquids	• Quantity and composition of free liquids must be identified in the characterization information
Particulates	No restrictions
Chemical Properties	
Metals	• Separable or contained beryllium metals, mercury and lead must be identified in the characterization information • Beryllium-contaminated waste from foundries, extraction plants, ceramic plants and propellant plants are prohibited

	• Mercury-contaminated waste must not exceed 1,000 ppm
Elemental Content Limits	• Chlorine is limited 3 wt% • Sulfur is limited to 1 wt% • Fluorine is limited to 15 wt% • Phosphorus is limited to 5 wt% • Barium is limited to 5 wt% • Chromium is limited to 2 wt% • Chromium is limited to 2 wt% • Nickel is limited to 12 wt% • Silver is limited to 10 wt% • Cadmium is limited to 5 wt% • Thallium is limited to 1 wt%

Table F-8. Summary of WAC for wastes received from non-INEEL sites (continued).

Criteria	Requirements
Elemental Content Limits (continued)	• Arsenic is limited to 2 wt% • Antimony is limited to 2 wt% • Selenium is limited to 2 wt% • Other elements are limited to 30 wt% except Si, Al, B, alkalis, alkaline earths, C, H, N, and O when calculated as the corresponding oxide
Corrosives	• Waste must not contain corrosive materials (<2 or >12.5 pH)
Explosives, Pyrophorics, Reactives, and Compressed Gases	• Waste must not contain explosiveor pyrophoric material, except for pyrophoric forms of radionuclides • Waste must not contain DOT Class 1 explosives • Waste must not contain reactive metals or forbidden materials per 49 CFR 173.21. • Waste must not contain compressed gases. Pressurized containers must be vented and drained
Mixed/TSCA Waste	• Mixed wastes which have as their Best Demonstrated Available Technology: AMLGM, CMBST, DEACT (for ignitable waste only), IMERC, and STABL will be accepted for treatment • Mixed waste with a technology-based treatment standard other than those listed above will be

	accepted on a case-by-case basis only • Liquid PCB waste must not exceed 50 ppm
Other	• Pathological or etiologic agents must be identified in characterization information • Waste must not contain incompatible material
Nuclear Properties	
Fissile Mass	• Drums must not contain more than 200 grams of Pu-239 fissile-gram equivalent (FGE) • Boxes must not contain more than 325 grams (FGE) • Waste containers with more than 15 grams of non-TRU fissile material (e.g. U-235) must be reviewed and approved on a case-by-case basis
Pu-239 Equivalent Activity (PE-Ci)	• Waste containers must not contain more than 1,000 PE-Ci
Non-Fissile Radionuclides	• Waste containers must not contain more than 1 Ci of non-TRU beta-gamma emitting radionuclides
Dose Rate	• Contact dose rate (beta + gamma + neutron) at any point on the surface of a container must not exceed 200 mrem/hr • Dose rate (gamma + neutron) at one meters from the surface of a container must not exceed 10 mrem/hr • Neutron contributions (at contact) greater than 20 mrem/hr must be documented in the characterization information
Surface Contamination	• Removable contamination shall not exceed 200 dpm/100 cm^2 beta-gamma activity, or 20 dpm/100 cm^2 of alpha activity
Thermal Power	• Containers with thermal power greater than 0.1 watt/ft^3 must be identified and quantified in the characterization information
Data	
Data Package	• Shipments of mixed waste must have an accompanying Hazardous Waste Manifest • The data package must contain the following information: package (container) identification number package assembly identification number (if

	applicable)

Table F-8. Summary of WAC for wastes received from non-INEEL sites (continued).

Criteria	Requirements
	1. Date of waste package certification 2. Waste generation site (certification site) 3. Date of packaging (closure date) 4. Maximum surface dose rate in mrem/hr and specific neutron dose rate if greater than 20 mrem/hr 5. Weight Container type
Data Package (continued)	• Physical description of waste form, content codes(s), weight percent of organic material, and estimated weight or mass of organic material • Assay information, including PE-Ci, alpha Curies, and Pu-239 fissile gram equivalent content • Fissile mass plus two times the error • Radionuclide information including radionuclide symbol and quantity and: a. Characterization data should include all radionuclides that contribute >1% (by Curies) of the total activity of the waste matrix and any of the following radionuclides even if they contribute <1% of the total activity: H-3, C-14, Co-60, Ni-59, Ni-63, Se-79, Sr-90 Nb-94 Tc-99, I-129, Pu-241, Cm-242, Cs-137 and alpha-emitting nuclides with half-lives >5 years b. Reporting of the radionuclides must include any parent-daughter radionuclide pairs that meet the above criteria (e.g., Ba-137 must be reported with Cs-137, Y-90 must be reported with Sr-90) c. Data must be reported in either grams or Curies 13. Mixed wastes must have LDR materials characterized 14. Organics and inorganics must be characterized in terms of type and concentrations 15. Measured or calculated thermal power (if greater than 0.1 watt/cubic foot); report this data in terms of decay heat plus error limits 16. Shipment number 17. Data of shipment 18. Vehicle type 19. Headspace VOC in ppm 20. Aspiration time determined and recorded in data package (or hydrogen gas concentration 21. Name of certifying official who certified the

	waste

Table F—9. Existing wastes stored at the TSA.[a,b,c]

Gen.	IDC[d]	Stream Name	EPA Haz. Waste Numbers	No. of Drums		No. of Boxes		No. of Bins		No. of Other		Tot. Vol.	Waste
				WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	(cubic meters)	Cat.[d]
ANL-E	100	General Plant Waste	D001,F003	0	2			24	301			1134.0	HD
ANL-E	101	Cut Up Gloveboxes	D008					6	66			251.1	MD
ANL-E	102	Absorbed Liquids	Unknown	26	79			0	13			67.2	IHS
ANL-E	104	Alpha Hot Cell Waste	None	1	399			0	6	0	2	111.1	HD
ANL-E	105	Empty Bottles and Absorbent	Unknown	3	4							1.5	SCW
ANL-E	106	Special Source Material	Unknown	0	1							0.2	TBD
ANL-E	107	Alpha Hot Cell Waste	None	0	217							45.1	RH
ANL-E	110	Research Generated Waste (RGW) Compactible and Combustible Solid	D004,D006,D008,F003	0	2			0	1			3.9	PRPR
ANL-E	111	WIPP Precertified RGW Noncompactible	D004-D009	0	6							1.2	TBD
ANL-E	120	D&D Waste	D004,D006,D008,F003	0	2							0.4	MD
ANL-E	121	WIPP Precertified D&D Waste Noncompactible	D004-D009					0	8			27.9	TBD
B&W	515	Plastic, Paper, Cloth, etc.	None	15	0							3.1	TBD
B&W	516	Steel, Al, Electrical Devices	None	2	0							0.4	TBD
B&W	517	Heavy Metals, Steel, Al, Brass	None	2	0							0.4	TBD
Battelle	201	Noncombustible Solids	D008	0	42			11	27			141.3	ID
Battelle	202	Combustible Solids, Paper, Cloth	Unknown	0	3			0	5			18.1	OD
Battelle	203	Paper, Cloth, Metals, Glass	PCBs	0	26			2	4			26.3	HD
Battelle	204	Solidified Solutions	Unknown	2	5							1.5	IHS
Battelle	UNK	Unknown	Unknown	38	0			6	0			28.8	TBD
Bendix	111	Solidified Wet Sludge	Unknown	1	0							0.2	TBD
Bettis	010	Combustibles (rags, gloves, poly)	F002	27	913							195.5	OD
Bettis	012	Miscellaneous Sources	None	1	0							0.2	RH
Bettis	015	Neutron Sources	None	3	0							0.6	RH
Bettis	020	Noncompressible, Noncombustible	D002,F002	3	791							165.2	HD&MD
Bettis	030	Solidified Grinding Sludge, etc.	F002	0	45					0	2	16.3	RH
Bettis	040	Solid Binary Scrap Powder, etc.	None (lead for shielding only)	0	107	4	0					34.9	MD
Bettis	050	Solidified Solutions	None	1	0							0.2	OHS
Bettis	081	Metal-Metal Samples Fissile	None	16	0							3.3	RH

IN-ICPP	021	Radioactive Mixed Lead Waste	D008			5	0					15.9	TBD
IN-NRF	021	Radioactive Mixed Lead Waste	D008			1	0					3.2	TBD
IN-TAN	021	Radioactive Mixed Lead Waste	D008			42	1					136.4	TBD
IN-TRA	021	Radioactive Mixed Lead Waste	D008			8	0					25.4	TBD
IN-RWMC	021	Radioactive Mixed Lead Waste	D008			2	0					6.3	TBD

Table F—9. Existing wastes stored at the TSA[a,b,c] (continued).

Gen.	IDC[d]	Stream Name	EPA Haz. Waste Numbers	No. of Drums		No. of Boxes		No. of Bins		No. of Other		Tot. Vol.	Waste
				WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	(cubic meters)	Cat.[d]
IN-ANLW	150	Laboratory Waste	D002,D008	99	13					0	19	89.6	HD
IN-ICPP	150	Laboratory Waste	D002,D008	1	6							1.5	HD
IN-TRA	150	Laboratory Waste	D002,D008	11	0							2.3	HD
IN-ICPP	151	Solidified Fuel Sludge	D008	0	2							0.4	RH
IN-ANLW	152	Pu Neutron Sources	None	2	0					0	1	3.9	RH
IN-ICPP	152	Pu Neutron Sources	None					0	1			3.5	RH
IN-NRF	152	Pu Neutron Sources	None	0	4							0.8	RH
IN-TAN	152	Pu Neutron Sources	None	0	2							0.4	RH
IN-ANLW	153	Combustible Lab Waste	None	1	0					0	7	24.6	RH
IN-NRF	153	Combustible Lab Waste	None	1	28							6.0	RH
IN-ANLW	154	Sample Fuel	None	3	0							0.6	RH
IN-TRA	154	Sample Fuel	None	5	2							1.5	RH
IN-ANLW	155	TRU Scrap	None	3	0							0.6	HD
IN-NRF	155	TRU Scrap	None	2	0							0.4	HD
IN-RWMC	155	TRU Scrap	None	0	4	1	3					13.5	HD
IN-TRA	155	TRU Scrap	None	3	5	0	1					4.8	HD
IN-ICPP	156	Chem Cell Rip-Out	Unknown			0	9					28.5	MD
IN-ARA	157	Miscellaneous Sources	Unknown	0	1							0.2	RH
IN-ICPP	157	Miscellaneous Sources	Unknown	1	0							0.2	RH
IN-RWMC	157	Miscellaneous Sources	Unknown			0	7					22.2	RH
IN-TAN	157	Miscellaneous Sources	Unknown	1	0							0.2	RH
IN-TRA	157	Miscellaneous Sources	Unknown	1	1							0.4	RH
IN-ANLW	160	HFEF Analytical Chem. & Metallographic Combustibles	Unknown							0	1	3.5	RH
IN-ANLW	161	ALC Glassware, Paper, Poly, and Miscellaneous	Unknown	3	2							1.0	RH

		Hardware											
IN-ANLW	162	FMF EFL Zr-U-Pu Fuel Casting Alloy Residues	Unknown	50	0							10.4	HD
IN-ANLW	163	ACL Cold-Line Absorbed Liquid, Misc. Hardware, Polyethylene	Unknown	6	0							1.2	HD
IN-ANLW	164[e]	WETP Process Waste	D005-D009,D011,D022,D028, D029,F001-F005	143	0							29.7	TBD
IN-ANLW	UNK	Unknown	Unknown	2	0							0.4	TBD
IN-RWMC	UNK	Unknown	Unknown			3	0					9.5	TBD
Monsanto	530	Compacted Waste	None	0	5							1.0	TBD

Table F—9. Existing wastes stored at the TSA[a,b,c] (continued).

Gen.	IDC[d]	Stream Name	EPA Haz. Waste Numbers	No. of Drums		No. of Boxes		No. of Bins		No. of Other		Tot. Vol.	Waste
				WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	(cubic meters)	Cat.[d]
Monsanto	535	Compacted Waste/Lead for Shielding	None	3	13							3.3	TBD
Monsanto	540	Noncompacted Waste	None					4	0			14.0	TBD
Monsanto	545	WEP Shielded Waste	None	0	5							1.0	TBD
Monsanto	550	Solidified Oil	None	0	1							0.2	TBD
Mound	801	Rags, Paper, Wood, etc.	None	4	31							7.3	OD
Mound	802	Dry-Box Gloves and O-Rings	D008	32	89							25.2	PRPR
Mound	803	Metal, Equip., Pipes, Valves, etc.	D009	51	129							37.4	MD
Mound	804	Plastic, Tygon, Mani-Boots, etc.	D009	64	156							45.8	OD
Mound	805	Asbestos Filters	D001,D002,D009	7	31							7.9	ID
Mound	810	Glass, Flasks, Sample Vials, etc.	D009	4	9							2.7	IHS
Mound	811	Evaporator and Dissolver Sludge	D001,D009	0	4							0.8	OHS
Mound	813	Glass Filters and Fiberglas	D001,D002,D009	0	3							0.6	ID
Mound	814	Graphite Waste with Cont'd Hg	D009	0	2							0.4	G
Mound	815	Miscellaneous Waste	Unknown	2	0							0.4	TBD
Mound	824	Equipment Boxes, Noncombustible	D005-D011			39	342					1208.5	MD
Mound	825	Equipment Drums, Noncombustible	Unknown	146	79	0	11					81.7	MD&HD
Mound	826	Equipment Boxes, Combustible	D009	5	0	8	20					89.9	OD
Mound	827	Equipment	D008,D009	5	4							1.9	OD

		Drums, Combustible											
Mound	834	High Level Acid	D001,D002	42	859							187.4	IHS
Mound	835	High Level Caustic	D002	462	1213							348.4	IHS
Mound	836	High Level Sludge/Cement	D006-D011,F001,F002,F003	994	3184							869.0	IHS
Mound	838	<10 nCi/g Noncombustible	Unknown	0	1							0.2	OD
Mound	842	Contaminated Soil	D002,D006-D011			3	36					123.7	S
Mound	847	LSA <100 nCi/g Combustible	Unknown	217	524							154.1	OD
Mound	848	LSA <100 nCi/g Noncombustible	Unknown	9	125							27.9	HD
Mound	UNK	Unknown	Unknown			1	0					3.2	TBD
RFP	000	Retrieved RFP TRU at RWMC	Unknown	0	18961			0	72			4195.0	TBD
RFP	000	Not Recorded-Unknowns from Rocky Flats Plant	Unknown	1	11							2.5	TBD
RFP	001	First Stage Sludge	D002,D004-D011,F001-F003,F005-F007,F009	5785	6201	16	7			0	1	2569.5	IHS
RFP	002	Second Stage Sludge	D002,D004-D011,F001-F003,F005-F007,F009	245	7466	3	0					1613.4	IHS
RFP	003	Organic Setups, Oil Solids	D005,D011,D022,D029,D036, F001-F003,F005,PCBs	2628	4580	0	12					1537.3	OHS
RFP	004	Special Setups (Cement)	D006,D008,F001-F003,F005	430	1112	0	1					323.9	IHS
RFP	005	Evaporated Salts	D001	0	52	0	1					14.0	IHS

Table F—9. Existing wastes stored at the TSA[a,b,c] (continued).

Gen.	IDC[d]	Stream Name	EPA Haz. Waste Numbers	No. of Drums		No. of Boxes		No. of Bins		No. of Other		Tot. Vol.	Waste
				WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	(cubic meters)	Cat.[d]
RFP	007	Bldg. 374 Dry Sludge	D002,D006-D011,F001-F003,F005-F007,F009	5254	2	20	0					1156.7	IHS
RFP	090	Dirt	F001-F004	0	135							28.1	S
RFP	095	Sludge	Unknown	0	23							4.8	IHS
RFP	241	Americium Process Residue	D001,D002,D008,F002,F003	1	118							24.8	HD
RFP	290	Sludge, Filter	D002,D006,D008,F001-F003	0	1							0.2	SCW
RFP	292	Cemented Sludge	D002,D004-D011,F001-F003, F005	354	225	4	0					133.1	OHS
RFP	300	Graphite Molds	None	1249	919							450.9	G
RFP	301	Graphite Cores	None	5	31							7.5	G
RFP	302	Benelex and Plexiglas	D005,D008,F001	11	12	0	23					77.7	OD
RFP	303	Scarfed Graphite Chunks	None	91	0							18.9	G
RFP	310	Graphite Scarfings	None	1	16							3.5	G
RFP	311	Graphite Heels	Unknown	0	6	0	1					4.4	G
RFP	312	Graphite, Coarse	F001,F002,F005	8	0							1.7	G

RFP	320	Heavy Non-SS Metal	D008,F001,F002,F005	285	289	0	2					125.7	MD
RFP	321	Lead	D008	4	0							0.8	TBD
RFP	328	Filters, Fulflo Incinerator	D002,D005,D007,D008,D011, F001-F003,F005	8	0							1.7	HD
RFP	330	Paper and Rags-Dry	D006-D008,D011,D022,F001-F003,F005-F007,F009	423	4701	402	2470					10175.8	PRPR
RFP	335	Filters, Absolute 8 x 8	D001,D005,D007,D008,D011, F001-F003,F005-F007,F009	28	98	0	5					42.1	ID
RFP	336	Paper and Rags-Moist	D001,D002,D006-D008, D022,F001-F003,F005-F007, F009	685	6786	333	254					3415.9	PRPR
RFP	337	Plastic, Teflon, Wash, polyvinyl chloride	D006-D008,D011,D022,F001-F003,F005-F007,F009	500	1802	6	10					529.6	PRPR
RFP	338	Insulation and CWS Filter Media	D001,D005,D007,D008,D011, F001, F002	28	224	1	77					299.8	ID
RFP	339	Leaded Rubber Gloves and Aprons	D001,D008,D022,F001,F002, F005	435	591	0	4					226.1	PRPR
RFP	360	Insulation	D005,D007,D008,D011,F001, F002	1	238	0	1					52.9	ID
RFP	361	Insulation Heel	None	0	1							0.2	SCW
RFP	368	Magnesium Oxide Crucibles	None	1	0							0.2	TBD
RFP	370	Crucible, LECO	None	3	32							7.3	IHS
RFP	371	Brick, Fire	D004-D011,F001-F003,F005	134	907	1	23					292.7	CBD
RFP	372	Grit	None	13	5							3.7	IHS

Table F—9. Existing wastes stored at the TSA[a,b,c] (continued).

Gen.	IDC[d]	Stream Name	EPA Haz. Waste Numbers	No. of Drums		No. of Boxes		No. of Bins		No. of Other		Tot. Vol.	Waste
				WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	(cubic meters)	Cat.[d]
RFP	374	Blacktop, Concrete, Dirt, & Sand	D004-D011,D018,F001-F007, F009	459	915	5	43					438.0	HD
RFP	375	Oil-Dri Residues from Incinerator	D004-D011,D022,F001-F003, F005	5	14							4.0	OHS
RFP	376	Cement, Insulation, and Filter Media	D005,D007,D008,D011,F001-F003,F005-F007,F009	1904	888	2	5					602.9	ID
RFP	377	Firebrick, Coarse	D004-D011,F001-F003,F005	30	0							6.2	TBD
RFP	391	Crucible and Sand	None	4	18							4.6	IHS
RFP	392	Sand, Slag, and Crucibles	None	1	6							1.5	IHS
RFP	393	Sand, Slag, and Crucible Heels	D007	28	17							9.4	IHS
RFP	409	Molten Salts, 30% Unpulverized	D028,F001,F002	30	0							6.2	SCW
RFP	410	Molten Salts, 30% Pulverized	None	0	22							4.6	SCW
RFP	411	Electrorefining Salt	None	19	2							4.4	SCW
RFP	412	Gibson Salts	None	1	0							0.2	SCW

RFP	414	Direct Oxide Reduction Salt	F001,F002	5	0							1.0	SCW
RFP	416	Zinc Magnesium Alloy Metal	None	1	0							0.2	MD
RFP	420	Ash, Incinerator (Virgin)	D004-D011,F001-F003,F005	1	9							2.1	IHS
RFP	421	Heels, Ash (>2% G/G)	D004-D011,F001,F002,F005	1	100							21.0	IHS
RFP	422	Soot	D004-D011,D029,F001-F003,F005	10	15							5.2	IHS
RFP	425	Fluid Bed Ash	D007,F003,F005	8	0							1.7	IHS
RFP	430	Resin, Ion Column Unleached	D001	0	29							6.0	OHS
RFP	431	Resin, Leached	None	0	6							1.2	OHS
RFP	432	Resin, Leached and Cemented	D007,D008,D029,F001,F002, F005	87	195							58.7	SCW
RFP	440	Glass	D001,D002,D005,D008,D009, F001, F002,F005	485	956	24	15					423.4	IHS
RFP	441	Raschig Rings, Unleached	D002,D008,F001-F003	8	1566	1	0					330.6	IHS
RFP	442	Raschig Rings, Leached	D008,F001,F002	745	506	22	27					415.6	IHS
RFP	460	Washables, Rubber, Plastics	F001,F002	0	6							1.2	PRPR
RFP	463	Gloves, Drybox	D008,F001,F002	0	53							11.0	PRPR
RFP	464	Benelex and Plexiglas	D005,D008,F001	2	45							9.8	OD
RFP	480	Metal, Scrap (Non-SS)	D001,D004-D011,D028,F001-F003, F005-F007,F009	917	1640	586	3515					13540.2	MD
RFP	481	Metal, Leached (Non-SS)	D006-D008,D011,F001-F003, F005-F007,F009	121	770	1	132					607.2	MD
RFP	488	Glovebox Parts with Lead	D008			3	0					9.5	TBD
RFP	490	Filters, CWS	D001,D005,D007,D008,D011, F001-F003,F006,F007,F009	50	54	171	1014					3780.5	ID

Table F—9. Existing wastes stored at the TSA[a,b,c] (continued).

Gen.	IDC[d]	Stream Name	EPA Haz. Waste Numbers	No. of Drums		No. of Boxes		No. of Bins		No. of Other		Tot. Vol.	Waste
				WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	WSF	TS-ARE	(cubic meters)	Cat.[d]
RFP	491	Plenum Prefilters	F001,F002			3	0					9.5	TBD
RFP	700	Organic and Sludge Immobilization System (OASIS) Waste	D022,F001-F003	60	0							12.5	OHS
RFP	800	Solidified Sludge, Bldg. 774	D002,D004-D011,F001-F003, F005-F007,F009	1570	0	1	0					329.7	TBD
RFP	801	Solidified Organics	D022,F001-F003	795	0							165.4	TBD
RFP	802	Solidified Lab Waste	D001,D011,F001-F003,F005	78	0							16.2	TBD
RFP	803	Solidified DCP Sludge	D002,D006-D008,D010,F001-F003,F005-F007,F009	161	0							33.5	TBD
RFP	806	Solidified Process Solids	D004-D011,F001-F003,F005	41	0							8.5	TBD
RFP	807	Cemented Incinerator Sludge &	D004-D011,F001-F003,F005, (also D002,F006,F007,F009)	1245	0	2	0					265.3	TBD

		Solidified Bypass Sludge											
RFP	817	Cemented Sand, Slag, & Crucible Heels	D007,D008,F001-F003	22	0	1	0					7.7	TBD
RFP	818	Cemented Ash	D004-D011,F001-F003,F005	7	0							1.5	TBD
RFP	820	Cemented Soot	D004-D011,F001-F003,F005	27	0							5.6	TBD
RFP	822	Cemented Resin	None	26	0							5.4	TBD
RFP	823	Cemented Miscellaneous Sludge	D004-D011,F001-F003,F005	13	0	1	0					5.9	TBD
RFP	831	Dry Combustibles TRU Mixed	F001,F002			71	0					225.2	TBD
RFP	832	Wet Combustibles TRU Mixed	F001,F002			96	0					304.5	TBD
RFP	833	Plastics TRU Mixed	F001,F002			10	0					31.7	TBD
RFP	900	LSA Paper, Plastic, etc.	D004-D011,D029,F001-F003,F005	27	323	0	6					91.8	PRPR
RFP	950	LSA Metal, Glass, etc.	D004-D011,F001,F002,F005	4	106	12	321					1079.2	HD
RFP	960	Concrete, Asphalt, etc.	D004-D011,F001,F002,F005	55	648	0	171					688.6	HD
RFP	970	Wood	D008,F001-F003,F005	5	17	8	54					201.2	OD
RFP	976	Bldg. 776 Process Sludge	D006-D009,D022,F001-F003	0	7	0	20					64.9	IHS
RFP	978	Laundry Sludge	D006-D009,F001-F003			0	11					34.9	IHS
RFP	980	Equipment (suspected to be IDC 290)	D008,F001,F002	0	1							0.2	SCW
RFP	990	Dirt	F001-F004	0	470							97.8	S
RFP	995	Sludge	None	0	296	0	8					86.9	IHS
RFP	UNK	Unknown	Unknown	31	0	69	0					225.3	TBD
UNK	UNK	Unknown	Unknown	17	0	33	0					108.2	TBD
			TOTALS:	30243	74426	2025	8663	53	504	0	33	57731	

Table F—9. Existing wastes stored at the TSA[a,b,c] (continued).

a. The number and type of containers listed in this table are based on a November 1997 query of the Transuranic Waste Management Information System (TWMIS) database. Volumes are calculated using the following conversion factors: (a) 0.208 cubic meters /drum, (b) 3.172 cubic meters/box, (c) 3.488 cubic meters/bin, and (d) 3.488 cubic meters/other container.

b. EPA Hazardous Waste Numbers are assigned based on the engineering design file RWMC-803, current revision, Chemical Constituents in Transuranic Storage Area (TSA) Waste. Waste streams listed with "none" in the "EPA Haz. Waste Number" column are radioactive-only waste.

[c.] Waste streams designated with remote handled, special case waste, and to-be-determined waste categories will be evaluated on a case-by-case basis, as information becomes available, to determine if a more appropriate waste category is warranted. Special case wastes in this table have been included in the Part A permit application under special case waste treatment, although they may not be treated in the special case waste glovebox.

[d.] IDC=item description code; HD=heterogeneous debris; IHS=inorganic homogeneous solids; SCW=special case waste; TBD=to be determined; RH=remote-handled; PRPR=paper/rags/plastic/rubber; MD=metal debris; ID=inorganic debris; OD=organic debris; G=graphite; S=soils; OHS=organic homogeneous solids; CBD=Ceramic/Brick debris.

[e.] Waste stream IN-ANLW 164 is a newly-generated waste stream that is currently stored at the WSF.

Note: Detailed information on the content of waste can be found in the following publically available documents: *Waste Description Information for Transuranic Contaminated Wastes Stored at the INEL* (December 1995); Appendix *A, Detailed Information for Mixed and Non-mixed Alpha Low Level Waste* (December 1995); Appendix B, *Detailed Information for Mixed and Non-mixed Transuranic Waste* (December 1995*); Characterization Information on Additional INEL and Offsite Transuranic Contaminated and Mixed Low-Level Waste Potentially Available for Treatment by the Advanced Mixed Waste Treatment Project* (September 1995); INEL Site Treatment Plan (October 1995).

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP.

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
1954-1970		TRU waste comes to the Idaho National Engineering Laboratory (INEL) from Rocky Flats for disposal in the RWMC (SDA).	This waste was disposed in pits and trenches at the SDA.
1970		TRU waste coming to the INEL is placed in retrievable storage.	Creates TSA berm. Storage begins on an asphalt pad; waste containers are covered with plywood, plastic and earth.
3/20/70	U.S. Atomic Energy Commission (AEC) issues Immediate Action Directive (IAD) 0511-21 "Retrievable Storage of Transuranium Waste".		This requires segregation of wastes with "known or detectable contamination of TRU nuclides." No levels of TRU nuclides are specified.
1971	AEC Chairman directs TRU waste be stored retrievably at all DOE facilities rather than disposed with low level waste.		Beginning in 1970, TRU waste is no longer disposed at the RWMC subsurface disposal area in anticipation of this direction.
1973	AEC Manual Chapter 0511 defines TRU contaminated solid wastes as those above 10 nCi/g and requires retrievable storage.		The INEL was already placing waste in retrievable storage due to earlier AEC requirement.
1976	PL 94-580 RCRA (codified at 42 USC § 6901 et seq.).		Regulates the generation, treatment, storage, disposal, and transportation of hazardous wastes. When initially enacted, DOE held that RCRA did not apply to DOE facilities because activities subject to the *Atomic Energy Act* (AEA) were exempt from RCRA.

1977			WAC for the RWMC shows that specific constituents such as pyrophorics, liquid metals, acids, sodium and explosives (now regulated by EPA) are prohibited from disposal.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
1978	EPA promulgates PCBs disposal and marking regulations (43 FR 7150) (codified at 40 CFR Part 761).		Regulates disposal and marking of PCBs. INEL takes action to identify PCBs over the next several years. Eventually, 180 drums are identified in accessible storage, with expected PCB contamination of an estimated total of 1,562 m^3 of waste in inaccessible retrievably stored waste in the berm. WIPP was subject to the PCB regulations in 1978. The WIPP WAC excludes disposal of PCBs over 50 parts per million (ppm).
Late 1970s		INEL examines what to do with stored TRU waste.	DOE predecessor agency examines options for TRU waste in the Final EIS for Waste Management Operations at the INEL (September 1977). INEL begins pre-conceptual development on TRU Waste Treatment Facility; one concept was the "Slagging Pyrolysis" Incinerator with a ~$1 billion estimate. The cost is so high, the M&O is asked to consider alternatives; this eventually leads to the Process Experimental Pilot Plant (PREPP).
12/79	Congress redefines mission of the WIPP in Carlsbad, NM.		Sets up WIPP as a research and development facility for disposal of only TRU radioactive waste from DOE facilities.
Early 1980s		INEL begins to evaluate stored TRU waste characteristics, and initiates design and development of the Stored Waste Examination Pilot Plant (SWEPP) for nondestructive examination and certification of wastes.	
1980		Storage of waste under the berm ceases.	Waste is stored at the RWMC in the Air Support Building II in anticipation of WIPP opening.
1981	Final EIS for WIPP and ROD issued.		Documents DOE's initial decision to proceed with the phased development of WIPP at a site near Carlsbad, NM. WIPP EIS defines TRU waste as above 10 nCi/g. WIPP plans to open in 1988.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
1982		PREPP was designed and constructed at Test Area North (TAN) utilizing an existing building and the TAN infrastructure. The project purpose was to obtain experimental data for TRU waste processing by incineration (rotary kiln incinerator) and grout stabilization of the residue.	Facility startup and cold testing with surrogates identified design and process deficiencies that required rework prior to commencing "hot" (radiological) operations. These deficiencies were largely the result of evolving DOE orders governing non-reactor nuclear facilities. Work was suspended and the facility was placed in "standby" status during the rework process. The PREPP project was canceled in 1990 due to these problems.
8/82		An Alpha-Contaminated Waste Management Workshop is attended by experts from DOE, EPA, NRC, and the private sector; proceedings result in a recommendation that TRU waste be defined as greater than 100 nCi/g.	This recommendation was adopted in DOE Order 5820.1.
9/30/82	DOE Order 5820.1, "Management of Transuranium Contaminated Material," defines TRU as above 100 nCi/g.		This change reclassified waste with TRU specific activities of less than 100 nCi/g as low level waste. The same order also indicated only TRU waste could be disposed at WIPP. This created a problem for the INEL because: (1) waste between 10 and 100 nCi/g cannot be disposed at the INEL per earlier prohibitions; and (2) the INEL estimated that between 25,000 cubic meters and 27, 000 cubic meters of the stored waste would assay between 10 and 100 nCi/g and not be eligible for disposal at WIPP. Due to the manner in which the waste had been stored, it is commingled within drums and boxes in the berm and is not easily identified or separable.
1984		Certified and Segregated (C&S) Building constructed.	This building, placed on asphalt, was used for temporary storage of TRU waste at the RWMC, along with the ASB II Building.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
1984	RCRA amended by Hazardous and Solid Waste Amendments.		Added LDRs, which require that all hazardous waste be treated before being placed "in or on the land" (40 CFR Part 268) and specifies strict treatment standards that must be met before land disposal can occur. Also prohibited long term storage of hazardous wastes unless wastes were being stored solely for the purpose of accumulating sufficient quantities for treatment or disposal.

1984	LEAF v. Hodel decision		Held that RCRA applies to DOE facilities except for wastes expressly regulated by AEA (source, special nuclear, and byproduct materials).
1985	WIPP Waste Acceptance Criteria Rev. 3 issued.		INEL initiates operations of Stored Waste Examination Pilot Plant (SWEPP) to qualify waste for shipment to WIPP.
5/87	DOE issues by-product rule addressing applicability of RCRA to radioactive mixed wastes (51 FR 24504).		Clarified EPA's position that the hazardous portion of mixed wastes is subject to RCRA regulation. Through waste characterization records, the INEL determines that over 95 percent of the stored TRU waste is mixed waste, and therefore subject to RCRA.
4/88		Breached containers found at the RWMC TSA Pad R and C&S Building. The hottest spot is 4,000,000 counts per minute; 15,000-sq. ft. of contamination is found on the asphalt pad.	In 12/88 DOE decides to build enclosure over berm to provide containment to prevent environmental problems during retrieval. This becomes the Transuranic Storage Area Retrieval Enclosure (TSA-RE). A later reason for building the enclosure (documented in Congressional budget project data sheets) was to provide weather protection of the stored waste.
8/20/88	P.L. 100-408, *Price-Anderson Amendments Act*, amends Section 11 of the AEA (P.L. 83-703) by adding a definition of TRU waste as "concentrations above 10 nCi/g, or such other concentrations as the NRC may prescribe to protect the public health and safety."		42 USC § 2014 (ee) of the AEA defines TRU waste as having an atomic number greater than 92, including neptunium, plutonium, americium, and curium, in concentrations greater than 10 nCi/g.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
9/88		WIPP does not open as scheduled.	INEL suspends SWEPP operations in 1989 due to WIPP delays and changes in the WIPP WAC.
10/88		Gov. Cecil Andrus of Idaho declares moratorium on offsite waste coming to the INEL.	TRU waste shipments from offsite cease. The moratorium did allow a limited number of additional shipments until 1989. The INEL now has total of 65,000 cubic meters of stored TRU/alpha LLMW waste.
1988	EPA issues clarification notice for facilities with		EPA made a determination that substantial confusion existed about the applicability of RCRA to radioactive mixed wastes. They clarified the

	radioactive mixed wastes (53 FR 37045).		interim status requirements for facilities with mixed wastes and set forth a deadline for such facilities to obtain RCRA interim status. DOE submits RCRA Part A applications to EPA for treatment, storage and disposal facilities. All mixed waste is prohibited from disposal in the RWMC SDA.
12/88		Line item for RWMC TRU Waste Treatment and Storage Facility submitted.	This facility was to provide repackaging and treatment (shredding/compaction, size reduction, and solidification) of TRU waste, as well as sampling and characterization capabilities. This project later becomes the Waste Characterization Facility (WCF). Treatment and repackaging capabilities were absorbed into the proposed Idaho Waste Processing Facility IWPF (see 1990).
3/89	EPA issued Complaint and Notice of Opportunity for Negotiation letter to DOE on PCBs.		Letter discussed management of PCBs at the INEL, and discussed storage of radioactively contaminated PCBs for longer than one year. Follow-on letter of July 17, 1990, from DOE-ID to EPA discusses specific quantities of waste at the RWMC.
1990		A budget line item for the TSA-RE is submitted; TRU WCF and Storage Facilities budget data sheets were revised and submitted in the Congressional budget.	The WCF was to characterize 10 percent of the WIPP bound waste and was to support production shipments of certified TRU waste to WIPP. The storage modules were to meet RCRA and/or TSCA requirements for storage of hazardous wastes.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
1990		The IWPF conceived to prepare alpha LLMW and TRU wastes for disposal.	IWPF was conceived because Alpha LLMW must be treated to LDR and TRU waste treated to meet the current WIPP WAC. The treatment facility is designed to be built and operated in two phases: phase I is to treat alpha mixed waste thermally to LDR, and phase II is to repackage the TRU and perform any thermal treatment needed to meet the WIPP WAC (such as PCBs). Initial construction costs for the facility were projected to exceed $600M.
1990	DOE receives Notice of Non-Compliance (NON) from EPA for RCRA violation related to improper storage of waste at the TSA in the C&S and Air Support Buildings and on Pads 1, 2 and R. Earthen covered		DOE was cited for violations of RCRA with respect to storage of mixed wastes at its facilities (inspection requirements, etc.). The Consent Order requires the reconfiguration of accessibly stored waste into RCRA compliant storage by 1/1/98. The resolution of the earthen covered storage violation was included in the September 1996 Permit Modification to the RWMC Partial Hazardous Waste Permit. It was resolved by a permit condition (II.K.6) that requires a closure plan

	storage was included in the NON but forgotten in the Consent Order.		for the earthen covered storage within 3 years and 30 days after issuance of a contract on the Advanced Mixed Waste Treatment Project (AMWTP).
1991		INEL Low-Level Radioactive Waste Acceptance Criteria, DOE/ID-10112, Rev. 4, issued continues the prohibition on disposal of mixed waste or waste containing above 10 nCi/g TRU at the RWMC.	This criteria was developed from performance assessment information, indicating mixed waste and waste above 10 nCi/g were threats to sole source aquifer under the INEL. This continues the "orphaned" waste problem with between 25,000 and 27,000 cubic meters of alpha LLMW stored at the RWMC.
1992	PL 102-386, *Federal Facility Compliance Act* (FFCA).		This act amends RCRA. It requires DOE to develop treatment plans for all mixed waste. The LDR storage prohibition will not apply to DOE after October of 1995 so long as DOE is in compliance with both a treatment plan and an order requiring compliance with the treatment plan. DOE included alpha LLMW and TRU waste in its Site Treatment Plan and Consent Order developed in 1995.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
1992		INEL M&O prepared Systems Design Study to examine privatized alpha LLMW treatment.	This was the first privatization effort related to IWPF. It was an alternative to IWPF Phase I. The study indicated privatization could achieve cost and schedules savings over IWPF.
1992	PL 102-579, *Waste Isolation Pilot Project Land Withdrawal Act*		Reserves 16-section area of land at WIPP for construction, experimentation, operation, repair, maintenance, disposal, shutdown, monitoring and decommissioning. It limits the radiation permitted at WIPP and the total volume of TRU waste to be disposed there.
5/92	INEL Environmental Assessment for TSA Retrieval Enclosure (TSAEA) construction, storage for 19 years, and retrieval.		The proposed action was for construction and operation of numerous facilities, the TSA RE, Operational Control Building and site utilities. A Finding of No Significant Impact (FONSI) was issued permitting construction and retrieval operations at 10,000 drum equivalents per year for 10 years.
3/93		INEL M&O issues Request for Interest in Commerce Business Daily for Alpha LLMW treatment.	The M&O took action based on earlier System Design Study. Widespread interest was shown by the private sector; they provided input for a future procurement action.
9/93		M&O procures studies by Dames and Moore on privatization of Alpha	The Dames and Moore study examined regulatory framework, cost and schedule issues. They further define potential cost savings.

		LLMW treatment. M&O begins work on an actual RFP for treatment services.	
10/93		DOE-ID Manager believes more work needs to be done before RFP for alpha LLMW treatment services is issued. Directs DOE staff to prepare RFP for feasibility studies from private industry.	DOE-ID requests authorization from EM-30 to proceed with feasibility studies for privatized alpha LLMW mixed waste treatment.
12/93		Deputy Assistant Secretary for EM-30 approves action to procure feasibility studies.	RFP issued by DOE-ID in 12/93 to obtain studies, which will include a business plan (cost and price data, suggested contract terms and conditions), a regulatory plan, a public involvement plan, and a technology plan.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
1994	Notice of Intent to prepare issued.		All Environmental Restoration (ER) and Waste Management (WM) site activities are to be included. IWPF and private sector alpha LLMW treatment projects are to be described in this document, rather than in a stand-alone EIS.
4/94		3 private sector teams awarded contracts to prepare feasibility studies for alpha LLMW treatment.	All teams had prior experience in design, construction and operation of waste management facilities in the U.S.
12/94		Private sector feasibility studies delivered to DOE-ID.	DOE-ID examines all its available options: non-treatment (including no action), treatment, and cost effectiveness of various alternatives. Information feeds into the DOE INEL EIS being prepared.
5/95		DOE-ID issues "Evaluation of Feasibility Studies of Private Sector Treatment of Alpha and TRU Mixed Wastes".	The evaluation concludes that private sector treatment of both INEL alpha LLMW and TRU waste to LDR standards is the most cost-effective option, and an onsite facility is preferable to offsite location. A competitive procurement is recommended to DOE-HQ EM.
5/30/95	Record of Decision issued on DOE INEL EIS.		A Modified 10 Year Plan alternative was selected for ER and WM activities. Decision indicates INEL will construct treatment facilities necessary to comply with the Federal Facility Compliance Act (FFCA). Treatment of TRU waste, at a minimum, must meet the WIPP WAC.
6/95		DOE Assistant Secretary	DOE-ID begins preparation of RFP for a prime

		for Environmental Management directs that an RFP be prepared for private sector treatment of alpha LLMW and TRU waste to LDR.	contract. With the inclusion of TRU waste in the solicitation, the project is renamed from the Private Sector waste Treatment Facility (or Private Sector Alpha Contaminated LLMW Treatment Facility) to the AMWTP.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary
6/95		All work on IWPF cancelled. The need for the WCF is re-examined.	The cancellation of work on the IWPF is a direct result of procurement action for AMWTP. WCF construction is placed on hold later in 1995.
10/95	Settlement Agreement reached with DOE, the Navy, and the State of Idaho regarding lawsuit related to the DOE INEL EIS; terms of the Settlement Agreement incorporated into a Court Order.		Among other things, the agreement mandates that 65,000 cubic meters of stored TRU waste be shipped out of the State of Idaho no later than 2018. The agreement states that a procurement for private sector waste treatment services must be executed by 6/1/97, and construction of a facility completed no later than 12/31/02, with operations beginning 3/31/03. The agreement states that offsite waste can come to the INEL for treatment but must be treated within six months after receipt, and shipped out of the state for storage/disposal within 6 months after treatment.
10/95	INEL STP completed in accordance with the FFCA and Idaho HWMA.		The plan indicates that both TRU and alpha are managed as TRU wastes at the INEL. Since the alpha LLMW and TRU waste will be handled together, both are referred to as transuranic-contaminated waste and are to be treated at the AMWTP.
11/95	INEL STP revised.		Dates in the plan were revised to reflect the Settlement Agreement. A procedure is articulated for state approval of offsite waste to be treated at the INEL.
1/96		DOE-ID issues final RFP for AMWTP.	Bids were received from four teams. Three teams were included in the competitive range for negotiations.
8/96	DOE prepares environmental critique in accordance with DOE's own 216 process (10 CFR § 1021.216).		The critique showed no significant potential environmental impacts for any of the proposals on the AMWTP.

Table F-10. History of regulatory drivers, program and/or political events leading to AMWTP (continued).

Chronology	Laws, rules, regulatory events	Program and/or political events	Impact/commentary

1996	PL 104-210, National Defense Authorization Act for FY-97.		This act amended the WIPP *Land Withdrawal Act*. Among other things, the amendment provided that RCRA land disposal restrictions do not apply to waste disposed at WIPP. DOE-ID maintained the AMWTP contract requirement for LDR because the feasibility study evaluation showed treatment of alpha mixed and TRU to LDR is more cost effective. In addition, if WIPP does not open, treatment to LDR will allow long term storage of mixed wastes.
12/96		DOE awards contract to BNFL Inc.	Phase I of the contract only is awarded. This is a three-year phase where permitting and ES&H activities will be performed, and data submitted for NEPA analysis. BNFL Inc. begins work in 1/97.
1/97		The INEL is renamed INEEL.	
11/97	DOE-ID issues Notice of Intent to prepare tiered EIS on AMWTP.		Document tiers from DOE INEL EIS, as well as other NEPA documentation. Refer to "Summary of Related NEPA Analyses" within this document.

APPENDIX G

ADVANCED MIXED WASTE TREATMENT PROJECT ENVIRONMENTAL IMPACT STATEMENT CONTRACTOR AND SUBCONTRACTOR DISCLOSURE STATEMENTS

The following are disclosure statements, pursuant to 40 CFR 1506.5 (c) provided by Tetra Tech, Inc. and the five major subcontractors involved in the preparation of this EIS.

APPENDIX H

BNFL INC. CONTRACT

This appendix includes Section A of the contract between the U. S. Department of Energy and BNFL Inc. The remainder of the contract is enclosed on a CD-ROM and is also available in Adobe Acrobat format on the internet at:

http://www.ID.DOE.GOV./DOEID/M&O/bnfl_contract.htm.