

# **FIRE HAZARDS ANALYSIS**

**FOR**

**BUILDING 9116**

**AT**

**Y-12 PLANT, OAK RIDGE, TENNESSEE**

[PREPARED AS A MODEL FHA  
FOR A NEW FACILITY]

March 1993  
REV. 5

PREPARED FOR  
DEPARTMENT OF ENERGY

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**AT**

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Prepared by:           -S-          

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Date: March, 1993

## EDITOR'S NOTE

This document was prepared under the requirements of DOE Order 5480.7A which was in effect during the preparation and review cycle. It is intended to represent a typical analysis for a simple new facility. DOE Order 5480.7A has subsequently been replaced by DOE Orders 420 and 440.1 as well as Implementation Guide G-420/440.1, which contain requirements and guidance for Fire Hazards Analyses and Fire Protection Assessments similar to those in DOE Order 5480.7A. One exception is that Fire Hazards Analyses would no longer be required for new facilities unless they contained hazardous material or high value equipment. While a Fire Hazards Analysis would not be required for Building 9116 under the new orders, this model may continue to be used for guidance at those sites that have not implemented the new orders and as generic guidance for writing a relatively simple Fire Hazards Analysis.

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## **1.0 INTRODUCTION**

### **1.1 Purpose**

This analysis is intended to provide a comprehensive evaluation of the risks from fire and fire related perils in Building 9116 at the Oak Ridge Y-12 Plant. The analysis has been prepared in accordance with the criteria listed in DOE Order 5480.7A.

### **1.2 Approach and Assumptions**

The approach taken to complete this evaluation involved identification of the fire risks present in the buildings, identification of the equipment present and its value to DOE, identification of the fire barriers and related materials used for the construction of the buildings, identification of the fire protection systems and equipment installed in the buildings, a determination of the adequacy of these systems, and a determination of the adequacy of the exit system in the buildings. After this data was collected, an analysis was performed to determine the relative nature of the fire risks present, whether the installed fire protection is adequate to effectively control these risks, and finally, a determination was made of the potential fire damage that could possibly occur in the building. Concerns such as the life safety of the building occupants and possible environmental damage from a fire incident were essential considerations in the evaluation.

The information presented in this report is based upon site documentation, construction plans and specifications, and a field inspection of the building. Waterflow test results were taken from the files of the site fire protection engineering group. No actual flow tests were conducted. Information regarding the HVAC systems and their operation was determined from construction documents and verified by the building mechanical supervisor. Specific fire protection engineering data were obtained from the Y-12 Plant fire protection engineering group.

### **1.3 Limitations**

This FHA has been prepared based upon the current occupancy, arrangement, and fire hazards in the building. This includes an evaluation of the equipment, chemicals, flammable and combustible materials, and hazards present. If occupancy changes, arrangement modified, different equipment, or significantly increased quantities or types of hazardous materials are introduced to the facility, the evaluation may be invalid.

### **1.4 Facility Use, Function, Occupancy**

Building 9116 is a two story office building that is occupied by approximately 70 personnel. The

building is used as offices for the Health, Safety, Environmental, and Accountability Division. There is no central data processing center, and no rooms with a large number of personnel or valuable equipment. The building is mainly enclosed offices, with a small break room, a copier room, a mechanical closet, and a janitor's closet on each floor.

This building is classified as a new Business occupancy per the Life Safety Code, and classified as a B-2 Business occupancy per the UBC.

### **1.5 General Site Fire Protection**

The fire protection for the Y-12 Plant, which is pertinent to Building 9116, consists of a site wide fire alarm system, a fire service main and water supply, and a site fire department. All are adequate for this building. Refer to Reference (a) for further details on plant's fire protection features.

## **2.0 CONSTRUCTION**

### **2.1 Description of Facility**

Building 9116 is a two story steel frame and brick veneer building constructed to codes and standards in effect in 1990. Due to the slope of the plant site, the first floor is at grade level on the south side of the building, while the second floor is located at grade on the north side. Another direct exit door is located on the first floor on the west side of the building. The bottom level of the building is constructed with poured concrete walls with a brick outer veneer. The first level floor assembly consists of concrete on fluted steel pans and bar joist on load bearing walls for support. With a suspended ceiling in place, this assembly conforms to UL Design G201 and provides a one hour fire rating. The second floor does not have interior concrete walls, but has gypsum board and metal studs walls. The brick veneer is attached directly to the exterior walls. The roof assembly does not incorporate steel bar joists for support. The roof is a flat built up membrane over a fluted steel deck supported by the main building beams. The roof construction is a FM Approved Class I assembly. Interior partitions are gypsum board and metal studs. The corridor walls around the mechanical (HVAC) room and electrical closets are slab to slab. Other corridor walls extend only to the suspended ceiling. The occupied areas have a suspended acoustical tile ceiling. The type of construction is considered to be Type II (000) as specified by NFPA 220 or Type II-N per the Uniform Building Code (UBC). The approximate gross area per floor is 6,525 square feet. Floor plans are provided in Appendix A.

Building 9116 is served by a roof mounted heat pump unit. An air handler is installed in the first floor mechanical (HVAC) room. This room extends from the ground floor through the second story to the roof. From the mechanical room, heated or cooled air is ducted to the various rooms in the building. The return air ducts are located above the suspended ceiling. Fire dampers are installed in the ducts where they penetrate fire barriers, such as in the walls of the mechanical (HVAC) room. Duct mounted smoke detectors are provided to stop the fans upon detection of smoke. This arrangement conforms to

NFPA 90A, and is considered adequate.

## **2.2 Fire Boundaries**

This building is basically one fire area based upon the DOE definition of Fire Area, which states that the area must be bounded by construction having a minimum fire resistance rating of 2 hours with openings properly protected. However, the first and second floors are separated by a floor/ceiling assembly having a 1 hour fire resistance rating (UL G201) for conformance to the Uniform Building Code. The main stairway is isolated by one hour fire rated gypsum board barriers and self closing Class B, 1-1/2 hour rated fire door assemblies. A small lobby area has been constructed from the stairway door on the first floor to the exterior door of the building. Fire doors, rated for 45 minutes for the Class C openings, have magnetic holders, operated by smoke detectors. These detectors are installed in the corridor to isolate the exit enclosure from the interior corridor. The mechanical (HVAC) room is isolated by one hour fire rated gypsum board construction. The electrical equipment room and the janitor's closet on each floor are separated by one hour fire rated gypsum board construction. Corridor walls in the office areas extend only to the non-rated suspended ceiling, which is noncombustible construction. Fire rated corridors are not required in the building per NFPA 101, since the business occupancy is under common management. The office doors are wood without closers. The fire separations in this building provide an adequate level of protection for the fire hazards present, and provide an adequate level of life safety for the building occupants. The fire separation meets NFPA 101, Uniform Building Code, and DOE criteria.

## **2.3 Interior Finish Materials**

The interior finish in the building includes painted drywall and commercial grade carpeting. The wall and ceiling tile materials provide a Class A interior finish rating. The carpeting in a Business occupancy office area and corridors has a Class I interior floor finish rating per NFPA 101. The interior finish materials meet NFPA 101 requirements, and provide an adequate level of protection for the building occupants.

## **3.0 LIFE SAFETY**

### **3.1 Types of Occupancy**

This building is classified as a new Business occupancy by NFPA 101.

### **3.2 Means of Egress**

Building 9116 is served by two exits on each level. The stairway from the second floor discharges to the first floor corridor, however, 3/4 hour rated fire doors for Class C openings have been installed to form a protected means of egress. The doors are held open by magnetic holders that are automatically

released by smoke detectors located on each side of the doors. The exit capacity significantly exceeds the occupant load of 65 persons per floor calculated according to Section 26-1.7.1 of NFPA 101-91. Therefore, the exit capacity is acceptable. The remote exits are separated by a straight line distance of 58 feet. The overall building diagonal is 116 feet. The exit remoteness is therefore acceptable for a non-sprinkler protected building.

The means of egress for this building comply with NFPA 101, meets the UBC exit requirements, and are adequate for the protection of the building occupants.

### **3.3 Emergency Lighting and Exit Signs**

Battery pack emergency lighting units are used for the illumination of the primary exit paths. Illuminated exit signs are installed above the exit doors and in the exit corridors. The provisions for emergency lighting and the locations of the exit signs are adequate and provide a level of protection consistent with the criteria of NFPA 101.

### **3.4 Security Interface**

There are no impediments created by the security system that would prevent timely evacuation of Building 9116.

## **4.0 FIRE HAZARDS**

### **4.1 Identification of Significant Fire Hazards**

There are no significant fire hazards in this facility.

The potential fire hazards and fire loading in the complex are those of a typical office occupancy. Office furniture, personal computers, bookcases, technical publications, and metal file cabinets are found in most rooms. A break room with small appliances, such as toaster ovens, is located on each floor of the building. The doors to the break rooms are usually kept open. Electrical switchgear and breaker panels are located in separate rooms on each floor. No unusual concentrations of combustibles were observed. All electrical conduits are metal.

### **4.2 Natural Hazards Impact on Fire Safety**

Building 9116 is designed for an extreme wind speed condition, as required by the building code. However, an occurrence of a natural hazard such as an earthquake or tornado would result in structural damage to the building, with possible short circuiting of the building electrical distribution system. There

are no natural gas lines or hazardous gases or liquid stored in this building. The increased fire risk to this building from a natural hazard is minimal.

### **4.3 Analysis of Potential Fire Scenarios.**

Based upon the fire hazards listed in Section 4.1, several potential fire scenarios can be postulated. A fire can be postulated in an office caused by an unattended space heater. If the fire occurs after hours and the office door left open, it is possible that the fire will involve the room of origin as well as adjacent corridor areas. Depending on the location of the fire, the limited smoke detection capability in the building may result in delayed detection. It is possible that the fire could burn for a long period before it is detected by the fire alarm system or discovered by passers-by. Similar scenarios can be postulated for a fire originating in a mechanical space, however, because these areas are separated by one hour fire rated construction, the fire is expected to be confined to the room of origin. The most severe fire is projected in a copier room, ignited by an electrical short circuit, equipment malfunction or other similar local source. These areas have fairly high combustible loading due to the boxes of copier paper stored in and near the rooms. The doors to these areas are usually left in the open position, which will increase the potential for fire spread. An uncontrolled fire occurring in a copier room is expected to cause fire damage to the room of origin as well as to several adjacent rooms, and smoke damage to a majority of the floor, before the fire department arrival. The maximum fire size in this business occupancy is expected to be less than 5 MW for a peak rate of heat release. Fires caused by other ignition sources would likely be of a similar order on magnitude.

Any postulated fires will evolve smoke into the return plenum ceiling. After some time, this smoke will be recirculated in sufficient quantities to reach the duct smoke detectors which will stop the HVAC fans, and transmit fire alarm signal to the fire department. The time required for the smoke detectors to activate is dependent on the type of fire, the nature of the combustibles, dilution of smoke in the HVAC system from non-fire areas, and the operating cycle of the HVAC system. In some cases, the smoke spread could be extensive.

### **4.4 Exposure Fire Potential**

Building 9116 is approximately 75 feet from the adjacent buildings. These buildings are also noncombustible office buildings which present a low exposure hazard. This spatial separation exceeds the recommended separation in NFPA 80A.

### **4.5 Potential for Toxic, Biological, or Radiation Incident**

#### **4.5.1 Criticality, Radioactive Materials, and Contamination**

None

#### **4.5.2 Chemical, Corrosive Agents, and Other Special Hazards**

None

#### **4.5.3 Offsite Impact**

None

#### **4.6 Runoff/Containment of Fluids**

In the event of a fire, runoff from fire fighting hose streams would drain out of the building and towards the south, due to the existing slope at this location. A system of storm drains is installed at the plant site. The runoff would enter the storm drain system. No fixed diking or other fluid containment barriers are provided in this building. In the event of fire, lack of early detection and localized suppression will likely increase the amount of water used for fire fighting activities and the subsequent release. Because there are no hazardous materials in this building, the impact of the runoff would be insignificant.

### **5.0 FIRE PROTECTION**

#### **5.1 Water Supply and Distribution System**

Local eight diameter inch mains in the section of the plant where Building 9116 is located is supplied by two sixteen inch diameter lines and two ten inch lines, which are supplied by multiple feeds from two independent water sources as described in Reference (a). Three hydrants serve the area. Hydrant 310, and Hydrant 311 are on the eight inch diameter line in front of the building along First Street. Hydrant 214 is on the eight inch line on the east side of the building. Isolation valves are provided, and adequately spaced on the fire water distribution system.

Water flow tests performed on the yard main in the vicinity of Building 9116 in September, 1992 showed excellent flows and pressures. Hydrant 214, located along First Street, north of Building 9202, provided a flow of 3770 gpm at a residual pressure of 62 psi. Static pressure at Hydrant 214 was recorded at 76 psi. The fire water demand for the office building is estimated to be less than 1500 gpm, which would supply a multiple hose line attack.

#### **5.2 Fire Suppression**

##### **5.2.1 Sprinkler System**

Building 9116 is not provided with automatic sprinklers. NFPA criteria do not specify sprinkler protection for a building of this floor area, number of stories, and occupancy type. DOE criteria at the time construction was started did not require automatic sprinklers in buildings with an MPFL of less than 1 million dollars. The 1991 Factory Mutual Survey and Report of this building states that the addition of

automatic sprinkler protection for the building was "not considered economically feasible". The noncombustible construction of the building, the limited fire hazards and the satisfactory exit system provide an adequate level of protection without sprinklers.

### **5.2.2 Standpipe System**

No standpipe systems are installed in this building. Interior fire attack will be performed using fire department equipment. Access to the interior of the building is adequate for the fire department to reach all areas with a standard 200 foot pre-connected line, thus eliminating the need for an installed standpipe system.

### **5.2.3 Portable Fire Extinguishers**

Multipurpose dry chemical fire extinguishers, having 10A-60BC ratings, are installed in the corridor areas of Building 9116. Three extinguishers are installed on each level, located in each of the three corridor sections. Travel distance and extinguisher capacities are within the criteria specified in NFPA 10 for a Business occupancy.

## **5.3 Protective Signalling System**

### **5.3.1 Fire Detection System**

Building 9116 is connected to the plant wide Gamewell fire alarm system. The local control panel is located in the building by the first floor entrance on the south side of the building. This panel is a Gamewell Zans 400 model with six zones. Each manual pull station is wired as a separate zone, and so is the duct smoke detector. The alarm system includes two manual pull stations near the exits on each floor, three smoke detectors located in the first floor lobby area, one smoke detector at the top of the stair, and duct smoke detectors for the HVAC system. The four smoke detectors in the building are intended to protect the exit stairway by automatically closing the ground level doors to isolate the exit discharge from the corridors upon detection of smoke in the vicinity of the stairway. The duct smoke detectors automatically stop the HVAC system fans to limit the recirculation and spread of smoke in the building.

NFPA 101 does not require an alarm system for a Business occupancy of this number of stories and floor area. The installation of an alarm system in this building exceeds both NFPA and DOE criteria.

### **5.3.2 Manual Alarm System**

Building 9116 is connected to the plant wide Gamewell fire alarm system. Any manual pull station or smoke detector activation will automatically be transmitted to the Y-12 Plant Fire Department. Standard operating procedure is for the fire department to respond to the master box, then determine the fire location from the annunciator located at the master box.

The local alarm control panel and manual pull stations are connected to Master Box #313 located on First Street, southwest of the building.

### **5.3.3 Notification System**

The building evacuation signals are announced over plant PA system speakers installed throughout the corridors. There are no automatic local alarms or automatic announcements. All personnel alerting signals are announced over the plant PA system. This includes all site emergencies such as severe weather, radiation incidents, fires, etc. The PA system is installed in each building, as well as in the yard areas, and is routinely tested. Although the PA system is not a UL listed fire alarm audible indicating system, it is tested and used daily. This is considered to provide a acceptable level of reliability as compared to UL listed appliances that are only periodically tested. This system has a UPS secondary power supply with diesel driven generator back-up. The PA system has been evaluated by Factory Mutual at the plant and found to be acceptable to FM, and therefore equivalent to an NFPA emergency voice/alarm communication system. The fire alarm and detection system is adequate to provide notification and evacuation of personnel in the event of a fire.

### **5.4 Fire Department/Fire Brigade Response**

Reference (a) verifies that the Y-12 Plant Fire Department is trained and equipped to handle any fire that could occur in a building the size of Building 9116.

Pre-fire plans have not been prepared for this small office building. Due to the uncomplicated nature of the building, and lack of hazardous materials, contamination, and fire department connections for installed systems, no pre-fire plans are considered necessary.

Based upon a review of the Y-12 Plant Fire Department response records over the last 12 months, the response time for the fire department to Building 9116 is less than 2 minutes from the receipt of the alarm or call. The distance from the fire station to the building is approximately 1/4 mile. Building 9116 is accessible by the fire department apparatus on the north, east, and south sides of the building. Three hydrants serve the area. Hydrant 310, and Hydrant 311 are on an eight inch line in front of the building along First Street. Hydrant 214 is on the eight inch line on the east side of the building. Isolation valves are provided, and adequately spaced on the fire water distribution system.

There is no fire brigade for this building, nor is one needed.

## **6.0 FACILITY EQUIPMENT AND PROGRAM PRESERVATION**

## **6.1 Protection of Essential Safety Class Systems**

No essential class safety systems are contained in this building.

## **6.2 Critical and Vital Programs**

### **6.2.1 Identification of Vital Programs Impacted**

The relative fire hazard in this building is low. In the event of a fire, the extent of fire damage and resultant downtime will depend on the length of time an incipient fire can burn before it is discovered. Without the benefit of automatic sprinkler protection or building wide smoke detection, it is anticipated that the postulated credible fires will cause the facility to be down for a period of 3 to 6 months, with the loss of non-critical records and software that are not duplicated elsewhere. The operations in this building do not perform a unique purpose. It is an office building, which if damaged, would result in displacement of office employees with loss of employee work time. Office space at the plant is very limited with alternative work stations not available.

### **6.2.2 Identification and Protection of Critical Process Equipment.**

No critical process equipment is located in this building.

## **6.3 Identification and Protection of High Dollar Equipment**

The only equipment in this building with a high dollar value is the secured computer network which is routed throughout the corridors. An exact value on this equipment is not available, but it is estimated by the authors to be less than \$100,000. Based upon this value, the building's computer network is adequately protected.

## **6.4 Facility Damage Potential**

### **6.4.1 Maximum Credible Fire Loss**

The MCFL, (i.e., loss with automatic system functioning, but no manual firefighting) for this building is predicted for an uncontrolled 5 MW fire occurring in a copier area after working hours. The downtime for the facility and potential loss of personal computer equipment and proprietary records located in the individual offices in the building are judged to be the largest loss. Because this building is not sprinkler protected, a fire is expected to spread to the corridor and cause fire and smoke damage to most offices on the floor of origin, with expected structural damage to the building. The MCFL considering this, is estimated to be \$900,000 or less. This is based upon the Y-12 Plant Finance Department's replacement value for the building of \$560,000. The contents are estimated at \$280,000 for the office equipment and furnishings. Clean up costs associated with an office building fire, less the salvage value, in a non-radiological area having no hazardous chemicals is estimated at \$60,000. This MCFL

represents an extreme case, with no fire department suppression efforts. For most cases, it is not expected that a fire of this magnitude would occur without intervention. During normal working hours, the fire would be discovered by personnel in the building, and the site fire department would be able to respond and extinguish the fire before significant damage occurred.

#### **6.4.2 Maximum Possible Fire Loss**

The MPFL (i.e., loss with no manual or automatic suppression) for this building is the same as the MCFL, as there is no installed fire extinguishing system.

#### **6.5 Emergency Planning**

Emergency planning at the Y-12 Plant is carried out by the site Emergency Preparedness department. This group has responsibilities in alarm notification and building evacuation, spill prevention and control, security planning, and other emergency operations. There are no specific pre-fire plans for this building, and it is not addressed in the emergency plan.

#### **6.6 Security Coordination**

The fire department responds to fire emergencies from a station located inside the protected area of the plant. Standard operating procedures are in place to assure that the emergency response through security gates is not delayed exiting the protected area. The security provisions for this building would have no adverse impact on the fire fighting operations.

### **7.0 CONCLUSION**

Building 9116 generally complies with the applicable DOE fire protection orders.

Building 9116 has no major fire protection deficiencies. The level of protection provided in this building is considered to present an acceptable level of risk, without the need for additional fire protection measures.

### **8.0 RECOMMENDATIONS**

There are no serious fire hazards in Building 9116 requiring correction.

Recommendations to correct minor deficiencies are found in the Fire Protection Assessment for Building 9116.

## **9.0 REFERENCES**

- (a) "Site-Wide Fire Protection Features", Y-12 Plant, Y/XP-198, dated February 10, 1992.
- (b) Fire Protection Assessment for Building 9116, dated March, 1993
- (c) Y-12 Plant Emergency Plan, dated July, 1992

**APPENDIX A**  
**BUILDING 9116 FLOOR PLANS AND SITE PLAN**

## **APPENDIX B**

### **QUALIFICATIONS OF AUTHORS**

Randall Eberly: B.S. degree in Fire Protection Engineering from the University of Maryland; Registered Professional Fire Protection Engineer; 21 years experience in fire protection engineering as a private consultant and as an employee of the Nuclear Regulatory Commission, U.S. Coast Guard, Tenera, and Events Analysis.

Robert O'Laughlin: B.S. degree in Fire Protection Engineering from the University of Maryland; Registered Professional Fire Protection Engineer; Certified Safety Professional; 32 years experience in fire protection engineering as a private expert and as an employee of Professional Loss Control, Union Carbide, and the Tennessee Valley Authority.