AMWTP-RPT-ESH-023, Rev. 3

WMF-610 Fire Hazard Analysis/Fire Safety Assessment

Advanced Mixed Waste Treatment Project

(*Signature on file. See DCR-5640.*) 04/25/07

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1.0 INTRODUCTION

1.1 Purpose and Approach

The purpose of this combined Fire Hazards Analysis (FHA) and Fire Safety Assessment (FSA) is to ascertain whether the objectives identified by Department of Energy (DOE) Order 420.1B, Facility Safety, are met for WMF-610, within the operations area at the Radioactive Waste Management Complex (RWMC) at the Idaho National Laboratory (INL).

The objectives identified by DOE Order 420.1B to be met by this FHA/FSA are:

- Minimize the potential for the occurrence of a fire or related event
- Ensure that fire does not cause an onsite or offsite release of radiological and other hazardous material that will threaten the health and safety of employees, the public, or the environment
- Ensure that vital U.S. Department of Energy (DOE) programs will not suffer unacceptable delays as a result of fire and related hazards
- Ensure that property damage from fire and related events does not exceed defined limits established by DOE
- Ensure that critical process control and safety class systems are not damaged as a result of fire or related events.

Department of Energy facilities, sites, and activities, including the design and construction, are characterized by a level of fire protection sufficient to fulfill the requirements of the best protected class of industrial risks ("Highly Protected Risk") and shall be provided protection to achieve "defense-in-depth." This protection includes meeting applicable building codes and National Fire Protection Association (NFPA) codes and standards, or exceeding them to meet safety objectives.

Department of Energy Order 420.1B stipulates compliance with applicable NFPA codes and standards. NFPA 801, Standard for Fire Protection for Facilities Handling Radioactive Materials, identifies general fire protection requirements intended to reduce the risk of fires and explosions at facilities handling radioactive materials. NFPA 801 requires that an FHA be performed to ensure that the fire hazards are evaluated and necessary fire prevention and protection measures are identified, including the identification of required fire protection systems and equipment. As such, this FHA also verifies that the criteria of NFPA 801 have been satisfied for the project.

This FHA/FSA addresses the conditions of the building and associated equipment that represents a fire hazard. When deemed appropriate, protection from other fire hazards identified within the project buildings and equipment were considered in the context of applicable codes, standards, and site criteria. Consistent with the implementation guidance requirements for an FHA presented in DOE Order 420.1B and DOE Guide 420.1/B-0, Fire Safety Program for Use with DOE O 420.1 and DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees, this FHA/FSA contains a conservative assessment of the following fire safety issues:

- Description of construction, critical process equipment, high-value property, and fire hazards
- Potential for a toxic, biological, or radiological incident as a result of a fire
- Nature hazards (such as, earthquake, flood, and wind) impact on fire safety
- Damage potential, maximum possible fire loss (MPFL)
- Fire protection features
- Protection of essential safety class systems
- Life safety considerations
- Emergency planning
- Fire department response
- Recovery potential
- Security and safeguards considerations related to fire protection
- Exposure to fire potential and the potential fire spread between two fire areas
- Effect of significant fire safety deficiencies on fire risk.

This FHA/FSA was prepared in accordance with the guidance and criteria contained in MP-ISIH-2.49, Fire Protection Program. Adherence to the identified fire protection design features and administrative controls and compliance with the recommendations of this FHA/FSA serve to satisfy the objectives of DOE Order 420.1B.

No attempt was made to provide or document verbatim compliance with current codes and standards. The codes in effect at the time of construction (Code of Record) remain in effect for the life of the facility as long as the occupancy class remains the same and no serious life safety hazard exists that would constitute an imminent threat. This analysis concentrated on conditions that would seriously affect life safety or property risks or jeopardize the ability of the AMWTP to satisfy external commitments.

1.2 Assumptions and Limitations

The adequacy and reliability of the RWMC water supply system is acceptable as documented in annual tests. Tests of the fire pumps, fire systems, water flow, and the piping investigations were not conducted as a part of this analysis. The last water flow and annual pump tests were conducted in May 2006.

Fire hazards were evaluated assuming an ignition source. The probabilities associated with specific fire scenarios were not evaluated.

Combustible loading evaluations are based on the site survey conducted during the course of this analysis in October 2006. Changes in combustible loading and/or occupancy may impact the validity of the results and conclusions of this report.

The replacement costs used in this report are based on information provided by BBWI.

Additional assumptions and limitations pertaining to specific fire scenario evaluations are addressed in other sections of this report.

2.0 OCCUPANCY

The Advanced Mixed Waste Treatment Project (AMWTP) is located at the RWMC, which is in the southwest corner of the INL. The RWMC is a 165-acre, controlled-access area with facilities and equipment capable of managing low-level waste (LLW), transuranic (TRU) waste, mixed solid radioactive waste generated by INL operations, and other offsite DOE operations. An 8-ft high chain link fence completely encloses the RWMC.

WMF-610 is used for nondestructive examination of contact-handled (CH) TRU and mixed TRU waste containers to ensure they meet applicable requirements for permanent offsite disposal. Portions of the building are permitted hazardous waste management units under the Resource Conservation and Recovery Act (RCRA) with the State of Idaho. The building is classified as Hazard Category 2 per DOE-STD-1027, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, and is operated by the AMWTP Nuclear Facility Manager (NFM). The building measures approximately 59 × 161 ft. The major portion of the building is an open high bay that houses the examination equipment and container storage areas. The remaining portion of the building is two stories and is used for control rooms, offices, restrooms, and eating areas. It has a floor area of approximately 11,447 ft^2. There are attached airlocks on the north and south sides of the building that allow for equipment access to the high bay. These measure approximately 40 × 90 ft. Thus, the total building floor area is 18,500 ft^2.

Operations in the building consist of radiological surveying and weighing of waste containers, radioscopic examination, fissile material assay, source storage, and support facilities for the operating crew. Waste is generally transferred to the building by fossil-fueled transports. Electric-powered forklifts are generally used to transfer containers to/from the transport to the high bay.

Transuranic waste at AMWTP was originally defined as waste containing greater than 10 nCi/g of alpha-emitting TRU radionuclides. The limit has been redefined as waste containing greater than 100 nCi/g. Waste meeting each definition is stored and handled in WMF-610. CH waste is defined as waste having a container surface radiation level less than 200 mR/hr. The radiation levels observed in the Type I are generally 1 mR/hr. Container fissile material is limited to 380 g.

Waste containers processed through are primarily 55- and 83-gal metal drums. Metal and fiberglass reinforced plywood (FRP) boxes are processed on a limited basis.

The normal operating periods for WMF-610 are Monday through Thursday from 0700 to 1700, with occasional backshift operations or shift adjustments to support accelerated throughput demands.

3.0 METHODOLOGY

The methodology used to analyze the fire-related hazards at the project includes:

- Evaluation for compliance with applicable DOE, Building Code, Fire Code, and NFPA criteria
- Identification of significant fire hazards
- Evaluation, estimation, and comparison of potential fire loss with respect to DOE fire loss limitations defined by DOE Order 420.1B.

This FHA/FSA is based on information contained in the design documentation, documented safety analysis, process descriptions, and consultations with cognizant facility personnel. The analysis includes both qualitative and quantitative methods to determine whether the DOE fire protection objectives are achieved. The methods of evaluation are described, cited, or referenced in the subsequent sections where they are used.

This combined FHA/FSA was prepared per MP-ISIH-2.47, Developing Fire Hazards Analyses, Fire Safety Assessments, and Abbreviated Fire Assessments, and DOE Order 420.1B. The approach taken in evaluating the fire-related perils in the building was to identify fire hazards that concern the life safety of personnel, property damage, environmental damage and mission impact and evaluating the effectiveness of in-place mitigation in relation to acceptable fire risk levels. The information presented is based on facility authorization basis documentation, construction specifications and drawings, operating procedures, and building inspections.

4.0 ANALYSIS

4.1 Description of Construction

General

The building was constructed in 1984. The Code of Record is the 1982 Uniform Building Code (UBC). The building consists of a two-story portion, a high-bay portion and two air locks (one on the south side and one on the north side). The two-story portion of the building, approximately 1,580 ft^2 per floor, contains office spaces, a mechanical room, a standby generator room and an electrical switchgear room. The high-bay portion of the building is approximately 8,140 ft^2 and each air lock is approximately 3,600 ft^2. Therefore, the total building floor area is 18,500 ft^2. The building is designed as an F 1 occupancy based on the current International Building Code (IBC). The building is classified as a Mixed Occupancy (Industrial and Business) per NFPA 101, Life Safety Code.

The UBC/IBC construction classification of WMF-610 is Type II-N/IIB. The exterior walls and roof are constructed of painted and insulated metal panels on steel frame. Interior walls for the office area are concrete block and gypsum board on metal studs. The floor is concrete slab on grade with perimeter spread footings. The building interior is column free. The airlocks are membrane over steel frame.

Mechanical Room 103 is separated from the high bay by 1-hour fire-rated barrier constructed of hollow core block (HCB) and gypsum board on metal frame. There are fire dampers in both duct penetrations in this wall. The dampers are not required or credited because they are not required for a barrier carrying a 1-hour fire rating (NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, National Fire Protection Association.). The lower portion of the north wall is a common two-hour rated barrier with Generator Room 105. The upper portion of the north wall is 1 hour rated and separates the Mechanical Room from the second story office spaces. Room 105 is provided with 2-hour fire-rated walls and ceiling. There is a fire damper protected ventilation opening in the wall facing Mechanical Room 103. Electrical Room 104 is separated from the adjacent office spaces by 1-hour fire-rated barrier. All penetrations in the above discussed fire barriers are properly protected. All door/frame assemblies carry appropriate fire ratings.

The 2-story office area is separated from Rooms 104 and 105 on the south as described above. First floor ventilation ducts are run from Room 104, in noncombustible chases, beneath the concrete floor and overhead, above a suspended acoustic tile ceiling. The east wall in this area is hollow concrete block from floor-to-roof deck. The wall does not currently carry a 1-hour rating because of the presence of a non-rated door and two non-rated 4- × 10-ft windows for observation of the high bay from the real time radiography (RTR) control room, office, and unsealed penetrations. The north wall of the office area completes the occupancy separation. This wall is the original exterior wall and separates the office area from the north airlock. The construction of the wall is metal panel, exterior on metal frame with a single layer of 5/8-in. gypsum board on the interior.

The storage area totals approximately 3,100 ft^2 of the south end of the high bay. The building exterior walls form the outer boundaries of the storage area. Curbing and an access ramp, near the center of the high bay floor area, form the north boundary. The entire perimeter is provided with concrete curbing. The floor in the storage area is sloped from south to north, approximately 0.4%. The floor on the west side of the storage area is sloped from the northwest corner to east approximately 0.6%. The containment capacity is approximately 3,700 gal.

There is a direct exit to the exterior of the building from each level of the office area and a direct exit to the exterior from the electrical room. There are four exits available from the high bay. One of the exits is a hinge/slide suspension system doors, into the north airlock. The third exit is through the first floor office area. The fourth exit is directly to the exterior of the building, on the west side. There are 16- × 12-ft overhead doors provided to allow vehicular access from the airlocks to the high bay.

The building airlocks are membrane structures supported by steel framing. At the time of construction, the membrane met NFPA 701, Fire Resistance Criteria. Because of its age, the membrane may no longer meet its original flame resistance characteristics. The north airlock membrane had been removed, and was replaced in early 2006.

Revolving doors have been removed. Pedestrian traffic enters the north airlocks through the openings left by the revolving doors on the west and east ends. Standard personnel doors have replaced the south airlock revolving door. There are electrically operated rollup doors that permit vehicular access to the airlocks from the east and west. The airlocks are provided with artificial lighting, but no ventilation.

Each airlock is provided with a manual pull station and a single horn/strobe.

Because any storage or operations in these areas presents a potential fire hazard to WMF-610, and no sprinkler protection currently exists in these area, no storage or operations is allowed without the approval of the AMWTP Fire Marshal.

Heating, Ventilation, and Air Conditioning

The heating, ventilation, and air conditioning (HVAC) system maintains a temperature of approximately 70ºF throughout the building area. The system consists of two small air-handling units and a third larger air-handling unit.

The two small units, HV-AHU-1003 and HV-AHU-1004, provide ventilation for the office areas. They are sized such that supply and return ducting do not require duct smoke detection. The systems provide cooling air via two heat pumps located on the east side of the building. Electric heating coils located in each AHU provide heated air to the office areas.

The third section, HV-CHTR-1002, is the primary ventilation system for the high bay. It is capable of pulling 7,500 cfm supplies from the exterior of the building in addition to 7,500 cfm recirculated from the high bay. The system is normally configured with the exterior supply damper closed. There are no provisions for air conditioning for the high bay. Return air for the high bay consists of 7,500 cfm back to the AHU and a series of roof-mounted exhaust fans. The capacity of the supply air for this system is such that it normally requires duct smoke detection per NFPA 90A, however, this system is not provided with duct smoke detection. This arrangement is considered acceptable by the facility Fire Protection Engineer (FPE) because supply air is primarily recirculated within the high bay, an open area entirely visible to occupants.

Additional ventilation is provided for the Radioscopic Examination Module. A small fan exhausts the radioscopic module.

A propane-fired heater section, consisting of two 400,000 BTU/hour furnaces, located in HV-CHTR-1001 and HV-CHTR-1002, provides heated air for the high bay during cold weather. The system is supplied from the 30,000-gal propane tank, pump, and vaporizer assembly located adjacent to Transuranic Storage Area (TSA) Pad 3. The distribution system meets the requirements of NFPA 54, National Fuel Gas Code. There is an isolation valve located outside the west wall of the building. The burner system is equipped with standard safety controls, including automatic isolation of fuel supply upon loss of pilot. There is no HVAC provided for the airlock portions of the building.

Electrical

A 500 kVA, 12.5 kV-4809/277 V pad-mounted transformer (N-XFR-SA02) provides power to the building. The 500 kVA transformer has primary side 15 kV lightning arresters and fused 30 A primary and 600 A secondary disconnects for transformer protection. The 480 Vac, 3-phase power is supplied via underground conduits to over current protection and service disconnects in the building. Power Panel N-PP-1001, located in Room 104 receives 480 Vac, 3-phase power from 500 kVA transformer and serves as a service disconnect and distribution point for other electrical panels in the building and WMF-617. Other distribution panels in the building are located in Rooms 103, 106, 109, and the high bay. Additional information on the electrical system can be found in facility design documentation.

Propane Detection System

Mechanical Room 103 and Generator Room 105 are provided with propane detectors. The low-alarm set point is 10% lower explosive limit (LEL). The upper alarm set point is 20% LEL. The alarms report to the annunciator panel in the main office, Room 106. Upon alarm, exhaust fans in the two rooms are started automatically. An operator is instructed to verify that the fans have started. The main supply to the building is isolated if necessary.

This system is not required by NFPA 58, Liquefied Petroleum Gas Code, with the building in its current configuration. It was primarily used when there was greater propane usage for heating an air supported building that was once connected to WMF-610. This building has been removed. Due to problems associated with nuisance alarms and the difficulty in calibrating the instrument, this system might be removed before the next revision of this FHA/FSA. Removal of the propane detection system has no impact on this FHA/FSA.

Lightning Protection

The building is not provided with a dedicated lightning protection system. It is a steel building with an electrically continuous roof located in the vicinity of substantially taller structures. An NFPA 780, Installation of Lightning Protection Systems, risk assessment reveals a moderate risk (R) of three, conservatively assuming a structure housing the manufacture, handling, or storage of hazardous materials.

The DOE-ID Architectural Engineering Standards, Section 1600-4, states lightning protection systems should be installed for buildings with a severe to moderate risk. This building meets this criterion. Facility management has decided to risk manage the consequences of a lightning strike to the building. Safety Analysis Report (SAR)-4, Radioactive Waste Management Complex Safety Analysis Report, postulates a lightning strike within the RWMC perimeter a credible accident scenario and considers a strike a potential initiator of fire for facilities not protected with lightning protection systems. This analysis supports the risk management decision. A lightning strike is expected to impact one of the taller, lightning-protected buildings in the TSA. No sidestroke effects are anticipated for the building because of adequately designed lightning protection systems for adjacent buildings.

4.2 Process Description

The WMF-610 building provides the necessary area for required nondestructive TRU waste examination activities. Containers enter WMF-610 though the building airlocks. Process equipment contained in the building is as follows:

- Waste container storage/warm-up
- Radiological survey and weigh (idle)
- Radioscopic examination
- Fissile material assay.

Waste Container Storage/Warm-Up

The storage area is a segregated area located in the south end of the high bay used for the temporary storage and preheating of waste containers. The purpose of the preheating is to thaw the waste contents in the containers so that any interior free liquids can be detected during the Real Time Radioscopic (RTR) System examination. Waste packages containing free liquids in quantities that exceed the volume limits specified in the Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria (WAC) must be treated as a special case. Containers stored in the storage area include 30-, 55-, and 83-gal metal drums and waste (steel or FRP) boxes.

Various combinations of drums and boxes can be stored in this area at any time. Maximum quantities permitted in the area based on a single container type are as follows:

- 30-gal drums 768 containers
- 55-gal drums 387 containers
- 83-gal drums 279 containers
- Waste boxes 34 containers.

Thirty- and 55-gal drums may be stored in rows four wide and three high. Eighty three-gal containers may be stored in rows three wide and three high. Boxes are stacked in various configurations three high. To allow inspection and emergency equipment access, container rows are configured to maintain at least 3 ft between rows and at least 2 ft between rows and walls. To permit forklift access down a north/south corridor, containers are stored on the east and west sides of the storage area. Containers are elevated above the floor using steel pallets. A single sided indexing spacer is used between the top of the pallet and the bottom of the first level of drums. Double-sided spacers separate subsequent layers of drums. The spacers are a thermoset-copolymer plastic material constructed of the same material as Department of Transportation (DOT) 7A drums currently in use throughout the DOE complex. The spacers carry an auto ignition temperature of between 900 and 1,000ºF. They present little material at risk. While in the stacking array, the total material at risk to an exposing fire is less than 1 ft^2 per EDF-RWMC-696, Evaluation of the Acceptability of Using Plastic Spacers as Part of the Drum Storage Array and the Storage of Fiberglass Reinforced Plywood (FRP) Boxes in the Type II Storage Modules with the Current Fire Protection System Design. The spacers provide for stack stability in the event of design basis seismic events. Maximum storage height in the area is less than 12 ft.

There are two designated staging areas for containers awaiting examination in the high bay that are located north of the storage area. Containers are not stacked in the staging areas.

Radiological Survey and Weigh (These functions are performed elsewhere. Therefore, the equipment is idle at the time of this report.*)*

A radiological control (RC) station is located along the east wall of the high bay north of the storage area. The RC station, when operational, is used for radiation and contamination surveys of the waste containers at the weigh station in preparation for examination.

The weigh station allows all containers to be entered into the examination cycle by container number and bar code. It consists of an electric scale, scale indicator, bar code scanner, and terminal, which are connected to a container tracking database system. This system initiates the beginning of the waste examination. Additional information on the weigh station can be found in facility design documentation.

Real Time Radioscopic (RTR) System

The RTR system is located near the northeast corner of the high bay. The purpose of the RTR is to examine, without opening, each of the waste containers for certification. This procedure determines, to the maximum extent practical, the physical contents of each container. This examination information is then correlated with the content code assessment to determine certifiability of each container. The system consists of an x-ray head, an imaging system, digital video recorder, and monitors. To provide radiation shielding, the x-ray head and imaging equipment is housed in a lead-shielded, 15- × 20- × 7-ft high room. An electric cart is used to transport waste containers in and out of the enclosure. A maximum of three drums or one box can be loaded into the unit at a single time.

The x-ray tube head is a constant potential, oil-cooled hooded-anode Phillips Model MCN 421. The maximum operating voltage of the tube is 420 kVdc. The output of the x-ray head is 11,000 R/min at 20 cm, when operating at maximum voltage. An oil cooling system removes heat generated in the tube head. Oil is circulated through the heat and around the target (anode). The oil is then forced air cooled by an oil-to-air heat exchanger on top of the shield room. A safety circuit terminates high voltage generation, if the oil temperature exceeds 70ºC, or if the oil flow drops below 14 L/min. The control for the unit is located in Room 109. Additional information on the RTR system can be found in facility design documentation. This system is used as a backup to the RTR trailer unit located in the south airlock.

Real Time Radiography Trailer

The RTR trailer (oriented east-west) located in the north airlock is an 8 × 48-ft trailer containing a lead lined steel enclosure for the RTR system, and a control area for running the system. The purpose of the RTR is to examine, without opening, each of the waste containers for certification. This procedure determines, to the maximum extent practical, the physical contents of each container. This examination information is then correlated with the content code assessment to determine certifiability of each container. The system consists of an x-ray head, an imaging system, digital video recorder, and monitors. To provide radiation shielding, the x-ray head and imaging equipment is housed in the lead shielded enclosure. Drums are placed on a conveyor, which extends out the back end of the trailer. The system can accommodate two drum at a time.

The RTR trailer is powered by a 220-V power supply, located underneath the trailer. The x-ray head and cooling system are similar to that of the RTR system located in the high bay.

Super HENC Trailer

The Super HENC trailer (oriented east-west) located in the south airlock houses a nondestructive assay process that will accommodate standard waste boxes and 100 gal drums. The trailer is 10 ft wide and 50 ft long and is divided into two distinct sections. A control room is located on the west end of the trailer while the assay process portion is on the east end of the trailer.

Utilities for the trailer include a 480 VAC three phase, 100 amp service, and a 3-in. fire water connection. The fire protection system within the trailer is connected to the WMF-610 fire suppression system, through a glycol loop, and is in service. As well, there is an ABC, dry chemical fire extinguisher located in the control room and in the assay process area.

A horn/strobe device, tied into the building fire alarm system, is located in the trailer and operators are required to maintain a radio within the control room so that emergency announcements can be heard.

Due to the low occupant load of the control room, the operators are required to maintain battery powered lighting (flashlights) when in the control room. This is in lieu of permanently mounted emergency lighting units.

Assay Systems

The majority of the waste assay system is located along the east wall of the high bay, south of the RTR system. The assay system measures the fissile material content in each waste container, estimates the thermal power density of the waste, and determines those containers with a TRU content of greater than 100 nCi/g. The assay information is used for waste certification and for nuclear criticality control. The assay system consists of a drum counter for 55-gal waste drums. The unit operates on the combined passive-active neutron (PAN) measurement principle. The unit is set up to process a single waste container at a time. Additional system description information on the Assay System can be found in facility design documentation.

This equipment is currently inactive. The equipment shall be assessed and any controls identified as a result of the assessment shall include in the following revision of this FHA/FSA.

Gamma-Ray Spectrometer

The Stored Waste Examination Pilot Plant (SWEPP) gamma-ray spectrometer (SGRS) is used for passive gamma-ray analysis of waste packaged in up to 55 gal drums. The unit is located in the southwest corner of the high bay. The SGRS is capable of identifying gamma-ray emitters at very low activity levels packaged in a wide variety of matrix materials. The system records gamma rays emitted from a drum, generates a gamma-ray spectrum, and processes the results in a specific energy region to arrive at calculated ratios of the mass of selected isotopes to the mass ratio of Pu-239 and/or to the mass of U-235. The isotopic mass ratio data are used to verify or adjust to the quantitative results from the PAN assay system. The SGRS system processes a single container at a time.

Included in the SGRS is a liquid nitrogen (LN) support system for operation of the hyper-pure germanium (HPGe) detectors. The detectors are currently filled manually with dewars stored in the south airlock. A 500-gal LN tank, with associated delivery piping, was located on the exterior west side of the building but has been removed. Additional information on the SGRS system can be found in facility design documentation.

Waste Assay Gamma Spectrometer System

The Waste Assay Gamma Spectrometer (WAGS) Absolute Assay System is located near the south end of the high bay area. The system consists of a shield chamber, internal conveyor, drum lift/turntable, turntable motor and controls, three transmission sources, six high resolution, HPGe detectors, associated amplifiers, high-voltage power supplies, analog-to-digital converters (ADCs), and acquisition and interface modules. An external air compressor operates pneumatically operated system components and an auto fill; LN support system is required for operation of the HPGe detectors. Additionally, a workstation, printer, monitor, keyboard, and barcode reader are part of the system. A six-drum conveyor transfers drums to the WAGS shield chamber.

The system will operate in the following manner: Up to six drums can be loaded onto the conveyor system at one time. A single drum is loaded into the shield chamber on a pneumatically raised internal conveyor. A photo sensor in the shield chamber indicates when the drum is in position on the chamber rotator and then the shield door is closed. The drum is pneumatically raised to position and rotated. The normally closed shutters that cover the transmission source beam paths are then opened by pneumatically raising the actuator shaft to which the shutters are mounted. When the shutters are open, exposing the sources, whether opened electro-pneumatically, or manually, a normally closed limit switch illuminates a "shutter open" red warning light on the mechanism control enclosure. Interlocks are provided to prevent opening of the shutters unless the shield chamber door is fully closed. The gamma-scan analysis is completed by exposing the three detectors to the source beams, which experience attenuation from the materials in the drum. Energy-dependent attenuation coefficients are calculated based on information obtained from the waste drum scan as compared to an empty drum scan. The shutters are opened and a passive gamma scan is completed. The attenuation coefficients are used in conjunction with the passive gamma-ray spectral analysis to arrive at an assay of particular radionuclides in the waste drum. The above process is essentially reversed to open the shield chamber door and remove the drum.

Miscellaneous High bay Activities

Other miscellaneous activities taking place in the high bay include forklift battery charging along the west wall of the storage area, for forklifts used within the facility.

Airlocks

There are airlocks on the north and south sides of the building. The airlocks now function as characterization areas. Transports are pulled into the airlocks and the containers off-loaded into the building. The north airlock contains an RTR trailer unit and the south airlock contains the Super HENC trailer unit.

Support Areas

The remainder of the building is used for support activities. There are two mechanical rooms that house the propane-fired furnaces for the building and a 75 kW propane-fired standby generator. The first level houses office spaces and control rooms; the second level houses changing rooms, more office spaces, and an employee break room.

4.3 Safety Class Items

The document safety analysis (DSA) has identified no safety class items for WMF-610.

4.4 Description of Fire Hazards

Fire Hazards Associated with the Waste Inventory

The AMWTP waste inventory consists primarily of cemented sludges and other noncombustible material. T. L. Clements, Jr., *Content Code Assessment for INEEL Contact-Handled Stored Transuranic Wastes,* states approximately 35% of the TSA inventory is combustible (Class A). Compressed gas cylinders are not permitted in waste containers. Containers with greater than 1% free liquids do not meet waste acceptance criteria and represent a very small container population, minimizing the potential for flammable or combustible liquids within the containers. The waste contents themselves do not propose significant fire intensity challenges.

In general, airborne radioactive and chemically hazardous material generated through combustion of the waste inventory is the primary fire hazard. Fire induced airborne material will originate from:

1. Contents burning in a waste container that has lost its lid or otherwise burst open
2. Expelled contents burning as a trash fire
3. A container which is venting.

Items 1 and 2 represent relatively open burning processes, such as flaming, that are not ventilation limited. This is compared to the venting of gases from ventilation limited, smoldering, or pyrolysis associated with Item 3. An initiating fire must be sufficient to cause container lid failure or include a means by which the container is breached in order to involve the container contents. The following discussion quantifies the significance of the associated hazard in relation to the waste storage matrix in WMF-610.

Spontaneous Ignition

There may be small quantities of solid pyrophoric material in some containers. Since 1952, three small fires have occurred at RWMC as a result of spontaneous combustion within a waste drum. None of the fires impacted more than one waste container. Two fires occurred in 1966, in waste deposited in cardboard boxes in the Subsurface Disposal Area (SDA). It is suspected that the fires were caused by alkali metals that were inadvertently deposited with the LLW. The third fire occurred in 1970, in a waste drum that was painted black and stored above ground, outdoors. The cause of the fire was postulated to have been absorption of radiant heat from the sun through the surfaces of the drum, which ignited pyrophoric materials in the drum. There has not been a fire in a waste container at

RWMC since the 1970 incident. Spontaneous ignition in a drum is considered a credible initiator.

Fire or Explosion Resulting from Hydrogen Gas Buildup

Transuranic waste generates hydrogen gas through the radiolysis process. There are additional causes of gasification within mixed TRU waste containers associated with thermal, bacterial, and chemical reactions. Concerns related to gasification in waste include explosion, deflagration, flammability, and over-pressurization leading to container rupture. These concerns have led to limiting activities such as venting sealed containers and limiting the curie content per container. All boxes and most, but not all drums that may be in WMF-610, are provided with vents or are inherently permeable. Tests have been conducted on sealed drums in an effort to estimate the potential for flammable hydrogen/oxygen mixtures in drums, T. L. Clements Jr., and D. E. Kudera, *TRU Waste Sampling Program; Volume I Waste Characterization* (EG&G-WM-6503). and T. L. Clements Jr., and D. E. Kudera, *TRU Waste Sampling Program; Volume II – Gas Generation Studies* (EG&G-WM-6503). Results indicate that approximately 5% of drums, without vents or semi permeable gaskets, may exhibit internal fuel/air concentrations with greater than 4% hydrogen and greater than 5% oxygen by volume, which is a flammable mixture. Explosion or deflagration of waste containers is theoretically possible, but unlikely, considering lack of readily available ignition sources within the container. There have been no reported cases of exploding drums or burst drums from over-pressurization at RWMC. It is considered a credible initiator and the consequences are expected to be limited to the container of origin.

Fire or Explosion of Nitrated Resins

Nitric acid is used in plutonium and other nuclear operations. Generally, no free nitric acid is present in solid waste packages. The acid has been absorbed on paper wipes, rags, or other absorbent material. Nitrated cellulose materials may become highly flammable if allowed to dry. Ion-exchange resins were also used in production plutonium recovery operations to purify plutonium-bearing solutions. During recover operations, the resins were exposed to various concentrations of nitric acid. Nitrated resins may become highly flammable or explosive if allowed to dry.

Before 1972, resin wastes were not leached for recovery of remaining plutonium and were packaged in plastic bags before being placed in waste drums. There are approximately 35 such drums in the TSA inventory, some of which may be located in at some point in time. Since 1972, resin wastes have been leached with water and then solidified with Portland cement before being placed in a waste drum. The cemented resins in the containers in the AMWTP inventory do not present a significant fire hazard (AMWTP-RPT-DSA-02).

Fire resulting from one of these mechanisms involving a single waste container of uncemented nitrated resins is considered a credible initiator.

Analysis of Fire Propagation Characteristics of Waste Containers

In-situ fire hazards associated with the waste matrix are low since all of the waste is contained within metal drums, boxes, or FRP boxes. Plywood waste boxes were over-packed in metal cake boxes before removal from the RWMC air-supported storage facilities.

Drums

Historical fire test data have shown that drums containing ordinary combustibles exposed to large pool fires can experience violent lid loss and expose the contents of the container or the atmosphere. With heat input from the initial fire, the drum contents may then burn. In cases where lid loss does occur, the lid gasket can be thermally degraded and loss of containment occur as heated air and pyrolysis products escape from the drum at the lid seal. *Fire Protection Guide for Waste Drum Storage Array* (WHD-SD-SQA-ANAL-501), documents full-scale fire tests performed on steel drums containing combustible, primarily Class A, and noncombustible contents to establish their associated fire risk in waste storage facilities. A review of the test report indicates the assessment can be applied to WMF-610, which contains steel drums with similar contents stored in similar configurations. The results of the testing are summarized as follows:

1. A significant exposing fire, diesel pool fire, is required to cause exposed drums to fail and burn. Drums must be directly exposed to flame thicknesses of 0.5 meter or more for at least 70 seconds to fail and involve the contents of the drum. The spread of fire through the drum array is limited by the ability of the burning drums to heat neighboring drums via radiation to allow fire propagation. It was found through a combination of experimental and analytical methods that horizontal drum-to-drum fire propagation based on the burning of drum contents within a drum is not likely. A similar analysis for a rack configuration showed that drum burning couldn’t support upward fire propagation.

2. Fire propagation through a drum array cannot occur from drums exposed to trash fires or from the burning of expelled drum contents. Flame thicknesses and associated heat input from such fires is not likely to affect the integrity of those drums directly exposed.

3. Full-scale testing showed that fire propagation can occur from pallet to pallet if wood pallets are used. The propagation via this method was slow and minimal fire size. Wood pallets are not utilized for drum storage at WMF-610. The plastic spacers used present minimal material at risk and provide no flue or air gap between drum layers to support propagation. Propagation of fire in this manner is not likely.

4. Drum vents do not affect drum response during fire exposure.

Spontaneous ignition of a drum is considered credible. The results of the fire tests discussed above indicate that this fire initiation scenario would involve only the drum of origin and not propagate to adjacent containers. A significant fire exposure is necessary to involve multiple containers.

Metal Boxes

As of this report, no fire test data are identified to quantify fire effects on metal waste boxes. Qualitative analysis based on engineering judgment and the results of the fire test data on other waste container types, indicates that metal waste boxes are likely the most resistant to fire loss as well as a recommended practice by the Uniform Fire Code (UFC) and Factory Mutual (FM). As with metal drums, spontaneous ignition of a metal waste box is credible, but not likely to spread to adjacent containers. The metal boxes are expected to resist the effects of a significant exposing fire with direct impingement of flames greater than 0.5 meters in width more effectively than waste drums. The wall thickness of metal boxes is much greater than that of drums. Therefore, they provide a greater resistance to conductive heat transfer. Box lids are much heavier than drum lids and are bolted in place versus the bolted, retaining ring on drums. Box lids are not expected to lift violently and expose contents during exposure to pool fires. The primary failure mechanism is expected to be thermal decomposition of the lid gasket resulting in oxygen limited smoldering and pyrolysis and the venting of associated gases, which may be flaming. This is a slow burning process that presents a smaller airborne release potential than the open burning process associated with catastrophically failed drums.

Fiberglass Reinforced Plywood Boxes

There are currently no plans to bring FRP boxes into WMF-610. However, they are not precluded from being brought into the building. Therefore, the hazards associated with them being assessed. The boxes are constructed of 3/4 in. plywood on 2 × 2-in. stud framing. The exterior is coated with a minimum of 0.125 in. of FRP (roving strand fiber reinforced polyester, carrying a Class A flame spread rating). They have been analyzed by EDF-RWMC-806, Fiberglass Reinforced Plywood Boxes Fire Hazards Analysis, and found acceptable for storage within AMWTP. The boxes response to diesel pool fires has been tested.

R. Brown, *DOT 7A FRP Box Fire Test at the INEEL, TREE-1367* (EG&G Idaho, Inc.), documents the results of the testing. The results are summarized as follows:

1. Test No. 2 utilized 4 gal of No. 2 diesel poured into a pan. The pool exposed a corner array of empty boxes stacked three high and extended under the stack. The diesel was ignited and the fire allowed to burn until the fire extinguished. The exposed box surfaces were actively involved while the diesel burned. Upon burn-off of all the fuel, approximately 15 minutes into the test, the combustion of box surfaces quickly dissipated until complete self-extinguishment, approximately 75 minutes into the burn. The highest recorded interior box temperature was 84°F for a box that had an exterior temperature of 1,374°F. A small breach, 6 × 8 in., was observed beneath the FRP coating for this container. All other containers remained completely intact. It is estimated that the breech occurred at least 45 minutes after fuel ignition, based on thermocouple readings of the affected box.

2. The test configuration was not large enough to completely evaluate the propagation potential on FRP boxes from such an exposure. The results from the limited test do indicate that even under direct flame, impingement from a combustible liquid pool fire, the FRP boxes hold up well. Isolated instances of container degradation should be anticipated, but the boxes do not efficiently sustain combustion. Limited flame spread may initially occur to adjacent containers, but should self-extinguish before breakthrough. Full waste boxes will present a more substantial heat sinc than the tested empty boxes, possibly slowing container failure. A significant exposing fire is considered necessary to breach FRP containers. Spontaneous ignition of a FRP waste box is credible, but is not expected to spread to and breach adjacent containers. FRP boxes, when placed in the waste matrix, are not prone to significant exposure. Adjacent containers shield the boxes from significant flame thicknesses. The boxes are most prone to fire loss when being handled by fossil-fueled vehicles and the associated energy source.

The FRP boxes, if present in the building, represent the most significant in situ fire suppression challenge. NFPA 231, Standard for General Storage, classifies FRP as a Group A Plastic. FM has assessed samples of FRP and concluded it is more accurately defined as a Class III commodity, EDF-RWMC-602, RWMC Fire Safety Equivalency Studies. The fire suppression system in was designed per NFPA 13, Ordinary Hazard. The presence of combustible waste packaging in storage heights less than 12 ft is consistent with the design criteria specified. Further discussion on the fire suppression system design can be found in Section 5.6.

Fire Hazards Associated with the Structure and Operations

The operations of moving waste within present the dominant fire hazard for the facility. Most waste container movements within the building are performed with hand-trucks or electric forklifts. A fossil-fueled vehicle, forklift or manlift, may be in the building periodically to handle heavier waste containers, or for maintenance purposes. Transport vehicles are pulled into the airlocks for loading/offloading. The fuel source associated with such vehicles is the largest single risk to the stored waste containers in the building. A ruptured fuel line can deliver a pool of fuel that would accumulate at low points of the high bay. Hot surfaces of the vehicle engine are credible ignition sources for the fuel. The resulting fire presents an exposure significant enough to impact directly exposed containers. Fossil-fueled vehicles are not permitted to be left unattended within the building unless approved by the Fire Marshal.

The processes in the high bay and airlock have some fire potential. An electrical fire in the RTR or assay units is considered credible for the purpose of this analysis. There is a fire potential due to overheated components associated with the x-ray tube in both the high bay RTR and the RTR trailer. Such a fire could impair the equipment involved and present an exposure for the containers within the equipment. A maximum of three drums or one box would be exposed to fire originating within the high bay RTR and one drum would be exposed to fire originating within the RTR trailer. Because of the low combustible loading, no suppression is required within either RTR cave.

A maximum of one drum would be exposed to fire originating within the PAN, SGRS, or WAGS Absolute Assay System.

The high bay contains the capacity for two battery-charging stations. However, at the time of this report, no battery-charging stations were present in WMF-610. Should the stations be re-installed, they would be fully automatic, equipped with computer circuits that monitor battery charging rate and hours of charge, current limiting transformers, reverse polarity protection, and would be fail-safe. If any critical component should fail the charge shuts down. Ventilation in the area is adequate for disbursement of hydrogen gas generated during charging operations. At the time of this report, the two battery-charging stations were removed.

The Type II-N/IIB construction of WMF-610 minimizes the in-situ combustible loading associated with the structure. Building materials are predominately concrete and steel. The primary elements of the structure, which may become involved in fire, are the electrical and cabling equipment in the high bay, and propane fuel sources in the generator and HVAC room. Electrical equipment was designed and installed in accordance with all mandatory criteria. The hazard is adequately mitigated by the system design and building suppression systems.

Propane delivery systems and utilization equipment comply with the requirements of NFPA 54 and 58. Because of the presence of available ignition sources, a significant fire is most likely to occur in the electrical, generator, and HVAC rooms. Therefore, they are separated from adjacent portions of the building by appropriate fire barriers. Fires originating in these spaces are expected to be contained to the room of origin by the in-place barriers and suppression systems.

Transient combustibles in the high bay and airlocks are minimized. Good housekeeping practices are required by facility management and embraced by all employees. In accordance with MP-ISIH-2.32, Housekeeping, periodic self-assessment inspections are performed in the area to ascertain the presence of accumulated combustibles that are not in use. Deficiencies are reported and acted upon in a timely manner. The administration support areas of the building contain moderate levels of Class A combustibles typical of office occupancies.

4.5 Life Safety Considerations

WMF-610 is classified as Mixed Occupancy, Industrial/Business, per NFPA 101. The high-bay is provided with four exits that discharge directly to grade (two exits pass through the airlocks. Egress from the second floor is via an unprotected interior stair and an outside stair. Each of the two airlocks is provided with two, well separated personnel exits that discharge directly to the exterior. All exits are adequately separated and marked. The building is provided with adequate emergency lighting. There are no recommendations for life safety improvements in WMF-610.

The RTR trailer has two separate and well-marked exits from the control room. Controls are in place to ensure that egress lighting is adequate. The Super HENC trailer has a single, well-marked exit from the control room. As well, controls are in place to ensure that egress lighting is adequate.

4.6 Vital Equipment

No equipment in WMF-610 is identified as vital by DOE. The RTR, PAN, SGRS, and WAGS are vital to the AMWTP mission. Each of these systems is commercially available, which would limit down time. It is expected that replacement equipment could be purchased, installed, and tested within six months if lost to fire. All critical software, electronic waste container data, and video media are backed-up and stored in redundant locations.

4.7 Security and Safeguards

The AMWTP is a controlled-access area with security personnel present 24 hours a day, seven days a week. The level of protection has been established by company security personnel and deemed adequate to protect the facility from terrorist threats. Deliberate fire losses are not anticipated. There is a limited-access area within the high bay. It is a small, locked closet designated as a Criticality Control area for radiological source storage. There are no limited-access issues that present unique fire protection or life safety challenges.

4.8 Natural Hazards

Natural hazards primarily range fires, lightning, earthquakes, high winds, and freezing temperatures, are credible concerns at the INL. The building is designed per UBC design requirements for earthquakes, Zone 2B, and high winds. The suppression systems are provided with seismic bracing per NFPA 13, Installation of Sprinkler Systems, requirements. The building is not provided with a lightning protection system, but is considered adequately protected from the effects of lightning. Range fires are a regular occurrence at the INL. The Type II-N/IIB construction of the building, 30-ft defoliated zone around the perimeter of the buildings, and established, defensible fire breaks around the perimeter of the building afford adequate exposure protection that makes the involvement of the building in a range fire not credible (AMWTP-RPT-DSA-02).

4.9 Damage Potential

For the purposes of maximum credible fire loss (MCFL) and maximum possible fire loss (MPFL), the building is considered a single fire area. The value for the structure is estimated to be $7,253,000 and contents of $9,123,000, for a total replacement value of $16,376,000.

Maximum Credible Fire Loss

The MCFL is predicted to be a fire involving the WAGS station. A fire in the WAGS station is assumed to impair the unit, requiring replacement, and involve up to three waste drums in the unit enclosure. The contents of the drums are assumed to be 100% combustible and fully involved in the fire. Fire damage is assumed to be contained primarily to the unit enclosure base on its lead shielding construction and the automatic firewater suppression system protecting the high bay area. Contamination is also assumed to be primarily confined to the enclosure, with some spot contamination in the immediate exterior locations of the enclosure. The replacement cost of the WAGS is estimated at $2,000,000. cleanup costs for the accident are estimated at $500/ft^2 for the WAGS enclosure or $50,000. The total MCFL is approximately $2,050,000.

Maximum Possible Fire Loss

The most severe fire exposure expected in involves the fuel of a fossil-fueled vehicle in the building for waste handling. Such a fuel source has the potential to impact multiple waste containers. The MPFL is therefore postulated as a diesel fuel fire involving a transport vehicle loaded with waste containers in one of the building airlocks. A fuel line on the transport tractor is assumed to fail and be ignited by hot surfaces of the engine, resulting in a 50-gal pool fire under the transport. The pool is assumed to be large enough to involve the entire transport. This scenario represents the maximum waste inventory subject to direct, intense flame impingement. The fire is expected to consume the membrane structure with isolated damage to the steel frame and north exterior wall. The transport vehicle can be loaded with metal drums or boxes, which are assumed to be FRP boxes. The FRP box assumption is conservative as they are rarely handled in the building. Each configuration is addressed separately.

Scenario 1: Metal Drums

In the absence of suppression actions, all waste drums on the transport, up to 32, are assumed to experience violent lid expulsion with the full combustion of all combustible contents prior to self-extinguishment. The postulated failure of all drums is considered conservative based on the fire test results documented in WHD-SD-SQA-ANAL-501. Flames from the exposing pool fire would lap around the perimeter of the transport, directly exposing only those sides of containers on the perimeter of the transport. Drums in the middle of the transport would be shielded from direct flame impingement and less likely to experience violent lid expulsion.

Scenario 2: FRP Boxes

In an absence of suppression actions, all boxes on the trailer, up to eight, would likely be involved with some experiencing at least minor degrees of failure prior to self-extinguishment. The postulated exposing fire is more significant both in terms of total heat output and fire duration than that tested in TREE-1367. Under this exposure, complete failure and combustion of all box contents is not anticipated, but smoldering combustion and venting of pyrolysis products could occur prior to adequate cooling for self-extinguishment. It is conservatively assumed that in the absence of automatic and manual suppression efforts, all boxes on the transport would become fully involved with all combustible contents consumed.

The value of the MPL is the replacement cost of the RTR trailer, repair/replacement of airlock structure and decontamination costs resulting from the involved mixed TRU waste. Decontamination is assumed to be required for the entire south airlock. An estimate of $\$500/ft^2$ of floor area is used in the calculation. The replacement value of the RTR trailer (according to VJ Technologies personnel) is estimated to be \$990,000. The damage to the airlock is estimated at \$150,000. The decontamination cost is estimated at \$1,800,000 ($3,600\ ft^2 \times \$500/ft^2$). The resulting MPFL value is \$2,940,000.

4.10 Recovery Potential

The INL Fire Department is equipped with recovery equipment. The processes in are replaceable if lost to fire. It is anticipated that a 6-month delay would be incurred for bringing temporary replacement facilities online if necessary. The delay would impact facility production.

4.11 Potential for a Hazardous Release Due to Fire

No significant quantities of water-reactive material have been identified in the mixed TRU inventory contained in WMF-610. AMWTP-RPT-DSA-02, AMWTP Documented Safety Analysis, has analyzed criticality safety at AMWTP and determined that no suppression water restrictions are necessary to maintain criticality safety. Contaminated water from fire suppression efforts is a concern in WMF-610. The only portions of the building with containment floors are the storage areas of the high bay. The containment is only capable of containing approximately eleven minutes of fire sprinkler flow in the storage area. Contaminated water that exceeds this containment, as well as suppression water from all other portions of the building, will escape the building and be gathered by the surface drainage system in the TSA. If unmitigated, the water will ultimately be routed to the canal that parallels Adams Boulevard. The surface drainage system is expected to direct contaminated water away from adjacent facilities and therefore not interrupt facility operations. Water limitations are identified in the pre-incident plan.

The predominant release concern from fire in WMF-610 is radioactive and chemically hazardous materials that become airborne, through transport of radioactive particles via smoke, in the thermal plume. WM FL-82-021 analyses the releases associated with the combustion of waste drums and boxes. The unmitigated release associated with the combustion of a trailer loaded with drums or boxes falls within DOE guidelines for a Hazard Category 2 facility.

4.12 Fire Exposure Potentials

The building is considered a single fire area. However, fires occurring in the generator, electrical, or furnace rooms are likely to be contained within the room of origin for most fire occurrences, because of the fire-rated barriers separating those areas of the building.

Potential exterior exposures include building WMF-618, located approximately 50 ft west and building WMF-635, located approximately 50 ft north of the building. Both buildings are composed of noncombustible construction and fully sprinklered, minimizing the exposure concern.

Other exposures to the building include the oil-filled transformers on the west side, WMF-690 non-sprinklered shed, located approximately 25 ft south, and the Transuranic Storage Area-Retrieval Enclosure (TSA-RE) sprinklered building, located approximately 50 ft west.

4.13 Fire History

The only reported fire for involved one of the overhead light fixtures in the high bay. The fire was isolated to the electrical wiring within the light fixture. The fire loss was restricted to a single light fixture.

5.0 FIRE PROTECTION FEATURES

5.1 Fire Water Distribution System

The water supply for the AMWTP is supplied through the RWMC. There are two separate systems, a fire water system and a domestic water system. This fire supply system consists of Building 639, Firewater Pump House and WMF-727, a dedicated 250,000-gal water storage suction tank with manual fill. Two 2,000 gpm at 125-psi fire pumps, one electrically powered and the other driven by a diesel engine, provide the primary and backup required fire flows for the facility. Normal system pressure is maintained at approximately 150 psi by a 22 gpm jockey pump.

The domestic water supply is located in Building 603 and consists of a deep well pump, 2 approximately 250 gpm domestic pumps that feed the domestic loop. There is an out-of-service old fire pump that is located in Building 603 that cannot be used, even in an emergency. Associated with Building 603 is a 250,000 gal domestic suction tank. The electric fire pump is a Peerless, Model 8AEF20, 1780-rpm, single stage, split case, horizontal, centrifugal pump. The impeller size is 17.7 in. Maximum brake horsepower (BHP) is 197.6. Churn pressure is 142.5 psi. A 200-hp Lincoln, Model TV-5386 motor, drives the pump. It is a 3-phase 460-V motor. The electric fire pump controller is a Metron Model M430-200-460C with an internal mercury switch. The controller is set to start the pump upon system pressure of 120 psi. The pump controller is provided with a minimum run timer set at approximately 11 minutes. Power to the pump motor is supplied in accordance with the requirements of NFPA 20, Installation of Stationary Pumps for Fire Protection.

The diesel fire pump is a Fairbanks-Morse, Model 28CF, 1750-rpm, single stage, split case, horizontal, centrifugal pump. The impeller size is 17.25-in. Maximum BHP is 218.9. Churn pressure is 140.3 psi. The pump is driven by a 255-hp Cummins Model NT-855-F1 diesel engine. The diesel fire pump controller is a Metron Model FD2-AFJPSV with an internal mercury switch. The pump is set to start with a system pressure of 110 psi. It has a start delay of approximately 24-seconds. The pump will start automatically upon loss of commercial power. The pump must be manually shut off once it has started. The pump controller has standard diesel engine supervision functions, per NFPA 20. A 300-gal tank provides fuel for the driver (within a diked area in the pump house). The fuel tank level is maintained at 75% (225 gal) full at all times. A low fuel level alarm is set at 70% (210 gal) full.

An FM Global approved 500-gal bladder tank is installed in building WMF-639 to provide water hammer shock protection for the equipment in the pump house and absorb pressure surges to the fire water distribution system when the fire pumps come on line.

The water level in water tank WMF-727 is maintained manually between 21 and 25 ft. (207,413 gal and 246,921 gal). Water is supplied to the tank by the domestic water pumps in WMF-603 that pull water from the 250,000-gal domestic water tank (WMF-709). A backflow prevention device is installed in the 10-in. cross connection between the two systems. The tank level is monitored electronically and manually during normal working days and filled when the level approaches 21 ft. A low tank level alarm is reported when the level drops to 20 ft. The tank is insulated and provided with a circulation pump and heater to maintain water temperature above freezing during cold conditions. A low tank water temperature alarm is transmitted when the water temperature drops to 40ºF.

The minimum water level maintained in the tank provides a dedicated water supply in excess of 90 minutes for the largest building demand (sprinkler and hose stream allowance).

The potable water system supply backs up the primary fire water supply. They are completely independent with the exception of a common 10-in. main that connects the potable water distribution system to the firewater distribution system. The firewater distribution system for the AMWTP consists of 8- and 10-in. underground mains. Lead-ins to the building consist of 8-in. piping. All underground piping is buried to a depth of not less than 6 ft. Underground piping conforms to the requirements of NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances.

Dry barrel fire hydrants and sectional post indicating valves (PIVs) are located around the AMWTP to provide water supply connections for manual suppression and localized isolation capability.

The water distribution system is a gridded/looped configuration that provides two directional water flow for the building fire system 6-inch lead-in. An 8-in. underground main is routed along the west side of the building. An underground valve that is operated by an above ground PIV controls the supply lead-in. The PIV is normally locked in the open position. There are three dry barrel fire hydrants located within 300 ft. of the building.

The fire suppression system demand in the building requires an available water supply of 643 gpm @ 68 psi to include a 250-gpm hose stream allowance for 2 hours. A maximum building water demand requirement of 1,500 gpm at 20 psi has been established for a duration of 2 hours, representing the fire flow requirements for the building airlocks.

5.2 Fire Detection and Alarm System

WMF-610 is equipped with a local fire alarm system that is connected to the INL Proprietary Fire Alarm System. The building fire alarm control panel is a Thorn KDR 1000. This panel functions as the local panel and reports alarms to the INL Fire Alarm Center (FAC). Signals are transmitted over copper to the RWMC dial room in WMF-619, where they are interfaced with the site-wide fiber optic telephone transmission network and sent to the FAC.

Initiating devices in WMF-610 consist of manual pull stations at all exits, a water flow alarm, and spot smoke detection in the first floor computer area. The spot smoke detection in the first floor computer area is presently in an “out of service” status. The building is provided with audible/visible alarm notification devices that satisfy the local notification requirements of NFPA 72, National Fire Alarm Code, and NFPA 101.

The fire alarm system is connected to the standby power system as well as provided with batteries capable of maintaining the system for 24 hours. The system is provided with required supervisory and trouble condition monitoring, including control valve tamper, loss of AC power, and loss of communication. All alarm signals report to the FAC. Emergency response is initiated upon receipt of any initiating device. Upon receipt of a supervisory or trouble alarm, the FAC operator notifies RWMC Shift Supervisor (SS) or the on-call emergency coordinator during backshift for initiation of investigation and corrective actions.

5.3 Fire Department

At the INL, the responsibilities of the INL Fire Department response organization include three service areas: (1) emergency medical, (2) fire suppression of hazardous material, and (3) technical rescue response for the entire site. To provide response capabilities in each service area, the INL Fire Department must provide timely response to any emergency with adequate forces and appropriate equipment. Apparatus must be maintained based on the potential emergencies for the site. In addition, the INL Fire Department has reciprocal firefighting agreements with the surrounding communities thereby increasing the response capabilities of the region as a whole. Details of manpower, equipment, and response time are found in the *INEEL Fire Department Emergency Response Baseline Needs Assessment* (Stonhill et al, 2005). The assessment establishes the maximum total response time to the RWMC and WMF-610 as 17 minutes for first and second Engine Company response, and 43 minutes for third Engine Company response. This is the estimated total time from alarm at station until manual suppression efforts are initiated at WMF-610.

The INL Fire Department has a current pre-incident plan dated March 2005, for this building. The pre-incident plan addresses the fire department's response in terms of manpower, equipment needs, and tactical considerations for fire events occurring in the building. The pre-incident plan is appropriate for credible situations that may be encountered in the building.

AMWTP does not have an incident response team. As such, no reliance is placed on a local plant brigade for responses to fire or hazardous material incidents.

5.4 Operational or Maintenance Factors Affecting Fire Protection

AMWTP has a comprehensive fire protection program in place. AMWTP maintains access to a qualified FPE to implement and monitor the effectiveness of the program. The program requires that all fire protection systems and equipment be inspected, tested, and maintained per MP-CMNT-10.18, Inspection, Testing, and Maintenance of Fire Protection Systems and Equipment. The fire protection systems are maintained operable to the extent possible. Any impairment associated with the systems are reviewed by the facility FPE and approved upon implementation of necessary compensatory measures per INST-CMNT-10.6.2, Fire Protection System Impairments. All facility modifications and operating procedures with fire protection concerns are reviewed and approved by the AMWTP FPE.

5.5 Emergency Planning

The emergency planning for WMF-610 is the same as that for the entire AMWTP. For specific information on emergency planning for WMF-610, see the AMWTP Emergency Plan/RCRA Contingency Plan (MP-EP&C-12.1). The Emergency Plan/RCRA Contingency Plan for the AMWTP contains the implementing documents for emergency response for the AMWTP and is written to comply with requirements that are in addition to those of Hazardous Waste Management Act of 1983, as amended (HWMA)/RCRA. The INL base plan organization has been followed in this plan to provide integration of the AMWTP Emergency Plan/RCRA Contingency Plan with the existing INL emergency plans as well as with the U.S. Department of Energy, Idaho Operations Office (DOE-ID) Emergency Organization to ensure coordination of notification and response activities.

5.6 Fire Suppression Systems

WMF-610 is equipped with a wet-pipe fire suppression system designed to meet NFPA 13 requirements for Ordinary Hazard Group 2, 0.19 gpm/per ft^2 over the most remote 1,500 ft^2 in the high bay; and Ordinary Hazard Group 1, 0.16 gpm/per ft^2 over the most remote 1,500 ft^2 for the remainder of the building. At the time of this report, the airlocks are not provided with automatic sprinkler coverage. The sprinkler heads are rated at 165ºF with the exception of high temperature heads in the mechanical Room 103. An antifreeze loop protect the normally unheated portions of the building to include Mechanical Room, Generator Room, Electrical Room, and Super HENC trailer. The sprinkler system design criterion is consistent with NFPA 13 requirements for the configuration of the hazards in the building. Table 1 provides a summary of the WMF-610 Fire Suppression system

Table 1. Summary of Fire Suppression for WMF-610.

<table>
<tr><td rowspan="2">WMF-610</td><td rowspan="2">Wet Pipe System
(Alarm Check)</td><td>High Bay
0.19 gmp/ft^2 over 1,500 ft^2</td><td rowspan="2">Hose Stream Allowance
250 gpm</td><td>High Bay
643 gpm @ 67.3 psi</td></tr>
<tr><td>Rest of Building
0.16 gpm/ ft^2 over 1,500 ft^2</td><td>Rest of Building
634 gpm @ 67.7 psi</td></tr>
</table>

A building water demand requirement of 1,500 gpm at 20 psi has been established for the facility for a duration of 2 hours. This figure represents the minimum fire flow requirement for the airlocks as defined by the UFC and is considered adequate to manually combat the MPFL fire scenario.

The building is provided with Class ABC dry chemical fire extinguishers in accordance with NFPA 10, Portable Fire Extinguishers.

Currently, neither the north nor the south airlock is provided with suppression. Both areas are used for characterization operations. These areas require sprinkler coverage.

5.7 Passive Fire Protection Systems

The only passive fire protection features associated with are the fire barriers that separate the mechanical room, generator room, and electrical room from the remaining portions of the building. The barriers including all through penetrations and openings, satisfy UBC criteria for 1- to 2-hour rated construction. The barriers are intended to contain a fire to the room of origin. See the recommendation as stated in Section 5.1.

5.8 Smoke Control and Heating, Ventilating, and Air Conditioning Systems

The system is not designed, nor required to provide smoke control functions.

6.0 PROGRAM DOCUMENTATION

6.1 Currency and Completeness of the Fire Hazards Analysis

This is the first combined FHA/FSA for WMF-610. The issues identified in the stand alone FHA have been addressed in this document.

6.2 Previous Facility Appraisal Reports

No previous facility appraisal reports exist; however, there is one previous FHA. All findings and recommendations are addressed in this document.

6.3 Review of Temporary Protection and Interim Compensatory Measures

All fire protection systems in WMF-610 are in service. Until suppression can be installed in the airlocks, compensatory measures (as specified by the AMWTP Fire Protection Engineer) include a fire watch during normal operations. When suppression installation is complete, a fire watch will no longer be required.

6.4 Status of Findings from Previous Assessments

Finding 1: The airlocks are not protected by a fire suppression system. The fire alarm system needs to be extended to cover the airlocks. It should be provided with sprinkler protection or implement administrative controls to restrict combustible material storage from airlock areas.

The north and south airlocks are currently being used for characterization operations. As a result, protection is required in these areas. Compensatory measures are allowed until automatic suppression can be installed. With compensatory measures in place, this finding should not preclude operations taking place within WMF-610. This finding is open.

6.5 Evaluation of Administrative Controls

Administrative controls are in place for the north and south airlocks in WMF-610. Administrative controls include:

- Storage and/or operations within the airlock portions of WMF-610 shall be reviewed by the AMWTP Facility Fire Protection Engineer.
- While waste containers are within the RTR trailer and/or south airlock, a designated fire watch shall be constantly present in the RTR trailer or near the south airlock. While waste containers are within the north airlock, a designated fire watch shall be constantly present in the RTR trailer or near the north airlock.
- Within the RTR trailer and Super HENC, operations shall only take place during daylight hours with the control room doors open unless an alternative, supplemental battery powered lighting is available the RTR trailer and/or Super HENC.

6.6 Documentation of Exemptions and Equivalencies

Currently, MP-ISIH-2.49, Fire Protection Program, provides for several methods of documenting variances from codes and standards. Equivalencies are submitted to DOE-ID, for review and approval, and usually address major items. Smaller items are addressed internally through the use of Form-1746, Authority Having Jurisdiction (AHJ) Record, sheets.

Currently, there are not equivalencies associated with WMF-610. One AHJ record is in place. This AHJ record grants relief in regards to drainage and containment in the south airlock and has been approved by DOE-ID.

7.0 OPERATIONS AND MAINTENANCE

7.1 Review and Evaluation of Procedures for Inspection, Maintenance, and Testing

The inspection, testing and maintenance of the fire protection systems was reviewed as part of this FHA, the following surveillances are conducted by either a trained and qualified fire protection engineer or trained and qualified subcontracted personnel:

- Monthly fire extinguisher inspection
- Monthly valve line-up inspection
- Monthly combustible loading inspection (included with fire extinguisher inspection)
- Monthly test of the emergency notification system
- Quarter/semi-annual/annual water based fire protection system surveillance based on NFPA 25, Standard for Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
- Five-year flushing examination of the sprinkler piping
- Annual inspection of the fire doors/fire walls.

No deficiencies were noted during the review of this program.

7.2 Review and Evaluation of Corrective Actions and Work Order Priority

The storage of RCRA waste and the associated RCRA permit ensure that all deficiencies at WMF-610 are addressed promptly. No pending corrective actions affect fire protection at WMF-610.

7.3 Fire Protection Engineering Staffing

Fire protection engineering consists of FPEs, meeting the requirements of a qualified FPE, as defined by DOE. Staff augmentation has been provided as needed.

Inspection, testing, and maintenance function for both the fire alarm system and fire suppression systems.

System Engineers for the fire alarm system and for the water based suppression systems have been identified.

7.4 Facility Management Support of the Fire Protection Program

Management is supportive of the fire protection program and is actively involved in the evaluation of deficiencies encountered during formal and routine safety and fire protection inspections. Management has aggressively pursued resolution of fire protection issues as they have arisen.

7.5 Summary of Identified Deficiencies

7.5.1 Deficiencies Related to U.S. Department of Energy Orders

None

7.5.2 Deficiencies Related to National Fire Protection Association Standards

Per the requirements of NFPA 801, Section 6.7, fire suppression systems are required for the north and south airlocks in the building. The FHA has determined that because radioactive materials are handled and/or staged in the north and south airlocks, these areas require

7.5.3 Deficiencies from Other Codes

None

7.5.4 Deviations from Good Practice

None

8.0 DEFICIENCIES

8.1 Recommendations

This revision of the FHA consolidates all prior design and occupancy information. As of the date of this report, all current information has been incorporated into the FHA.

There is a 3-year review cycle, or a review when the building has a change of occupancy, process or significant modification for this FHA/FSA, which will be coordinated through the AMWTP FPE.

8.2 Deficiencies

At the time of this report, there were no new findings or recommendations.

8.3 Deficiency Table

A deficiency table will not be completed as a part of this report.

8.4 Exemptions and/or Equivalencies

There are no exemption associated with AMWTP. Two equivalencies have been approved and they are:

1. Per DOE-ID letter EM-AMWTP-02-032, dated August 14, 2002, Approval of AMWTP equivalency request for the TSA-RE Fire Suppression System Operability is granted and given equivalency file number DOE-ID-FPEQ-AMWTP-02-01.

2. Per DOE-ID letter EM-AMWTP-04-078, dated May 20, 2004, Approval of AMWTP equivalency request for Contract No. DE-AC07-97ID13481, Advanced Mixed Waste Treatment Project Testing on the AMWTP Water Mist Fire Protection Systems is granted and given equivalency file number DOE-ID-FPEQ-AMWTP-04-02.

9.0 DEFINITIONS

None

10.0 REFERENCES

AMWTP-RPT-DSA-02, Rev. 4, Advanced Mixed Waste Treatment Project Documented Safety Analysis, June 2006.

DOE-ID Architectural Engineering Standards,

DOE-ID letter EM-AMWTP-02-032, Approval of AMWTP equivalency request for the TSA-RE Fire Suppression System Operability (equivalency file number DOE-ID-FPEQ-AMWTP-02-01)

DOE-ID letter EM-AMWTP-04-078, Approval of AMWTP equivalency request for Contract No. DE-AC07-97ID13481, Advanced Mixed Waste Treatment Project Testing on the AMWTP Water Mist Fire Protection Systems (equivalency file number DOE-ID-FPEQ-AMWTP-04-02)

DOE O 420.1B, 2005, Facility Safety, U. S. Department of Energy, December 22, 2005.

DOE O 440.1A, 1998, Worker Protection Management for DOE Federal and Contractor Employees, U.S. Department of Energy, March 27, 1998.

DOE-STD-1027, 1992, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, U.S. Department of Energy, December 1992.

DOE-STD-1066, 1999, Fire Protection Design Criteria, U.S. Department of Energy, July 1999.

EDF-RWMC-696, Evaluation of the Acceptability of Using Plastic Spacers as Part of the Drum Storage Array and the Storage of Fiberglass Reinforced Plywood (FRP) Boxes in the Type II Storage Modules with the Current Fire Protection System Design.

EDF-RWMC-806, Fiberglass Reinforced Plywood (FRP) Boxes Fire Hazards Analysis.

EPIP- 4.1, RWMC Emergency Plan Implementation Procedure (EPIP).

ICC, 2003a, 2003 International Building Code, ISBN 1892395266, International Code Council, Falls Church, Virginia.

ICC, 2003b, 2003 International Fire Code, ISBN 1892395304, International Code Council, Falls Church, Virginia.

MP-CMNT-10.6.2, Fire Protection System Impairment

MP-CMNT-10.18, Inspection, Testing, and Maintenance of Fire Protection System and Equipment

MP-EP&C-12.1, AMWTP Emergency Plan/RCRA Contingency Plan

MP-ISIH-2.32, Housekeeping

MP-ISIH-2.47, Developing Fire Hazards Analyses, Fire Safety Assessments, and Abbreviated Fire Assessments

MP-ISIH-2.48, Fire Protection Exemptions and Equivalencies

MP-ISIH-2.49, Fire Protection Program

NFPA 10, Standard for Portable Fire Extinguishers, National Fire Protection Association.

NFPA 13, Standard for the Installation of Sprinkler Systems, National Fire Protection Association.

NFPA 20, Installation of Stationary Pumps for Fire Protection, National Fire Protection Association.

NFPA 24, Installation of Stationary Pumps for Fire Protection, National Fire Protection Association.

NFPA 25, Standard for Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, National Fire Protection Association.

NFPA 54, National Fuel Gas Code, National Fire Protection Association.

NFPA 58, Liquefied Petroleum Gas Code, National Fire Protection Association.

NFPA 70, National Electric Code, National Fire Protection Association.

NFPA 72, National Fire Alarm Code, National Fire Protection Association.

NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, National Fire Protection Association

NFPA 101, Life Safety Code, National Fire Protection Association.

NFPA 231, Standard for General Storage, National Fire Protection Association.

NFPA 701, Fire Resistance Criteria, National Fire Protection Association.

NFPA 780, Installation of Lightning Protection Systems, National Fire Protection Association.

NFPA 801, Standard for Fire Protection for Facilities Handling Radioactive Materials, National Fire Protection Association.

R. Brown, DOT 7A FRP Box Fire Test at the INEEL, TREE-1367, EG&G Idaho, Inc.

Stonhill, D. G. N., E. B. Gosswiller, D. N. Whitaker, W.S. Schum, 2001, INEEL Fire Department Emergency Response Baseline Needs Assessment, INEEL/INT-05-02628, Rev 0.

T. L. Clements Jr., and D. E. Kudera, TRU Waste Sampling Program; Volume I – Waste Characterization, EG&G-WM-6503, EG&G Idaho, Inc.

T. L. Clements Jr., and D. E. Kudera, TRU Waste Sampling Program; Volume II – Gas Generation Studies, EG&G-WM-6503, EG&G, Idaho, Inc.

T. L. Clements, Jr., Content Code Assessment for INEEL Contact-Handled Stored Transuranic Wastes, WM-FL-82-021.

WHD-SD-SQA-ANAL-501, Fire Protection Guide for Waste Drum Storage Arrays, Rev. 0, Westinghouse Hanford Company.

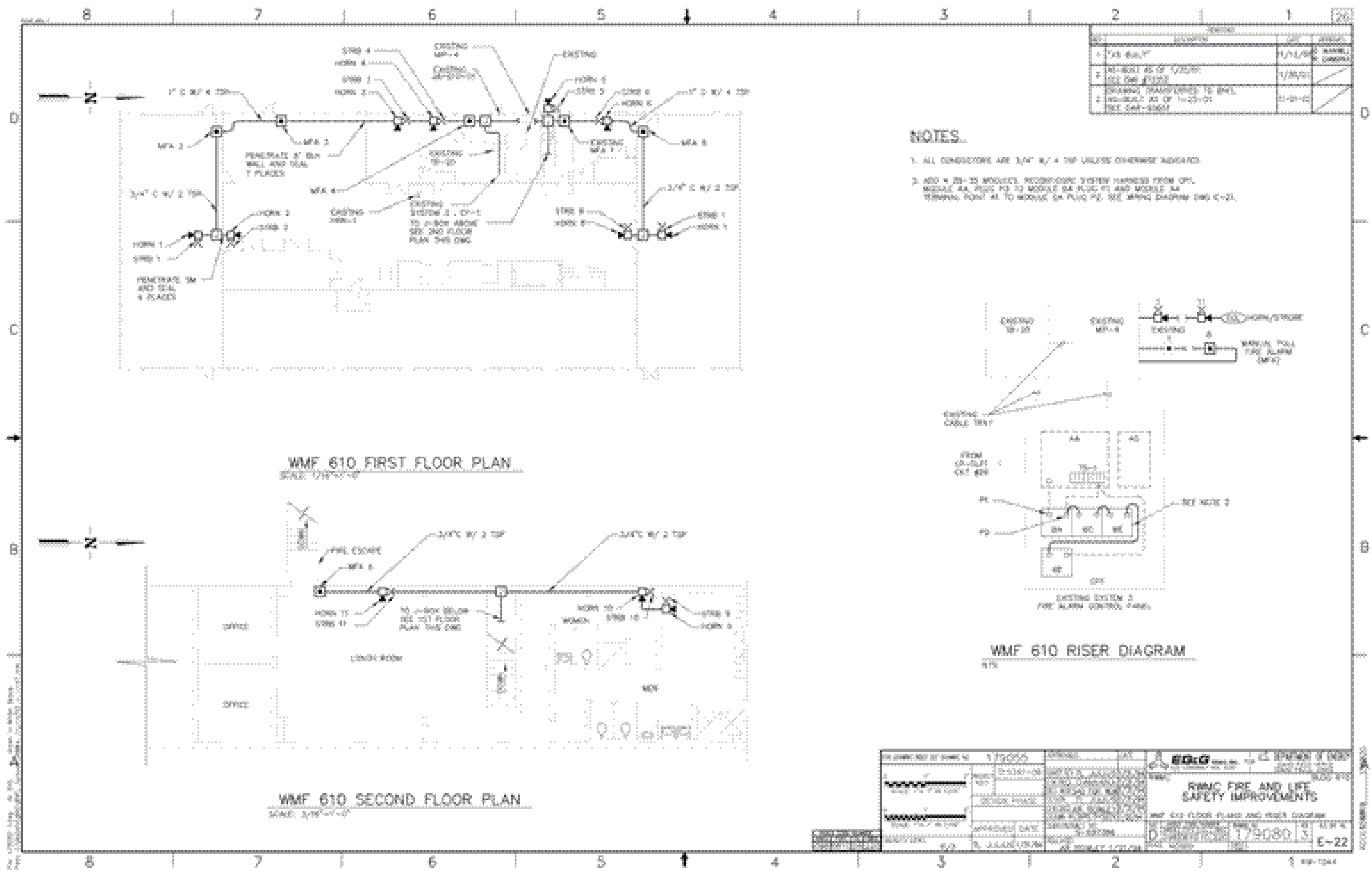
11.0 APPENDIXES

Appendix A, Drawing 179080, RWMC Fire and Life Safety Improvements

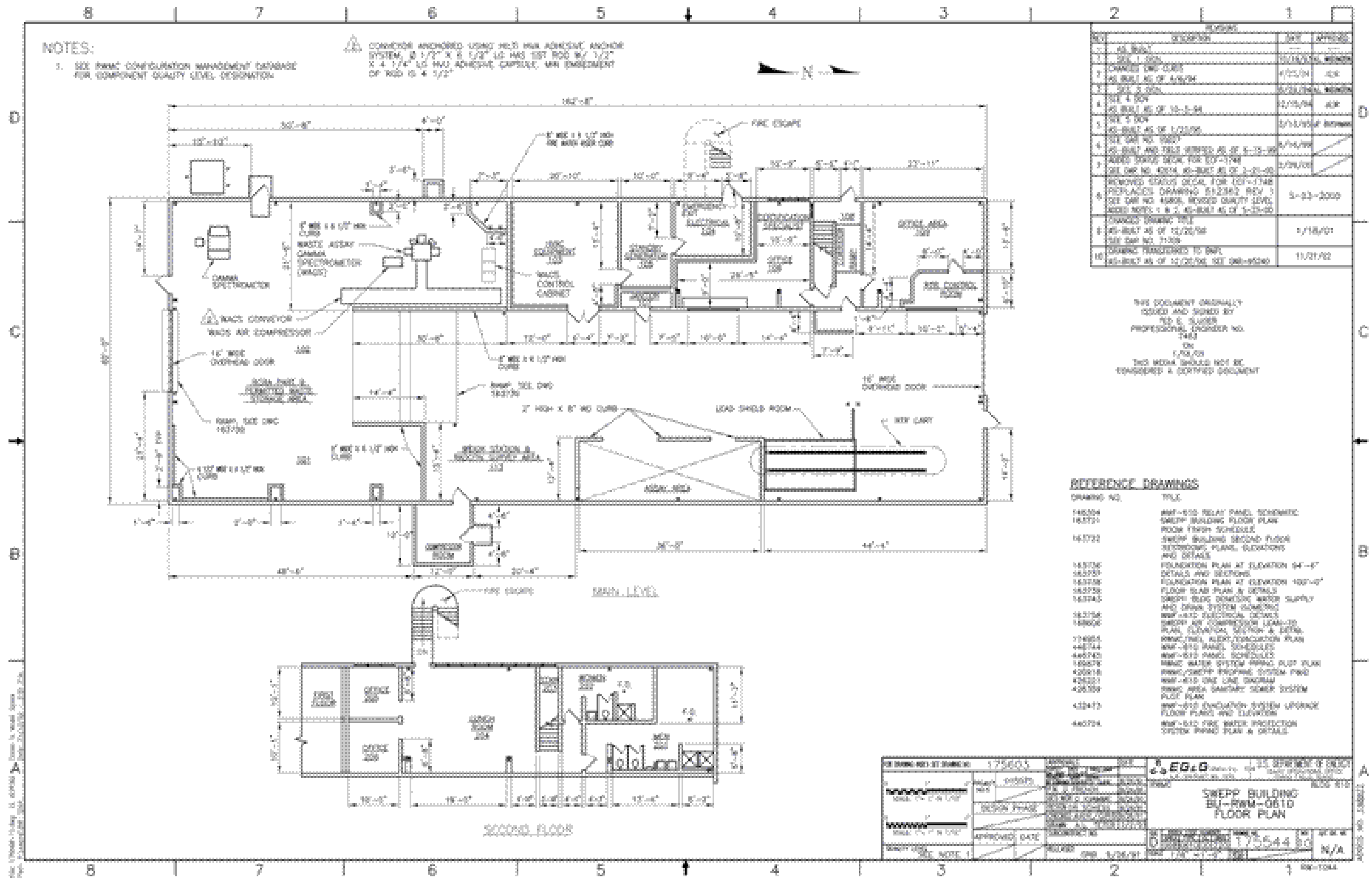
Appendix B, Drawing 11554, SWEPP Building BU-RWM-0610 Floor Plan

Appendix C, Drawing 163752, SWEPP Building Lighting Plan

Appendix A – Drawing 179080, RWMC Fire and Life Safety Improvements



Appendix B – Drawing 11554, SWEPP Building BU-RWM-0610 Floor Plan



Appendix C – Drawing 163752, SWEPP Building Lighting Plan