APPENDIX B

FACILITY DESCRIPTION INFORMATION

The following descriptions are taken from BNFL-5232-RCRA-01, Rev. 0, *Hazardous Waste Management Act/Toxic Substances Control Act* (HWMA/TSCA) permit application for the Advanced Mixed Waste Treatment Project (AMWTP) facility.

B-1 Nonthermal Treatment Operations

Waste containers within the nonthermal 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 nonthermal treatment activities include:

- Wastes slated for direct supercompaction have been identified by item description codes, generator-supplied information, and real-time radiography 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 nonthermal treatment units to ensure that only compatible wastes are treated.

- All nonthermal 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 nonthermal 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 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 nonthermal 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 non-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.

- 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-gal direct-feed waste drums or 55-gal transfer containers from the pretreatment lines are routed to the supercompactor via the central conveyor system. 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 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.

Although dry waste is being compacted, a sloped glovebox floor and an adequately sized sump are provided to collect any liquids produced during the compaction process. The sump has a capacity of approximately 4 L 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 pump and placed into collection containers, which are transferred out of the glovebox and delivered to the special case waste glovebox for treatment, as required.

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. 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 allow 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 or baskets of metal debris, which have been placed in 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 (OPC) and pulverized fuel ash (PFA)] are delivered to the receiving storage hoppers by bulk tankers and transferred into the respective weigh hoppers by the OPC/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 a basket, 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. Lasers are used to prevent overfilling during the grouting process. At a predetermined level monitored by a laser (approximately 1 in. 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 pig 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 (e.g., Addmix) to the excess grout that inhibit the cement mixture from curing may be used to return grout washings 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 clean 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 28 staging bays (roller conveyor units), and 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 roller conveyor/forklift interface in the operating corridor, and then to the product certification area for external contamination monitoring and certification.

B-1.3 Special Case Waste Glovebox

The special case waste glovebox is provided for treatment of special case waste on a case-by-case basis. This glovebox is fitted to treat 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, containers requiring venting, or wastes indicated as special case waste in Table C-1-1 of Book 1 of the AMWTP *Resource Conservation and Recovery Act* (RCRA) Permit Application.

Special case waste removed from waste containers in the pretreatment lines is placed into baskets in transfer containers and routed (via the central conveyor system) to the special case waste interface point. The transfer containers are then moved into the transfer airlock and identified by a barcode reader. With the special case waste transfer container in the airlock, the glovebox hatch is opened and an elevator lifts the transfer container up to the special case waste glovebox. At this point, a hoist is used to retrieve the basket from the transfer container, and then the waste containers are removed from the basket. Liquid waste effluents from the supercompactor, as well as the pretreatment lines, may also be manually transferred to the glovebox and imported via the bagless transfer purge port.

Within the special case waste glovebox, containers of liquid waste are examined for physical properties, including pH, viscosity phases, and conductivity. The containers are sampled and then placed into a staging rack until analytical results are available. Samples are analyzed for organics. Liquids are separated by a settling/decanting process, if required. If liquids are found to be acidic/basic, they are 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. Elemental mercury is amalgamated.

The following presents specific information on the three treatment processes conducted in the special case waste 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. Aqueous and/or organic liquid wastes, which have been neutralized as required, are separated (if two phases) and absorbed in order to meet downstream treatment requirements. 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, 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 air pollution control system, shown schematically in Figure B-2-2, is a combination dry filtration and wet scrubbing system. The system employs air injection and a liquid quencher for cooling, a packed bed absorber for acid gas scrubbing, and a high temperature filter and HEPA filters for particulate removal.

Table B-2-1. Incinerator operating conditions for LLMW.

Parameter	Operating Condition
Thermal capacity	3.0 MMBtu/h
Feed Capacity	Solid waste 650 lb/h
Types of Feed	Solid combustible mixed waste
Temperature	PCC - 1400 to 1800 °F Secondary chamber - 1800 to 2200 °F
Auxiliary Fuel	Propane
Waste Feed System	Solids – sized reduced and fed continuously through auger system
Gas Residence Time	Nominal 2 seconds in SCC when operating at thermal capacity of system

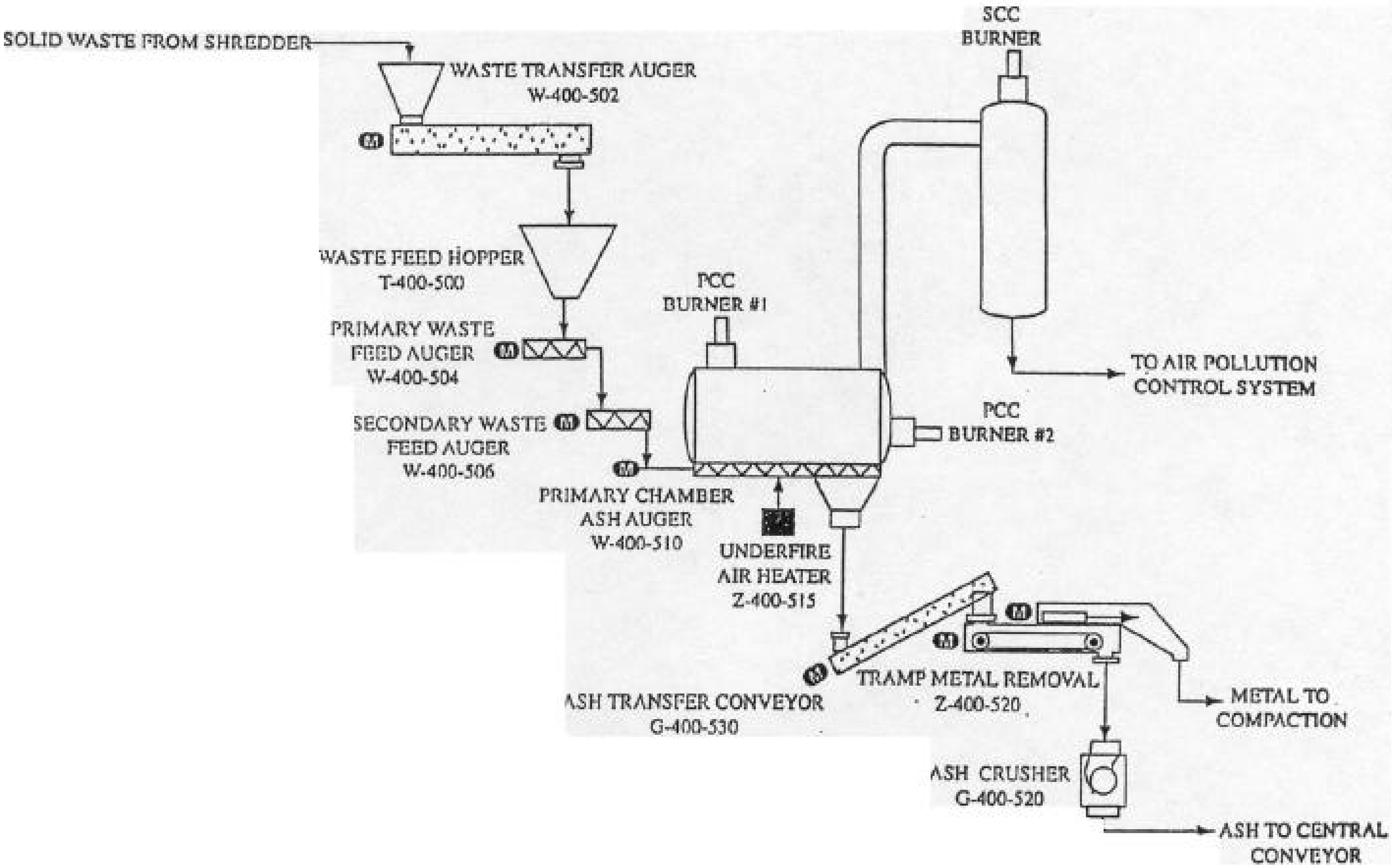

Figure B-2-1. AMWTP facility incinerator schematic.

Part of the offgas cooling is accomplished by mixing with ambient air. This is the initial operation conducted on the offgas stream. This reduces the gas temperature into the operating range of the high temperature filtration unit. The high temperature filtration unit is a mechanical filtration device that operates at high temperatures. The high temperature filter employs filtration elements to capture particulate entrained in the offgas. Offgas passes through the elements, and the particulate is trapped on the outer surface. Periodically, the elements are cleaned with a pulse of compressed air to drop the ash into a hopper for removal. High temperature filters are a very efficient means of particulate removal, collecting more than 99 percent of all particles greater than 0.5 microns in diameter.

After the high temperature filter is a full liquid quench of the offgas. The quencher injects an atomized liquid stream into the offgas stream for rapid cooling and saturation. The saturated and cooled gas is then treated in a packed bed absorber. The packed bed absorber is capable of removing over 99 percent of the acid gas from the offgas. A candle demister following the packed bed absorber separates entrained water droplets from the offgas stream.

Following the demister is a reheater. The reheater reduces the relative humidity of the gas stream to protect the HEPA filters from moisture. Two stages of HEPA filtration are used in series. HEPA filters are certified capable of removing 99.97 percent of all particulate in the range of 0.1 to 0.3 microns in diameter; the efficiency increases on all other particle diameters. The HEPA filters are also an effective means of toxic metals control.

Following the HEPA filters, a blower maintains a negative pressure within the incinerator and air pollution control system, ensuring confinement of particulate within the system and fugitive emissions control. The filtered exhaust exits the system through the facility stack.

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.

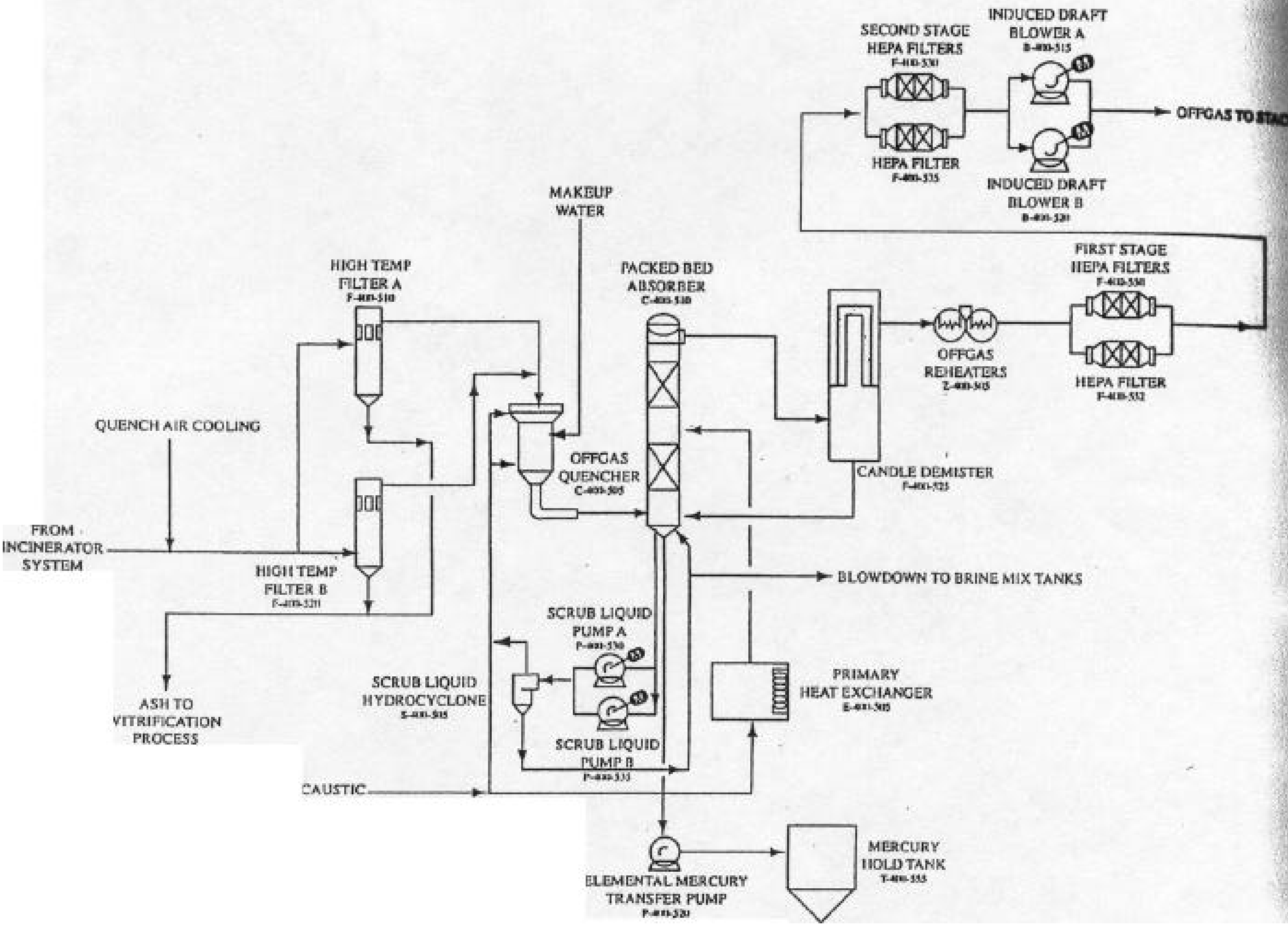

Figure B-2-2. AMWTP facility incinerator Air Pollution Control System.

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 Allowable 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 air pollution control system.

- 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.

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 liner are separated from the container and are passed through a shredder 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 containers, dumped into a shredder for size reduction and collected in a hopper underneath the shredder. 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 1,400 to 1,800° F to dry, volatilize, and pyrolyze 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 a screw 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 1800 to 2200°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 an interconnecting duct to the refractory-lined SCC where combustion of the residual organic compounds is completed. The SCC has been sized to provide a nominal 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 ft long by 9 ft wide by 10 ft high. The internal volume of the PCC is approximately 240 ft^3. The SCC is cylindrical with an external diameter of 6 ft, an external length of 19 ft and an internal volume of approximately 220 ft^3. 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.

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 ft. The pencil burner in the PCC produces a maximum flame length of approximately 7 ft 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 1400°F (per National Fire Protection Association 86).

B-2.2.2.4 Underfire Air System. Combustion air is preheated prior to entering the underfire air manifolds. Four jet tubes in each of two manifolds direct the heated air at 1500°F to the trough containing the ash auger and waste. The trough consists of four zones in sequence: moisture removal, 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 1900 acfm at the inlet and a differential pressure of 30 in. w.g. The blower is provided with an inlet silencer and HEPA grade filter and variable 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 shredder, waste transfer auger, waste feed hopper, primary waste feed auger, secondary waste feed auger, and waste feed cutoff valve.

The waste feed shredder uses a dual auger/cutter within a sealed enclosure that size reduces the incinerator feed material to less than 2-in. pieces. The shredder is hydraulically controlled with automatic overload protection for auger/cutter reversal to free lodged waste material. Additional details of the shredder may be found in Appendix D-3 of the AMWTP RCRA Permit Application.

The waste transfer auger moves shredded waste from the shredder to the top of the waste feed hopper. The transfer auger is driven by a reversible, torque-sensing, variable speed electric motor to detect jamming by obstructions. The waste feed hopper assembly includes weight 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. A rotating agitator has been included with the hopper to prevent sludges from bridging or caking and thereby ensuring a constant supply of waste to the primary waste feed auger. The waste feed to the incinerator is measured in the waste feed hopper by load cells, which detect weight loss in the hopper over time.

Waste from the waste feed hopper falls by gravity into the primary waste feed auger and is then transferred to the secondary waste feed auger. The secondary waste feed auger includes a conical shaped tapered section near its exiting end that compresses the waste to approximately a 5-to-1 compression ratio, which provides a gas pressure seal between the incinerator and the feed system of approximately 2 psig.

The waste feed cutoff valve provides emergency waste feed cutoff during upset conditions or 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 moved back from the cutoff valve at its flange for repair or replacement while the PCC remains at operating temperature. The waste feed cutoff valve provides positive gas sealing, whenever compacted waste sealing is not available, as during startup conditions.

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 1250 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 damper control to maintain negative pressure in the system and to draw flue gas through the PCC, SCC, and air pollution control system and deliver it to the stack. The exhaust blowers are constructed of alloy AL6XN or equivalent to prevent corrosion. Each fan has been designed to handle approximately 1500 standard cubic ft per minute when operating at a static pressure of approximately 36 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 air pollution control system for the AMWTP facility incinerator consists of the following: quench air cooling, redundant high temperature filters, saturation quencher, packed bed absorber, candle demister, redundant first stage HEPA filtration, redundant second stage HEPA filtration, associated pumps and blowers, and an exhaust stack (see Figure B-2-2).

B-2.3.1 Process Description. Flue gas from the SCC is first cooled to approximately 1500°F before entering the high temperature filters. Cooling of the hot SCC exit gas is accomplished by mixing with ambient air supplied by redundant air supply blowers. The cooled gas from the SCC is directed into one of two parallel redundant high temperature filter vessels. Each filter vessel is refractory lined with a conical bottom for reliable discharge of solids by gravity. When the differential pressure across the filters reaches a preset value, the filters are cleaned in place by a jet-pulse blowback system using compressed air. Fly ash discharged from the filters is cooled in a holding volume prior to being discharged into a container. All fly ash collected in the high temperature filter is vitrified.

The gas exiting the high temperature filtration unit enters the quench tower where it is cooled and saturated by spraying the gas with brine. The cooled and saturated flue gas then passes through a wetted elbow at the base of the quench tower and discharges directly to the packed bed absorber below the packed bed column.

Upon entering the absorber tower, liquid droplets entrained in the offgas fall to the sump while the gas rises through the packing material. As the rising gas passes through the packed bed media, it comes into contact with the alkaline brine sprayed from the top of the packing. The brine absorbs the acidic gases to form salts. The brine solution falls from the packed bed and collects in the sump. From there it is pumped via redundant scrubber liquid pumps to the hydrocyclone.

Underflow from the hydrocyclone is continuously recirculated to the packed bed absorber sump. A slip stream is drawn off this line and sent to the scrubber brine mix tank to maintain brine density and to control the volume of liquid in the brine recirculation system. The overflow stream from the hydrocyclone is split with a portion being sent to the quench tower and the remainder being sent to a heat exchanger for cooling prior to being recirculated back to the packed bed absorber.

The rate of recirculation in the packed bed absorber is controlled to ensure an adequate liquid-to-gas ratio between the brine and flue gas at the expected maximum gas flow rate. Caustic is added to the brine to maintain a minimum pH, and makeup water is added to adjust the specific gravity and recirculating liquid volume.

Because mercury may be present in the waste streams treated by the AMWTP facility incinerator, the air pollution control system has been specifically designed to remove mercury from the offgas and scrubber brine. Mercury is maintained in its elemental state by maintaining the offgas exiting the SCC at high temperatures followed by rapid cooling of the offgas by quenching with subcooled brine. Since elemental mercury is more dense than brine, mercury collects in the bottom of the packed bed absorber sump. The mercury, along with sludge and brine is periodically pumped into the mercury hold tank. The elemental mercury is then tapped from the bottom of the mercury hold tank through a sight glass and double valves and then transferred to the special case waste glovebox for amalgamation.

Flue gas from the packed bed absorber tower enters the candle demister vessel and passes through the demister candles. The fiber mesh candles are periodically irrigated with a spray of fresh water to remove water-soluble constituents from the fiber media.

The saturated gas leaving the candle demister vessel passes through an in-line electrical resistance reheater that raises the temperature of the gas stream to approximately 50° F above the gas saturation temperature. Raising the temperature prevents moisture condensation in downstream process equipment, including the HEPA filters. The reheater housing contains two banks of redundant electrical resistance heaters in series. 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.

Flue gas from the reheater passes through two sets of HEPA filter banks. The first stage contains redundant parallel modules, consisting of the following filters in series: a 65 percent roughing filter, a 90 percent roughing filter, and a glass matrix nuclear grade HEPA filter. The second stage contains redundant parallel modules and consists of the following filters in series: a 90 percent roughing filter and a nuclear grade stainless steel or higher alloy nuclear grade HEPA filter.

Following the second stage of HEPA filter modules, the flue gas passes to the exhaust blower where it is delivered to the stack. The exhaust blowers control the draft through the AMWTP facility incinerator and air pollution control system. A variable damper on the suction side of the blowers allows control of the draft to maintain negative pressure within the incinerator system and to sustain the movement of the flue gas through the air pollution control system. Only one exhaust blower is in service at any given time as each blower is capable of handling all flue gas flow rates from the incinerator system. The exhaust blower discharges the flue gas to the atmosphere via the stack.

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 air pollution control system 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 progammable 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 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 Allowable 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 Allowable 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 at Fall 1998), 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 polychlorinated biphenyl (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 and cleaning the high temperature filters and ash collection system. The high temperature filters will be cleaned by back-pulsing with compressed air to remove as much flyash from the bags as possible. All of the flyash will be transferred to the ash collection area and drummed out, leaving the high temperature filters and ash collection system as clean from ash as possible. 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 high temperature filters, roughing filters, HEPA filters, and brine 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 burners
- Stops the air supply blowers
- Begins a maximum flow of tempering steam to the PCC.

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 air pollution control system. Figures B-3-1 and B-3-2 provide simplified process flow diagrams of the melter and the melter air pollution control system, respectively.

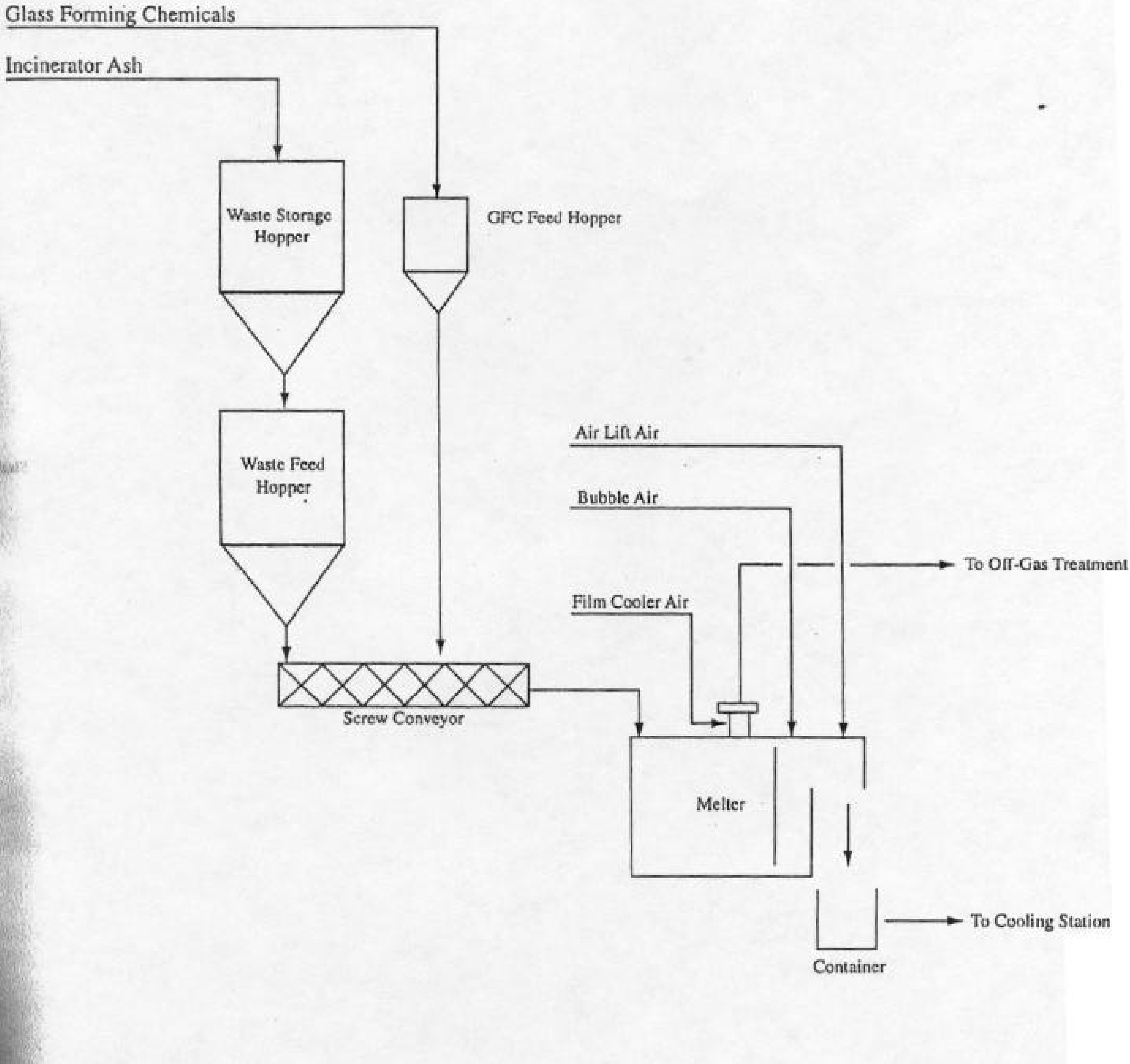

Figure B-3-1. Simplified process flow diagram of the melter.

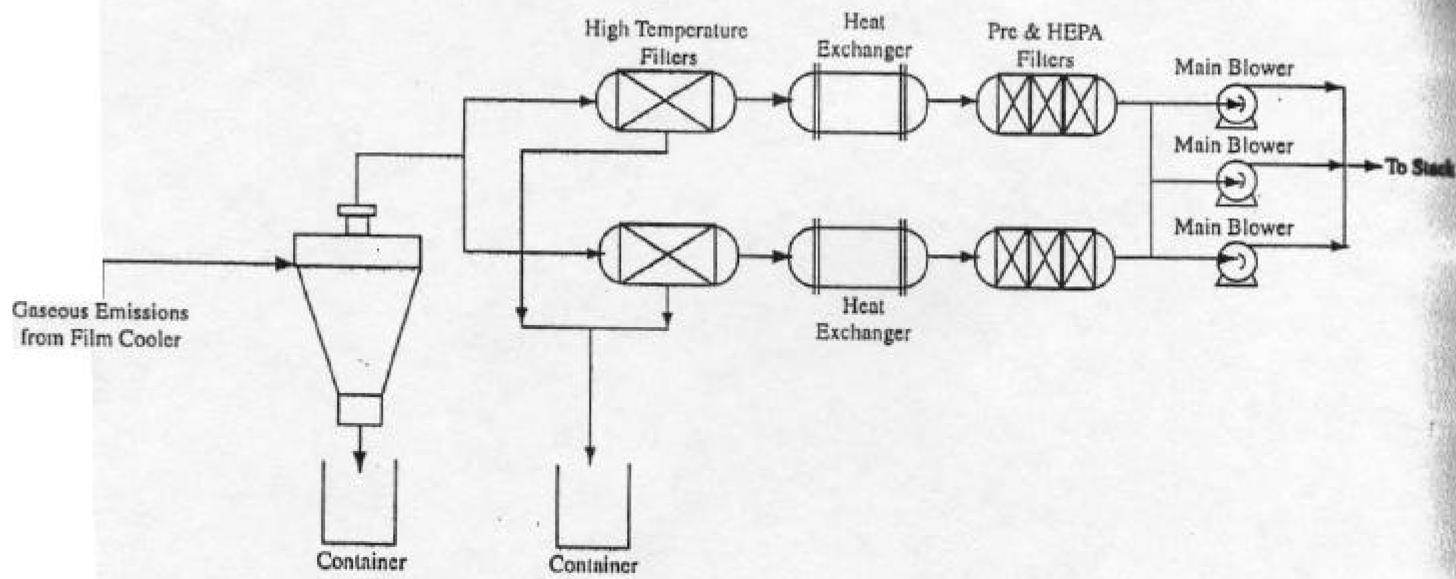

Figure B-3-2. Simplified process flow diagram of the melter Air Pollution Control System.

The 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 air pollution control system. 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.

The target glass melting temperature is less than 2200 °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 ft2, with internal dimensions of approximately 16 ft by 6.5 ft. The external dimensions of the melter, excluding the feed and air pollution control system, are approximately 21 ft long by 16 ft wide by 9 ft 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 2100 ^{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 signals proportional 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 1250°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 in. thick and the secondary layer is approximately 5 in. 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-in. 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 in. 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 in. 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 air pollution control system 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 air pollution control system 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 air pollution control system 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 1750^{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°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°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°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 air pollution control system and delivers it to the stack. The main blower has a nominal capacity of 180 acfm at 130°F and a static pressure of negative 80 in. 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 air pollution control system 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, air pollution control system 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 304L 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 air pollution control system. 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.