CHAPTER 9: AUXILIARY SYSTEMS

9.1 FUEL STORAGE AND HANDLING

9.1.1 New-Fuel Storage

9.1.1.1 Design Bases

The new-fuel storage racks, as shown in Figure 9.1-1, are designed to maintain sufficient spacing between the new-fuel assemblies under fully loaded conditions to ensure that the array will limit the effective multiplication factor (k_{eff}) to ≤0.90 for the dry condition and to ≤ 0.95 in the event of complete flooding of the storage vault. New-fuel storage racks are supplied for 30 percent of the full core fuel load.

These racks are designed to withstand combined loadings, including impact and seismic disturbance, to ensure against damage to the racks or distortion of the fuel storage arrangement.

The new-fuel storage vault is designed to preclude flooding of the new-fuel assemblies.

9.1.1.2 Facilities Description

9.1.1.2.1 New-Fuel Storage Vault

After receipt, uncrating, and transfer to the operating floor, the new fuel may be placed in dry storage in racks. These racks are contained in a Category I new-fuel storage vault. The new fuel may be placed in the new fuel storage vault, provided criticality concerns are addressed as outlined in letter EF2-61,906. The vault, shown in Figure 9.1-2, accepts 23 new-fuel storage racks, each of which accommodates 10 new-fuel assemblies. The 230-assembly capacity of the vault amounts to 30 percent of the 764 assemblies in the reactor. The vault dimensions are shown in Figure 9.1-2.

The vault is closed at the top by a shield plug 12 in. thick. The shield plug is divided into five sections, each with redundant lifting rings. The openings and shield plugs are steel lined. The plugs extend 4 in. above the refueling floor. The vault floor slopes to an open drain located in the center of the vault floor.

The new-fuel vault is served by the reactor building crane.

9.1.1.2.2 New-Fuel Storage Racks

The new-fuel storage racks provide a place for storing new fuel in the new-fuel storage vault, as shown in Figure 9.1-1. The location of the new-fuel storage vault within the station complex is shown in Figure 9.1-3. Each new-fuel storage rack holds up to 10 channeled or unchanneled fuel assemblies in a row, spaced nominally 6.625 in. apart, center-to-center.

The new-fuel storage racks are designed so that arrangement in rows on a nominal 11.5-in. center-to-center spacing between rows limits the k_{eff} of the array to ≤ 0.90 for the dry condition. The k_{eff} is ≤ 0.95 in the event of complete flooding of the storage vault. The fuel assemblies are loaded into a rack through a hole in the top of each rack. Each hole for a fuel assembly has adequate clearance for the insertion or withdrawal of the assembly while enclosed in a protective plastic wrapping. Guides are provided to guide the fuel element spacers the full length of their insertion into the rack so that damage to the fuel assemblies is precluded. The spacers and the upper tie plate of the fuel element rest against the rack to provide lateral support. The design of the racks prevents accidental insertion of the fuel assembly in a position not intended for the fuel. The weight of the fuel assembly is supported by the lower tie plate which is seated in a chamfered hole in the rack base. The new-fuel racks can withstand an upward force of 6000 lb.

9.1.1.3 Safety Evaluation

Calculations of k_{eff} are based upon the geometrical arrangements of the fuel array, and subcriticality does not depend upon the presence of neutron-absorbing materials. The arrangement of the fuel assemblies in the fuel storage racks results in a k_{eff} below 0.90 in a dry condition or in the absence of moderator. In an abnormal condition, if the fuel array were to be flooded with water, k_{eff} would not exceed 0.95. The criticality analysis for initial licensing of the new-fuel storage vault is provided in Reference 1. Use of the new fuel storage vault is currently restricted as discussed in Section 9.1.1.2.1.

The new-fuel storage racks are designed to meet Category I requirements as described in Section 3.2. Stresses in a fully loaded rack will not exceed stresses specified by ASTM Specifications (B108, B179, B209, and B221) on light-weight metal alloys when subjected to a 1.5g horizontal acceleration.

The storage rack structure is designed to withstand the impact resulting from a falling object possessing 2000 ft-lb of kinetic energy. The structural arrangement is such that no lateral displacement of the fuel occurs; therefore, subcritical spacing is maintained.

The new-fuel racks are designed to be restrained by hold-down bolts in case a stuck fuel assembly is inadvertently hoisted and to ensure that rack spacing does not vary under specified loads. The rack structure and hold-down bolts are designed to maintain the minimum required cell spacing due to forces that might occur if a fuel bundle were to jam in the rack during removal.

The new-fuel storage racks are made from aluminum. All welds are in accordance with GE standards which are based on ASME Section IX and ASTM Standards Part 6. The material choice is based on a consideration of the susceptibility of various metal combinations to electrochemical reaction. When considering the susceptibility of metals to galvanic corrosion, aluminum and 300-series stainless steel are relatively close together, insofar as their coupled potential is concerned. The use of stainless steel fasteners in aluminum to avoid detrimental galvanic corrosion is a recommended practice and has been used successfully for many years by the aluminum industry.

9.1.1.4 Testing and Inspection

The new-fuel storage racks do not require any special periodic testing or inspection for nuclear safety purposes.

9.1.2 Spent Fuel Storage

9.1.2.1 Design Bases

Spent fuel storage space is provided to accommodate 3590 fuel assemblies. Stainless steel high-density fuel storage racks are provided for all fuel assemblies. The spent fuel assemblies are placed in racks designed to ensure a k_{eff} equivalent of $\leq$0.95 with the spent fuel pool filled with unborated water at 68°F for both normal and abnormal storage conditions.

The calculated k_{eff} includes margins for uncertainty in the calculations, including mechanical tolerances, which are statistically combined such that the true k_{eff} will be less than 0.95 with a 95 percent probability at a 95 percent confidence level.

To ensure that the analysis followed a conservative approach, the criticality calculations for the high-density racks were performed with the following criteria:

a. Initial uniform enrichment of 4.9 weight percent ^{235}U with credit for gadolinia burnable poison normally present

b. Maximum reactivity evaluated at the point of peak reactivity over burnup

c. Both unchanneled and channeled fuel with maximum expected distortion

d. Abnormal and accident conditions considered

e. Lattice of storage racks is infinite in all directions; that is, no credit for axial or radial neutron leakage

f. Unborated water at 20°C.

To simplify the analysis, no credit is taken for:

a. Neutron absorption in minor structural members; that is, spacers and Inconel springs are replaced by water in the calculation

As indicated in Section 4.0 of Reference 1 and Section 4.0 of Reference 3, the results of the criticality analysis for the spent fuel racks show that for all normal and abnormal storage conditions, the calculated k_∞ is below the criterion of $k_{eff} \leq 0.95$.

The spent fuel storage racks (SFSR) are designed such that no fuel assembly can be placed within the rack array in other than a design storage location.

The spent fuel pool and storage racks, containing their full complement of fuel, are designed to meet Category I requirements.

Reference 1 documents the Abnormal and Accident Conditions analyzed for the Holtec High Density Racks. Reference 3 documents similar analyses performed for the Joseph Oat High Density Racks.

Spent fuel storage racks are designed and arranged so that the fuel assemblies can be handled efficiently during refueling operations.

Shielding for the spent fuel storage arrangement is sufficient to protect plant personnel so that exposure to radiation is well within the Occupational Limits of 10 CFR 20.101.

The spent fuel storage facilities provide the capability to limit the potential offsite exposures in the unlikely event of significant release of radioactivity from the stored fuel to a fraction of 10CFR50.67 limits.

9.1.2.2 Facilities Description

9.1.2.2.1 Spent Fuel Pool

The two main functions of the Category I spent fuel pool are to provide a storage place for irradiated fuel and other radioactive equipment requiring shielding and to provide a convenient area for performing work on selected radioactive equipment. The spent fuel pool is shown in Figure 9.1-3. The spent fuel pool has an inside length of 40 ft, an inside width of 34 ft, and a height of 38 ft 9 in. The surface of the water is maintained at Elevation 683.5 ft (New York Mean Tide, 1935) by scuppers that act as skimmers and wave suppressors. This results in a minimum water depth for shielding of 7 ft above the top of the fuel while it is being moved over storage racks. The Technical Specifications require that a minimum of 22 ft of water be maintained over the top of irradiated fuel assemblies in the spent fuel storage pool racks during movement of irradiated fuel assemblies in the spent fuel storage pool. Pool water-level indication is painted on the north and east walls of the spent fuel pool starting at 18 ft above the stored fuel assemblies. Spent fuel pool levels are monitored by primary and backup instrumentation channels and level indication is provided in the main control room and reactor building 2nd floor grid B-11 which are capable of supporting pool actual water levels to comply with NRC Order EA 12-051. Refer to Figure 9.1-23 for details.

The spent fuel pool is of poured reinforced-concrete construction with an all-welded stainless steel plate liner. The water in the spent fuel pool is filtered, demineralized, and cooled as described in Subsection 9.1.3.2.

The stainless steel spent fuel pool liner is designed in accordance with the following codes and standards: ASME Boiler and Pressure Vessel (B&PV) Code Section VIII, Division 1, Subsection B (for welds); and ACI 347, recommended practice for concrete formwork (for tolerances). The liner can withstand thermal loads due to operating temperatures of 125° to 150°F (assume installation temperature of 70°F) and thermal loads due to abnormal temperatures inside the pool of 212° and external temperatures of 150°F. The liner plate is designed based on an acceptance criterion that neither the construction allowable tensile stress (f_t), nor the allowable compressive stress (f_c), exceeds 0.67 yield stress (f_y). The normal allowable compressive membrane strain is 0.003 in./in. and the abnormal allowable compressive membrane strain is 0.005 in./in. All welded seams in the pool liner are backed by channels to collect any possible leakage. All the channels are interconnected to the bottom peripheral drain with four separate outlet drains that are used to monitor leakage. The leaktight integrity of the spent fuel pool liner is verified to be upheld in a postulated fuel assembly drop accident. (Analysis shows that the fuel assembly can be dropped 17 ft 7 in. without penetrating the liner or causing overall slab instability.)

Two self-sealing gates with a monitored drain between them separate the spent fuel pool from the reactor well pool.

Should there be leakage, this arrangement would permit the repair of a gate without disturbing the integrity of the spent fuel pool. Each gate has two solid-rubber seals that seal to the spent fuel pool liner.

Spent fuel assemblies will be stored in thirteen (13) Joseph A. Oat supplied high-density stainless steel racks (designated F1600E002A through H and F1600E002J through N) (See Figures 9.1-4 for the design details of these racks.) These racks have a nominal 6.22-in. center-to-center distance between assemblies (pitch). Each of these racks each contain 169 storage cells. There are nine (9) additional Holtec supplied racks (designated F1600E011A through I) with a nominal 6.23-in. pitch, (See Figure 9.1-15 for the design details of these racks). The spent fuel storage rack description, individual rack size and the number of storage cells are summarized below:

Spent Fuel Pool

Rack and Storage Capacity Summary

Rack Description	Size	Total Number of Cells
F1600E002A through H	13 X 13	169 X 8 = 1352
F1600E002J through N	13 X 13	169 X 5 = 845
F1600E011A and B	9 X 11	99 X 2 = 198
F1600E011C	19 X 19	361 X 1 = 361
F1600E011D	12 X 17	204 X 1 = 204
F1600E011E	9 X 17	153 X 1 = 153
F1600E011F	9 X 12 minus 28 Cell cutout	80 X 1 = 80
F1600E011G	9 X 13 minus 28 Cell cutout	89 X 1 = 89
F1600E011H	9 X 14	126 X 1 = 126
F1600E011I	13 X 14	182 X 1 = 182
Storage Cell Total		3590

Two of the above cells may be used for Boraflex in-service surveillance program.

The arrangement of the fuel storage modules is shown in Figure 9.1-3 (Sheet 3). Four dual purpose cells in F1600E011F and six dual purpose cells in Rack F1600E011G are provided to store defective fuel assembles, control rods, control guide tubes and other equipment and components.

The spent fuel pool is also used to store 104 control rods that are suspended in a vertical position from 52 hooks. These hooks are mounted on frames located adjacent to the spent fuel shipping cask restraining framework on the west wall and on the south wall of the pool. A total of 114 control rods (104 suspended from hooks plus 10 in the dual-purpose cell racks) can be accommodated in the spent fuel pool. If storage for more than 114 rods should ever be required, the rods can be supported by mounting additional hooks on the equipment lugs on the east wall of the pool or control rod curb hanger(s) may be utilized. Temporary storage racks may also be used, as needed, to store control rod blades.

The area in the vicinity of the north wall of the spent fuel pool is laid out as a working area. In Figure 9.1-3, Sheet 3, two fuel-preparation machines are shown, an outline of which is shown in Figure 9.1-8. The function of the fuel-preparation machines is to remove and replace fuel bundle channels. The fuel preparation machines are used for fuel inspections and new fuel receipt/transfer activities. Strict administrative control on the fuel preparation machine's full-up end stop is required for personnel protection. Holtec high density Racks F1600E011C and F1600E011H are designed to support a specially engineered overhead platforms referred to as "Holtec Overhead Platforms (HOPs)" on top of the rack which permits storage of miscellaneous objects up to five tons total dry weight without interfering with the normal functions of the module. The structural and thermal-hydraulic qualification of these racks includes the appropriate consideration of the overhead platform.

A special storage area is provided on the west wall of the spent fuel pool to accommodate the spent fuel shipping cask. Details of the storage area are given in Subsection 9.1.4.2.1.

The spent fuel pool is supplied with several types of underwater lights; some provide general illumination and others provide specific local illumination.

The spent fuel pool shielding design objectives and design criteria are presented in detail in Subsections 12.1.1 and 12.1.2. Special provisions for ventilation of the fuel pool area are discussed in Subsection 12.1.1.1. Estimates of exposure to plant personnel in the fuel pool area are presented in Subsection 12.1.5.2.2.

9.1.2.2.2 Spent Fuel Storage Racks

Spent fuel storage racks provide a place in the spent fuel pool for storing spent fuel assemblies received from the reactor pressure vessel (RPV). There are two types of high density spent fuel storage racks (Holtec and Oat) being used. Both are full-length top entry racks, designed to preclude the possibility of criticality under normal and abnormal conditions.

The original Oat high-density spent fuel storage racks are of welded stainless steel construction with a neutron absorber sandwiched between the stainless steel sheets. The neutron absorber is marketed under the trade name of Boraflex, supplied by BISCO of Park Ridge, Illinois. The original high-density spent fuel racks are designed and fabricated by the Joseph Oat Corporation of Camden, New Jersey.

The basic philosophy of the high-density spent fuel storage rack design is consistent with the NRC Position Paper (Reference 2), General Design Criteria (GDC) 61 and 62, and Standard Review Plan (SRP) Sections 9.1.1 and 9.1.2. Seismic classification and analysis are in accordance with Regulatory Guides 1.29, 1.61, and 1.92.

The modules of the Holtec high density spent fuel racks are square cross-section boxes. Each box is equipped with Boral neutron absorber panels on its sides to form a composite box.

Reference 3 contains a detailed discussion of various aspects of the Oat high-density fuel rack design, analysis, and fabrication.

The high-density spent fuel storage racks provide for a total of 3590 storage locations arranged in 22 racks. All the racks are freestanding; that is, they are not anchored to the pool floor or connected to the pool wall through snubbers or lateral restraints. For the new racks, the minimum gap between adjacent racks is 1.0 in. at all locations, and the nominal gap between the fuel pool wall and storage rack is 2.39 in. The respective gaps for the Oat racks are 3.625 and 24 to 28 inches.

Of the 3590 storage locations, 3588 locations are intended for the storage of spent fuel assemblies. Two locations are designated for the Boraflex neutron absorber material surveillance program. This program is described in plant procedures. An additional 53 locations are inaccessible due to interferences. This will reduce the available storage locations to 3535. If the two Holtec Overhead Platforms (HOPs) are installed, an additional four cells per HOP will be unavailable.

The Oat high-density fuel storage racks are constructed from SA-240, type 304, austenitic stainless steel sheet material; SA-240, type 304, austenitic stainless steel plate material; and SA-182, type F304, austenitic stainless steel forging material. Boraflex, a patented brand name product of BISCO, serves as the neutron absorber material in the Oat high-density racks. Boraflex material has been tested in a fuel-pool-like environment to a minimum of 1.03×10^{11} rad and found to perform satisfactorily. Boraflex has been observed, however, to shrink and develop gaps. These effects have been evaluated in Reference 7. Alterations in physical properties and offgassing due to irradiation and material chemical or galvanic interactions with the rack structure have been considered in the design of the rack.

The Holtec high density racks are constructed from SA-240, type 304L, austenitic stainless steel sheet and plate material; and male spindles (lower part of support feet) of SA-564-630; age hardened at 1100°F. The storage cells are 6.035 ± 0.04 in. square cross-section. Modules F1600E011E-I are 3 inches shorter than the other Holtec racks with the result that the bale handle is exposed. This is for ease of fuel handling operations. They employ Boral as the neutron absorber material. Boral is a thermal neutron poison material composed of boron carbide and 1100 alloy aluminum. The composite boxes containing the Boral panels and enveloping sheathing are arrayed in a vertical fixture over a solid monolithic baseplate. Boron-10 is the neutron-absorptive agent in both Boraflex and Boral. The boron carbide and aluminum materials in Boral do not degrade as a result of long-term exposure to radiation.

The Oat high-density fuel storage rack contains storage cells that have a 6-in. minimum (+0.125 in., -0 in.) internal cross-sectional opening. These cells are straight to within ± 1/8 in. These dimensions ensure that fuel assemblies with maximum permissible out-of-straightness can be inserted into the storage cells without interference.

To illustrate the elements that make up a typical Oat rack, Figure 9.1-10 shows a horizontal cross section of an array of 3 x 3 cells. (A typical Oat high-density fuel storage rack has an array of 13 x 13 cells.)

The construction of the Oat racks may be best described by the basic building blocks of the design, namely the "cruciform," "ell," and "tee" elements, shown in Figure 9.1-11. The cruciform element is made of four angular subelements, "A" (Figure 9.1-12), with the neutron absorber material tightly sandwiched between the stainless steel sheets. The long edges of the cruciform are welded using a 0.070-in.-thick stainless steel backing strip as shown in Figure 9.1-13. The bottom of the cruciform assembly has a 4-1/4-in.-high stainless steel strip that prevents slippage of the poison material downward due to gravitation loads or operating conditions. The top of the cruciform is also end welded, using a spacer strip as shown in Figure 9.1-13. Skip welding at the top ensures proper venting for off-gassing.

The "ell" and "tee" elements are constructed similarly using angular subelements “A” and “B” and flat subelements "C" (Figures 9.1-12 and 9.1-14). Having fabricated the required quantities of the "cruciform," "tees," and "ells," the assembly is welded in a specially designed fixture that serves the vital function of maintaining dimensional accuracy while fillet welding the adjacent spokes of all elements. In this manner, the cells are produced that are bonded to each other along their long edges, thus, in effect, forming an "egg crate." The following manufacturing deviations were detected subsequent to installation in the spent fuel pool: a cruciform was installed upside down in F1600E002J (Module A9), and a tee was installed upside down in F1600E002L (Modules A11). The effects of these manufacturing deviations have been analyzed in Reference 7 and determined to be acceptable for use.

The bottoms of the cell walls are welded to the base plate, which has 4.75-in.-diameter holes concentric with cell center lines. Carefully machined sleeve elements are positioned in the base plate and are fillet welded to the base plate (Figure 9.1-15). The conical machined surface of the sleeve provides a contoured seating surface for the "nose" of the fuel assembly. Thus, the contact stresses at the fuel assembly nose bearing surface are minimized.

The central hole in the sleeve provides the coolant flow path for heat transport from the fuel assembly cladding. Lateral holes in the cell walls (Figure 9.1-15, Sheet 1) provide the redundant flow path in the unlikely event that the main coolant flow path is clogged.

The composite box assemblies of the Holtec high density racks are arrayed in a vertical fixture over a solid monolithic baseplate which is machined with an array of equispaced cylindrical holes containing tapered crowns (Figure 9.1-15, Sheets 2 and 3). These tapered holes serve as the seating surface for the nose of the fuel assembly.

The high-density fuel storage rack assembly is supported at four corners. The supports elevate the rack base plate 7.5 in. above the pool floor level, thus creating the water plenum for coolant inventory (Figures 9.1-4 and 9.1-5).

The high-density fuel storage racks are designed to meet Category I requirements, in accordance with Regulatory Guide 1.29. They are required to remain functional during and after a safe-shutdown earthquake (SSE). As noted previously, these high-density fuel storage racks are neither anchored to the pool floor nor attached to the side walls. The individual rack modules are not interconnected. Furthermore, a high-density fuel storage rack may be completely loaded with fuel assemblies (which corresponds to greatest rack inertia), or it may be partially loaded so as to produce maximum geometric eccentricity in the structure.

Dynamic simulation analyses involving nine Holtec high density and thirteen Oat high density spent fuel storage racks have been performed to establish the structural margins of safety. Six simulations modeled 22 high density fuel racks (13 Oat and 9 Holtec) in the pool for campaign II with a comprehensive Whole Pool Multi Rack (WPMR) model. References 1 and 3b presents the incorporation of all relevant physical data into the computer code

DYNARACK which then handles simultaneous simulation of all racks in the pool as a WPMR 3-D analysis. Some classical single rack runs were also performed. Parameters varied were interface coefficients of friction and extent of storage locations occupied by spent nuclear fuel, ranging from nearly empty to full. A WPMR run was also performed with four Holtec racks installed in the SFP for the same scenario that resulted in the greatest displacement from among the parametric runs. The results show that all stresses are well below their corresponding ASME Section III, Subsection NF limits and there is no rack-to-rack or rack-to-wall impact. Results also show that rack overturning is not a concern.

Nonlinearities of fuel-to-rack impact and, if appropriate, rack-to-rack impact are included. The racks are designed as freestanding and the effects of rack slide are addressed. Hydrodynamic effects are also included. No additional credit for structural damping is taken unless substantiated by testing or detailed analysis.

Synthetic time-histories in three orthogonal directions (N-S, E-W, and vertical) are generated in accordance with the provisions of SRP 3.7.1. The SRP calls for both the response spectrum and the power spectral density corresponding to a generated acceleration time-history to envelop their target (design basis) counterparts with only finite enveloping infractions. The time-histories for the pool have been generated to satisfy this preferred (and more rigorous) criterion. The seismic files also satisfy the requirements of statistical independence mandated by SRP 3.7.1. Time-history accelerograms were generated for a 20-sec duration of OBE and SSE events, respectively. These artificial time-histories are used in all the non-linear dynamic simulations of the racks.

The time-history data were generated from the floor response spectra given in Section 3.7. These spectra are enveloped with a smooth design spectra. For a complete time-history analysis of the equipment situated on the pool floor, artificial time-history accelerations in three orthogonal directions were generated so that their corresponding response spectra will envelop the smoothed design spectra mentioned above. These artificial time-history series were also verified to be statistically independent.

Figure 9.1-16 displays the dynamic model for the high-density fuel storage racks. Features of the dynamic model are as follows.

a. The fuel rack structure motion is captured by modeling the rack as a 12 degree-of-freedom structure. Movement of the rack cross-section at any height is described by six degrees-of-freedom of the rack base and six degrees-of-freedom at the rack top. In this manner, the response of the module, relative to the baseplate, is captured in the dynamic analyses once suitable springs are introduced to couple the rack degrees-of-freedom and simulate rack stiffness

b. Rattling fuel assemblies within the rack are modeled by five lumped masses located at H, .75H, .5H, .25H, and at the rack base (H is the rack height measured above the baseplate). Each lumped fuel mass has two horizontal displacement degrees-of-freedom. Vertical motion of the fuel assembly mass is assumed equal to rack vertical motion at the baseplate level. The centroid of each fuel assembly mass can be located off-center, relative to the rack structure centroid at that level, to simulate a partially loaded rack

c. Seismic motion of a fuel rack is characterized by random rattling of fuel assemblies in their individual storage locations. All fuel assemblies are assumed to move in-phase within a rack. This exaggerates computed dynamic loading on the rack structure and, therefore, yields conservative results

d. Fluid coupling between rack and fuel assemblies, and between rack and wall, is simulated by appropriate inertial coupling in the system kinetic energy. Inclusion of these effects uses the methods of References 3c and 3d for rack/assembly coupling and for rack-to-rack coupling

e. Fluid damping and form drag are conservatively neglected

f. Sloshing is found to be negligible at the top of the rack and is, therefore, neglected in the analysis of the rack

g. Potential impacts between the cell walls of the new racks and the contained fuel assemblies are accounted for by appropriate compression-only gap elements between masses involved. The possible incidence of rack-to-wall or rack-to-rack impact is simulated by gap elements at the top and bottom of the rack in two horizontal directions. Bottom gap elements are located at the baseplate levation. The initial gaps reflect the presence of baseplate extensions, and the rack stiffnesses are chosen to simulate local structural detail

h. Pedestals are modeled by gap elements in the vertical direction and as "rigid links" for transferring horizontal stress. Each pedestal support is linked to the pool liner (or bearing pad) by two friction springs. The spring rate for the friction springs includes any lateral elasticity of the stub pedestals. Local pedestal vertical spring stiffness accounts for floor elasticity and for local rack elasticity just above the pedestal. Details of the derivation and computation of the element stiffnesses are given in Reference 4

i. Rattling of fuel assemblies inside the storage locations causes the gap between fuel assemblies and cell wall to change from a maximum of twice the nominal gap to a theoretical zero gap. Fluid coupling coefficients are based on the nominal gap in order to provide a conservative measure of fluid resistance to gap closure

j. The model for the rack is considered supported, at the base level, on four pedestals modeled as non-linear compression only gap spring elements and eight piecewise linear friction spring elements; these elements are properly located with respect to the centerline of the rack beam, and allow for arbitrary rocking and sliding motions.

The high-density spent fuel storage racks are designed to withstand the most severe environmental, loading, and seismic conditions assumed to occur simultaneously. Load combinations are in accordance with SRP Section 3.8.4.

The structural acceptance criteria are in accordance with ASME B&PV Code Section III, Subsection NF.

The breakdown of the load combinations and acceptance limits is as follows:

D + L	Normal limits of NF 3231.1a

$D + L + E$ Normal limits of NF 3231.1a

$D + L + T_o$ The lesser of 2 S_y and S_u

$D + L + T_o + E$ The lesser of 2 S_y and S_u

$D + L + T_a + E$ The lesser of 2 S_y or S_u

$D + L + T_a + E^1$ Faulted condition limits of NF 3231.1c

where

D = dead loads of racks, buoyant rack weight

L = live loads, buoyant fuel weight

E = operating-basis earthquake (OBE) seismic loads including impact of fuel due to clearance within rack

T_o = operating thermal load

T_a = accident thermal load based on pool temperature of 212°F

E^1 = safe-shutdown earthquake seismic loads including impact of fuel due to clearance within rack

In addition to thermal and seismic loads, the high-density spent fuel storage racks are designed to withstand each of the following loadings superimposed on the submerged rack dead weight plus the weight of any stored fuel:

a. A 1200-lb uplift force applied at the top of the rack in the "weakest" storage location. The force is assumed to be applied on one wall of the storage cell boundary as an upward shear force. The damage, if any, is limited to the affected storage locations

b. Fuel assembly dropped on top of the rack with an impact energy of 2000 ft-lb. The impact energy is assumed to correspond to a buoyant mass of 600 lb dropped from a height of 40 in. The impact is assumed to occur on the top ridge of the rack

c. A horizontal force of 1000 lb applied at the most vulnerable location on the top of the rack. The load is assumed to act over the width of one storage cell. The subcriticality of all fuel assemblies is to be maintained with a $k_{eff} \leq 0.95$

d. A fuel assembly (assumed buoyant weight = 600 lb) dropping 16 ft 9 in. through a storage location and impacting the base. Local failure of the base plate is acceptable; however, an impact with the pool liner is not allowed. The subcriticality of all fuel assemblies is to be maintained with a $k_{eff} \leq 0.95$.

The allowable stress criteria are in accordance with ASME B&PV Code Section III, Subsection NF. The high-density spent fuel storage racks were checked for normal operating conditions, severe environmental conditions (OBE), extreme environmental conditions (SSE), and abnormal plant conditions (pool temperature = 212°F), and were found to be satisfactory.

The design of the Fuel Pool Cooling and Cleanup System (FPCCS) is described in Subsection 9.1.3. The decay heat load generated by the stored spent fuel is calculated in accordance with NRC Branch Technical Position ASB 9-2 (BTP ASB 9-2) (Reference 23). Where noted, heat up analyses are performed using the corrected form of the BTP decay heat model (References 24 and 25).

The spent fuel pool capacity expansion mentioned in Subsection 9.1.2.2 will occur over a series of campaigns, with the storage capacity increasing after each campaign. The bounding configuration from a thermal-hydraulic standpoint is the final, maximized configuration. This involves the largest number of stored assemblies and therefore the highest SFP decay heat load and lowest net SFP thermal capacity. All analyses discussed in this section are performed for the final configuration and thereby bound all intermediate configurations.

Thermal-hydraulic qualification analyses for the modified rack array are as follows:

a. Evaluation of the maximum bulk temperature. The bulk temperature is limited to 150°F for all conditions where forced cooling is available

b. Evaluation of loss-of-forced cooling scenarios, to establish minimum times to perform corrective actions and maximum makeup water requirements

c. Determination of the maximum local temperature in the pool to establish that localized boiling in the SFSRs is not possible

d. Evaluation of the maximum temperature difference between the fuel rod cladding and the local SFP water, to establish that nucleate boiling is not possible while SFP forced cooling is operating.

For each of the above analyses, evaluation is performed for an analytically bounding scenario as detailed below.

During normal SFP operation, the maximum normal bulk temperature of 150°F is based on the Fuel Pool Cooling and Cleanup System with the SFP gates installed.

In the scenario as addressed in support of the Amendment 141 spent fuel pool re-rack (Reference 7c), an emergency full core discharge comprised of 764 assemblies is discharged into an SFP that already contains 4016 previously discharged assemblies. This analyzed fuel inventory (4780) conservatively exceeds the maximum licensed capacity of 4608 assemblies. The minimum decay time of the previously discharged fuel assemblies for this scenario is 12 months. In addition to those mentioned above, the following conservative framework is applied in the maximum pool bulk temperature calculation:

a. The decay heat load is based on a discharge schedule with bounding parameters (i.e., maximum irradiation time and batch size) for all projected discharges.

b. Design temperatures are used for the coolant water flow inlet to the FPCCS and RHR System heat exchangers.

For evaluating the minimum time-to-boil and corresponding maximum boiloff rate, the following conservatisms are applied:

a. Loss of forced cooling is assumed to occur coincident with the SFP peak decay heat generation.

b. The thermal capacity of the SFP is based on the net SFP water volume only. The energy storage capability of the fuel racks, fuel assemblies and pool structure is neglected.

c. Makeup water supplied to maintain the SFP water level is assumed to be at the coincident SFP bulk temperature. No credit is taken for the difference in enthalpy between the SFP and the cooler makeup water, maximizing the boiloff rate.

For the same pool inventory described above for the maximum pool temperature case, the results of the analysis show that, in the extremely unlikely event of a complete failure of both the FPCCS and RHR System, there would be sufficient time available for corrective actions. The maximum water boiloff rate is less than the minimum available makeup capacity of 100 gpm available from the condensate storage tanks. Additional sources of makeup are also available.

In order to determine an upper bound on the maximum local water temperature, a series of conservative assumptions are made:

a. The walls and floor of the SFP are modeled as adiabatic surfaces, neglecting conduction heat loss through them.

b. Heat losses by thermal radiation and natural convection from the SFP surface are neglected.

c. The rack-to-wall gaps are modeled as 2 inches wide. The actual rack-to-wall gaps are larger.

d. The bottom plenum gap used in the model is approximately 50 percent of the actual gap.

e. No downflow is assumed to exist between the rack modules.

f. The hydraulic resistance of every SFSR cell is determined based on the most hydraulically limiting fuel assembly type.

g. The hydraulic resistance of every SFSR cell is determined based on the most restrictive water inlet geometry of the cells over the rack support pedestals.

h. The hydraulic resistance of every SFSR cell includes the effects of blockage due to an assumed dropped fuel assembly lying horizontally on top of its rack. This condition bounds the effects of contemplated overhead platforms, which add little extra flow resistance because of the large (~16 in.) spacing between the cell exit and the platform. Blockage due to a dropped assembly also bounds that of a vertically blocked gate, because the width of a channeled assembly is larger than the gate thickness.

i. With a full core discharged into the SFP racks and placed approximately equidistant from the coolant water inlet and outlet, the remaining cells in the spent fuel pool are postulated to be occupied with previously discharged fuel.

j. The in-pool sparger piping is modeled as truncated above the elevation of the racks.

k. In the evaluation of local water temperatures in dual-purpose rack cells containing loaded damaged fuel containers, only two of the cell baseplate holes are credited. This conservatively neglects the two additional baseplate holes and the eight cell side holes, thereby yielding greater than 100 percent redundancy in these cells.

The maximum local water temperature is substantially lower than the local boiling temperature at the top of the SFSRs and nucleate boiling does not occur anywhere within the Fermi 2 SFP.

Dose calculations (Subsection 9.1.3.3) performed based on the boiling condition indicate that the spent fuel pool cooling and cleanup system is adequate to provide reasonable assurance that the plant can be operated without undue risk to the health and safety of the public, consistent with the requirements of Criterion 2 of 10 CFR 50, Appendix A.

9.1.2.2.3 ISFSI Storage Pad

The function of the Independent Spent Fuel Storage Installation (ISFSI) storage pad is to provide a level resting surface for dry fuel storage casks. The pad is a 141' by 141' square reinforced concrete structure that is two feet thick designed to accommodate sixty four dry storage casks. The pad is compliant with ACI 349, "Code Requirements for Nuclear Safety-Related Concrete Structures," 2001, and designed in accordance with 10CFR Part 72-Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste. The pad includes a surrounding fence with signage indicating that the pad is a radiologically controlled area. There is a subsurface drainage system surrounding the pad to help prevent the soil under the pad from being displaced as a result of freeze and thaw cycles. The subsoil in the area to the north of the pad has also been prepared for possible future expansion of the pad to allow additional placement of up to thirty two dry storage casks.

9.1.2.3 Safety Evaluation

The design of the spent fuel pool and storage racks meets the requirements of Regulatory Guide 1.13, except as noted in Appendix A of the UFSAR. Moreover, the spent fuel storage racks are designed to meet Category I requirements as described in Section 3.2.

The SFP will contain original Oat racks and Holtec racks introduced in Subsection 9.1.2.2.1. A wide range of conditions has been addressed in the design validation of all the racks. Examples relevant to the Oat racks include SFP water temperature increase to 212°F, the effect of manufacturing deviations (inverted cruciform and tees) and Boraflex panel degradation. Every Boraflex panel is assumed to have experienced an 8-10 in. gap (or reactivity equivalent) randomly distributed in the axial direction and losses in width and areal B-10 density due to thinning within the reactivity margin that is provided in the criticality analysis (see References 7 and 22). References 7 and 22 provide a discussion of the techniques and assumptions used in the criticality analysis of the Oat racks. The K_{eff} for the existing spent fuel storage racks, including an allowance for uncertainties is shown in the above references to be less than or equal to the 0.95 limit.

The criticality analyses for the high density fuel storage racks were performed with the MCNP code. MCNP (Monte Carlo N-Particle Transport) is a continuous energy Monte Carlo code. See Section 3.13.3.17.

As the SFP capacity expansion progresses, a greater and greater percentage of the pool will be occupied by Holtec high-density racks. Neutronic coupling between the Oat Boraflex racks and the Holtec Boral racks is precluded by the water gap between modules and by the absorber panels on both sides of the gap. Accordingly, to ensure that the design of the spent fuel storage racks provides for a $k_{eff} \leq 0.95$, the following normal and abnormal conditions are addressed in References 7b and 22 for the new racks:

a. The nominal design case, normal positioning of spent fuel assemblies in the spent fuel storage rack to act as a baseline

b. Temperature and water density effects: analyses are performed for a temperature decrease to 4°C (maximum water density), boiling (giving rise to voids) at various levels in the SFP. The calculations confirm that the reference temperature of 4°C is most conservative

c. Abnormal location of a fuel assembly was shown to have a negligible reactivity effect, while the nominal case was shown to yield a higher reactivity than a case with the fuel assembly moved to the corner of the storage rack cell (a four assembly cluster at closest approach)

d. The drop of a fuel assembly on a spent fuel storage rack. Such event was found to result in an insignificant increase in the calculated k_{eff}

e. The effect on reactivity of tolerances with respect to rack manufacture (stainless steel thickness, lattice spacing), B-10 loading, Boral width, fuel (enrichment and depletion) uncertainties has also been assessed.

The maximum calculated reactivity, including allowance for all uncertainties, was below 0.95.

Consideration has been given to various objects that might be dropped into the spent fuel pool and impact with the spent fuel storage racks. The spent fuel storage racks are designed to withstand the dropping of a fuel assembly as documented in Reference 1 for Holtec Racks and Reference 3 for Joseph Oat racks. A pool gate drop is evaluated to assess damage to the stored fuel assemblies in a fuel rack, the drop of an overhead platform during installation onto the top of a rack is evaluated, and an additional evaluation was also performed to consider the ability of the rack to withstand the uplift force from a stuck fuel assembly. The drop accident events postulated for the Fermi 2 fuel pool were analyzed and found to produce localized damage well within the design limits for the racks. Consequently, the spent fuel storage racks have a very large margin of safety.

The materials of the high-density spent fuel storage racks are described above in Subsection 9.1.2.2.2.

Provision is made to limit potential offsite exposures in case of significant release of radioactivity from the spent fuel. This would be done by using the standby gas treatment system (SGTS), when necessary, to control the release rate of radioactivity from the fuel storage area.

By maintaining the minimum spent fuel pool water level and the use of the normal reactor building ventilation, the exposure to plant personnel is maintained below the limits of 10 CFR 20.

Subsection 9.1.3.3 discusses the radiological consequences of loss of cooling to the spent fuel pool.

9.1.2.4 Testing and Inspection

A detailed and rigorous inspection of the Holtec high-density spent fuel storage modules is carried out at the fabrication facility prior to their release. The racks are also receipt inspected at the site before the racks are installed in the pool.

The design incorporates provisions for periodic testing of the Boraflex poison material throughout the life of the plant to verify the continued presence of a sufficient amount of neutron absorber in the spent fuel storage racks to maintain a $k_{eff} \leq 0.95$.

In situ verification of the poison material was performed at initial installation for the Oat racks to confirm the presence of the neutron absorber (Boraflex) in the spent fuel storage racks.

9.1.2.5 Reactivity of Fuel in Storage

The basic criterion associated with the storage of both irradiated (spent) and new fuel is that the effective multiplication factor of fuel stored under normal conditions will be ≤ 0.90 for the low density racks and ≤ 0.95 for the high density racks. Abnormal storage conditions are limited to a k_{eff} of 0.95 for both high and low density racks.

For the low density racks removed from the Spent Fuel Pool during Cycle 12, these storage criteria were satisfied if the uncontrolled lattice k_∞ calculated in the normal reactor core configuration met the following condition:

$k_\infty \leq 1.31$ for 20°C to 100°C. (Reference 7a)

For the Oat high density racks, these storage criteria will be satisfied if the uncontrolled lattice k_∞ calculated in the normal reactor core configuration (standard cold core geometry) is less than or equal to 1.3113 (Reference 7). For the Holtec racks, the design-basis hypothetical bundle has a k_∞ of 1.3392 in standard cold core geometry. These values reflect the more limiting of the GE14 (References 7 and 7b) and GNF3 (Reference 22) criticality analyses. The net result is the k_∞ condition to meet the storage criteria is higher for the Holtec racks than for the Oat and the original low density racks. Thus, the Oat and low density racks are more limiting. The maximum k_∞ in the normal reactor core configuration at cold conditions for fuel assemblies in the spent fuel storage racks is 1.31, based on the Technical Specifications.

The peak uncontrolled lattice k_∞ in normal reactor core configuration is calculated by the fuel fabricator for each bundle type.

9.1.3 Fuel Pool Cooling and Cleanup System

9.1.3.1 Design Bases

The fuel pool cooling and cleanup system (FPCCS) is designed to remove the decay heat produced by stored spent fuel assemblies during all anticipated conditions of plant operation and during plant refueling outages 18 days after reactor shutdown. This includes refueling using either a full-core offload or core shuffle method. The system consists of two identical trains, which include pumps, heat exchangers, and filter-demineralizers.

The heat load in the spent fuel pool is anticipated to increase subsequent to each progressive refuel outage until the pool is filled to the maximum capacity where all of the storage locations are filled. The spent fuel pool temperature is maintained at or below 125°F during normal operation and 150°F during refuel outages. In anticipation of installing additional storage locations in the pool, the spent fuel pool and the FPCCS have been evaluated for a normal operating temperature of 150°F. However, additional engineering evaluation is required if the spent fuel pool is to be maintained at a temperature greater than 125°F during normal operating conditions.

The Amendment 141 spent fuel pool re-rack criteria for the FPCCS design analysis were as follows:

a. The originally installed spent fuel pool storage capacity was, nominally, 3.0 cores (2383 assemblies), plus room for removing a full core. EDP-27387 (Campaign I) and EDP-34306 (Campaign II) placed additional racks in the pool, increasing the installed capacity to 3588 locations, with a maximum licensed capacity to 4608 locations.

b. The original Amendment 141 re-rack licensing analysis considered both one-quarter core 12-month and one-third core 18-month fuel discharges; plant operation began at Cycle 1 with one-third core 18-month fuel discharge cycles. The spent fuel pool and the FPCCS have been analyzed assuming a maximum spent fuel population composed of the following:

   1. 6.25 cores composed of 20 groups of spent fuel assemblies, each of the first 19 groups containing from 176 to 228 assemblies discharged approximately every 18 months, ending with a full core discharge 30 years after the first cycle.

c. The spent fuel assemblies have a power history giving the discharge batch an average irradiation less than or equal to 50,000 MWd/MTU

d. The system heat load removal capacity is based on heat exchangers sized for a design heat load of 16.66×10^6 Btu/hr with a 55°F hot-to-cold side inlet temperature differential and two trains operating. The system is managed to maintain the spent fuel pool bulk temperature at or below 125°F during normal plant power operation with up to 3.0 cores of spent fuel stored in the spent fuel pool.

e. The decay heat was calculated assuming a bounding 4780 assemblies, exceeding the actual number of licensed storage locations (4608), based on the uncorrected BTP ASB 9-2 (Reference 23) decay heat model. The original Amendment 141 spent fuel pool re-rack evaluation (Reference 7c) was subsequently updated to consider both the impact of a 3486 MWth GNF3-based 24-month equilibrium fuel cycle as well as the effect of the assumed EDP-80016 installation of BORALCAN inserts to address historical Boraflex degradation associated with the original Joseph Oat racks. This more recent evaluation was performed using a corrected form of the BTP ASB 9-2 decay heat model (Reference 24 and 25) that predicts lower calculated decay heat loads, even though the actual GNF3 equilibrium core has a higher exposure (5.74 years at 3486 MWth) and corresponding real higher relative decay heat. In addition, whereas the original re-rack analysis considered 4780 loaded pool locations the analysis updated for GNF3 is based on the licensed capacity of 4608 locations (6.03 cores). The effect of these updates is a net reduction in calculated pre and post offload pool decay heat such that the original analysis remains bounding. Except as noted, the description of the more limiting original Amendment 141 analysis results are retained below. The following assumptions are made to calculate decay heat load to the spent fuel pool.

   1. Each discharged assembly has been irradiated for 5.2 years

   2. During the irradiation period, the reactor is operating at 100 percent power

   3. After shutdown, the RHR cooling system is used as the primary decay heat removal system for up to 18 days while the reactor head is off and refueling/maintenance operations are proceeding, including full-core offload when scheduled

   4. In applying BTP ASB 9-2, the uncertainty factor K for irradiation time $t > 10^7$ sec is taken to be 0.1

f. Refer to Table 3.2-1 for seismic and quality group for FPCCS system.

g. The FPCCS is designed to achieve the following additional functions.

   1. Minimize corrosion product buildup and control water clarity, through filtration and demineralization so that the fuel assemblies can be efficiently handled underwater

   2. Minimize fission product concentration in the water that could be released from the spent fuel pool to the reactor building environment

   3. Monitor spent fuel pool water level and maintain a water level above the fuel sufficient to provide shielding for normal building occupancy

   4. Maintain the bulk water temperature at less than 150°F, with the heat loading resulting from the removal of a full core either during plant

refueling (greater than 18 days cooling) or in a plant outage following a normal refueling. This may be achieved by being able to interconnect the RHR system and the FPCCS to supplement spent fuel pool cooling.

5. Preclude siphoning the spent fuel pool by providing siphoning breakers on all lines penetrating the spent fuel pool.

9.1.3.2 System Description

The FPCCS cools the spent fuel pool by transferring decay heat through heat exchangers to the reactor building closed cooling water system (RBCCWS), as shown in Figure 9.1-23. Water purity and clarity in the spent fuel pool, reactor well pool, and dryer-separator storage pool are maintained by filtering and demineralizing the pool water as shown in Figure 9.1-24.

The FPCCS is composed of two trains. Each train is designed to remove 8.33×10^6 Btu/hr with a 55°F (FPCCS to RBCCW inlet flows) temperature differential, 550 gpm tube flow and 800 gpm (RBCCW) shell flow (Table 9.1-1). The system consists of two fuel pool cooling pumps; two heat exchangers; two filter-demineralizers; two skimmer surge tanks; and associated piping, valves, and instrumentation. The two fuel pool cooling pumps are connected in parallel, as are the two heat exchangers. The pumps and heat exchangers are located in the reactor building below the level of the bottom of the spent fuel pool.

The filter-demineralizer units are located in the radwaste building in separate shielded cells, with enough clearance to permit removing filter elements from the vessels. Each cell contains only the filter-demineralizers and piping. All air-operated valves (such as inlet, outlet, recycle, vent, and drain) are located on the outside of one shielding wall of the cell, together with necessary piping and headers, instrument elements, and controls. Penetrations through shielding walls are located so as not to compromise radiation shielding requirements (Subsection 12.1.2).

The pumps circulate the spent fuel pool water in a closed loop, taking suction from the skimmer surge tanks through the heat exchangers, circulating the water through the filter-demineralizers, and discharging nominally 7’ -6” below the normal water level in the fuel storage pool. The cooled water traverses the pool, picking up heat and debris before starting a new cycle by discharging over the skimmer weirs and scuppers into the skimmer surge tanks. The normal makeup water source for the system is provided from the condensate storage tank to the skimmer surge tanks.

Backup cooling is provided to the spent fuel pool by means of a permanently piped cross tie to the RHR system. In this mode of operation, one RHR pump and the corresponding RHR division heat exchanger will provide the means to cool the spent fuel pool. This cooling circuit is established by opening cross-tie valves V8-3264, G4100F016 and V8-3029, G4100F036 and closing FPCCS valves V8-3006, G4153F004 and V8-3253, G4100F011 (Figure 9.1-23). For the designed piping configuration, the RHR pump flow is throttled with valve G4100F231 to a maximum of 3500 gpm. If the fuel pool gates are removed and the reactor cavity is flooded up, the RHR discharge may be configured to split the flow between the reactor cavity and fuel pool by opening G4100F036. The RHR suction will be from the operating SDC loop, therefore G4100F016 is closed. During this split flow configuration, the FPCC is operated in parallel with RHR SDC as FPCC is discharging to the reactor cavity, G4153F004 and G4100F039 are open and G4100F011 is closed. An RHR heat exchanger will remove the total spent fuel pool decay heat load of approximately 42.22 x 10^6 Btu/hr of a full-core offload, completed at 156 hrs decay cooling since reactor shutdown, with about a 49°F temperature differential (Table 9.1-1). To ensure the availability of backup cooling via the RHR system, the cross-tie piping, the FPCCS piping from the skimmer tanks to the first anchor downstream of valve V8-3006, and the FPCCS piping from the first anchor upstream of valve V8-3253 to the spent fuel pool are Seismic Category I.

Both FPCCS heat exchangers operating in parallel are designed to remove the maximum heat load produced by various combinations of spent fuel discharged from the equilibrium fuel cycle at the time the RHR system is isolated from the spent fuel pool, plus the heat being released by batches discharged at previous refueling (see Subsection 9.1.3.1). The maximum heat load 18 days after a reactor shutdown with about 4276 fuel bundles in the spent fuel pool is 14.29 x 10^6 Btu/hr. The maximum heat load 18 days after reactor shutdown with 9 1/3 core off loads in the spent fuel pool is approximately 11.9 x 10^6 Btu/hr. This load is within the capacity of the FPCCS heat exchangers with a temperature differential of about 39°F. Re-evaluated for the GNF3 equilibrium cycle with 4088 pool locations filled, the 18 day heat load is predicted to be 11.54 x 10^6 Btu/hr.

During refueling outages (up until mode change for plant restart), when spent fuel pool circulating flow is interrupted to drain the reactor well and the dryer/separator storage pool or when the FPCCS becomes incapacitated, either of the RHR system heat exchangers may be used to supplement spent fuel pool cooling in the event the pool bulk temperature cannot be maintained below 150°F. During refueling outages, the RHR system can provide necessary supplemental cooling of the spent fuel pool until the RHR system is isolated from the spent fuel pool to restore low-pressure coolant injection (LPCI) standby mode. After RHR is isolated, the spent fuel pool decay heat is managed to remain within the FPCCS duty capability. Table 9.1-1 also lists the characteristics of an RHR subsystem in the fuel pool cooling assist mode.

The design of the spent fuel pool is such that the top of the stored fuel is at a lower elevation than the bottom of the gate between the reactor well and spent fuel pool. There are no connections to the spent fuel pool that could drain the pool below the elevation of the bottom of the gate when the gate is removed for refueling, or below the normal spent fuel pool level when the gate is in place. To prevent water from being siphoned out of the pool, the piping entering the spent fuel pool is fitted with normally submerged vents which will break a siphon before the minimum required water coverage over the stored fuel is lost. A level indicator, mounted at the valve rack, monitors reactor well water during refueling. A high rate of leakage through the refueling bellows assembly, drywell to reactor seal, or the spent fuel pool gates is indicated on the operating floor instrument racks.

Spent fuel pool water is continuously recirculated during normal FPCCS operation. The circulation patterns within the reactor well and spent fuel pool are established by the placement of the diffusers and skimmers to sweep particles dislodged during refueling operations away from the work area and out of the pool.

For refueling operations, the reactor well and dryer-separator storage pools are filled by transferring water from clean stored condensate. After the vessel head is removed, the fill water is transferred through the reactor vessel by flooding vessel level up into the reactor well. Clarity and purity of the pool water are maintained by a combination of filtering and ion exchange. The cleanup system has sufficient capacity to ensure pool water clarity and purity. The water purity is maintained by monitoring the demineralizer conductivity and differential pressure with periodic sampling and analysis of spent fuel pool water. The filter-demineralizers maintain water purity within the chemical limits specified below.

	Fuel Pool Chemical Limits	Demineralizer Effluent
Conductivity	≤ 3 µmho/cm at 25°C	≤ 1 µmho/cm at 25°C
Chloride	≤ 500 ppb	≤ 50 ppb
pH	5.3-7.5 at 25°C	6.0-7.5 at 25°C
Total insolubles	≤ 1 ppm	

Demineralizer differential pressure operating limit is 30 psi, and an alarm is provided at 25 psi. No radiochemical limits are needed to monitor the spent fuel pool water and initiate corrective action for the following reasons:

a. Crud buildup that would contribute to gross gamma activity is minimized by the filter-demineralizer

b. Iodine-131, with an assumed concentration of 64 µCi/g, is the most radiologically significant nuclide; doses from the other nuclides, by comparison, are relatively negligible

c. The assumed concentration of 64 µCi/g of ^{131}I is almost 10^{-6} of the specific activity if its solubility limit is attained. Therefore, assuming a partition factor of 10 and a removal efficiency of 99 percent by the SGTS, ^{131}I would not be a problem.

The system flow rate is larger than that required for two complete water changes per day of the spent fuel pool, or one change per day of the fuel storage, reactor well, and dryer-separator pools.

The maximum system flow rate is twice the flow rate needed to maintain the specified water quality. Particulate matter is removed by powdered ion-exchange resin-fiber mixtures. Alternatively, a combination of powdered resin and precoated material such as cellulose may be used as the disposable filter medium. The filter elements are stainless steel mesh elements mounted vertically in a tube sheet and replaceable as a unit. The filter vessel is constructed of carbon steel and coated with a phenolic resin material.

Spent fuel pool water and demineralizer effluent are sampled and analyzed once per week.

Instrument readings for conductivity and differential pressure are taken once per shift. Alarms sound in the control room if demineralizer conductivity, flow, or differential pressure limits are attained so that corrective action may be initiated. Backwashing and precoating operations are controlled from a local panel in the radwaste building. The spent filter medium is removed from the elements by backwashing with air and condensate and then is flushed to the phase separator tank.

A poststrainer in the effluent stream of the filter-demineralizer limits the migration of filter material. The filter-holding element can withstand a differential pressure greater than the developed pump head for the system.

System instrumentation is provided for both automatic and remote manual operations. A low-low level switch stops the circulating pumps when surge tank reserve capacity is low. Manual control for the circulating pumps is either from local panels or the control room panel. Pump low suction pressure automatically turns off the pumps.

The FPCCS has alarm functions for cooling pump low discharge pressure, refueling bellows seal leakage, spent fuel pool gate reactor well seal leakage, skimmer surge tank high level, spent fuel pool high level, and skimmer surge tank low level. All of these functions give a common alarm signal to the main control room; for example, spent fuel pool cooling system trouble. Each function also has a light, located on local control panels, which determines the cause of the common alarm in the main control room. In addition, there are specific alarms in the control room for spent fuel pool high temperature, spent fuel pool low level, and spent fuel pool demineralizer trouble.

The local control panels receive power from a standby source if normal power is not available. Circulating pump motor loads are considered nonessential loads and will be operated as required under accident conditions.

9.1.3.3 Safety Evaluation

The FPCCS maintains the peak spent fuel pool bulk temperature below 150°F with the maximum design decay heat load during an outage and at or below 125°F during normal plant power operation. Although the spent fuel pool and the FPCCS are evaluated for a normal operating temperature of 150°F, additional engineering evaluation is required if the spent fuel pool is to be maintained at a temperature greater than 125°F during normal operating conditions. The FPCCS and RBCCW pumps are powered from redundant buses; this ensures continued normal cooling operation. The RHR system provides a safety source of emergency makeup water and redundant heat removal capability.

No inlets, outlets, or drains are provided that would permit the spent fuel pool to be drained below a safe shielding level. Lines extending below this level are equipped with siphon breakers, check valves, or other suitable devices to prevent inadvertent pool drainage. The line draining the space between the two gates is sufficiently high to preclude draining excessive water above the spent fuel storage racks.

Except during refueling operations, the spent fuel pool will be isolated from the reactor head cavity and dryer-separator storage pool by two redundant watertight gates that close the opening through which spent and new fuel is transported to and from the spent fuel pool. The bottom of the gate opening is above the top of the fuel storage racks in the bottom of the spent fuel pool to ensure that the stored fuel can never be uncovered.

The only interconnection between the cooling and cleanup subsystems is the spent fuel pool itself. The FPCCS return lines to the spent fuel pool are provided with siphon breakers.

The decay heat load in the spent fuel pool may vary widely because of various possible combinations of the following:

a. The number of groups and the respective irradiation periods of spent fuel assemblies in the racks (see Subsection 9.1.3.1.b. and e.)

b. The duration of time-after-shutdown for each of the spent fuel groups.

The original Amendment 141 re-rack decay heat calculated for the bounding case of an emergency full core offload using the assumptions of Subsection 9.1.3.1 resulted in a maximum calculated spent fuel pool heat load of 42.65 x 10^6 Btu/hr (12.5 MWt). Re-evaluated for GNF3 based on the corrected BTP decay heat model (References 24 and 25), Reference 7c predicts a maximum pool heat load is 40.7 x 10^6 Btu/hr (approx. 12 MWt). In either case, the FPCCS does not have the heat removal capacity to maintain the pool temperature to less than 125°F. Engineering evaluation is required to operate with this heat load in the spent fuel pool.

The FPCCS is normally capable of maintaining the spent fuel pool temperature at or below its maximum normal design temperature of 125°F. Under full-core offload with spent fuel pool decay heat load above the system design capacity, the required differential temperature across the FPCCS heat exchangers exceeds the nominal design temperature differential. In the event of other system abnormal conditions of decay heat load higher than available FPCCS removal capacity due to other refueling outage activities and/or FPCCS capacity restriction (e.g., due to maintenance), the heat load may also result in higher temperature differential across the operating FPCCS heat exchanger(s). This would cause the temperature of the spent fuel pool to rise. Should FPCCS not be able to maintain spent fuel pool temperature below 150°F, then an RHR loop would be aligned to take suction from, and discharge to, the spent fuel pool. If the fuel pool gates are removed and the reactor cavity is flooded up, then the suction remains from the shutdown cooling line and the discharge may be split between the recirculation loop and the fuel pool. The use of the RHR system in the fuel pool cooling assist mode makes both low pressure coolant injection (LPCI) subsystems inoperable.

FPCCS and natural circulation have been analyzed to be capable of serving as an alternate method of decay heat removal to enable RHR Shutdown Cooling to be taken out of service for maintenance during refueling. When operating in this alternate shutdown cooling mode, the fuel pool gates are removed and the RPV cavity is flooded. Entry into this mode requires satisfying the refuel technical specification associated with high RPV water level. FPCCS is normally operated with two pumps and two heat exchangers in service. In this capacity, FPCCS and natural circulation maintain FPCCS suction temperature less than 140°F, cooling both the old and freshly off-loaded assemblies in the fuel pool as well as those remaining in the RPV. RWCU may also be placed in operation with the regenerative heat exchanger bypassed to provide additional cooling and in-vessel mixing. This ability to enter this mode of FPCCS operation for RHR maintenance activities is evaluated on a per cycle basis using the expected vessel and spent fuel pool heat loads. The activity is managed such that normal shutdown cooling can be restored within 8 hrs. This is an arbitrary time frame that conservatively assures cooling can be restored prior to the onset of pool and core boiling. In addition, the operation of this mode restricts the operation of temporary auxiliary pool water filtration units such that the flow discharge does not interfere with the core exit flow and thereby impede natural circulation cooling.

The heat load to the spent fuel pool is caused by the decay heat of the fission products and the activated heavy elements (^{239}U and ^{239}Np) contained in the spent fuel assemblies stored in the racks, including those temporarily stored for a refueling outage. Since different combinations of assemblies are reinserted into the core than were originally removed (possibly including some reinserted assemblies that were removed at prior refuelings), the decay heat load will vary from cycle to cycle. The original Amendment 141 design analysis conservatively assumed a higher number of assemblies in the spent fuel pool storage racks than there are actual storage locations as presented in Subsection 9.1.2.2.2 above. Table 9.1-2a presents the fractional decay heat as a function of time after shutdown for this bounding case determined with the method given based on the uncorrected BTP ASB 9-2 decay heat model. Pool decay heat corresponding to a 24-month GNF3 fuel cycle is presented in Table 9.1-2b.

The data in the table for the prior discharges are based on a full-power operating period of 5.2 years that is conservatively consistent with an approximately one-third core, 18-month equilibrium fuel cycle. The number of fuel assemblies and the decay heat contribution for each discharge are also given in Table 9.1-2a and Table 9.1-2b. The decay heats in MW for fuel assemblies discharged in normal refuelings for the entire plant cycle, ending with a normal partial core unload of 260 assemblies, are presented in Tables 9.1-3a and 9.1-3b are computed as follows:

$$\text{QDKP}\ (t_s) = \text{RTP MWt} \times \frac{P}{P_o}(t_o, t_2) \times \frac{N}{764}$$

where

QDKP (t_s) = decay heat of fuel assemblies that have been stored in spent fuel pool racks for t_s sec, MW_t

RTP MWt = 100 percent of the rated thermal output of core

$\frac{P}{P_o}(t_o, t_2)$ = fractional decay heat

$\frac{N}{764}$ = fraction of full core discharged per Refueling/Unload

Tables 9.1-3a and 9.1-3b give the cumulative spent fuel pool heat load and quantity of spent fuel stored in the racks versus time after the initial discharge to the spent fuel pool for 18-month and 24-month fuel cycles, respectively. To develop a conservative maximum spent fuel pool heat load, the case of a complete operating cycle followed by an emergency full core offload is considered. Under the original heat load analysis, the total number of assemblies in the spent fuel pool was taken as 4780. This maximum heat load case includes 19 approximately one-third core discharges from previous refuelings plus a full-core offload of the last operating cycle started at 2-1/2 days decay cooling from reactor shutdown. The maximum spent fuel pool heat load in this case would be 12.50 Mwt (~42.65 x 10^6 Btu/hr; see Table 9.1-1). In this case, one loop of the RHR system would be needed in the fuel pool cooling assist mode to maintain bulk temperature below 150°F.

Upon completion of refueling activities, FPCCS is evaluated to determine that it is capable of maintaining the spent fuel pool temperature below 125°F. Insufficient decay heat removal capability may occur due to FPCCS performance degradation, capacity limitation due to insufficient temperature differential from high RBCCW service water temperature, larger than normal core discharge, and/or less than design cooling time from reactor shutdown. If this situation should exist, then one loop of RHR would continue to be employed to control the spent fuel pool temperature until the FPCCS decay heat removal capacity is sufficient to allow plant restart (RHR LPCI is considered inoperable and Technical Specifications limits with RHR LPCI inoperable apply to plant operations).

Should two active components in the spent fuel pool cooling system be unavailable and the RHR system be unavailable for cooling, the spent fuel pool water temperature would be inherently limited to 212°F, on boiling.

An analysis has been performed to determine the radiological doses at the site boundary which might result as a consequence of a complete loss of cooling of the spent fuel pool (see Reference 15). Such a complete loss of pool cooling is not considered a Design Basis Accident, and it is not considered a design basis for the fuel pool or for the FPCCS. The subject radiological analysis is currently included in the UFSAR for information only, and is not part of the basis for NRC acceptance of the FPCCS design. Details of the analysis are as follows:

a. Heat released from the spent fuel is conservatively assumed to have a constant value for a period of 30 days after the assumed loss of the FPCCS. For purposes of evaluating the radiological dose consequences only, it is conservatively assumed that no other heat removal method is available except for spent fuel pool boiling and that the time to achieve pool boiling is zero. Makeup water is assumed to be provided at a rate equal to that of boiling and thus maintains the spent fuel pool water volume at a constant value of approximately 48,000 ft^3. Potential makeup sources are the RHR service water, condensate storage, and fire protection system.

b. There is 1.3 x 10^{-2} μCi/g of ^{131}I in the reactor water during power production (see Table 11.1-3). The temperature, pressure, and flow rate of the spent fuel pool water are much lower than those of the water in the reactor under full-power conditions. Spent fuel in the spent fuel pool storage racks should not cause a water iodine concentration greater than the reactor water concentration, even assuming the spent fuel pool begins to boil. Notwithstanding the above, a ^{131}I concentration of 64 μCi/g was assumed and used. This concentration is more than 5000 times the ^{131}I concentration in the spent fuel pool water during full-power operation and adequately accounts for an "iodine spike."

c. The variation of iodine concentration in the spent fuel pool as a function of time is calculated realistically to account for decay, boiling, and the addition of makeup water. Two cases are considered: one assumes the makeup water to contain no radioactivity, and the other assumes an unlimited supply of makeup water at an initial concentration of 64 μCi/g.

d. The spent fuel pool water volume is about 48,000 ft^3. Based on a concentration of 64 μCi/g, there would be about 87,300 Ci of ^{131}I in the spent fuel pool water. Doses were calculated from other nuclides (gas and particulate) and it was concluded that ^{131}I is the most radiologically significant radionuclide, the others by comparison being negligible.

e. Iodine in the spent fuel pool water is assumed to be released from the pool at a rate that corresponds to the initial concentration and boiling rate with the application of a partition factor of 10.

f. The use of a partition factor of 10 is justified as follows: the solubility limit for iodine in hot water is 0.078 g/100 ml of water. If this amount of ^{131}I were to be dissolved in water, the specific activity would be 9.9 x 10^7 μCi/ml. The iodine concentration used in this analysis was 64 μCi/g. However, assuming the spent fuel pool water contained an amount of stable iodine equal to the radioiodine that would exist in the water during this postulated accident, the spent fuel pool water would still be able to accept almost one million times more iodine before the solubility limit was reached. On the basis of solubility, therefore, a partition factor of 10 is justified.

g. Iodine removal efficiency credit for the SGTS is assumed to be 99 percent, consistent with Regulatory Guide 1.52. The SGTS is designed to accommodate an inlet relative humidity of 100 percent; that is, the secondary containment is conservatively assumed to be filled with saturated air.

h. The meteorological condition assumed for the accident is the fifth percentile short-term (accident) χ/Q's for actual site meteorological data provided from Edison's 60-m tower and as reported to, and accepted by, the NRC staff (NRC letter dated April 26, 1976, G. W. Knighton to H. Tauber, Reference 8). These data are presented in Table 2.3-27.

i. The calculations estimate the 2-hr thyroid (inhalation) dose at the site boundary to be 0.17 rem for both radioactive and nonradioactive makeup water. The 30-day thyroid (inhalation) dose at the low-population zone for radioactive makeup is 0.186 rem; whereas for nonradioactive makeup, the 30-day dose is 0.134 rem.

Results indicate that the dose from this postulated accident would not exceed a fraction of 10 CFR 100 limits.

Thermal-hydraulic calculations confirm that the peak clad temperature for the hottest assembly, offloaded after 2-1/2 days of decay heat cooling from reactor shutdown, will remain below the local saturation temperature assuming a bundle inlet temperature at the maximum spent fuel pool temperature of 150°F. In addition, the calculations confirm that at the time of maximum spent fuel pool decay heat loading, with surface temperature approaching boiling (bulk temperature approximately 200°F), the hottest assembly peak clad temperature would still not exceed local saturation temperature. Should the spent fuel pool water temperature increase to the surface boiling point, the peak fuel cladding temperature would be slightly higher than the local saturation temperature ($T_{sat[racks]} \approx 240°F$). This fuel cladding temperature is a fraction of the fuel cladding temperature during normal plant operation. The physical characteristics of the fuel and the integrity of the fuel cladding would not experience changes that could cause an activity concentration in the spent fuel pool water in excess of the activity in the reactor water during full-power operation. Dose calculations performed by Edison, based on the above, indicate that the design criteria applied to the spent fuel pool cooling system are adequate to provide reasonable assurance that the plant can be operated without undue risk to the health and safety of the public, consistent with the requirements of Criterion 2 of Appendix A to 10 CFR 50.

In summary, the spent fuel pool cooling system's design, siphon-breaking piping arrangement, redundant transfer gates, emergency makeup water supply from the RHR service water system, and RHR backup capability provide a completely reliable system for the storage and cooling of spent fuel.

9.1.3.4 Testing and Inspection

Prior to power operation following a refueling outage, a determination will be made that the heat generation rate in the spent fuel pool is within the current capacity of the FPCCS with both trains in normal operation at a spent fuel pool bulk temperature less than or equal to 125°F.

No special tests are required for instrumentation on the FPCCS. The instrumentation will be subjected to routine testing. The FPCCS Preoperational Test program is discussed in Chapter 14.

9.1.4 Fuel Handling System

9.1.4.1 Design Bases

The fuel handling system provides a safe and effective means for transporting and handling fuel from the time it reaches the plant until the time it leaves the plant after postirradiation cooling.

9.1.4.2 Equipment Description

Table 9.1-5 is a listing of tools and servicing equipment supplied with the nuclear system. The following paragraphs briefly describe the use of some of the major tools, servicing equipment, spent fuel shipping cask, and reactor building crane. Where applicable, safety aspects of the design are discussed. For a historical discussion of the reactor building crane and spent fuel cask-handling details, see Reference 9. The procedure for load testing at 125 percent rated load described in Section 2.3.2 of Reference 9 has been modified in accordance with the guidelines established in NUREG-0554, ANSI B30.2, and NRC BTP ASB 9-1.

9.1.4.2.1 Spent Fuel Shipping Cask

Spent Fuel Shipping Cask Description

Edison does not now contemplate owning its own spent fuel shipping cask, but intends to use a licensed cask from an authorized approved vendor.

Arrangements are being made for the shipment and reprocessing of spent fuel. Since two types of spent fuel shipping casks are presently being used, the equipment and the handling techniques have been developed to utilize either type. To ensure the adequacy of the equipment and techniques, the reactor building is designed to accept the larger spent fuel cask weighing not more than 125 tons.

The spent fuel shipping cask has a cylindrical configuration with a maximum diameter of 8 ft and a maximum length of 21 ft. Two pairs of lifting lugs are furnished to provide redundancy to the lifting mechanism. All four lugs are used simultaneously for lifting the cask. The cask is designed to conform to 10 CFR 71 with regard to structural design; radiological releases, effects, and protection; allowable spent fuel shipping conditions; shielding; and continuity of decay heat removal capacity for all credible cask accident events.

Spent Fuel Shipping Cask Handling

The fuel cask is delivered through the airlock into the reactor building by truck. The truck is positioned under the equipment access hatch. The cask is upended from its horizontal shipping position by the reactor building crane main hoist.

After upending is completed, the cask is attached to the redundant hook system via either a lifting device or two sets of slings (Figure 9.1-26) that engage the cask on all four lifting lugs and to the redundant hook system. The method of providing a redundant link between the hooks and the cask will be based upon the type of cask used.

The cask is then hoisted from the first floor grade elevation to the fifth floor operating level and traversed to the cask-washdown area, where the cask head is removed and the cask is prepared for fuel storage pool entry. Depending on the cask head removal details, the cask may not have to be disengaged from the crane during this handling step.

The cask enters the pool by traversing the crane from the washdown bay due north until it is in line with the pool storage area for the cask. This line will be marked on the operating floor surface, as shown in Figure 9.1-27. The trolley will then be traversed due east for the cask centerline to follow the marker line until the cask is suspended over the cask storage area and completely clear of the pool edge. The crane operator receives his instructions from a signalman stationed on the operating floor level adjacent to the cask. The signalman remains in visual and voice contact with the crane operator.

Prior to being lowered into the pool, the cask is steadied. Lowering of the cask will be done at minimum speed until the cask has completely cleared the pool edge. Underwater lights will be used to illuminate the cask-setdown area. A 9-ft by 9-ft by 1-in.-thick stainless steel plate is provided in the pool bottom liner to accept the cask.

All of the above-described steps are reversed when the cask is extracted from the pool.

Spent Fuel Shipping Cask Storage Area

There is no spent fuel cask storage pit as committed to in response to PSAR Question 3.2.6. A detailed discussion regarding the elimination of the spent fuel cask storage pit is presented in Reference 3. Except when in transit or when being washed down, the spent fuel shipping cask is kept submerged in its storage area in the northwest corner of the spent fuel storage pool. It will be conveyed there from its truck by the redundant crane system. The spent fuel shipping cask storage area is described above under "Spent Fuel Shipping Cask Handling."

9.1.4.2.2 Reactor Building Crane

An overhead traveling (reactor building) crane is utilized in the Fermi 2 reactor building to handle heavy objects, including the spent fuel shipping and transfer casks. The essential design bases applicable to Fermi 2 spent fuel cask handling are:

a. To minimize, to the maximum extent practical, the probability of dropping heavy objects into the fuel storage pool resulting in damage to fuel or compromising the integrity of the pool

b. To prevent a spent fuel shipping cask drop from exceeding the design limits for the cask as set forth in 10 CFR 71

c. To minimize the probability and the effect of dropping heavy objects, including the spent fuel shipping and transfer casks, during movement through the reactor building, so that damage is prevented to structures, systems, and components important to safety.

In order to obviate the possibility and to minimize the probability, to the greatest extent practical, of occurrence of events a, b, or c above, the special crane design features and improvements that have been incorporated are the following:

a. A completely redundant hoisting system

b. An upgrading of the crane for SSE and design-basis tornado

c. Upgrading of the crane quality assurance criteria

d. Crane control redundancy

e. A crane surveillance and test program

f. Administrative control of crane movements.

Crane operations over the spent fuel storage pool when fuel assemblies are stored therein are not allowed when either of the following conditions occur:

a. less than 22 feet of water over the top of irradiated fuel assemblies seated in the spent fuel storage pool racks.

b. less than the Technical Specification required ac electrical power sources operable, when in modes 4, 5 and when handling irradiated fuel in the secondary containment.

Prior to suspending crane operations, fuel assemblies shall be placed in a safe condition.

The reactor building crane is of the single trolley top running type, carried on two main girders. The girders have a rated lifting capacity of 125 short tons and a span of 113 ft 9 in. Power is applied by twin hoist motors through two gearboxes to the two drum gear rings, located on each end of the drum. In this manner, the hoist mechanism is duplicated. In normal operation, the twin hoist trains share the load, but each is separately able to carry the rated load at allowable code stresses, thus providing adequate safety should one gear train fail. Both hoist trains are provided with electrical and electromechanical type brakes; each of the latter is capable of sustaining the load should a mechanical failure occur in a gear train. Each mechanical brake is sized for 150 percent motor torque or 300 percent for redundant systems. (This is based on a required brake torque of 277.5 ft-lb, and a rating of each of the two 13-in. brakes of 550 ft-lb. The required brake torque, B_T, is calculated by using

$$B_T = 1.5 \times 33{,}000 \; P_{hp}/2\pi N$$

where P_{hp} is the motor horsepower of 20, and N is equal to 570 rpm.)

The electrical brakes complement the mechanical brakes. The electrical brakes can limit the hoist-lowering speed to 1.6 fpm at rated load in the event of failure of both the redundant mechanical brakes. If there should also be a loss of normal power to the electrical brakes, an integrated alternator generates enough power to the units to prevent the lowering speed from exceeding the fully rated load speed.

For the main hoist, this speed is 4.7 fpm at rated load. The reactor building floor and the floor under the equipment hatch have sufficient strength to withstand the impact of a fully rated load at this speed.

The redundant wire rope system consists of two balanced reeving systems utilizing two individual wire ropes. These two wire ropes are reeved side by side from double-scoured drum groovings at each end of a single drum through the upper and lower block sheaves and to the double-sheave-type equalizer. Breakage of one cable system would reduce the factor of safety, but since each system is reeved to both sides of the bottom block and upper block system, there is no swinging or pendulum action of the block upon failure of one system. Equalizer sheaves are used in preference to equalizer bars so that ropes may more readily adjust to differences in length without the need for physical maintenance. Each of the equalizers is hung from a main pivot mechanism which is designed to be redundant within itself.

For the Fermi 2 crane, the wire rope safety factor for each single wire rope is a minimum of 10. This is determined by dividing the design rated load (125 tons) by the number of load-carrying parts (l6) and the efficiency factors (0.933) and comparing the result with the published breaking strength of 102 (nominal) tons for the 1-1/4 in. (nominal) diameter rope. The design of the dual reeving system is consistent with paragraph 3.f of BTP ASB 9-1.

In both the lower and upper blocks, the sheaves are mounted in a structural cage system having supporting plates on each side of each sheave. Thus, the load being carried by the sheave pin is shared by each of these support plates. Should a pin fail on any one particular sheave group, the adjacent sheave still maintains its integrity. This allows either reeving system to take over the entire load.

The main hook block is provided with a conventional hook, and the redundant feature is provided by two smaller hooks, each capable of sustaining 50 percent of the rated load at code stresses. The two additional hooks are individually mounted on their own pins and supported directly in the main block frame. They are intended for use only when handling the fuel cask.

To ensure against damage due to a tornado, the crane is provided with electrically operated locking bars that effectively connect the unloaded crane to the runway when it is not in use. These locking bars are capable of withstanding a tornado windforce of 410 lb/ft^2 intensity at a maximum of 90 percent of the yield strength of the crane components.

Earthquake protection is provided by restraints on the crane and trolley to prevent either from leaving its respective rails due to horizontal and/or vertical displacement. Seismic responses of the crane, based on its fundamental frequency in the vertical and two horizontal directions (perpendicular and parallel to the girder), have been calculated for the SSE and are 0.65g.

The crane is designed to accommodate SSE forces and deflections with the rated load suspended in the cask-hoisting position. Crane accelerations for the vertical SSE in the unloaded condition were also determined and found in all cases to be less than 1.0g. Seismic uplift forces are therefore not encountered.

The crane responses to the SSE, as determined above, are well below the design limits of the reactor building crane. Thus, the crane will remain within its restraints if subjected to an SSE.

Crane control can be either from the cab or by radio control. In the event that the crane cab becomes uninhabitable, control may be continued by means of the remote radio control provided. The only crane components that are actuated by the crane electrical control system and are an integral part of the mechanical load-retaining hoist system are the two shoe-type hoist holding brakes. The two electrical control components that actuate the hoist holding brakes are either the raise or lower hoist reversing contactors. If either the raise or lower hoist reversing contactor fails to open when called upon, the backup is the stop button in either the cab or in the radio control, which will interrupt the main power to the crane, causing the two independent hoist holding brakes to set and thereby stop the load.

To ensure that crane control can only be executed from one position at a time, a master control transfer switch is situated on the bridge. This switch must be manually operated by the operator and thus interrupts all of the control circuits so there can be no simultaneous operation of the crane from both the radio control and the cab control.

The crane control system is protected from actuation by signals from an outside source by use of a Security Start circuit. With this feature, the control system cannot be enabled until multiple conditions have been met which are unique to each receiver and its companion transmitter. To activate the equipment under control, the specific companion transmitter must be used. With this security start feature, there is no possibility of an outside source radio transmitter interfering with this system or causing inadvertent actuation since these foreign signals could not match the security circuit's multiple enabling conditions.

The crane test and surveillance programs include both preoperational tests and periodic testing, surveillance, and inspection programs.

Preoperational tests include crane hook certification to 100 percent overload, gear train no-load running tests, and complete functional tests after final crane assembly.

Periodic testing, surveillance, and inspection programs will be performed no more than 1 year prior to any usage of the crane. However, these tests and inspections will be performed just prior to each major refueling outage. Periodic testing will be conducted not more than 1 month prior to lifting of the first cask for a spent fuel transfer. The programs include magnetic particle or liquid penetrant examination of all hook surfaces; inspection of wire ropes for wear or damage, and measurements of wire rope diameters; other periodic testing, maintenance, and surveillance conducted in accordance with Occupational Safety and Health Administration (OSHA) requirements as set forth in 29 CFR 1910.179, Paragraphs (j), (k), (m), and (n); and periodic inspections as recommended by the crane manufacturer. Testing prior to refueling also includes a full test run of all motions of a typical fuel cask unloading and loading sequence.

The spent fuel cask-handling operation is performed under strict procedural control and under the direct supervision of the Shift Manager or his designated operator. The crane operator receives his instructions from the flagman by verbal communication. All operations that cannot be visually observed by the crane operator from his cab are transferred to radio control.

Personnel carrying out cask- and fuel-handling operations are qualified to meet the guidelines set forth in Regulatory Guide 1.8.

The reactor building crane is designed in accordance with the requirements of:

a. EOCI No. 61, Class A Service, and the structural guidelines of CMAA Specification No. 70

b. Seismic response spectra for Fermi 2

c. Material Specifications: ASTM; AISI; SAE; ASA

d. Electrical Specifications: N.E.C.; NEMA; IEEE; NBFU

e. Welding: AWS

f. Federal, State, and local codes, including OSHA.

Welding specifications used in the crane fabrication are as follows:

a. Manual shielded metal-arc welding (SMAW) in accordance with AWS D1.1 and AWS D14.1 for welding of structural steel of unlimited thickness and base metals of ASTM-A36, ASTM-A242, ASTM-A441, and ASTM-A572. The required preheat and interpass temperatures are as follows:

Plate Thickness (in.)	Minimum Preheat and Interpass Temperature (°F)		
Up to 3/4	50	50	
3/4 to 1-1/2	150	70	For FCAW
1-1/2 to 2-1/2	225	150	
Over 2-1/2	300	225	

(Reference: P&H welding procedure WP-SC of September 1972)

b. Flux cored arc welding (FCAW), same application as above

c. Submerged arc welding (SAW), same application as above, with preheat and interpass temperatures as for FCAW

d. Joint welding procedure classification tests were performed for all welding processes, including groove and fillet type welds

e. No postweld heat treatment was performed.

Girders, trolley frame, and general structures are constructed of ASTM, A-36 steel. The end ties are of ASTM, A-514 material.

9.1.4.2.3 Fuel Servicing Equipment

Two fuel-preparation machines are used to remove the channels from fuel assemblies and to reinstall the channels on fuel bundles. Additionally, the fuel preparation machines are used for fuel inspections and new fuel receipt/transfer activities. Strict administrative control on the fuel preparation machine's full-up end stop is required for personnel protection. These machines are designed to be removed from the pool for servicing.

The new-fuel transfer crane is a 1500 lb, wall-mounted, traveling-hinged boom crane which services the area (B, E, 15, 17) in Figure 9.1-3.

A new fuel uprighting stand is used to hold the steel shipping box in a vertical position while the fuel assembly is removed. A new-fuel inspection stand is used to restrain the fuel bundle in a vertical position for inspection. The inspection stand can hold two bundles. The new fuel uprighting stand and the inspection stand are approximately designated by point C,15 in Figure 9.1-3.

The general-purpose grapple is a small, hand-actuated tool used generally with the fuel. The grapple can be attached to the Reactor building auxiliary hoist and the auxiliary hoists on the refueling platforms. The general-purpose grapple or approved equivalent is used to remove new fuel from the vault, place it in the inspection stand, and transfer it to the fuel storage pool. It also can be used to shuffle fuel in the pool and to handle fuel during channeling.

A channel-handling boom with a spring-loaded takeup reel is used to assist the operator in supporting a portion of the weight after the channel is removed from the fuel assembly. The boom is set between the two fuel-preparation machines. With the channel-handling tool attached to the reel, the channel may be conveniently moved between fuel-preparation machines.

9.1.4.2.4 Servicing Aids

General area underwater lights are provided with a suitable reflector for downward illumination. Suitable light support brackets, independent of the platform, are furnished to support the portable lights in the reactor pressure vessel (RPV) to allow the light to be positioned over the area being serviced. Local area underwater lights are small-diameter lights for additional downward illumination. Drop lights are quartz lamps with no reflector and are used for intense radial illumination where needed. These lights are small enough in diameter to fit into fuel channels or control blade guide tubes. Portable underwater cameras and monitor are part of the plant optical aids. The transmitted image can be viewed on a monitor. This assists in the inspection of the vessel internals and general underwater surveillance in the RPV and fuel storage pool. A general-purpose clear plastic viewing aid that floats is used to break the water surface for better visibility.

Portable underwater vacuum/filter units are provided to assist in removing crud and miscellaneous particulate matter from the pool floor or from the RPV. These units may be completely submerged for extended periods. Fuel pool tool accessories are also provided to meet servicing requirements.

9.1.4.2.5 Reactor Vessel Servicing Equipment

Reactor vessel servicing equipment is supplied for safe handling of the vessel head and its components, including nuts, studs, bushings, and seals.

The head strongback is used for lifting the drywell head and for backup lifting of RPV head. The strongback is designed to keep the head level during lifting and transport. It is cruciform in shape with four equally spaced lifting points. The strongback is designed so that no single component failure can cause the load to drop or to swing uncontrollably. The head strongback meets the requirements of NUREG-0612. The strongback, including hook pins and turnbuckles, has been load tested to three times its rated capacity of 93 tons in accordance with ANSI N14.6-1978, Paragraph 6.3.

The RPV head strongback carousel combines the functions for stud tensioning/detensioning operations, closure stud nut and washer handling and storage (by supporting the Nut Rack), and the head strongback previously used for reactor pressure vessel head lifting and transport. The carousel meets the requirements of NUREG-0612. The carousel including hook pins and turnbuckles, has been load tested to three times its rated capacity of 117.3 tons in accordance with ANSI N14.6-1978, Paragraph 6.3.

A vessel nut-handling tool is provided. This tool handles four nuts and features a spring device to lift the nut and clear the threads.

The head-holding pedestals are designed to properly support the vessel head and permit seal removal and replacement, seal surface cleaning, and inspection. The mating surface between vessel and pedestal is selected to minimize the possibility of damaging the vessel head.

The RPV ventilation equipment consists of a portable unit that is attached to the RPV head for the purpose of removing trapped radioactive gases under the head during removal. After the head nuts and washers are removed, the RPV ventilation system is attached. As the head is raised, the trapped gases are drawn from the area under the head, passed through chemical filters, and exhausted. This eliminates possible inhalation doses to personnel during RPV head removal.

9.1.4.2.6 In-Vessel Servicing Equipment

The instrument strongback is attached to the reactor building crane auxiliary hoist and is used to lift replacement in-core detectors from their shipping containers.

The auxiliary hoist on the refueling platform is used with appropriate grapples to handle control rods, flux monitors, sources, and other internals of the reactor. Interlocks on both the grapple hoist and auxiliary hoist are provided for safety purposes. The refueling interlocks are described and evaluated in Subsection 7.6.1.1.

The Reactor Cavity Work Platform is used during the In-service Inspection of the vessel and other refueling outage related activities. This platform remains on the Reactor Building Fifth Floor during normal operation, secured safely to the reactor cavity concrete shield blocks. During refueling outages the platform will be installed in the reactor cavity, supported by eight (8) legs resting freely on the refueling deck. The leak-tight work area of the platform remains partially submerged in the flooded reactor cavity. The jib crane associated with this platform can be used to handle objects weighting up to 500 pounds.

The Reactor Cavity Work Platform is considered Seismic Category II/I since it is not required to ensure the three requirements of Category I system as discussed in Section 3.2.1. This Work Platform is designed to accommodate safe-shutdown earthquake (SSE) forces and deflections. Dynamic analysis using the Fermi 2 site characteristics for the refueling floor of the reactor building verifies that the Reactor Cavity Work Platform can withstand the SSE for the Fermi 2 site and will remain supported by the eight legs resting on the refueling deck.

The lifting lugs for the Reactor Cavity Work Platform are designed so that no single component failure can cause the load to drop or to swing uncontrollably. The lifting devices meet the requirements of NUREG-0612. The lift and handling system, including hook, pins and turnbuckles, has been load tested to three times its rated capacity of approximately 28 tons, in accordance with ANSI N14.6-1978, Paragraph 6.3.

9.1.4.2.7 Refueling Equipment

The refueling platform is used as the principal means of transporting fuel assemblies between the reactor well and the fuel storage pool. The platform travels on tracks extending along each side of the reactor well and the fuel storage pool. The platform supports the refueling grapple and auxiliary hoists. The grapple is suspended from a trolley system that can traverse the width of the platform. Platform operations are controlled from an operator station on the trolley. The platform contains a position-indicating system that indicates the position of the fuel grapple over the core.

The refueling platform is designed to accommodate safe-shutdown earthquake (SSE) forces and deflections. It has been designed to withstand a 1.5g horizontal and a 0.14g vertical acceleration based on static analysis. Dynamic analysis using the Fermi 2 site characteristics for the refueling floor of the reactor building verifies that the refueling platform can withstand the SSE for the Fermi 2 site and will remain on the rails. However, the refueling platform is considered Seismic Category II/I since it is not required to ensure the three requirements of Category I system as discussed in Subsection 3.2.1.

To ensure access to the drywell for inspection and maintenance during spent fuel transfer, a refueling shield bridge is utilized. A U-shaped trough lined with a nominal 6 in. of lead is placed across the gap between the RPV flange and the inner edge of the fuel transfer canal. When in place, the refueling shield bridge provides sufficient shielding to ensure continuous access to the drywell during spent fuel transfer.

9.1.4.2.8 Storage Equipment

Specially designed fuel storage racks are provided. For a description of fuel storage racks and fuel arrangement, see Subsections 9.1.1 and 9.1.2.

If sipping indicates a fuel assembly with defects of a large enough magnitude, the defective-fuel assembly is placed in a defective-fuel storage container. The defective-fuel storage containers (containing defective fuel) are stored in the Dual Purpose cells of the fuel storage racks. These are used to isolate leakage of defective fuel while in the fuel storage pool and during shipping. A defective-fuel storage container containing a fuel bundle may be moved.

The channel is removed from the defective-fuel assembly before it is placed in the container.

9.1.4.2.9 Under Reactor Vessel Servicing Equipment

The necessary equipment to remove several control rod drives (CRDs) during a refueling outage is provided. An equipment-handling platform with a rectangular open center is provided. This platform can rotate to provide space under the vessel so that a CRD can be lowered and removed. If a control rod guide tube must be removed, the thermal sleeve within the CRD housing must be rotated to disengage the guide tube. A thermal sleeve tool that permits installation or complete removal at the thermal sleeve is provided for this purpose. Special tools and instruments to service and test individual control rod hydraulic units are also provided.

Miscellaneous tools are provided to install and remove the neutron detectors. A drain can be opened after in-core insertion to drain any residual water. Correct seating of the in-core string is indicated when drainage ceases.

Additional tools and servicing equipment not covered in these paragraphs are listed in Table 9.1-5.

9.1.4.2.10 Dry Storage Cask Servicing Equipment

A variety of ancillary equipment is used to lift, move, and prepare the dry storage transfer cask and MPC as discussed in the HI-STORM 100 System FSAR. This includes such items as lifting devices, (e.g., lift yoke, lift links, and slings), draining, drying, and backfill equipment, and welding equipment. After a dry storage cask loading campaign is completed the ancillary equipment is either removed from the site or stored in the dry cask equipment storage building near the ISFSI.

9.1.4.3 Description of Fuel Transfer

The fuel handling system provides a safe and effective means for transporting and handling fuel from the time it reaches the plant until it leaves the plant after postirradiation cooling. The previous subsection described the equipment and methods utilized in fuel handling. The following paragraphs describe the integrated fuel transfer system.

9.1.4.3.1 Arrival of Fuel on the Fermi Site

Fuel arrives on the Fermi site by truck. The fuel elements are shipped in steel boxes that support the fuel element along its entire length. The stainless steel box is contained in a stainless steel overpack. Cushioning material and a support frame positions the stainless steel box in the overpack. Two fuel assemblies are contained in each shipping container. Each shipping container is designed to ensure subcritical geometry in handling as required by 10 CFR 71.

A specific criticality safety analysis, as identified in reference 12 herein, was performed for safe storage, handling and transport of GE BWR nuclear fuel shipping containers during new fuel receipt for Fermi 2. A new generic criticality evaluation, identified as reference 16 herein, has been performed for the new stainless steel shipping container. The updated analysis provides assurance that an inadvertent criticality is highly improbable during onsite storage, handling and transportation of new fuel within shipping containers. This meets the criterion of GDC 62, "Prevention of Criticality in Fuel Storage and Handling." The former safety analysis provided is the bases for Fermi 2's exemption from the requirements of 10 CFR 70.24, as granted by the Nuclear Regulatory Commission and identified by reference numbers 13 and 14 herein. The exemption requires criticality monitoring in areas where fuel is handled outside the inner metal shipping containers (the refuel floor). In contrast, the exemption allows administrative controls, such as the use of geometrically safe configurations as bound by the aforesaid former safety analysis for areas in which the new fuel remains in the inner metal shipping containers (the yard and the reactor building up to the refuel floor). The updated criticality evaluation provides for similar controls. Therefore, monitoring for an inadvertent criticality while handling or transporting new fuel is not required in the yard or during transport to the refuel floor.

The fuel can be handled by wearing gloves and other protective clothing. The containers are lifted to the refueling floor through the equipment hatch using the reactor building crane. Once the fuel is removed from the inner shipping containers on the refuel floor, criticality monitoring is required. Monitoring for an inadvertent criticality event on the refuel floor, is provided by two redundant detectors (D21-N115 and D21-N117). These detectors are high sensitivity gamma ray detectors (GM tubes) and are located on the east wall approximately 9 ft to 12 ft in the air. The alarm trip setting on these detectors is in the proscribed range of 5-20 mR/hr, which is adequate to detect the minimum accident of concern as described in 10 CFR 70.24 and ANSI/ANS 8.3-1986. The alarm circuitry of these detectors is arranged in a fail safe mode such that any malfunction of the detectors or a loss of power results in an alarm condition. Additionally, the detectors have a meter pegging circuit which precludes a downscale low reading (no foldover) during saturation of the GM tube due to high intensity radiation fields. Periodic performance tests are conducted to confirm instrument response to radiation and the operability of the alarm signal generator.

The aforementioned design meets the criterion of GDC 63, "Monitoring Fuel and Waste Storage." Additionally, Fermi 2 personnel are instructed to evacuate areas in which radiation or criticality alarms are activated. Evacuation of plant areas is periodically tested by the conduct of emergency response drills.

Depending on the laydown area, the metal containers can be placed in the new fuel uprighting stand using the auxiliary hoist, the new-fuel transfer crane, or a mobile crane. Any of these cranes can be used to transfer fuel from the new fuel uprighting stand to the inspection stand and to the fuel pool. Transfer of fuel from the new fuel storage vault can be done only with the auxiliary hoist. However, due to the lack of criticality detector redundancy, Fermi 2 does not strictly comply with 10 CFR 70.24 with regard to the new fuel storage vault. Accordingly, the spent fuel pool is used for storage of new fuel rather than the new fuel storage vault.

9.1.4.3.2 Refueling Procedure

Figure 9.1-28 defines, in general, the steps that make up a refueling outage. The heavy lines on the chart define the critical path in a normal outage. Deviations from this path may be encountered under normal circumstances for various reasons, such as scheduling and convenience. The reactor shall be determined to have been subcritical for at least 60 hours by verification of the date and time of subcriticality prior to movement of irradiated fuel in the reactor pressure vessel.

9.1.4.3.3 Departure of Fuel From the Fermi Site

Spent fuel assemblies may be shipped off site in two different ways: 1) directly from the spent fuel pool into a shipping cask or 2) after a period of storage at the ISFSI and then in a shipping cask. For direct shipping, fuel assemblies from the spent fuel pool are conveyed by the fuel-handling bridge crane into the spent fuel cask located in the fuel storage pool. After insertion into the spent fuel cask, the cask head is replaced, and the flooded container with fuel is raised out of the pool by the reactor building crane for transfer to the cleaning station. The cleaning station is a depression in the floor adjacent to the pool and is designed for 1000 pounds per square foot load. The cask head is bolted down, and the cask is thoroughly cleaned. Final transfer from the cleaning station down the shaft to the vehicle-loading station is by crane. The cask is laid on its side on a flatbed, one to a flatbed, for return to the fuel processing/storage facility.

Spent fuel to be stored at the ISFSI before shipment offsite is prepared for storage and moved to the ISFSI which is described in Section 9.1.2.2.3. At some time in the future, the fuel at the ISFSI will be shipped offsite. The storage overpack containing the fuel-loaded MPC will be moved to a location where the MPC can be transferred directly from the storage overpack to an NRC-licensed transportation overpack, which is designed and licensed to ship the MPC pursuant to 10 CFR 71. The MPC inside the shipping overpack is loaded on a conveyance (e.g., rail car) for direct shipment offsite. The fuel inside the MPC does not need to be removed and re-packaged in the Fermi spent fuel pool before shipment.

9.1.4.4 Control of Heavy Loads in Close Proximity to Irradiated Fuel or Safety Systems

The NRC in Reference 10 concluded that Fermi 2 meets the guidelines of NUREG-0612 for the handling of heavy loads near spent fuel. Travel paths for the handling of these loads have been graphically described, and the procedures controlling adherence to these travel paths have been identified.

The reactor building crane, Subsection 9.1.4.2.2, main hoist is single-failure proof. There are no heavy-load handling applications at Fermi 2 other than those that can be handled by the main hoist, that require handling within single-failure-proof guidelines. In order to meet NUREG-0612 guidelines, the reactor building crane auxiliary hoist has a load-limit feature that restricts the hoist from handling heavy loads (greater than 2000 lb) over the spent fuel pool and open reactor vessel.

The training and qualification of crane and hoist operators are in accordance with NUREG-0612 guidelines. The testing, inspection, and maintenance of these cranes and hoists also conform to these guidelines. Hoisting of all heavy loads around critical equipment will be covered by written procedures.

Cranes, hoists, and slings used to handle heavy loads around critical equipment are in conformance with the standards specified in NUREG-0612. The matrix analysis performed on all heavy load hoist combinations has identified all potentially affected safety system components and has defined the hazard elimination category under the NUREG-0612 guidelines for each of these components.

The special lifting devices at Fermi 2 include the head strongback, the dryer/separator lifting device, the spent fuel transfer cask lifting yoke and the RPV head strongback carousel. These special lifting devices, except for the lifting yoke, were found acceptable by the NRC in Reference 10. All lifts of the spent fuel transfer cask are made with a single-failure-proof lifting system to ensure the likelihood of a drop of either load is so low as to be considered not credible. A single-failure-proof lifting system consists of the crane, lifting devices (e.g., lifting yoke, lift links or brackets, slings, etc.), and interfacing lift points (e.g., cask lifting trunnions and MPC lift cleats). The design of the RB crane lifting system for lifts of a spent fuel transfer cask or canister inside the power plant meets the guidelines for a single-failure-proof lifting system in NUREG-0612, Section 5.1.6.

Periodic testing of these special lifting devices meets the guidelines of NUREG-0612 by following ANSI N14.6-1978 and the NRC's interpretation of the NUREG-0612 guidelines provided with Reference 11. Testing and/or inspection of the RB crane lifting system components used to lift and move dry spent fuel storage cask equipment inside the power plant is performed in accordance with NUREG-0612, Section 5.1.6.

9.1 FUEL STORAGE AND HANDLING

REFERENCES

1. Holtec Report HI-992154, "Licensing Report for Spent Fuel Rack Installation at Fermi Unit 2", (DECo File Number R1-7696)

1a. Letter from Holtec to B. Cummings, Impact of Proposed Rack Height Reduction on Existing Calculations, March 17, 2006 (DECo File Number P1-16952)

2. NRC Position Paper, subject: "Fuel Pool Storage and Handling Application," April 1978 and amended January 1979.

3. Joseph Oat Corporation, Licensing Input on High Density Spent Fuel Racks for Fermi II Project, Report TM-586, Camden, New Jersey.

3a. Deleted

3b. Holtec Proprietary Report HI-961465 – WPMR Analysis User Manual for Pre&Post Processors & Solver, August, 1997.

3c. Singh, K.P. and Soler, A.I., Dynamic Coupling in a Closely Spaced Two-Body System Vibrating in Liquid Medium: The Case of Fuel Racks, 3rd International Conference on Nuclear Power Safety, Keswick, England, May 1982.

3d. Fritz, R.J., The Effects of Liquids on the Dynamic Motions of Immersed Solids, Journal of Engineering for Industry, Trans. of the ASME, February 1972, pp 167-172.

4. S. Levy and J. P. D. Wilkinson, The Component Element Method in Dynamics with Application to Earthquake and Vehicle Engineering, McGraw-Hill, New York, New York, 1976.

5. Joseph Oat Corporation, A Method for Hydro-Thermal Analysis of High Density Fuel Racks, Standard Document No. 20, Camden, New Jersey.

6. Southern Science Applications, Inc., Benchmark Calculations for Spent Fuel Storage Racks, Report SSA-127, Dunedin, Florida.

7. Global Nuclear Fuel, GE-14 Boraflex Spent Fuel Storage Rack Criticality Analysis for Fermi 2 Unit 2. (R1-7976)

7a. General Electric Company, General Electric Standard Application for Reactor Fuel, Latest Revision.

7b. Global Nuclear Fuel, GE-14 Boral Spent Fuel Storage Rack Criticality Analysis for Fermi 2 Unit 2. (R1-7687)

7c. Holtec Report HI-992207, Bulk SFP Thermal-Hydraulic Analyses For Reracking of Fermi Unit 2. (R6-422)

7d. Global Nuclear Fuel, GE-14 Defective Fuel Storage Rack Criticality Analysis for Fermi 2 Unit 2. (R1-7686)

8. Letter from G. W. Knighton, NRC, to H. Tauber, Detroit Edison, April 26, 1976.

9. Detroit Edison Co., "Summary Report, FSAR Stage Open Item, Fuel Cask Storage Pool Reactor Building, Crane Redundancy Fuel Cask Drop Accident," EF2-25622, June 25, 1974.

9.1 FUEL STORAGE AND HANDLING

REFERENCES

10. Letter from B. J. Youngblood, NRC, to Wayne Jens, Detroit Edison, subject: Issuance of Supplement No. 5 to NUREG-0798-Fermi 2, March 21, 1985.

11. Letter from B. J. Youngblood, NRC, to H. Tauber, Detroit Edison, subject: Control of Heavy Loads at Fermi 2 in Accordance with NUREG-0612, November 1, 1983.

12. Letter from General Electric (RDW:98-037) to Detroit Edison, "Detroit Edison Company Fuel Handling Criticality Assessment," dated April 9, 1998. Superseded by Reference 16.

13. Detroit Edison Letter NRC-98-0063, "Request for Exemption from 10 CFR 70.24, Criticality Accident Requirements," dated April 17, 1998.

14. NRC Letter, "Fermi 2 - Issuance of Exemption from the Requirements of 10 CFR 70.24 (TAC NO. MA1645)," dated June 2, 1998.

15. Detroit Edison Design Calculation DC-4231 Vol I, "Loss of Decay Heat Removal – High Density Fuel Storage Pool."

16. RAJ II Safety Analysis Report, Docket No. 71-9309, Chapter 6, Criticality Evaluation.

17. NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," U.S. NRC, July, 1980.

18. HI-STORM 100 System 10 CFR 72 Certificate of Compliance 1014, Amendment 5.

19. HI-STORM 100 System 10 CFR 72 Final Safety Analysis Report, Revision 7.

20. Detroit Edison Company Independent Spent Fuel Storage Installation 10 CFR 72.212 Evaluation Report, as updated.

21. NRC Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation.

22. TRVEND 24MCGNF3FTRT0211, GNF3 – Boral and Boraflex Fuel Storage Rack Criticality Analyses for Fermi Unit 2.

23. Branch Technical Position ASB 9-2, "Residual Decay Energy for Light-Water Reactors for Long-Term Cooling." Attached to NUREG-0800, Section 9.2.5 (NRC ADAMS Accession# ML052350549).

24. W3F1-2004-0102, Supplement to Amendment Request NPF-38-249, Extended Power Uprate Waterford Steam Electric Station, Unit 3 (NRC ADAMS Accession# ML043010238).

25. WATERFORD STEAM ELECTRIC STATION, UNIT 3 – ISSUANCE OF AMENDMENT RE: EXTENDED POWER UPRATE (TAC NO. MC1355) Dated April 15, 2005 (NRC ADAMS Accession# ML051030068).

TABLE 9.1-1 FUEL POOL COOLING AND CLEANUP SYSTEM

Total pool, well, and pit volume	107,000 ft^3	
Fuel storage pool net water volume[c]	42.030 ft^3	
Operating heat load	9.12×10^6 Btu/hr	
Design heat load[c]	16.66×10^6 Btu/hr	
Maximum heat load (core offload)[c]	42.65×10^6 Btu/hr	
	Fuel Pool Cooling Water Pumps	
Quantity	2	
Type	Horizontal, centrifugal	
Design flow/TDH (each)	550 gpm/300 ft	
Motor hp	60 hp	
	Fuel Pool Cooling Heat Exchangers	
Quantity	2	
Design code	ASME B&PV, Section VIII	
	Shell Side	Tube Side
Fluid circulated	RBCCW[a]	Spent fuel pool water
Sizing Temperature	95 °F	125 °F
Sizing Fluid flow	800 gpm	550 gpm
Number of passes	1	2
Material	CS, SA-106B	SS-304, SA-249
Design system pressure	150 psig	200 psig
Design system temperature	150 °F	150 °F
Spent Fuel Pool Cooling Capacity of FPCCS		
FPCCS to RBCCW Inlet temperature differential	30 °F	55 °F
Cooling Capacity, Btu/hr:		
1 pump/1 H-X, design service rated	4.56×10^6	8.33×10^6
2 pump/2 H-X, design service rated	9.12×10^6	16.66×10^6

Fuel Pool Filter-Demineralizers

Type	Pressure precoat
Quantity	2
Design filter area	270 ft^2
Filter capacity	550 gpm
Maximum pressure drop	30 psi
Design code	ASME B&PV, Section VIII

TABLE 9.1-1 FUEL POOL COOLING AND CLEANUP SYSTEM

Holding pump flow	150 gpm
Precoat flow	>400 gpm

Spent Fuel Pool Cooling Capacity of RHR[b]

RHR to RHRSW Inlet ΔT	36 °F	49 °F	61 °F
Cooling capacity, Btu/hr			
RHR/FPC-Assist @ 3,500 gpm	30.72×10^6	42.22×10^6	52.51×10^6
RHR/SDC @ 10,000 gpm	41.6×10^6		

---

[a] Maximum design temperature of RBCCW is 95°F at 85°F lake water temperature. When lake water temperature is 60°F or below, the RBCCW is controlled to 70°F.

[b] All RHR design capacity values assume 9,000 gpm RHR Service Water flow and fully fouled (service rated) heat exchanger tubes.

[c] These values assume additional storage locations are added in the spent fuel pool to be consistent with Tables 9.1-2 and 9.1-3.

TABLE 9.1-2a FRACTIONAL DECAY HEAT VERSUS TIME AFTER SHUTDOWN, 5.2 YEARS' IRRADIATION, ONE-THIRD CORE, 18-MONTH CYCLE WITH EMERGENCY CORE OFFLOAD AT 3430 MWt AND 3486 MWt

Time After Shutdown, t_s (days)	T_s (sec)	$\frac{P}{P_o}$	Number of Assemblies Discharged to Pool	Decay Heat per Discharge QDKP[1] 3430 MWt	Decay Heat per Discharge QDKP[2] 3486 MWt
1.08E+04	9.33E+08	6.109E-05	220	0.0603	0.0399
1.02E+04	8.81E+08	6.333E-05	228	0.0648	0.0429
9.67E+08	8.35E+08	6.563E-05	224	0.0660	0.0437
9.21E+03	7.96E+08	6.763E-05	228	0.0692	0.0458
8.27E+03	7.15E+08	7.193E-05	176	0.0568	0.0376
7.48E+03	6.46E+08	7.573E-05	220	0.0748	0.0495
6.93E+03	5.99E+08	7.853E-05	224	0.0790	0.0522
6.38E+03	5.51E+08	8.138E-05	224	0.0818	0.0541
5.40E+03	4.67E+08	8.434E-05	224	0.0849	0.0561
6.29E+03	4.57E+08	8.746E-05	224	0.0879	0.0582
4.74E+03	4.10E+08	9.063E-05	224	0.0911	0.0603
4.20E+03	3.63E+08	9.395E-05	200	0.0844	0.0558
3.65E+03	3.15E+08	9.740E-05	200	0.0875	0.0579
3.10E+03	2.68E+08	1.011E-04	200	0.0908	0.0601
2.55E+03	2.20E+08	1.053E-04	200	0.0945	0.0628
2.01E+03	1.74E+08	1.112E-04	200	0.0998	0.0670
1.46E+03	1.26E+08	1.237E-04	200	0.1111	0.0771
9.12E+02	7.88E+07	1.627E-04	200	0.1460	0.1114
3.65E+02	3.15E+07	3.423E-04	200	0.3074	0.2742
6.50E+00	5.62E+05	3.107E-03	764	10.6600	10.653
		Total	4780	12.50	11.959

[1] 3430 MWt QDKP values obtained using uncorrected BTP ASB 9-2 (Rev 5 of Reference 7c).
[2] 3486 MWt decay heat values represent GNF3 fuel evaluated using corrected BTP ASB 9-2 (References 23-25).

TABLE 9.1-2b FRACTIONAL DECAY HEAT VERSUS TIME AFTER SHUTDOWN, 5.74 YEARS' IRRADIATION, ONE-THIRD CORE, 24-MONTH GNF3 EQUILIBRIUM CYCLE WITH EMERGENCY CORE OFFLOAD AT 3486 MWt

Time After Shutdown, t_s (days)	T_s (sec)	$\frac{P}{P_o}$	Number of Assemblies Discharged to Pool	Decay Heat per Discharge QDKP[1] 3486 MWt
11.32E+03	9.782E+08	3.834E-05	184	0.0322
10.59E+03	9.151E+08	4.022E-05	244	0.0448
9.861E+03	8.520E+08	4.219E-05	244	0.0470
9.131E+03	7.889E+08	4.426E-05	244	0.0493
8.400E+03	7.258E+08	4.643E-05	244	0.0517
7.670E+03	6.627E+08	4.871E-05	244	0.0542
6.939E+03	5.995E+08	5.110E-05	244	0.0569
6.209E+03	5.364E+08	5.360E-05	244	0.0597
5.478E+03	4.733E+08	5.623E-05	244	0.0626
4.748E+03	4.102E+08	5.899E-05	244	0.0657
4.017E+03	3.471E+08	6.190E-05	244	0.0689
3.287E+03	2.840E+08	6.502E-05	244	0.0724
2.556E+03	2.209E+08	6.879E-05	244	0.0766
1.826E+03	1.577E+08	7.588E-05	244	0.0845
1.095E+03	9.467E+07	1.038E-04	244	0.1155
3.65E+02	3.155E+07	3.004E-04	244	0.3344
6.50E+00	5.616E+05	3.056E-03	764	10.653
		Total	4608[2]	11.930

[1] Decay heat values obtained using corrected BTP ASB 9-2 (Rev 8 of Reference 7c).
[2] Amendment 141 Licensed capacity.

TABLE 9.1-3a CUMULATIVE POOL HEAT LOAD AND QUANTITY OF FUEL STORED IN POOL AT END OF NORMAL 18-MONTH REFUELING CYCLE AT 3430 MWt AND 3486 MWt

Time After Initial Discharge (years)	Decay Heat per Discharge QDKP[1] (MWt)	Quantity of Fuel Stored After Discharge (assemblies)	Bulk Pool Heat Load After Discharge 3430 MWt[1]	Bulk Pool Heat Load After Discharge 3486 MWt[2]
30.0	0.060	220	0.060	0.0394
28.5	0.064	448	0.124	0.0817
27.0	0.065	672	0.189	0.125
25.7	0.068	900	0.257	0.170
23.2	0.056	1076	0.313	0.207
21.0	0.074	1296	0.387	0.256
19.5	0.078	1520	0.465	0.308
18.0	0.081	1744	0.546	0.361
16.5	0.084	1968	0.630	0.417
15.0	0.087	2192	0.717	0.474
13.5	0.090	2416	0.807	0.534
12.0	0.083	2616	0.890	0.589
10.5	0.086	2816	0.977	0.646
9.0	0.090	3016	1.066	0.705
7.5	0.093	3216	1.160	0.767
6.0	0.098	3416	1.257	0.832
4.5	0.106	3616	1.363	0.905
3.0	0.129	3816	1.493	1.000
1.5	0.218	4016	1.711	1.183
0.0106	4.551	4276	6.262	5.728

[1] Decay heat obtained using uncorrected BTP ASB 9-2 (Rev 5 of Reference 7c).
[2] Decay heat for GNF3 obtained using corrected BTP ASB 9-2 (References 23-25).

TABLE 9.1-3b GNF3 CUMULATIVE POOL HEAT LOAD AND QUANTITY OF FUEL STORED IN POOL AT END OF NORMAL 24-MONTH REFUELING CYCLE AT 3486 MWt

Time After Initial Discharge (years)	Decay Heat per Discharge QDKP[1] (MWt)	Quantity of Fuel Stored After Discharge (assemblies)	Bulk Pool Heat Load After Dicharge 3486 MWt
32.0	0.031	184	0.031
30.0	0.044	428	0.075
28.0	0.046	672	0.121
26.0	0.048	916	0.169
24.0	0.051	1160	0.220
22.0	0.053	1404	0.273
20.0	0.056	1648	0.328
18.0	0.058	1892	0.386
16.0	0.061	2136	0.447
14.0	0.064	2380	0.512
12.0	0.067	2624	0.579
10.0	0.071	2868	0.650
8.0	0.074	3112	0.724
6.0	0.080	3356	0.803
4.5	0.094	3600	0.897
2.0	0.168	3844	1.066
0.0103	4.334	4088	5.400

[1] Decay heat obtained using corrected BTP ASB 9-2 (Rev 8 of Reference 7c).

TABLE 9.1-4 HAS BEEN INTENTIONALLY DELETED

TABLE 9.1-5 TOOLS AND SERVICING EQUIPMENT

Fuel Servicing Equipment

Fuel-preparation machines
New fuel inspection stand
Channel bolt wrenches
Channel-handling tool

Fuel inspection fixture

General-purpose grapples

Servicing Aids

Pool tool accessories
Actuating poles
General area underwater lights
Local area underwater lights
Drop lights
Underwater camera and monitor system
Underwater vacuum/filter units
Viewing aids
Lights support brackets
In-core detector cutting tool
In-core manipulator

Reactor Pressure Vessel Servicing Equipment

RPV servicing tools
Steam line plugs
Shroud head bolt wrenches
RPV nut-handling tool
Head-holding pedestals
Head nut plus washer racks
Head stud rack
Dryer-separator sling
Head strongback
Steam line plug installation tool
RPV head ventilation equipment
Reactor Cavity Work Platform
RPV Head Strongback Carousel

In-Vessel Servicing Equipment

Instrument strongback
Control rod grapple
Control rod guide tube grapple
Fuel support grapple
Grid guide
Control rod latch tool
Instrument-handling tool
Orifice grapple (peripheral)
Control rod guide tube seal
In-core guide tube seals
Orifice holder (peripheral)
Blade guides

Refueling Equipment

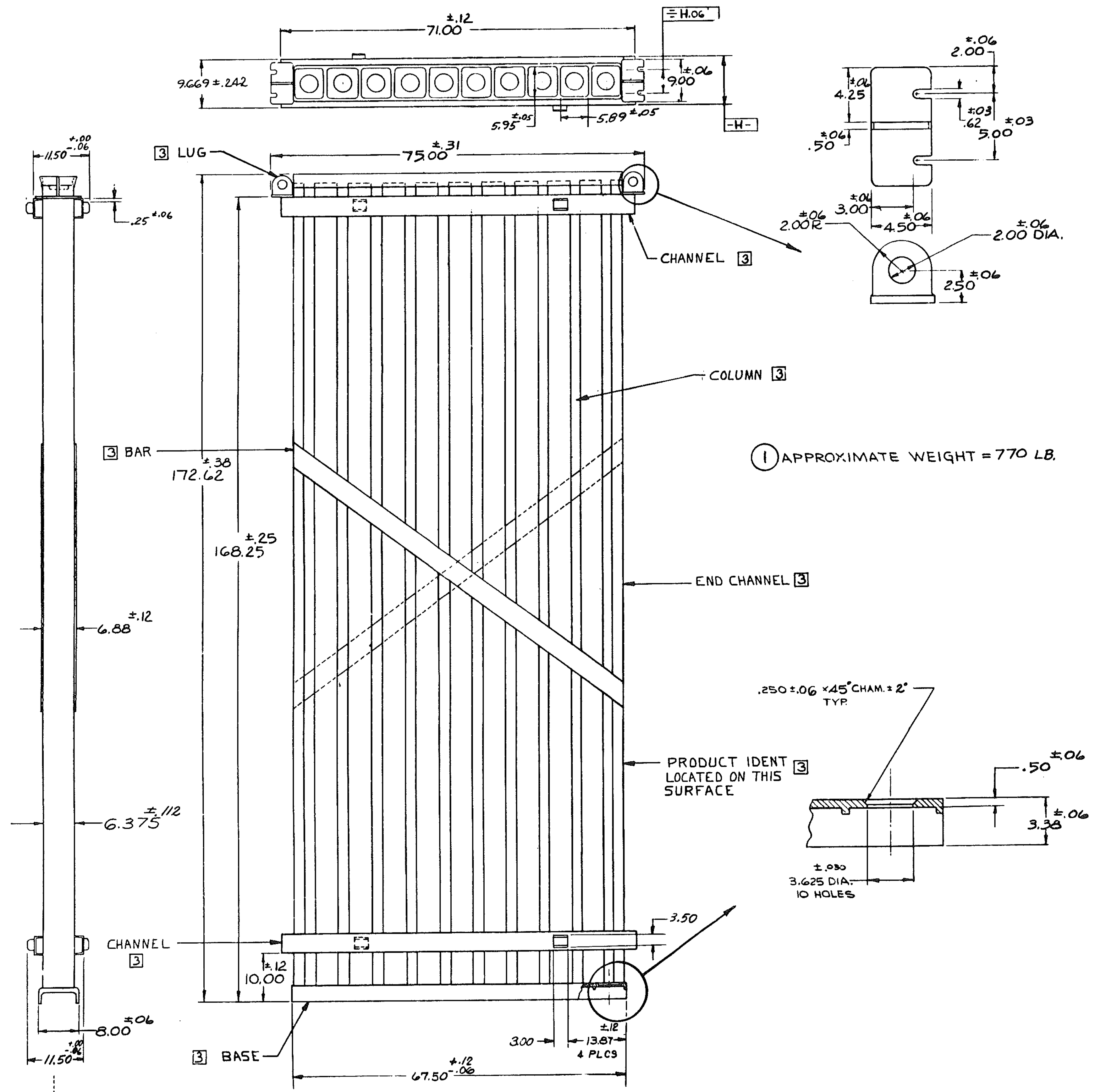
Refueling equipment servicing tools
Refueling platform equipment
Refueling shield bridge

Storage Equipment

Spent fuel storage racks
Storage racks (control rod)
Defective-fuel storage containers

Under Reactor Pressure Vessel Servicing Equipment

CRD servicing tools
CRD hydraulic system tools
Neutron monitoring system servicing tools
CRD handling equipment
Equipment-handling platform
Thermal sleeve installation tool
In-core flange seal test plug

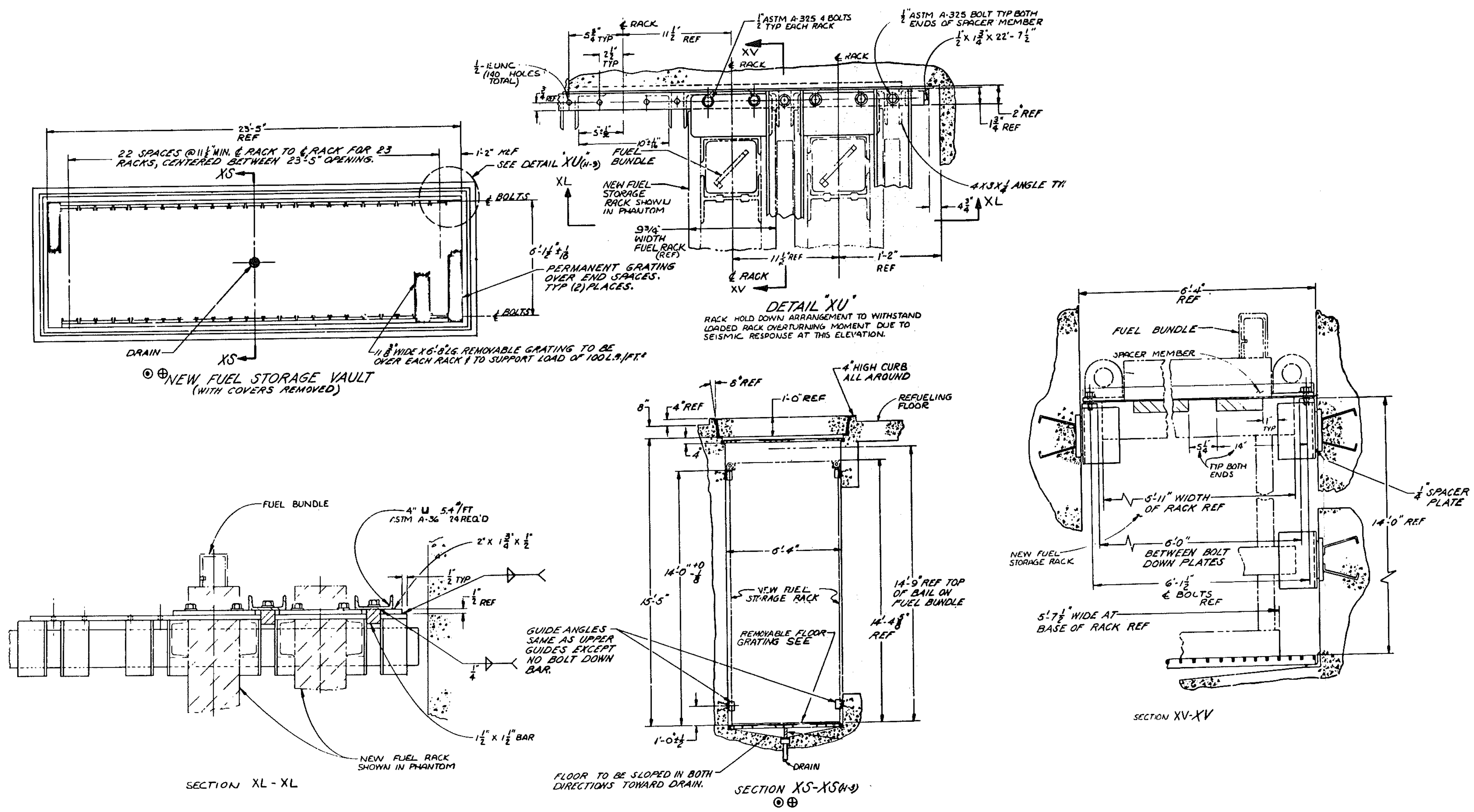


Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-1

NEW-FUEL STORAGE RACK

GENERAL ELECTRIC COMPANY DRAWING NO. 922D173, REV. C



GENERAL ELECTRIC COMPANY DRAWING NO. 762E156, REV. A

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-2

NEW-FUEL STORAGE VAULT

Figure Intentionally Removed
Refer to Plant Drawing A-2003-01

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-3, SHEET 1

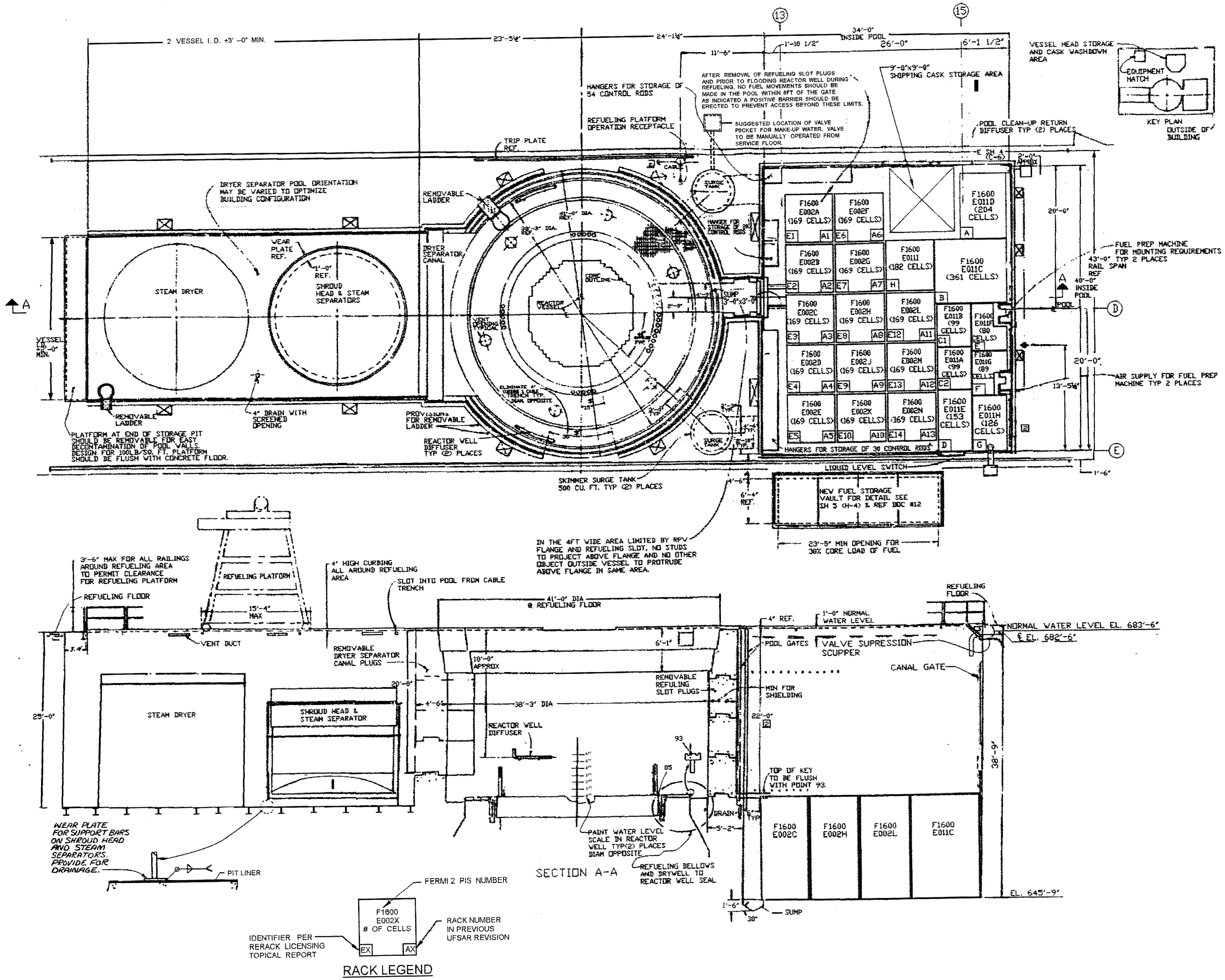
REFUELING FACILITIES

Figure Intentionally Removed
Refer to Plant Drawing A-2003-02

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-3, SHEET 2

REFUELING FACILITIES



NOTES:

1. FUEL POOL FLOOR LOADING SHOULD INCLUDE WEIGHT OF STORED FUEL ELEMENTS.
2. NEW FUEL STORAGE VAULT FLOOR GRATE LOADING, 1,500#/SQ. FT.
3. RAIL INSTALLATION TO BE DESIGNED FOR 10,000#/ WHEEL WITH 10' -0" MIN, WHEEL SPAN.
4. APPROX. SIZE & WEIGHT OF SHIPPING CASK 7' -0" X 18' -6" X 100 TON FLOOR REINFORCEMENT SHOULD BE ADEQUATE TO SUPPORT 100 TON OR REACTOR BUILDING CRANE RATING, WHICH EVER IS GREATER.

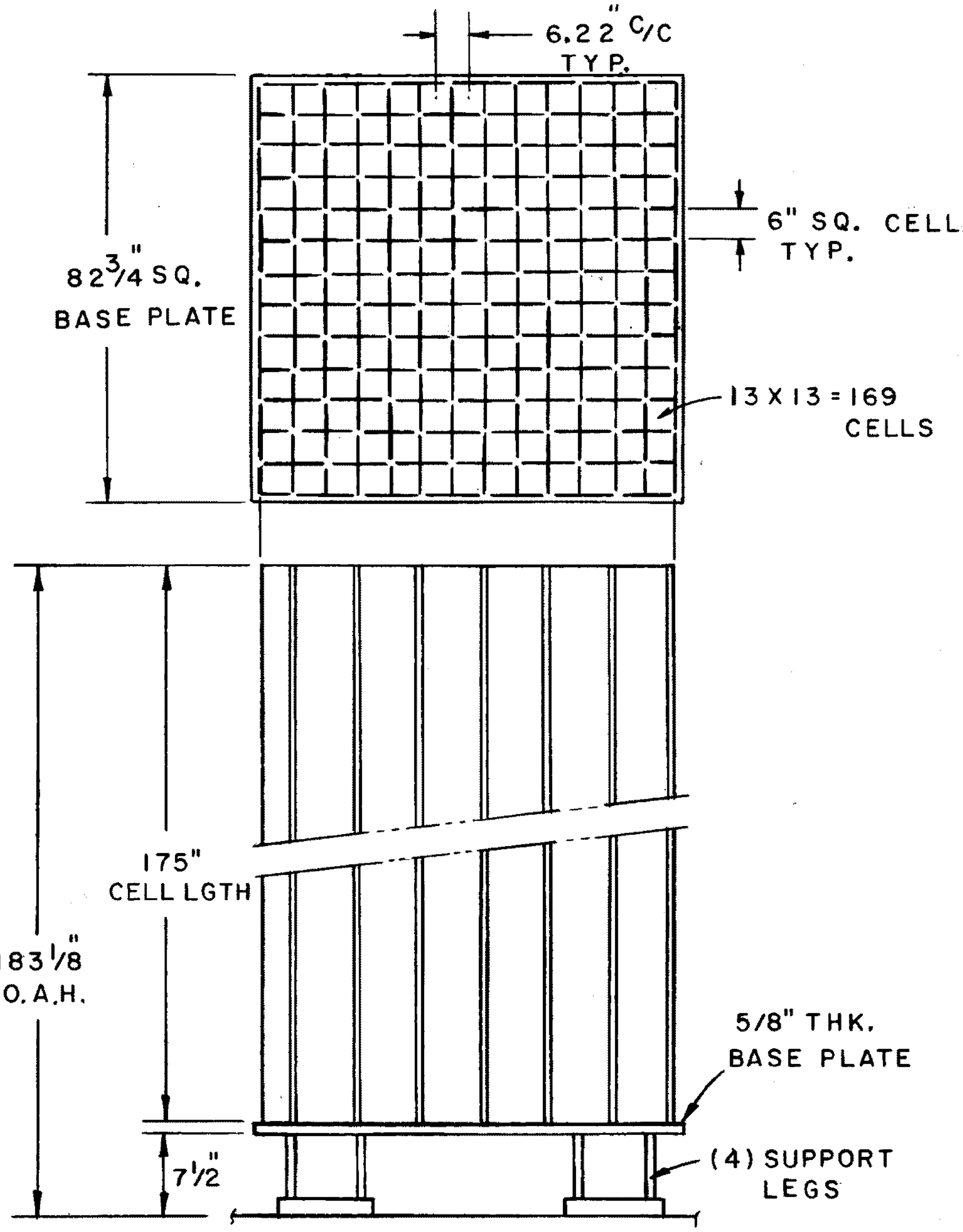
BASED ON GENERAL ELECTRIC COMPANY DRAWING NO. R6-222

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-3, SHEET 3

REFUELING FACILITIES



NOTE: DIMENSIONS ARE NOMINAL AND FOR INFORMATION ONLY

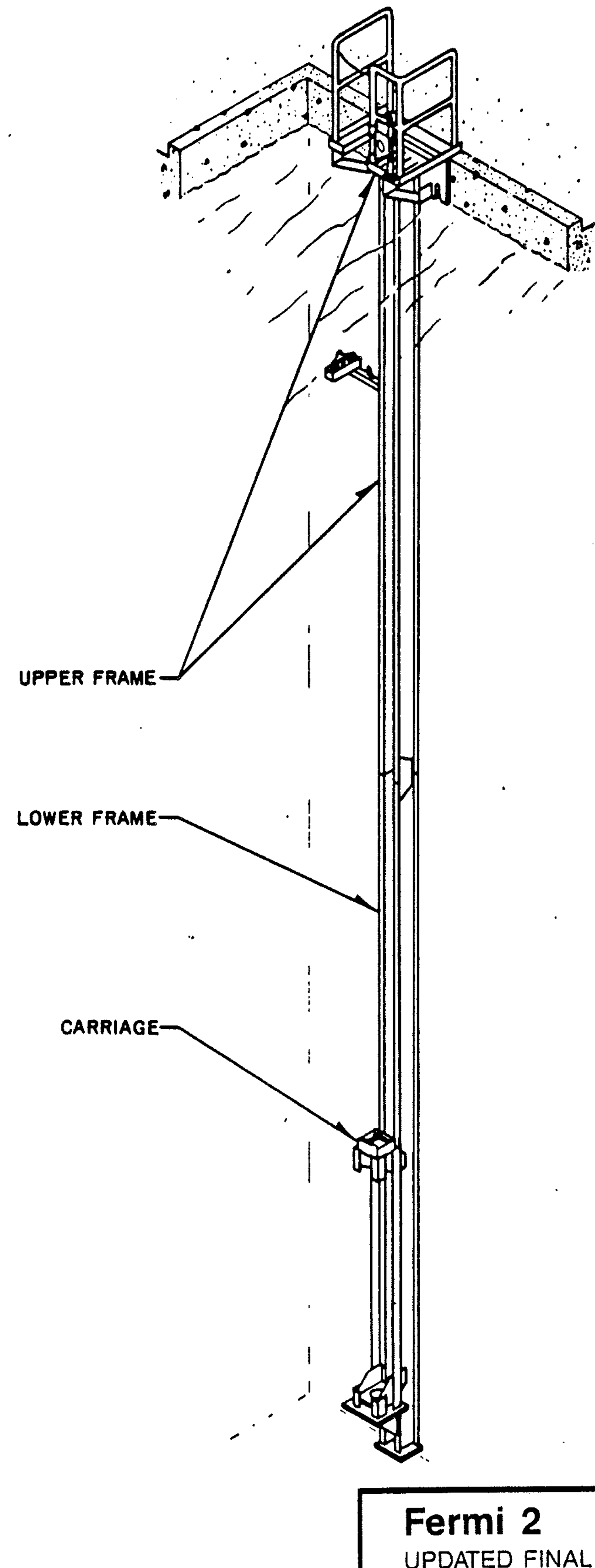
Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-4

MODULE TYPE “A” (169 CELLS) OAT HIGH-DENSITY SPENT FUEL RACKS

FIGURES 9.1-5 THROUGH 9.1-7
HAVE BEEN INTENTIONALLY DELETED

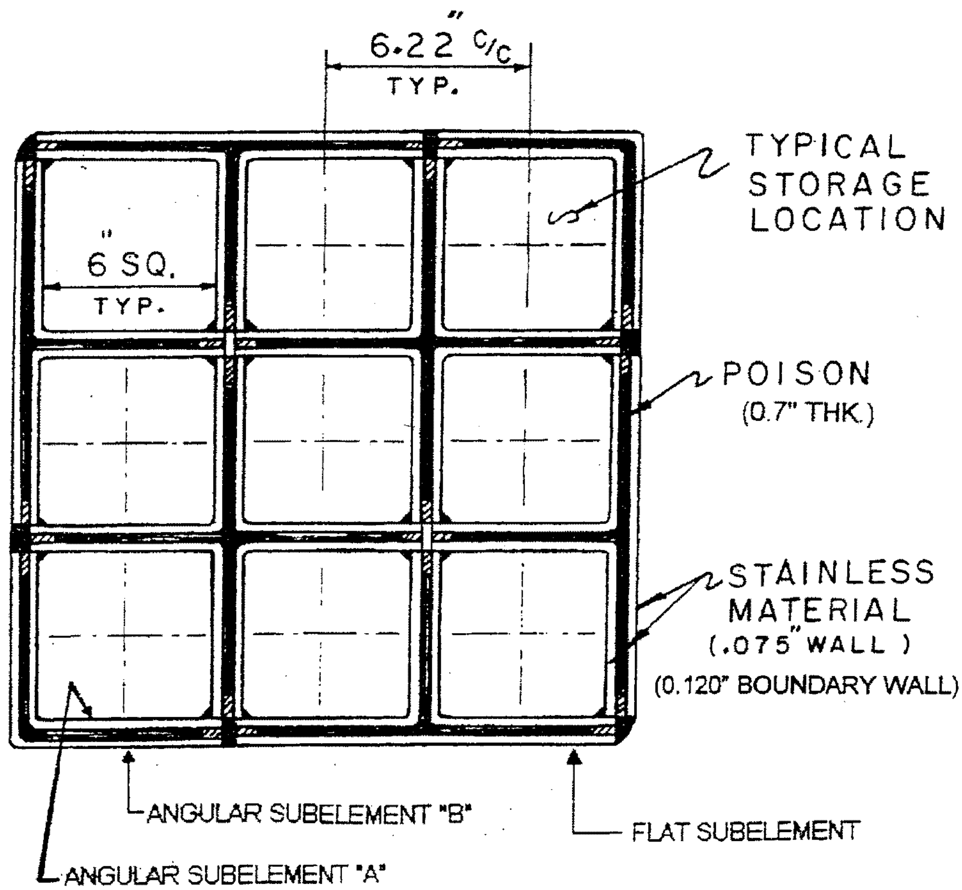


Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-8

FUEL PREPARATION MACHINE

FIGURE 9.1-9 HAS BEEN INTENTIONALLY DELETED



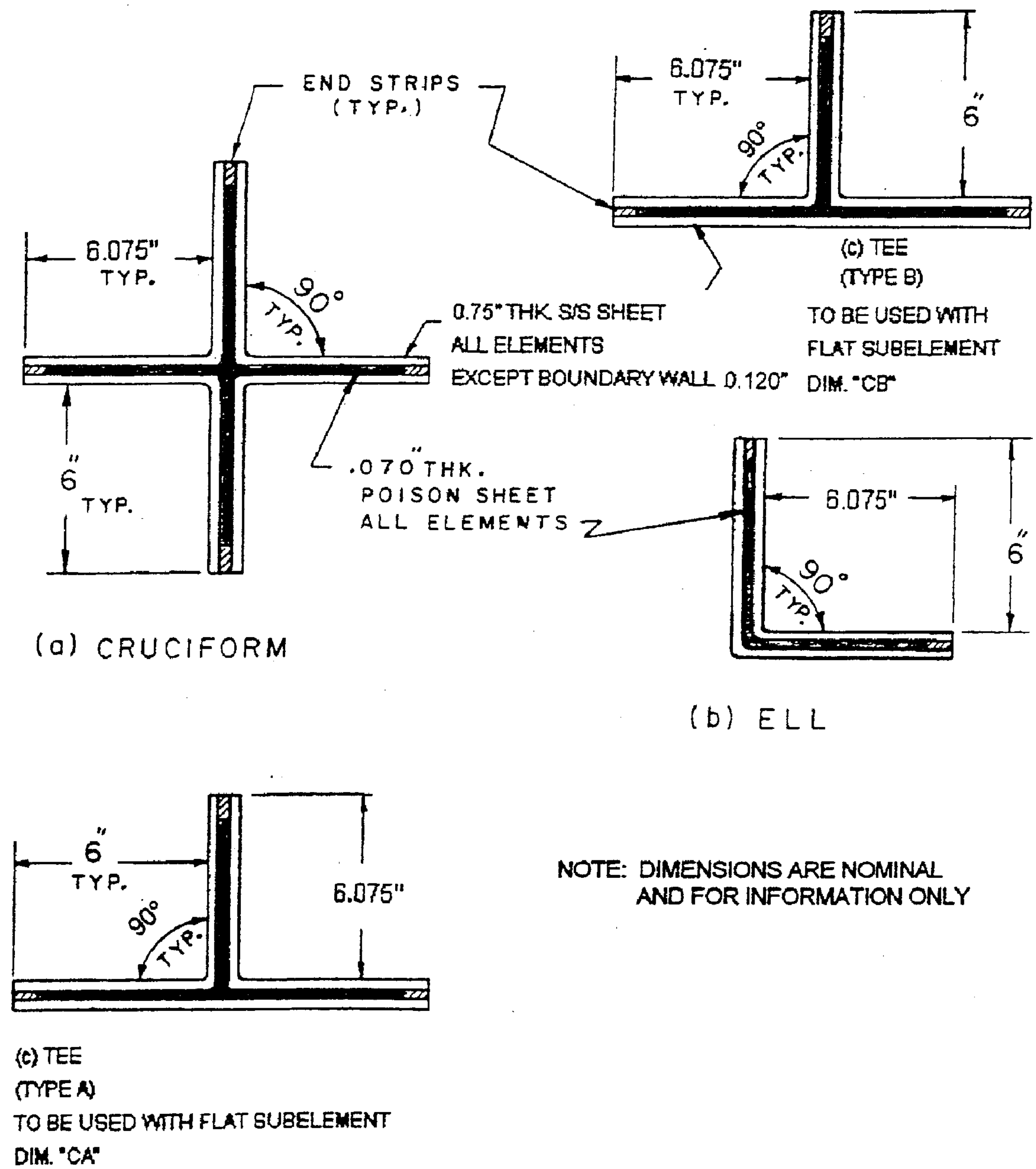
NOTE: DIMENSIONS ARE NOMINAL AND FOR INFORMATION ONLY

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-10

ARRAY OF CELLS (3x3) OAT HIGH DENSITY SPENT FUEL RACKS



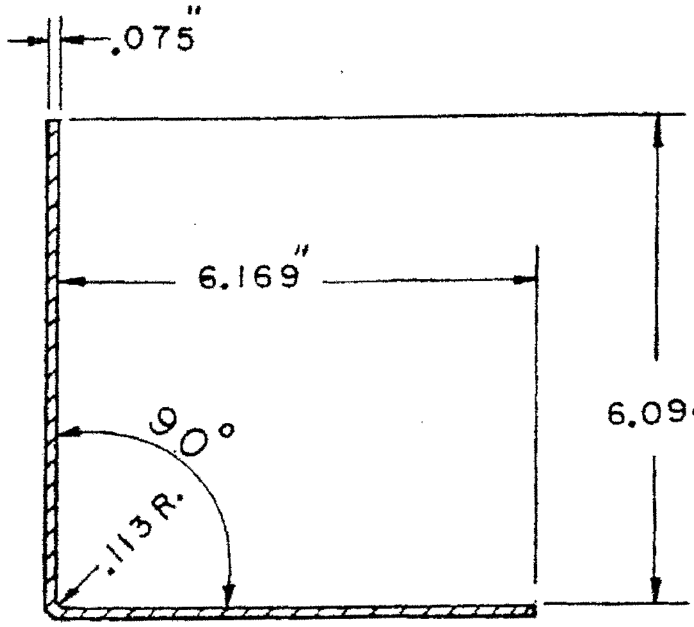
NOTE: DIMENSIONS ARE NOMINAL AND FOR INFORMATION ONLY

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-11

ELEMENTS CROSS SECTION OAT HIGH DENSITY SPENT FUEL RACKS



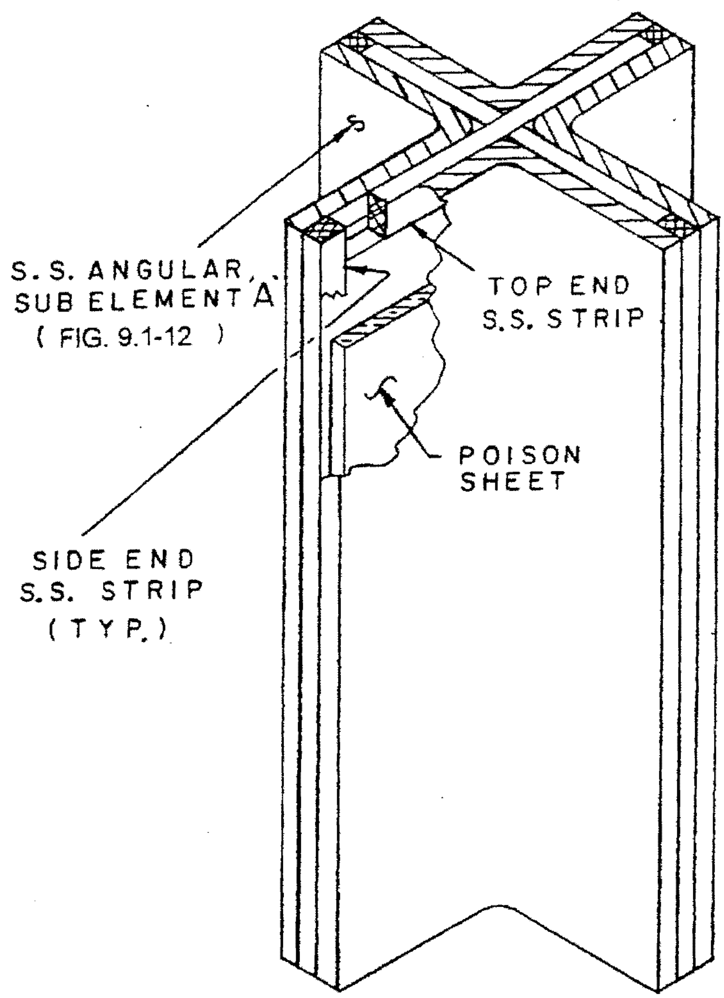
NOTE DIMENSIONS ARE NOMINAL AND FOR INFORMATION ONLY

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-12

ANGULAR SUBELEMENT “A” OAT HIGH DENSITY SPENT FUEL RACKS

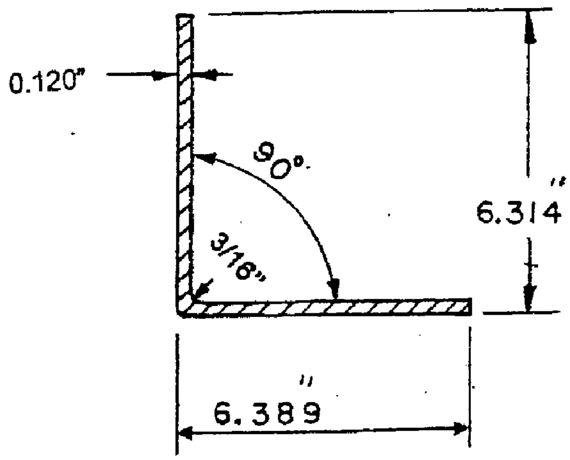


Fermi 2

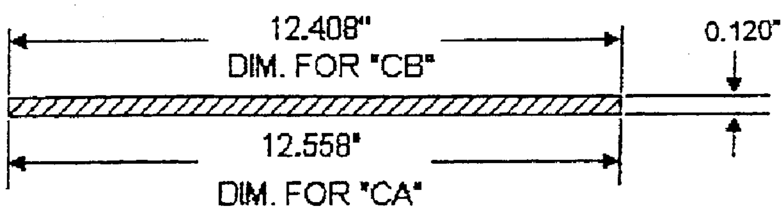
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-13

CRUCIFORM ELEMENT (ISOMETRIC VIEW)
OAT HIGH-DENSITY SPENT FUEL RACKS



(a) ANGULAR SUB ELEMENT "B"



(b) FLAT SUB ELEMENT "C"

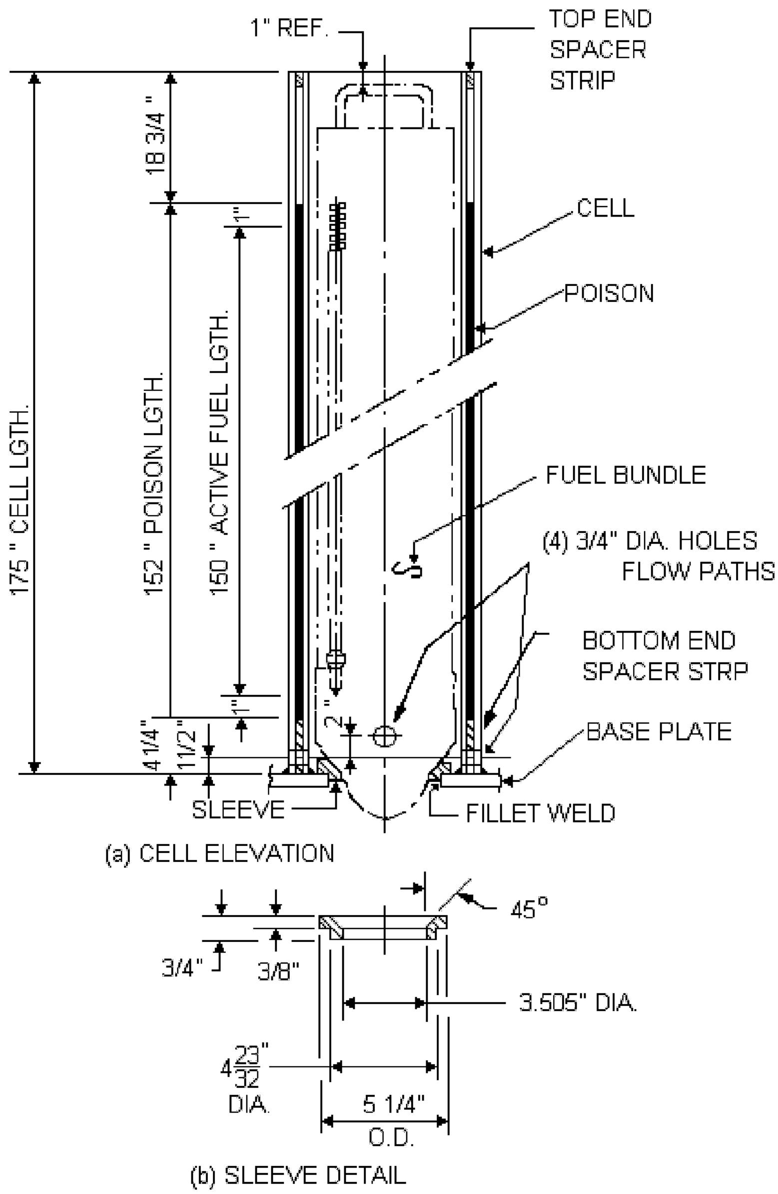
NOTE: DIMENSIONS ARE NOMINAL AND FOR INFORMATION ONLY

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-14

SUBELEMENTS – OAT HIGH DENSITY SPENT FUEL RACKS



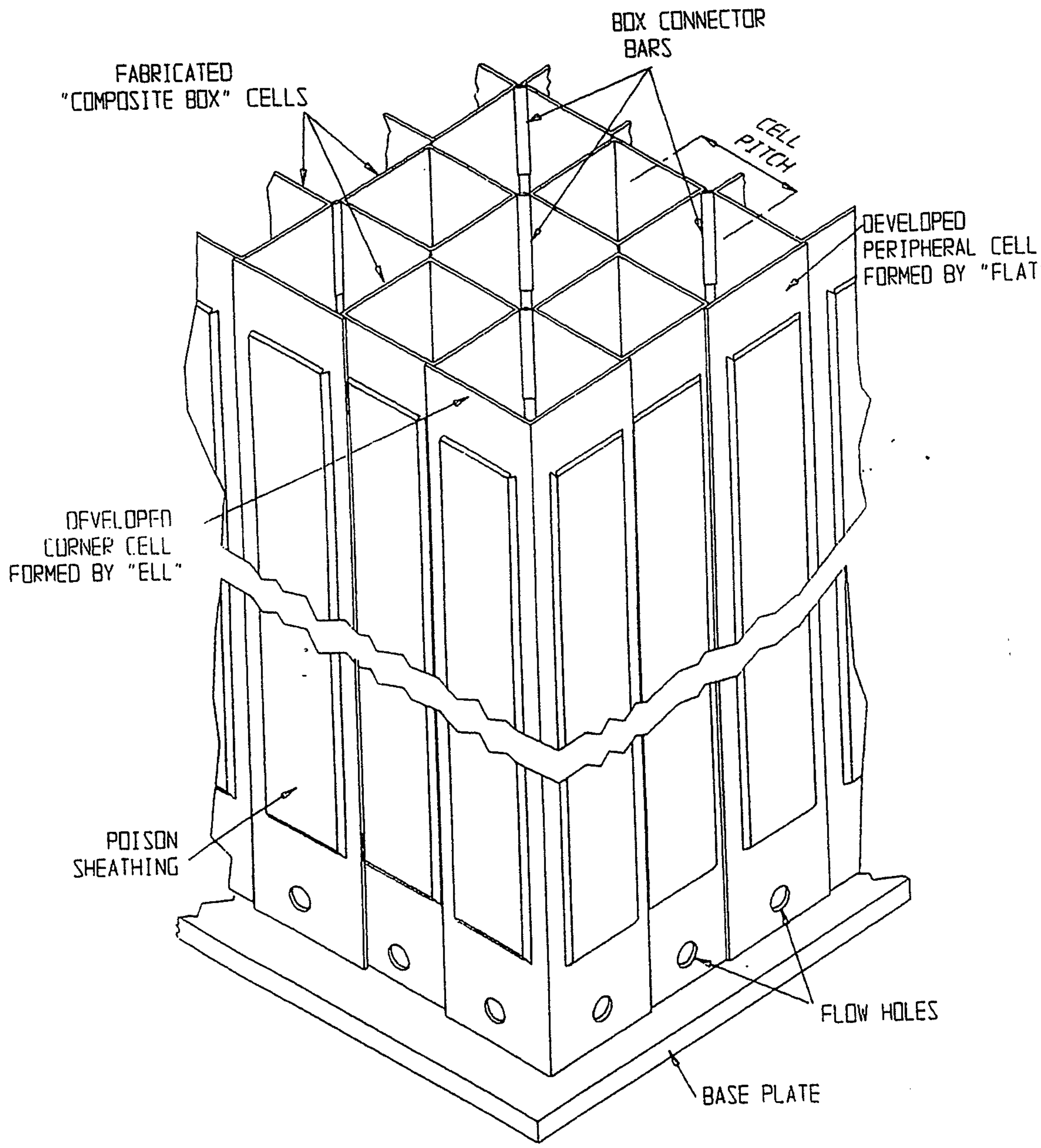
NOTE: DIMENSIONS ARE NOMINAL AND FOR INFORMATION ONLY

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-15, SHEET 1

TYPICAL CELL ELEVATION – OAT HIGH DENSITY SPENT FUEL RACKS

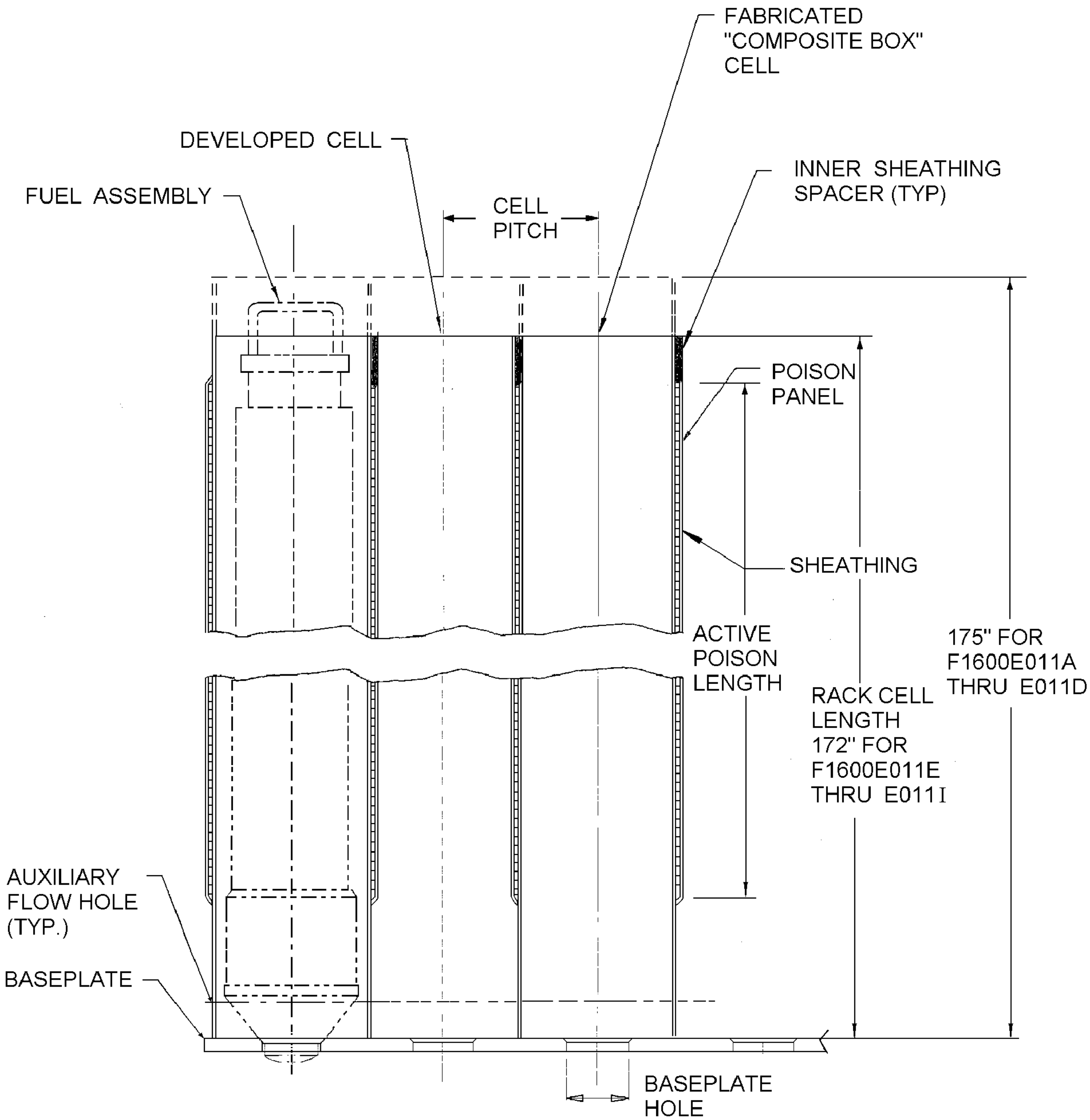


Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-15, SHEET 2

TYPICAL ARRAY OF HOLTEC HIGH DENSITY STORAGE CELLS (NON-FLUX TRAP CONSTRUCTION)

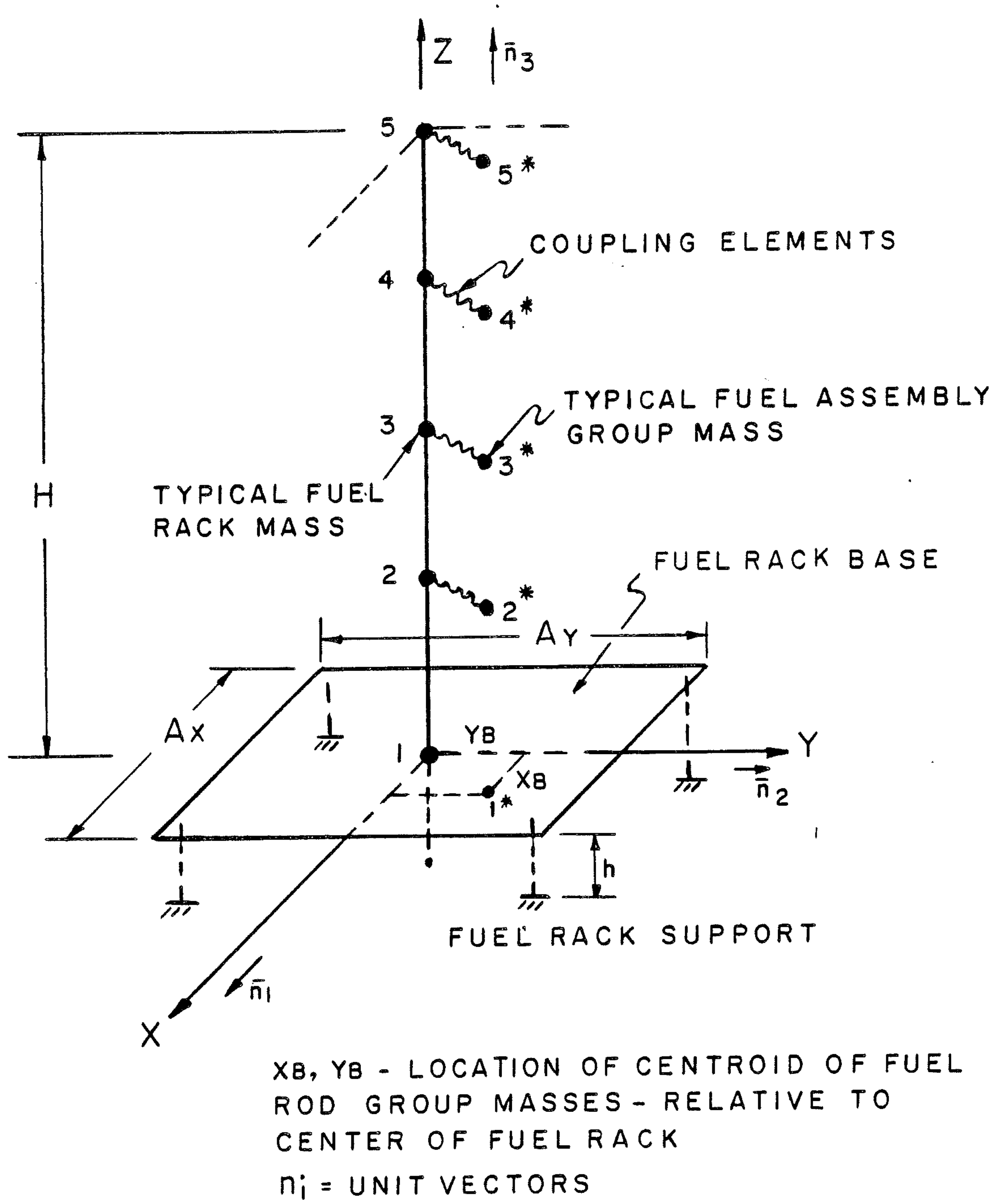


Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-15, SHEET 3

ELEVATION VIEW OF A TYPICAL HOLTEC HIGH DENSITY STORAGE RACK MODULE



SOURCE: FIGURE 6.1, JOSEPH OATS REPORT
TM 586 (REFERENCE 1)

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-16

DYNAMIC MODEL – HIGH-DENSITY SPENT FUEL RACKS

FIGURES 9.1-17 THROUGH 9.1-22
HAVE BEEN INTENTIONALLY DELETED

Figure Intentionally Removed
Refer to Plant Drawing M-2048

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-23

FUEL POOL CLEANING AND CLEANUP SYSTEM
P&ID

Figure Intentionally Removed
Refer to Plant Drawing M-2049

Fermi 2

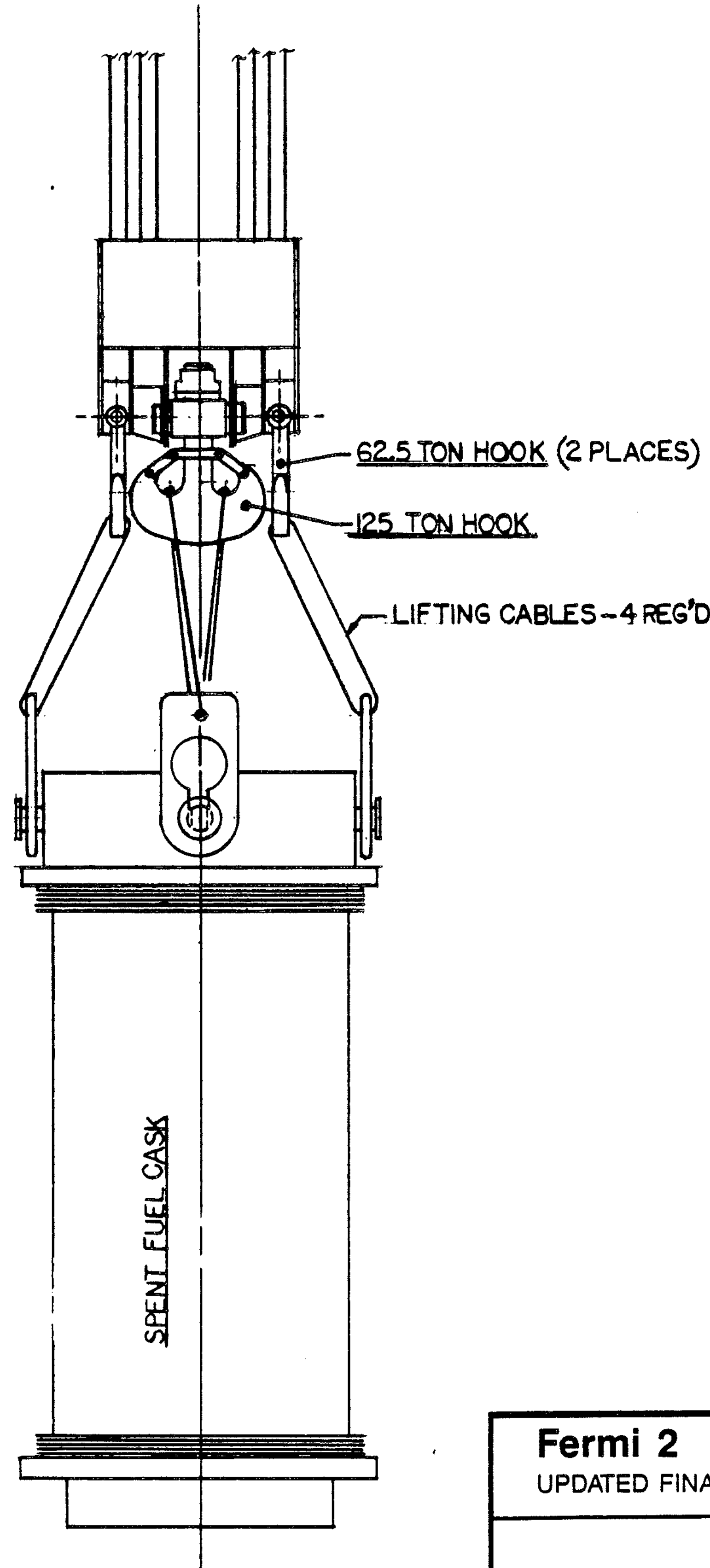
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-24

FUEL POOL FILTER/DEMINERALIZER

FIGURE 9.1-25 HAS BEEN DELETED

THIS PAGE INTENTIONALLY LEFT BLANK

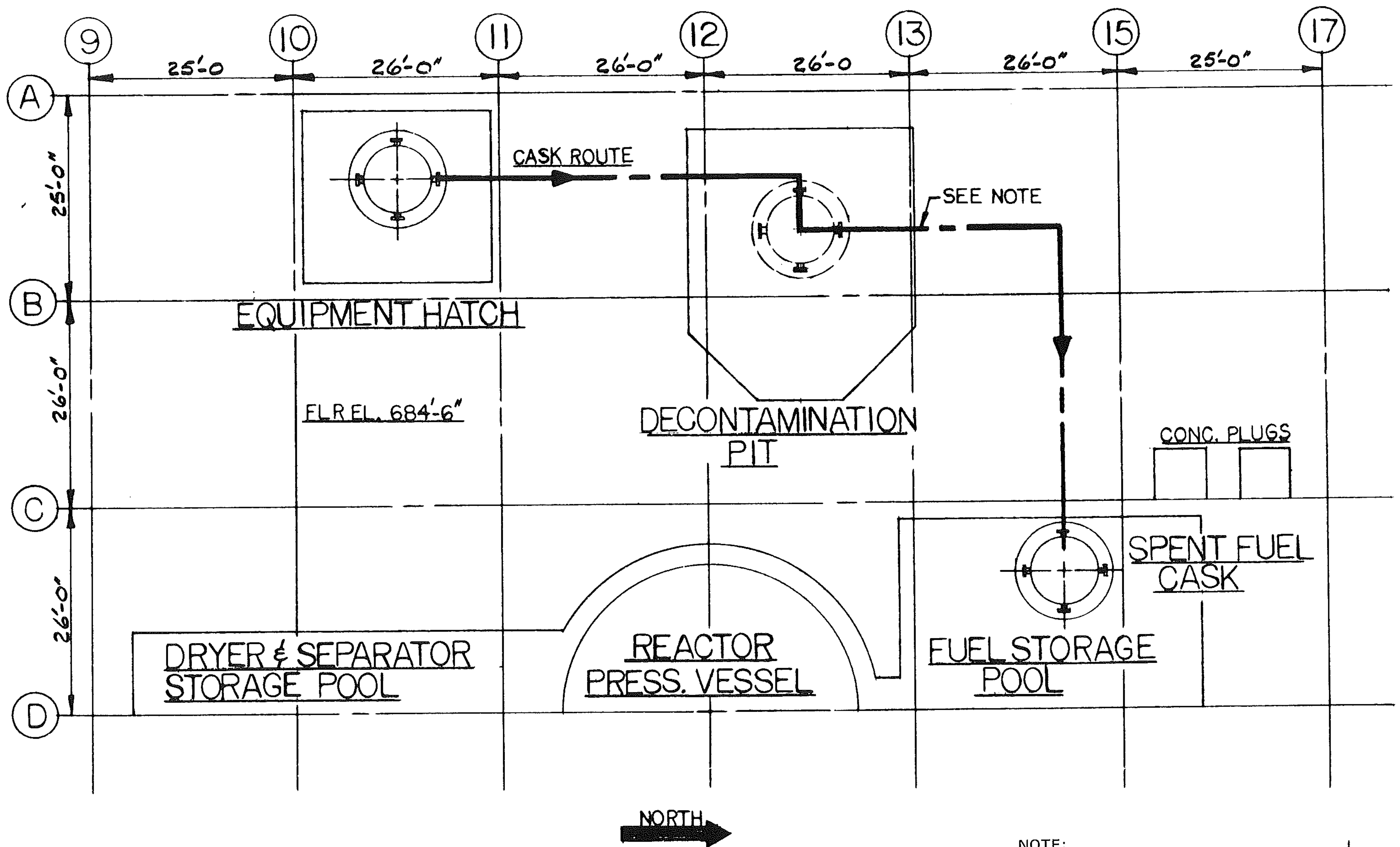


Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-26

CASK RIGGING SCHEME

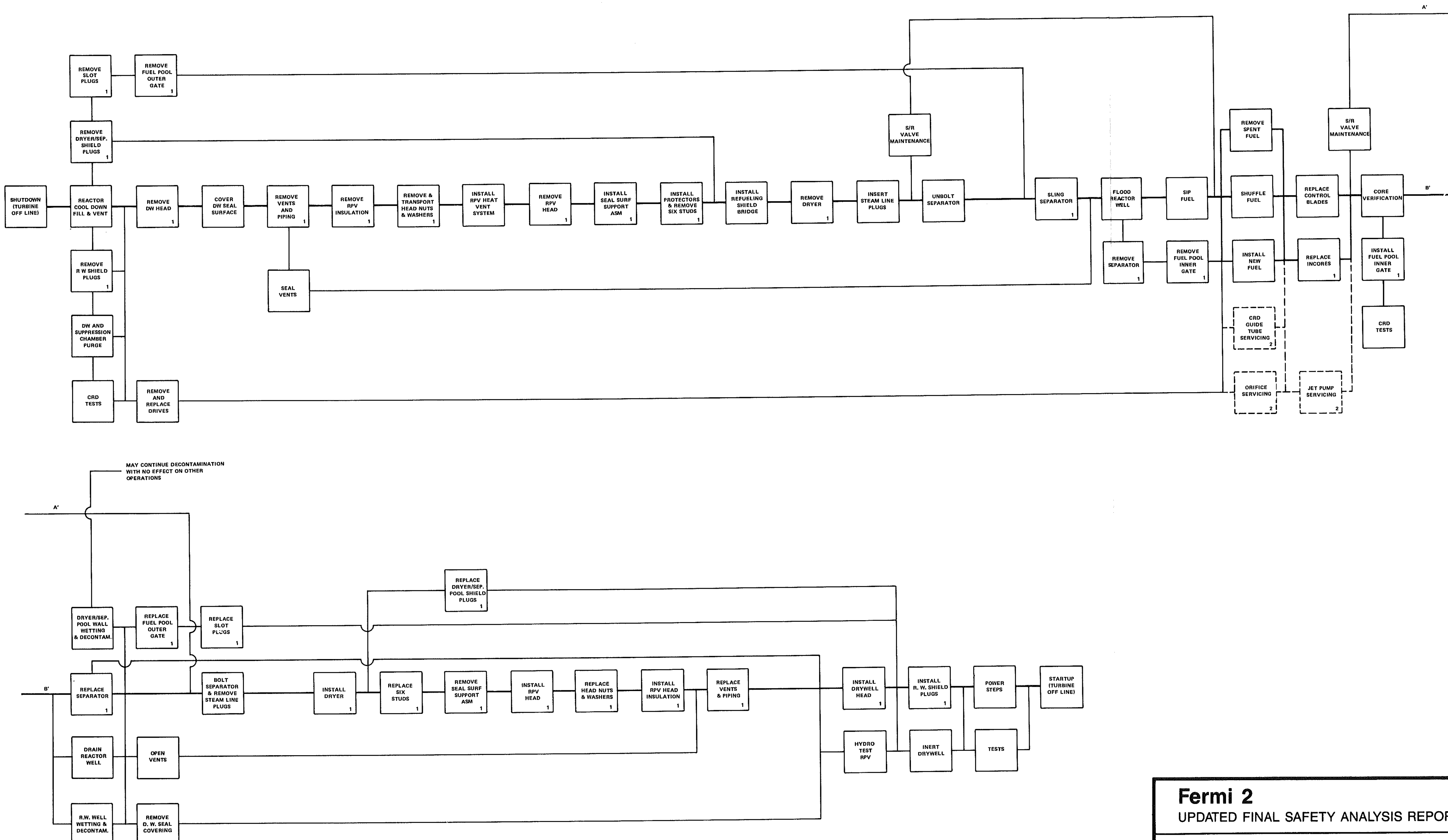


NOTE:
WIDE BLACK TAPE OR PAINT ON FLOOR
TO GUIDE CRANE OPERATOR.

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-27

OPERATING FLOOR CASK TRAVELING PATH



Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-28

PLANT REFUELING OUTAGE – FLOW DIAGRAM

GENERAL ELECTRIC COMPANY DRAWING NO. 197R568, REV. D

9.2 WATER SYSTEMS

9.2.1 General Service Water System

9.2.1.1 Design Bases

The general service water (GSW) system is designed to remove various plant heat loads principally from the reactor, turbine, and radwaste buildings during normal station operation. Cooling water is drawn directly from Lake Erie, passed through traveling screens, pumped throughout the plant, and is then returned to the circulating water system where the heat is ultimately rejected to the atmosphere via the plant's natural draft cooling towers.

The GSW system is designed to operate at a higher pressure than the systems it cools, to provide protection against potential outleakage of radioactive contaminants to the environment.

The GSW system is classified as a nonnuclear system and is constructed in compliance with standards for Quality Group D components. This criterion is met by designing the system to ASME Section VIII and ANSI B31.1.0 code requirements. The system is nonseismic, except that portion of the system within the reactor building, auxiliary building, and RHR complex which is designated as Seismic Category II/I.

9.2.1.2 System Description

The GSW system, as shown in Figure 9.2-1, Sheet 1 is designed to remove heat from or provide water to the following equipment on a continuous basis:

a. The reactor building closed cooling water system (RBCCWS) heat exchangers
b. The turbine building closed cooling water system (TBCCWS) heat exchangers
c. The turbine oil coolers
d. The generator hydrogen coolers
e. The radwaste evaporator condenser
f. Reactor building and turbine building room coolers
g. Circulating water pump bearing cooling water and lubricating water.
h. GSW biocide injection system
i. Supplemental cooling chilled water system

The GSW system also provides, on an intermittent basis, water for the following systems or functions:

a. Circulating water biocide injection system
b. Traveling water screen backwashing and deicing
c. Fire protection system (FPS) makeup (via the FPS jockey pump or the GSW to FPS cross-tie line)

d. Residual heat removal (RHR) reservoir makeup

e. Lawn sprinklers

f. Sump flushing.

g. The Sanitary Sewage Treatment Facility (outside protected area)

h. Side Stream Liquid Radwaste Processing System (SSLRPS)

GSW system pump data is shown in Table 9.2-1.

The GSW system takes its water from Lake Erie. The lake water is drawn into an intake canal, passed through a trash rack and a traveling screen, and enters the GSW pump pit. The five GSW pumps take suction from the intake pit and discharge the water into a common header. The GSW pumps operate continuously, maintaining pressure in the GSW header. Minimum pump flow protection is provided by relief valves at each pump's discharge to prevent overheating in the event that the pump is inadvertently run deadheaded. Relief valves are provided in the system piping to prevent overpressurizing the system.

The GSW pump house is located on the existing intake canal serving Fermi 1. It houses the five 25 percent-capacity GSW pumps, two 100 percent-capacity circulating water reservoir makeup pumps, and two 100 percent-capacity fire pumps. The two stage GSW pumps are of the vertical wet-pit type, rated for 7700 gpm flow, and a tested head between 241 and 270 ft. Since the flow demand varies seasonally, the pumps are manually started and stopped by the operator from the main control room. Each pump has a basket strainer located in its discharge line to remove suspended material that has been carried through the traveling screens at the pump house inlet. The strainers are provided with automatic self-backwashing feature.

The GSW system is treated with a biocide to inhibit slime and algae growth and to control organic and inorganic fouling of heat exchanger and piping surfaces. The biocide injection system is shown in Figure 9.2-1, Sheet 2.

Traveling screens and stationary racks are provided to keep floating debris from entering the GSW intake pit. A line from the GSW supply header automatically provides high-pressure water to each screen for backwashing whenever the differential pressure across the screens rises above a predetermined value. A screen deicing line, tapped off the GSW discharge header just prior to its connection into the main condenser circulating water line, provides warm water to keep ice from forming around the screens.

The majority of GSW flow to equipment being cooled is controlled by temperature control valves. Each valve is modulated in response to the exit temperature of the process equipment that the GSW is cooling. The flow to remaining GSW loads is modulated by manual flow valves.

A cross connection is provided from the HPCI Test Line piping to the GSW piping to be used as part of the Flexible and Diverse Coping Strategy (FLEX) to mitigate Beyond Design Basis External Events (BDBEE) in response to NRC Order EA-12-049.

9.2.1.3 Safety Evaluation

The GSW system is not required to be operable in order to effect the safe shutdown of the reactor. Thus, the GSW system is not designed for a single active or passive failure as required of a safety or safety-related system, but sufficient redundancy and automatic protective features are provided to ensure efficient plant operation and availability. Since the GSW system is not an engineered safety feature (ESF), it is not powered by an essential power bus.

The only portion of the GSW system directly involved in reactor operation and shutdown is the section serving the RBCCWS (via the RBCCW shell and tube heat exchangers and the supplemental cooling chilled water system chiller condensers). If the GSW system becomes inoperative, the emergency equipment service water system (EESWS) takes over to serve the equipment essential to safe reactor shutdown through the emergency equipment cooling water system (EECWS) (described in Subsection 9.2.2). The EECWS and the EESWS are powered off the essential buses. No failure in the GSW system can prevent a safe shutdown of the reactor.

The GSW intake structure is designed for operation during low lake levels by drawing water through a 54-in. line from the circulating water reservoir. On low lake level, an alarm alerts the operator of the condition. If necessary, the operator can supply GSW from the circulating water reservoir by opening the normally closed valve in the 54-in. connecting line between the circulating water reservoir and the GSW pump intake pit, and simultaneously closing the sluice gates to isolate the intake canal from the intake pit. The GSW and circulating water systems can be operated for a limited period of time in this mode to support plant load reduction and shutdown. Subsection 2.2.3.1 further discusses the low water considerations.

Radioactive contamination of GSW is avoided by using closed heat exchangers between the service water and the closed cooling water systems. The GSW remains uncontaminated by operating at higher pressure than the cooled system, and any leakage would be from the GSW system to either the TBCCWS or the RBCCWS. In addition, further protection is provided by activity detection equipment located in the circulating water discharge line downstream from the GSW system discharge connection so that both systems are monitored for radioactive contamination.

The cross connection between the HPCI Test Line (at the orifices) and the GSW System is designed to prevent cross contamination during normal plant and under DBA conditions. Double isolation valves are used in the cross connection piping to avoid any potential cross contamination. A tell-tale drain is provided between the two isolation valves to monitor potential leakage or failure of either isolation valve.

9.2.1.4 Tests and Inspections

Initial construction tests such as hydrostatic leak tests were conducted per ASME Section VIII and ANSI B31.1.0 code requirements. Initial system flow distribution, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program. After plant startup, heat exchanger operating performance is observed using actual system heat loads.

Periodic testing of the GSW pumps is done during normal system operation by utilizing each pump's test lines and orifice. Each pump's head and flow point is then compared to its initial flow characteristic curve, and an assessment is made for any deterioration to determine the need for any corrective pump maintenance. Instruments and controls are inspected periodically. No periodic leak tests are planned since the system is continuously operating. Periodic visual inspection of the system will detect minor leakages, such as those from valve stems, flanges, and instrument tubing connections.

9.2.1.5 Instrumentation

Sufficient instrumentation is provided to allow the plant operator to assess the status of the GSW system. The GSW pumps are manually started and shut down from the control room operating panel via coordinated manual control (CMC) switches. Pump status and motor amperage readouts are provided in the control room.

The discharge from each GSW pump flows through an automatic self-cleaning strainer and a discharge isolation valve. GSW system pressure is regulated by changing the number of pumps in service, adjusting the GSW flow through heat exchangers, and/or bypassing some flow back to the pit as necessary. The discharge header pressure is indicated with high and low pressure alarms in the control room.

Water levels in the GSW pump house are measured on each side of the traveling screens to provide additional pump operating intelligence to plant operators. This level instrumentation controls traveling screens and alarms the control room operator of abnormal inlet water levels.

The GSW flow to the major GSW users, turbine oil-coolers, generator hydrogen coolers, TBCCW coolers, and RBCCW coolers, are modulated by temperature control valves. The process temperatures are also provided with a high and low temperature alarm in the control room. The other GSW loads are modulated by manual controls.

9.2.2 Cooling System for Reactor Auxiliaries

9.2.2.1 Design Bases

The RBCCWS is designed to remove heat from the auxiliary equipment housed in the reactor building and auxiliary building during normal plant operation. The RBCCWS is cooled by the GSW system, and makeup is supplied by the demineralized makeup water system. The supplemental cooling chilled water system provides a source of chilled water for cooling the water supplied to each division of EECW serviced by the RBCCW supplemental cooling loops. The GSW system provides service water for condenser cooling of the SCCW chillers. The RBCCW supplemental cooling loops are intended for operation when the GSW supply temperature is greater than 60°F.

In the event of a mechanical failure of the RBCCWS, high drywell pressure, or upon loss of offsite electrical power, the EECWS will start automatically (or may be manually initiated) to cool equipment needed for reactor shutdown. In addition, the EECWS may be used to augment RBCCW for the purpose of assisting in equipment cooling. The EECWS is cooled by the EESWS which is supplied by the RHR reservoir.

To provide for reactor shutdown under severe natural environmental conditions, as well as upon loss of normal offsite power and failure of the RBCCWS, two full-capacity Emergency Equipment Cooling Water loops are provided.

Motor-operated isolation valves are provided to isolate the nonessential loads on the RBCCWS from each EECW loop.

The RBCCW system is operated at a pressure lower than the GSW system to prevent leakage of potentially radioactive water to the environment. Continuous surveillance of the quality and activity level of the RBCCWS is maintained to detect inleakage of GSW or inleakage from the cooled reactor building auxiliary components.

During emergency situations when EECW is in operation, the EECW pressure is slightly greater than the EESW pressure at the EECW heat exchangers. It would take multiple equipment failures to create a situation where radioactive contamination would enter the EESW. First a component being cooled by EECW would have to leak contaminated water into EECW. This would have to be accompanied by a failure in the EECW heat exchanger in order to release radioactive material into the RHR reservoir. If this were to happen, drift losses from the cooling towers could cause a radioactive release to the environment. Given the fact that it would take multiple equipment failures and that monitoring and sampling provisions exist (as described in Subsections 11.4.3.9.2.3 and 11.4.3.9.2.4), the potential for an unmonitored radioactive release is minimal.

The makeup line between the EECW makeup tank and the EESW system for each division is furnished with a check valve and a normally closed air-operated isolation valve. The test return line is provided with two isolation valves that are closed during normal operation. These valves would minimize the potential of radioactively contaminated water leaking into the EESW system during normal operation. The check valve in the makeup line and the closed test return line isolation valves would also minimize the potential for radioactively contaminated water leaking into the EESW system during a design basis accident. The check valves installed as boundary valves on the nitrogen inerting (T48) and demineralized makeup water (P11) systems would minimize the potential for radioactively contaminated EECW water leaking into these systems.

System construction for cooling the essential equipment necessary for reactor shutdown is in compliance with standards for Quality Group C or Quality Group B. Components and equipment not essential to reactor shutdown are built as a minimum to Quality Group D standards. The EECWS is Category I, and is designed in accordance with ASME Section III, Class 2 and Class 3 requirements. The RBCCWS is Seismic Category II/I and is designed to ASME Section VIII and ANSI B31.1.0 code requirements.

9.2.2.2 System Description

The RBCCWS, as shown in Figure 9.2-2, is designed to remove heat from reactor auxiliaries that fall into two categories: those that are essential to reactor shutdown and those that are non-essential to reactor shutdown. Table 9.2-2 lists RBCCWS component design parameters.

The RBCCWS outside of the RBCCW supplemental cooling loops consists of two RBCCW heat exchangers and three 50 percent-capacity pumps. The two, divisional RBCCW supplemental cooling loops are each designed with one RBCCW supplemental cooling (plate-and-frame) heat exchanger and two 100 percent-capacity RBCCW supplemental cooling pumps (see Figure 9.2-2(2)). During normal operation, two heat exchangers and two pumps operate to provide cooling to all the essential and nonessential heat loads. The third pump is in standby and is designed to be started manually on low RBCCWS pressure. When the RBCCW supplemental cooling loops are in operation, one RBCCW supplemental cooling pump will operate for each EECW division. The second pump in each division is in standby and is designed to automatically start on loss of the operating pump. The RBCCW supply header temperature is maintained nominally at 70°F by a temperature control valve modulating the GSW flow through the RBCCW heat exchanger. During the summer season, the RBCCW temperature may be higher. When these higher temperature conditions occur, the RBCCW supplemental cooling loops may be used to cool the water that is supplied to EECW. The water temperature exiting each RBCCW supplemental cooling heat exchanger will be maintained by a temperature control valve which may be operated in automatic or manual mode. Both divisional loops of RBCCW supplemental cooling exchange heat with the supplemental cooling chilled water (SCCW) system. SCCW may be placed in operation when the GSW supply temperature exceeds 60°F. The system thermal capacity is based on a nominal 85°F RBCCW temperature. System pressure is controlled by a differential PCV located in the bypass line between the suction and discharge headers of the RBCCW pumps. Makeup to the system as well as system expansion and contraction resulting from load changes are provided by a makeup tank. Makeup water is automatically supplied via a level control valve. Normal makeup is from the demineralized water system and alternatively from the condensate storage system.

Reactor auxiliaries impose a maximum cooling load on the RBCCW heat exchangers of approximately 68 x 10^6 Btu during normal operation. This requires approximately 10,000 gpm of GSW, assuming a maximum service water temperature of 85°F. Circulation on the RBCCW side of the heat exchanger is approximately 8000 gpm; heat exchanger rate is based on temperatures of 112°F in and 95°F out.

The GSW is not used directly because the relatively high impurity level in this system might result in fouling of equipment heat transfer surfaces. Furthermore, the intermediary loop between contaminated reactor auxiliaries and the GSW system provides additional protection against radioactive water leakage into the environment.

The EECW section of the RBCCWS consists of two redundant full-capacity loops, each with two (2) 100 percent capacity heat exchangers, pump, and makeup pump and tank, as shown in Figures 9.2-3 and 9.2-4. One heat exchanger is manually aligned for service. The second heat exchanger is provided as a backup. The twin systems designated as Division I and Division II are cooled by the EESWS. The EESWS, described in Subsection 9.2.5, is powered off the essential buses and is designed to be redundant throughout. Upon loss of offsite power, high drywell pressure, or failure of the RBCCWS, both divisions of the EECWS are automatically activated; that is, pumps start, makeup tanks isolation valves open, and valves isolate the nonessential portion of the RBCCWS. The makeup tanks isolation valves do not start to open until the divisional isolation valves are closed. Upon loss of RBCCWS differential pressure between the supply and return headers, either Division I and/or Division II EECW loops will start automatically, depending on the portion of the

RBCCWS affected. The EECWS may also be manually initiated. Component design parameters of the EECWS are shown in Table 9.2-3.

The EECW heat exchangers are designed for a maximum heat load of 13.6 mBtu/hr. This requires approximately 1450 gpm of EESW, assuming a maximum service water inlet temperature of 89°F. Circulation on the EECW side of the heat exchanger is approximately 1700 gpm; heat exchanger rate is based on temperatures of 111.1°F in and 95°F out. The EECWS temperature is maintained nominally at 70°F in a similar manner as the RBCCW heat exchanger by modulating the heat exchanger exit cooling water flow.

The replacement of the original shell-and-tube EECW heat exchangers with a plate-and-frame design increased nominal heat transfer capability, but reduced the minimum flow channel dimension from 0.78-in. diameter tubes to 0.0732 inch plate spacing; thus, making the new units potentially more susceptible to plugging. The design analyses that define minimum EECW heat exchanger thermal performance consider the potential effects of initial plugging and plugging rate to establish the thermal performance and heat exchanger differential pressure vs. flow test criteria necessary to ensure the accident mission can be accomplished with credit for only one of the two identical units provided in each division. Once the maximum allowed normal operating plugging limit on a unit is reached, the EECW and EESW flows may be aligned to the clean spare heat exchanger in each division; thereby facilitating maintenance without interrupting normal plant operation.

The RBCCW makeup tank and the EECW makeup tanks are supplied with demineralized water and pressurized with nitrogen during normal plant operation. Normal makeup to the tanks is supplied automatically from the demineralized makeup water system by a level control valve. The pressure regulating valve of the normal nitrogen supply system maintains a nitrogen blanket in the tank at a pressure which will keep the EECW loop full to the upper elements. Nitrogen is provided to prevent leakage of oxygen into the system, thereby retarding corrosion of the closed cooling water system.

The EECW (Division I and Division II) system makeup tank is connected with a makeup line to the EESW system to provide an alternate makeup supply for each division when the normal makeup supply to this tank is lost during and after the design basis accident. The isolation valves for the alternate makeup supply consist of a check valve and an air-operated valve which opens automatically on a makeup pump start, a loss of air or a loss of electrical power. This valve is normally closed to prevent EESW, low quality water from entering the EECW, high quality water system during winter operation when TCV F400A/B is nearly closed. Each makeup pump auto starts and provides the makeup water to the tank. A check valve is installed in this makeup supply line to prevent a reverse flow from the EECW makeup tank to the EESW system. The test return line is provided with two isolation valves that are closed during normal operation and accident conditions to minimize the potential for radioactively contaminated water leaking into the EESW system. Inadvertent injection to the EECW system is minimized by system initiation setpoints and permissives. Inadvertent injection of EESW water into the EECW system during testing is minimized by isolation of the tank during testing. The makeup tank for Division I is also provided with the emergency backup nitrogen supply cylinders which automatically provide nitrogen to the makeup tank whenever the normal nitrogen supply is lost and/or the nitrogen supply pressure is reduced below approximately 26 psig. The check valves are added as the boundary valves between the makeup tank and nonsafety-related nitrogen inerting and demineralized water makeup systems to reduce the potential loss of the makeup tank inventory or pressure due to the loss of the nonsafety-related systems. The backup nitrogen supply cylinders are sized to maintain nitrogen pressure in the makeup tank until the makeup tank has refilled the EECW loop during an Appendix R fire. This will maintain a positive suction head on the EECW pump and provide protection against momentum transients when the EECW pump experiences a delayed start during the dedicated shutdown scenario.

The following equipment, considered essential to reactor shutdown, can be cooled either by the RBCCWS or, in an emergency, by at least one division of the EECWS:

a. RHR pumps (two out of four)

b. Core spray pumps (two out of four)

c. Reactor auxiliary space coolers (three in Division I or four in Division II)

d. Standby control air compressor, aftercooler, and space cooler (one out of two sets)

e. Deleted

f. Switchgear room space coolers (two out of four)

g. Standby gas treatment room space cooler (one out of two)

h. Control center air conditioning equipment (one out of two)

i. Auxiliary building battery charger area space coolers (one out of two).

The nonessential components of the RBCCW that are connected to the EECWS piping have automatic isolation valves installed in their supply lines. The following equipment, considered nonessential to reactor shutdown, is cooled only by the RBCCWS:

a. Two in-series reactor water cleanup nonregenerative heat exchangers

b. Water sample station cooler

c. Twin reactor water cleanup pump seals and bearings

d. Twin fuel pool heat exchangers

e. Twin recirculating pump motor-generator coupling cooler heat exchangers

f. Recirculating pump motor-generator ventilation cooling coils

g. Steam tunnel cooler

h. Drywell equipment sump heat exchanger

i. Reactor building equipment sump heat exchangers (two)

j. Control rod drive (CRD) pumps

k. Battery room space cooler

l. Drywell penetration cooling (eight)

m. High-pressure cask-washdown pump heat exchanger

n. Instrument rack H21-P284.

NOTE: All twin units are sized for 100 percent redundancy.

Two additional loads, drywell coolers (seven per division) and the reactor recirculation pumps, are normally cooled by RBCCW. Flow to this equipment is maintained upon activation of the EECWS. Should EECWS activate in conjunction with a high drywell pressure signal, the supply valve to the drywell will close, thus ensuring cooling of the essential loads.

9.2.2.3 Safety Evaluation

The EECW Division I and Division II portions of the RBCCWS are designed to provide cooling to equipment required for reactor shutdown in spite of a single active or passive failure. Division I and Division II loops are completely isolable from each other. Each loop of the EECWS is operable from a separate emergency bus. Single-failure analysis for the RBCCW and EECW systems is presented in Table 9.2-4. Upon activation of the EECWS, all nonessential loads of the RBCCWS will be isolated except for the drywell coolers and the reactor recirculation pumps. These loads can be manually isolated from the control room and the supply valve will be automatically closed if a high drywell pressure occurs.

The EESWS cooling the EECWS is also completely redundant and powered off separate emergency buses. This system is discussed in Subsection 9.2.5.

The EECWS components of Division I and Division II are located in different areas of the reactor building to preclude failure of both systems due to pipe whip, jet forces, and generated missiles. Physical separation also provides protection against common failure induced by fire, as described in Appendix 9A.

To detect leakage from the RBCCW and EECW systems, the makeup tanks are provided with low-level alarms and an alarm on the makeup valve stem position. Excessive opening of the makeup valve will be indicative of a substantial system leak. Inleakage of GSW or SCCW will be indicated by a high-level alarm in the RBCCW makeup tank. The RBCCWS is continuously monitored for radioactivity. Leakage to GSW and SCCW is minimized by operating the RBCCW at a relatively low pressure.

The use of demineralized water for makeup and nitrogen capping of the makeup tanks gives reasonable assurance against long-term degradation caused by impurities in the circulating loops. Additionally, corrosion inhibitors are added for pH and oxygen control. Alternatively, the cooling water system may be maintained with pure demineralized water only, with no chemicals added.

The makeup line between the EECW makeup tank and EESW system in each division provides emergency makeup water to the makeup tank by automatically starting the makeup pump and opening the air-operated valve. This makeup system is initiated on either low makeup tank pressure or low makeup tank level when the makeup tank isolation valve is open, and normal pump suction pressure is achieved. In Division I the backup nitrogen supply system to the EECW makeup tank is automatically actuated, based on the makeup tank pressure, upon loss of the nonsafety-related nitrogen inerting system and maintains the nitrogen pressure throughout a dedicated shutdown fire scenario. The check valves installed in the nonsafety-related water and nitrogen supply lines will protect the makeup tank from the potential loss of water inventory or nitrogen pressure.

Both EECW loops are automatically started on high drywell pressure or upon loss of normal offsite power. Upon failure of the RBCCWS, such as pipe rupture, redundant differential pressure switches automatically start the EECW pump(s), depending on the location and severity of the break, and initiate appropriate loop isolation consistent with the operating EECW pump(s).

EECW may be manually initiated with the nonessential loads subsequently restored to facilitate RBCCW heat exchanger cleaning, to enhance drywell cooling during high lake water (GSW) temperature, for testing, or to provide RHR Reservoir freeze protection during extreme cold weather. EECW auto-start on high drywell pressure (i.e., a LOCA) or on a loss of offsite power is unaffected by this mode of operation; therefore, these signals will initiate the automatic protective action of reisolating the nonessential portions of RBCCW piping located inside the EECW system envelope. A loss of RBCCW while EECW is operating in this mode will not reinitiate EECW or reisolate the nonessential loads. This action is not required, however, since this is not a condition requiring protective action as described in Section 7.1.2.1 and EECW remains capable of supporting the safe shutdown of the plant in this configuration.

9.2.2.4 Tests and Inspections

Initial construction tests such as hydrostatic leak tests were conducted per applicable code requirements for the RBCCW and EECW systems. Initial system flow distribution, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter l4. Heat exchanger operating performance will be observed during plant operation. Availability of the RBCCW standby pump and automatic start of the EECW pumps and makeup pumps are tested periodically. Periodic inspections and testing will be performed to monitor heat exchanger performance and cleanliness. Individual pump performance will be assessed in regularly scheduled inspections that can be performed without interruption of plant operation. Isolation of the EECWS will be tested periodically by simulating the initiating events that automatically bring the EECW and EESW systems into operation.

No periodic leak tests will be performed because the system is under continuous pressure during operation. Periodic visual inspection of the system will detect minor leakages such as those from valve stems, flanges, and instrument tubing.

9.2.2.5 Instrumentation

The RBCCW pump motors are equipped with standard controls and protective devices, and are monitored from the main control room. Readouts to observe pressure and inlet and outlet temperatures in the RBCCW and EECW systems are also provided in the main control room. Interlocks are provided on the RBCCW pumps to prevent their starting upon low makeup tank level and/or low suction pressure. High/low pump differential pressure and high/low makeup tank level are alarmed for the RBCCW and EECW systems. Low suction pressure is alarmed only on the EECW pumps. Individual components are equipped with local temperature indicators to periodically monitor performance. The temperature of the RBCCWS (or the EECWS) during operation is controlled by modulating the discharge flow of tube-side cooling water through the respective heat exchangers.

High- and low-level alarms and alarms for low system pressure are provided on the makeup tanks to alert the operator of system leakage and EECW makeup pump failure.

The RBCCW supplemental cooling pumps will be controlled and monitored from a control panel located in the basement of the turbine building. When one or more of these pumps trip, a common trouble alarm will be generated in the main control room. An interlock is provided to trip the RBCCW supplemental cooling pumps on low flow to the RBCCW header. A trip of the operating pump will automatically start the standby pump supplying the same division. A low level in the RBCCW makeup tank will prevent operation of all RBCCW supplemental cooling pumps. During the normal mode of operation when both loops of supplemental cooling are in operation, an interlock is provided to prevent these pumps from operating without the SCCW chillers in operation. Should no SCCW chillers be in operation, none of the pumps will start and all operating RBCCW supplemental cooling pumps will be tripped.

During the normal mode of operation one of the following two (2) modes are applicable. These two (2) modes of operation are dependent upon a single SCCW chiller's Full Load Amps (FLA) reading. Mode 1 allows the operation of any one single chiller and two (2) chilled water pumps to provide cooling to both RBCCW-SCS loops SCS-1 and SCS-2 when GSW inlet temperature is low. Mode 2 requires the operation of two (2) chillers and two (2) chilled water pumps to provide cooling for both RBCCW SCS loops.

If it is desired to operate only the supplemental cooling pumps or chilled water pumps for the purpose of maintaining water quality, a maintenance switch is provided which permits operation of the pumps without the chillers running.

The water temperature exiting each RBCCW supplemental cooling heat exchanger is maintained at the required value by a temperature control valve that controls the bypass of RBCCW flow around the heat exchanger.

9.2.3 Demineralized Water Makeup System

9.2.3.1 Design Bases

The demineralized water makeup system is designed to deionize water and store it for makeup to the reactor coolant system and plant auxiliary system and services, and is designed as a direct source of water for flushing and cleaning operations.

The raw water is supplied from the potable water system. The influent and effluent water qualities are shown in Tables 9.2-5 and 9.2-6, respectively.

The demineralized water makeup system is nonseismic, and is constructed in compliance with standards for Quality Group D components. This criterion is met by designing the system to ASME Section VIII and ANSI B31.1.0 code requirements.

9.2.3.2 System Description

The demineralized water makeup system consists of a 300-gal potable water holding tank, a packaged skid-mounted reverse osmosis unit, and two raw water booster pumps with associated distribution piping.

Normal operation of the make-up demineralizer is manually initiated from the reverse osmosis (RO) unit control panel. The booster pump takes suction from the raw water holding tank and sends it to the RO water treatment system. The RO system consists of three separate skid mounted units. The first skid is the pretreatment unit which contains the media filters, carbon filters and the softeners. The second skid is the main RO unit which includes both passes of the reverse osmosis system and the cleaning pump. The last skid, the post treatment unit, contains the transfer pump, ultraviolet light and deionization (DI) bottles.

The normal operation of the RO units is in series. The system operated in the series mode, will provide approximately 25 gpm of purified water. Only one of the two booster pumps needs to operate to supply water to the RO unit. The purified water is stored in the demineralizer make-up water storage tank. The concentrate which is the reject water of this system is simply concentrated potable water and is discharged into the boiler blowdown sump.

Potable water flow into the holding tank is controlled automatically by a level control inlet valve. Operation of the system depends on the water level in the makeup demineralized water storage tank. Makeup demineralized water storage tank level indication with a low-level alarm is provided in the main control room.

Connections are provided to recycle the contents in the demineralized storage tank through the makeup demineralizer to upgrade the quality of the water as it deteriorates due to CO_2 absorption during storage.

9.2.3.3 Safety Evaluation

The demineralized water makeup system is not required for reactor shutdown and as such is not a safety-related system. Redundancy to ensure continuity of design function is not required. Because of the processes involved in this facility, only high-purity water is handled, and no long-term degradation of equipment is anticipated.

9.2.3.4 Tests and Inspections

Initial system flow checks, valve operability, instrumentation and control loop checks, and alarm setpoints were performed in accordance with the Preoperational Test program as discussed in Chapter 14. Flow meters are provided to ascertain pump performance as are on-line conductivity monitors to determine water quality. Grab samples will be taken periodically to confirm water quality and to verify instrument accuracy.

Visual inspection will detect minor leakages such as those from valve stems, flanges, and instrument tubing. Potable water booster pumps will be operated on a rotating basis.

9.2.3.5 Instrumentation

The demineralized water makeup system is operated from the RO unit control panel which is a local panel located in the auxiliary boiler house. Local flow meters provide indication of raw water flow through the system, including the flow through the various skids of the RO unit. On-line conductivity monitors provide information on the various skids of the RO unit performance. The various RO unit trouble alarms and the raw water holding tank low level alarm will shut down the RO unit operation. Any one of these alarms will also initiate the make-up demineralizer trouble alarm in the main control room.

Switchover and operation of the regenerative and backwashing cycle are manual and done from the local RO unit control panel.

All process instrumentation, including that required to maintain temperature, pressure, and flow for the process cycle and the regenerative cycle, is locally indicated.

9.2.4 Potable Water System

9.2.4.1 Design Bases

The potable water system for Fermi 2 is composed largely of existing facilities at Fermi 1, with extended underground distribution lines.

The potable water system is designed to comply with Quality Group D Standards and State of Michigan Health Department code requirements.

9.2.4.2 System Description

The potable water system for Fermi 2 consists of an underground distribution header with branches to the various facilities that require service.

Fermi 2 demand is supplied by the Frenchtown Water System. The 100,000 gallon elevated storage tank on site is abandoned in place. Potable water is used in Fermi 2 to supply the demineralized water makeup system described in Subsection 9.2.3, sanitary plumbing, drinking fountains, washrooms, kitchen facilities, safety showers, and TBHVAC evaporative coolers.

9.2.4.3 Safety Evaluation

The potable water system has no apparent source of contamination. There are no interconnections between the potable water system and any other systems, except that the potable water supplies the demineralized water makeup system and TBHVAC evaporative air coolers. Potential contamination is precluded by an open break in the fill pipe for the demineralized water make-up system and the TBHVAC evaporative air cooler. Because the facility is specifically intended to handle and eliminate impurities, no long-range degradation of equipment is foreseen. Apart from the demineralized water makeup system (which is not critical to the operation or safe shutdown of the reactor), end users of the potable water system are plant personnel. There is, therefore, no requirement for redundancy in order to maintain uninterrupted service. Adequate water supply to the safety showers and eyewash stations is maintained by the tandem booster pumps of the potable water system with one in operation and the other in standby.

9.2.4.4 Tests and Inspections

No special test or inspections are required for the Potable and Sanitary Water System.

9.2.4.5 Instrumentation

Indicating instruments are read out locally in the Potable Water Building.

9.2.5 Ultimate Heat Sink

The ultimate heat sink is provided by the RHR complex, which contains the RHR service water (RHRSW) system, the EESWS, the diesel generator service water system, the mechanical draft cooling towers, the emergency ac power system (diesel generators), and the reservoir. The systems are shown in Figure 9.2-6. The ultimate heat sink design conforms to the requirements of Regulatory Guide 1.27.

9.2.5.1 Design Bases

The RHRSW system is designed for the following functions:

a. With the RHR system, to remove decay heat and residual heat from the nuclear system so that refueling and nuclear system servicing can be performed

b. With the RHR system, to supplement the fuel pool cooling system with additional cooling capacity

c. With the RHR system, to remove decay heat and residual heat from the nuclear system by cooling the suppression pool water, following a postulated LOCA

d. To provide a method to flood the reactor pressure vessel (RPV), acting as a backup in the extremely unlikely event that all RHR (low pressure coolant injection [LPCI] mode) and core spray pumps fail to operate following a postulated LOCA

e. To provide a method to flood primary containment so that the fuel can be removed from the RPV following a postulated LOCA.

The EESWS is designed to provide a cooling water source for the EECWS. The system functions only during a loss of offsite power, high drywell pressure, or upon failure of the RBCCWS.

The diesel generator service water system is designed to provide a cooling water source for the emergency diesel generators (EDGs) during testing and emergency operation.

The ultimate heat sink system structures are designed to comply with Category I requirements. System construction is designed to comply with requirements for Quality Group C components. Piping, valves, and pumps conform to the ASME Section III Class 3 Code requirements.

The ultimate heat sink system is sized to provide sufficient cooling for 7 days following a reactor shutdown without makeup water addition to the RHR reservoir.

The system structures (pump house, diesel generator building, reservoir, and cooling towers) are designed so that the equipment is physically separated or separated by barriers to ensure against multiple damage from missiles, pipe whip, and fire.

The ultimate heat sink is designed to withstand severe natural phenomena (safe-shutdown earthquake, tornado, storm, flood, and freezing). It is designed to withstand any single failure of manmade structures or components. All necessary electrical equipment is served by the essential buses in the event of loss of offsite power.

The RHRSW supply pressure is less than the pressure in the recirculating RHR system during a normal shutdown or under accident conditions. Therefore, radiation detectors are attached to return lines from the RHR heat exchangers to the cooling towers to monitor for leaks in the exchangers.

9.2.5.2 System Description

The RHR complex consists of a single highly reliable water supply (reservoir); a means for heat rejection (cooling towers); a standby power source comprising four EDGs; a makeup and decanting system; and associated pumps, piping, and instrumentation.

9.2.5.2.1 RHR Complex Reservoir

The RHR complex reservoir consists of two one-half-capacity reinforced-concrete structures of Category I construction, each with a capacity of 3.41×10^6 gal of water at elevation 583 ft. The reservoirs are connected by redundant QA I, Seismic I, ten-inch penetrations which permit access to the combined inventory of the two reservoirs for either RHRSW, EESW, or EDGSW division usage, which assures that the 7-day supply of water is available.

Normal reservoir water level is at Elevation 583 ft (New York Mean Tide, 1935). Waterproof construction of the walls is provided to Elevation 590 ft (New York Mean Tide, 1935) for protection against flooding from Lake Erie. Subsection 2.4.2.2.3 contains a further discussion of the RHR complex flood protection. Each division of the reservoir is fitted with a floodproof nonsiphon overflow to eliminate excess water. Makeup water delivery ports are designed to prevent siphon losses in the event of a break in makeup water supply piping.

Reservoir water loss due to leaks in the RHRSW, EESW, or diesel generator service water lines is detected by redundant level indicators in each division of the reservoir. Comparison between expected water level due to cooling tower losses and actual indicated level will provide sufficient data to determine any system leakage.

9.2.5.2.2 Cooling Towers

A two-cell induced-draft cooling tower is located over each division reservoir. The towers are of Category I fireproof construction with reinforced-concrete shells, cement board fill, and mist eliminators. Each tower is designed to cool one division of the plant load (one RHR heat exchanger, one EECW heat exchanger, and two EDGs), thus providing complete redundancy. Component design parameters for each tower are given in Table 9.2-7.

Each RHRSW cooling tower cell fan is driven by a 150-hp two-speed motor. The motor is connected to the ESF bus of the EDGs for a redundant power supply, and is manually started and stopped from the main control room.

The towers and fan drives are provided with a reinforced-concrete protective shell for tornado, earthquake, and missile protection.

The fans are provided with a brake system to prevent overspeed from the design-basis tornado. The fan drive shaft is provided with a shield to protect it from tornado missiles.

The cooling tower structure is designed to withstand horizontal and vertical tornado missiles. The cooling fan motor is enclosed in a concrete cubicle designed to repel both types of missiles, and the cooling tower gear hub and shaft are protected by missile shields. Using the guidelines in Standard Review Plan (SRP) Section 3.5.1.4, the only design missile that can be elevated to the top of the towers is the 1-in.-diameter by 3-ft, 8-lb rebar. This missile could damage the cooling tower fan blades if the velocity is sufficiently high. However, analysis has shown that the probability of damaging fans in both cooling tower divisions by rebar tornado missiles is very low (see subsection 3.5.1.3 for more detail). Not withstanding this low probability, two spare sets of two RHR cooling tower fan blades and the necessary tools to install them are stored in the RHR complex building in a location protected from the tornado and tornado missiles. In the event that the cooling tower fan blades are damaged, the blades can be replaced and the fan restored to an operating condition. Plant safe shutdown will not be precluded in the event of tornado missile damage to all four of the RHR cooling tower fans, including assuming a loss of offsite power and a single independent failure. The plant organization estimates that it would take six hours or less to replace a set of cooling tower fan blades. If no fans are available for six hours, reservoir temperature is calculated rise to approximately 100 degrees F. All essential equipment cooled by the UHS is capable of performing its required safety functions at the higher reservoir temperature. One cooling tower fan can maintain hot standby and two cooling tower fans can achieve cold shutdown under these conditions.

In addition to missiles, miscellaneous debris can fall into the tower from the tornado. The debris would not damage the fan blades or other structural components of the towers. The debris would be removed while the blades are being replaced.

9.2.5.2.3 Emergency Diesel Generators

The EDGs are located as a part of the RHR complex. Two divisional pairs of two EDGs are provided; only one divisional pair is required for a safe plant shutdown. The divisional separation is maintained in the EDG system; each EDG division powers only equipment of that same division, and is cooled by that same division. In this manner, no postulated single failure can affect more than one division. A more detailed description of the system is provided in Subsection 8.3.1.1.8 and Subsections 9.5.4 through 9.5.7.

The EDG building is a Category I reinforced-concrete structure. An isolation wall is provided between each EDG for fire and missile protection. Independent fire detection and automatic fire- fighting systems are provided for each EDG.

Diesel generator cooling water is supplied from the RHR reservoirs with each diesel generator supplied by its own pump. Supply lines are also independent for each diesel generator. The diesel generator service water pumps start and stop automatically in conjunction with the diesel generators. The diesel generator service water supplies cooling water to the lube oil heat exchanger, the engine inlet air cooler heat exchanger, and the engine jacket coolant heat exchanger. Demineralized water with corrosion inhibitors is used for the closed loop engine jacket coolant. Makeup is provided by the demineralized water storage tank. The diesel generator service water flows through the tube side of the three-stage heat exchanger. The first stage cools the engine inlet air coolant system, then the second stage cools the lube oil, and finally the third stage cools the jacket coolant.

9.2.5.2.4 Makeup and Blowdown Systems

The makeup system is provided to replace evaporation and blowdown losses during normal shutdown cooling. The makeup system is not designed to withstand accidental and natural phenomena nor to function in the event of a single failure. The system is designed to fill and replenish the reservoir as required, to prevent flooding of the reservoirs, and to prevent siphon losses from the reservoirs in the event of a pipe break. The water makeup and the decanting system are shown in Figure 9.2-7.

Normal makeup water will be supplied by the plant GSW system. Normal water level in each division of the reservoir will be maintained automatically by regulating supply valves.

Five GSW (7700 gpm each) pumps are available to supply makeup water, using installed GSW system piping.

The blowdown system is provided to control the buildup of solids in the reservoir water during normal shutdown cooling. The piping is designed to prevent siphoning from the reservoirs in the case of a line break or other incident. Decanting pumps route blowdown from the reservoir to the main condenser circulating water reservoir. Details of blowdown from the main condenser circulating water reservoir are described in Subsection 10.4.5. Details of effluent monitoring are given in Section 11.4.

9.2.5.2.5 Pumps

Each division of the complex is provided with full-size vertical turbine pumps and a separate reinforced-concrete pump house. All pumps are mounted to ensure adequate net positive suction head (NPSH) under all anticipated operating modes. The pump vendor indicates that a minimum submergence at Elevation 554.6 ft will prevent vortexing of the inlet water to the suction bell of the emergency diesel generator service water (EDGSW) pumps, assuming rated flow at 100°F. The other service water pumps, the EESW and RHRSW pumps, require a minimum submergence at Elevation 554.9 ft and 555.7 ft, respectively. The pump motors and electrical switchgear are located at Elevation 590 ft (New York Mean Tide, 1935), ensuring that the system will continue to operate even if the reservoir is breached during the postulated site high-water event. The pumps and pump houses are Category I construction. Column bracing is provided as required to limit stress to allowable values. All pumps are connected to the essential bus for redundant power supply.

The RHRSW pumps are started and stopped manually from the main control room. Each pair of pumps is capable of delivering 9000 gpm* to the RHR heat exchangers and then to the cooling towers. In the flooding mode, the head of water is sufficient to fill 300,000 ft^3 of air space in the drywell in 1 week, at a rate of approximately 250 gpm. In the event of failure of all four of the 10,000-gpm RHR pumps, the RHRSW pumps in Division II will be capable of backup to the RHR pumps in the LPCI mode at the rate of 3250 gpm.

The 1600-gpm EESW pumps are started automatically on demand of the EECWS. One 800-gpm diesel generator service water pump is provided for each of the four diesel generators.

These pumps start and stop automatically, corresponding to the operation of the respective EDG.

Since the reservoir is covered as shown in Figures 1.2-26 through 1.2-28 and 1.2-31, no automatic backwash strainers are provided on the pump discharge.

NOTE: *RHRSW pump flow reduces below 9000 gpm with time due to the RHR reservoir evaporative and drift losses.

9.2.5.2.6 <u>Piping</u>

The piping system consists of two redundant loops. Each loop serves one division of the system.

Separate piping systems supply the service water from the pumps to the RHR and EECW heat exchangers. The EDG units also have individual cooling water supply lines. The RHRSW and EESW return lines are combined into a single header for each division and are routed to the reservoir via the cooling towers. Diesel generator cooling water return lines for each division also join these two common return headers to the cooling towers. The piping conforms to the following conditions:

a. Piping is Quality Group C and Category I (except for the makeup line and the overflow line). Thermal stress and seismic analysis calculations are made in accordance with the ASME Code Section III, Subsection ND for Class 3 components

b. Pressure indicators are provided on the discharge side of the RHRSW and EDGSW pumps, with PCVs for minimum-flow protection. The PCV air operators are supplied with interruptible air, and the valves fail closed on loss of air

c. Heat removal rate is controlled by a remote manually controlled globe valve on the RHR (for RHRSW), an automatic control valve on the EESW, and a manually controlled globe valve on the diesel generator service water system

d. The cross tie required for primary containment flooding is located in Division II between the discharge side of one pair of RHRSWS pumps and the discharge pipe of the shell side of an RHR system heat exchanger

   Keylock dual isolation valves are provided on the cross tie and are normally closed to prevent the service water from entering the RHR system loop. A testable check valve is provided to prevent the RHR system water from leaking into the service water loop. The cross tie is sized for a flow of 3250 gpm. The two isolation valves are motor operated from the main control room

e. Provision is made for process radiation monitoring on the service water discharge of each RHR heat exchanger division

f. The EESW pumps are provided with spring to close pressure regulating valves for minimum flow protection.

9.2.5.3 Safety Evaluation

The ultimate heat sink consists of a single highly reliable water source with fully redundant cooling towers, pumps, and conduits capable of providing sufficient cooling for 7 days to permit safe shutdown and cooldown of the nuclear unit in the event of a design-basis accident. Procedures for ensuring continued cooling availability after 7 days are available. The RHR complex is designed for a single active or passive failure of any fluid system component without loss of safety function. The ultimate heat sink is capable of withstanding the effects of the most severe natural phenomenon associated with the site. Other applicable site-related events have been analyzed, including a single failure of man-made structural features. System failure analysis is summarized in Table 9.2-8.

9.2.5.3.1 Protection Against Natural Phenomena

The physical separation of RHRSWS Division I and Division II equipment, along with the single highly reliable water source with the two reservoirs cross-connected contributes to the reliability of system performance in the event of damage by natural phenomena (earthquake, tornado, storm, or flood) to provide a sufficient water source for 7 days.

9.2.5.3.1.1 Earthquakes

The RHRSWS is designed to meet Category I requirements. The method used in the seismic analysis of the RHR complex is similar to that of the reactor building as outlined in Section 3.7.

9.2.5.3.1.2 Tornadoes

A design-basis tornado and the missiles it might generate are described in Sections 3.3 and 3.5.

9.2.5.3.1.3 Freezing

The RHR building is designed to protect the reservoirs from direct exposure to winter weather. The floors of the RHR building cover a large portion of the reservoir surfaces and the remaining portion of the reservoirs is covered by floor gratings and tower baffles and is protected by high walls. In addition, 80 to 90 percent of the reservoir water is below the frost line. Drain lines provide passive freeze protection for the Mechanical Draft Cooling Tower (MDCT) spray distribution headers by allowing standing water to drain to the RHR Reservoir subsequent to MDCT operation.

The pump columns below the pump room are protected from freezing by an enclosure which is installed at the two open sides of the area below the pump room floor. The enclosed air volume temperature is locally monitored from the pump room.

During unit operation, the RHR complex reservoirs would receive heat from surveillance testing of plant systems such as the EDG, high pressure coolant injection (HPCI), and reactor core isolation cooling (RCIC) systems, and from other plant activities (such as operating the torus water management system). This heat would go directly to the RHR complex or the torus. Heat sent to the torus is removed by sending it to the RHR complex. During unit shutdowns, the RHR complex would receive reactor decay heat that is sufficient to prevent the reservoirs from freezing. The RHR complex also has cold weather bypasses around the cooling towers that can direct service water to the reservoirs instead of the RHR complex cooling towers. This would help retain the heat sent to the reservoirs.

The reservoir temperatures are monitored by readout in the control room and alarm at 43°F. The heat added to the reservoir during normal operation and testing is expected to be sufficient for this temperature to be exceeded during the winter. If needed, additional heat may be used to increase the reservoir temperatures by operating an EECWS or a temporary system installed for that purpose. Surveillance requirements of the reservoir temperature and required action in the event of low temperatures are contained in the Technical Specifications.

9.2.5.3.1.4 Floods

The reactor/auxiliary building and the RHR complex are designed to withstand the maximum postulated flood-water level and associated wave actions as described in Subsection 2.4.2.2 and Section 3.4.

The reservoir overflow is a nonsiphon floodproof port. Sidewalls are waterproofed to Elevation 590 ft (New York Mean Tide, 1935) and are above the Lake Erie stillwater level at the plant site. All active equipment that could be damaged by water (pump motors, switchgear, diesel generators) is located above the maximum flood-water level. The site flood considerations and plant protective structures are discussed in Subsections 2.4.2, 2.4.3, and 2.4.5.

9.2.5.3.1.5 Snow and Ice

The RHR complex roof structure is designed for the probable maximum snow and ice (including cooling tower drift) loads. The roof structure is capable of supporting a maximum loading of 70 lb/ft^2.

9.2.5.3.2 Protection Against Accident Phenomena

The RHR complex is designed to withstand the effects of the most severe natural phenomena associated with the Fermi plant site, as stated in Subsection 9.2.5.3.1 above. Other applicable site- related events such as river blockage, river diversions, reservoir depletion, or transportation accidents are not applicable to the design or postulated to occur. Flooding of the plant by surface runoff is not possible (Subsection 2.4.3.5). Transportation accidents are expected to have no effect on the complex because

a. The nearest main-line railroad and interstate highway are at least 3 miles from the plant site

b. The nearest ship channel is at least 4-1/2 miles from the plant site; the lake is of insufficient depth for commercial traffic in the plant vicinity; and the RHR complex is approximately 1100 ft inland from the lake shore

c. No significant aircraft operations occur in the plant vicinity.

A single failure of man-made structures such as the cooling tower or the pump house would not result in the loss of capability of the heat sink to accomplish its safety functions, because of the redundancy and separation of these components. A breach in the reservoir retaining wall above grade elevation would not compromise the reservoir's 7-day capacity since the reservoir capacity is contained below grade of 583 ft. A below grade structural failure would only result in a limited degree of water loss since the damaged reservoir(s) would leak only until the ground-water elevation is reached. The 7-day capacity includes allowance for a below grade structural crack in both reservoir basins. Stability of ground-water level is discussed in Subsection 2.4.13.

The RHR complex structures, systems, and components are designed so that the minimum performance requirements of the complex can be met in case the postulated turbine missile strikes the complex.

Typical missiles that could be ejected from the EDGs will be small auxiliary items knocked loose from the engine exterior by blows from within. The maximum velocity of the missiles would be 40 fps, with a maximum mass of 5 lb each. The walls of the EDG rooms are designed to withstand such missiles and contain them within the room. Refer to Subsection 3.5.1 for further discussion of these postulated missiles.

9.2.5.3.3 System Reserve Capacity

The ultimate heat sink system was originally sized to provide sufficient cooling for 30 days following an accident without make-up water addition to the RHR reservoir. Regulatory Guide 1.27 states that a UHS capacity of less than 30 days may be acceptable if it can be demonstrated that replenishment can be effected to ensure the continuous capability of the sink to perform its safety functions, taking into account the availability of replenishment equipment and the limitations that may be imposed on freedom of movement following an accident. In order to provide additional head for the service water pumps, a 7-day reservoir replenishment was reviewed and was found to satisfy the R.G. 1.27 guidelines.

The Fermi 2 UHS design evolved long before the post-TMI improvements in Emergency Preparedness. Those improvements are reflected in the Detroit Edison Radiological Emergency Response Preparedness Plan. One of the objectives of this program is effective and timely implementation of emergency measures. Detroit Edison now has the resources of the Emergency Response Organization to rapidly identify the need for reservoir replenishment and to direct procurement of material and field implementation. This change significantly improves the ability to provide reservoir replenishment within 7 days as it relates to resolving problems associated with freedom of movement following an accident or occurrence of severe natural phenomena.

The 7-day make-up provision for the RHR reservoir is consistent with the 7-day make-up provisions allowed for replenishment of the diesel generator fuel supply. Therefore, this period of time is sufficient to recover from the effects of natural phenomena such as tornado, storm, earthquake or flood and restore site access for replenishment activities.

The reservoir replenishment procedure requires that reservoir make-up be established within 7 days following exceeding the Technical Specification reservoir level limit. Make-up will be provided by the normal make-up system or using RHR Complex fire hoses. If these systems are not available, temporary equipment will be used. The necessary pumps and hoses are commercially available from many sources and 7 days is sufficient time to procure and install the equipment. The procedure requires redundant replenishment equipment so that a single failure will not interrupt make-up. Necessary equipment requirements and vendors are listed to allow rapid procurement. Temporary pumps are located in lower postulated post-accident dose rate areas so that access in available for monitoring and periodic refueling. The water source will be either Lake Erie, the Fermi 1 discharge canal, the circulating water reservoir, the on-site Quarry Lake or Swan Creek. Projected dose for hose installation is below allowable limits. The temperature and quality of make-up water is maintained to ensure that the service water systems and cooling towers perform as required. Siphon of the reservoir is prevented by ensuring that hoses are not placed into the reservoir water.

The reservoir will continue to store approximately 6 million gallons of water which was the previous 30-day supply. However, the level below that needed for 7 days of operation will be used to provide additional service water pump head margin. Therefore, if the level were to go below that required for 7 days of operation, a slow degradation in service water pump performance (discharge head) below design requirements would be possible.

The 7-day supply calculations utilize the Marley design and test data for cooling tower drift and evaporative water losses. In addition, the seven day supply also assumes a below grade structural crack in both reservoir basins and losses for EECW makeup using EESW. To maximize drift and evaporative losses, the reservoir basins are assumed to be cross-connected and both divisions of EDGs, RHR, EECW/EESW, and RHRSW cooling towers are assumed to be operating. The RHR heat exchanger was assumed to be clean (unfouled) to maximize heat loads on the ultimate heat sink. Constant historical worst-case meteorological data is used to compute evaporative water losses. The 7-day supply also assumes initial reservoir level at the technical specification limit of 580’-0” versus the normal operations level of between 582’-0” and 583’-0” which provides additional conservatism.

The RHR reservoirs are sized to provide for the evaporative and drift losses from the RHR cooling towers for 7 days following a design-basis recirculation line break, assuming a total loss of offsite power for the 7-day period. Evaporative losses are calculated as a function of cooling tower range using computer generated curves based on data supplied by the cooling tower manufacturer.

Since the cooling towers are designed to function largely by evaporative heat transfer, water loss due to evaporation is the largest contributor to water consumption. Drift losses (liquid droplet carryover in the air stream) are assumed to be 0.05 percent of liquid flow. Drift losses in combination with the other secondary contributors to water consumption (i.e. reservoir leakage and EECW makeup*) are small compared to evaporative loss.

* The cooling load for the spent fuel pool is not included since the normal burden is insignificant. When all or part of the core is unloaded, the cooling load in the spent fuel pool will increase, and the cooling load imposed by decay heat in the core will decrease proportionately.

The RHR reservoirs are nominally maintained between 583 ft and 582 ft elevation by an automatic makeup system. The Technical Specifications limit is established at 580 ft, or 5,980,000 gal. The 7-day water loss will result in a water level above Elevation 567’-6”. This level is above the minimum submergence level required for the service water pumps as indicated in Subsection 9.2.5.2.5.

The heat load into the suppression pool as a function of time for the first 24 hours post LOCA was taken from the suppression pool peak temperature calculations described in Section 6.2.1.3.3. This suppression pool heat load includes decay heat (based on a pre-trip power level of 3499 MWt, which is 102% of 3430 MWt), sensible/blowdown energy, and RHR and core spray pump heat. The heat input to the suppression pool after 24 hours is from decay heat and pump heat. The decay heat after 24 hours is determined using the Standard Review Plan, Section 9.2.5, Branch Technical position ASB 9-2. The fractions of decay heat (as a fraction of operating power) versus time were converted to decay heat using a pre-trip reactor power level of 3499 MWt, which is 102% of 3430 Mwt.

The heat from the station auxiliary systems includes heat from the EECWS, the EDGs, and pump energy. The heat from the EECWS includes the emergency core cooling system (ECCS) pump cooling, control room air conditioning, air compressor cooling, ECCS room coolers, thermal recombiner area coolers, and standby gas treatment system (SGTS) room coolers. The thermal recombiner units are retired in place, de-energized, and isolated from primary containment with redundant locked-closed isolation valves. The associated area coolers are retained and credited as a heat sink for post-accident environmental conditions. The heat rejected by the EDGs is based on loads commensurate with the function required during each stage of the 7-day period. The pump energy created by the work input of the RHR, core spray, RHRSW, EECW, EESW, and EDGSW pumps has been considered.

The LOCA coincident with a loss of offsite power is the worst-case condition for reservoir water usage because:

a. The main condenser is unavailable for removal of any core decay energy or primary system energy

b. The EDGs run at the highest loads, resulting in highest heat rejection to the complex

c. The EECWS is operating (in lieu of RBCCWS)

The reservoir is not sized to supply the water required for flooding the core or primary containment to allow access to the core for accident recovery. Flooding of the primary containment is a long-term action, initiated many days or weeks after an accident, following an administrative decision. Such a decision would not be made until offsite power is available and the makeup water system is restored to service.

9.2.5.3.4 Multiple Water Sources

Two half-sized reservoirs are provided, each with a capacity of 3,410,000 gal of water at elevation 583 ft. Redundant penetrations cross-connect the two reservoirs and permit access to the total UHS water supply in the event of a mechanical failure in one division. Each division of the system has a separate piping system with adequate separation such that a failure of one will not induce failure of the other. The reservoirs are designed to withstand all applicable site-related natural and accidental phenomena, and there is no retaining "dam," as such, to fail. The water in the UHS is stored below site grade level and approximately 90 percent of the total water volume is below site ground-water level. Therefore, it is concluded that there is an extremely low probability of losing the 7-day cooling capability of the UHS.

9.2.5.4 Tests and Inspections

Initial construction tests such as hydrostatic leak tests of the RHRSWS were conducted per applicable code requirements. Initial system flow checks, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14. After startup, a test will be run to observe the heat exchanger (including cooling tower) performance. Periodic tests are made to assess continuing pump performance and to demonstrate piping system integrity. The RHRSWS is periodically checked during its normal system function of cooling down the plant, such as during refueling or other outages. The EESWS will be tested in conjunction with the EECWS. The diesel generator service water system is tested in conjunction with the diesel generator testing. The reservoir and cooling tower are periodically inspected for macro and micro biological fouling and are treated, as required. Sampling and surveillance for control of dissolved solids and macro and micro biological fouling are performed by the Chemistry Section.

9.2.5.5 Instrumentation

System temperatures, pressures, and flows are monitored either locally or in the main control room. Pressure, temperature, and flow indicators are provided with local readouts. Pump and fan motors and controls incorporate standard protection devices.

Makeup for the RHRSW reservoir is automatic (except under accident conditions), controlled by level monitors in the two RHRSW reservoir divisions. These level monitors signal low-level alarms in the main control room.

9.2.6 Condensate Storage and Transfer System

9.2.6.1 Design Bases

The condensate storage and transfer system is designed to store and distribute condensate and demineralized water for use throughout the plant during normal and shutdown plant conditions. To provide for high plant availability, two full-capacity 600,000-gal storage tanks are provided, one designed as the normal storage tank and the other as the return tank. Demineralized water is stored in a 50,000-gal storage tank.

The condensate storage and return tanks are located near the turbine building and the auxiliary boiler house. They are arranged to permit gravity feed to condensate supply pumps and to the HPCI, RCIC, CRD, standby feedwater (SBFW), and core spray systems. During normal station operation, hotwell level is raised as necessary by vacuum dragging water to the hotwell from the CST or CRT. When the plant is shutdown, or when a greater flow is required, the normal, or if necessary the emergency, hotwell supply pumps will start and stop automatically depending on hotwell level. The condensate storage tank is designed to deliver its last 150,000 gal only to the HPCI or RCIC system (see Section 6.3.2.6).

A containment wall surrounds the tanks. Surveillance of surface conditions and radioactive content will be performed during plant operation.

The makeup demineralizer storage tank is located near the auxiliary boiler house and gravity feeds to the demineralized water transfer pumps and jockey pump. These pumps provide demineralized water to the service risers and the condensate storage tank.

Collection and distribution piping for the condensate and demineralized water is carbon and stainless steel. A cathodic protection system is supplied for the piping. The condensate tanks are fabricated of corrosion-resistant, high-strength aluminum alloy.

Piping to the HPCI and RCIC systems conforms to Quality Group B standards and is built to ASME Section III, Class 2, requirements. The balance of the condensate storage facilities conforms to Quality Group D standards and is built to ASME Section VIII and ANSI B31.1.0 code requirements. The tanks are designed to withstand a 100-mph wind when empty. They conform to USAS B96.1, "Welded Aluminum-Alloy Field-Erected Storage Tanks," code requirements. A minimum water temperature of 40°F is maintained in the insulated condensate storage tank by steam from the auxiliary boiler.

9.2.6.2 System Description

The condensate storage and transfer system, as shown in Figure 9.2-10, consists principally of two large storage tanks and three pumps, with associated receiving and distribution lines, one demineralized water tank, and three pumps with associated receiving and distribution lines. Component design parameters are given in Table 9.2-9. The condensate return and the condensate storage tanks are 600,000-gal aluminum tanks with open vents. The condensate storage tank is insulated and has sufficient heating capacity to maintain a water temperature of at least 40°F, which is the design limit for thermal shock to the RPV nozzles. Both tanks are located inside a containment wall near the turbine building. The condensate storage tank receives demineralized water from the demineralized water makeup system and may also receive low-conductivity water from the condensate return tank. There is also a normally closed balance line connecting these two tanks to allow gravity transfer from one tank to the other above the 150,000-gal limiting level of the storage tank.

Containment for any condensate loss that might be experienced is provided by a containment wall in the immediate area around the condensate storage tanks, as shown in Figure 9.2-11. All valves associated with either condensate storage tank are located in valve pits at the base of the tank. Any leakage into either valve pit is automatically pumped through a 4-in. drain line to the waste collector tank in the radwaste building.

A single wall, 3 ft high above the normal grade level, encloses both condensate storage tanks. This forms a contained area approximately 109 ft wide by 232 ft long. The contained area is also excavated 3 ft below grade level. The enclosed area has been sealed with a Hypalon liner (waterproof barrier) to contain all spillage of contaminated water from the condensate system and prevent it from entering the soil in the condensate storage tank and condensate return tank diked area.

Relief valves are installed in the condensate return tank valve pit to prevent inlet piping overpressurization. A 30 gpm relief valve discharges directly to the CRT valve pit. Relief valves with 600 and 5000 gpm relief capacities discharge into the lined dike area surrounding the CRT and CST for subsequent cleanup and processing.

Direct access to Lake Erie by lost condensate seeping into the ground is prevented by the clay fill seal beneath the shore barrier. Initial movement of any seepage would be downward to mix and dilute with the ground water from the dolomite aquifer. Thereafter the diluted material would move into and through the aquifer at the same rate of flow and direction of movement as the transient ground water. The direction of movement would be to the east, at a rate of 0.24 ft per day or less. In essence, this would be the same sequence of events as that documented for the loss of all radwaste water to the aquifer in Edison's response to AEC Question 10.2 in the Fermi 2 PSAR, except that the condensate water would be orders of magnitude less radioactive.

The storage tanks are provided with horizontal slots (weirs) in the sides of the tanks with ducting to channel overflow down the side of the tank and eliminate spray. An alarm system is provided that alarms in the control room to indicate that a tank is in the process of overflowing. This alarm system is independent of any other instrumentation or alarms associated with the condensate storage tank or condensate return tank.

Recycle streams are treated and monitored prior to transfer to the condensate return tank. If water in the condensate return tank requires further treatment, it can be transferred to the radwaste system by gravity for processing, or it can be sent through the polishing demineralizer via the hotwell and condensate system.

It is possible for the following water sources to be transferred directly to the condensate tanks:

a. Return from radwaste system

b. Return from CRDs

c. HPCI pump test return

d. RCIC pump test return

e. SBFW pump test return

The inlet valves on the condensate storage tank and condensate return tank are provided with an interlock to prevent the two valves from being simultaneously closed. This interlock provides protection against overpressurization of the tank inlet piping by the CRD, HPCI, RCIC, or SBFW pump.

Treated recycled condensate water is normally routed to the condensate return tank. Typical sources are:

a. Reactor well drain

b. Return from drywell seal rupture

c. Spent fuel storage pool drain

d. Main condenser high-level relief

The demineralized water makeup system supplies only the heated condensate storage tank, the auxiliary boiler, and the demineralized water distribution system.

The condensate storage tank is sized for the following duty:

Fuel pool and reactor well	410,000 gal
Reserve for the HPCI and RCIC pumps (see Section 6.3.2.6)	150,000 gal
Additional reserve	40,000 gal
Total	600,000 gal

The condensate storage tank provides a source of water for the HPCI, RCIC, SBFW, core spray, and CRD pumps. Either condensate tank can supply the low-pressure turbine hood spray pump through a common header.

The condensate return tank is the same size as the condensate storage tank in order to provide operational flexibility so that one tank may be substituted for another for certain functions as described herein. The condensate return tank has sufficient capacity for:

Fuel pool and reactor well	410,000 gal
Additional reserve	190,000 gal
Total	600,000 gal

The primary function, however, of the return tank is to receive condensate from the plant and to store any temporary excess condensate. Excess water from the condenser hotwell is normally relieved to this tank. During normal station operation, hotwell level is raised as necessary by vacuum dragging water to the hotwell from the CST or CRT. When the plant is shut down, or when a greater flow is required, the normal, or if necessary the emergency, hotwell supply pumps will start and stop automatically depending on hotwell level. Makeup to the hotwell is normally supplied by the hotwell supply pump drawing condensate from the condensate return tank. During normal station operation, the hotwell supply pump starts and stops automatically, depending on the hotwell level of the condenser.

Condensate for distribution to other plant areas is supplied from the condensate pump discharge header, downstream of the condensate polishing demineralizers, via a pressure-reducing valve. Condensate at 100 psig feeds the condensate storage system distribution header.

The condensate storage and transfer system distribution pumps are housed in the turbine building and are supplied from the same header, feeding from either condensate tank. The three pumps required for distribution are described as follows:

a. The condensate storage jockey pump (one 100-gpm pump) is used to maintain condensate pressure during startup/ shutdown and supply water to the condensate distribution header whenever the supply from the condensate system is not available. The condensate storage jockey pump has minimum flow protection to provide sufficient pump cooling in the event of low or zero flow in the condensate distribution system. The condensate distribution system supplies the following:

    1. Radwaste building

    2. The turbine building backwash tank

3. A reactor building supply header. This portion of the reactor building supply header is intended for preoperational flushing and fill, and not for makeup.

   It provides RHR system flushing and maintains the RHR keep fill system. As such, the various distribution branches to the following items are normally valved off:

   (a) RBCCW makeup tank

   (b) EECW makeup tank (two).

   The reactor building supply header supplies makeup to the following:

   (a) Cleanup phase separators

   (b) Reactor water cleanup filter-demineralizer

   (c) Fuel pool skimmer surge tank

b. The normal hotwell supply pump is a 600-gpm pump discharging to the main condenser hotwell level control station. The normal hotwell supply pump can be used to supply water to the condensate distribution system when either of the other two sources (jockey pump or condensate system supply) are insufficient or out of service. The normal hotwell supply pump has a minimum flow valve which provides flow protection for a limited time. Should plant outage activities require prolonged operation of the pump with minimum flow, a supplemental, temporary flow path is established to provide adequate minimum flow protection.

c. The emergency hotwell supply pump is a 2000-gpm pump with an independent distribution line to the main condenser hotwell and branch to the TBCCWS for flushing. This emergency pump can also discharge into the condensate return line to the storage tanks. In this way, it can be used to transfer condensate water from one tank to the other.

The makeup demineralized water tank supplies demineralized water for the following:

a. Condensate storage tank

b. Auxiliary boiler deaerator makeup

c. TBCCWS makeup

d. RBCCWS makeup

e. EECWS makeup

f. Standby liquid control tank in reactor building

g. Service risers in turbine building, reactor building, auxiliary building, and radwaste building

h. Plant instrument backflush

i. Cask washdown in reactor building

j. Health Physics and chemistry laboratories

k. Deleted

l. Emergency showers in the radwaste building

m. Core spray system charging, and for maintaining the keep fill system.

The demineralized water is distributed to the condensate storage tank and throughout the plant by two 100-gpm transfer pumps and by a 20-gpm jockey pump. Normally the jockey transfer pump operates continuously with bypass flow unloading on low water demand. The jockey pump thereby provides a minimum hydrostatic pressure of 30 psi throughout the system. On increasing flow demand (system pressure decreases), one 100-gpm transfer pump starts automatically. If flow demand is still not satisfied and header pressure continues to drop, the second transfer pump starts.

9.2.6.3 Safety Evaluation

Adequate protection from environmental conditions is provided by designing the tanks to withstand a 100-mph wind when empty. The tanks are designed for -10°F to 95°F ambient temperatures.

Condensate water within the plant is separated from the demineralized water system and confined to areas of limited access. Health Physics surveillance is maintained on this equipment. An exclusion fence surrounds the condensate storage and condensate return tanks. Because of these conditions, personnel injury from radiation is extremely unlikely. Construction materials are corrosion resistant and should serve without failure during the 40-year life of the plant. The tank is constructed of aluminum alloy, and the HPCI and RCIC pump suction lines are stainless steel. Carbon steel piping is provided with cathodic protection.

The design of the demineralized water makeup system precludes radioactive contamination of the storage tank. The transfer line between the uncontaminated demineralized water storage tank and the potentially contaminated condensate storage tank terminates in the condensate storage tank above the normal operating water level. This feature, along with check valves at the transfer pump discharge lines and the normally closed motor-operated isolation valve, provides reasonable assurance against inadvertently contaminating the demineralized water makeup system. Contamination of the potable water system is prevented by an open break between it and the demineralizer water makeup system.

Active functioning of the condensate storage and transfer system is not required during a reactor shutdown. Suction for RCIC (or HPCI) can be manually transferred from the condensate tank to the Category I suppression pool. In addition, on low level in the tank, suction is automatically transferred. Therefore, it is not necessary to install redundant power sources and redundant water sources throughout the condensate system. Nevertheless, the system is designed with certain redundancies (e.g., cross- connections, standby pumps) to reduce, as far as practical, the probability of causing a plant shutdown because of some failure in the condensate storage and transfer system.

Normally, water from the plant is returned to the condensate return tank after treatment and analysis. The water in the return tank will be analyzed to ensure that it is of sufficiently high quality. In the event that water has excessive radioactivity or conductivity readings, it will be transferred to either the polishing demineralizer via the hotwell or to radwaste for further treatment. These operating procedures will ensure a source of high-quality water for station operation.

Leakage is controlled by utilizing welded construction for the storage tanks, and as much as is practicable for the piping. Each penetration on the tank is supplied with an isolation valve. Levels in the two storage tanks are recorded and alarmed in the main control room.

Accidental release of liquids in the condensate storage tank would not result in concentrations in Lake Erie exceeding the limits of 10 CFR 20. Any accidental release that is not retained by the lined containment around the storage tanks will infiltrate the site fill; however, horizontal permeability of the soil will provide sufficient holdup to attain the required decontamination factor by radioactive decay before entering Lake Erie. No credit is taken for filtration or ion exchange through the soil.

9.2.6.4 Tests and Inspections

Initial construction tests such as hydrostatic leak tests were conducted per applicable code requirements for the condensate storage system. Initial system flow tests, valve operability, instrumentation and control loop checks, and alarm setpoint checks were performed in accordance with the Preoperational Test program as discussed in Chapter 14.

Periodic tests are conducted to confirm pump performance and operation of automatic controls. Inspection for system leakage is coincident with pump testing and routine monitoring activities.

9.2.6.5 Instrumentation

Pump motors are equipped with standard controls and protective devices and are controlled and monitored from the main control room. Each pump's flow is indicated locally. The level and temperature of the condensate storage tanks and the demineralized water storage tank are continuously recorded in the main control room. High-and low-water-level and overflow alarms are provided. Level and temperature indicators are provided locally at the tanks.

The storage tank temperature can be manually controlled from the main control room by continuously circulating stored condensate through the condenser hotwell.

9.2.7 Cooling System for Turbine Auxiliaries

9.2.7.1 Design Bases

The TBCCWS is designed to remove heat from auxiliary equipment housed in the turbine building. The TBCCWS is cooled by the GSW system and makeup is supplied by the demineralized water system. The TBCCWS is designed to operate at a lower pressure than the GSW system to prevent leakage to the environs.

The TBCCWS is nonseismic and is constructed in compliance with standards for Quality Group D components. This criterion is met by designing the system to ASME Section VIII and ANSI B31.1.0 code requirements.

9.2.7.2 System Description

The TBCCWS, as shown in Figure 9.2-12, consists of two 100 percent-capacity TBCCWS heat exchangers and three 50 percent-capacity pumps. The TBCCWS component design parameters are listed in Table 9.2-10. During normal operation, one heat exchanger and two pumps operate to remove all the equipment heat loads. The third pump is in standby and is designed to be started manually on low TBCCWS pressure. The TBCCW supply header temperature is maintained by a temperature control valve modulating the GSW flow through the TBCCW heat exchanger. System pressure is controlled by a differential PCV located in the bypass line between the suction and discharge headers of the TBCCW pumps. Makeup to the system as well as system expansion and contraction due to load changes are provided by a makeup tank. Makeup water is automatically supplied via a tank level control valve from the demineralized makeup water system. A pressure-regulating valve maintains nitrogen overpressure in the tank. Nitrogen is provided to prevent the introduction of oxygen into the system, thereby retarding corrosion of the closed cooling water system, and to maintain a positive suction head on the pumps.

Turbine auxiliaries impose a maximum cooling load on the TBCCW heat exchanger of approximately 45 x 10^6 Btu/hr during normal operation. This requires approximately 9000 gpm of GSW, assuming a maximum GSW temperature of 85°F. Circulation on the TBCCW side of the heat exchanger is approximately 6000 gpm; design temperatures are 110°F in and 95°F out. Normal operating temperature is 80°F out. The operating temperature range is 75°F to 88°F as measured at the TBCCW pump suction. The TBCCW header temperature control high-alarm setpoint is 88°F and the low-alarm setpoint is 75°F.

The GSW is not used directly because the relatively high impurity level in this system might result in fouling of equipment heat transfer surfaces. Furthermore, the intermediary loop between potentially contaminated turbine auxiliaries and the GSW system provides additional protection against radioactive water leakage into the environment. The following equipment is cooled by the TBCCWS:

a. First floor:
   1. Station air compressors with associated coolers
   2. Heater feed pump lube oil coolers
   3. Heater drain pump motors
   4. Condenser mechanical vacuum pumps
   5. Oil coolers for each reactor feed pump and turbine drive
   6. Coolers for air conditioning unit serving the Health Physics laboratory and radwaste control room
   7. Cooler for the chemical sampler

b. Second floor:

1. Generator bus duct cooler heat exchangers
2. Hydrogen seal oil coolers
3. Stator winding coolers
4. Excitation equipment area air coolers
5. Offgas system aftercoolers.

c. Third floor:

1. Ring water coolers for the offgas vacuum pumps
2. Adsorber room air conditioner cooler for the offgas system
3. Unitized actuators cooling.
4. Offgas Chiller Refrigeration Unit N6200D010 Condenser.

9.2.7.3 Safety Evaluation

Turbine auxiliaries housed in the turbine building are not considered essential to safe reactor shutdown. An alternative power source for TBCCW pumps and controls is not required. Because a reactor shutdown can be safely executed without depending upon turbine auxiliaries, no alternative water supply to the TBCCWS is required. Redundancy is therefore properly limited to two normally operating pumps and one standby pump to facilitate periodic tests and maintenance and to ensure plant availability.

The design of the TBCCWS avoids direct application of GSW to cooling components and heat exchangers. This excludes impurities from the turbine auxiliaries and service piping and reduces the chances of long-term degradation from fouling or corrosion. Additionally, corrosion inhibitors are added for pH and oxygen control. Alternatively, the TBCCW system may be maintained with pure demineralized water only with no chemicals added.

The TBCCWS operates at a lower pressure than does the GSW system to protect against leakage into the GSW system. Leakage from the TBCCWS into the building is detected by a low-level alarm in the makeup tank and by an alarm on the makeup level control valve stem position. Excessive opening of the makeup valve is indicative of a substantial system leak. Inleakage of GSW will be indicated by a high-level alarm in the makeup tank.

9.2.7.4 Tests and Inspections

Initial construction tests such as hydrostatic leak tests were conducted per applicable code requirements for the TBCCWS. Initial system flow distribution, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14. Heat exchanger performance is observed during plant operation using actual system heat loads.

Instruments and controls are inspected periodically. No periodic leak tests are planned since the system is continuously operating and pressurized. Periodic visual inspection of the system will detect minor leakages, such as those from valve stems, flanges, and instrument tubing.

9.2.7.5 Instrumentation

Pump motors are equipped with standard controls and protective devices, and are monitored from the main control room. Readouts to observe pressure and inlet and outlet temperatures in the TBCCW are provided in the main control room. Interlocks are provided on the TBCCW pumps to prevent their starting on low makeup tank level and/or low suction pressure. The temperature of the TBCCWS during operation is controlled by modulating the discharge flow of GSW through the TBCCW heat exchangers. Closed loop pressures are regulated by pump unloading (bypass) valves.

High- and low-level alarms are provided on the makeup tank as are alarms for low system pressure, to alert the operator of system leakage or loss of nitrogen capping.

9.2.8 Torus Water Management System

9.2.8.1 Design Bases

The torus water management system (TWMS) is designed to provide thermal mixing of the torus water, torus water volume inventory control, torus water quality maintenance, and to drain and fill the torus to facilitate inside torus recoating, inspections, and repair work. The TWMS design flow, makeup, and discharge rates are based on draining or filling the 1,000,000 gal of torus water in 48 hr and circulating the torus water at a rate of 500 gpm (maximum). Figure 9.2-13 is the system schematic.

The TWMS pumps (refer to Table 9.2-11) are located in the subbasement of the reactor building in the HPCI room. The interconnected piping required to perform the circulating, cleaning, draining, and filling functions of the TWMS is located in the reactor, turbine, and auxiliary buildings.

The TWMS primary containment penetrations and the associated isolation valves are classified as ASME Section III, Class 2, and designated as Category I. The balance of the TWMS is classified as ASME Section VIII for pressure vessels and ANSI B31.1.0 for piping, and is designated as nonseismic.

9.2.8.2 System Description

The TWMS pumps take suction from two torus connections placed at a 180° angle around the torus from each other. Water is similarly returned to the torus using two different torus connections also at a 180° angle from each other. These torus connections were selected to maximize thermal mixing efficiency to the extent practical.

The TWMS normally maintains torus water quality. The TWMS pumps will transfer torus water to the condensate system at the main condenser continuously or intermittently, as selected by the operator. Clean condensate from the condensate reject line to the condensate storage tank provides return water to the torus. The rate at which torus water is transferred to the condensate system for cleaning and subsequently returned to the torus is regulated by the control room operator to maintain the proper torus water level and desired quality. One facet of the primary containment monitoring system provides the operator with a wide-range torus water level indication and one aspect of the TWMS provides a narrow-range torus level indication.

As required for recoating, inspections, and repair work, the TWMS is used to drain and fill the torus. Torus draining is accomplished by using the TWMS pumps to transfer torus water directly to the main turbine condenser for storage. Torus filling is accomplished using a condensate system pump to transfer water back to the torus through the TWMS return piping. During the filling operation, one of the eight polisher/demineralizers may be placed into service to clean the water returned to the torus.

9.2.8.3 Safety Evaluation

The TWMS is not required for reactor shutdown or accident mitigation and as such is not a safety-related system. However, the availability of the TWMS increases the reliability and availability of the plant. The reliable operation of the TWMS is ensured through the redundancy of the TWMS pumps (two at 250 gpm each) and two 50 percent-capacity suction and discharge lines with required isolation valves.

To ensure that the TWMS will not impair the safety function of the torus, the TWMS primary containment isolation valves automatically close. These valves trip in response to selected primary containment isolation system isolation signals (refer to Table 6.2-2) and to the high-high level alarm of the drywell floor drains or the torus room floor drain sump. The power supplies for containment isolation valves are arranged so that loss of one supply cannot prevent automatic isolation of a TWMS suction or return line when required. Torus water level and temperature limits and alarms are monitored and provided by the primary containment monitoring system, which is designated as a safety-related system.

Administrative controls and other constraints are provided to ensure that the suppression pool is not drained by the TWMS when the need for the ECCSs could be required. The limiting conditions for the draining of the suppression pool are specified in the Technical Specifications. Operational procedures for the TWMS include detailed information on the draining of the suppression pool. The TWMS pumps will automatically trip, preventing a torus water-level decrease, when the torus water level low-low alarm setpoint is reached at an elevation of 556.83 ft (2 in. below normal level) except when in the torus drain mode of TWMS.

Because the TWMS is considered a moderate energy system, flooding and spraying effects from postulated cracks in the system piping have been evaluated. Flooding and spraying effects have been determined to be enveloped by the limiting RHR pump discharge line crack (refer to Subsection 3.6.2.3.4.1.2). System overpressure protection is maintained by pump discharge relief valves.

9.2.8.4 Tests and Inspections

Initial system flow checks, valve operability, and instrumentation and control loop checks were performed in accordance with the test program as discussed in Chapter 14. A flow meter in the TWMS transfer line to the condensate system is provided to indicate the torus water removal rate and establish TWMS pump operability. Conductivity monitors on the discharge side of the polisher/ demineralizers provide continuous monitoring of the water returned to the torus. Minor leakages such as those from valve stems, flanges, and instrument tubing are detected through visual inspection.

9.2.8.5 Instrumentation

The TWMS is operated from the control room. Flow meter indication of the torus water flow to the condensate system is provided in the main control room. Position indication for the TWMS primary containment isolation valves and the control valves on the transfer and return lines are also provided in the main control room. Torus water management system controls and instrumentation are augmented by the containment monitoring functions of the primary containment monitoring system and the water quality monitoring devices in the turbine building.

9.2.9 Supplemental Cooling Chilled Water System

9.2.9.1 Design Basis

The SCCW system is a closed cooling water system which during normal plant operation will provide chilled water that will be used to lower the temperature of the cooling water supply to EECW that is normally cooled by RBCCW. The SCCW system is designed to remove 100 percent of the normal heat produced by the EECW system during normal operation. The SCCW system transfers the heat it has removed to the GSW system via mechanical chillers.

The SCCW system is designed to operate at a higher pressure than the RBCCW system to provide protection against potential outleakage of radioactive contaminants from the RBCCW system.

The SCCW system is classified as a non-nuclear system and is constructed in compliance with standards for Quality Group D components. This criterion is met by designing the system to ASME Section VIII and ANSI B31.1.0 code requirements. The system is nonseismic.

9.2.9.2 System Description

The SCCW system, as shown on Figure 9.2-14, is designed to remove heat from the RBCCW system headers that supply cooling water to the EECW headers and from the fan coil that cools the SCCW chiller area (turbine building basement).

The SCCW system consists of three 50 percent-capacity chillers (two normally operating), only one may be operating during low load conditions, three 50 percent-capacity chilled water pumps (two normally operating), a chilled water expansion tank and associated valves and controls. The system is designed to be started when RBCCW temperature first exceeds its nominal control temperature and left in operation until the RBCCW temperature can be maintained at or below its nominal control temperature. Table 9.2-12 provides SCCW system design parameters.

After a manual startup from the local control panel, system operation does not require operator intervention unless it is desired to rotate equipment that is operating or a trouble signal is annunciated in the control room. In the event a chiller were to trip, the standby chiller would automatically start. A trip of one of the operating chilled water pumps would automatically start the standby pump. The chiller trip logic is tied to the chilled water pump operation to ensure an adequate number of pumps are operating.

An expansion tank is provided to accommodate changes in water volume as the temperature of the chilled water varies. This tank will also maintain a constant chilled water pump suction pressure.

The demineralized water system will provide system make-up water.

9.2.9.3 Safety Evaluation

The SCCW system is not required for the safe shutdown of the reactor or for accident mitigation. Therefore, the SCCW system is not designed for a single active or passive failure as required of a safety-related system, but sufficient redundancy and automatic protective features are provided to ensure efficient system operation and availability. Since the SCCW system is not an engineered safety feature (ESF), it is not powered by an essential power bus.

The SCCW system is involved in normal plant operation. During periods when RBCCW temperature is above its nominal control point, it may be used to cool the cooling water supply to EECW that is normally cooled by RBCCW. If the SCCW system trips off or is removed from service, RBCCW and/or EECW, as required, will perform the cooling function. The RBCCW system is nonsafety and its pumps are not powered by an essential bus. If the RBCCW cooling water temperature is not available, the EECW and EESW systems can be used to provide the required cooling of the drywell and other equipment. The EECW and EESW systems are powered off essential buses. A failure of the SCCW system will not prevent a safe shutdown of the reactor.

The possibility of radioactive contamination of the SCCW system is reduced by using plate heat exchangers between the RBCCW supplemental cooling and SCCW systems. The SCCW system operates at a higher pressure than the RBCCW supplemental cooling system and therefore any leakage would be from the SCCW system into the RBCCW supplemental cooling system. The SCCW system does not contain a radiation monitor. Due to the design of a plate type heat exchanger, any leakage is likely to be to the ambient (auxiliary building) rather than to the SCCW system. The SCCW system is manually sampled to detect any developing problems. Should the barrier between RBCCW and SCCW fail, there is no potential release path to the environment. The SCCW system interfaces with the GSW system via mechanical chillers. The closed refrigerant system which is between the SCCW and GSW systems has a relief valve which exits the turbine building. However, that relief valve setpoint is much higher than any pressure that can be developed in the SCCW system and therefore does not constitute a release path.

9.2.9.4 Tests and Inspections

Initial construction tests such as hydrostatic leak tests were conducted per ANSI B31.1.0 code requirements. Initial system flow distribution, instrumentation and control loop checks and alarm setpoints were performed in accordance with the design change test program.

9.2.9.5 Instrumentation

Sufficient instrumentation is provided to allow the plant operator to assess the status of the SCCW system. Three alarm windows are provided in the main control room to alert the operator to system trouble. The specific details regarding these alarms are provided by control panels located in the vicinity of the chiller units.

In the event a chiller was to trip, the standby chiller would automatically start. A trip of one of the operating chilled water pumps would automatically start the associated standby pump.

During the normal mode of operation when both supplemental cooling loops are in operation, interlocks have been provided to prevent the operation of a chilled water pump should no chillers be in operation. In addition, should all operating chillers trip and the standby unit not start, the operating chilled water pumps will trip.

9.2 WATER SYSTEMS

REFERENCES

1. AEC letter Docket 50-341, from Voss A. Moore, Assistant Director for Boiling Water Reactors/Directorate of Licensing, to The Detroit Edison Company, dated November 30, 1973.

2. Applicant's Responses to the July 9, 1973 AEC letter with 17 questions regarding the RHRSW Pond (Complex) Design, Docket 50-341, dated August 10, 1973.

TABLE 9.2-1 GENERAL SERVICE WATER SYSTEM PUMP DATA

General Service Water Pump

Number supplied	Five
Type	Vertical, wet-pit, turbine
Fluid	Chlorinated lake water
Capacity, gpm	7700
Total head, ft (Tested two stage pump)	241 to 270
Motor	
Type	Vertical, dripproof, induction
Horsepower	900
Speed	1779
Voltage/frequency/phase	4000/60/3

Circulating Water Makeup Pump

Number supplied	Two
Type	Vertical, wet-pit, turbine
Fluid	Chlorinated lake water
Capacity, gpm	15,000
Total head, ft	32
Motor	
Type	Vertical, dripproof, induction
Horsepower	200
Speed	880
Voltage/frequency/phase	460/60/3

TABLE 9.2-2 REACTOR BUILDING CLOSED COOLING WATER SYSTEM COMPONENT PARAMETERS

RBCCW Pumps

Number supplied	Three
Type	Horizontal, single-stage centrifugal
Fluid	Demineralized water
Capacity, gpm	4000
Total head, ft	167
Motor	
Type	Horizontal 445 TS Frame
Horsepower	200
Speed, rpm	1770
Voltage/frequency/phase	460/60/3

RBCCW Supplemental Cooling Pumps

Number supplied	Four (Two per EECW Division)
Type	Horizontal, single-stage centrifugal
Fluid	Demineralized water
Capacity, gpm	1557 for EECW Division I 1715 for EECW Division II
Total head, ft	260
Motor	
Type	Horizontal 445 TS Frame
Horsepower, HP	150
Speed, rpm	1785
Voltage/frequency/phase	460 V/60 Hz/3

RBCCW Heat Exchangers

Number supplied	Two
Type	Shell and tube, single pass
Heat transfer duty, Btu/hr	67.8×10^6
Heat transfer area, ft^2	12,780
Design code	ASME Section VIII, TEMA Class C
Shell	
Fluid	Demineralized water
Design pressure, psig	150
Design temperature, °F	120
Flow, gpm	8000
Inlet temperature, °F	112
Outlet temperature, °F	95
Material	Carbon steel A-285-C
Tube	
Fluid	Lake water

TABLE 9.2-2 REACTOR BUILDING CLOSED COOLING WATER SYSTEM COMPONENT PARAMETERS

Design pressure, psig	175
Design temperature, °F	120
Flow, gpm	10,000
Inlet temperature, °F	85
Outlet temperature, °F	99
Material	304 stainless steel

RBCCW Supplemental Heat Exchangers

Number supplied	Two 1 @ 100% capacity for EECW Division I 1 @ 100% capacity for EECW Division II
Type	Plate heat exchanger
Heat transfer duty, Btu/hr	10×10^6 for EECW Division I 11.5×10^6 for EECW Division II
Heat Transfer Area, ft^2	1229 for EECW Division I 1272 for EECW Division II
Design code	ASME Section VIII
Material	Plates: 304 SS Nozzles: 316 SS
Cold Side	
Fluid	SCCW, demineralized water
Design pressure, psig	150
Design temperature,°F	150
Flow, gpm	1100 for EECW Division I 1300 for EECW Division II
Inlet temperature,°F	60.2
Outlet temperature,°F	78.4 for EECW Division I 77.9 for EECW Division II
Hot Side	
Fluid	RBCCW Supplemental, demineralized water
Design pressure, psig	150
Design temperature,°F	150
Flow, gpm	1557 for EECW Division I 1715 for EECW Division II
Inlet temperature,°F	82.9 for EECW Division I 83.4 for EECW Division II
Outlet temperature,°F	70

Note: The heat duties are the maximum expected values and will not occur simultaneously.

RBCCW Makeup Tank

TABLE 9.2-2 REACTOR BUILDING CLOSED COOLING WATER SYSTEM COMPONENT PARAMETERS

Number provided	One
Type	Horizontal, elliptical dished heads
Design pressure, psig	100
Design temperature, °F	120
Operating pressure, psig	45
Internal volume, gal	600
Liquid volume, gal	300
Pressurizing gas	Nitrogen
Material	Carbon steel ASTM-A515 GR70

TABLE 9.2-3 EMERGENCY EQUIPMENT COOLING WATER SYSTEM COMPONENT DESIGN PARAMETERS

EECW Pumps

Number supplied	Two
Type	Horizontal, centrifugal
Fluid	Demineralized water
Capacity, gpm	1775
Total head, ft	167
Motor	
Type	Induction, dripproof
Horsepower	100
Speed, rpm	1785
Voltage/frequency/phase	460/60/3

EECW Heat Exchanger

Number supplied	Four (Two per EECW Division)
Type	Single Pass, Plate and Frame
Heat transfer duty, Btu/hr	13.6 x 10^6
Heat transfer area, ft^2	4214.1 ft^2
Design code	ASME Section III, Class 3,
Hot Side	
Fluid	Demineralized water
Design pressure, psig	150
Design temperature, °F	150
Flow, gpm	1700
Inlet temperature, °F	111.1
Outlet temperature, °F	95
Material	T-316 Stainless Steel
Cold Side	
Fluid	RHR service water
Design pressure, psig	175
Design temperature, °F	150
Flow, gpm	1450
Inlet temperature, °F	89

TABLE 9.2-3 EMERGENCY EQUIPMENT COOLING WATER SYSTEM COMPONENT DESIGN PARAMETERS

Outlet temperature, °F	107.9
Material	T-316 Stainless Steel

EECW Makeup Tank

Number provided	Two
Type	Horizontal, elliptical dished heads
Design pressure, psig	100
Design temperature, °F	140
Operating pressure, psig	36
Internal volume, gal	600
Liquid volume, gal	300
Pressurizing gas	Nitrogen
Material	Carbon steel SA-515 Grade 70

EECW Makeup Pump

Number provided	Two
Type	Motor driven horizontal centrifugal, vert. disch
Power	480 Vac/3Ph, 3.0 HP
Design pressure	60 ft TDH
Design flow	20 gpm
Material	Stainless steel

EECW Makeup Pressure Regulator Valve

Number provided	Two
Type	Discharge regulator, self-actuated
Size	1-1/2 in.
Setpoint (discharge)	36 psig
Maximum design flow	25 gpm (Div I): 15 gpm (Div II)
Minimum design flow*	10.4 gpm (Div I): 8.3 gpm (Div II)`
Design makeup flow to EECW Head Tank*	2.7 gpm (Div I, or Div II)

* Coincident flows

TABLE 9.2-4 REACTOR BUILDING CLOSED COOLING WATER AND EMERGENCY EQUIPMENT COOLING WATER SYSTEMS FAILURE ANALYSIS

Component	Failure Mode	Consequences on Safety
RBCCW pumps	Loss of pumping due to loss of offsite power	Loss of offsite power automatically starts both EECW pumps and initiates isolation of the nonessential loads.
RBCCW pumps	Trip on low suction pressure or low makeup tank water level	Each EECW pump will start on low differential pressure between its respective supply and return headers. Isolation of nonessential loads is also initiated. (a)
RBCCW piping	Pipe rupture in the RBCCWS	Each EECW pump will start on low differential pressure between its respective supply and return headers. Isolation of nonessential loads is also initiated. (b)
EECW pump	Fails to start due to failure of one set of diesel generators	Redundant full-capacity EECW loop is provided, powered off the second emergency bus.
EECW piping	Piping leak or rupture in the EECWS	Automatic makeup valve will open to maintain tank level. If leak exceeds makeup capacity, the low tank level or low suction pressure will be alarmed. Redundant full-capacity EECW loops are provided that are isolable from each other.
EECW Makeup Tank	Loss of nonsafety-related demineralized water and nitrogen inerting systems	Safety related EESW makeup water to the makeup tank restored by automatic start of EECW makeup pump if makeup tank has low pressure or level and makeup tank isolation valve is open, and normal pump suction pressure is achieved. Nitrogen pressure in the makeup tank will be automatically maintained by the backup nitrogen supply for Division I until the makeup tank Nitrogen leaks off and the Makeup tank is filled and Pressurized with EESW water via the makeup pump

TABLE 9.2-4 REACTOR BUILDING CLOSED COOLING WATER AND EMERGENCY EQUIPMENT COOLING WATER SYSTEMS FAILURE ANALYSIS

Component	Failure Mode	Consequences on Safety
Isolation valve between EECW and RBCCW [P4400F601A(B), P4400F603A(B)]	Fails to close for isolating nonessential loads	Water may be lost from the EECW loop if a break exists in the RBCCWS. Redundant EECW loop available.
Isolation valve on makeup tank outlet line	Fails to open on automatic system initiation	Low suction pressure to the EECW pump may alarm, requiring manual shutdown, but the other redundant EECW division is available. Makeup pump is disabled.
Isolation valve on nonessential load in essential loop	Fails to close on demand	No adverse effects since the heat loads and flow requirements for the nonessential loads affected are small. (c)
Control valves	Loss of control air or instrument power supply	The EESW temperature control valve will fail open. The EECW will continue to operate and provide the necessary cooling water. The Div I controller will continue to operate on a loss of offsite power to fail the TCV open. NIAS is available for Temperature Control Valve (TCV) P44F400A/B.
Isolation valve for Drywell Loads	Fails to close on high drywell pressure/signals	Redundant full-capacity EECW loop is provided plus the valve can be closed manually.

TABLE 9.2-4 REACTOR BUILDING CLOSED COOLING WATER AND EMERGENCY EQUIPMENT COOLING WATER SYSTEMS FAILURE ANALYSIS

Component	Failure Mode	Consequences on Safety

(a) The differential header pressure sensors are located inside the EECW system boundary; thus, if EECW has been manually initiated with the nonessential loads subsequently restored (either for RBCCW heat exchanger cleaning, enhanced drywell cooling during periods of high lake water temperature, testing, or to provide RHR Reservoir freeze protection during extreme cold weather), a loss of RBCCW pumps while EECW is operating in this mode would not reinitiate EECW or re-isolate the nonessential loads. This protective action is not required, however, since this is not a condition requiring protective action as described in Section 7.1.2.1 and EECW remains capable of supporting the safe shutdown of the plant in this configuration. EECW auto-start on high drywell pressure (i.e., a LOCA) or on a loss of offsite power is unaffected by this mode of operation; therefore, these signals will initiate the automatic protective action of reisolating the nonessential portions of RBCCW piping located inside the EECW system envelope.

(b)The differential header pressure sensors are located inside the EECW system boundary; thus, if EECW has been manually initiated with the nonessential loads subsequently restored (either for RBCCW heat exchanger cleaning, enhanced drywell cooling during periods of high lake water temperature, testing, or to provide RHR Reservoir freeze protection during extreme cold weather), a rupture of the RBCCW piping outside of the EECW system envelope while EECW is operating in this mode would not reinitiate EECW or reisolate the nonessential loads. This protective action is not required, however, since this is not a condition requiring protective action as described in Section 7.1.2.1 and EECW remains capable of supporting the safe shutdown of the plant in this configuration.

(c) If a rupture of the RBCCW piping located inside the EECW system envelope were to occur (with EECW either in standby or in operation for RBCCW heat exchanger cleaning, enhanced drywell cooling during periods of high lake water temperature, testing, or to provide RHR Reservoir freeze protection during extreme cold weather), it is unlikely that the loss in differential header pressure would be sufficient to cause an EECW auto-start due to the small bore of these nonessential lines. It is also unlikely that the RBCCW head tank would deplete to the low level RBCCW pump trip setpoint since the normal makeup capacity exceeds the predicted leak rates. These events rely on the normal EECW makeup supply to feed the break until operators locate and isolate the leak. Again, the protective actions of initiating EECW and isolating the nonessential loads are not required since this is not a condition requiring protective action as described in Section 7.1.2.1 and EECW remains capable of supporting the safe shutdown of the plant during the period required to locate and isolate the break.

Consequences default to those of a rupture of EECW piping as described in the table above.

TABLE 9.2-5 MAKEUP DEMINERALIZED WATER SYSTEM TYPICAL INFLUENT WATER QUALITY ANALYSIS

Major Cation Constituents	Calcium Carbonate $CaCO_3$ (ppm)
Calcium (Ca^{++})	42
Magnesium (Mg^{++})	8
Sodium (Na^{+})	11
Total cations	61

Major Anion Constituents	Calcium Carbonate $CaCO_3$ (ppm)
Bicarbonate (HCO_3^-)	74
Carbonate ($CO_3^=$)	Not Detected
Chloride ($C1^-$)	20
Fluoride (F^-)	0.1
Hydroxide (OH^-)	0
Sulfate ($SO_4^=$)	45
Total anions	139

Additional Analysis

pH at 25°C	7.6
Specific conductivity, mmho/cm at 25°C	275[a]
Total solids, ppm	160
Total hardness, ppm as $CaCO_3$	124
Total alkalinity, ppm as $CaCO_3$	87
Iron, ppm as Fe	Trace
Soluble silica, ppm as SiO_2	0.4
Insoluble silica, ppm as SiO_2	0.07
Turbidity, Jackson Turbidity Units	<0.1
Free carbon dioxide, ppm as CO_2	0
Free available chlorine, ppm as Cl_2	1.1
Total Phosphate, ppm as PO_4	0.2[b]
Chemical oxygen demand, ppm as O_2	12

[a] This value will vary with the season, with a maximum of 350 mmho/cm during periods of heavy runoff.

[b] The total phosphate figure may vary based on the actual treatment at the Frenchtown Plant

TABLE 9.2-6 DEMINERALIZED WATER MAKEUP SYSTEM TYPICAL EFFLUENT WATER QUALITY

Specific conductivity, mmho/cm at 25°C	0.1
pH at 25°C	6.5 to 7.5
Chloride (ppb as Cl^-)	2
Silica (ppb as SiO_2)	<5
Total metallic impurity (ppb of which 2 ppb maximum is Cu)	<10

TABLE 9.2-7 ULTIMATE HEAT SINK COMPONENT DESIGN PARAMETERS

RHR Service Water Pumps	
Number supplied	Four
Type	Vertical, turbine type
Fluid	Service water
Capacity, gpm	4500
Total head, ft	185
Motor	
Type	Vertical, induction, dripproof
Horsepower	300
Speed, rpm	1800
Voltage/frequency/phase	4000/60/3
Emergency Equipment Service Water Pumps	
Number supplied	Two
Type	Vertical, turbine
Fluid	Service water
Capacity, gpm	1600
Total head, ft	145
Motor	
Type	Vertical, induction, dripproof
Horsepower	100
Speed, rpm	1760
Voltage/frequency/phase	460/60/3
Diesel Generator Service Water Pumps	
Number supplied	Four
Type	Vertical, turbine
Fluid	Service water
Capacity, gpm	800
Total head, ft	115
Motor	
Type	Vertical, induction, dripproof
Horsepower	50
Speed, rpm	1760
Voltage/frequency/phase	460/60/3
Cooling Towers	
Number supplied	Two
Type	Induced Draft
No. of cells/tower	Two

TABLE 9.2-7 ULTIMATE HEAT SINK COMPONENT DESIGN PARAMETERS

Design flow, gpm	13,000
Design heat load, Btu/hr	160×10^6
Water inlet temperature, °F	116
Water outlet temperature, °F	89
Ambient air dry bulb, °F	92
Ambient air wet bulb, °F	76
Fan motor horsepower	150
Fan type	Eight blades, two-speed
Motor electrical requirements	460/60/3

TABLE 9.2-8 ULTIMATE HEAT SINK FAILURE ANALYSIS

Component	Failure Mode	Consequences on Safety
RHRSW, EESW, and DGSW pumps	Loss of pumping due to loss of offsite power	Power is automatically supplied by the emergency buses fed by the diesel generators.
RHRSW, EESW, or DGSW pump	Loss of pumping due to mechanical failure	RHRSW has one-half capacity still available in one division, completely redundant division still intact. A check valve in pump discharge prevents loss of flow through malfunctioning pump. EESW has full capacity pump in redundant division. DGSW pump failure will cause loss of the particular EDG it services. One half of the electrical division plus full redundant electrical division still remain.
RHRSW, EESW, and DGSW pumps	Do not start due to failure of one divisional pair of diesel generators to start on loss of offsite power	Redundant RHRSW, EESW, and DGSW pumps are provided which are powered off the redundant divisional pair of diesel generators.
RHRSW, EESW, and DGSW pumps	Do not start due to failure of <u>one</u> EDG to start on loss of offsite power	The RHRSW pump associated with the particular EDG will not start; 150 percent cooling capacity still provided. The associated DGSW pump will not start but is not needed. The EESW pump is normally run off a particular EDG. Associated EDG failure causes loss of associated EESW pump. Manual throw-over to other EDG within a division is provided to increase reliability during EDG maintenance. Full-capacity redundant division pump intact.
Valve or piping in Division I or Division II	Loss of flow path due to pipe break or failure of valve to open	Fully redundant flow path with separate supply and return lines is provided to redundant RHR heat exchanger, redundant EECW heat exchanger, and redundant diesel generator.

TABLE 9.2-8 ULTIMATE HEAT SINK FAILURE ANALYSIS

Component	Failure Mode	Consequences on Safety
RHR complex structures	Local structural failure due to tornado-borne missiles, turbine missiles, or EDG missiles	Division I and Division II components are physically separated and divided by a divisional barrier wall. Structure will withstand external missiles. Each EDG is protected by interior walls designed to withstand EDG generated missiles.
Cooling tower structure	Collapse or damage from tornado-borne or turbine missiles	Full-capacity redundant cooling tower provided. Physical separation prevents loss of both divisions.
Cooling tower fan motor	Mechanical failure of fan blades or motor	Each cooling tower has two one-half capacity cells. With redundant cooling tower, capacity of 150 percent still available.
	Failure to start due to diesel generator failure to respond upon loss of offsite power	The particular fan motor not needed as service water pump capacity also reduced; 150 percent cooling capacity still available.

TABLE 9.2-9 CONDENSATE STORAGE SYSTEM COMPONENT DESIGN PARAMETERS

Normal Hotwell Supply Pump	
Number supplied	One
Type	Centrifugal
Fluid	Condensate
Capacity, gpm	600
Total head, ft	246
Motor	
Type	Dripproof, induction
Horsepower	60
Speed, rpm	3550
Voltage/frequency/phase	460/60/3
Emergency Hotwell Supply Pump	
Number supplied	One
Type	Centrifugal
Fluid	Condensate
Capacity, gpm	2000
Total head, ft	108
Motor	
Type	Dripproof, induction
Horsepower	75
Speed, rpm	1750
Voltage/frequency/phase	460/60/3
Condensate Storage Jockey Pump	
Number supplied	One
Type	Centrifugal
Fluid	Condensate
Capacity, gpm	100
Total head, ft	246.2
Motor	
Type	Dripproof, induction
Horsepower	15
Speed, rpm	3500
Voltage/frequency/phase	460/60/3
Condensate Tanks	
Number provided	Two
Type	Vertical, cylindrical
Design code	USAS B96.1
Design pressure, psig	Hydrostatic head
Design ambient temperature, °F	-10 to 95
Operating pressure, psig	Atmospheric

TABLE 9.2-9 CONDENSATE STORAGE SYSTEM COMPONENT DESIGN PARAMETERS

Internal volume, gal	600,000
Dimensions	
Diameter, in.	644 I.D.
Height, in.	432
Material	Aluminum alloy, B-209-5454

Demineralized Water Storage Tank

Number provided	One
Type	Vertical, cylindrical
Design code	USAS B96.1
Design pressure	Hydrostatic head
Design ambient temperature, °F	-10 to 95
Operating pressure	Atmospheric
Internal volume, gal	50,000
Dimensions	
Diameter, in.	228 I.D.
Height, in.	288
Material	Aluminum alloy, SB-209-5454

TABLE 9.2-10 TURBINE BUILDING CLOSED COOLING WATER SYSTEM COMPONENT DESIGN PARAMETERS

TBCCW Pumps

Number supplied	Three
Type	Horizontal, single-stage centrifugal
Fluid	Demineralized water
Capacity, gpm	3000
Total head, ft	57.8
Motor	
Type	Open dripproof
Horsepower	60
Speed, rpm	1770
Voltage/frequency/phase	460/60/3

TBCCW Heat Exchangers

Number supplied	Two
Type	Shell and tube, single pass
Heat transfer duty, Btu/hr	45×10^6
Design code	
Shell	TEMA Class C
Fluid	Demineralized water
Design pressure, psig	150
Design temperature, °F	120
Flow, gpm	6000
Inlet temperature, °F	110
Outlet temperature, °F	95
Material	Carbon steel
Tube	
Fluid	Lake water
Design pressure, psig	175
Design temperature, °F	120
Flow, gpm	9000
Inlet temperature, °F	85
Outlet temperature, °F	95
Material	SB-543 Alloy C194

TBCCW Makeup Tank

Number provided	One
Type	Horizontal, elliptical dished heads
Design pressure, psig	20
Design temperature, °F	120

TABLE 9.2-10 TURBINE BUILDING CLOSED COOLING WATER SYSTEM COMPONENT DESIGN PARAMETERS

Operating pressure, psig	15
Internal volume, gal	600
Liquid volume, gal	300
Pressurizing gas	Nitrogen
Material	Carbon steel ASTM A-515 Grade 70

TABLE 9.2-11 TORUS WATER MANAGEMENT SYSTEM COMPONENT DESIGN PARAMETERS

TWMS Pumps

Number supplied	Two
Type	Horizontal, single-stage centrifugal
Fluid	Torus water
Capacity, gpm	250
Total head, ft	480 (rated)
	500 (by test)

Motor

Type	Open dripproof
Horsepower	75
Speed, rpm	3550
Voltage/frequency/phase	460/60/3

9.2-12 SUPPLEMENTAL COOLING CHILLED WATER SYSTEM DESIGN PARAMETERS

A. Chillers	
Type	Centrifugal, water cooled
Quantity	Three, 50% capacity each
Refrigerant	R-134a (HFC 134a)
Capacity, tons refrigeration	800 each
Input Power, kw	505
Evaporator	
Chilled water source	SCCW, demineralized
Chilled water flow, gpm	1230
Chilled water temperature, °F	75.8 in/60.2 out
Chilled water pressure drop, ft	16.1
Condenser	
Cooling water source	GSW
Cooling water flow, gpm	2000
Cooling water temperature, °F	85 in/96.2 out
B. Chilled Water Pumps	
Number supplied	Three, 50% capacity each
Type	Centrifugal single stage, horizontal split case
Fluid	Demineralized water
Capacity, gpm	1230
Total head, ft	110
Motor	
Type	Horizontal 324T Frame
Horsepower, HP	40 hp
Speed, rpm	1775
Voltage/Frequency/Phase	460 V/60 Hz/3
C. Expansion Tank	
Number provided	One
Type	Vertical with diaphragm
Design pressure, psig	125
Design temperature, °F	125
Operating pressure, psig	30
Total volume, gal	134
Acceptance volume, gal	46
Pressurizing gas	Air
Material	Carbon steel

Figure Intentionally Removed
Refer to Plant Drawing M-2010

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-1, SHEET 1

GENERAL SERVICE WATER

Figure Intentionally Removed
Refer to Plant Drawing M-5743-1

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-1, SHEET 2

GENERAL SERVICE WATER
BIOCIDE INJECTION SYSTEM

Figure Intentionally Removed
Refer to Plant Drawing M-2010-1

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-1, SHEET 3

GENERAL SERVICE WATER SYSTEM
PIPING DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-5358

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-2, SHEET 1

REACTOR BUILDING CLOSED COOLING WATER SYSTEM PIPING DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-5358-1

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-2, SHEET 2

REACTOR BUILDING CLOSED COOLING WATER PIPING DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-5444

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-3

EMERGENCY EQUIPMENT COOLING
WATER SYSTEM - DIVISION 1
PIPING DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-5357

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-4

EMERGENCY EQUIPMENT COOLING WATER SYSTEM
DIVISION II - PIPING DIAGRAM

FIGURE 9.2-5 HAS BEEN DELETED

THIS PAGE INTENTIONALLY LEFT BLANK

Figure Intentionally Removed
Refer to Plant Drawing M-N-2052

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-6

RESIDUAL HEAT REMOVAL SERVICE WATER SYSTEM (DIVISION 1) RESIDUAL HEAT REMOVAL COMPLEX

Figure Intentionally Removed
Refer to Plant Drawing M-N-2054

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-7

SERVICE WATER, MAKEUP, DECANT, AND
OVERFLOW SYSTEMS - DIVISIONS I AND II
RESIDUAL HEAT REMOVAL COMPLEX

FIGURE 9.2-8 HAS BEEN DELETED

THIS PAGE INTENTIONALLY LEFT BLANK

FIGURE 9.2-9 HAS BEEN DELETED

THIS PAGE INTENTIONALLY LEFT BLANK

Figure Intentionally Removed
Refer to Plant Drawing M-2006

FIGURE 9.2-10
CONDENSATE STORAGE AND TRANSFER

Figure Intentionally Removed
Refer to Plant Drawing C-Y-2003

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-11

CONTAINMENT WALL AROUND
CONDENSATE STORAGE TANKS

Figure Intentionally Removed
Refer to Plant Drawing M-2008

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-12, SHEET 1

TURBINE BUILDING CLOSED COOLING WATER
SYSTEM PIPING DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2008-1

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-12, SHEET 2

TURBINE BUILDING CLOSED COOLING WATER SYSTEM PIPING DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-4100

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-13

TORUS WATER MANAGEMENT SYSTEM

Figure Intentionally Removed
Refer to Plant Drawing M-2020

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-14

SUPPLEMENTAL COOLING CHILLED WATER
SYSTEM - PIPING DIAGRAM

9.3 PROCESS AUXILIARIES

9.3.1 Compressed Air System

9.3.1.1 Design Bases

The Fermi 2 station and control air system provides the plant with a reliable source of clean, dry, oil-free compressed air for plant operation. Control air system is designed to provide oil and dirt-free air with a dewpoint of -40°F (at pressure). The control air compressors, aftercoolers, dryers, and receiver tanks are provided to supply air to some of the engineered safety feature (ESF) equipment in the plant when the normal supply of control air is not available. Because the noninterruptible portion of the control air system provides control air to ESF equipment, it is classified as a safety-related system.

The station air and interruptible control air systems are constructed in compliance with standards for Quality Group D components. The criteria are met by designing the systems to ASME Section VIII and ANSI B31.1.0 code requirements. These systems are nonseismic.

The noninterruptible control air system is constructed in compliance with upgraded standards for Quality Group D components. These criteria are met by designing this system to ASME Section III, Class 3 requirements. The system is Category I.

9.3.1.2 System Description

The air system is composed of two subsystems. The first is the supply and distribution of station air and the second is the supply and distribution of interruptible and noninterruptible control air. The station air and interruptible control air supply equipment is located in the turbine building. The non-interruptible control air system is located in the auxiliary building. The station and control air systems are the source of compressed air for use in routine maintenance operations, in equipment process cycles such as demineralizer backwashing, and as an instrument and control media. The compressed air system is shown in Figure 9.3-1.

The station air system consists of three, two stage, nonlubricated compressors equipped with inlet filter-silencers, and intercoolers and aftercoolers. Two 150-ft^3-capacity air receivers and the station air distribution piping, valves, and fittings complete the station air equipment.

In operation, ambient air from the turbine building is drawn into the station air compressors via the inlet filter-silencers. This air is compressed, cooled, and discharged into the station air receivers. Normal practice is to have one compressor running and one lined up in automatic. The running compressor maintains near constant pressure (100 psig) in the air receivers while the compressor in automatic is available to start if more capacity is required. A connection is provided in the 8” inlet line to the west Air Receiver tank (P5001A002) for installing and operating an alternate air source at any time when an additional source of compressed air is desired to supply or supplement the needs of the compressed air system. The use of this tap is administratively controlled and, when not in use, a blank flange is installed.

From the station air receiver, the station air is distributed throughout the plant via the station air header/riser system. The station air system is sized to minimize the pressure loss of air at the point of use.

The noninterruptible control air portion of the system consists of two 100 percent-capacity 100 scfm, single-stage nonlubricated reciprocating air compressors; two 100 percent-capacity parallel strings of oil filters, air dryers, and afterfilters; two control air receivers; and associated piping, fittings, and valves. During normal plant operation, the source of noninterruptible and interruptible control air is through interconnections between the station and control air systems. Compressed air from the station air system is supplied through one of these interconnections to the Division I and II noninterruptible control air compressor discharge headers. The air then flows from each header through its divisional 100 percent-capacity filter and dryer. It is cleaned of all particles of dirt ≥0.5μm (nominal), ≥0.9μm absolute, and then dried by a regenerative desiccant-type dryer which is designed to establish a -40°F dewpoint (at line pressure). After leaving the filter/dryer, the noninterruptible control air flows to its divisional control air receiver from which it eventually flows to its point of use through its divisional noninterruptible control air distribution system.

Another station air connection supplies the interruptible control air system. The interruptible control air system contains two 100 percent redundant dryers. Each dryer has its own prefilter, afterfilter, and instrumentation. Each dryer unit is capable of supplying the same quality of instrument air as the noninterruptible control air system. Redundancy allows for maintenance to be performed on one unit without jeopardizing the system's air quality or quantity. Dryer redundancy improves the reliability of the interruptible control air system. The interruptible control air flows to the interruptible control air receiver, which supplies the interruptible control air distribution system. The station and control air compressors, air receivers, filters, and dryers are designed to operate in an ambient temperature range of 60°F to 100°F, a range of 20 percent to 100 percent relative humidity, and a radiation field of 1mR/hr.

The control air distribution system is divided into two distinct parts: interruptible and noninterruptible. Noninterruptible control air (NIAS) supplies, through two separate distribution systems (Divisions I and II), equipment in the following systems:

a. Standby gas treatment system (SGTS)

b. Control center air conditioning system (CCACS)

c. Primary containment atmosphere monitoring system (PCAMS)

d. Emergency equipment cooling water system (EECWS)

e. Primary containment pneumatic supply system

f. Torus to reactor building vacuum relief system.

g. Railroad bay airlock door seals.

In addition, Division I NIAS provides control air for the following:

a. Primary containment isolation of drywell equipment and floor drain sump pump discharge lines

b. Back-up supply for Division I (N_2) pneumatic supply to the primary containment.

Division II NIAS supplies, in addition, air operated valves in the following systems:

a. High pressure coolant injection system (HPCI)

b. Reactor core isolation cooling system (RCIC).

c. Standby Gas Treatment Primary Containment Isolation Valves which support Torus Venting.

d. Torus Vent Secondary Containment Isolation Valves.

All other control air users are connected to the interruptible control air distribution system. Interruptible control air (IAS) is supplied through its own set of filters, dryer, and receiver tank, which is fed from the station air system.

The station air compressors and their associated coolers are cooled by the turbine building closed cooling water system (TBCCWS). The control air compressors and aftercoolers are cooled by the reactor building closed cooling water system (RBCCWS) or the EECWS.

During normal operation, any one of three installed station air compressors will be in operation. One of the other two will be in "auto" and the third compressor will be in the "off" position. Normal operating pressure from the station air compressors is nominally 100 psig. If the station air header pressure drops below 95 psig, the compressor in "auto" will automatically start.

If the pressure drops to 90 psig, an alarm in the control room will be initiated and the third compressor may be manually started from the control room panel. If the station air header pressure continues to decrease, at 85 psig the station air supply header isolates and only supplies the IAS and NIAS. An alarm is initiated in the control room.

Should station air supply pressure to either division of NIAS decrease to 85 psig, its division's control air compressor automatically starts. If the pressure continues to decrease, at 75 psig the station air supply isolates from the NIAS and alarms. Each division of NIAS is supplied at this point by its own control air compressor.

There is a normally locked closed intertie between Divisions I and II of the noninterruptible control air system. During a maintenance outage on a control air compressor, after cooler, filters, or dryer of one division the intertie may be opened so that the division having the outage may be fed by the other division. Similarly, the normally closed interruptible control air intertie to Division II noninterruptible control air system may be opened during a Division II supply maintenance outage (i.e., Division II compressor, after cooler, filters/dryer outage). In this latter case, loss of offsite power or any other station air failure would render Division II of the noninterruptible control air system inoperable. The intertie auto isolation valve will close on loss of power or low header pressure, thus maintaining Division II noninterruptible air receiver tank integrity. In addition, the isolation valve for the station air supply to the noninterruptible control air system interconnection has a normally locked closed bypass valve and a normally locked open outlet valve. These valves may be unlocked and repositioned (i.e., the bypass valve opened and the outlet valve closed) to provide an alternate lineup for station air supply to the noninterruptible control air system to support normal plant operation in the event the isolation valve is unavailable.

9.3.1.3 Safety Evaluation

The noninterruptible portion of the control air system is required to effect a safe reactor shutdown; it is also required for control during long-term recovery. The station air system and interruptible control air system are not required to effect a safe reactor shutdown. The pneumatic supply to the primary containment is normally fed from the nitrogen inerting system (Subsection 9.3.6). An intertie is provided to permit Division I noninterruptible control air to be used as an emergency backup to the Division I containment pneumatic supply system.

Bottled nitrogen can also be connected to both containment pneumatic supply divisions as an additional backup supply source. Bottled nitrogen can also be used to reopen Division II PCMS isolation valves, T5000F420B and T5000F421B, that go closed in the event of an extended power failure as shown in Figure 7.6-11.

On loss of offsite power, the control air compressors are automatically started with power supplied from the emergency diesel generators (EDGs). Enough receiver capacity is provided to supply compressed air to the air users for the short duration transition period (See Table 8.3-5) before control air compressor load pickup by the diesel generators is required. With normal offsite power available, the control air compressors start immediately on low noninterruptible control air header pressure.

Maximum plant availability and control air system reliability are ensured by providing three station air compressors and two standby control air compressors. Additionally the control air compressors are powered by independent ESF power sources, and each division includes a control air receiver tank sized to supply compressed air to air users for the short duration transition period during a loss of offsite power event until control air compressors are in-service (See Table 8.3-5).

Control air accumulators are located so as to maximize protection for the associated valve and nearby safety-related equipment. Physical separation criteria for the associated system of the valve were also maintained in determining the accumulator location. Inside the drywell, the accumulators have been integrally supported and welded to drywell support steel; outside the drywell, anchor bolts have been used to secure the welded accumulator support structures in position. The accumulator supports and anchor system were analyzed for stressed conditions resulting from seismic excitation, thrust loading from a tank rupture or supply line rupture, and external jet impingement during a LOCA environment. In each of the above loading conditions, the support and anchor designs were found to be adequate to preclude the accumulators from becoming missiles.

9.3.1.4 Tests and Inspections

Initial construction tests such as air leak tests were conducted per applicable code requirements for the station and control air systems. Initial system flow checks, valve operability, instrumentation and control loop checks, and alarm setpoints for the control air subsystem were done in accordance with the Preoperational Test program as discussed in Chapter 14. The station air subsystem was subjected to similar acceptance testing. The quality of the air delivered by the filter/dryer units was also determined.

Periodic examinations of filters and dryers and periodic replacement of filter cartridges are scheduled to ensure control air quality. Periodic inspections are made of compressors to ensure performance of these active units.

Periodic inspections of receiver tanks are performed. Inspection of instruments is made to confirm actuation of relief valves, isolation valves, automatic switchovers, and alarms. Automatic compressor starts are also demonstrated.

9.3.1.5 Instrumentation

Local (turbine building) instrumentation in the station and interruptible control air systems is provided to monitor line and receiver air pressure, pressure drop across filters, compressor airflow rates, and temperature of the compressed air and cooling water. Similar local instruments in the reactor/auxiliary building are provided for the noninterruptible control air system.

Main control room instrumentation consists of pressure indication of station air and control air headers (with low-pressure alarms), selector switches to isolate either division of noninterruptible air, and control switches for the control air compressors.

The station air compressors are started in the main control room and controlled locally.

9.3.2 Process Sampling

Figures 9.3-2, 9.3-3, and 9.3-4 illustrate the sampling systems in the reactor building, turbine building, and radwaste building, respectively. Details of the process radiation monitoring system (RMS) are given in Section 11.4.

9.3.2.1 Design Bases

The Fermi 2 process sampling system is designed to permit samples to be taken for the following purposes:

a. To maintain radiological surveillance

b. To provide analog measurement signals to controls for process equipment

c. To evaluate the performance of system equipment

d. To measure the quality of the process fluid.

Rad Protection supervision is provided where required (some samples will be radioactive). Wherever samples are delivered through shielding walls, backflushing facilities are provided to confine the radioactive material to the shielded area. Where necessary to avoid health hazards to operators, the system is designed with special safeguards, such as one or more remote air-operated block valves with remote position indicators. The system is designed to permit continuous sampling and minimize plate-out or decay that could bias analyses.

Where feasible, the system piping and sample taps are designed to permit mixing and sampling before process inventories are transferred in the process train.

To ensure that the samples taken are representative, the following considerations are provided for in the design:

a. Line lengths are minimized and the smallest practical line diameter is used to reduce lag time and to minimize plating-out of sample

b. Sampling lines avoid traps, deadlegs, and dips

c. The sample flow rates and line sizes are chosen to ensure flow in the turbulent-flow regime.

Sample lines are type 304 stainless steel tubing. After the source or isolation valves, lines connected to Quality Groups A, B, and C systems are constructed to meet Quality Group D requirements. Lines connected to Quality Group D systems are constructed to meet Quality Group D requirements.

All sample tubing or piping, from the point where it connects to a process system to and including the source valve (or if inside primary containment, from the source to the isolation shutoff valve outside primary containment) is the same piping class as the system piping to which it connects. Further, sample lines are either pitched to drain or are equipped with vents and drains, and are designed to prevent damaging water hammer in operation. External lines are heat traced to prevent freezing and all hot lines are stress analyzed to accommodate thermal movement.

9.3.2.2 <u>System Description</u>

Tables 9.3-1 through 9.3-4 describe the process sampling system by listing, for each system sampled, the sample locations, the analyses to be performed, and anticipated pressures and temperatures. Grab samples are taken for laboratory analysis. Grab samples may be taken locally near the process point or remotely at a central sampling station. For remote grab samples, a sample line is routed from the process pipe to the central sampling station. For local grab samples, a sample line is routed from the process pipe to the nearest accessible area for plant personnel. To determine whether a grab sample should be remote or local, the samples are put into the following classification or criteria:

a. Classification or criteria for remote grab sample:

    1. Sample is taken frequently

    2. Sample point is inaccessible during operation

    3. Sample has to be conditioned

    4. Sample may be radioactive

    5. Entrained gases must be vented through a hood.

b. Classification or criteria for local grab samples:

    1. Sample is taken infrequently

    2. Sample point is accessible

    3. Sample taken only during shutdown

    4. Sample tends to form deposits which would cause plugging of longer lines.

Remote grab samples are routed to a central sampling station, where they are temperature conditioned to 120°F or less and are provided with manual flow control. Continuous samples are routed to the central sampling station where the samples are regulated for proper flow and are temperature controlled as required by the instrument manufacturer. Continuous samples are provided with a means for taking grab samples at the central sampling station and are designed so that grab samples do not reduce flow below the design requirements of the continuous analysis instrumentation.

After sample conditioning, except for those samples recovered directly into the process flow, the samples flow through the analysis instrumentation to the radwaste floor drain system.

A special sample drain collection/recovery system has been designed to reduce radwaste burden by collecting and recovering certain sample drains which are of sufficient water quality to allow recovery into the condensate process flow without radwaste processing. The system consists primarily of a single tank with 240 gallon working volume and 20 gpm pump. Normally this system discharges to the condensate pump suction header but defaults to turbine building floor drains.

Central sampling stations are located in the radwaste, turbine, and reactor buildings. This is done to minimize the length of the sample lines and therefore shorten the transport time for the samples. Each central sampling station contains the remote grab and continuous samples as discussed in previous paragraphs, and the temperature conditioning equipment and analysis instrumentation. The central sampling stations are provided with exhaust hoods to draw air from the sample sinks. Airflow is 100 to 150 linear ft per minute.

All remote sample lines, where possible, are pitched 1/4 in./ft in direction of flow. The sample line lengths are as short as possible and the routing avoids traps, deadlegs, and dips upstream from the sample discharge. Sample flow is in the turbulent-flow region to minimize deposition and to ensure representative samples. Local samples are located in well-ventilated accessible areas. Drain funnels are provided to carry sample streams, which are not recoverable, to the floor drain system.

9.3.2.3 Safety Evaluation

Samples that require special handling, and all sample lines that flow continuously, lead to central sampling stations in the reactor building, the turbine building, or the radwaste building. The central sampling stations are equipped with ventilation hoods, backflushing facilities, and pressure and temperature controls. Remote air-operated sample valves are controlled from these central sampling stations.

High-pressure sample lines are required to pass hydrostatic tests with the process units they serve and must conform to the same construction standards.

All sample lines have a shutoff valve located as close as possible to the sample source connection. This valve is manually operated if accessible, and solenoid operated where inaccessible.

Solenoid valves are designed to fail closed. Division II PCMS isolation valves T5000F420B and T5000F421B fail closed following a power failure but can be reopened since these valves are equipped with DC solenoid valves powered from a DC battery and the pneumatic power for these solenoids is provided from bottled nitrogen as shown in Figure 7.6-11. Softseated solenoid valves are provided to ensure minimum leakage because leakage could go undetected for long periods of time. Since all samples have a potential for becoming radioactive, the following special precautions are taken to minimize radiation hazards to plant personnel:

a. Sample lines are routed wherever possible in shielded areas where plant personnel have little or no access

b. Equipment that tends to trap activated "crud" is kept behind shield walls

c. Provisions are made for sample line backflushing with demineralized water at the sample stations

d. Ventilated hoods are provided at the sample station

e. Local grab samples are located in well-ventilated areas that are accessible to plant personnel

f. Remote samples are extended through shield walls if located near radioactive equipment or if the sample line creates significant radiation field.

9.3.2.4 Tests and Inspections

During plant operation or shutdown, no special tests or inspections are required for sample lines and sample stations beyond inclusion in the test and inspection programs conducted on the systems they serve. Continuous analysis instrumentation will be periodically checked and recalibrated.

9.3.2.5 Instrumentation

Pressure controls and remotely operated valves are procured to the same specification as the lines they are sampling. The continuous monitors installed in various sample stations are identified by function in Tables 9.3-l through 9.3-4.

9.3.3 Plant Equipment and Floor Drains

9.3.3.1 Design Bases

The plant equipment and floor drainage systems are designed to collect and remove all waste liquids from their points of origin to a suitable disposal area in a controlled and safe manner. Water from radioactive drains is collected for sampling and analysis prior to disposal to the environment in accordance with 10 CFR 20. Drain line penetrations through containment barriers are designed to maintain containment during normal operation and design-basis accidents (DBAs).

In the reactor, auxiliary, turbine, and radwaste buildings, most drain water is considered potentially radioactive and is accumulated for periodic discharge to the radwaste system for treatment. In general, drainage from production equipment is of high purity and high activity relative to floor drain discharge, and is collected separately from the floor drain discharges. In the radwaste process, cleanup of the floor drain accumulations may be more complex and could require more unit separation than do the equipment drain accumulations routed to the radwaste waste collector tank.

Equipment drain water of relatively high purity and high activity is separately collected and discharged to the radwaste waste collector tank and subsequent cleanup train. If the effluent from this cleanup train is of satisfactory quality, the purified stream is normally recycled to the 600,000-gal condensate return tank. Floor drain water of relatively low purity is collected in separate sumps and periodically discharged to the radwaste floor drain collector tank and cleanup train. If this water is of satisfactory quality, the purified stream may also be recycled to the CST or exhausted to the plant circulating water reservoir decanting line that flows into Lake Erie.

The normal equipment and floor drain water in each quadrant of the reactor building sub-basement is collected in the local sump of the respective quadrant. The drain water from the NW and SE quadrant sumps is discharged to the radwaste waste collector tank. The drain water from the SW and NE quadrant sumps is discharged to the radwaste floor drain collector tank.

Equipment drain connections are generally through open funnels (sight drains) at those locations where it is considered desirable to verify performance at a glance, where periodic temperature observations may be required, or where the coolant water system is a high pressure system and might overpressurize drain lines and equipment.

Drain system piping effecting drywell isolation is constructed to meet standards for Quality Group B components. They are designed to ASME Section III, Class 2 code requirements. The balance of the drain system is either Quality Group C designed to ASME Section III, Class 3 code requirements or Quality Group D, designed to ANSI B31.1.0, except for the recirculating sump heat exchangers. Their piping is designed to ASME Section VIII and to ANSI B31.1.0 code requirements.

All the equipment drain piping above the floor in the reactor building sub-basement is designed to ANSI B31.1.0 code requirements.

9.3.3.2 System Description

NOTE: Pump rates are nominal flow rates.

The Fermi 2 drainage system is designed for accumulation of discharges from equipment and floor drains inside the reactor building, auxiliary building, turbine building, and radwaste building, and for periodic transfer of these accumulations to the liquid radwaste system.

Within the reactor building, seven separate drain collection systems operate, each with an independent sump. The reactor and auxiliary buildings drain systems are shown in Figures 9.3-5 and 9.3-6.

An equipment drain collection system from primary coolant components terminates in a 1100-gal nominal capacity sump located in the drywell area under the reactor pressure vessel (RPV) with twin parallel 50-gpm transfer pumps that discharge to the radwaste waste collector tank. The sump is closed and vented, with a recirculating bypass capability from the transfer pump discharge header line returning to the sump. This bypass flows through a heat exchanger cooled by RBCCW. The sump fluid is automatically recirculated on a signal from a temperature sensor in the sump, in order to protect radwaste-system resins from deleterious overheating. The sump liquid setpoint is 135°F. Periodic sump discharge is initiated automatically on a signal from the sump level controller. The discharge header to the radwaste waste collector tank penetrates the primary containment wall. In order to preserve the integrity of primary containment, this line is sealed by the submerged pump suction lines inside primary containment.

These lines are also protected by one air-operated isolation valve and one motor-operated isolation valve installed in tandem in the discharge header; one valve is located inside containment, the other outside. Each valve is fed from a different division. These isolation valves are automatically closed by a rise in pressure inside primary containment and by other primary containment isolation signals (See Table 6.2-2).

Equipment drains from secondary containment spaces in the reactor building and auxiliary building are also collected and discharged to the radwaste waste collector tank. Two drain sumps, each holding 1500 gal (nominal capacity), are provided, each with twin submersible pumps and bypass heat exchangers.

The fourth drain system in the reactor building draws from a trench drain and an undervessel drain and exhausts to the radwaste floor drain collector tank. This system is similar to the equipment drain systems located in the drywell discussed previously. Dual isolation valves ensure the integrity of primary containment, but the bypass cooling heat exchanger is omitted. Sump capacity is 1000 gal (nominal capacity).

The fifth and sixth drain systems in the reactor building collect from the floor drains in secondary containment areas and exhaust through twin parallel pumps to the radwaste floor drain collector tank. These systems, like the other floor drain system, have no sump cooling provision. Each sump has a 1500-gal nominal capacity.

The seventh reactor building drain system consists of a sump in the torus area (with no collection piping). This system discharges through twin parallel transfer pumps and an external water seal to the radwaste floor drain collector tank. This sump has a 900-gal nominal capacity.

Equipment and floor drains in the emergency core cooling system (ECCS) pump rooms, in the subbasement of the reactor building, have been physically separated to prevent possible flooding between ECCS Division I and Division II equipment through the drain lines in the event of an accident that causes one of the rooms to flood.

Equipment and floor drains in the emergency core cooling system (ECCS) pump rooms,in the sub-basement of the reactor building, are collected in each room's sump to prevent possible inter-divisional flooding between ECCS Division I and Division II, with the exception of HPCI room. The floor and equipment drains from the HPCI room are collected in the RHR Division II pump room sump. A motor operated auto-close flood control valve is provided in the floor and equipment drain line to prevent possible flooding between the two rooms in the event of an accident that causes one of the rooms to flood. The flood control valve will normally be open, but will close on high-high sump level to prevent water from backing up into the subbasement floor and equipment drains. The valves will reopen on low sump level. Selected RHR pump and rack H21-P596B drains in the southwest corner room are hard piped to the southeast corner sump, but are isolated by normally closed manual valves.

Flooding of any individual corner room or the HPCI room due to a line break in either room can be confined to that corner room. The configuration of the motor operated flood control valve and its associated sump is shown in Figure 9.3-6. The level switch data for the motor operated flood control valve is given in Table 9.3-5.

The motor-operated flood-control valve and its limit switches are tested periodically to ensure their satisfactory performance. This testing is done as required by the Performance Evaluation Procedures of the overall plant surveillance program. Maintenance procedures cover the testing of the valves. Switches and other pertinent instrumentation are covered by a section of the overall balance-of-plant (BOP) preventive maintenance program.

The turbine building has eight separate radioactive drain collection systems, each with an independent sump. The drain system is shown in Figures 9.3-8 and 9.3-9.

Two equipment drain sumps, with nominal capacities of 400 and 4400 gal, collect oil-free radioactive liquids from equipment and piping systems. Each sump has twin 50-gpm sump pumps that periodically discharge to the waste collector tank in the radwaste building.

A third 2300-gal nominal capacity service water drain sump is provided to collect nonradioactive liquids from such systems as the general service water (GSW) system, and TBCCWS piping. This sump can be emptied into the liquid waste holding pond in the yard.

Two floor drain sumps, with nominal 1600-gal and 4400-gal capacities, are provided to collect oil-free liquids, and each has twin 50-gpm sump pumps discharging to the floor drain collector tank in the radwaste building.

Finally, three sumps, with approximate capacities of 1900, 2200, and 3000 gal, are provided to collect oil-contaminated liquids. These sumps are each provided with two 50-gpm to 64-gpm pumps as well as a 200-gpm or a 250-gpm emergency pump. The discharge is normally routed to an oil-water separator prior to treatment in the radwaste building. The emergency pumps can be used to empty the sumps to the liquid waste holding pond, if desired.

The radwaste building contains an equipment and a floor drain sump, each with a 900-gal nominal capacity. First-floor leakages drain directly into the waste collector tank or into the floor drain collector tank located in the basement. Basement leakages are collected in the appropriate sump and pumped out by twin 50-gpm pumps. The system drains are shown in Figures 9.3-10 and 9.3-11.

The RHR complex drain system is segregated into two types of wastes, oil-free water and oil-contaminated water. Equipment and floor drains that are potentially contaminated with oil drain to a manway which is connected by an overflow line to the liquid waste holding pond. Equipment and floor drains that are oil free drain to another manway which is connected by an overflow line to the circulating water reservoir. The piping pits are provided with sump pumps which discharge to the clear-water manway. The RHR system drains are shown in Figure 9.3-12.

9.3.3.3 Safety Evaluation

All potentially contaminated internal drain water is processed through the radwaste purification trains before release or recycle. The integrity of primary containment is ensured by tandem isolation valves. The drainage system is protected from overpressure by open sight funnel drains at most collection points.

To further ensure performance, the high-temperature drains in the reactor building are cooled by the RBCCWS. This ensures an acceptable net positive suction head (NPSH) at the transfer pumps.

9.3.3.4 Tests and Inspections

The drain lines are all welded and all required tests for joint soundness were carried out in accordance with applicable codes. For this reason, the closing field welds are in accessible positions.

Because spare pumps are installed, no periodic qualifying tests were undertaken. Completed piping has been hydrostatically tested in the field.

9.3.3.5 Instrumentation

Each sump is equipped with a high-high-level alarm to signal automatic initiation of the second pump. The starting of the second pump would be indicative of a system leakage. In addition, temperature controls are provided to cool critical sumps by actuating the flow of sump water through heat exchangers.

All reactor building sumps have leak-detection instrumentation. Timers monitor the operation of the sump pumps both for frequency and for length of operation. Leakage is detected by a pump operating before the timers time out or by a pump operating too long. Leakage is alarmed in the main control room.

9.3.4 Chemical, Volume Control, and Liquid Poison Systems

The only BWR systems that are related to this general class of systems are the standby liquid control system (SLCS) and the reactor water cleanup (RWCU) system.

The SLCS is described in Subsection 4.5.2.4 and the RWCU system is described in Subsection 5.5.8.

9.3.5 Failed Fuel Detection System

In the event of gross rod failure, the increased activity in the coolant would be transferred to the steam and detected by the main steam line RMS. Downstream of the steam line monitors are the offgas RMS and the reactor building exhaust vent RMS. The design bases, system description, safety evaluation, tests and inspections, and instrumentation applications for each of these subsystems are found in Section 11.4.

9.3.6 Nitrogen Inerting System

9.3.6.1 Design Bases

The Fermi 2 nitrogen inerting system provides and maintains a nitrogen atmosphere inside the primary containment and also provides pressurized nitrogen for pneumatic service inside the primary containment and distribution throughout the plant. The system schematic is shown in Figures 9.3-13 and 9.3-14.

The nitrogen inerting system supply is located outside the reactor building on the west side. The components are shown in Figure 9.3-15. The remainder of the system is located in the reactor building. The nitrogen inerting system supplies nitrogen gas at the proper pressure and temperature for inerting the primary containment and for distribution throughout the plant.

The nitrogen inerting system design requirements are the following:

a. To provide nitrogen gas at the proper temperature and pressure to inert the primary containment to a minimum of 97 percent by volume of nitrogen. The nitrogen gas will be injected into the primary containment and the existing atmosphere will be displaced out through the reactor/auxiliary building ventilation system or through the SGTS. Mixing of the injected nitrogen will be accomplished by the use of the drywell cooling system (see Subsection 9.4.5).

b. To provide nitrogen makeup for atmospheric leakage out of the primary containment during normal operation and to ensure that a positive pressure is maintained inside the primary containment with respect to the secondary containment. Makeup requirements to some degree will be taken care of by the bleed-off of nitrogen gas from the pneumatic instrumentation inside the primary containment. Provisions for nitrogen addition to the primary containment atmosphere have been made at the drywell and suppression chamber supply lines through a separate on-line purge system. This system controls the pressure of the drywell and torus through vent/makeup of nitrogen

c. To provide nitrogen gas for the pressurized distribution system for the following services:

    1. To provide pressurized nitrogen for the pneumatic instrumentation inside the primary containment. During normal operation, nitrogen will be supplied to this instrumentation from the nitrogen inerting system. In the event of a loss of nitrogen supply, bottled nitrogen will be available for emergency use for the pneumatic requirements inside the primary containment

    2. To provide pressurized nitrogen to any other remaining services requiring nitrogen throughout the plant.

Air purging of the primary containment to the breathable limit will be accomplished by the use of the reactor/auxiliary building ventilation system or the SGTS.

9.3.6.2 System Design

The nitrogen inerting system primary containment penetrations and the associated isolation valves are classified as ASME Section III, Class 2. The pneumatic supply system inside primary containment is classified as ASME Section III, Class 3. The balance of the nitrogen inerting system pressure vessels are classified as ASME Section VIII, and the piping is classified as ANSI B31.1.0.

The nitrogen inerting system primary containment penetrations and associated isolation valves and the pneumatic supply system inside primary containment are designated as Category I. The remainder of the system is classified as nonseismic.

The nitrogen inerting system has been designed in accordance with the following criteria.

a. Liquid nitrogen requirements are based on the following usage:
    1. To inert the primary containment to less than 3 percent by volume of oxygen
    2. To provide additional nitrogen to the primary containment to compensate for leakage.
    3. To provide nitrogen for the pressurized distribution system.
b. The inerting and air purging procedures for the primary containment will be completed in approximately 6 hr.
c. The minimum distribution temperature of the nitrogen gas for all phases of operation of the nitrogen inerting system is controlled. The vaporizing medium during the primary containment inerting procedure is saturated steam at 15 psig from the plant auxiliary boilers. Heat for the pressurized distribution system will be provided electrically
d. The design capacity of the liquid storage tank is based on the service requirement of the pressurized distribution system for Fermi 2 and the vapor loss from the storage tank during the interval of storage
e. The receiver usable capacity will be designed to allow a system flow rate of 50 cfm for a period of 5 minutes if the liquid nitrogen source should be out of service. A full-capacity standby receiver is available
f. The pressurized distribution system is designed to allow connection of bottles as a backup source of nitrogen
g. The design flow of the nitrogen gas to the primary containment for the inerting procedure is 3000 scfm.

9.3.6.3 Design Evaluation

The system fluid will be commercial 99-percent pure nitrogen. The fluid will not be radioactive. System components for the handling of liquid nitrogen have been constructed of materials suitable for temperatures of -320°F.

The liquid nitrogen storage tank provides the source of supply for pressurized nitrogen distribution. The tank is equipped with a pressure build coil and an auxiliary pressure build vaporizer. The pressure build coil will transfer heat to the liquid nitrogen to generate saturated nitrogen vapor.

The nitrogen inerting system has a steam vaporizer and electric heat exchanger. The steam vaporizer will be used only when nitrogen is required for the inerting of the primary containment. The electric heat exchanger is used to supply gaseous nitrogen for pressurized distribution.

The nitrogen receivers provide temporary storage to meet sudden demands for pressurized nitrogen throughout the plant. One receiver will be in full standby to allow maintenance without disturbing normal plant operation.

The source of system pressure is the liquid nitrogen storage tank. The vapor pressure in the tank will be regulated to provide the required system pressure. All pressure-retaining components of the system are equipped with properly sized pressure relief valves. Piping that is handling liquid nitrogen has pressure relief valves installed in any segment where liquid nitrogen could become entrapped between closed valves. All liquid nitrogen transfer lines are sloped upward in the direction of flow to prevent vapor pocket buildup at the nitrogen source.

The nitrogen inerting system is not required for the safe shutdown of the reactor, and hence is not required to protect the health and safety of the public. However, the continuous operation of the plant is contingent upon the nitrogen inerting system maintaining the required nitrogen atmosphere inside the primary containment. Therefore, to ensure that nitrogen gas is always available to meet the primary containment nitrogen requirements, small amounts of bottled, high-pressure nitrogen will be stored at the site as a secondary source of nitrogen supply.

9.3.6.4 Tests and Inspections

The liquid storage and vaporizing facilities for the nitrogen inerting system are located outside the reactor building and are accessible for inspection. The nitrogen receiver tanks and bottled nitrogen tanks are located in the reactor building and are accessible for inspection during normal plant operation. Initial system checks, valve operability, instrumentation and control loop checks, and alarm setpoints for the nitrogen inerting system were done in accordance with the Preoperational Test program as discussed in Chapter 14. The temperature and pressure of nitrogen delivered by the steam and electric vaporizers have also been determined.

Periodic inspections of receiver tanks and the passive Division II backup nitrogen supply system will be performed. The inspection of instruments will be made to confirm the actuation of relief valves and alarms. The system and its components will be periodically tested and maintained as appropriate for the system safety classification.

9.3.6.5 Instrumentation Requirements

When the primary containment is being inerted, pressure and temperature control will be maintained in the following manner:

a. A pressure control valve located downstream of the liquid storage tank discharge and the steam vaporizer automatically maintains a discharge pressure of approximately 30 psig

b. A temperature indicator is located in the condensate discharge line of the steam vaporizer as is a low-temperature switch that shuts down the nitrogen discharge from the vaporizer at preset temperature.

Pressure and temperature control of the pressurized nitrogen distribution system will be maintained as follows:

a. A pressure control station located between the liquid storage tank and the electric heat exchanger automatically maintains a downstream pressure of approximately 110 psig

b. A variable setpoint temperature controller on the discharge side of the electric heat exchanger maintains a nitrogen discharge temperature

c. A pressure control station located downstream of the receivers maintains a downstream pressure

d. The drywell makeup station will sense the pressure of the primary containment and the secondary containment and with manual action, a positive pressure will be maintained in the primary containment

e. The provision for a bottle backup station will include a manually operated pressure regulator to maintain the receiver pressure when required. However, Division II is backed up by a passive nitrogen supply using bottles in the secondary containment. This capability supports manual operation of Division II SRVs from the control room for certain post-fire shutdowns requiring low pressure makeup systems

f. A pressure indicator is provided to monitor pressure downstream of the receivers. When the pressure of the receiver in operation reaches a setpoint, an alarm is provided to indicate low receiver pressure.

The primary containment isolation valves will automatically isolate on high drywell pressure, low reactor level, or high reactor building radiation.

TABLE 9.3-1 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
1	TBCCW (2)	E and W heat exchanger outlet	Tube leaks	Conductivity Laboratory	Local grab	95/130	35
2	Condenser	Condenser leak troughs	Spare tap not used				
3	Condensate (3)	Condensate pumps discharge north-center-south	Condensate quality and tube leaks	Laboratory	Grab station	94	213
4	Condensate	Condensate pumps discharge header	Spare tap not used			94	213
5	Condenser (6)	Condenser leak troughs inlet and outlet each quadrant turbine	Spare taps -not used			100	-14
6	Condenser	Condenser leak trough	Spare tap not used			125	147
7	Condenser circulating water system (2) A or B	NE and SE water box influent	Water analysis	pH, Biocide Residual laboratory	Local Grab	95	50
8	Condenser circulating water system (2) A or B	E and W water boxes effluent	Water analysis	Biocide Residual Conductivity, pH, Total solids Laboratory	Local Grab	100	50
9	Condensate polishing demineralizer	Polishing demineralizer inlet header	Condensate quality and tube leaks	Conductivity Cation, Dissolved 0_2 Corrosion Products Laboratory	Continuous Grab station	94	213
10	Condensate polishing demineralizer	Polishing demineralizer outlet header	Treated condensate quality	Conductivity Dissolved 0_2 Corrosion Products Laboratory	Continuous Grab station	94	213
11	Feedwater heaters (4) 11, 11A, 11B, 11C	No. 2 FWH effluent header 2N, 2C, 2S	Water analysis	Laboratory	Grab station	388 170	498 634
12	Reactor feedwater system (2) A and B	After last heater 6A and 6B (2)	Water analysis	Laboratory	Continuous Grab station	425	1106
13	Heater feed	Heater feedpump discharge header	Water analysis	Laboratory	Grab station	94	700
14	Main steam (2) (A or B)	Main steam line	Steam conditions	Conductivity Laboratory	Continuous Grab station	549	1020
15	Drains cooler	Drain discharge to condenser	Water analysis	Laboratory	Local grab	134 104	-12 psia
16	Deaerating No. 5 heater (2) drain	No. 5N + 5S drain outlet	Drain water quality for pumping drains forward	Corrosion Products when required Laboratory	Local grab or tie continuous with item 25	392	224 210
17	Feedwater heaters (12)	Condensate inlet and outlet to heaters	Water analysis	Laboratory	(a)	105-400	580 634
18	Feedwater heaters (12)	Drains inlet and outlet to heaters	Water analysis	Laboratory	(b)	105-400	-13.5-345

TABLE 9.3-1 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
19	Condensate polishing demineralizer	Polishing demineralizer inlet header	Condensate quality	Conductivity Laboratory	Continuous Grab station	94	213
20	Condensate polishing demineralizer	Polishing demineralizer effluent header	Demineralizer efficiency	Conductivity Laboratory	Continuous Grab station	94	213
21	General service water header	Effluent header to circulating water	Water analysis	Biocide Residual	Local grab	85	80-125*
22	Reactor Feedwater System	36 in. header after heater 6A and 6B	Water analysis	Conductivity Dissolved 02 Turbidity Corrosion Products Laboratory Dissolved H2	Continuous Grab station	425	1116
23	Condensate (4)	Hotwell discharge pipe each quadrant, condenser	Tube leaks	Conductivity Sodium Laboratory	Continuous Grab station	91.7	-9
24	Circulating water decant	Circulating water decant line	Sample of decant to Lake Erie	Laboratory	Local grab	85	50
25	Feedwater heater drains	Heater drain pumps discharge header	Evaluating heater drain contribution to feedwater	Dissolved 0_2 Turbidity Corrosion Products	Continuous Grab station	392	791
26	Circulating water decant before radwaste	Discharge of decant pumps	Water analysis	Corrosion Products Laboratory	Local grab	95	50
27	Makeup demineralizer storage tank	Tap on tank	Tank water purity	Laboratory	Local grab	Ambient	Tank head
28	Condensate storage tank	Tap on tank	Tank water purity	Laboratory	Local grab	Ambient (>40°F)	Tank head
29	Condensate return tank	Tap on tank	Tank water purity	Laboratory	Local grab	Ambient (95°F)	Tank head
30	Inlet line to condensate return tank	CRT return line	CRT supply purity	Laboratory	Local grab	95	58
31	Torus water management	Discharge of torus water management pumps	Water analysis	Laboratory	Grab station	160	210
32	SCCW Chilled Water (3)	Outlet of chilled water evaporator	Water analysis	Laboratory	Local grab	60	100

(a) Local grab for Sample No. 17a, c, d and e

(b) Local grab for Sample No. 18c and d

* Bounds plant operating procedures

TABLE 9.3-2 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
33	SCCW (1)	Chilled water common return	Water analysis	Laboratory	Local grab	76	100
34	RBCCW (3)	RBCCW Return Headers from EECW	Water analysis	Laboratory	Local grab	85	80
35	RBCCW (2)	Heat exchanger outlet (2) N and S	Tube leaks	Conductivity	Local grab	85	80
36	RBCCW	Pump discharge header	Tube leaks	Conductivity	Grab station	85	80
37	Reactor primary coolant water	Main recirculating system pipe	Monitor reactor water when cleanup is isolated	Conductivity Dissolved 0_2 pH, Corrosion Products Laboratory Dissolved H_2	Continuous Grab station	540	1230
38	Reactor water cleanup filter-demineralizer	Filter inlet pipe	Reactor water quality	Conductivity Laboratory	Continuous Grab station	120	1214
39	Reactor water cleanup filter-demineralizer (2) (A or B)	Filter outlet pipe	Demineralizer efficiency	Corrosion Products Conductivity Laboratory	Continuous Grab station	120	1214
40	Suppression pool (4)	RHR pump suction A, B, C, D	Water analysis	Laboratory	Local grab	90	Atm
41	Standby liquid control	Dip from tank	Test for boron concentration	Laboratory	Dip sample	90	Atm
42	Reactor shutdown cooling system (2) (A and B)	RHR heat exchanger outlet A & B	Water analysis	Conductivity Dissolved 0_2 pH, Laboratory Dissolved H_2	Continuous Grab station	335	480
43	Cleanup phase separator decant	Decant line to waste collector tank	Process data	Laboratory	Local grab	125	130
44	Cleanup phase separator sludge	Cleanup sludge discharge mix pump	Process data	Laboratory	Local grab	70-130	70
45	Fuel pool water	Dip from fuel Storage pool	Water analysis	Laboratory	Dip sample	70	Atm

TABLE 9.3-2 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
46	EECW Division I Outlet (2)	Heat exchanger	Plate Leaks	Laboratory	Local grab	85-95	80
47	EECW Division II Outlet (2)	Heat exchanger	Plate Leaks	Laboratory	Local grab	85-95	80
48	Reactor water cleanup heat exchangers (2) cooling water	Cooling water (RBCCW) outlet, A and B RWCU heat exchanger	Tube leaks	Laboratory	Local grab	110	80
49	Fuel pool heat exchangers (2) and cooling water	Cooling water (RBCCW) outlet, A and B fuel pool cooling and clean- up heat exchanger	Tube leaks	Laboratory	Local grab	110	80
50	Reactor water cleanup	Cleanup pump discharge (RWCU Inlet)	Reactor water quality	Conductivity Dissolved 02 pH Corrosion Products Laboratory Dissolved H2	Continuous Grab station	537	1220
51	Reactor water cleanup	RWCU Outlet header (before addition to feedwater	Cleanup system operation	Corrosion Products Conductivity Laboratory	Continuous Grab station	537	1220
52	Spent fuel pool circulating system	Fuel pool pump discharge (2) A and B	Water quality	Laboratory	Local grab	130	130
53	Service water discharge from RBCCW heat exchangers	Service water discharge header from heat exchangers	Tube leaks	Laboratory	Local grab	100	80-125*
54	Control rod drive	CRD filter outlet	CRD water quality	Conductivity Dissolved oxygen	Grab Station		
55-56	Not used						

TABLE 9.3-2 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
57	Reactor Water Cleanup	Cleanup Pump Suction	Reactor Water Quality	Laboratory Conductivity Dissolved O2 ph Dissolved H2	Grab Station, Continuous	537	1050

* Bounds Plant Operating Procedures

TABLE 9.3-3 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
58	Floor drain demineralizer	Outlet pipe	Demineralizer efficiency	Laboratory	Local grab	140	40-140
59	Turbine building floor drain oil separator	Discharge to floor drain collector tank	Process data	Laboratory	Local grab		
60	Turbine building floor drain sumps (3)	Discharge to oil separator	Process data	Laboratory	Local grab		
61	Turbine building floor drain sumps (3)	Discharge to trash pond	Process data	Laboratory	Local grab		
62	Not used						
63	Floor drain sumps (7)	Sump pump discharge to floor drain collector tank	Process data	Laboratory	Local grab		
64	Equipment drain sumps (6)	Sump pump discharge to waste collector tank	Process data	Laboratory	Local grab		
65	Radwaste building emergency drains sump (5)	Sump pump discharge	Process data	Laboratory	Local gab	140	40-140
66	Radwaste evaporator (2) (A and B)	Concentrate pump discharge A and B	Process data	Laboratory	Local grab	165	40
67	Waste surge tank pump discharge	Waste surge tank	Process data	Laboratory	Grab station	140	40-140
68	Waste collector tank	Waste collector tank pump discharge	Process data	Laboratory	Grab station	140	40-140
69	Floor drain collector tank pump discharge	Floor drain collector tank pump discharge	Process data	Laboratory	Grab station	80	100
70	Not used						
71	Not used						
72	Waste sample tanks (2) (A and B)	Waste pump dis-charge	Discharge suitability	Laboratory	Grab station	40-140	40-140
73	Waste sample tank	Recirculating line to waste sample tank	Discharge suitability	Laboratory	Grab station	40-140	40-140

TABLE 9.3-3 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
74	Waste collector filter-demineralizer	Filter-demineralizer outlet	Filter-demineralizer efficiency	Laboratory	Local grab	140	140
75	Not used						
76	Waste demineralizer	Demineralizer outlet	Demineralizer efficiency	Laboratory	Local grab	140	40-140
77	Floor drain filter-demineralizer	Filter-demineralizer outlet	Filter-demineralizer efficiency	Laboratory	Local grab	140	40-140
78	Not used						
79	Condensate phase separator	Condensate decant pump discharge	Process data	Laboratory	Local grab	80	Atm
80	Chemical waste tank	Chemical waste pump discharge	Process data	Laboratory	Grab station	80	40
81	Fuel pool cooling and cleanup filter-demineralizer	Inlet pipe	Fuel pool water quality	Laboratory	Local grab	130	130
82	Fuel pool cooling and cleanup filter-demineralizer	Outlet pipe efficiency	Filter	Laboratory	Local grab	125	130
83	Not used						
84	Not used						
85	Distillate (2)(A and B) surge tank	Distillate surge tank (A and B)	Distillate data	Laboratory	Grab station	40	40
86	Radwaste effluent	Discharge line to decant line	Discharge data	Laboratory	Grab station	150	50
87 to100	See Table 9.3-4						
101	Waste collector etched-disk filter	Discharge to etched-disk filter	Filter efficiency	Laboratory	Local grab	40-140	55-167
102	Waste collector oil coalescer filter	Discharge of oil coalescer	Oil coalescer efficiency	Laboratory	Local grab	0-140	55-167
103	Floor drains etched-disk filter	Discharge of etched-disk filter	Filter efficiency	Laboratory	Local grab	40-140	22-100
104	Floor drains oil coalescer	Discharge of oil coalescer	Oil coalescer efficiency	Laboratory	Local grab	40-140	22-100

TABLE 9.3-3 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
105	Distillate surge tank A	Discharge of distillate A pump	Distillate data	Laboratory	Local grab	40	40
106	Distillate surge tank B	Discharge of distillate B pump	Distillate data	Laboratory	Local grab	40	40
107	Evaporator feed surge tank	Discharge of evaporator feed-pumps	Process data	Laboratory	Grab station	80	100
108	Centrifuge	Decant line to waste clarifier	Process data	Laboratory	Local grab	140	Atm
109	Extruder/evaporator distillate	Discharge line to waste clarifier	Process data	Laboratory	Local grab	212	0
110	Floor drain demineralizer	Demineralizer outlet before strainer	Distillate quality	Conductivity	Continuous	140	40-140
111	Waste demineralizer	Waste demineralizer discharge	Distillate quality	Conductivity	Continuous	140	40-140
112	Waste collector oil coalescer filter	Discharge of oil coalescer	Water effluent quality	Conductivity	Continuous	40-140	55-167
113	Floor drain oil coalescer	Discharge of oil coalescer	Process data	Conductivity	Continuous	40-140	22-100
114 to 119	Not used						
120	Fuel pool cooling and cleanup demineralizer A	Demineralizer A effluent	Demineralizer efficiency	Conductivity	Continuous	140	40-140
121	Fuel pool cooling and cleanup demineralizer B	Demineralizer B effluent	Demineralizer efficiency	Conductivity	Continuous	140	40-140
122	Circulating water	Circulating water pumps discharge header	pH control	pH	Continuous with recirculating pump operation	60	50
123	Not used						
124	Floor drain demineralizer	Floor drain demineralizer outlet before recycle valve	Demineralizer efficiency	Conductivity	Continuous	140	40-140
125	Waste demineralizer	Waste demineralizer discharge	Demineralizer efficiency	Conductivity	Continuous	140	40-140

TABLE 9.3-3 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
126	TBCCW supply	Discharge header from pumps	Process data	Laboratory	Local grab	95	50
127	Radwaste evaporator (2) (A and B)	Discharge lines from A and B distillate pumps to distillate coolers	Process data	Laboratory	Local grab	135	Atm
128	Evaporator drains holdup tank	Discharge line from evaporator drains pump	Process data	Laboratory	Local grab	165	Atm
129	Not used						
130	Radwaste system fuel pool filter-demineralizer A outlet	Line to fuel pool cooling cleanup system	To check water purity	Laboratory	Local grab	140	40-140
131	Radwaste system fuel pool filter-demineralizer B outlet	Line to fuel pool cooling cleanup system	To check water purity	Laboratory	Local grab	140	40-140
132	RHR heat exchanger B	Discharge to RPV	Water analysis	Conductivity	Continuous	335	480
133	RHR heat exchanger A	Discharge to RPV	Water analysis	Conductivity	Continuous	335	480
134	RHR heat exchanger B(service water)	Discharge to RHR	Radiation water tube leaks	Isotopic chloride	Continuous grab	155	80
135	RHR heat exchanger A(service water)	Discharge to RHR	Tube leaks	Isotopic chloride	continuous grab	155	80
136 to 151	Not used						
152	RHR Division I	RHR service water return, Division I	Tube leaks	Laboratory	Grab station	155	80
153	RHR Division II	RHR service water return, Division II	Tube leaks	Laboratory	Grab station	155	80
154 to157	Not used						
158	Main and reheat system	52-in. manifold	Spare tap			542	997
159	Not used						

TABLE 9.3-3 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
160	Offgas vacuum and recombiner chain	20-in. manifold	Spare tap			94	-14.2
161	Offgas vacuum and recombiner chain	2.2-minute delay pipe from precooler	Monitor hydrogen and oxygen	Hydrogen oxygen	Continuous	70	-14.2
162	Offgas vacuum and recombiner chain	2.2-minute delay pipe from precooler	Spare tap			70	
163	Stator Winding Cooling de-oxygenating unit	Inlet/outlet of contactors	Monitor dissolved oxygen	Oxygen	Grab Sample	Ambient	80
164	Stator Winding Cooling demineralizer unit	Vent/drain stator winding cooling unit	Oxygen & metallic imputities	Conductivity	Grab Station	150	180
165	Station and control air	2-in. air header	Monitor control air moisture	Dewpoint hygrometer	Continuous	75	110
166 to 169	Not used						
170	Primary containment monitoring system	In reactor drywell	To check quality of reactor atmosphere	Hydrogen oxygen content	Continuous	135	2
171	Primary containment monitoring system	In reactor drywell	To check quality of reactor atmosphere	Hydrogen-oxygen content	Continuous	135	2
172	Primary containment monitoring system	In suppression pool	To check quality of atmosphere in suppression pool	Hydrogen-oygen content	Continuous	150	2
173	Primary containment monitoring system	In suppression pool	To check quality of atmosphere in Suppression pool	Hydrogen-oxgen content	Continuous	150	2
174	Not used						
175	Not used						

TABLE 9.3-4 PROCESS SAMPLING SYSTEM

Item No.	Description	Sample tap Location	Purpose of Sample	Type of Analysis	Analysis Mode	Source Operating Temperature (°F)	Source Operating Pressure (psig)
87	Auxiliary boiler steam (2)	N and S steam drum	Steam quality	Laboratory	Local grab	341	105
88	Auxiliary boiler feedwater	Feedwater inlet header	Feedwater quality	Laboratory	Local grab	220	125
89	Makeup demineralizer anion exchanger	Discharge from anion exchanger	Demineralizer efficiency	Conductivity	Continuous	80	50
90	Makeup demineralizer mixed bed	Discharge from mixed- bed exchanger	Demineralizer efficiency	Conductivity	Continuous	80	40
91	Makeup demineralizer	Makeup demineralizer outlet	Demineralizer efficiency	Conductivity	Continuous	80	40
92	Makeup demineralizer potable water	Raw water booster pump discharge	Raw water data	Laboratory	Grab station	80	50
93	Makeup demineralizer carbon filter	Carbon filter discharge	Filter efficiency	Laboratory	Local grab	80	65
94	Makeup demineralizer cation exchanger (2)	Discharge from cation exchanger	Demineralizer efficiency	Laboratory	Grab station	80	60
95	Makeup demineralizer anion exchanger (2)	Discharge from anion exchanger	Demineralizer efficiency	Laboratory	Grab station local grab	80	50
96	Makeup demineralizer mixed bed (2)	Discharge from mixed bed exchanger	Demineralizer efficiency	Laboratory	Grab station local grab	80	40
97	Makeup demineralizer system	Makeup deminer-	Demineralizer alizer outlet	Laboratory efficiency	Grab station	80	40
98	Makeup demineralizer acid solution	Discharge to mixed bed and cation exchangers	Acid concentration	Laboratory	Grab station	80	50
99	Makeup demineralizer caustic solution	Discharge to mixed bed and anion exchangers	Process data caustic concentration	Laboratory	Grab station	80	50
100	Not used						

TABLE 9.3-5 REACTOR BUILDING: FLOOD CONTROL VALVE

Division	Sump	Isolation Valve	Level Switch[a]
II	DO76 (Floor and equip. drains)	T4500F601	LSE-N076-B

[a] Switch limit points:

High-high	45 in. (valve closes)
High	39 in.
Low	24 in. (valve opens)
Low-low	22 in.

Figure Intentionally Removed
Refer to Plant Drawing M-2015

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-1

STATION AND CONTROL AIR SYSTEM

Figure Intentionally Removed
Refer to Plant Drawing I-2400-04

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-2

SAMPLES IN REACTOR BUILDING

Figure Intentionally Removed
Refer to Plant Drawing I-2400-03

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-3

SAMPLES IN TURBINE BUILDING

Figure Intentionally Removed
Refer to Plant Drawing I-2400-02

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-4

SAMPLES IN RADWASTE BUILDING

Figure Intentionally Removed
Refer to Plant Drawing M-2223

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-5

EQUIPMENT DRAINS IN AUXILLARY AND
REACTOR BUILDING

Figure Intentionally Removed
Refer to Plant Drawing M-2224

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-6

FLOOR DRAINS IN AUXILIARY AND
REACTOR BUILDINGS

Figure Intentionally Removed
Refer to Plant Drawing M-2218

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-7

FLOOR AND EQUIPMENT DRAINS IN REACTOR BUILDING SUBBASEMENT

Figure Intentionally Removed
Refer to Plant Drawing M-2534

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-8

EQUIPMENT DRAINS IN TURBINE BUILDING

Figure Intentionally Removed
Refer to Plant Drawing M-2535

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-9
FLOOR DRAINS IN TURBINE BUILDING

Figure Intentionally Removed
Refer to Plant Drawing M-2550

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-10

EQUIPMENT DRAINS IN RADWASTE BUILDING

Figure Intentionally Removed
Refer to Plant Drawing M-2551

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-11

FLOOR DRAINS IN RADWASTE BUILDING

Figure Intentionally Removed
Refer to Plant Drawing M-N-2050

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-12

EQUIPMENT DRAINS AND FLOOR DRAINS
(DIVISIONS I AND II) RESIDUAL HEAT REMOVAL
COMPLEX - P&ID

Figure Intentionally Removed
Refer to Plant Drawing M-3445

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

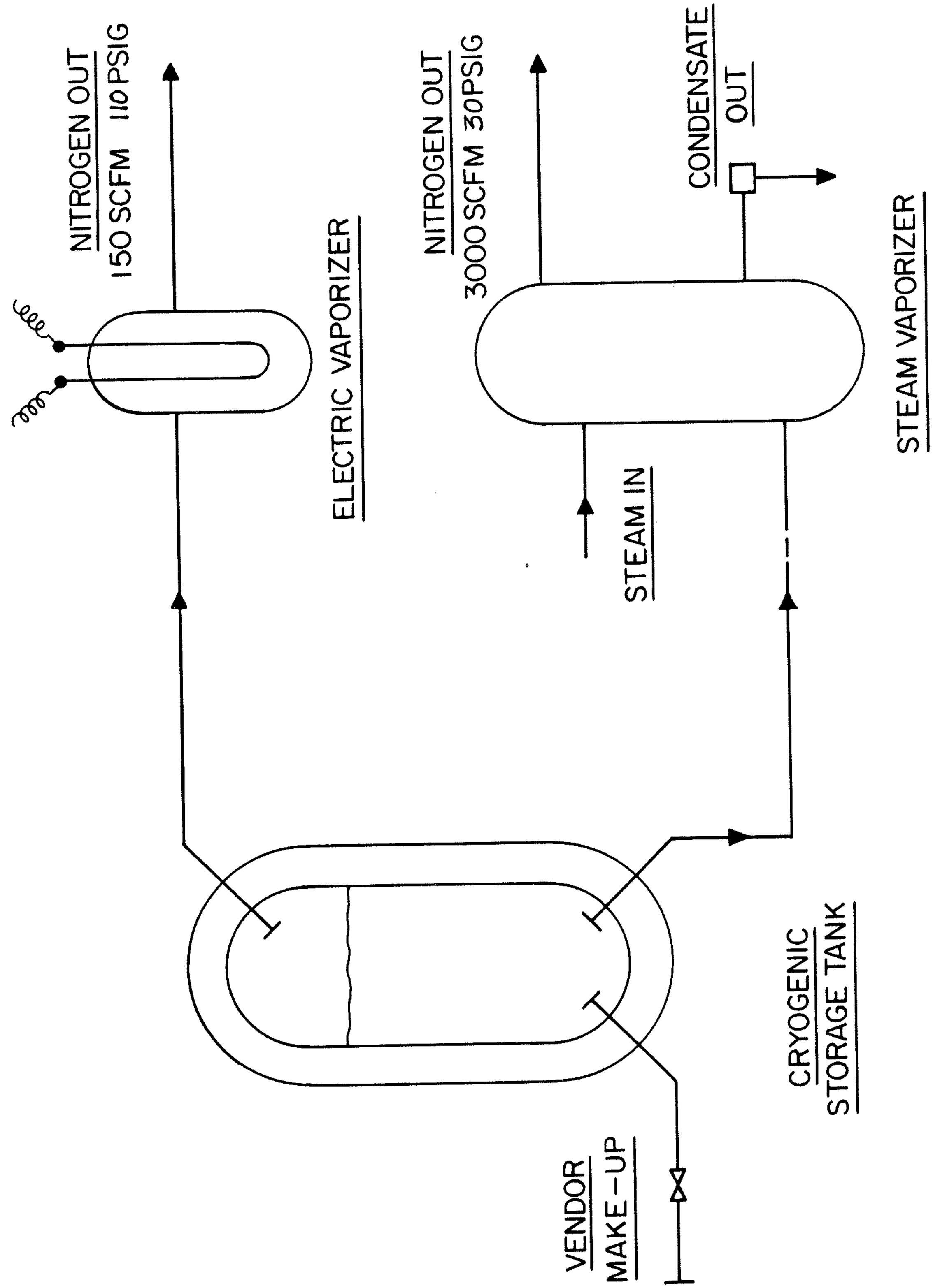
FIGURE 9.3-13
NITROGEN INERTING SYSTEM

Figure Intentionally Removed
Refer to Plant Drawing M-3445-1

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-14

NITROGEN INERTING SYSTEM



Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-15

NITROGEN INERTING SYSTEM SUPPLY

9.4 AIR CONDITIONING, HEATING, COOLING, AND VENTILATION SYSTEMS

9.4.1 Control Center Air Conditioning System

9.4.1.1 Design Bases

The control center air conditioning system (CCACS) is designed to provide ventilation, heating, and cooling, and to limit the relative humidity in the control center envelope (as described in Subsection 9.4.1.2) during normal operation and following a design-basis accident (DBA).

The CCACS is designed as follows:

a. The system is designed to limit the maximum relative humidity* to 60 percent and the nominal ambient temperature to 75°F dry bulb during normal operation, except for the mechanical equipment room (MER) and SGTS room, to ensure comfort of the operators as well as to obtain an optimum environment for controls and instrumentation. The system is designed to limit the nominal ambient temperature in the MER to 95°F during normal operation and following a design-basis accident, and in the SGTS room to 104°F during normal operation. The system is designed to maintain the above temperatures, assuming an ambient temperature of 95°F dry bulb and 75°F wet bulb during the summer and -10°F dry bulb during the winter

b. The system is designed to detect and limit the introduction of radioactive material into the main control room and to remove airborne radioactivity from the environment therein such that the dose to main control room personnel following a DBA does not exceed the requirements of General Design Criterion 19

c. The system is designed to limit the introduction of chlorine gas into the main control room

d. Redundant components are powered by their corresponding redundant Division I and Division II engineered safety feature (ESF) buses

e. The system is designed to accomplish its design objectives assuming a single active component failure. A single active failure in the Halon fire protection system will cause loss of cooling to the relay room, cable spreading room, or computer room. Redundant smoke/Halon dampers are not provided. Adequate time exists to take manual actions to restore airflow

f. The CCACS is designed to meet Category I requirements.

---

* The relative humidity in the control room and the computer room is controlled between a minimum of 40 percent and a maximum of 60 percent.

g. The system is designed for accessibility in making adjustments and periodic inspections and for testing principal system components to ensure continuous functional reliability

h. The control center emergency air filtration system design conforms to Regulatory Guide 1.52 except as stated in Subsection A.1.52. The system is redundant only at the active component level.

Environmental design considerations relating to main control room habitability following an accident are discussed in Subsection 6.4.1.

The CCACS is designed to maintain the control center under a positive pressure of approximately 1/4 ± 1/8-in. water gage in the "recirculation mode" in order to minimize inleakage of contaminated air. Such outside contamination could be the result of radioactivity leakage after a LOCA.

Isolation valves and isolation dampers are capable of remote manual operation so that failure of their control system will not render the system inoperable.

Surveillance of airborne radioactivity levels in the main control room is provided by the airborne radiation monitoring system (Subsection 12.2.4).

9.4.1.2 System Description

9.4.1.2.1 System Equipment

The control center envelope encloses a total air volume of approximately 275,960 ft^3 (during normal mode) and 252,731 ft^3 (during emergency modes). The following areas are air conditioned as separate zones as indicated:

Zone	Area Description
1	Relay room
2	Cable spreading room
3	Main control room
4	Computer room
6	Office
7	Conference room
8	Mechanical equipment room and standby gas treatment system (SGTS) rooms (during normal mode). However, the SGTS rooms are not part of the control center envelope during emergency modes (See Subsection 9.4.1.2.3)

The CCACS diagram is shown in Figures 9.4-1, 9.4-2, and 9.4-3, and principal system component design data are listed and described in Table 9.4-1. The CCACS consists of two

100 percent-capacity air-conditioning supply units, an air distribution system, and an emergency filtration system. The control center is heated, cooled, and pressurized by a recirculating air system.

There are four operating modes for the ventilating system, as follows:

a. Normal Mode: A minimum of 2769 cfm outside air mixes with recirculated ventilating air, bypassing the emergency makeup and recirculation filters

b. Purge Mode: 100 percent outside air is circulated through the control center and exhausted to the atmosphere to purge any smoke or fumes within the control center

c. Recirculation Mode: A maximum of 1800 cfm outside air is filtered and mixes with 1200 cfm recirculated air that is filtered again and mixed with recirculating ventilation air to prevent intrusion and to provide continuous removal of contaminants during a radiation-release emergency

d. Chlorine Mode: All outside intakes are closed to prevent ingress during a chlorine-release emergency. Ventilating air is recirculated with 1200 cfm passing through the emergency recirculation filter.

Each of the multizone air-conditioning supply units includes a fail-closed air-operated inlet damper, an electronic air cleaner, a roll filter, a centrifugal fan, and an electrically heated hot deck and a cold deck with a chilled water cooling coil. The supply air temperature for each zone is controlled by a pair of zone dampers that proportion the hot and cold air. Each of the air-conditioning supply units is served by a Category I chiller unit. During normal operation, the condenser section of the chiller is cooled by the reactor building closed cooling water system (RBCCWS). During emergency operation, the chiller condenser is cooled by the emergency equipment cooling water system (EECWS).

The emergency filtration system processes control center air and makeup air through charcoal filters if the control center is subjected to airborne contamination. This system consists of two separate emergency air intakes. Each has a dual set of "bubble tight" dampers in each of two parallel lines.

These dampers are valves with pneumatic piston actuators. The emergency makeup air filter train is sized for a flow rate of 3000 cfm, but is restricted to a maximum emergency intake flow of 1800 cfm. The filter train consists of the following components arranged in the direction of flow:

a. Mist eliminator (prefilter type)

b. Two electric heaters, one each for Division I and Division II

c. High-efficiency particulate air (HEPA) filter with a design filtration efficiency of 99.97 percent for 0.3 μm particles or larger. The filters are installed and field tested such that a 95 percent decontamination efficiency can be assumed for removal of particulate iodine

d. 2-inch deep charcoal adsorber. The carbon is purchased, lab tested, and tested for bypass leakage after installation such that a 95 percent decontamination efficiency can be assumed for removal of all forms of gaseous iodine

e. HEPA filter with a design filtration efficiency of 99.97 percent for 0.3 μm particles or larger.

The emergency intake flow is then combined with 1200 cfm of control center recirculation airflow. This airflow is then processed through the recirculation air filter train.

The emergency recirculation filter train is sized for a flow rate of 3000 cfm and consists of the following filters in the direction of flow:

a. Prefilter

b. HEPA filter with a design filtration efficiency of 99.97 percent for 0.3 μm particles or larger. The filters are installed and field tested such that a 95 percent decontamination efficiency can be assumed for removal of particulate iodine.

c. 4-inch deep charcoal adsorber. The carbon is purchased, lab tested, and tested for bypass leakage after installation such that a 95 percent decontamination efficiency can be assumed for removal of all forms of gaseous iodine.

d. HEPA filter with a design filtration efficiency of 99.97 percent for 0.3 μm particles or larger.

The air is drawn through these emergency filters by one of two redundant emergency recirculation air fans. Redundant air-operated dampers are installed on the intake, upstream of make-up air filter unit, and exhaust side of each of the fans. The fans receive electrical power from ESF buses.

In order to provide adequate makeup air to the control center during normal operation, the intake air damper is provided with a minimum stop to ensure a minimum airflow at all times except while the control center is isolated. The design minimum airflow is 2769 cfm. This minimum airflow is based on the normal airflow to the main control room exhaust vent, the exfiltration from the building, and the ventilation air supplied to the standby gas treatment room, kitchen, and washrooms. A modulating damper in the system exhaust restricts exhaust flow relative to supply airflow rate to maintain approximately 1/4 ± 1/8 in. of water difference between the lower of the outside ambient pressure or the turbine building pressure and control center pressure when the system is in the normal mode.

The two fan-coil cooling units are located in the mechanical equipment room. Each of these units is sized to dissipate the total heat load generated in the mechanical equipment room during an emergency. The units are of the factory-assembled, integral-fan-type with a chilled water cooling coil. One fan-coil unit is for Division I and the other for Division II. Chilled water is supplied to these units from the control center chillers.

The air conditioning system is equipped with alarms annunciated in the main control room for detection of equipment malfunction. Each division has similar alarms. A malfunction in the operating division will annunciate an alarm; if necessary, the entire division will be shut down manually and the standby division will be manually started. Shutoff dampers on the outlet of each unit are interlocked with the fan starter. Chiller starter contacts are held open until verification of chilled water, condenser water flow, supply air, and return airflow. The chiller starter contacts are tripped if oil pressure is not verified after a time delay.

For heat and smoke removal from the control center complex in the event of a fire in either the relay room or the cable spreading room, the fire detection system automatically switches the air conditioning system to a purge mode. Smoke and fire detection systems for the control center are covered in Subsection 9.5.1.

All electrical power for motor operation is supplied by the reactor building ESF buses and the division concept of separation and redundancy is maintained. Power to these buses is supplied from the emergency diesel generator (EDG) system if offsite electrical power is lost. Refer to Subsection 7.3.5 for a discussion of the CCACS instrumentation and controls.

9.4.1.2.2 Normal Operation

During normal operation, the master selector switches in the main control room activate all components in the Division I or Division II system. A mixture of return and outside air is filtered, then cooled, heated, and dehumidified, as required by a multizone air-conditioning supply unit. Each zone thermostat modulates zone mixing dampers to obtain the supply air temperature necessary to satisfy the zone cooling or heating requirements.

Heating is supplied by an electric heating coil and is provided on demand from any one of the zone thermostats. The air temperature leaving the heating coil is maintained at approximately 95°F and reset to lower temperatures on rising outside air temperature. Steam is supplied by the auxiliary boiler and controlled by humidistats located in the control room and computer room. Positive pressure is maintained in the control center by throttling the exhaust air modulating damper. This damper modulates only in the normal mode. It has no essential function and opens upon loss of power to allow "purge" mode operation if required. Exhaust fans are provided in the kitchen and washrooms.

9.4.1.2.3 Emergency Operation

During an emergency, the control center is isolated from all other areas of the plant. All air supplies to the standby gas treatment rooms and the normal operation of air intake and exhaust ducts are dampered closed.

The multizone air-handling unit, the chiller, chilled water pump and the return air fan continue to operate as during normal operation. The return air damper assumes a full open position. Condenser water is supplied from the EECWS. The fan in the mechanical equipment room fan-coil cooling unit is also energized under room thermostat control. Chilled-water flow through the cooling coil of the unit continues unimpeded as during normal operation.

The emergency recirculation air fan is energized and the isolation dampers on the emergency intake air duct are opened. Pressure control dampers, which regulate the proportion of recirculated air to emergency makeup air, modulate to maintain approximately 1/4 ± 1/8-in. water gage positive pressure in the control room. The dampers in the kitchen and washroom exhaust air ducts are closed. In the event that chlorine gas is detected in the control center by control room personnel, manual operator action will place the CCHVAC system in chlorine mode which will cause all system isolation dampers to automatically close. Damper position indications in the main control room allow continuous monitoring of system performance and confirm all remote manual control actions taken.

9.4.1.3 Safety Evaluation

Continued operation of the CCACS during both normal and emergency conditions is ensured by the following:

a. Design of system components to meet Category I requirements

b. Redundancy of components to meet single active failure. Smoke/Halon dampers are not single active failure proof. A system single-failure analysis is presented in Table 9.4-2

c. During loss of offsite power, all active components, such as valve and damper operators, fan motors, controls, and instrumentation, are served by their respective emergency power sources.

d. The unfiltered inleakage into the main control room is limited to a maximum of 171.9 cfm as evaluated in accordance with the AST methodology in Regulatory Guide 1.183.

Alarms in the control center will alert the operator to any malfunction in the CCACS so that, if necessary, he can manually actuate the standby division. The instrumentation in the main control room is designed to operate without degradation of performance in an ambient temperature of 120°F.

Detection of radioactivity in the main control room environment is provided by radiation monitors, as described in Subsection 12.2.4. Signals generated by high radioactivity in the control center makeup air, the reactor building exhaust, and fuel pool exhaust; low reactor water level; and high drywell pressure will initiate automatic isolation of the control center.

Protection of main control room personnel against an offsite chlorine release can be provided by manual isolation of the main control room and the use of breathing apparatus by the main control room operators as discussed in Section 6.4.

A discussion and analysis of the chlorine accidents considered in the design of the plant and an evaluation of the habitability of the main control room after a chlorine accident are presented in Subsection 6.4.3.4.

An evaluation of the buildup of carbon dioxide in the main control room, with the CCACS isolated, is given in Subsection 6.4.1.2.

A fire outside the plant will not affect control room habitability because the control center will be isolated. The operator will receive an indication of an onsite fire through the control center air inlet smoke detector.

The sources of smoke closest to the control center outside air intake are the system service and main unit transformers approximately 80 to 240 ft from the air intake. Smoke from a fire outside the plant should be detected within 1 minute after the smoke begins to enter the control center. The control center can then be manually isolated in less than 10 sec. The operators will have immediate access to self-contained breathing apparatus for respiratory protection as discussed in Section 6.4.

9.4.1.4 Inspection and Testing Requirements

The CCACS equipment was subjected to a dynamic system test to directly verify the acceptability of the supplied equipment in accordance with the design specifications. At the conclusion of the work, all of the heating, cooling, hydronic, and ventilating systems were tested and balanced to meet the design conditions.

Routine procedures require checking for proper mode of operation, proper positioning of dampers, and proper operation of the system equipment. All those dampers which are required to provide tight shutoff were checked in the closed position by the vendor to verify proper operation of the seals, and those dampers are periodically observed in service to confirm proper functioning of the operating air connections. Design provisions are made so that active components of the air conditioning system can be periodically inspected for operability and required functional performance.

Initial system flow distribution, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

The control center emergency filtration system has been subjected to shop test, acceptance test, and inservice inspection in accordance with Regulatory Guide 1.52 as delineated in Appendix A. Laboratory testing was also in accordance with Regulatory Guide l.52. The control center emergency filtration system was given a preoperational test as discussed in Chapter 14.

An inservice surveillance program has been implemented in accordance with the Technical Specifications to ensure that the main control room emergency filtration system can perform its design functions.

9.4.2 Reactor/Auxiliary Building Ventilation System

9.4.2.1 Design Bases

The reactor/auxiliary building ventilation system is designed to provide normal ventilation for the reactor and auxiliary buildings and to maintain the temperature in general access areas between 65°F and 104°F. The temperature in potentially contaminated areas is maintained between 65°F and 125°F. To maintain these temperatures, additional room coolers have been added to selected areas. Equipment in the emergency core cooling system (ECCS) pump rooms was originally designed to operate at temperatures below 148°F during emergency conditions. The actual conditions to which this equipment is environmentally qualified under the Fermi 2 EQ program are documented in EQ0-EF2-018. Also see Section 3.11 for discussion of original Fermi 2 design and environmental qualification activities performed for Fermi 2. During normal operation, when the emergency core cooling equipment is not in service, the temperature in these rooms is maintained below 104°F.

The HVAC System for battery rooms controls the temperature at an approximate value of 75°F. The ventilation system is designed to maintain these temperatures when the outside ambient dry bulb temperature is between -10°F and 95°F.

The ventilation system provides a means of purging the drywell of the nitrogen inerting atmosphere, prior to entry by personnel.

The system is designed to maintain airflow from areas of low potential radioactivity to areas of progressively higher potential radioactivity. In addition, the system will maintain the reactor and auxiliary buildings at a negative pressure with respect to the ambient pressure, assuming a maximum wind velocity of 32 mph.

All components, piping, valves, and dampers are designed to meet the criteria of appropriate system quality group classification as listed in Subsection 3.2.2. The reactor/auxiliary building ventilation system is nonseismic, with the exception of ventilation penetrations of the reactor building secondary containment and the engineered safeguard equipment space coolers, which are Category I. The reactor building secondary containment ventilation penetrations consist of the ventilation ductwork and associated isolation valves and actuators. The isolation valves and space coolers receive control and operating power from buses that are connected to the EDGs. The essential battery room ventilation fans are also Category I. The power supplies to these fans are from motor control centers (MCCs) that were installed non-1E, but are automatically restorable from essential power. The MCCs were purchased to the same specifications (except for documentation requirements) as Class 1E, and their installation is seismically qualified. The MCCs will be maintained as 1E equipment.

9.4.2.2 System Description

The reactor/auxiliary building ventilation system is shown in Figure 9.4-4, Sheets 1 and 2. The nominal size and type of principal system components are listed in Table 9.4-3.

Areas in the reactor and auxiliary buildings that have separate ventilation and air conditioning and/or cooling systems are not covered in this subsection. These areas, given in the following listing, are covered in the indicated subsections:

a. Steam tunnel (Subsection 9.4.6)

b. Control center and standby gas treatment system (SGTS) room (Subsection 9.4.1)

c. Drywell cooling (Subsection 9.4.5).

Normal ventilation of the SGTS equipment rooms is handled by the CCACS and is discussed in Subsection 9.4.1. However, ventilation of these rooms is isolated during a DBA. The emergency fan-coil coolers, which are included as part of the reactor/auxiliary building ventilation system, will then handle the cooling requirements for this room.

Air conditioning of the motor-generator set is discussed in Subsection 9.4.11.

The reactor/auxiliary building ventilation system supplies filtered outside air to accessible areas of the reactor and auxiliary buildings through a central fan system consisting of an outside air intake, filters, heating coils, and three 50 percent-capacity fans. The air intake is located midway down the south side of the auxiliary building. The ventilation air is supplied to accessible areas of the buildings through ductwork and is exhausted from areas of high potential contamination through a common vent located on top of the auxiliary building. Three 50 percent-capacity exhaust fans are provided.

Normally, one exhaust and one supply fan are on standby. Gravity backdraft dampers with counterbalancing weights are provided to prevent backflow of contaminated air and permit control of the required differential pressure (approximately 1/4 in. of H_2O) between general access areas and potentially contaminated areas. Backdraft dampers are fitted on the inlets of exhaust ducts that run between general access areas and potentially contaminated areas.

Each of the two battery rooms that are located in the auxiliary building has two 100 percent-capacity exhaust fans. One air-conditioning unit serves both battery rooms. However, safety- related space coolers provide essential cooling at the battery charger location next to each battery room. The exhaust fans draw air into and through the battery room from general access areas and exhaust the air to other general access areas when the air conditioner is off. The main function of the battery exhaust fans is to prevent the buildup of hydrogen from reaching an explosive concentration in the battery room. The fan units are seismically qualified and powered from an automatically restorable ac bus on loss of offsite power. The air-conditioning unit is not considered part of the ESFs in that it is provided only to prolong the life of the batteries. However, battery charger area coolers are capable of maintaining area temperature under 120°F independent of the air-conditioning unit, with or without a loss of offsite power.

The design of the refueling floor area ventilation is sized for a minimum of 7 air changes per hour based on the volume in the lower 15 ft of the refueling area. The supply air outlets are located 15 ft above the refueling floor level. The airflow is directed across the refueling floor toward the pools. The building ventilation system exhaust takes suction from the following refueling areas:

a. Dryer-separator storage pool - 25 percent, 8250 cfm

b. Fuel storage pool - 50 percent, 16,500 cfm

c. The reactor well - 25 percent, 8250 cfm.

During non-refueling periods, the reactor well will not be ventilated; however, the excess air will be exhausted along the wall above the refueling floor.

The ventilation system also serves to purge the primary containment to permit personnel access. This is accomplished through the cross tie between the primary containment purge piping and the building ventilation system. Sufficient airflow (8500 cfm) is provided to purge the drywell and suppression chamber a minimum of three air changes per hour. The purge air is normally processed through the building exhaust system. However, when the drywell atmosphere is contaminated, initiating a reactor building heating, ventilation, and air conditioning (HVAC) shutdown and isolation, the purge air is processed through the SGTS, which is described in Subsection 6.2.3.

The only areas not ventilated in the reactor and auxiliary buildings are stairwells that are fire rated.

Two reactor building isolation dampers are provided in each supply and exhaust duct that penetrates the reactor building. These dampers are closed when there is high radioactivity in the reactor building, high drywell pressure, low reactor water level, or loss of offsite power. When the reactor building is isolated, the ventilation supply and exhaust fans are tripped off and the reactor building is maintained under negative pressure by the SGTS. The same signal that isolates the reactor building ventilation also signals the isolation valve between the reactor building ventilation duct and the SGTS to open. A reactor building isolation pushbutton is provided in the main control room. The fan-coil cooling units are intended primarily to function while the reactor building is isolated, at which time the ventilation system is shut down. The fan-coil cooling units are either automatically controlled by a thermostat located in the room they serve or they are operated in a manual mode where they operate continuously. Thus, the fan-coil units will also aid to cool their respective areas whenever the ventilation system is unable to maintain the designed room temperatures.

During normal plant operation and outages, it sometimes becomes necessary to take a fan-coil unit out-of-service for preventive or corrective maintenance. When this happens, the plant determines the operability of the safety-related equipment that relies on the fan-coil unit for local cooling and then follows the plant's Technical Specifications.

The following fan-coil cooling units are required to operate following a DBA and, as such, are part of the plant ESFs:

a. One unit of 100 percent capacity furnished for each division of residual heat removal (RHR) pumps

b. One unit of 100 percent capacity furnished for each division of core spray pumps. The Division I unit also cools the reactor core isolation cooling (RCIC) pump

c. One unit of 100 percent capacity furnished for the high pressure coolant injection (HPCI) pump room

d. One unit of 100 percent capacity furnished for each division of SGTS filter unit room

e. One unit of 100 percent capacity furnished for each division of EECW pumps

f. Deleted

g. Two units, each of 50 percent capacity, furnished for each division of the switchgear room

h. This item is not used

i. One unit of 100 percent capacity furnished for each division of the control air compressors

j. One unit of 100 percent capacity furnished for each division of the battery charging area.

The fan-coil cooling units recirculate room air to remove heat generated by process equipment. Cooling water is normally supplied to the fan-coil units by the RBCCWS. During malfunction of the RBCCWS or on loss of offsite power, cooling water is supplied by the EECWS. All of the above fan-coil cooling units are physically separated by virtue of their location.

Radiation monitors are provided in the building exhaust to monitor the release of airborne activity. Upon detection of high radioactivity in the exhaust vent, an alarm is sounded in the main control room. Simultaneously, the building ventilation system fans are automatically tripped off and the isolation dampers are closed automatically. A description of the monitoring system is presented in Subsection 12.2.4.

9.4.2.3 Safety Evaluation

The reactor/auxiliary building ventilation system is required to operate only during normal plant operations except the fan-coil cooling units, the battery room exhaust fans, and the reactor building supply and exhaust isolation dampers, which are required to operate after a DBA. To ensure the reliable and safe operation of the ventilation system over the full range of normal plant operations, the portion of the system that is not required to operate after a DBA incorporates the following design features:

a. The ventilation system maintains the building at a negative pressure with respect to the ambient pressure to preclude exfiltration of potentially contaminated air. (The reactor building is maintained at a negative pressure by the SGTS following the isolation of the reactor building)

b. Backdraft dampers are used in the ventilation system to prevent backflow between general access areas and contaminated areas

c. Standby exhaust and supply fans are provided to increase the availability of the ventilation system

d. The ventilation system in the area of the refueling pool is designed to exhaust more air than is supplied. In addition, the supply air is directed across the refueling pool. This method of ventilating the refueling pool area limits the spread of radioactivity from the refueling pool to other parts of the reactor building

e. Potentially contaminated effluent rising from the surface of the refueling pool and the dryer-separator pool is entrained in the normal ventilation air and is drawn into the exhaust openings located above the pool water level. A radiation monitor is provided on the exhaust ducts from the pool areas. The monitors will alarm in the main control room if a high radiation level is detected and will automatically start the SGTS, isolate the reactor building normal air intake and exhaust, and place the CCACS into recirculation mode.

The fan-coil cooling units, the battery room exhaust fans, and the reactor building supply and exhaust isolation dampers, all of which are required to operate after a DBA, incorporate the following design features to ensure their reliable and safe operation following a DBA:

a. Battery room exhaust fans and fan-coil units receive power from the same division as the equipment they protect. The diesel generators are the source of electrical power in the event of a loss of normal offsite power

b. The loss of any of the fan-coil units has the same effect on the safety of the plant as the loss of the equipment being cooled. Therefore, a single failure of the ventilation system affecting the safety-related equipment rooms will not prevent safe shutdown of the plant. Each ECCS subsystem (Division 1 RHR pump room, Division 2 pump room, Division 1 core spray and RCIC pump room, Division 2 core spray pump room, and HPCI pump room) has its own integral area cooling subsystem and fan-coil unit which is supplied from the same essential bus as the ECCS subsystem being cooled and which is an ESF. The loss of a particular ECCS subsystem, its room, or its equipment area cooling subsystem would result in automatic initiation of the redundant ECCS subsystem

c. Each battery room has two 100 percent-capacity exhaust fans. The loss of one of these fans has no effect on plant availability.

9.4.2.4 Inspection and Testing

All equipment is factory inspected and tested in accordance with applicable equipment specifications, quality assurance requirements, and codes. The system ductwork and erection of equipment were inspected during various construction stages, and construction tests were performed on all components of the system. The system was balanced for the design airflow and system operating pressures in accordance with Sheet Metal and Air Conditioning Contractors National Association procedures. Controls, interlocks, and safety devices on each system were adjusted and tested to ensure proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14. Periodic tests of all system functions will be performed in accordance with normal operating procedures.

9.4.2.5 Instrumentation and Controls

Each exhaust and supply fan is manually controlled from the main control room. In order to ensure that a negative pressure is maintained in the reactor building while starting a fan combination, a time delay is provided so that the exhaust fan will start first. In addition, the motor starters are interlocked after starting to ensure that the associated fan shuts down when either an exhaust or supply fan is tripped.

The outside barometric pressure is detected on each of the four sides of the building and compared with the pressure being detected on the inside of the building. The difference between the lowest outside pressure and the inside pressure then is used as the control signal for modulating the inlet vanes of the ventilation system exhaust fan in order to maintain the building pressure lower than the outside pressure. Should the pressure in the building become excessively high or low (2.50 in. H_2O above or below the setpoint), the fans are automatically tripped.

The fan-coil cooling units located in a harsh environment are operated in a manual mode where they run continuously. The remainder of the fan-coil cooling units are operated in an automatic mode where the units start when the thermostat in the room being cooled reaches its setpoint.

Tripping of the supply and/or exhaust fans and dampers is indicated by audible and visible alarms in the main control room and audible and visible alarms on the refueling floor.

9.4.3 Radwaste Building Ventilation System

9.4.3.1 Design Bases

The radwaste building ventilation system is designed to maintain a suitable environment that conforms to the equipment and personnel ambient requirements in that area. The specific temperature design criteria used in sizing the system components are as follows:

a. Outside air design temperatures

   1. Dry bulb temperature, -10°F to 95°F

   2. Wet bulb temperature, 75°F maximum.

b. Inside air design temperatures

   1. Radwaste office, control room, and Health Physics laboratory, 75°F ±5°F

   2. Other general access areas, below 105°F

   3. All other areas, below 125°F.

In order to maintain the general access areas as free from potential radioactivity as possible, the system is designed to direct airflow from general access areas to areas of higher potential radioactivity. Exfiltration of potentially contaminated air to the environment is prevented by maintaining the building at a lower pressure than the ambient pressure.

Filters are provided in both the intake and exhaust systems. The intake filters reduce the amount of dust particles that are induced into the radwaste building. The exhaust filters are provided to remove particulate activity from the ventilation exhausts of the radwaste building.

Local hoods are provided to exhaust fumes from selected equipment handling radioactive wastes. Each fume hood exhaust system is designed to maintain a minimum face velocity of 100 fpm across the door opening of the hood.

This system is required to function under normal operating conditions only and therefore is not specifically designed to operate after a DBA. This system is nonseismic.

9.4.3.2 System Description

The radwaste building ventilation system diagram is presented in Figures 9.4-5 and 9.4-6. The nominal size and type of principal system components are presented in Table 9.4-4.

The radwaste building ventilation system consists of two 100 percent supply fans, two l00 percent exhaust fans, one fume hood exhaust fan, and a radwaste control room and laboratory air conditioning system. System fans, including booster fans, take suction through modulating dampers, a prefilter, and either a HEPA or a high-efficiency filter. The intake, exhaust, and fume hood fans all discharge through shutoff dampers. The supply fans take suction through louvers that are located above the radwaste building and supply a total of approximately 22,567 cfm to principal areas of various floor levels of the building. These fans also supply approximately 1650 cfm to the pipe tunnel between the radwaste and turbine buildings. Normally, air is supplied to general access areas and is exhausted from potentially contaminated areas. Wherever an exhaust duct is located between a general access area and an area of higher potential radioactivity, the inlet to the duct is fitted with a backdraft damper. This prevents exfiltration of air from a higher to a lower potential radioactive area. The Drum Conveyor Rooms and a portion of the Drum Conveyor Operating Aisle (DCOA) Room (east of column line S) were converted to a storage area. A 9'x8' opening was installed in the Radwaste Building south wall (just east of column line T), and three openings in the wall between the Drum Conveyor Rooms and the DCOA Room. To isolate this storage area from the Radwaste Building to allow maintaining the design negative pressure in the remainder of the building, fire walls were installed and all perimeter walls, ceiling, and floor penetrations, including drains, were made air tight. In addition, the registers on the supply duct along column line 14 in the DCOA Room were closed, the make up vents on the west wall of Drum Conveyor Room III were sealed, and the return duct routed along column line V was removed and the ceiling penetration sealed. A new return air register was installed in the return air duct in the East Corridor area in order to compensate for the air supply isolated from the Drum Conveyor Room.

Each of the radwaste building exhaust fans discharges approximately 31,818 cfm from the radwaste building. The exhaust fans take suction from all principal areas on the various floor levels of the building and from the vents of the following tanks and equipment:

a. Waste collector tank

b. Waste surge tank

c. Waste sample tanks

d. Floor drain sample tank

e. Floor drain collector tank

f. Waste sludge tank

g. Spent resin tank

h. Centrifuges

i. Condensate phase separators

j. Chemical waste tank

k. Radwaste evaporators.

l. Side Stream Liquid Radwaste Processing System (SSLRPS) Distillation Inlet Batch Tank

m. SSLRPS Post Treatment System Inlet Batch Tank

n. SSLRPS High and Low Rad Side Stream Evaporator Condenser Air Exhausts

o. SSLRPS Sample Batch Tank

p. SSLRPS Granular Activated Carbon Filter Tanks

q. SSLRPS Mixed Bed Filter Tanks

In addition, the hood exhaust fan in the Health Physics area exhausts approximately 6600 cfm from the radwaste laboratory fume hoods. The radwaste exhaust fans and the fume hood exhaust fan discharge air through a common exhaust vent located on top of the radwaste building. A radiation monitor is connected to the common exhaust header.

The radwaste office, radwaste control room, and Health Physics laboratory air conditioning subsystem consists of a double-duct air-handling unit, fan, steam heating coil, evaporator-type cooling coil, and remote water-cooled chiller unit which is cooled by the turbine building closed cooling water system (TBCCWS). Steam to the heating coils is supplied by the auxiliary boilers. The system supply ductwork consists of three decks: hot, cold, and auxiliary. The hot and cold ducts go to mixing boxes that mix the air to the temperature required by each room. The auxiliary air is ducted to the low-level laboratory fume hood through a pressure reducing valve. Return air is ducted to the air-conditioning unit, where it is mixed with fresh air to make up for the air exhausted by the fume hood exhaust fan. The air-conditioning unit consists of a filter, preheat coil, fan, cooling coil, and heating coils with face and bypass dampers.

In addition to the normal ventilation systems, a Dedicated Shutdown Air Conditioning Unit is installed on the second floor of the Radwaste building to support post-fire dedicated shutdown as described in section 7.5.2.5 and Appendix 9A. It is a split system with the air-handling unit (AHU) located inside the room and outside condensing unit located on the adjacent roof. The AHU consists of an inlet filter, fan, evaporator-type cooling coil, condensate collection tank and condensate pump. The discharge ductwork and dampers cool the area in the vicinity of the dedicated shutdown panel. The condensing unit is a split system cooling condenser consisting of two refrigerant circuits that reject heat to the ambient outdoor air. Each circuit consists of a compressor/motor, coil and fan/motor.

Radiation monitors are provided in the building exhaust vent to monitor the release of airborne radioactivity. Upon detection of high radioactivity in the exhaust vent, an alarm is sounded in the main control room. Simultaneously, the building ventilation system fans are tripped off and the isolation dampers are closed automatically. A description of the monitoring systems is presented in Subsection 12.2.4.

9.4.3.3 Safety Evaluation

The radwaste building ventilation system is required to operate only during normal plant operation. However, the system does incorporate features to ensure its reliable and safe operation over the full range of normal plant operation. These features include the installation of standby exhaust and intake fans, and the use of backdraft dampers between general access areas and areas of potentially high radioactivity to prevent general access areas from becoming contaminated. In addition, the system is designed to prevent exfiltration of potentially contaminated air to the environment by maintaining the internal pressure of the radwaste building negative with respect to the ambient pressure.

The Dedicated Shutdown Air Conditioning Unit supports a post-fire shutdown from outside the Main Control Room as described in Section 7.5.2.5.

9.4.3.4 Inspection and Testing

All equipment has been factory inspected and tested in accordance with applicable equipment specifications, quality assurance requirements, and codes. The system ductwork and erection of equipment were inspected during various construction stages. Construction tests were performed on all components of the system. The system has been balanced for the design airflow and system operating pressures. Controls, interlocks, and safety devices on each system were adjusted and tested to ensure proper sequence of operation. Initial system flow distribution, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

The Dedicated Shutdown Air conditioning Unit is also balanced for its operating conditions. This system and its components will be tested and maintained periodically, as appropriate for the system safety classification.

9.4.3.5 Instrumentation and Controls

Each exhaust and supply fan is manually controlled from the main control room. In order to ensure that a negative pressure is maintained in the radwaste building while starting a fan combination, a time delay is provided to make the exhaust fan start first. In addition, the motor starters are interlocked after starting to make the associated fan shut down when either an exhaust or supply fan is tripped.

The outside barometric pressure is detected on each of three sides of the building and compared with the pressure being detected on the inside of the building. The difference between the lowest outside pressure and the inside pressure then is used as the control signal for modulating the inlet vanes of the ventilation system exhaust fan in order to maintain the building pressure lower than the outside pressure. Should the pressure in the building exceed the alarm setpoints, the fans will be manually tripped.

The balance-of-plant battery room cooling equipment is controlled by a thermostat.

The exhaust air radiation monitoring system will alarm in the main control room in the event of high radioactivity in the exhaust header. A radwaste building isolation pushbutton is provided in the main control room to isolate the exhaust and shut down the supply and exhaust fans.

The instrumentation and controls for the Dedicated Shutdown Air Conditioning System are discussed in Section 7.5.2.5.

9.4.4 Turbine Building Ventilation System

9.4.4.1 Design Bases

The turbine building ventilation system is designed to provide a suitable environment for personnel and to ensure the integrity of equipment and controls located in the turbine building.

The turbine building ventilation system, which has been modified to repitch the fans on the supply and return air, is designed to maintain the temperature in general access areas below 115°F and to ensure that the temperature in all other areas within the turbine building is below 125°F, with the following exceptions:

a. The lube oil room, feedwater heater room, turbine building overhead crane bay, off gas preheater, off gas filter, turbine deck, and the second floor steam tunnel exceed the 115°F and 125°F design temperatures. The maximum nominal temperature for the steam tunnel is 180°F (measured at the ceiling). The maximum nominal temperature for the other specified rooms is less than 150.5°F.

b. The offgas system charcoal adsorber room, which has its own air conditioning system to ensure that the temperature within the room is 70°F (Nominal), and the excitation equipment area, which has its own air cooling system to ensure that the nominal temperature within the area does not exceed approximately 104°F.

The turbine building ventilation system is designed based on the following outside air temperatures:

a. Dry bulb temperature, -10°F to 95°F

b. Wet bulb temperature, 75°F maximum.

To maintain areas within the turbine building as free from potential radioactive contamination as possible, the system is designed to direct the airflow from areas of low potential radioactivity to areas of progressively higher potential radioactivity. The exhaust from the turbine building is monitored to detect and annunciate high radiation levels.

Exfiltration of potentially contaminated air to the environment is prevented by maintaining the building at a negative pressure with respect to the plant environment.

This system is required to function under normal plant operating conditions only and therefore is not specifically designed to operate after a DBA. The system components are designed to nonseismic requirements, with the exception of a few PAS system components located in the Auxiliary Building which are designed to seismic class II/I requirements.

9.4.4.2 System Description

The turbine building ventilation system is shown schematically in Figure 9.4-7. The nominal size and type of principal system components are presented in Table 9.4-5.

The turbine building is heated, cooled, and ventilated during normal and shutdown operation by a circulating air system. The building is heated by the ventilation air intake heating coils, and unit space heaters which are serviced by the auxiliary boiler of the plant. Cooling of the building is accomplished by circulating outside air throughout the ventilation system. All outside air enters the building through an intake located on top of the building and then passes through an evaporative air cooler cooling unit, the fresh air intake dampers, a filter bank, heating coils, a shutoff damper, and two of the three 50 percent-capacity intake fans. The air from these fans is generally distributed to areas of low potential radioactivity through distribution ducts. If the air is discharged into an area of high potential radioactivity, it is exhausted from that area by exhaust ducts and is discharged through the building exhaust enclosure. The air that is discharged into areas of low potential radioactivity is circulated through areas of higher potential radioactivity by the use of propeller fans. The air is then induced into the exhaust ductwork and discharged through the exhaust enclosure by two of the three 50 percent-capacity fans.

A radiation monitor is provided in the building exhaust vent to monitor the release of airborne radioactivity. Upon detection of high radioactivity in the exhaust vent, an alarm is sounded in the main control room. Simultaneously, the building ventilation system fans are automatically tripped off. A description of the monitoring systems is presented in Subsection 12.2.4.

The ventilation system also provides ventilation to the switchgear and exhaust fan rooms of the radwaste building and to the RBCCWS equipment area in the auxiliary building.

The offgas system charcoal adsorber room is provided with one air change per hour. Three cooling coil units are provided in the adsorber room, complete with fan, direct expansion cooling coil, and expansion valve. The compressor/condenser units are located outside the adsorber room. Cooling water is supplied to the condenser by the TBCCWS. The three cooling units are sized to maintain the adsorber room at 70°F during normal operation.

Gravity-type backdraft dampers having adjustable counterbalancing weights are provided on the discharge of propeller fans functioning to exhaust air from general access areas to potentially contaminated areas. This prevents backflow of contaminated air.

The excitation equipment area is provided with a separate air cooling system located on the second floor of the turbine building. Two 100% capacity, water cooled air coolers are provided to maintain the excitation equipment area at a nominal ambient temperature of 104°F during normal operation. Cooling water is supplied by the TBCCW System.

9.4.4.3 Safety Evaluation

The turbine building ventilation system is required to operate only during normal plant operation. However, the system incorporates features to ensure its reliable and safe operation over the full range of normal plant operation. These features include the installation of standby exhaust and intake fans, and the use of backdraft dampers between general access areas and areas of potentially high radioactivity to prevent general access areas from becoming contaminated. With respect to the higher temperature areas in the turbine building (i.e. areas above 115°F/125°F), an evaluation of the impact to equipment and personnel was performed. Results of the review show that the components are fully capable of functioning at the higher temperatures. Plant personnel are not required to access any of the high temperature areas during plant operation or following an accident condition in order to safely shut down and/or maintain the plant in a safe shutdown condition.

The system is designed to prevent exfiltration of potentially contaminated air to the environment by maintaining the internal pressure of the turbine building negative with respect to the ambient pressure.

A radiation monitor in the exhaust vent automatically trips the turbine building ventilating system in the event of a high radiation level.

9.4.4.4 Inspection and Testing

All equipment has been factory inspected and tested in accordance with applicable equipment specifications, quality assurance requirements, and codes. The system ductwork and erection of equipment were inspected during various construction stages. Construction tests were performed on all components of the system. The system has been balanced for the design airflow and system operating pressures. Controls, interlocks, and safety devices on each system were adjusted and tested to ensure proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

9.4.4.5 Instrumentation and Controls

Each exhaust and supply fan is manually controlled from the main control room and, to ensure that a negative pressure is maintained in the turbine building while starting a fan combination, a time delay is provided to ensure that the exhaust fan starts first. In addition, the motor starters are interlocked after starting to ensure that the associated fan shuts down when either an exhaust or supply fan is tripped.

The outside barometric pressure is detected on each of the four sides of the building and compared with the pressure being detected on the inside of the building. Should the pressure in the building become excessively high or low, both the supply and exhaust fans are automatically tripped.

The adsorber room cooling equipment is controlled by a thermostat.

9.4.5 Drywell Cooling System

9.4.5.1 Design Bases

The cooling system is designed to maintain the average ambient temperature at 135°F. The drywell volumetric average temperature may increase over 135°F and up to 145°F. The area around the primary coolant recirculating pump motors is limited to 128°F during normal operation. During a scram, the system is designed to limit the temperature in the area below the reactor pressure vessel (RPV) to 185°F. The system is not required to operate following a LOCA and is isolated.

The design of the system permits periodic inspection and testing of the principal system components where they are accessible.

The power supply to the drywell cooling unit fans is designed to allow operation from the EDG-fed buses if normal ac power is not available.

The system components, excluding single-speed fan and fan motors but including fan-coil units and ducts, are Category I.

The cooling water supply piping to the fan-coil units in the drywell is provided with a check valve inside containment and one remote, manually actuated isolation valve outside containment. The supply line outboard isolation valves will automatically close on high drywell pressure initiation of EECWS. The cooling water return piping has two remote, manually actuated isolation valves, one on each side of the drywell wall for containment isolation.

Pressure relief valves are provided to relieve hydrostatic pressure caused by water expansion in the cooling water header subsequent to system isolation during and after a LOCA. The system will be operated during nitrogen purging of the containment in order to provide proper mixing of the containment atmosphere.

9.4.5.2 System Description

The system design for drywell cooling is presented in Figure 9.4-8. The nominal size and type of principal system components are listed in Table 9.4-6.

The system design is based on recirculating drywell air and cooling water through fan-coil units to limit the maximum drywell temperature. Cooling water is supplied by the RBCCWS under normal conditions and EECWS during abnormal operating conditions. However, high drywell pressure in conjunction with EECW operation will automatically close the EECW supply line outboard isolation valves.

The cooling system consists of 14 fan-coil coolers. Each unit is furnished with cooling coils, supply air fan, distribution ductwork, air-diffusing devices, and controls. Drywell temperature is maintained by mixing the cool air with the heated air at the heat source.

The fourteen drywell coolers are physically separated into two divisions, each consisting of five single-speed and two two-speed coolers. During normal plant operation, six of seven drywell cooler fans in each division are continuously operating in order to maintain the drywell atmosphere temperatures below the prescribed limits. All of the two-speed fans operate at high speed during normal operation.

All of the fan motors are provided with temperature detectors for the motor windings, a bearing vibration detector, and an integral space heater to maintain motor temperature above ambient during motor shutdown.

All ductwork is fabricated from carbon steel. Each section is galvanized after fabrication.

Electrical power for operation of the Category I cooling units is supplied from ESF buses, maintaining the divisional concept of separation and redundancy. Electrical power for operation of the single-speed fans is supplied from EDG restorable BOP buses. One-half of the fans are supplied from the Division I bus, the other half from the Division II bus. These buses are supplied from the EDG system if offsite electrical power is lost.

Cooling water is supplied to the coolers from two redundant EECWS piping loops during abnormal operation of the system. The loops are designated as Division I loop and Division II loop. Each loop is designed to supply cooling water to one-half of the coolers. Both loops are supplied by cooling water from a single header of the RBCCWS during normal operation.

9.4.5.3 Safety Evaluation

The drywell cooling system is not required for the safe shutdown of the plant. The system incorporates features that ensure its reliable operation over the full range of normal plant operations. These features include the separation of the system into two cooling divisions.

In the event of a postulated design basis accident (LOCA), all of the single-speed drywell cooler fans in AUTO are automatically tripped, and the four two-speed drywell cooler fans then automatically shift to slow speed. Plant procedures provide the necessary guidance for returning any of the drywell coolers to service.

This is done to preclude the possibility of two phase flow phenomenon accompanied by potential water hammer damage due to the initial formation of steam bubbles and their subsequent collapse by the introduction of colder supply water to the drywell cooling system.

Instrumentation is provided to monitor the temperature in various zones in the drywell and to annunciate high temperatures in the main control room.

The equipment and ducts inside the drywell are designed to Category I requirements. Relief valves on the EECWS preclude the possibility of coil rupture inside the drywell as a result of a rise in cooling water temperature and pressure after closure of the isolation valves.

All equipment meets the criteria of the appropriate system quality group classification and codes listed in Subsection 3.2.2.

Upon the loss of offsite power, all fans will trip off. All previously operating units will be restarted automatically using power supplied to the essential and BOP buses from the diesel generators, unless a LOCA signal is also present concurrent with the loss of offsite power.

9.4.5.4 Inspection and Testing

The system will not be accessible during reactor operation. Routine testing and inspection of the system will be accomplished during scheduled reactor shutdowns. However, monitoring devices are provided to determine that the fan-coil units are functioning properly during normal operation.

All equipment has been factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. System ductwork and the erection of equipment has been inspected for quality assurance during various construction stages. Construction tests were performed on all mechanical components. The system was balanced for the design airflow and system operating pressures. Controls, interlocks, and safety devices on each system were cold checked, adjusted, and tested to ensure proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

9.4.5.5 Instrumentation and Controls

The drywell cooling system is a "full-on" system in that no modulating controls are installed to automatically reduce or maintain set temperatures. The cooling water flow through the cooling coils and the airflow are constant. Manual balance valves are provided at each air discharge diffuser to adjust the airflow. Cooling capacity can be reduced by shutting down individual unit coolers.

Controls required for remote operation of the system are located in the main control room.

Restart of the cooling units after a loss of offsite power is accomplished automatically on a permissive signal. Restart of the cooling units is initiated within 90 sec after a loss of offsite power, and all cooling units will be in operation within 120 sec after a loss of offsite power.

Thermocouples are provided in various areas in the drywell to monitor the temperature, with alarms and temperature indication provided in the main control room.

9.4.6 Steam Tunnel Cooling System

9.4.6.1 Design Bases

The system is designed to maintain the temperature in the steam pipe tunnel below 130°F and is nonseismic.

9.4.6.2 System Description

A diagram of the steam tunnel cooling system is shown in Figure 9.4-9. Nominal sizes and types of principal system components are listed in Table 9.4-7.

The system consists of two 100 percent-capacity cooling coils and fans that are connected to a common supply plenum. The supply ducts from the plenum deliver the cooled air to various areas within the tunnel. The air is returned to the cooling coils by the induced draft of the fan. Cooling water is supplied to the cooling coils by the RBCCWS.

Balancing dampers are provided in each supply duct downstream of the common supply plenum, and shutoff dampers are provided for each fan.

A pressure equalizing line between the steam tunnel and the reactor building functions primarily to maintain secondary containment negative atmospheric pressure within the steam tunnel in the event of a DBA.

9.4.6.3 Safety Evaluation

The steam tunnel cooling system is required to operate only during normal plant operation. To ensure high reliability of the system and safe operation over the full range of normal plant operation, two 100 percent fan-coil units are provided.

9.4.6.4 Inspection and Testing

All equipment has been factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. Controls and safety devices on each system have been cold checked, adjusted, and tested to ensure the proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Acceptance Test program as discussed in Chapter 14.

Routine maintenance and tests, based on the manufacturer's recommendations and/or operating/maintenance experience, are scheduled in accordance with the plant preventive maintenance program.

9.4.6.5 Instrumentation and Controls

The steam tunnel cooling system is manually controlled from the main control room.

A temperature-sensing element is located inside the steam tunnel and displays the temperature in the main control room. This same element sounds an alarm in the main control room when the steam tunnel air temperature exceeds 160°F.

9.4.7 Residual Heat Removal Complex Ventilation Systems

The RHR complex is composed of two identical divisions. The safety-related equipment in one division is 100 percent redundant to that in the other division. Each RHR division is composed of two diesel generator rooms, two diesel oil storage rooms, two switchgear rooms, and a pump room. The diesel-fuel-oil storage room ventilation system is used to purge the diesel generator room, diesel generator oil storage room, and air receiver room. This system operates continuously for all modes of plant operation. Each division of the RHR complex includes ventilation systems, as described in the following subsection. Failure analysis of the ventilation system for the RHR complex is provided in Table 9.4-8.

A typical ventilation system flow diagram for the RHR complex is presented in Figure 9.4-10. Nominal sizes and types of principal system components are listed in Tables 9.4-9 through 9.4-12.

9.4.7.1 Residual Heat Removal Diesel Generator Room Ventilation System

9.4.7.1.1 Design Bases

The diesel generator room ventilation systems are not required to operate during plant operation unless the ventilation equipment itself is in the manual mode, the diesel generators are running, or the room temperature rises above the room temperature controller setpoint.

The diesel generator room ventilation systems limit the temperature of each diesel room to a maximum of 122°F in conformance with the equipment requirements. The systems are available under all plant operating conditions.

Outside air with a maximum design temperature of 95°F is used to dissipate heat produced by the operation of the equipment in the diesel room.

The systems are designed to Category I requirements.

The fans are powered from ESF buses corresponding to the diesel generators they are serving.

The air intake and exhaust openings are located a sufficient distance apart to preclude reintroduction of exhaust air into the room. The outside air intakes and exhaust openings are protected by missile walls or slabs.

9.4.7.1.2 System Description

Each diesel room is provided with two 50 percent-capacity supply air fans. The operation of the fans induces outside air through a control damper and mixes the recirculation air from the diesel room in order to maintain the minimum air temperature above 65°F during diesel generator operation. The recirculation air path is provided with a control damper.

The mixed air is discharged into the diesel room by the supply fans. A part of the exhaust air is recirculated, depending upon the temperature of the return air. The balance of the exhaust air is forced through gravity dampers provided at the exhaust outlet.

Each division of the RHR complex is redundant to the other, thereby satisfying the need to make the respective equipment redundant.

9.4.7.1.3 Safety Evaluation

The loss of any ventilating fan or damper does not affect the safe-shutdown capability of the plant, since separate ventilation systems are provided for each redundant diesel generator.

To ensure maximum automatic fire-fighting capability, and to minimize potential cold-weather damage to equipment, the outside air damper fails closed upon loss of control power.

9.4.7.1.4 Inspection and Testing

All equipment has been factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. System ductwork and erection of equipment has been inspected for quality assurance requirements during various construction stages. Construction tests were performed on all mechanical components and the system was balanced for design airflow rates and system operating pressures. Controls, interlocks, and safety devices on each system were cold checked, adjusted, and tested to ensure proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

Routine maintenance and tests, based on the manufacturer's recommendations and/or operating/maintenance experience, are scheduled in accordance with the plant preventive maintenance program.

9.4.7.1.5 Instrumentation

Each diesel generator room ventilation fan is interlocked to start with the operation of the respective diesel generator set. The ventilation fan will start automatically on high room temperature and can also be manually started by the switches provided in the main control room.

Temperature controllers sense temperature in each diesel generator room to modulate the intake and recirculation air dampers to maintain the room temperature within the design limits.

Indication of room temperature is provided locally. Damper position is indicated locally and in the main control room. An alarm is provided in the main control room for high and low room temperature. Supply fan "no airflow" indication is provided locally and is indicated and alarmed in the main control room.

9.4.7.2 Residual Heat Removal Switchgear Room Ventilation System

9.4.7.2.1 Design Bases

The switchgear room ventilation system is not required to operate during plant operation unless the ventilating equipment is in the manual mode, corresponding essential equipment is running, or the room temperature rises above the room temperature setpoint.

The system dissipates the heat produced by the switchgear room equipment, and limits the inside ambient temperature to 104°F under all plant operating conditions.

The outside air, with a design ambient temperature of 95°F, is used for cooling if necessary.

The system is designed to Category I requirements. Electrical power is furnished from the same ESF buses that supply power to equipment in the room being cooled.

The air intake and exhaust openings are located a sufficient distance apart to preclude reintroduction of exhaust air into the system. The outside air intakes and exhaust openings are protected by missile barriers.

9.4.7.2.2 System Description

Each switchgear room system consists of an intake air duct, high efficiency filter, and two 50 percent-capacity fans in parallel, arranged in the order given. The fan outlets are connected to a common supply air duct that distributes air to the switchgear room.

An outside air control damper is provided on the outside air duct, and a recirculation damper is provided on the mixing box upstream of the supply air filter. The operation of fans induces outside air and recirculated air into the mixing box to maintain the minimum air temperature above 65°F.

The mixed air is discharged in the switchgear room through the supply air duct system. A part of the exhaust air is recirculated, depending upon room temperature, and the balance of the air is forced through gravity dampers provided at the exhaust outlet.

9.4.7.2.3 Safety Evaluation

The loss of any ventilating fan does not affect the safe-shutdown capability of the plant, since a separate ventilation system is provided for each switchgear room.

To ensure maximum automatic fire-fighting capability, and to minimize potential cold-weather damage to equipment, the outside air damper fails closed upon loss of control power.

9.4.7.2.4 Inspection and Testing

All equipment was factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. System ductwork and the erection of equipment were inspected during various construction stages. Construction tests were performed on all mechanical components, and the system was balanced for the design airflow rates and system operating pressures. Controls, interlocks, and safety devices on each system were cold checked, adjusted, and tested to ensure the proper sequence of operation. Initial system flow distribution, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

Routine maintenance and tests, based on the manufacturer's recommendations and/or operating/maintenance experience, are scheduled in accordance with the plant preventive maintenance program.

9.4.7.2.5 Instrumentation and Controls

Each switchgear room ventilation system is started automatically on high room temperature or when its corresponding diesel generator sets are started. In addition, manual switches are provided in the main control room. A temperature controller located in the switchgear room modulates the intake and recirculation air dampers to maintain the room temperature within the design limits.

Room temperature and filter high differential pressure are indicated locally. An alarm is provided in the main control room for high and low room temperature. Supply fan "no airflow" indication is provided locally and is indicated and alarmed in the main control room.

9.4.7.3 Pump Room Ventilation System

9.4.7.3.1 Design Bases

The pump room ventilation system is not required to operate during normal plant operation unless the ventilating equipment itself is in the test mode, the corresponding essential pump is running, or the room temperature rises above the room temperature controller setpoint.

The system provides ventilation and limits the temperature of the pump room to 104°F.

The system dissipates the heat produced by the pumps and associated equipment, limiting the inside ambient temperature to 104°F under all plant operating conditions. The outside air, with a design ambient temperature of 95°F, is used for cooling.

The system is designed for Category I requirements. Electrical power is furnished from the same ESF buses that supply power to the equipment in the room being cooled.

The air intake and exhaust openings are located a sufficient distance apart to preclude reintroduction of exhaust air to the system. The outside air intakes and exhaust openings are protected by missile barriers.

9.4.7.3.2 System Description

The pump room ventilation system consists of an intake air duct, high efficiency filter, and two 50 percent-capacity fans in parallel, arranged in the order given. The fan outlets are connected to a common supply air duct that distributes air in the pump room.

An outside air control damper is provided on the outside air duct and a recirculation damper is provided on the mixing box upstream of the supply air filter. The operation of fans induces outside air and recirculated air into the mixing box to maintain a mixed air temperature above 65°F.

The mixed air is discharged to the pump room through the supply air duct system. A part of the exhaust air is recirculated, depending upon the room temperature, and the balance of the air is forced through the gravity dampers provided at the exhaust outlet. The intake and exhaust air openings are protected from missiles.

9.4.7.3.3 Safety Evaluation

The loss of the ventilating system does not affect the safe shutdown capability of the plant, since separate ventilation systems are provided for each redundant pump room.

To ensure maximum automatic fire-fighting capability and to minimize potential cold-weather damage to equipment, the outside air damper fails closed upon loss of control power.

9.4.7.3.4 Inspection and Testing

All equipment was factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. System ductwork and the erection of the equipment were inspected for quality assurance requirements during various construction stages. Construction tests were performed on all mechanical components, and the system was balanced for the design airflow rates and system operating pressures. Controls, interlocks, and safety devices on each system were cold checked, adjusted, and tested to ensure the proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

Routine maintenance and tests, based on the manufacturer's recommendations and/or operating/maintenance experience, are scheduled in accordance with the plant preventive maintenance program.

9.4.7.3.5 Instrumentation and Controls

The pump room ventilation system is started automatically on high temperature or when the corresponding EDGs are running. Manual switches are provided in the main control room.

Room temperature and filter high differential pressure are indicated locally. An alarm is provided in the main control room for abnormal high or low room temperature. Supply fan "no airflow" indication is provided locally and is indicated and alarmed in the main control room.

9.4.7.4 Diesel-Fuel-Oil Storage Room Ventilation System

9.4.7.4.1 Design Bases

The diesel-fuel-oil storage room ventilation system is used to pull an adequate quantity of ventilation air through the diesel generator room, CO_2 storage room, fuel-oil storage room, and ventilation equipment room to maintain the temperature in these rooms below 104°F while the diesel is not operating and below 125°F when the diesel is operating. This system is designed to operate continuously for all modes of plant operation.

The outside air, with a design ambient temperature of 95°F, is used for cooling.

The system is designed to Category I requirements. The system is powered from ESF buses corresponding to the respective diesel generator.

9.4.7.4.2 System Description

The system exhausts air through exhaust ducts from the diesel generator room, CO_2 storage room, fuel-oil storage room, and ventilation equipment room. Air is induced through exhaust ducts by an exhaust fan. The exhaust air is discharged to the atmosphere through a missile-protected exhaust opening.

Nominal sizes and types of principal system components are listed in Table 9.4-12. Fire dampers are provided between rooms.

9.4.7.4.3 Safety Evaluation

The loss of any ventilating fan does not affect the safe-shutdown capability of the plant, since a ventilation system for each set of redundant rooms is provided.

9.4.7.4.4 Inspection and Testing

All equipment was factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. System ductwork and the erection of equipment were inspected for conformance with drawing and specification requirements during various construction stages. Construction tests were performed on all mechanical components, and the system was balanced for the design air and system operating pressures. Controls, interlocks, and safety devices on each system were cold checked, adjusted, and tested to ensure the proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Test program as discussed in Chapter 14.

Routine maintenance and tests, based on the manufacturer's recommendations and/or operating/maintenance experience, are scheduled in accordance with the plant preventive maintenance program.

9.4.7.4.5 Instrumentation and Controls

Manual switches are provided in the main control room. An indication of the temperature in each room except for the CO_2 storage room, fuel-oil storage room, and diesel generator ventilation equipment room is provided, along with an alarm in the main control room for high room temperature.

9.4.7.5 RHR Complex Heating System

9.4.7.5.1 Design Basis

Electric unit heaters are provided for the following areas:

a. RHR pump room

b. Diesel generator room

c. CO_2 storage room

d. Switchgear room

e. Switchgear ventilation equipment room

f. Diesel generator ventilation equipment room.

The electric unit heaters will maintain the RHR complex equipment rooms at an ambient temperature of 65°F during normal operation and shutdown. The electric unit heaters can be powered from an essential bus. The operation of the heaters inside the diesel generator rooms is required to support the standby readiness of each diesel by ensuring the temperature inside the diesel generator rooms remains above a design minimum value of 40°F. This ensures the initial combustion air inside the EDG intake manifolds remains above the 40°F minimum value necessary to support fast, cold-starting.

9.4.7.5.2 System Description

The electric unit heaters are self-contained with their own fan, heating coil, and thermostat. The heaters recirculate room air to maintain area air temperatures above 65°F. A Control Room Process Computer point alarms if the EDG room temperature begins to approach the 40°F design minimum value so that appropriate corrective action may be taken to restore the room environment.

9.4.7.5.3 Safety Evaluation

The RHR Complex Heating System has no safety design bases. However, the system is relied upon to maintain the temperature of the initial combustion air above the 40°F design minimum required for reliable fast, cold-weather starting. Thus, while the loss of the unit heaters during normal operation does not directly affect the safe-shutdown capability of the plant, EDG operability is compromised if the room is not maintained above the required 40°F.

9.4.7.5.4 Inspection and Testing

All unit heaters were factory inspected and tested in accordance with the applicable equipment specifications. Erection of the heaters was in conformance with drawing and specification requirements. Construction tests were performed on the unit heater system to ensure that the heaters will provide the desired flow distribution. Controls and safety devices for each unit heater were checked and adjusted to ensure proper operation. During the heating season, the heating units are periodically inspected to verify continued proper operation. Operator rounds are performed to verify EDG room temperatures are within the design envelope daily.

9.4.7.5.5 Instrumentation and Controls

Control of the electrical unit heaters is by an individual thermostat built into each unit heater.

9.4.8 Plant Heating System

9.4.8.1 Design Bases

The plant heating system is designed to limit the minimum temperature inside the reactor building, auxiliary building, radwaste building, and other miscellaneous facilities to 65°F. The system is designed to preheat the ventilation air to 65°F and provide perimeter heating to these buildings during the winter. The turbine building heating system is similar. However, the supply air temperature may be controlled in a range of 55°F to 65°F during the heating season.

The system performs its function during normal plant operation and shutdown. The heating steam isolation valves and piping on either side of the secondary containment boundary are seismic I. The remainder of the plant heating system is nonseismic. The system is required to function under normal plant operating conditions. Safety related motor operated isolation valves in the heating steam piping at the secondary containment boundary have been provided to allow the operators to isolate the steam piping in the event of a postulated break in the heating steam piping.

9.4.8.2 System Description

A diagram of the plant heating system is shown in Figure 9.4-11. Nominal sizes and types of principal system components are listed in Table 9.4-13. Steam is used for plant heating in the reactor, auxiliary, turbine, and radwaste buildings. Electrical unit heaters are provided to heat all other buildings. Steam is supplied to heating coils, located in the building ventilation supply system, and to unit heaters from the auxiliary steam boilers via a 15 psig pressure reducing station. To ensure that the steam pressure in the heating system does not exceed 15 psig, the reducing station is equipped with a pressure relief valve. The unit heaters are provided to offset transmission heat loss through exposed walls and roofs. The condensate from the heating coils is returned to a deaerator located in the auxiliary boiler room.

Permanent fuel oil, feedwater, and steam line connections are provided so that a portable boiler can be connected to the existing system to supply steam in a timely manner in the event of failure of the auxiliary boilers.

The system is designed to maintain the building temperature at 65°F, with an ambient temperature of -10°F.

9.4.8.3 Safety Evaluation

The operation of the plant heating system is not required to ensure the safe shutdown of the plant.

The system incorporates features that ensure its reliable operation over a full range of normal plant operations. These features include the installation of control valves on the coil inlet and multiple condensate return pumps.

Instrumentation is provided to monitor the temperature and pressure at various points.

Necessary safety features are provided for the operation of auxiliary boilers.

9.4.8.4 Inspection and Testing

All equipment was factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. System ductwork and the erection of equipment were inspected for quality assurance during various construction stages. Construction tests were performed on all mechanical components, and the system was balanced for the design water flows and system operating pressures.

Controls, interlocks, and safety devices were cold checked, adjusted, and tested to ensure their proper operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Acceptance Test program as discussed in Chapter 14.

Maintenance is performed on a scheduled basis in accordance with the recommendations of the equipment manufacturer and/or operating/maintenance experience.

9.4.8.5 Instrumentation and Controls

The plant heating system works in conjunction with various ventilation systems in the plant. The system is put in service by manually starting the auxiliary boiler. The steam temperature and pressure at various points are monitored and indicated. The capacity control of the coils is achieved by modulating the inlet steam and not by throttling the condensate quantity, thereby precluding the possibility of coil freezeup resulting from low steam flow conditions.

The unit heaters are controlled by locally mounted thermostats with integrated on-off-auto switches.

9.4.9 General Service Water Pump House Heating and Ventilation System

9.4.9.1 Design Bases

The system is designed to maintain the temperature in the pump and switchgear rooms between 50°F and 120°F during all normal modes of plant operation and during plant shutdown periods. The ambient design temperature is between -10°F and 95°F.

The system is nonseismic.

9.4.9.2 System Description

A diagram of the general service water pump house heating and ventilation system is shown in Figure 9.4-12. Nominal sizes and types of principal system components are listed in Table 9.4-14.

The pump room is provided with three propeller-type fans equipped with gravity backdraft dampers. The fans are mounted in the roof of the pump house. A centrifugal blower unit equipped with an air filter and an intake damper is mounted on an outside wall of the switchgear room.

The pump room fans draw outside air into the room through intake louvers located at either end of the pump house. The switchgear room fan supplies outside air to the room and forces the heated air into the pump room.

Five electrical heaters are provided in the pump room and one in the switchgear room. The heating units heat and recirculate room air.

9.4.9.3 Safety Evaluation

This system is not required for the safe shutdown of the plant. An indication of high and low room temperatures, along with an alarm, is provided in the main control room.

9.4.9.4 Inspection and Testing

All equipment was factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. Controls, interlocks, and safety devices on each system were cold checked, adjusted, and tested to ensure the proper sequence of operation. Initial system flow distribution, valve operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Acceptance Test program as discussed in Chapter 14.

Routine maintenance and tests, based on the manufacturer's recommendations and/or operating/maintenance experience, are scheduled in accordance with the plant preventive maintenance program.

9.4.9.5 Instrumentation and Controls

Heating and ventilating of each room are controlled by a thermostat located in that room. Each ventilating fan is equipped with a local on-off switch. High and low temperatures for the pump and switchgear rooms are alarmed in the main control room.

9.4.10 Circulating Water Pump House Ventilation System

9.4.10.1 Design Bases

The circulating water pump house ventilation system is designed to limit the temperature in the pump room, switchgear room, and chemical treatment room to a maximum of 104°F.

The ventilation system is nonseismic.

9.4.10.2 System Description

Nominal sizes and types of principal system components are listed in Table 9.4-15.

The circulating water pump house has three separate ventilation systems, one each for the pump room, switchgear room, and chemical treatment room.

9.4.10.2.1 Pump Room

At each circulating water pump location, there is one exhaust fan that draws room air through the pump motor shroud for motor cooling and provides ventilation of the pump area during pump operation. For operation during cold weather, warm air from the pump motor shroud is mixed with a mixture of recirculated room air and outside air to maintain room temperature. During warm-weather operation, outside air is drawn directly into the pump area, through the pump motor shroud, and discharged back to the outside, thereby providing pump area ventilation and adequate cooling for the pump motor. Supplemental electric heating is provided to maintain room temperature well above freezing during cold weather when the circulating water pump is out of service.

9.4.10.2.2 Switchgear Room

Operation of the switchgear room ventilation system is initiated when the switchgear room temperature reaches 80°F. The exhaust fan starts and the outside air damper opens automatically.

9.4.10.2.3 Chemical Treatment Room

The ventilation fan in the chemical treatment room draws in air from the adjacent pump room when the chemical treatment room temperature is below 80°F. Above 80°F, the pump room damper closes and the outside air damper opens. When the chemical treatment room temperature is below 50°F, a room thermostat regulates the electric duct heaters at the ventilating fan.

9.4.10.3 Safety Evaluation

The circulating water pump house ventilation systems are required to operate only during normal plant operation.

9.4.10.4 Tests and Inspections

All equipment was factory inspected and tested in accordance with applicable equipment specifications, quality assurance requirements, and codes. The system ductwork and erection of equipment were inspected during various construction stages. Construction tests were performed on all components of the system. The system was balanced for the design airflow and system operating pressures. Controls, interlocks, and safety devices on each system were adjusted and tested to ensure proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Acceptance Test program as discussed in Chapter 14.

9.4.10.5 Instrumentation

All rooms are provided with high and low temperature alarms in the main control room. Flow status lights are provided for all rooms and an alarm is provided for a loss of ventilation flow in the pump room.

9.4.11 Motor-Generator Set Cooling System

9.4.11.1 Design Bases

The motor-generator (M-G) set cooling system is designed to provide 104°F cooling air to the reactor recirculating pump M-G sets.

The system is nonseismic.

9.4.11.2 System Description

A diagram of the M-G set cooling system is shown in Figure 9.4-13. Nominal sizes and types of principal system components are listed in Table 9.4-16.

Three 50 percent fan-coil cooling units are provided to cool the two reactor recirculating pump M-G sets located on the fourth floor of the reactor building. The cooling unit fans induce room air to flow through each generator and motor. The air is then drawn through a common exhaust duct system to the fan-coil units. The fan-coil unit cools the air and discharges it back into the room. Two of the three fan-coil units are normally operating, with the third on standby. The standby unit is automatically started if the discharge air temperature in one of the two operating cooling units exceeds 125°F. The cooling coils are cooled by the RBCCWS.

9.4.11.3 Safety Evaluation

The M-G set cooling system is required to operate only during normal plant operation.

In order to ensure that the system has a high reliability during normal plant operation, three 50 percent fan-cooling coil units are provided.

9.4.11.4 Inspection and Testing

All equipment was factory inspected and tested in accordance with the applicable equipment specifications, quality assurance requirements, and codes. Controls, interlocks, and safety devices on each system were cold checked, adjusted, and tested to ensure the proper sequence of operation. Initial system flow distribution, valve and damper operability, instrumentation and control loop checks, and alarm setpoints were done in accordance with the Preoperational Acceptance Test program as discussed in Chapter 14.

Routine maintenance and tests, based on the manufacturer's recommendations and/or operating/maintenance experience, are scheduled in accordance with the plant preventive maintenance program.

9.4.11.5 Instrumentation and Controls

Two M-G set cooling units are selected to operate manually when the M-G sets need to be started. If after 30 sec the chosen fan does not provide airflow, it will be tripped and a standby fan started. Temperature switches are also provided in the discharge of the cooling units to trip above 125°F and automatically start a standby fan. Alarms are provided in the main control room for "motor trip" and "M-G set vent air fan auto start" to alert the operator that the automatic trip has occurred.

TABLE 9.4-1 CONTROL CENTER HVAC SYSTEM MAJOR COMPONENTS DESCRIPTIONS

A. Air Handling Equipment Trains

Type	Built-up
Quantity	Two, 100 percent capacity

1. Air Handling Units

Type		Blow-through
Quantity		Two, 100 percent capacity
Capacity:	cooling, Btu/hr	12×10^5
	heating, Btu/hr	5.3×10^5

2. Supply Air Fans

Type	Centrifugal
Drive	Belt, variable speed
Capacity, scfm	37,000
Total static pressure, in. H_2O	3.6
Motor, hp	40

3. Supply Air Filters

Type	Fiberglass roll filter with electrostatic precipitator
Quantity	Two, 100 percent capacity
Efficiency (NBS Dust Spot Test)	90 percent
Capacity, scfm	37,000
Pressure Drop (Clean), in. H_2O	0.16

4. Return Air Fans

Type	Centrifugal
Drive	Belt
Quantity	Two, 100 percent capacity
Capacity, scfm	35,550
Total static pressure, in. H_2O	2.5
Motor, hp	25

B. Refrigeration Units

Type	Centrifugal packaged chillers (water cooled)
Quantity	Two, 100 percent capacity
Capacity, tons	100
Power, kW	85

TABLE 9.4-1 CONTROL CENTER HVAC SYSTEM MAJOR COMPONENTS DESCRIPTIONS

C. Chilled Water Pumps

Type	Centrifugal, vertically split casing
Total dynamic head capacity, gpm	300
Total dynamic head, ft H_2O	50
Motor, hp	7.5

D. Emergency Makeup Air Filter Trains

Type	Built-up
Quantity	One, 100 percent capacity
Components of emergency makeup air filter trains	

1. Fans

Type	Centrifugal
Drive	Belt
Quantity	Two, 100 percent capacity
Capacity, scfm	3000
Static pressure, in. H_2O	11
Motor, hp	20

2. Makeup Air Filter

a. Prefilter-Moisture Separator

Type	Baffles & fiberglass
Medium	Fiberglass 5 1/2 in.
Efficiency (per NBS Dust Spot Test)	85 percent
Pressure Drop (Clean), in. H_2O	0.80 in. at 1800 cfm flow saturated air at 70 °F

b. Electric Heaters

Type	Resistance, single stage
Quantity	Two
Capacity, kW	12

c. HEPA Filters

Type	High-efficiency particulate dry
Medium	Glass fiber (fire retardant)
Efficiency	Design efficiency of 99.97 percent for 0.3µm particles or larger.

TABLE 9.4-1 CONTROL CENTER HVAC SYSTEM MAJOR COMPONENTS DESCRIPTIONS

c. HEPA Filters (cont.)

	Installed and tested such that an overall decontamination efficiency of 95 percent is assumed for removal of particulate iodine
Pressure drop (Clean) in. H_2O	1.1

d. Charcoal Adsorber

Type	2-in. gasketless
Quantity	One bank
Medium	Impregnated charcoal
Efficiency, percent	Lab tested to ensure a 99 percent removal efficiency for methyl iodide Installed and tested in the adsorber housing such that an overall decontamination efficiency of 95 percent is assumed for removal of all forms of gaseous iodine
Capacity, cfm	3000 by design, 1800 maximum during operation

3. Recirculation Air Filter

a. HEPA Filters

Type	High-efficiency particulate dry
Medium	Glass fiber (fire retardant)
Efficiency	Design efficiency of 99.97 percent for 0.3µm particles or larger. Installed and tested such that an overall decontamination efficiency of 95 percent is assumed for removal of particulate iodine.
Pressure Drop (Clean), in. H_2O	1.1

b. Charcoal Adsorber

Type	4-in. gasketless
Quantity	One bank

TABLE 9.4-1 CONTROL CENTER HVAC SYSTEM MAJOR COMPONENTS DESCRIPTIONS

b. Charcoal Adsorber (cont.)

Medium	Impregnated charcoal
Efficiency	Lab tested to ensure a 99 percent removal efficiency for methyl iodide. Installed and tested in the adsorber housing such that an overall decontamination efficiency of 95 percent is assumed for removal of all forms of gaseous iodine.
Capacity, cfm	3000

E. Control Center Air Conditioning Equipment Room Fan-Coil Cooling Units

1. Type — Package

2. Quantity — Two

3. Components of each unit

a. Fan

Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	1200
Static pressure, in. H_2O	1.03
Motor, hp	1.0

b. Heat Exchange Coil

Type	Finned tube
Face velocity, ft/minute	449
Capacity, Btu/hr	49,100

F. Control Center Computer Room Air Conditioning Units

1. Type — Horizontal package

2. Quantity — Two

3. Components of each unit

TABLE 9.4-1 CONTROL CENTER HVAC SYSTEM MAJOR COMPONENTS DESCRIPTIONS

a. Air Conditioning Unit

Fan type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	6200
Static pressure, in. H_2O	2
Motor, hp	7-1/2
Cooling coil type	6-row direct expansion
Face velocity, ft/minute	500
Capacity, Btu/hr - nominal	180,000

b. Refrigeration Compressors

Quantity	Two
Size, tons	15
Type	Semi-hermetic reciprocating 3-stage unloading
Motor amps (RLA)	29 @ 460 V
Refrigerant	R-22

c. Air-Cooled Condensers

Quantity	Two
Gross heat rejection each, Btu/hr	229,000
Motors per unit	Three
Motor, hp (each)	3/4

TABLE 9.4-2 MAIN CONTROL ROOM AIR CONDITIONING SYSTEM SINGLE-FAILURE ANALYSIS

System	Component Malfunction	Comments
1. Offsite power	Not available	Emergency diesels start and supply electrical load to systems
2. Emergency diesels	One not available	The operative diesel supplies necessary to power one of the System's redundant active components
3. Main control room air conditioning	Rupture of equipment casing and/or ducts	Consideration has been given in the detailed design to withstand the design- basis temperature, pressure, and seismic forces during a postaccident situation. The equipment and components are also inspectable and protected against credible missiles
	Rupture of chiller piping or loss of one of the chiller systems	Rupture is not considered credible since all piping is designed to withstand the design-basis temperature, pressure, and seismic forces during a post accident situation and is inspectable and protected from missiles. 100 percent redundant control center air conditioning systems are provided. The operating division will be shut down and the standby division manually started
	System fan fails	100 percent redundant fans are provided. Loss of a fan will be alarmed in the control room. The operating division must be shut down and the standby division manually started
	Normal intake or exhaust isolation damper fails to close	Two redundant dampers provided in series in each line. Each damper in series receives power from a separate ESF bus. This ensures that at least one damper in each line will close
	One of the emergency filtration intake isolation dampers fails to close during a chlorine accident	Four dampers provided, two per division in each line. The dampers are normally closed and fail closed
	One of the kitchen/washroom exhaust isolation dampers fails to close during a chlorine accident	Four dampers provided, two in each exhaust duct. Each damper in each exhaust duct receives power from a separate ESF bus. This ensures that at least one damper will close in each exhaust duct.
	One of the emergency filtration intake isolation dampers fails to open	Redundant intake lines provided. Two intake isolation dampers provided in each line. Both dampers in series receive power from the same ESF bus. This ensures that two dampers in series will open.
	Smoke/Halon dampers for relay room, cable spreading room or computer room close	Loss of cooling to the respective room. Manual action is required to reopen dampers.

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

A. Reactor Auxiliary Building Ventilation Supply

1. Type — Built-up

2. Components

a. Fans

Type	Vaneaxial
Quantity	Three, 50 percent capacity
Drive	Direct
Capacity, scfm	52,088 each
Total pressure, in. H_2O	4.75
Motor, hp	75

b. Filters

Type	Disposable cartridge
Quantity	One bank
Media	Glass fiber (fire retardant)
Efficiency (NBS Dust Spot Test)	85 percent
Capacity, scfm	104,176
Pressure Drop (Clean), in. H_2O	0.5

c. Heating Coils

Type	Finned tube
Quantity	One bank
Capacity, Btu/hr	8.4×10^6

B. Reactor Auxiliary Building Ventilation Exhaust Fans

Type	Vaneaxial
Quantity	Three, 50 percent capacity
Drive	Direct
Capacity, scfm	54,388 each
Total pressure, in. H_2O	5.1
Motor, hp	75

C. Battery Room Exhaust Fans

Type	Centrifugal
Drive	Direct
Quantity	Four
Capacity, scfm	400

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

Total static pressure, in. H_2O	1.7
Motor, hp	1

D. HPCI Pump Cubicle Fan-Coil Unit

1. Type — Package

2. Quantity — One

3. Components of each unit

a. Fan

Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	6400
Total static pressure, in. H_2O	3.3
Motor, hp	7.5

b. Heat Exchange Coil

Type	Finned tube
Face velocity, ft/minute	650
Capacity, Btu/hr	2.95×10^5

E. Core Spray Pump Cubicle Fan-Coil Unit

1. Type — Package

2. Quantity — One

3. Components of each unit

a. Fans

Type	Centrifugal
Quantity	Two
Drive	Belt
Capacity, scfm	11,800 total
Total static pressure, in. H_2O	4.1
Motor, hp	15

b. Heat Exchange Coil

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

Type	Finned tube
Face velocity, ft/minute	690
Capacity, Btu/hr	5.4×10^5

F. Core Spray/RCIC Pump Cubicle Fan-Coil Unit

1. Type — Package

2. Quantity — One

3. Components of each unit

a. Fans

Type	Centrifugal
Quantity	Two
Drive	Belt
Capacity, scfm	14,500
Total static pressure, in. H_2O	3.3
Motor, hp	15

b. Heat Exchange Coil

Type	Finned tube
Face velocity, ft/minute	645
Capacity, Btu/hr	6.25×10^5

G. RHR Pumps Cubicles Fan-Coil Units

1. Type — Package

2. Quantity — Two

3. Components of each unit

a. Fans

Type	Centrifugal
Quantity	Two
Drive	Belt
Capacity, scfm	18,200
Total static pressure, in. H_2O	3.5
Motor, hp	20

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

b. Heat Exchange Coil

Type	Finned tube
Face velocity, ft/minute	589
Capacity, Btu/hr	8.43×10^5

H. Essential Switchgear Room Fan-Coil Units

1. Type — Package

2. Quantity — Four

3. Components of each unit

a. Fans

Type	Centrifugal
Quantity	Two
Drive	Belt
Capacity, acfm	9750
Total static pressure, in. H_2O	2.5
Motor, hp	5

b. Cooling Coil

Type	Finned tube
Face velocity, ft/minute	696
Capacity, Btu/hr	10.5×10^4

I. SGTS Cubicle Fan-Coil Units

1. Type — Package

2. Quantity — Two

3. Components of each unit

a. Fans

Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	9030
Total static pressure, in. H_2O	0.5
Motor, hp	3

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

b. Heat Exchange Coil

Type	Finned tube
Face velocity, ft/minute	516
Capacity, Btu/hr	1.95×10^5

J. Deleted

K. Control Air Compressor Fan-Coil Units

1. Type — Package

2. Quantity — Two

3. Components of each unit

a. Fans

Type	Centrifugal
Quantity	One
Drive	Belt
Minimum capacity, acfm	4600
Total static pressure, in. H_2O	Free delivery
Motor, hp	5

b. Heat Exchange Coil

Type	Finned tube
Minimum capacity, Btu/hr	49,500

L. Thermal Recombiner Fan-Coil Units

1. Type — Package

2. Quantity — Two

3. Components of each unit

a. Fans

Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	6500

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

Total static pressure, in. H_2O	Free delivery
Motor, hp	5

b. Heat Exchange Coil

Type	Finned tube
Face velocity, ft/minute	812
Capacity, Btu/hr	68,975

M. EECW Pump Fan-Coil Units

1. Type	Package
2. Quantity	Two
3. Components of each unit	

a. Fans

Type	Centrifugal
Quantity	One
Drive	Belt
Minimum capacity, acfm	4600
Total static pressure, in. H_2O	Free delivery
Motor, hp	5

b. Heat Exchange Coil

Type	Finned tube
Minimum capacity, Btu/hr	49,500

N. Battery Room Air Conditioning Unit

1. Type	Package
2. Quantity	One
3. Components of each unit	

a. Fans

Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	6000

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

Total external static pressure, in. H_2O	0.5
Motor, hp	5

b. Evaporator Coil

Type	Finned tube
Face velocity, ft/minute	500
Capacity, Btu/hr	1.38×10^5

c. Condenser

Type	Shell and tube, water cooled

d. Compressor

Type	Hermetic
Nameplate data	26 amp @ 460-V ac

O. Battery Charging Area Fan-Coil Units

1. Type — Horizontal package

2. Quantity — Two

3. Components of each unit

a. Fans

	Division I	Division II
Type	Centrifugal	Centrifugal
Quantity	One	One
Drive	Belt	Belt
Capacity, acfm	5370	2800
Total static pressure, in. H_2O	1/3	1/4
Motor, hp	5	2

b. Cooling Coil

Type	Fin-tube, water cooled	
Capacity, Btu/hr	69,000	33,000

P. Switchgear Room Air Conditioning Units

1. Type — Split system

2. Capacity, Btu/hr — 120,000

TABLE 9.4-3 REACTOR/AUXILIARY BUILDING VENTILATION AND COOLING SYSTEM COMPONENTS DESCRIPTIONS

3.	Quantity	Four (two per room)
4.	Condensing Unit	
	Fans	Propeller
	Quantity	One each
	Motor, hp	1 each
	Refrigerant	Freon 22
5.	Air-Handling Unit	
	Fan	Centrifugal
	Quantity	One each
	Drive	Belt
	Motor, hp	3
	Coil face area, ft^2	11.2

TABLE 9.4-4 RADWASTE FACILITY VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

A. Radwaste Building Ventilation Supply

1. Type — Built-up

2. Components

a. Fans

Type	Centrifugal
Quantity	Two
Drive	Belt
Capacity, scfm	32,400
Total static pressure, in. H_2O	3.00
Motor, hp	25

b. Prefilter

Type	Pad
Quantity	One bank (15 filters)
Medium	Glass fiber (fire retardant)
Nominal capacity, scfm	30,000
Pressure Drop (Clean), in. H_2O	
At rated flow (30,000 cfm)	0.4
At actual flow (32,800 cfm)	0.45

c. High-Efficiency Filter

Type	Vericel
Quantity	One bank (15 filters)
Medium	Glass fiber (fire retardant)
Efficiency	80-85 percent
Nominal capacity, scfm	30,000
Pressure Drop (Clean), in. H_2O	
At rated flow (30,000 cfm)	0.55
At actual flow (32,800 cfm)	0.64

d. Heating Coil

Type	Finned tube
Quantity	One bank
Capacity, Btu/hr	2.88×10^6

TABLE 9.4-4 RADWASTE FACILITY VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

B. Radwaste Building Ventilation Exhaust

1. Type	Built-up
2. Components	
a. Fans	
Type	Centrifugal
Quantity	Two
Capacity, scfm	33,700
Total static pressure, in. H_2O	6.5
Motor, hp	50
b. Prefilter	
Type	Disposable cartridge
Quantity	One bank
Efficiency (NBS Dust Spot Test)	85 percent
Nominal capacity, scfm	60,000
Resistance (Clean), in. H_2O	
At rated flow (60,000 cfm)	0.55
At actual flow (45,945 cfm)	0.42
c. HEPA Filters	
Type	Astrocel
Quantity	One bank (30 filters)
Medium	Glass fiber (fire retardant)
Efficiency, percent with 0.3 micron dioctyl phthalate (DOP)	99.97
Nominal capacity, scfm	60,000
Pressure Drop (Clean), in. H_2O	
At rated flow (60,000 cfm)	1.16
At actual flow (45,945 cfm)	0.80

C. Radwaste Battery Room Air Conditioning Unit Package

1. Type	Package
2. Components	
a. Fans	
Type	Centrifugal
Quantity	One
Drive	Belt

TABLE 9.4-4 RADWASTE FACILITY VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

Capacity, scfm	2000
Total external static pressure, in. H_2O	0.25
Motor, hp	3/4

b. Evaporator

Type	Finned tube
Face velocity, ft/minute	460
Capacity, Btu/hr	56,500

c. Condenser

Type	Tube-in-tube, water cooled

d. Compressor

Type	Hermetic

D. Health Physics Laboratory Air Conditioning Unit

1. Type — Split system

2. Components

a. Fans

Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	11,280
Total external static pressure, in. H_2O	4.5
Motor, hp	20

b. Evaporator

Type	Finned tube
Face velocity, ft/minute	343
Capacity, Btu/hr	4.69×10^5

c. Condenser

Type	Shell and tube

d. Compressor

TABLE 9.4-4 RADWASTE FACILITY VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

Type	Hermetic
Motor, hp	40

e. Preheat Coil

Type	Finned tube
Face velocity, ft/minute	500
Capacity, Btu/hr	3.57×10^5

f. Reheat Coil

Type	Finned tube
Face velocity, ft/minute	454
Capacity, Btu/hr	2.36×10^5

E. Fume Hood Exhaust Fan

Type	Centrifugal
Drive	Belt
Capacity, scfm	6500
Total static pressure, in. H_2O	6.0
Motor, hp	1

F. Dedicated Shutdown Air Conditioning Unit Package

1. Type — Split System

2. Components

a. Air Handling Unit Fan

Type	Centrifugal
Drive	Belt
Capacity,scfm	6,000
Total external Static Pressure,(in.H20)	1.84
Motor,(HP)	5

b. Evaporator

Type	Finned Tube
Face velocity,(Ft/Minute)	616
Capacity (BTU/Hr)	240,830
Refrigerant Type	R22

c. Condenser

TABLE 9.4-4 <u>RADWASTE FACILITY VENTILATION SYSTEM COMPONENTS DESCRIPTIONS</u>

Number of Condensers	2
Type	Finned Tube-Air Cooled
Fan Motor(HP)	1 (for each condenser)
Type	Direct Drive

d. <u>Compressor</u>

Number of Compressors	2
Type	Hermetic Scrolls
Motor (HP)	10

TABLE 9.4-5 TURBINE BUILDING VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

A. Turbine Building Ventilation Supply System

1. Type — Built-up

2. Components of each unit

a. Fans

Type	Vaneaxial
Quantity	Three, 50 percent capacity
Drive	Direct
Capacity, cfm	205,000
Total pressure, in. H_2O	5.54
Motor, hp	250

b. Filter

Type	High efficiency
Quantity	One bank
Media Efficiency (NBS Dust Spot Test)	85 percent
Capacity, scfm	390,000
Pressure Drop (Clean), in. H_2O	0.5

c. Heating Coil

Type	Finned tube
Quantity	One bank
Face velocity, ft/minute	695
Capacity, Btu/hr	20×10^6

d. Evaporative Air Cooler

Type	Wetted fill
Quantity	Two sections
Flow Rate	250,000 cfm
Pressure Drop	0.5 in WG

B. Turbine Building Ventilation Exhaust Fans

Type	Vaneaxial
Quantity	Three, 50 percent capacity
Drive	Direct
Capacity, cfm	215,000
Total pressure, in. H_2O	4.5

TABLE 9.4-5 TURBINE BUILDING VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

Motor, hp	250

C. Offgas Adsorber Room Air Conditioning System

1. Type	Split system
2. Quantity	Three, 50 percent capacity
3. Components of each unit	
a. Fan-Coil Units	
Quantity	Three
Fans	
Type	Centrifugal
Quantity (per fan-coil unit)	Two
Drive	Belt
Capacity, scfm	2250 each fan
Total external static pressure, in. H_2O	0.1
Motor, hp	1
Evaporator Coils	
Type	Finned tube
Quantity (per fan-coil unit)	One
Face velocity, ft/minute	470
Capacity, Btu/hr	129,600
b. Condensers	
Type	Shell and tube
Quantity	Three
c. Compressors	
Type	Semi-Hermetic reciprocating
Quantity	Three
Power input	22.5 amps @ 460 V ac

D. Deleted

E. Excitation Equipment Area Air Cooling System

TABLE 9.4-5 TURBINE BUILDING VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

1.	Type	Self Contained Water Cooled Air Conditioning Units
2.	Quantity	Two
3.	Capacity	30 Tons Cooling Each
4.	Manufacturer	Trane
5.	Components of Each Unit	
	Fan Type	Vertical Discharge Direct Drive
	Quantity	Two
	Capacity, scfm	12,000
	Static Pressure, in. WC	4.5
	Motor HP	25

F. Operational Support Center (OSC) Air Conditioning System

1.	Type	Split system
2.	Quantity	One
3.	System Capacity	15 Tons Cooling
4.	Design Flow	6,000 scfm
5.	Manufacturer	Trane
6.	Components of Unit	
	Fan Types	Supply (5.0 hp) (Centrifugal) Return (3.0 hp) (Centrifugal)
	Condensing Unit	
	Compressors	2 @ 7.5 hp each
	Condenser Fans	2 @ 1/2 hp each
	Refrigerant	R-22

TABLE 9.4-5 TURBINE BUILDING VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

G. SCCW Chiller Area (Turbine Building Basement) Fan Cooler

Quantity	1
Fans	
Type	Centrifugal
Drive	Belt Driven
Capacity, scfm	9000
Total Pressure, in H_2O	2.00
Motor, hp	5
Cooling Coil	
Type	Finned tube, 6 Rows
Quantity	1 Bank
Face Velocity, fpm	470
Capacity, Btu/hr	387,187 Total 322,596 Sensible
Chilled Water Flow, gpm	50
Chilled Water Temp, °F	60 in/75.7 out
Filters	
Type	Medium Efficiency, Throwaway
Quantity	1 Bank
Pressure Drop (Dirty), in H_2O	0.40

TABLE 9.4-6 DRYWELL COOLING SYSTEM COMPONENTS DESCRIPTIONS

A. Drywell Fan-Coil Units

1.	Type	Built-up
2.	Quantity	14
3.	Components of each unit	
	a. Fans	
	Type	Vaneaxial
	Quantity	One
	Drive	Direct
	Capacity, scfm	20,000
	Total pressure, in. H_2O	5.0
	Motor, hp	30
	b. Coils	
	Type	Finned tube
	Quantity	Two (see Note below)
	Capacity, Btu/hr	324,000

Note: Various drywell coolers have been replaced utilizing a split coil design in place of the original single full size coil while retaining the units' functionality and capacity.

TABLE 9.4-7 STEAM TUNNEL COOLING SYSTEM COMPONENTS DESCRIPTIONS

A. Steam Tunnel Fan-Coil Units

1. Type	Package
2. Quantity	Two
3. Components of each unit	
a. Fan	
Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	24,700
Total static pressure, in. H_2O	3.7
Motor, hp	25
b. Heat Exchange Coil	
Type	Finned tube
Face velocity, ft/minute	645
Capacity, Btu/hr	6.95×10^5

TABLE 9.4-8 RHR COMPLEX HEATING AND VENTILATION SYSTEM FAILURE ANALYSIS

System	Component Malfunction	Comments
Diesel generator room ventilation	One or both the supply air fans for a diesel room fail	Failure of one or both of the supply air fans will actuate a no-flow alarm in the main control room through its associated differential pressure switch, and the temperature in the diesel room will rise. The operator will take the necessary actions in accordance with the alarm response procedures
	Outside air damper fails closed and recirculating air damper fails open	The system will operate at 100 percent recirculation air. The temperature may rise as a result of the outside air damper failing closed. The high temperature in the diesel generator room will actuate an alarm in the control room, and the operator will take the necessary actions in accordance with the alarm response procedures
	Controller memory fails, the outside air and recirculating air dampers fail “as is”	The system will operate at the “as is” damper position at the time of failure. The temperature may rise or drop depending on the damper position and outside temperature. The temperature high or temperature low alarm for the diesel generator room will actuate an alarm in the control room, and the operator will take the necessary actions in accordance with the alarm response procedures
Switchgear room ventilation	Failure of one or both fans for individual switchgear room ventilation	Failure of one or both fans will actuate a no- flow alarm in the main control room through its associated differential pressure switch, and the temperature in the switchgear room will rise. The operator will take the necessary actions in accordance with the alarm response procedures
	Outside air damper fails closed and recirculating air damper fails open	The system will operate at 100 percent recirculation air. The temperature may rise as a result of the outside air damper failing closed. The high temperature in the switchgear room will actuate an alarm in the control room, and the operator will take the necessary actions in accordance with the alarm response procedures
	High pressure differential across the supply air filter	High pressure differential across the filter will illuminate a local indicator light. The operator will take the necessary actions depending upon the room temperature
	Controller memory fails, the outside air and recirculating air dampers fail “as is”	The system will operate at the “as is” damper position at the time of failure. The temperature may rise or drop depending on the damper position and outside temperature. The temperature high or temperature low alarm for the switchgear room will actuate an alarm in the control room, and the operator will take the necessary actions in accordance with the alarm response procedures

TABLE 9.4-8 RHR COMPLEX HEATING AND VENTILATION SYSTEM FAILURE ANALYSIS

Pump room ventilation	Failure of one or both fans for individual pump room ventilation	Failure of one or both supply air fans will actuate a no-flow alarm in the main control room through its associated differential pressure switch, and the temperature in the pump room will rise. The operator will take the necessary actions in accordance with the alarm response procedures
	Outside air damper fails closed and recirculating air damper fails open	The system will operate at 100 percent recirculation air. The temperature may rise as a result of the outside air damper failing closed. The high temperature in the pump room will actuate an alarm in the control room, and the operator will take the necessary actions in accordance with the alarm response procedures
	High pressure differential across the supply air filter	High pressure differential across the filter will illuminate a local indicator light. The operator will take the necessary actions depending upon the room temperature.
	Controller memory fails, the outside air and recirculating air dampers fail "as is"	The system will operate at the "as is" damper position at the time of failure. The temperature may rise or drop depending on the damper position and outside temperature. The temperature high or temperature low alarm for the pump room will actuate an alarm in the control room, and the operator will take the necessary actions in accordance with the alarm response procedures

TABLE 9.4-9 DIESEL GENERATOR ROOM VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

(Per Division of RHR Complex)

Ventilation Fans

Type	Vaneaxial
Quantity	Four
Drive	Direct
Capacity, scfm	34,000
Total pressure, in. H_2O	2
Motor, hp	15

TABLE 9.4-10 SWITCHGEAR ROOM VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

(Per Division of RHR Complex)

Ventilation Fans

Type	Centrifugal
Quantity	Four
Drive	Direct
Capacity, scfm	3900
Total pressure, in. H_2O	2
Motor, hp	3

TABLE 9.4-11 PUMP ROOM VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

(Per Division of RHR Complex)

Ventilation Fans

Type	Vaneaxial
Quantity	Two
Drive	Direct
Capacity, scfm	12,500
Total pressure, in. H_2O	2
Motor, hp	7.5

TABLE 9.4-12 DIESEL-FUEL-OIL STORAGE ROOM VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

(Per Division of RHR Complex)

Ventilation Fans

Type	Centrifugal
Quantity	Two
Drive	Direct
Capacity, scfm	2500
Total pressure, in. H_2O	2
Motor, hp	2

TABLE 9.4-13 PLANT HEATING SYSTEM COMPONENTS DESCRIPTIONS

A. Condensate Return Unit (Turbine Building)

1.	Condensate return tank capacity, gal	2000
2.	Pump	
	Number supplied	Three
	Type	Centrifugal
	Design pressure, psig	150
	Design temperature, °F	365
	Capacity, gpm	120
	Total head, psi	70
	Motor	
	Horsepower	10
	Speed, rpm	3550
	Voltage/frequency/phase	460/60/3

B. Condensate Return Unit (Boiler Building)

1.	Condensate return tank capacity, gal	36
2.	Pump	
	Number supplied	Two
	Type	Centrifugal
	Design pressure, psig	150
	Design temperature, °F	365
	Capacity, gpm	15
	Total head, psi	26
	Motor	
	Horsepower	3/4
	Speed, rpm	3500
	Voltage/frequency/phase	460/60/3

C. Condensate Return Unit (Reactor Building)

1.	Condensate return tank capacity, gal	198
2.	Pump	
	Number supplied	Two
	Type	Centrifugal
	Design pressure, psig	150
	Design temperature, °F	365
	Capacity, gpm	90
	Total head, psi	35
	Motor	
	Horsepower	5
	Speed, rpm	3500
	Voltage/frequency/phase	460/60/3

D. Unit Heaters

Steam pressure, psig	15
Capacity, mBtu/hr	44.4 to 310

TABLE 9.4-13 PLANT HEATING SYSTEM COMPONENTS DESCRIPTIONS

E. Auxiliary Steam Boilers

Number supplied	Two
Steam capacity, lb/hr	50,000 (each)
Operating pressure, psia	120
Design pressure, psig	250
Feedwater temperature, °F	227
Steam temperature	Saturated
Fuel	No. 2 oil

F. Feedwater Pumps

Number supplied	Three
Type	Centrifugal
Fluid	Demineralized condensate
Design pressure, psig	200
Design temperature, °F	250
Capacity, gpm	120 (each)
Total head, ft	400
Motor	
Type	324 TS
Horsepower	30
Speed, rpm	3500
Voltage/frequency/phase	400/60/3

G. Deaerating Heater

Capacity, lb/hr	100,000
Design pressure, psig	120
Design temperature, °F	450
Operating pressure, psig	5
Dissolved oxygen at design load,cm^3/l	0.005
Dissolved at 120 percent design load, cm^3/l	0.005
Vented steam required at full load, lb/hr	169

TABLE 9.4-14 GENERAL SERVICE WATER PUMP HOUSE HEATING AND VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

A. Pump Room Ventilation Exhaust Fans

Type	Vertical roof ventilator
Quantity	Three
Drive	Direct
Capacity, scfm	25,300
Total external static pressure, in. H_2O	1/4
Motor, hp	5

B. Switchgear Room Ventilation Supply

1. Fan

Type	Centrifugal
Quantity	One
Drive	Belt
Capacity, scfm	2850
Total ext. static pressure, in. H_2O	5/8
Motor, hp	3/4

2. Filter

Type	Disposable
Quantity	One bank
Medium	2-in.-thick flat fiberglass

C. Pump Room Heating

Type	Vertical electric unit heaters
Quantity	Five
Capacity, kW	20 (68,200 Btu/hr)
Fan capacity, scfm	1300
Motor, hp	1/6

D. Switchgear Room Heating

Type	Horizontal electric unit heater
Quantity	One
Capacity, kW	10
Fan capacity, scfm	750
Motor, hp	1/10

TABLE 9.4-15 CIRCULATING WATER PUMP HOUSE VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

A. Pump House Ventilation

1. Fans

Type	Axial flow
Quantity	Five
Drive	Direct
Capacity, scfm (each)	21,400/32,000
Total external static pressure, in. H_2O	0.90/2.00
Motor, hp	20

B. Pump Room Heating

1. Heaters

Type	Horizontal elec. unit heaters
Quantity	10
Capacity, kW/Btu/hr	15/51,195
Fan capacity, scfm	750

C. Chemical Treatment Room Ventilation and Heating

Type	Built-up

1. Exhaust System

Fan

Type	Axial flow roof exhauster
Quantity	One
Drive	Belt
Capacity, scfm	6000
Total ext. static pressure, in. H_20	0.45
Motor, hp	1

2. Supply System

Fan

Type	Axial duct
Quantity	One
Drive	Direct
Capacity, scfm	6000
Total ext. static pressure, in. H_2O	0.875
Motor, hp	2

TABLE 9.4-15 CIRCULATING WATER PUMP HOUSE VENTILATION SYSTEM COMPONENTS DESCRIPTIONS

a. Duct Heater

Type	Electric fin tube
Quantity	One
Capacity, kW/Btu/hr	80/273,000

b. Duct Heater

Type	Electric fin tube
Quantity	One
Capacity, kW/Btu/hr	22.5/76,770

D. Switchgear Room Ventilation and Heating

1. Fan

Type	Axial flow roof exhauster
Quantity	One
Drive	Belt
Capacity, scfm	6000
Total ext. static pressure, in. H_2O	0.45
Motor, hp	1

2. Heater

Type	Horizontal electric unit
Quantity	Five
Capacity, kW/Btu/hr	5/17,076
Fan capacity, scfm	420

TABLE 9.4-16 MOTOR-GENERATOR SET COOLING SYSTEM COMPONENTS DESCRIPTIONS

1.	Type	Built-up
2.	Quantity	Three
3.	Components of each unit	
	a. Fan	
	Type	Vaneaxial
	Quantity	One
	Drive	Direct
	Capacity, scfm	38,000
	Total pressure, in. H_2O	1.9
	Motor, hp	20
	b. Heat Exchange Coil	
	Type	Finned tube
	Face velocity, ft/minute	650
	Capacity, Btu/hr	1.8×10^6

Figure Intentionally Removed
Refer to Plant Drawing M-2751

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-1

CONTROL CENTER AIR CONDITIONING SYSTEM
AIR FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2847

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-2

CONTROL CENTER AIR CONDITIONING SYSTEM
FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-4325

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-3

CONTROL CENTER AIR CONDITIONING WATER
CONTROL FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2707-1

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-4, SHEET 1

REACTOR AND AUXILIARY BUILDING
VENTILATION SYSTEM FLOW DIAGRAM
UNIT NO. 2

Figure Intentionally Removed
Refer to Plant Drawing M-2707

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-4, SHEET 2

REACTOR AND AUXILIARY BUILDING
VENTILATION SYSTEM FLOW DIAGRAM
UNIT NO. 2

Figure Intentionally Removed
Refer to Plant Drawing M-4952

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-5, SHEET 1

RADWASTE BUILDING VENTILATION FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-4953

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-5, SHEET 2

RADWASTE BUILDING VENTILATION FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2711

FIGURE 9.4-6

HEALTH PHYSICS LAB VENTILATION SYSTEM
FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2240

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-7, SHEET 1

TURBINE BUILDING VENTILATION
FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2240-1

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-7, SHEET 2

TURBINE BUILDING VENTILATION
FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-4127

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-8
DRYWELL COOLING SYSTEM FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2756

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-9

STEAM TUNNEL COOLING SYSTEM
FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-N-2058

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-10

DIVISION II RESIDUAL HEAT REMOVAL COMPLEX
TYPICAL VENTILATION SYSTEM - DIESEL
GENERATOR 13 - FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2271

FIGURE 9.4-11

PLANT HEATING SYSTEM
FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-S-2003

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-12

GENERAL SERVICE PUMP HOUSE VENTILATION SYSTEM FLOW DIAGRAM

Figure Intentionally Removed
Refer to Plant Drawing M-2708

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.4-13

MOTOR-GENERATOR SET COOLING SYSTEM
FLOW DIAGRAM

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection System

9.5.1.1 Design Basis

9.5.1.1.1 Introduction

The fire protection system is designed to provide adequate fire protection for all potential fire hazards. It provides prompt fire detection, alarm, and suppression. The fire protection system is designed to supplement the other fire protection safeguards incorporated into the plant design, including a low combustible fire loading and adequate separation of fire areas. Included in the total fire protection system are a fire protection water supply and distribution system, a fire detection and alarm system, and gaseous extinguishing systems, as well as fixed water spray and automatic sprinkler systems. Manual fire protection hose connections are provided on all floors, and hydrants are located in the yard. Plant operators are trained on a routine basis in fire-fighting techniques.

The Fermi 2 fire protection system has been developed using the fire hazards analysis, National Fire Protection Association (NFPA) standards, and recommendations made by the Nuclear Energy Liability-Property Insurance Association (NEL-PIA) (now named American Nuclear Insurers (ANI)) after its review of the entire system. This method is equivalent to postulating peak fire intensities due to the fire calculations and experience inherent in the standards and NEL-PIA recommendations.

The entire fire protection system is designed using the NFPA standards and the NEL-PIA recommendations for guidance.

The concrete building materials, the compartmentalization, and fire doors provide the structural features needed to prevent the spread of fires in Category I structures. The concrete used in the walls, floors, and ceilings will not support combustion. The compartmentalization of the plant for shielding purposes also provides fire barriers between equipment areas. The fire zones in the safety-related areas are established in the fire hazards analysis presented in Appendix 9A.

Because of the plant construction using noncombustible materials, the fire protection system is a nonseismic system. The piping is designed to Category II/I criteria (Section 3.7).

9.5.1.1.2 Codes and Standards

The following codes and standards were used for guidance in the design of the Fermi 2 fire protection system:

a. NFPA-10, Portable Fire Extinguishers - 1978

b. NFPA-12, Carbon Dioxide Systems - 1977

c. NFPA-12A, Halogenated Fire Extinguishing Agent Systems – 1977. Guidance in NFPA-12A, Standard on Halon 1301 Fire Extinguishing Systems – 2009, Section 6.7.2.4.2(5), is also used, with supporting justifications identified in FPEE-20-0006.

d. NFPA-13, Installation of Sprinkler Systems - 1980. Certain deviations to NFPA-13 requirements, with supporting justifications, are identified in sections 9.5.1.2.3.3, 9A.4.1.6.1, 9A.4.1.7.1, 9A.4.2.3.1, 9A.4.3.1 and 9.5.1.2.1.

e. NFPA-13A, Care and Maintenance of Sprinkler Systems - 1976

f. NFPA-13E, Fire Department Operations in Properties Protected by Sprinklers and Standpipe Systems - 1973

g. NFPA-14, Standpipe and Hose Systems - 1976

Certain deviations to NFPA-14 requirements, with supporting justifications, are identified in sections 9.5.1.2.1 and 9A.2.3.5.2.

h. NFPA-15, Water Spray - Fixed Systems - 1979

i. NFPA-20, Centrifugal Fire Pumps - 1970

Certain deviations to NFPA-20 requirements, with supporting justifications, are identified in section 9.5.1.2.3.2.

j. NFPA-24, Outside Protection – 1970

Certain deviations to NFPA-24 requirements, with supporting justifications, are identified in section 9.5.1.2.1.

k. NFPA-30, Flammable and Combustible Liquids - 1977

l. NFPA-72D, Proprietary Protective Signaling Systems for Watchman, Fire Alarm, and Supervisory Service - 1975

m. NFPA-72E, Automatic Fire Detectors - 1974

n. NFPA-198, Fire Hose (Including Couplings and Nozzles) - 1972

o. Underwriters Laboratories approved materials for fire protection

p. ANSI Specification B1.1, B18.2.1, Nuts and Bolts

q. ANSI Specification B31.1.0, Power Piping

r. ANSI Specification B16.1 - 1967, Standard Flange

s. 10 CFR 50, Appendix A, Criterion 3, Fire Protection.

9.5.1.1.3 Multiple-Unit Fire Protection

Fermi 2 is not a multiple-unit plant; therefore, no precautions are necessary to protect the operating plant during the construction of multiple units.

9.5.1.2 System Description

9.5.1.2.1 General Description

The FPS is shown in Figures 9.5-1, 9.5-2, and 9.5-3.

The dedicated fire protection water supply is obtained from a 2500-gpm electric-driven fire pump and a 2500-gpm diesel-driven fire pump located in the GSW pump house. Either fire pump will supply the required fire protection water demands. The diesel- and electric-driven fire pumps are normally on standby, since the fire mains are supplied with makeup water and pressurization from the FPS jockey pump which takes suction from the GSW pump header. The FPS jockey pump operates continuously, maintaining pressure in the fire main. If fire header pressure falls below GSW header pressure, makeup water will also be supplied via the cross-tie line between GSW and FPS. The electric fire pump starts automatically when the fire protection system header pressure drops to 130 psig, and the diesel fire pump starts when the fire protection system header pressure drops to 110 psig; both require manual shutdown once started. The fire pumps meet the intent of NFPA Standard 20 (except for certain deviations identified in section 9.5.1.2.3.2) and NEL-PIA recommendations, and are Underwriters Laboratories (UL) approved. The fire main loop is completely isolable from the GSW system, and a check valve is provided to prevent flow from the fire main loop into the GSW system. This design provides flexibility to support the fire main loop while maintaining its integrity with respect to system flow.

The distribution fire main in the yard surrounding the plant is a 12-in. and 14-in. underground header, which is buried below the frost line to prevent freezing. Normally open valves with post indicators are installed in the fire main on each side of every branch and also on every branch leading from the fire main. Those valves, together with individual hydrant shutoff valves, permit isolation of a line break anywhere, with minimum interruption of service to undamaged sections. Hydrants and underground fittings are provided with suitable thrust blocks to prevent blowouts of the system. The underground portion of the system is coated with corrosion-resistant materials and is also protected by cathodic protection, as applicable.

The 12-in. fire main is designed to provide the required water demands for the automatic sprinkler systems and 500 gpm for all hose demands. The hose pipe system is designed as an NFPA Standard 14 Class II hose system. Pressure reducing devices are not installed as required by NFPA-14 at all hose station outlets where the pressure exceeds 100 psig, to reduce the pressure with required flow at the outlet to 100 psig. This is acceptable because the hose stations and fire hose are only used by trained fire brigade members, and adjustable pattern fog nozzles are provided at all hose stations, except for the fifth[h] (refueling) floor of the reactor building where solid stream nozzles are provided. Pressure reducing devices that significantly reduce pressure are provided for hose station outlets on the fifth floor of the reactor building and on floors below the grade floor of 583 ft 6 in., due to excessively high pressure at those hose stations. The reason for utilizing a higher pressure at hose stations is to be able to more effectively fight fires at the ceiling height where cable trays are located. The fuel storage tank for the diesel fire pump holds sufficient fuel to continuously operate the pump for a minimum of 8 hr.

The fire main loop serves the outdoor hydrants, which are spaced in accordance with NFPA Standard 24. Additional hydrants on branches of the main loop are located in the general vicinity of the cooling water towers, in the protected area, and in the vicinity of the warehouses and the CTG fuel storage tank outside the protected area. Underground branches from the fire main loop supply water to the reactor, turbine, radwaste, auxiliary, residual heat removal (RHR) complex, Independent Spent Fuel Storage Installation (ISFSI) equipment storage, FLEX Storage Facility (FSF#1), and warehouse buildings within the protected area. A separate branch with an isolation valve supplies warehouses, fire hydrants and other buildings as shown in Figure 9.5-1, Sheet 2. In addition to the 12-in. steel pipe, this branch includes 12-in., 8-in. and 6-in. portions of transite pipe, 6-in. cement lined ductile iron pipe, 6-in. portions of poly vinyl chloride pipe, as well as 14-in. high density polyethylene (HDPE) pipe, as shown in Figure 9.5-1, Sheet 2. The underground fittings are provided with suitable thrust blocks to prevent blowouts of the system. Valves are provided to isolate this branch in the event of a pipe failure. The underground feeds into the RHR Complex building are embedded in an exterior wall and floor where the two lines are exposed to outdoor temperatures. Freezing is avoided by a combination of exterior wall insulation and by running a continuous amount of water through the lines during the winter season. This is an alternative method of providing freeze protection to the specific requirements of NFPA 13 and 24 and was in a report filed with the NRC in VP-85-0204 (Reference section 9A.1.1.2).

The sprinkler system supplies water to the sprinklers. At a set ambient temperature, the sprinkler system initiates water flow in the sprinkler. An alarm valve and/or flow switch in the line actuates a visible and audible alarm in the main control room for sprinklers in the protected area. Indication for those sprinkler systems in the owner controlled area are located within normally manned security areas. The areas covered by the sprinkler systems are indicated in Table 9.5-1.

The deluge system consists of a system employing open sprinklers attached to a piping system connected to the fire protection water supply through a valve that is opened by the operation of a fire detection system installed in the same area as the sprinklers. Audible and visible alarms are actuated in the main control room for the deluge systems located in the protected area. The deluge valves in the protected area can also be opened by manual switches from the main control room. These deluge valves can be reset only when there is no pressure upstream of the valve. This can be achieved by manually closing the outside screw and yoke valve upstream of the deluge valve. Position-indicating lights for the deluge (and outside screw and yoke) valves of both the sprinkler and the deluge systems in the protected area are provided in the main control room. Provisions for monitoring the electrical control circuits of the deluge valve manual switches are also incorporated into the main control room for valves in the protected area. Indications for those fire protection valves in the owner-controlled area are located within normally manned security areas. Areas with deluge system protection are listed in Table 9.5-1.

Each divisional pair of diesel generators is provided with a low-pressure CO_2 flooding system. The initiation of CO_2 in the diesel generator room does not affect the starting and running of the diesel generators. The diesel-fuel-oil storage tanks are protected by wet-pipe sprinkler systems. The fuel oil storage tanks are contained in their own rooms with elevated doorways that would prevent the fuel oil from flowing into other adjacent areas in the event of a rupture of the tanks. In addition, floor drains are provided in these rooms to drain the oil, and the water from the sprinkler system, to the outside liquid chemical waste holding pond. Diking is also provided around the 150,000-gal auxiliary boiler fuel-oil storage tank.

The standby gas treatment system (SGTS) charcoal filters are provided with a low-pressure CO_2 flooding system.

Fire protection and detection also include provisions of motor-operated dump valves on the reactor feedpump (RFP) turbine-oil reservoir and the emergency diesel generator (EDG) fuel-oil storage tank, fusible-link fire dampers in the supply and return air ducts of the ventilation systems of the reactor and service buildings, control center, and RHR complex, and ionization detectors and/or photoelectric detectors for the detection of combustion products and smoke. The turbine building is provided with 13 heat- and smoke-relief vents in the roof, which open either automatically on high temperature or high pressure in the building or manually from the main control room.

Portable fire extinguishers are deployed throughout the plant, and each unit is selected on the basis of the type of fire anticipated. NFPA Standard 10 was used as a guide for the selection, spacing, location, use, and maintenance of the portable extinguishers. Approximately 200 portable fire extinguishers are distributed throughout all the floors of the reactor, auxiliary, RHR, turbine, and radwaste buildings. These include multipurpose portable dry-chemical extinguishers for Class A, B, and C fires and portable CO_2 and Halon extinguishers. Where necessary, in support of the manual fire suppression systems, masks and portable breathing apparatus are provided for personnel protection.

Temperature, photoelectric, infrared, or ionization detectors are provided throughout the plant and are identified in Appendix 9A. In addition, the activation of any automatic fire-fighting equipment, component, or detector energizes visible and audible alarms in the main control room.

The type of fire-extinguishing equipment provided for each area is as follows:

Type	Area
Yard main and hydrants	Exterior of buildings, yard structures, and storage areas
Deluge and sprinkler systems	Parts of reactor, turbine, radwaste, and service buildings, transformer area, oil storage, reservoirs, diesel-fuel-oil storage tanks in RHR complex, ISFSI equipment storage building, warehouse, and FLEX Storage Facilities #1 and #2
Standpipe system and hose stations	On every floor inside all major plant buildings, except the office building annex (034)
Automatic CO_2 extinguishing systems	Diesel generator rooms, SGTS charcoal filters, cable tunnel (manual only), outside Division II switchgear room, and selected cable tray areas
Portable fire extinguishers	Throughout the plant, especially in critical control areas where general flooding could adversely affect safety-related equipment
Automatic Halon suppression systems	Relay room, cable spreading room, computer room and other selected minor areas
Automatic Clean Agent suppression system	Parts of radwaste building and the Security Diesel Generator enclosures

9.5.1.2.2 Control Room Protection Systems

A potential main control room fire would be extinguished by manual fire-fighting techniques. Portable CO_2 and Halon extinguishers are provided, and if needed, the normal standpipe and hose connections are located outside the main control room. Equipment in the main control room is noncombustible.

The main control room fire detection system covers the main control room, the areas above the false ceiling, inside the COP panels, and under the computer area floor. Main control room habitability in the event of smoke is maintained by the ventilation system as described below.

The exhaust from each zone listed in Subsection 9.4.1.2.1 is either partially recirculated or completely exhausted under normal operating conditions. All of the control center air conditioning system (CCACS) zones are equipped with ionization-type detectors or other approved types of detectors. These areas include the air conditioning system mechanical equipment room, computer/main control room, cable spreading room, and relay room. If smoke is detected by any of the early-warning ionization detectors, an indicating light on the area smoke, fire, and radiation protection panel in the main control room will illuminate, indicating the zone, and an audible alarm will be sounded in the main control room. The control center ventilation will automatically be placed in the smoke purge mode of operation upon confirmed actuation of the Halon system in the cable spreading room or relay room. The ventilation systems for the cable spreading room and relay room automatically isolate when the Halon system initiates in these areas. This prevents dilution of the Halon when the control center ventilation is placed in the purge mode of operation. The purge mode results in once-through ventilation system operation throughout the control center (approximately seven air changes per hour) with no recirculation. This operation clears smoke from the fire area and prevents smoke and Halon from being recirculated into the main control room. The smoke purge mode, however, is overridden by a LOCA signal which places the ventilation system into 100 percent recirculation.

Wherever the control center ventilation supply or return ducts penetrate a fire barrier wall, a 3-hr fire damper installation is provided or a specific fire hazards analysis evaluation has been performed and documented. These fire dampers automatically close either by spring action or by gravity when a fusible link melts on high temperature. In the cable spreading and relay room supply and return ducts, remotely resettable dampers are provided that automatically close when the gaseous system actuates. These dampers can be reset from the main control room. Position indication is provided on the remotely resettable dampers.

In the event of a fire outside the main control room but within the control room complex, the early-warning fire detection system will alert the operators to the problem. The fire detection system includes all areas of the control center. A ventilation equipment room fire will be extinguished by manual fire-fighting means. A relay or cable spreading room fire will be extinguished by manual means or by the automatic Halon suppression system.

A panel is installed outside the main control room that satisfies the requirements of 10 CFR 50, Appendix R, paragraph III.L for alternative or dedicated plant shutdown. The approach to the alternative shutdown design, the analysis, and method used are described further in Subsection 7.5.1.5.

Automatically initiated water systems are not employed on control center complex Class 1E electrical equipment because of the loss of reliability associated with the operation of fire protection equipment. The relay room, selected cable tray areas, and the EDGs are protected with automatic gaseous systems. Class 1E equipment located in other areas is protected by early-warning fire detectors. The above areas are identified in Appendix 9A.

9.5.1.2.3 Design Features

The design features of the Fermi 2 fire protection system equipment are described in the subsections that follow.

9.5.1.2.3.1 Electric Fire Pump

The electric fire pump has the following specifications: 2500 gpm at a discharge pressure of 150 psi, 1780 rpm, and 370-ft total developed head. The motor is 4000 V, 300 hp. The fire pump is UL listed equipment. The controller is not UL listed but does meet the general design and functional requirements of listed controllers. Status alarms indicating the availability of the electric fire pump are provided in the control room.

9.5.1.2.3.2 Diesel Fire Pump

The diesel fire pump has the following specifications, UL listed for 2500 gpm at a discharge pressure of 150 psi, 1775 rpm, and 370-ft total developed head. The engine is a diesel engine, UL listed for 340 hp, 2300 rpm, with a 275-gal fuel-oil tank for 8 continuous hr of operation. This pump and controller are UL listed equipment. Alarms are provided in the control room to indicate pump availability.

The electric fire pump was rebuilt and has replaced the original diesel fire pump. The diesel engine driver, when de-rated in accordance with NFPA 20, cannot develop the required horsepower to operate the diesel fire pump at rated speed to meet NFPA 20 requirements at the 100 percent and 150 percent flow points. The inability of the de-rated diesel driver and pump to meet the NFPA 20 flow and pressure requirements is an acceptable deviation because the diesel fire pump can provide the required flow and pressure demand for simultaneous operation of a suppression system and 500 gpm for hose streams.

9.5.1.2.3.3 Sprinkler Systems

The sprinkler systems are wet- or dry-pipe systems designed to provide a minimum water spray density per square foot of the most hydraulically remote area using NFPA Standard 13 and NEL-PIA requirements as guidelines. The sprinkler alarm check valves have been modified by adding a small bypass line to the trim of each valve to prevent any overpressure developing on the sprinkler system because of temperature changes or other reasons. This trim arrangement differs from the listed alarm check valve trim arrangements required by NFPA 13 but has no adverse effect on the functions of the Fermi sprinkler systems.

Other noncompliances with NFPA 13 have been evaluated in accordance with Generic Letter 86-10 as acceptable. These include the omission of return bend piping on pendent sprinklers, the omission of auxiliary drains on small trapped sections of sprinkler piping, the use of in-place welding to join and modify piping, and the lack of minimum required clearance distance for sprinklers below ceilings, ducts, or other items. The lack of return bends is acceptable based on the periodic change-out of the pendent sprinkler to prevent excessive accumulation of sediment in the sprinkler waterway. The other subject noncompliances are acceptable based on not adversely affecting the required function of the sprinkler systems and based on the administrative controls of the plant Fire Protection Program procedures.

The minimum water spray density used for each sprinkler system was determined by the occupancy classification defined in NFPA Standard 13 listed below:

Sprinkler System	Occupancy Classification
High pressure coolant injection (HPCI) room	Extra hazard, group #1
Reactor core isolation cooling (RCIC) room	Ordinary hazard, group #3
Motor-generator (M-G) set and oil cooler area	Extra hazard, group #1
Torus room	Ordinary hazard, group #3
Equipment unloading area	Ordinary hazard, group #3
2nd floor reactor building area	Ordinary hazard, group #3
Auxiliary building basement area	Ordinary hazard, group #3
Auxiliary building 1st floor mezzanine	Extra hazard, group #1
Cable spreading room (Elevation 630 ft)	Extra hazard, group #1
EDG fuel tank rooms	Extra hazard, group #1
Diesel fire pump room	Ordinary hazard, group #3

The sprinkler heads used in these systems are all fusible-link closed heads.

9.5.1.2.3.4 Deluge Systems

The deluge systems are open directional spray nozzle systems designed to provide density in accordance with NFPA Standard 15 and NEL-PIA requirements.

Deluge valves are solenoid valve operated, controlled automatically by the fire protection system or controlled manually from the main control room.

9.5.1.2.3.5 Gaseous Suppression Systems

A 6-ton low pressure CO_2 storage unit is provided for two EDGs in the same division. A total of two units each serving two EDGs is located in the RHR complex. The CO_2 system for the SGTS provides internal protection for the charcoal beds. Each SGTS division has an independent 1.25-ton CO_2 system. CO_2 systems are provided to protect certain areas of the reactor/auxiliary building, as listed in Table 9.5-1. A low pressure CO_2 storage unit is located outside the reactor building. A distribution system will select the proper zone where the fire is detected. Halon and Clean Agent suppression systems are provided in areas identified in Table 9.5-1.

9.5.1.2.3.5.1 General Design Information for the RHR Complex and Reactor/Auxiliary Building CO_2 Systems

The CO_2 system instrumentation and control equipment detects fires, initiates and terminates fire suppression discharges, and monitors system performance. Detection of fires is accomplished by heat and/or smoke detectors. Detection devices activate alarms to indicate the presence of a fire and activate control equipment to initiate discharge of fire-extinguishing agents. Discharge is delayed for sufficient time to enable personnel to leave the area. Activation of fire suppression equipment is accomplished either manually at local panels or automatically by fire detection devices. The control instrumentation directs the discharge into the selected area and closes ventilation dampers to isolate the fire and contain the discharge. Alarms indicate the operation of the systems.

Controls automatically terminate the discharge after a predetermined time. Instrumentation monitors the system operation and alarms under abnormal conditions. The CO_2 system controls provide for proper operation of the storage tank refrigeration unit.

Wall and floor penetrations for the areas protected by the CO_2 system are sealed to contain the CO_2 discharge. Any CO_2 leakage that may occur after the area is isolated is included in the extended discharge application rate. Further, upon completion of the system, a concentration test was conducted to confirm the design parameters.

Entrance to an area after a CO_2 discharge can be gained by resetting the ventilation dampers to the open position and initiating the exhaust function. To further aid in purging, portable smoke fans can be used as needed. Self-contained breathing apparatus is available and can be used to gain access for manual fire fighting or cleanup.

9.5.1.2.3.5.2 Design Guidance for Reactor/Auxiliary Building CO_2 Systems

a. The CO_2 storage capacity is sufficient to provide two-shot (100-percent redundancy) protection for the hazard area requiring the greatest quantity of CO_2, based on a design concentration of 50 percent. The quantity of CO_2 includes a 50 percent margin for leakage during an extended discharge. This allowance is based on all accesses and ventilation ducts being closed

b. The distribution system pipe sizing and arrangement are based on providing and maintaining an extinguishing concentration of CO_2 in the hazard area for 20 minutes. This is accomplished by applying an initial discharge at a sufficiently high rate to achieve a 30 percent concentration in 2 minutes or less, and the design 50 percent concentration in 7 minutes or less, in conjunction with an extended discharge at a lower rate sufficient to maintain the 30 percent concentration for 20 minutes

c. The design CO_2 concentration is 50 percent for each protected area. Flooding factors are based on the guidelines of NFPA Standard 12 for total flooding systems, assuming dry electrical wiring hazards in general cable areas

d. The storage tank refrigeration unit is sized to maintain the storage tank at 0°F and 300 psig, assuming the highest expected ambient temperature of 105°F. Power is provided as described in item e below

e. Fire detection devices, actuating instrumentation, and control equipment are powered from the 120-V restored ac bus. In addition, the fire detection system for CO_2 actuation is provided with a 4-hr, 24-V dc battery system.

9.5.1.2.3.5.3 Design Guidance for Diesel Generator CO_2 Systems

a. Each division contains two EDGs. The 6-ton storage tank for each division will provide one complete shot to both EDGs or double shot protection for one EDG

b. The design CO_2 concentration is 50 percent for each protected area. Based on guidelines of NFPA 12, the minimum design concentration for diesel fuel is 34 percent

c. Detection devices consist of thermal detectors

d. Fire detection and CO_2 controls are normally powered from the balance-of-plant 130-V dc system. Emergency power for the fire detection and CO_2 controls are powered from a 120-V manual restored ac bus. The power is then rectified to 130-V dc. Power for the refrigeration units and room warning lamps are powered from a 120-V manual restored ac bus

e. The system is designed to maintain the room concentrations for 20 minutes.

9.5.1.2.3.5.4 Design Guidance for the Standby Gas Treatment System CO_2 System

a. When the SGTS charcoal bed temperature reaches 250°F, an alarm sounds, which alerts the control room operator to an overtemperature condition well before there is danger of ignition. If the beds continue to heat up and reach 310°F, the low pressure CO_2 Suppression System will be automatically initiated and 250 lb of CO_2 are injected in the bed over a 10-minute period. This actuation of the CO_2 system is indicated on the fire protection mimic panel and an alarm on the control panel. Based on the alarm response procedure, the SGTS exhaust and cooling fans will be manually shut off if they are running.

   This cycle is repeated as long as the temperature exceeds 310°F. Each of the divisional CO_2 storage tanks holds enough CO_2 for 10 injections

b. Detection devices consist of a continuous thermal fire detection system

c. The detection devices and CO_2 controls are powered from the 120-V restored ac bus.

9.5.1.2.3.5.5 Design Guidance for Halon Systems

a. The Halon storage capacity consists of a main bank and a reserve bank for each system. Each bank will provide sufficient capacity for a complete shot

b. The systems are designed to provide a minimum 5 percent concentration for a 10-minute holding period

c. Emergency power for the fire detection and halon control systems is powered from a 120-V restored ac bus.

9.5.1.2.3.6 Design Guidance for Clean Agent Systems

a. The Clean Agent storage capacity consists of two storage cylinders, a primary and a reserve, for each system. Each will provide sufficient capacity to provide protection for the potential hazard based on concentration, volume of area, and known leakage pathways out of the designated area.

b. The systems are designed for a discharge time to provide a 95 percent minimum design concentration for flame extinguishment based on a 20 percent safety factor and will not exceed 10 seconds.

c. Power for the fire detection and Clean Agent control systems is provided by a separate dedicated 120V, 1 phase 60Hz source that will not be shutdown on system operation.

Use of this system is limited to the Security Diesel Generator enclosures and areas in the Radwaste Building which do not include any systems or circuits credited for reactor shutdown in the event of a fire (i.e. – activation of the Clean Agent fire suppression system will not adversely affect the plant's ability to achieve and maintain shutdown in the event of a fire).

9.5.1.2.3.7 Turbine Room Roof Vents

Thirteen roof vents in the turbine room are opened automatically at 20-psf differential pressure, or at 160°F by fusible link, or manually from the main control room, or locally by pull rings.

9.5.1.2.3.8 Dampers

Fire dampers located in the ventilation ductwork are curtain type with fusible links. Dampers are either spring loaded or rely on gravity to close. The fire damper will close only when high temperature melts the fusible link. Resettable smoke/halon and smoke/CO_2 dampers provided with the gaseous systems have the damper position monitored in the main control room.

9.5.1.2.3.9 Instrumentation

a. Flow Switches

Flow switches are provided in various locations of the fire protection system to detect water flow

b. Thermal Detectors

Thermal detectors are provided as part of the equipment package for the deluge systems, the EDG CO_2 systems, and the Security Diesel Generator enclosures.

c. Ionization Detectors

Ionization detectors are provided in areas requiring early-warning detection. Additionally, a separate ionization detection system was installed to actuate the gaseous systems (except for the CO_2 systems in the EDG rooms in the RHR building, where thermal detectors are used as noted above and the under-floor detectors in the main control room computer room where photoelectric detectors are used along with ionization detectors above the floor).

d. Photoelectric Detectors

Photoelectric detectors are used in areas requiring early-warning detection. These are usually used in place of ionization detectors in areas with difficult access. Photoelectric detectors are used under the floor, to actuate the halon system, in the main control room, computer room.

e. Infrared Detectors

Infrared detectors are utilized on the fifth floor of the reactor building and in the Security Diesel Generator enclosures.

f. Instrumentation and Control

Instrumentation and control of the fire protection systems is fed from various power sources identified in Sections 9.5.1.2.3.5 and 9.5.1.2.3.9. The sprinklers operate independently of ac or dc power. The deluge valves are controlled and fed from the dc power system. The standpipe system, which also supplies the sprinkler and deluge systems, is pressurized in a ready-for- service condition without need for valve operation. The GSW pumps and the electric fire pump operate from the ac system service and are not connected to the onsite power source. On loss of offsite power, the diesel fire pump starts and operates from its own 24-V battery and charger system

g. Fire Detector Location

The types and locations of fire detectors are provided in Appendix 9A.

9.5.1.2.3.10 Fire Detection Circuits

The Fermi 2 early warning only fire detection high-voltage system is a Class B system as defined in NFPA Standard 72D, employing a configuration of two independent detector circuits designated Group A and Group B. Because of the 220-V dc operating voltage, the fire detection circuits are not Class I per NFPA Standard 70. It is not a requirement of Appendix A to BTP APCSB 9.5-1 for the detection circuits to meet NFPA Standard 70, Class I. The Fermi 2 design does meet the Class 3 requirements of this code. However, the danger of a fault-initiated fire is minimized because the current is low (milliamperes) and the power is only about 200 W at each detection panel. Also, the fire detection circuits are routed in non-safety-related trays and are contained in conduits outside the trays.

In the redundant safety division areas, the early warning only fire detection circuits employ a two-circuit configuration of detectors designated Group A and Group B. Each detector group has approximately half the detectors of a given detection area. The two groups of detectors are installed in an interspersed configuration covering the protected region. The detector density in each detection area is such that floor area per detector is within the current NFPA recommendation.

In non-safety-related areas, the early warning only detector circuits are of a single group energized from either of the two main panels. The single group detector circuits are about evenly divided between the two panels to achieve a balanced arrangement. The service building complex has a separate fire detection panel.

The two early warning only fire detector groups are powered from separate non-Class 1E motor control centers (MCCs). Each MCC is fed from opposite divisional Class 1E switchgear. Normal offsite power provides the primary supply for the detectors. Upon loss of offsite power, the detectors are automatically connected to the onsite EDG. This design meets the requirements of Appendix A of BTP APCSB 9.5-1.

The reactor/auxiliary building gaseous suppression systems use a low-voltage smoke detection system. The design is a Class A cross-zoned detection system with a detector required from each zone to actuate the gaseous systems. Power is supplied from a 120-V ac restored bus. Additionally, a 4-hr, 24-V dc battery package provides secondary (backup) power.

For the Security Diesel Generator enclosures, a cross-zoned fire detection system uses both infrared and heat detectors. Should the second heat detector alarm, then the clean agent solenoid activates and, after the thirty second timer expires, the clean agent is released.

All fire detector circuits, flow switch circuits, and alarm bell circuits are electrically supervised in accordance with requirements of the NFPA.

Sensitivity of the ionization smoke detectors is adjustable. Final sensitivity settings are determined after a period of fire detection system operation. The sensitivity used is the highest that is practical and consistent with minimization of false alarms.

In the main control room, annunciator windows are provided for fire alarm (detector actuation or flow switch actuation) and fault in the fire detection/protection circuits. A fault annunciation would occur upon a detector circuit or bell circuit open, ground, or short; detector out of socket (open circuit); power loss; or outside screw and yoke water valve not full open. Other fault conditions, such as low CO_2 pressure, also are covered by an alarm.

On the main control room panel, a display is provided to indicate fire detection zone number in the alarm state, CO_2 release, outside screw and yoke valve closed, power status at panels, and smoke/CO_2 shutoff damper open/closed.

The fire annunciator system, a fire protection system mimic, is combined with the area radiation mimic. The mimic shows the building outlines, with orientation in respect to one another as accurately as possible, within which are color-coded alarm lights for fire, high temperature, smoke, and radiation.

A fire alarm will sound when flow switches indicate flow in the fire protection ring header, or flow in a deluge or sprinkler system, or flow from the electric or diesel fire pump. The alarm will designate the area on the mimic panel. An area indication on the mimic will alarm when any of the outside screw and yoke valves are closed or any deluge valve is opened. The panel will indicate the general area in which a fire detector is indicating the presence of smoke or fire. In the plant, a local panel for each area will display detailed information for each detector. Startup of either the electric or diesel fire pump will be alarmed.

The following remote manual control functions can be performed in the main control room: the deluge valves can be manually initiated by pushbutton. The smoke roof vents in the turbine house can be manually opened, and the smoke dampers can be manually closed. The electric and diesel fire pumps can be manually started from the main control room. The motor-operated dump valves on the EDG fuel-oil storage tank, on the main turbine-oil reservoir, and on the reactor feed pump oil reservoir can be operated from the main control room.

The system diagram of the fire protection system is given in Figure 9.5-1. Table 9.5-1 provides a list of the equipment and devices that make up the fire protection system.

9.5.1.2.3.11 Fire Barriers

The fire hazards analysis has identified the fire barriers and determined the barrier requirements for the floors, walls, and ceilings enclosing separate fire areas and for the doors and other penetrations through these barriers. (See Appendix 9A.) See Subsection 8.3.1.4.2.2 for a discussion of cable tray fire barriers at floor and wall penetrations.

9.5.1.2.3.12 Fire Emergency Lighting and Communications

Fixed emergency lighting with 8-hr battery power supplies is provided in the main control room, in all plant areas where operator action, for safe shutdown in the event of fire, is required within 8 hrs and along access and egress routes for these areas. Emergency communications capability is provided by telephones, public address systems, and radio communications equipment powered from redundant power sources. Repeater stations are installed to improve the quality of radio communication. Loss of a particular repeater will not result in a loss of communication capability in the area adjacent to the repeater.

9.5.1.2.4 Atmosphere Control

To aid in smoke removal, the reactor/auxiliary building ventilation system will continue to operate in the event of a fire in the reactor/auxiliary building except when a loss of offsite power results in initiation of the standby gas treatment system and automatic isolation of RBHVAC. The airflow will generally follow a path from areas of low potential radioactivity to areas of progressively higher potential radioactivity before finally being exhausted to the atmosphere at the roof of the reactor/auxiliary building. Fire dampers are provided where all ventilation ducts penetrate fire barrier walls.

The control center in the auxiliary building is equipped with its own air conditioning system and is not connected with the reactor/auxiliary building ventilation system during emergency mode operation of the CCACS as described in Section 6.4.4.2. Smoke, combustible and explosive gases, and airborne toxic contaminants in the reactor/auxiliary building atmosphere will not enter the control center because the CCACS maintains the atmosphere at a slight positive pressure with respect to the reactor/auxiliary building atmosphere.

The air conditioning zones within the control center can be individually isolated by smoke dampers that are operated from the control room. The detection system and smoke removal process are described in Subsection 9.5.1.2.2. Habitability of the main control room after a chlorine-release accident is discussed in Appendix A, Regulatory Guides 1.78 and 1.95.

Because of the combustible liquids stored in the diesel-oil storage room and the diesel generator room of the RHR complex, a purge ventilation fan will operate continuously (except during an actual fire). The diesel generator room, the CO_2 storage room, diesel-oil storage room, and diesel generator ventilation equipment room will be continuously purged with a 2500-cfm exhaust fan. Each EDG and diesel-oil storage room has a separate exhaust purge fan. Loss of airflow in the purge system is alarmed in the main control room. The exhaust fan will be automatically stopped if a signal is received from the automatic fire protection systems.

The RHR complex is divided into various fire zones, as indicated in Appendix 9A. The ventilation systems for the diesel generator switchgear zone and the EDG zone (two per division) and the pump room zone are entirely separate. Isolation of any of these zones will not affect the ventilation systems in other zones.

The CO_2 system for each EDG requires automatic shutdown of the ventilation system to be effective. The design of the system will allow operation of the remaining EDG in the division as well as the other unaffected division. Other zoned dampers are motor operated and controlled by startup or shutdown of the ventilation fans in the main control room. The ventilation fans for all zones can be manually shut down for fire containment or manually started or left running for smoke purge purposes. The 3-hr-rated fire dampers at ventilation duct penetrations of fire barriers will close only when high temperature melts the fusible link.

9.5.1.2.5 Electrical Cable Fire Protection

The electrical cables are fabricated with fire-retardant insulating and jacketing material. NEL-PIA has approved this design. Fire stops are included in all wall and floor tray penetrations, and fire barriers are installed in areas where a fire could propagate from one area or tray system to another. Details of the fire-resistant wall penetrations are found in Subsection 8.3.1.4.2.2.

Redundant engineered safety feature (ESF) equipment is fed by redundant essential electrical circuits. Physical separation is provided between electrical divisions to prevent loss of more than one division from a fire. As part of the fire hazards analysis, areas were identified that have more than one division in the same fire zone. In these areas, a fire barrier and/or a suppression system was added. The fire hazards analysis shows that any postulated fire will not prevent the ability to initiate or maintain shutdown of the reactor.

Fire protection instrumentation and control circuits are classified as non-safety-related and are not redundant. These cables could be lost and not cause loss of the portable fire extinguishers or loss of the standpipe automatic or manual systems. The electric fire pump and diesel fire pump with its own starting battery are normally on standby since the fire mains are supplied with makeup water and pressurization from the FPS jockey pump which takes suction from the GSW pump header.

These numerous sources of water to the fire protection water header ensure a source of water for extinguishing fires. No motor-operated valves are required to operate. The hose connections and valves are operated manually. Loss of fire protection instrumentation to the main control room would not prevent extinguishing a fire.

9.5.1.3 System Evaluation

9.5.1.3.1 Introduction

A fire hazards analysis of the Fermi 2 fire protection provisions was originally conducted in accordance with BTP APCSB 9.5-1 based on the Fermi 2 design as of April 1977. A point-by-point comparison was made with Appendix A to BTP APCSB 9.5-1. Subsequent minor revisions have been made to keep the analysis current. The results of these fire protection evaluations of Fermi 2 are included in Appendix 9A. Fermi 2 is in compliance with the guidance of Appendix R to 10 CFR 50, Sections III.G, III.J, and III.O. The deviations of Fermi 2 from Appendix R are addressed in Appendix 9A. These deviations provide an equivalent level of protection to the technical requirements of Section III.G of Appendix R.

The possibility of fire is minimized by the use of noncombustible materials in the construction of the plant. The spread of fire from one area to adjacent areas is prevented by high-integrity concrete enclosures and by fire-rated barrier walls where necessary.

The plant design is reviewed by NEL-PIA for potential fire hazards, and recommendations made by NEL-PIA on flame-retardant materials for structures, insulation, and electrical and mechanical equipment have been used.

The fire protection water system is not considered essential to the safe shutdown of the reactor. It is not designed to Category I requirements. The failure of the system piping or the inadvertent operation of the system does not affect the operation of the safety-related systems, as adequate drainage is provided in all buildings to prevent flooding and as all safety-related systems are designed to be protected from water spray and jet forces from the piping in the area. Flow switches provided throughout the system indicate system operation in the main control room. The layout and valving arrangement of the underground water system permit isolation of any defective section, without interruption of service to other parts of the plant. The inadvertent operation of the CO_2 systems does not affect the operation of safety-related equipment in the area. Smoke dampers in areas with gaseous fire suppression systems are remotely resettable from the main control room so that inadvertent actuation does not cause loss of ventilation to these areas.

The fire hydrants are installed at various yard locations such that the maximum distance between adjacent hydrants is not more than 300 ft, and, if possible, are within 40 ft of the plant buildings. Adequate pressure in the system lines will be available at the uppermost floors of all the buildings. Early-warning detection alarm instrumentation, smoke damper closure, CO_2 and Halon systems actuation alarms, and indication in the main control room of water fire protection system actuation provide reliable identification of the location of any fire so that corrective measures can be instituted with minimum delay. Temperature-operated (fusible-link) fire dampers in the ventilation ducts help contain the fire in the affected area. Audible fire alarms in the areas protected with CO_2 systems warn personnel of the impending actuation of the CO_2 system.

Table 9.5-2 provides a failure mode and effects analysis to demonstrate that operation of the fire protection system in areas containing safety-related equipment does not produce an unsafe condition or preclude a safe shutdown.

9.5.1.3.2 Failure of Nonseismic Fire Protection Systems

For safety-related buildings, the fire protection systems are seismic Category II/I. Therefore, the fire protection system piping will not fall and damage Category I equipment. The overall design of the fire protection system, because it is not a safety-related system, has not included design features to withstand the effects of single failures, except that the underground supply piping and fire pumps will allow for a single break or pump failure.

9.5.1.3.2.1 RHR Complex CO_2 System Failure

The CO_2 system is designed to discharge approximately 5000 lb of CO_2 into one diesel generator room. This quantity of CO_2 will flood the room and extinguish the fire by cutting off the supply of oxygen. If the CO_2 system inadvertently discharges into the diesel room, it will cause cooling that will lower the room temperature and the equipment temperature. The operating heat loads in the EDG room are less than 1,840,000 Btu/hr. The CO_2 discharge can provide approximately 20 minutes of cooling for this heat load. It is estimated that the CO_2 would not reduce the room temperature more than 100°F and at most would reduce the diesel engine generator temperature 40°F.

The inadvertent operation of the CO_2 system will not affect the operation of the EDG, since separate combustion air is provided for the engine by direct connection to the outside. Also, the CO_2 discharge horns are not directed toward any of the equipment. The horns are designed so that there is not a concentrated blast, but a diffuse stream of CO_2 vapor and solid particles. The cold gas will warm up and the solid particles will vaporize before coming into contact with the equipment. The quantity of cooling provided by the CO_2 system and the fact that it does not directly impact on the equipment will eliminate the possibility of thermal shock and will not cause a significant drop in equipment temperatures.

The rupture of a CO_2 storage tank will not cause damage to any safety-related equipment. Each CO_2 storage tank is located in its own room, and no safety-related equipment is located in that room. A rupture of the tank would confine the CO_2 to that room except for a possible small leakage under the doors. The CO_2 would extinguish any fire within that room. Leakage under the doors into the diesel generator room would not affect the operation of the diesels because they are designed to operate in a CO_2 environment.

9.5.1.3.2.2 Failure of Water Fire Protection Systems

The analysis of water fire protection line failures and the subsequent effect of water on safety-related equipment is presented in Subsection 3.6.2.3, which includes an analysis of the failure of all moderate-energy fluid systems throughout the plant, including the RHR complex.

To avoid freezing of the RHR fire protection water supply mains, a continuous flow of approximately 0.1 gpm is maintained during the winter.

9.5.1.3.2.3 Failure of Other Gaseous Systems

The gaseous systems provided other than in the control center will not cause loss of function of Class 1E equipment since the equipment can operate in a gaseous environment. The gaseous systems in the control center will also not affect Class 1E equipment. Failure (closure) of the smoke/Halon dampers for the relay room, cable spreading room or computer room will cause loss of cooling to their respective rooms. Manual actions are required to reopen these dampers to reestablish airflow. As described in Subsection 9.5.1.2.2, the smoke purge mode of the control center ventilation prevents concentration of Halon in areas outside the Halon suppression zone. The CO_2 storage tank for CO_2 systems inside the auxiliary building is located outside the plant.

9.5.1.3.3 Removal of Fire-Fighting Water

Floor drains are designed to remove the expected fire-fighting water flow from areas where fixed water fire suppression systems are installed or where fire hoses may be used. Equipment is installed on pedestals to protect it from water. Water drainage from areas which may contain radioactivity is collected in the floor drain collection tank for normal liquid radioactive waste.

9.5.1.4 Inspection and Testing Requirements

Preoperational testing of the fire pumps, hydrants, sprinklers, deluge systems, gaseous systems, standpipe, and hose systems was performed in accordance with the applicable NFPA codes. In addition, the instrumentation and control for the automatic starting of the fire pumps, flow detection and alarm, and SGTS thermal detection systems was tested for operability and limits.

Inspection, testing, and maintenance of all equipment of the fire protection system use the applicable NFPA codes as guidelines.

9.5.1.5 Personnel Qualification and Training

The fire-fighting training program, testing, and inspection are discussed in Subsection 13.2.4.

9.5.2 Communications Systems

9.5.2.1 Design Bases

A comprehensive communications system is provided to ensure reliable intraplant communications, offsite commercial telephone service, and offsite emergency communications capabilities. Effective communication between personnel during startup, operation, shutdown, refueling, and maintenance is made possible by the use of an adequate number of telephones, public address speakers, and two-way radios.

The public address speaker system and the two-way radio repeaters are powered from emergency power bus 72B. The other diverse means of communications are physically independent to preclude the loss of all systems as a result of a single failure.

An emergency alarm system is installed that provides an alarm signal to ensure personnel evacuation.

9.5.2.2 System Description

9.5.2.2.1 Two-Way Radio

Two separate communication channels of unique wave lengths for operations personnel and for maintenance personnel are provided to enable two-way radio communication between the main control room and the various plant buildings. The main control room is equipped with handheld microphones on each panel section and at the operations desk console. Portable transmitter-receivers of the hearing-protector headset and boom-mike type, operating on either or both channels, are provided for use by the operations and maintenance personnel for communication between various areas of the plant.

To improve reception from the various plant buildings, monitor receivers are provided in these buildings. The radio transmitter carrier frequencies are chosen so that no interference with the reactor building or turbine building radio-controlled crane is possible.

9.5.2.2.2 Hi-Com (Public Address) System

The Hi-Com system provides two separate and independent channels of communication, namely page and party lines. The Hi-Com loud-speakers are powered by individual amplifiers, and the system is supplied from the ac emergency system, which is powered by the EDG upon loss of normal offsite power.

The system layout permits communication between the main control room and site buildings and areas of the plant. The volume level of each Hi-Com channel is adjusted to be louder than the ambient background noise level. For high-noise areas where ear protection is required, or site emergency evacuation notification is not broadcasted, special arrangements for evacuation notification have been provided as described in Subsection 9.5.2.2.4.

The handsets permit channel switchover from paging to party line conversations between any two or more handset stations.

9.5.2.2.3 Telephone System

An independent dial telephone system is provided to facilitate simultaneous conversations between extensions which are located throughout the plant and Detroit Edison network. The main control room is provided with telephones, some of which have access to the Edison network via microwave and also have access to the local telephone company exchange via land line. Incoming calls are received automatically from either network. Microwave provides backup offsite communication in the event of loss of land line resulting from environmental conditions. A telephone is installed in each elevator.

9.5.2.2.4 Emergency Alarm System

The emergency alarm system is designed to broadcast distinct signals using the plant Hi-Com system to the plant. This alarm system is activated from the control room, and different tones have been provided. Activation of the emergency alarm system automatically adjusts the output volume level of each Hi-Com station to a preferred level of 10 dB above the calculated background noise. If the preferred level of 10 dB (above background noise) cannot be obtained, a speaker output of not less than 7 dB above the calculated background noise is acceptable. In Hi-Com broadcast areas where the 7 dB differential could not be obtained or the background noise exceeds 95 dB, visual beacons are provided for emergency notification. For high-noise areas where ear protection is required or site emergency evacuation notification is not broadcasted, special arrangements for evacuation notification are provided by damage and rescue team searches. If a plant area evacuation is required, the Emergency Director (Shift Manager - short term or Executive Director - Nuclear Production - long term) will dispatch the damage and rescue team after Security receives notification of missing personnel.

9.5.2.3 Inspection and Testing Requirements

All communication systems were inspected and tested at the completion of installation to ensure their operability. Most of the systems, except for the emergency alarm system, are used daily and hence do not need any special testing. Testing of the emergency alarm system is carried out on a routine basis.

9.5.3 Lighting Systems

9.5.3.1 Design Bases

The lighting system is designed to provide indoor and outdoor illumination during normal plant operation and during shutdown. During failure of offsite power sources, the system provides alternative emergency lighting to critical facilities.

9.5.3.2 System Description

The lighting system is composed of the normal facilities, the emergency facilities, and the special lighting for the main control room.

The normal area lighting system consists of fixtures and facilities placed in areas of the plant to meet the target light intensities identified by the Illuminating Engineering Society (IES) for nuclear power plants and industrial facilities. In general, high intensity discharge (HID) lighting is used for general area lighting with florescent lighting used for office areas, entry points and stairwells. Provisions for containment of mercury containing elements are made where breakage of the bulbs could potentially result in direct mercury intrusion into the reactor coolant.

Normal lighting for the plant buildings is supplied by a grounded 480/277-V and 208/120-V, three-phase, four-wire distribution system from the distribution receptacle panels located in the reactor, auxiliary, and radwaste buildings. These panels receive power from the 480-208/120-V lighting transformers that are powered by 480-V switchgears in the master distribution panels.

Lights that utilize the 480/277-V system are directly supplied from the master distribution panels. The receptacle panels are conveniently located throughout the plant to permit efficient distribution of the lighting load.

One-third of the lights in vital operating areas such as the main control room, RHR complex, reactor building, safety-related equipment areas and access routes, stairwells, and exits are powered by the ESF 480-V buses so that an offsite power failure does not produce a total blackout in these areas. In addition, emergency lighting units consisting of battery-operated sealed-beam units capable of 8 hr of continuous operation are provided in these critical areas of the plant where operator action is required within 8 hrs for safe shutdown in the event of a fire. Emergency lighting for Station Blackout (SBO) is provided by these 8-hr Appendix R Fire Protection units where they exist, or by 4-hr emergency battery lights where Appendix R lighting units are not required. These are activated automatically on loss of normal power. Adequate redundancy is provided in the emergency lighting equipment.

9.5.3.3 Safety Evaluation

Provision of normal power supply, diesel generator power, and individual batteries to the lighting system, together with physical separation and redundancy in the system, ensures dependable lighting to all critical areas at all times.

9.5.3.4 Inspection and Testing Requirements

Periodic inspection of the lighting system, including batteries and simulation tests to monitor operation for the automatic actuation of the emergency lighting, is performed to ensure a reliable lighting system.

9.5.4 Diesel Generator Fuel-Oil Storage and Transfer System

9.5.4.1 Design Bases

The diesel generator fuel-oil storage and transfer system is designed to perform its operational function automatically during emergency conditions. Each diesel generator is furnished with an individual fuel-oil storage tank.

The onsite storage capacity of each of the fuel-oil storage tanks is determined on the basis of continuous operation of the diesel generators for 7 days at continuous load. In addition, the storage capacity includes requirements for testing of the diesel generators. Full day tanks provide more than 2 hr of fuel supply to each diesel generator.

The system complies with Appendix B of ANSI Standard N195-1976, "Fuel Oil Systems for Standby Diesel Generators" and is designed to Category I requirements. The system piping and as much equipment as practicable are designed to either ASME B&PV Code Section III, Class 3 or the Diesel Engine Manufacturers Association (DEMA) standards as shown in Figures 9.5-4, 9.5-5, and 9.5-6. The diesel generator fuel-oil storage and transfer system for each diesel generator is separate and is located in separate compartments. The system is housed in the RHR complex, and, as such, is protected from flooding, tornado winds, and missiles. Adequate fire protection is provided and fire walls separate each compartment containing the individual diesel generator and its associated systems.

The ventilation system for the diesel generator room and CO_2 storage tank room is designed to maintain room temperatures between 65°F and 104°F when the diesel is not operating. The ventilation system for the fuel oil storage room is designed to maintain room temperatures between greater than 32°F and 104°F when the diesel is not operating. When the diesel is operating, the ventilation system is designed to maintain the temperature in the fuel oil storage tank room and the CO_2 storage tank room below 125°F. A separate ventilation system maintains the diesel generator room below 122°F when the diesel is running.

Provisions are made for independently testing redundant components.

9.5.4.2 System Description

Four 2850-kW diesel-engine-driven generators power the ESF buses and are located in the RHR complex. The fuel-oil storage and transfer system is shown in Figures 9.5-4, 9.5-5, and 9.5-6. Power to all of the auxiliaries for each diesel generator is fed from the respective diesel generator.

Each diesel generator set is supplied by a 42,000-gal diesel-fuel storage tank located adjacent to the associated diesel generator. The capacity of the storage tank is based on 7 days fuel supply at 210 gal/hr, plus fuel requirements for routine engine testing. The fuel-oil day tanks are of 550-gal capacity. Two redundant motor-driven fuel-oil transfer pumps deliver fuel to the day tank. Fuel flows by gravity from the day tank to the suction of the engine-driven fuel pump.

The engine driven pump is safety related and required to operate in order to mitigate a design basis accident. An electric motor driven fuel pump is also provided to purge air from the fuel line following maintenance on the fuel oil system. The electric motor driven fuel pump will receive a start signal if a low pressure condition exists on the supply side of the duplex filter. Although the electric motor driven pump is not credited to operate during a design basis accident, it is considered to be a passive safety-related pump. Both pumps supply fuel to the engine fuel injectors.

One transfer pump is started automatically when the diesel generator starts and the day tank overflow is routed to the fuel-oil storage tank. The other transfer pump is started automatically by a low-level switch on the fuel-oil day tank.

The fuel oil storage tanks are filled from tanker trucks through yard couplings and are vented above grade. Each storage tank is fitted with level sight glasses and high- and low-level alarms. Each day tank is fitted with a level sight glass and low-level alarm. Redundant motor-operated and manual valves for draining of the storage tank are provided.

Fuel quality in the storage tanks is ensured by using two strainers between the storage tank and the fill line connection and by performing delivery and periodic sampling for water and sediment. Each of the four EDGs has redundant fuel transfer pumps and separate fill lines to each day tank from each storage tank. Each transfer pump is fitted with a strainer. In addition, between the day tank and the EDG skid there is a strainer for the engine-driven fuel-oil pump line and a duplex filter before the fuel injectors.

The day tank is kept full, and, as required, one of the transfer pumps automatically operates (with the other pump in standby) to maintain the tank level. If sediment plugs the running pump's strainer and the day tank level drops, the alternate transfer pump will automatically start and the low level alarm will sound if the level continues to drop. The plugged strainer can be cleaned by blowing down within the time interval established by the fuel inventory remaining when the low level alarm sounds. Also, the strainers at the fuel transfer pumps and between the day tank and the EDG have pressure differential indicators that are to be monitored during monthly testing.

9.5.4.3 Safety Evaluation

The diesel generator fuel-oil storage and transfer system is designed to Category I requirements and also to withstand any single failure and still satisfy the design requirements. Although any single failure may result in loss of fuel to one diesel generator, the plant demand is met by the remaining three diesel generators. There are no common components of the fuel-oil system between any EDGs. The diesel generator and its associated fuel-oil storage tank, fuel-oil day tank, transfer pumps, and piping are physically separated and adequately protected against tornado missiles, flooding, and fire. The EDG fuel-oil storage tank room is designed to contain the entire volume of oil and the floor drains are sized to handle the fuel oil and sprinkler volumes. Refer to Subsection 9.3.3 for details.

Independent thermal detectors for fire detection are provided in each diesel generator compartment. Automatic fire-fighting systems such as carbon dioxide and wet-pipe sprinkler systems are also provided. In the event of a fire, fuel oil from the storage tank can be dumped to a basin in the yard by opening the dump valves from the main control room. See Subsections 9.5.1.2.3.3 and 9.5.1.2.3.5 and Appendix 9A.

No shortage of fuel supply can be reasonably anticipated, because low-level alarms are periodically inspected and an ample fuel supply is ensured, both by redundant equipment and by conservatively sized reserves. Arrangements are made for the procurement of additional supplies of oil when needed.

The diesel-fuel-oil storage tanks are fabricated from ASME-SA285, Grade C carbon steel. The piping and tanks are inside the RHR complex, and hence no corrosion problems are anticipated during the life of the plant.

9.5.4.4 Inspection and Testing Requirements

All components of the diesel-generator fuel-oil storage and transfer system are tested after installation in accordance with the applicable codes. The Preoperational Test program verifies system performance including indicating instrumentation and alarm signals. Operation of the fuel-oil system is tested by periodic operation of each generator under load.

9.5.4.5 Instrumentation Application

Each diesel-fuel-oil storage tank and fuel-oil day tank is provided with local level sight glasses. High- and low-level alarms for the storage tank and low-level alarm for the day tank are provided. Fuel transfer pump motors are provided with automatic starting circuits and standard Institute of Electrical and Electronics Engineers protection.

Remote operation of each transfer system is possible from the main control room.

9.5.5 Diesel Generator Cooling Water System

9.5.5.1 Design Basis

The diesel generator cooling water system is designed to provide adequate cooling water to remove the heat given off by the lube-oil coolers, inlet air coolers, and the engine jacket coolant heat exchangers. The engine jacket coolant system, which is a closed loop system, removes heat from the engine and transfers it to the diesel generator service water system. The diesel generator service water system is part of the RHR service water (RHRSW) system described in Subsection 9.2.5.

The jacket coolant system is designed to Category I requirements and the system piping, valves, and heat exchangers meet either the requirements of the ASME B&PV Code Section III, Class 3, the DEMA standards, or Group D (ANSI B31.1), and are seismically supported as shown in Figures 9.5-7 through 9.5-9.

9.5.5.2 System Description

The diesel generator service water system, which supplies cooling water from the RHR reservoir to the diesel generator components, is described in Subsection 9.2.5.

The diesel generator jacket coolant system shown in Figure 9.5-7 is described in this section. Each diesel generator is provided with a separate and independent jacket coolant system.

Major components of the system are an expansion tank, an engine-driven jacket coolant pump, an engine-driven air-cooler coolant pump, a standby coolant circulating pump, a heat exchanger, an air cooler, a standby heater, a three-way thermostatic bypass valve, a three-way air-operated bypass valve, high- and low-temperature alarms, low-pressure alarm, and indicators for pressure and temperature.

The jacket coolant is demineralized water with corrosion inhibitors. The engine-driven coolant pump maintains coolant circulation in the closed loop during diesel generator operation. The expansion tank accommodates the volume changes in the coolant due to temperature changes and also provides a means for venting the system. In addition, the expansion tank is to provide for minor system leaks at pump shaft seals, valve stems, and other components, and to maintain the net positive suction head (NPSH) on the system recirculating pump. System losses are made up by adding demineralized water to the expansion tank. The cooling-water expansion tank for each diesel engine has a capacity of 57 gal. The EDG manufacturer considers this tank size adequate to maintain continuous full-load operation for 7 days under normal conditions. To provide the required pump NPSH, the bottom of the expansion tank is located at an elevation of 603 ft, which is above the highest point of the engine cooling system (Elevation 601 ft).

The heat removed by the coolant from the engine is transferred to the diesel generator service water through a heat exchanger. To maintain the coolant temperature in the proper operating range, a three-way thermostatic valve controls the amount of coolant passing through or around the heat exchanger. The orifices in the bypass lines across the heat exchanger are sized based on the system piping and equipment pressure losses to provide design flows through the heat exchanger. To ensure quick starts, a motor-driven standby circulating pump maintains the jacket coolant temperature at approximately 110°F by pumping the coolant through a thermostat-controlled electric heater.

The system instrumentation consists of a low-level expansion tank alarm, a jacket coolant high- and low-temperature alarm, a jacket coolant low-pressure alarm, and system pressure and temperature indicators.

The jacket coolant also cools the scavenger air in a separate subloop of the engine jacket coolant system. This closed loop system has an engine-driven coolant pump, heat exchanger, and three-way air-operated bypass valve. This valve is automatically adjusted to maintain proper scavenger air temperature. The coolant loop is connected to the jacket water expansion tank for both filling and venting. Reliable cold fast starting requires initial EDG combustion air having a temperature of greater than 40°F. The RHR Complex Heating System, which normally maintains the EDG room temperature above 65°F, is relied upon to maintain the temperature of the initial combustion air above the 40°F design minimum required for reliable fast, cold starting of the units.

9.5.5.3 Safety Evaluation

Each diesel generator has independent jacket coolant and service water systems. The jacket coolant system meets the single- failure criterion in that if a failure in the system prevents the operation of its associated diesel generator, the remaining diesel generators will provide adequate emergency power to meet the safe-shutdown requirements of the plant.

The jacket coolant system is housed within Category I structures and the system piping, valves, and heat exchanger meet the seismic and other code requirements specified in Subsection 9.5.5.1.

9.5.5.4 Inspection and Testing Requirements

Inspection and testing of the system are performed as a part of the overall engine performance checks and routine scheduled engine testing. Instrumentation provided for expansion tank level and coolant temperature is inspected regularly. The jacket coolant chemistry is checked periodically and suitably treated to maintain desired quality.

9.5.6 Diesel Generator Starting System

9.5.6.1 Design Bases

Each diesel generator is equipped with a separate starting system to provide cranking power on demand. A compressed-air starting system is employed to provide fast starts and high reliability.

Each starting system includes separate air receivers, piping, and air start distributors and can independently start the EDG. The combined capacity of the two air receivers per system is sized to provide compressed air for starting a diesel generator five times without recharging.

One air compressor is provided for each diesel generator and automatically recharges the air receivers to normal operating pressure when required. Piping is provided to cross-connect the EDG Air Compressors so that one EDG’s air compressor can charge the air receiver for both EDGs within a division.

The system piping and components, excluding the air compressors, dryers, and piping upstream of the air receiver inlet check valves, are designed to Category I requirements, and are also designed and constructed in accordance with ASME B&PV Code Section III, Class 3 where practicable. Code classifications are identified in Figures 9.5-8 through 9.5-10. The system is protected from tornado winds, external missiles, and flooding since it is housed in the RHR complex. Separation is provided between systems so that failure of one starting system disables only the associated diesel generator.

9.5.6.2 System Description

The starting system for each diesel engine consists of a motor-driven air compressor which keeps two air receivers pressurized at all times. A separate compressed-air line from the outlet of each of these air receivers serves the start distributors for the air-over-piston starting mechanism. On the inlet side of each of the air receivers, a check valve has been provided to prevent backflow to the compressor. The diesel generator starting system is shown in Figures 9.5-8 through 9.5-10.

The air receivers have low-pressure alarms, pressure indicators, and low-pressure switches to start the motor-driven air compressors and thus ensure that the air receivers are filled with air to the required pressure for EDG standby. One air compressor can be manually valved to charge the air receivers for both EDGs within a division. This operation is for temporary situations and may require manual initiation of the air compressor. The air receivers are equipped with drain valves that are manually opened to drain moisture accumulation. In addition, a refrigerated air dryer is provided between the compressors and the receivers to ensure that the air supplied is adequately dehumidified. Relief valves are provided on the air receiver and on the discharge piping from the compressor to prevent overpressurization.

There are two air start subsystems for each EDG. The two subsystems increase the reliability of an air start in the case of a failure due to fouling of an air start valve with contaminants and moisture. The use of air strainers further precludes the fouling of the air start system.

9.5.6.3 Safety Evaluation

The diesel generator starting system, excluding the air compressor, is designed to Category I requirements and is located inside the RHR complex. The starting system for each diesel generator is independent and physically separated from starting systems of other diesel generators.

Failure of a motor-driven air compressor or the piping up to the air receiver check valves does not prevent the functioning of the starting system. Similarly, manually operating an air compressor connected to all EDG air receivers within a division does not affect the function of the starting air system as an operable EDG only requires that the air receivers be charged, regardless of the source of air. A single failure of the air receiver, starting solenoid valves air distributor, or connecting piping does not prevent the starting of the EDG. Adequate redundancy is provided in the number of diesel generators to effectively perform the required safety functions.

9.5.6.4 Inspection and Testing Requirements

The system is operated and tested initially for flow path obstructions, leaks, flow capacity, and mechanical operability. The low-pressure alarms are calibrated and the low-pressure switch is checked to ensure reliability of compressor activation. Relief valves are set and checked. The diesel generator starting system was tested as part of the Preoperational Test program as discussed in Chapter 14. Subsequent testing is scheduled to meet plant Technical Specifications.

9.5.6.5 Instrumentation Application

The air receivers are provided with pressure indicators, low-pressure alarms, and low-pressure switches to activate the air compressor. Local manual starting of the air compressors is possible.

9.5.7 Diesel Generator Lubrication System

9.5.7.1 Design Bases

The diesel generator lubrication system is designed to provide adequate engine lubrication under all operating conditions, including immediate full-load operation after starting. The system maintains the lube-oil temperature in the specified range under all loading conditions and ambient temperatures.

The system is designed to Category I requirements and meets the DEMA or Quality Group D design and construction requirements except for the lube-oil cooler, which is designed and constructed in accordance with ASME B&PV Code Section III, Class 3 requirements. Specific code classifications are shown in Figures 9.5-4, 9.5-5, and 9.5-11.

9.5.7.2 System Description

The diesel generator lubrication system is shown schematically in Figure 9.5-11. This system is an integral part of the diesel generator package and is supplied by the vendor. Each diesel generator has a separate and independent lube-oil system.

Major components of the system are: a lube-oil tank, an engine-driven lube-oil pump, a lube-oil circulation pump and heaters, a full-flow lube-oil filter with an internal relief valve, a thermostat three-way bypass valve, a lube-oil cooler, a full-flow strainer, three lube-oil pressure switches, high- and low-temperature switches, a motor-driven prelube pump, and panel-mounted temperature, pressure, and crankcase vacuum gages.

The lube oil flows by gravity from the lube-oil tank to the sump located at the base of the engine. Lube-oil flow to the engine is regulated by a level control switch. The engine-driven lube-oil pump takes oil from the sump through a suction strainer and passes it through a full-flow filter. The lube-oil filters are equipped with a pressure indicator and an oil sample tap. Depending on the oil temperature, the thermostatically controlled three-way valve on the discharge side of the filter directs the lube oil through or around the lube-oil cooler. The lube oil is cooled by the diesel generator service water system, which flows through the tubes of the lube-oil cooler. Before being delivered to the engine, the lube oil passes through a three-element strainer that removes large particles that might have become entrained in the oil.

A 2-hp motor-driven prelube pump, which can be manually operated from the remote panel, is provided for prelubricating the engine prior to nonemergency starts. Prelubrication is not required on emergency starts. However, a vendor-supplied prelubrication piping modification is installed and eliminates the potential for dry starts. This piping routes the keep-warm system so that it discharges into the upstream side of the lube-oil strainer. This will provide continuous lube oil to the lower bearings and greatly reduce voids in the lube-oil system. The solid lube-oil system will provide faster lubrication of the upper bearings on the starting of the diesel and the engine-driven pump.

For purposes of lubrication on the bearings of the upper crankline, operating procedures require approximately 2 minutes of prelubrication prior to planned starts of the diesel generators. Also, operating procedures require, whenever possible, gradual loading and unloading of the diesels to ensure that the bearings are adequately lubricated before they are subjected to the stress associated with high speed and large loads.

The lube-oil headers are routed so that they will not readily drain when the engine is stopped. In addition, lube-oil booster/accumulators are provided for the more remote areas of the engine (aft lower main bearing and upper crankline). This booster system fills with oil during normal engine operation. The next time the engine is started, the lube oil in the accumulator is forced into the subject bearings by starting air pressure, thus filling the bearings with oil as the engine begins to be rotated in starting. A standby motor-driven circulation pump keeps the lube oil in the system warm (when the diesel engine is idle) by passing the oil over thermostatically controlled heater elements and returning the oil to the engine-driven pump discharge.

Three lube-oil low-pressure switches are provided. Actuation of one of the switches causes an audible alarm, and actuation of any two switches shuts down the engine. Three high-pressure switches are provided for the crankcase which actuate an audible alarm and shut down the engine in the same manner as the lube-oil low- pressure switches. The lube-oil tank is provided with high- and low-level switches and alarms and a low-level switch and alarm is provided in the engine sump. In addition, high- and low-temperature alarms, crankcase low-level alarm, pressure gauges, and temperature indicators are provided as shown in Figure 9.5-11.

9.5.7.3 Safety Evaluation

The lube-oil system, including lube-oil storage for each diesel generator, is completely independent of the lube-oil systems of the other diesel generators. Therefore, failure of one lube-oil system results in the loss of only one diesel generator in a division. The other diesel generator in the division, along with the diesel generators in the second division, is adequate to meet the safe-shutdown requirements of the plant.

The lube-oil system is designed to Category I requirements.

The diesel engines are designed to contain a crankcase explosion. The manufacturer conducted actual crankcase explosion tests (20 lb/in.^{2}) and then designed the crankcase inspection cover and fasteners to contain such explosions (100 lb/in.^{2}). These tests showed that the explosion was not harmful to the engine and posed no danger to the operators.

9.5.7.4 Inspection and Testing Requirements

The operability of the lube-oil system is tested and inspected along with the scheduled overall testing of the engine. Lube-oil samples are analyzed and diesel engine main bearing gap checks are performed in accordance with the Technical Specifications.

TABLE 9.5-1 FIRE PROTECTION EQUIPMENT AND DEVICES LIST

I. Water Systems

A. Electric fire pump

B. Diesel fire pump

C. Fire Protection System Jockey Pump

D. Standpipe System

1. Hose reels and connections
2. Yard hydrants inside protected area
3. Yard hydrants outside protected area

E. Deluge Systems

1. Transformer Bay
   a. Service Transformer No. 64
   b. Service Transformer No. 65
   c. Main Transformer No. 2A
   d. Main Transformer No. 2B

2. Radwaste Building Roof
   a. Voltage Regulator Transformer No. 65L (On Roof)

3. Turbine Building
   a. Hydrogen Seal Oil Unit (EL 613'-6")

F. Pre-Action Sprinkler Systems

TABLE 9.5-1 FIRE PROTECTION EQUIPMENT AND DEVICES LIST

1. Service Building
   a. Receiving and Loading Dock Area

2. Outside Protected Area
   a. Piping Warehouse (Warehouse 21)
   b. Piping Warehouse (Warehouse 20)(Fed through Warehouse 21 above)

G. Wet Pipe Sprinkler Systems

1. Reactor Building
   a. RCIC Turbine and Pump and Core Spray Room (EL 540'-0")
   b. HPCI Turbine and Pump Room (EL 540'-0")
   c. Torus Room Floor (EL 540'-0")
   d. Railroad Unloading Area (EL 583'-6")
      Separation Area (EL 613'-6")
   e. Cable Trays (EL 613'-0")
   f. MG Sets/Duct Area (EL 569'-6")

2. Auxiliary Building
   a. Air Compressor Room (EL 551'-0")/Corridor (EL 562'-0")/Cable Trays (EL 562'-0")/Cable Tunnel Trays (EL 562'-0")
   b. Cable Trays (EL 583'-6" and 603'-6")

3. RHR Complex
   a. Emergency Diesel Generator Fuel Oil Tank Room No. 11 (EL 590'-0")
   b. Emergency Diesel Generator Fuel Oil Tank Room No. 12 (EL 590'-0")
   c. Emergency Diesel Generator Fuel Oil Tank Room No. 13 (EL 590'-0")

TABLE 9.5-1 FIRE PROTECTION EQUIPMENT AND DEVICES LIST

d. Emergency Diesel Generator Fuel Oil Tank Room No. 14 (EL 590'-0")

4. Radwaste Building
   a. Storage Area
   b. Extruder Area and Chemical Stores
   c. Drum Storage and Conveyor Area

5. On-Site Storage Facility
   a. Solid Waste/Empty Drum Storage/Compactor Areas/Asphalt Tank and Pump Rooms
   b. Truck Loading/Dry Active Waste Areas

6. Turbine Building
   a. Equipment Hatch
   b. North RFPT Room
   c. Bearing Pits and Under Turbine Area
   d. Used Oil Storage Area
   e. South RFPT Room
   f. RFPT Oil Reservoir Room
   g. Main Turbine oil Reservoir
   h. Cable Tunnel Trays (EL 628'-6")

7. Service Building
   a. Warehouse Storage Area
   b. Material Store/Dead Files

8. Office Building Annex
   a. Record Storage Area

9. General Service Water Pump House

TABLE 9.5-1 FIRE PROTECTION EQUIPMENT AND DEVICES LIST

a. Diesel Engine Fire Pump Room

10. Miscellaneous Buildings Inside Protected Area
    a. Maintenance Oil Storage Building (Warehouse 18)
    b. Availability Improvement Building (AIB)
    c. ISFSI Equipment Storage Building

11. Miscellaneous Buildings Outside Protected Area
    a. Warehouse 19 (Warehouse B)
    b. General Training and Orientation Center (GTOC)(Warehouse 30)
    c. Warehouse 22 (Warehouse G)
    d. Warehouse 23 (Warehouse H)

H. Manual Wet Pipe Sprinkler Systems

1. Auxiliary Building
    a. Cable spreading Room (EL 630'-6")
    (System provides supplemental protection for the Halon suppression system provided for the Cable Spreading Room)

I. Manual Flooding Systems

1. Control Center HVAC Make-up Filter Charcoal Absorber Unit (EL 677'-6")
2. Reactor Building HVAC Recirculation Filter Charcoal Absorber Unit (EL 677'-6")
3. Office Building Annex Charcoal Filter Beds

J. Dry Pipe Sprinkler System Outside Protected Area

TABLE 9.5-1 FIRE PROTECTION EQUIPMENT AND DEVICES LIST

1. FLEX Storage Facility 2

K. Dry Pipe Sprinkler System Inside Protected Area

1. FLEX Storage Facility 1

II. Gaseous Systems

A. Carbon Dioxide Suppression Systems

1. RHR Complex
   a. Emergency Diesel Generator Room No. 11 (EL 590’-0”)
   b. Emergency Diesel Generator Room No. 12 (EL 590’-0”)
   c. Emergency Diesel Generator Room No. 13 (EL 590’-0”)
   d. Emergency Diesel Generator Room No. 14 (EL 590’-0”)

2. Auxiliary Building
   a. Cable Tunnel (EL 613’-6”)
   b. Cable Trays (EL 631’-0”)
   c. Outside Division II Switchgear Room (EL 643’-6”)

3. Standby Gas Treatment System
   a. Standby Gas Treatment System Charcoal Filter Beds (EL 677’-6”)

B. Carbon Dioxide Hose Reel Stations

1. Outside the Relay Room (EL 613’6”)
2. Outside the Division I Switchgear Room (EL 613’6”)
3. Inside the Division II Switchgear Room (EL 643’6”)

C. Halon Suppression Systems

TABLE 9.5-1 FIRE PROTECTION EQUIPMENT AND DEVICES LIST

1. Auxiliary Building
   a. Relay Room (EL 613'-6")
   b. Cable Spreading Room (EL 630'-6")
   c. Computer Room (EL 655'-6")
   d. Computer Room Sub Floor (EL 655'-6")

2. Service Building
   a. Electrical Equipment Room
   b. Central Alarm Station

3. Office Building Annex
   a. Computer Room (Above Floor)
   b. Computer Room (Sub Floor)

4. Guard House
   a. File Room
   b. Secondary Alarm Station

D. Clean Agent Suppression System
   1. Parts of Radwaste Building
   2. Security Diesel Generator Enclosures

III. Confinement Control

A. Compartmentalization of structures with fire doors

B. Fire dampers in ventilation systems

C. Roof vents in Turbine Building Area

D. Remotely resettable smoke dampers in Carbon Dioxide suppression

TABLE 9.5-1 FIRE PROTECTION EQUIPMENT AND DEVICES LIST

system protected areas

IV. Detection Systems

A. Thermal Detection

B. Photoelectric Detection

C. Ionization Detection

D. Infrared Detection

TABLE 9.5-2 FAILURE MODE AND EFFECTS ANALYSIS: INADVERTENT OPERATION OF SAFETY-RELATED FIRE PROTECTION SYSTEM

Fire Protection System	Safety-Related Equipment Protected	Results of Inadvertent Operation of Fire Protections System
HPCI turbine room sprinkler system	HPCI turbine	Loss of HPCI turbine. HPCI not needed for normal shutdown of reactor. Backup LOCA protection provided by automatic depressurization system and low-pressure ECCS
RCIC turbine room sprinkler system	RCIC turbine, core spray pumps	Loss of RCIC turbine. RCIC not needed for normal shutdown. If Division I reactor is isolated, backup protection provided by HPCI. Core spray pump motors are dripproof
M-G set oil coupler and oil cooler sprinkler system	Reactor building structure	Recirculation pumps lost if M-G sets lost. Recirculation pumps not needed for shutdown of reactor
EDG CO_2 system	EDG	Operation of CO_2 system will not hinder operation of an EDG
Diesel-fuel-oil storage room sprinkler system	EDG fuel-oil tanks, day tank, lube-oil tank, and fuel-oil transfer pumps	Tanks will not be affected, but transfer pumps could be lost. An EDG can run 2 hr without fuel-oil transfer pumps. At most, only one EDG can be lost. EDGs in other division provide backup to shut down reactor
SGTS CO_2 system	SGTS charcoal beds	One division of the SGTS temporarily lost until it is manually restarted. No permanent damage to the charcoal filter beds. Remaining SGTS not affected
Sprinkler system in cable tray area over torus	Cable trays, torus, and reactor building structure	Cable trays not affected by sprinklers. Motor-operated valve operators are dripproof. A sump pump is provided in torus area
Sprinkler system in railroad bay area in reactor building at Elevation 583 ft 6 in.	Division II cable trays	Cable trays not affected by sprinklers
Sprinkler system in reactor building at Elevation 613 ft 6 in.	Divisions I and II cable trays	Cable trays not affected by sprinklers
Sprinkler system in auxiliary building at Elevation 551 ft and 562 ft	Divisions I and II cable trays	Cable trays not affected by sprinklers. Control air compressors in Divisions I and II separated by 65 ft

TABLE 9.5-2 FAILURE MODE AND EFFECTS ANALYSIS: INADVERTENT OPERATION OF SAFETY-RELATED FIRE PROTECTION SYSTEM

Fire Protection System	Safety-Related Equipment Protected	Results of Inadvertent Operation of Fire Protections System
Sprinkler system in auxiliary building at Elevation 583 ft and 603 ft	Divisions I and II cable trays	Cable trays not affected by sprinklers
Halon system in relay room, control center at Elevation 613 ft	Divisions I and II relay cabinets and cable trays	Electrical equipment not affected by Halon system. Ventilation dampers remotely resettable (1)
CO_2 system in cable tunnel, auxiliary building at Elevation 613 ft	Divisions I and II cable trays	Cable trays not affected by CO_2 system
Halon system in cable spreading room, at control center Elevation 630 ft	Divisions I and II cable trays	Cable trays not affected by Halon system. Ventilation dampers remotely resettable (1)
CO_2 system in cable tray area, auxiliary building at Elevation 630 ft	Divisions I and II cable trays	Cable trays not affected by CO_2 system
CO_2 system outside switchgear room in auxiliary building at Elevation 641 ft	Divisions I and II cable trays, motor control centers	Cable trays and electrical equipment not affected by CO_2 control centers system
Halon system in main control room computer under and above floor area, Elevation 655 ft	Main control room	Computer not safety related. Control room habitability discussed in Subsection 9.5.1.2.2 (1)

Note 1): Fire Protection relay failure will cause loss of cooling to relay room, cable spreading room or computer room.

Figure Intentionally Removed
Refer to Plant Drawing M-2135

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-1, SHEET 1

FIRE PROTECTION SYSTEM DIVISIONS I AND II RESIDUAL HEAT REMOVAL COMPLEX P&ID

Figure Intentionally Removed
Refer to Plant Drawing M-2135-1

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-1, SHEET 2

FIRE PROTECTION SYSTEM DIVISIONS I AND II
RESIDUAL HEAT REMOVAL COMPLEX P&ID

Figure Intentionally Removed
Refer to Plant Drawing M-2086

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-2

FIRE PROTECTION SYSTEM
REACTOR AND AUXILIARY BUILDINGS P&ID

Figure Intentionally Removed
Refer to Plant Drawing M-N-2051

FIGURE 9.5-3

FIRE PROTECTION SYSTEM - DIVISIONS I AND II
DIESEL GENERATOR ROOM P&ID

Figure Intentionally Removed
Refer to Plant Drawing M-N-2048

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-4
DIESEL-FUEL-OIL SYSTEM AND LUBE OIL SYSTEM
DIVISION I - RESIDUAL HEAT REMOVAL COMPLEX
P&ID

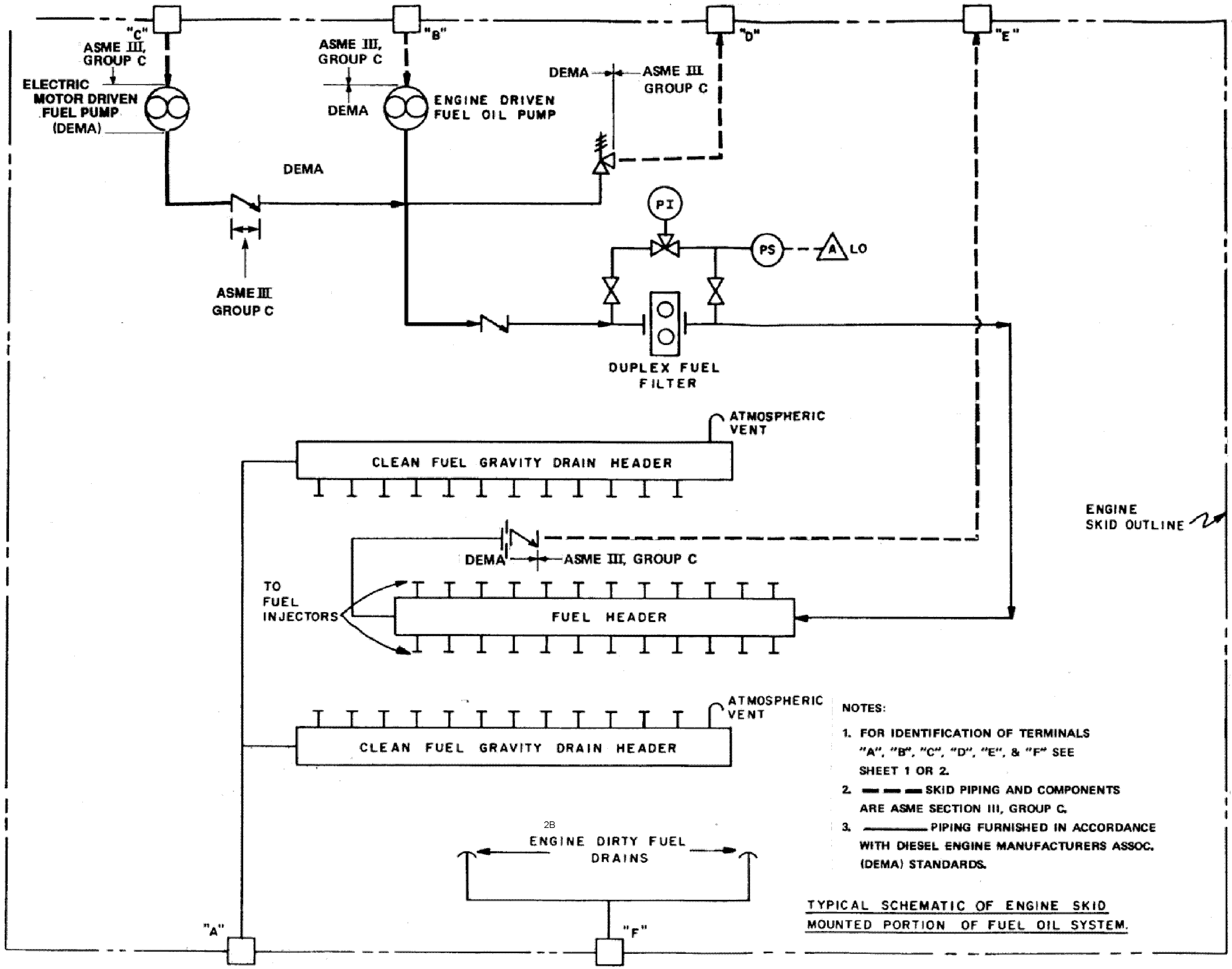
Figure Intentionally Removed
Refer to Plant Drawing M-N-2049

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-5

DIESEL-FUEL-OIL SYSTEM AND LUBE OIL SYSTEM
DIVISION II - RESIDUAL HEAT REMOVAL COMPLEX
P&ID



NOTES:

1. FOR IDENTIFICATION OF TERMINALS "A", "B", "C", "D", "E", & "F" SEE SHEET 1 OR 2.
2. — — — SKID PIPING AND COMPONENTS ARE ASME SECTION III, GROUP C.
3. ———— PIPING FURNISHED IN ACCORDANCE WITH DIESEL ENGINE MANUFACTURERS ASSOC. (DEMA) STANDARDS.

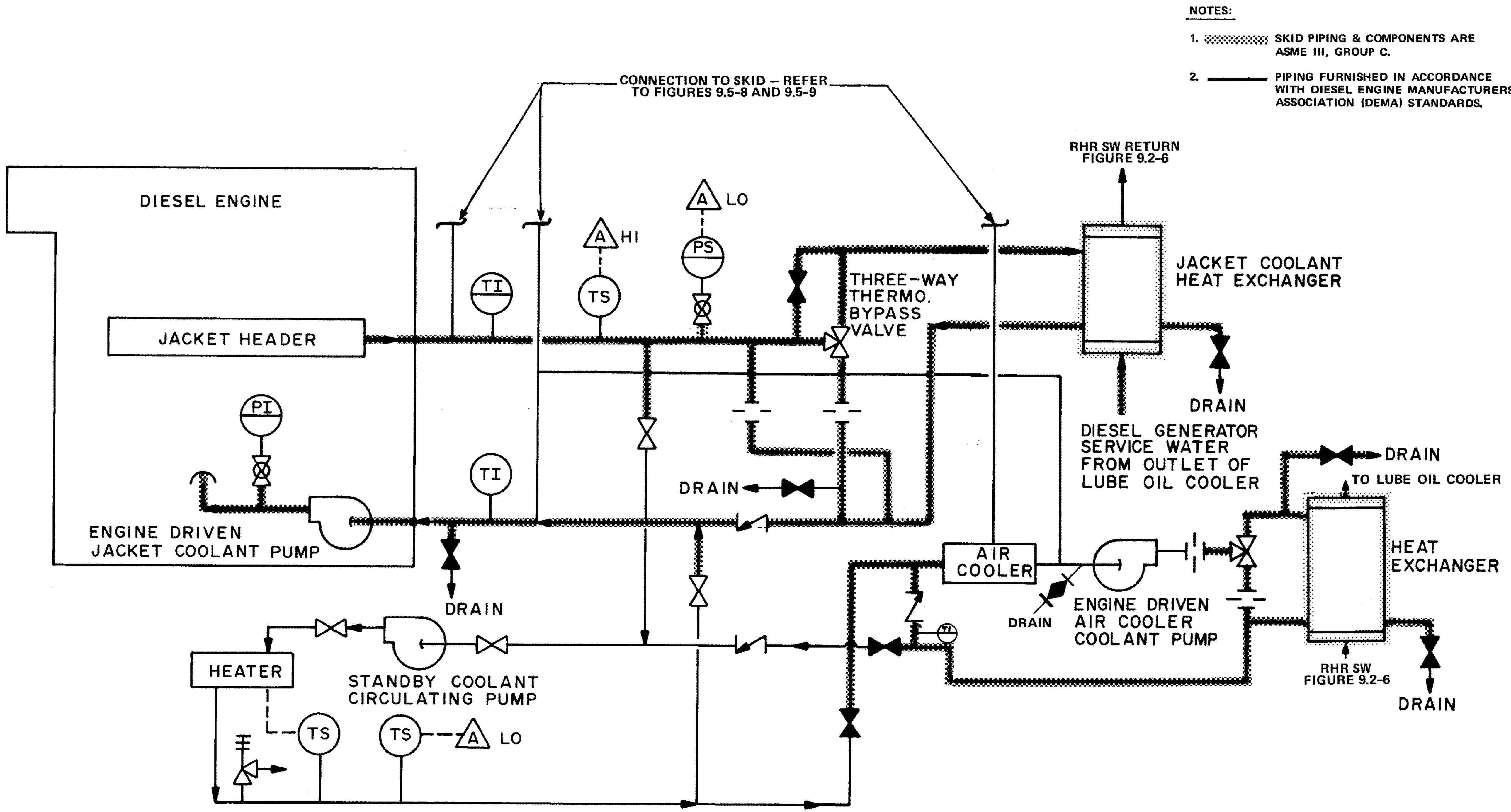
TYPICAL SCHEMATIC OF ENGINE SKID MOUNTED PORTION OF FUEL OIL SYSTEM.

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-6

ENGINE-SKID MOUNTED DIESEL-FUEL-OIL SYSTEM



Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-7

DIESEL GENERATOR JACKET COOLANT SYSTEM

Figure Intentionally Removed
Refer to Plant Drawing M-N-2046

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-8

DIESEL GENERATOR SYSTEM
DIVISION-RESIDUAL HEAT REMOVAL COMPLEX
P&ID

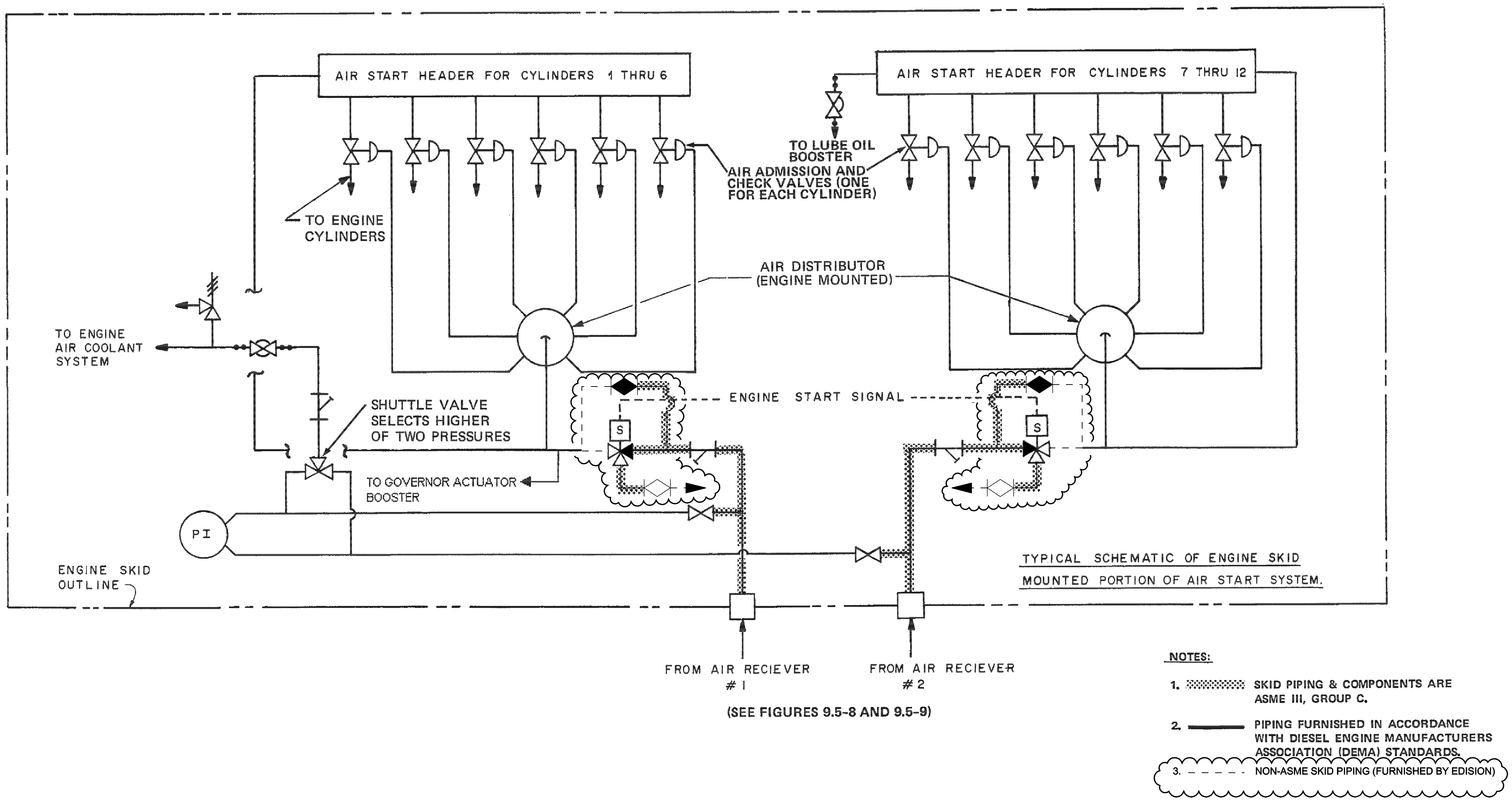
Figure Intentionally Removed
Refer to Plant Drawing M-N-2047

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-9

DIESEL GENERATOR SYSTEM
DIVISION II - RESIDUAL HEAT COMPLEX
P&ID

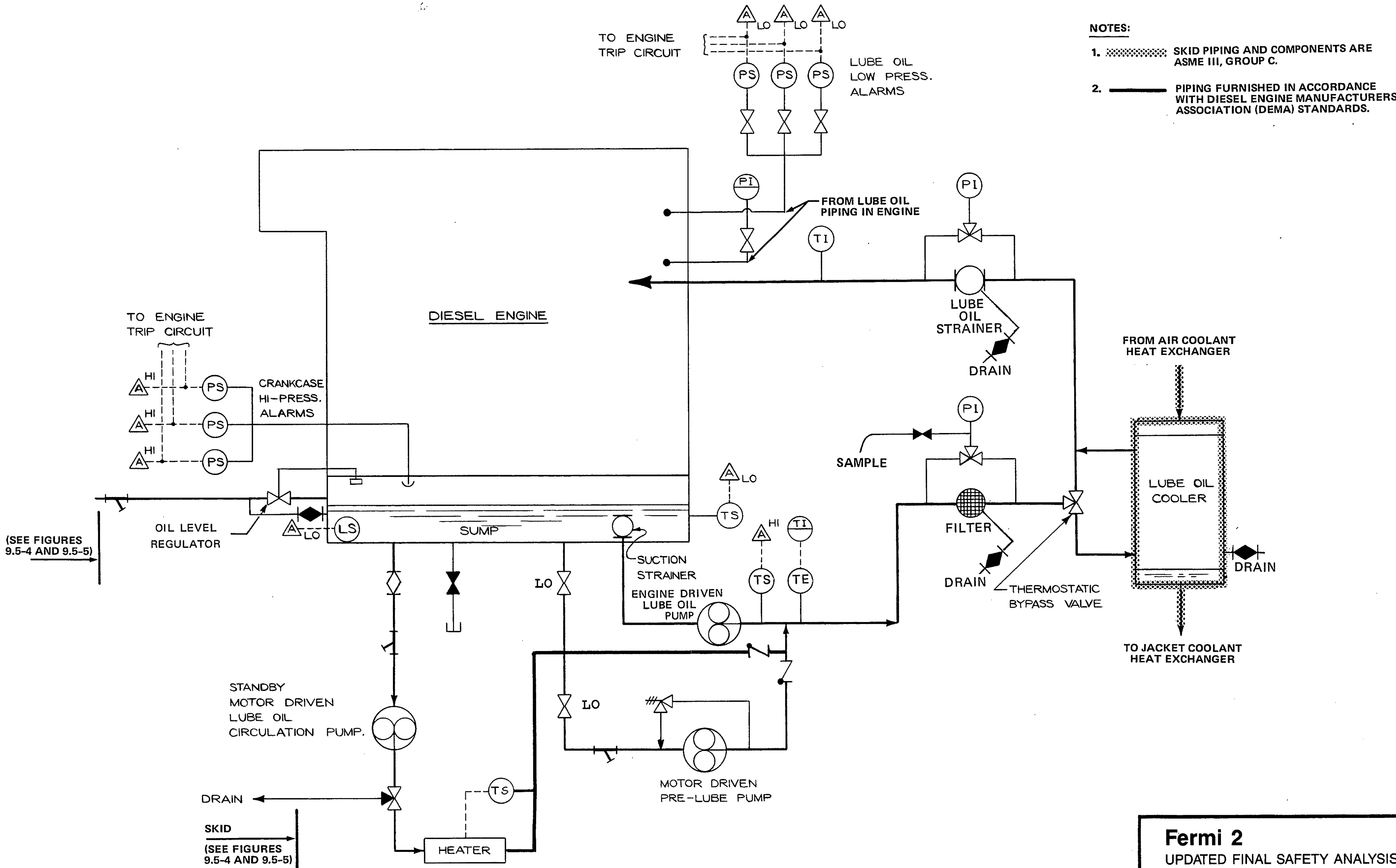


Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-10

ENGINE-SKID MOUNTED DIESEL GENERATOR AIR START SYSTEM



Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-11

DIESEL GENERATOR LUBRICATION SYSTEM

REV 9 4/99

9A.1 INTRODUCTION

9A.1.1 Background and Purpose

9A.1.1.1 General

In a letter dated May 3, 1976, the NRC transmitted to Edison a copy of revised Standard Review Plan (SRP) 9.5.1, "Fire Protection," dated May 1, 1976, which included Branch Technical Position (BTP) APCSB 9.5-1. This revision of SRP 9.5.1 contained new guidelines for NRC staff evaluations of fire protection in its review of nuclear power plant construction permit applications docketed after July 1, 1976. The letter stated (1) that to the extent reasonable and practical, the revised SRP will be used by the NRC staff in evaluating fire protection provisions of operating plants, applications currently under review for construction permits and operating licenses, and future applications for operating licenses for plants then under construction; and (2) that the NRC would provide more definitive criteria or acceptable alternatives for the application of SRP 9.5.1 when available.

In a subsequent letter dated September 30, 1976, the NRC transmitted Appendix A to APCSB 9.5-1, which provides for plants docketed prior to July 1, 1976, certain acceptable alternatives to the positions given in SRP 9.5.1. This letter also directed Edison to conduct an evaluation of the fire protection provisions for Fermi 2. The evaluation must include a fire hazards analysis conducted under the technical direction of a qualified fire protection engineer and performed to the level of detail indicated by enclosure 2 to NRC's letter "Supplementary Guidance on Information Needed for Fire Protection Program Evaluation." In addition, the evaluation must provide a detailed comparison of the fire protection provisions proposed for Fermi 2 with the appropriate guidelines in Appendix A to APCSB 9.5-1, which for Fermi 2, are those designated as "plants under construction and operating plants."

As a result of the correspondence, Edison performed a fire protection evaluation of Fermi 2. The fire protection evaluation consisted of performing a fire hazards analysis, doing a point-by-point comparison to Appendix A of APCSB BTP 9.5-1, developing fire protection related drawings, and evaluating the overall Fermi 2 fire protection program.

This evaluation was conducted by Gilbert Associates, Inc., Reading, Pennsylvania, under the technical direction of W. A. Brannen, who is a qualified fire protection engineer. His qualifications include full membership in the Society of Fire Protection Engineers and registration as a Professional Engineer in fire protection in the Commonwealth of Pennsylvania.

The original evaluation report was submitted as Amendment 10 to the original FSAR in November 1977 and subsequently revised and amended in Amendments 39, August 1981; 45, November 1982; 52, December 1983; 58, July 1984; and post OL Revision 1 in March 1985. It presented the results of the fire protection evaluation (fire hazards analysis), the methodology employed, and a description of the shutdown systems of Fermi 2, as well as a point-by-point comparison to Appendix A of APCSB 9.5-1.

Subsequent Appendix R analyses have been performed and have resulted in the submittal of deviations for specific plant fire zones and the design and installation of an alternative shutdown system. The Fermi 2 safe-shutdown capability and systems are discussed in Sections 9A.3 and 7.5.

During the course of the NRC review, the NRC asked for additional information, which was transmitted in Edison letter EF2-53791, dated June 18, 1981, documenting commitments made by Edison at the fire inspection exit critique of May 15, 1981, and at a meeting in Bethesda, Maryland, on May 27, 1981. Changes to Section 9A.4 described in Edison letter EF2-53791 were incorporated in FSAR Amendment 39.

During 1984, Edison met with the NRC staff several times to resolve staff concerns about the potential consequences of a postulated fire in the Fermi 2 control room. As a result of these meetings, Edison committed to provide an alternative shutdown system that could operate independently of the control center. The basis, the design, and the analysis of this alternative shutdown approach were described in Edison letters to the NRC (EF2-72001 and EF2-71994, dated October 22, 1984, and EF2-72718, dated August 16, 1984). Appropriate information presented in these letters has been incorporated into Section 9A and Subsection 7.5.2.5.

Appendix E, "Safety Evaluation Report on the Fire Protection Program for the Fermi 2 Facility," of Supplement No. 5 to the SER issued March 1985 replaces and supersedes Appendix E of the SER dated July 1981 and SSER 2 dated January 1982. Approval of the Fermi 2 fire protection program is provided in SSER No. 5. Subsequent information and approval are provided in SSER No. 6 dated July 1985.

In the process of updating Section 9A, Generic Letter 86-10 was used as guidance in developing and incorporating Section 9A.6, Fire Protection and Alternative Shutdown System Conditions for Operations.

Since the original Fermi 2 fire hazards analysis, the NRC produced clarification on fire protection features for nuclear power facilities, for example, Generic Letters 81-12, 82-21, 84-09, 85-01, and 86-10. Generic Letter 86-10, "Implementation of Fire Protection Requirements," clarifies such subjects as documentation, deficiency notification, and removal of Fire Protection Limiting Conditions for Operation and Surveillance Requirements from the Technical Specifications. This clarification has been considered in the development of the Fermi 2 Fire Protection Program. Generic Letter 86-10 was used as guidance in developing Section 9A.6, Fire Protection and Alternative Shutdown System Conditions for Operations.

The fire protection system limiting conditions for operation and surveillance requirements have been removed from the Technical Specifications and included in Section 9A.6.

Section 9A.1 presents the results of the fire protection evaluation of Fermi 2. The methodology used and a description of the shutdown systems are presented in Sections 9A.2 and 9A.3, respectively. The fire hazards analysis is presented in Section 9A.4. The point-by-point comparison to Appendix A of APCSB 9.5-1 is provided in Section 9A.5. The fire protection and alternative shutdown system conditions for operations are provided in Section 9A.6.

9A.1.1.2 Documents

The following is a listing of pertinent correspondence with the NRC and of other fire protection program documents. The documents have been incorporated into UFSAR as appropriate.

Letters to the NRC

Date	Number	To	From	Subject
01-28-87	VP-NO-87-0014	NRC	F. E. Agosti	Alternative Shutdown System – Additional Information
12-10-86	GP-86-0014	NRC Region III Keppler	B. R. Sylvia	CTG Diesel Fuel Oil Warmer Installation Clarification
10-14-86	VP-86-0136	NRC Adensam	F. E. Agosti	3L Appendix R Alternate Shutdown Testing
02-20-86	VP-86-0006	NRC Andensam	F. E. Agosti	Deviation Reg-Emergency Lighting
01-21-86	VP-86-0002	NRC Adensam	W. H. Jens	Alternate Shutdown System
01-03-86	VP-85-0221	NRC Adensam	W. H. Jens	Alternate Shutdown System
03-04-85	NE-85-0365	NRC Youngblood	W. H. Jens	Resolution of Certain Fire Protection Issues
12-07-84	EF2-72025	NRC Youngblood	W. H. Jens	Additional Information Concerning Fire Protection
03-07-85	NE-85-0345	NRC Youngblood	W. H. Jens	Request to Revise Draft FERMI 2 Technical Specification 3.3.7.9
02-18-85	EF2-70391	NRC Region III Keppler	W. H. Jens	Additional Fire Protection Information
10-23-85	VP-85-0204	NRC Region III Keppler	W. H. Jens	Amended Final Report of 10 CFR 50.55(e), Item 116 “Potential Deficiency by allowing Freezing of Buried Piping Systems”

Date	Number	To	From	Subject
09-27-84	EF2-72260	NRC Youngblood	W. H. Jens	Additional Information Concerning "Cross-over" Cable Fire Stops and Use of Vinyl Tile Center
10-29-85	VP-85-0202	NRC Region III Keppler	W. H. Jens	Diesel Fuel Oil Warmer
02-04-85	NE-85-0275	NRC Youngblood	W. H. Jens	Additional Fire Protection Information
08-03-84	EF2-72717	NRC Youngblood	W. H. Jens	Submittal…Deviations to Appendix R
10-22-84	EF2-72001	NRC Youngblood	W. H. Jens	Design of Alternate Shutdown Approach
08-16-84	EF2-72718	NRC Denton	W. H. Jens	Alternate Shutdown in the Control Center Complex
10-22-84	EF2-71994	NRC Denton	W. H. Jens	Implementation of Alternative Shutdown at FERMI 2
08-04-84	EF2-69218	NRC Youngblood	W. H. Jens	Transmittal of Fire Protection Information
06-18-85	VP-85-0142	NRC Youngblood	W. H. Jens	Additional Fire Doors and Dampers
01-09-85	NE-85-0030	NRC Youngblood	W. H. Jens	Fire Door Qualification Report

Other Documents

Fire Protection:

Technical Requirements Manual	3.12.1 Fire Detection Instrumentation
Technical Requirements Manual	3.12.2 Fire Suppression Water System
Technical Requirements Manual	3.12.3 Spray and Sprinkler Systems
Technical Requirements Manual	3.12.4 CO_2 Systems
Technical Requirements Manual	3.12.5 Halon Systems
Technical Requirements Manual	3.12.6 Fire Hose Stations

Technical Requirements Manual 3.12.7 Yard Fire Hydrants and Hydrant Hose Houses

Technical Requirements Manual 3.12.8 Fire Rated Assemblies

Dedicated Shutdown System Design Review Summary, February 24, 1986.

Supplement No. 5 of the Safety Evaluation Report - March 1985.

Supplement No. 6 of the Safety Evaluation Report - July 1985.

9A.1.2 Applicable Codes

The following National Fire Protection Association (NFPA) codes were used for guidance in the development of the Fermi 2 fire protection program.

NFPA Code	Edition Used
10	1978
12	1977
12A	1977
13	1980
13A	1976
13E	1973
14	1976
15	1979
20	1970
24	1970
30	1977
72E	1974
72D	1975
198	1972

The 1978 edition was used for other NFPA codes not specifically mentioned above or in Subsection 9.5.1.1.5. Certain deviations to the above listed NFPA codes have been evaluated as being acceptable and are discussed in Subsection 9.5.1.

9A.1.3 Fire Protection Program

9A.1.3.1 Objective and Purpose

The Fermi 2 fire protection program defines the requirements and responsibilities for control of the fire protection equipment and activities and is designed to minimize the adverse effects of fires on safety-related structures, systems, and components and to ensure safe-shutdown capability in the event of a plant fire.

This program has been established to outline the fire protection systems and associated tasks and personnel necessary to perform those tasks to ensure that the fire protection program is effective in minimizing risks associated with fires. Fire protection activities associated with safety-related systems, components, or structures will be conducted in accordance with the provisions of the Operating License.

9A.1.3.2 Description

The fire protection program consists of the following components:

a. Definition of the organizational responsibilities and lines of communication, pertaining to fire protection, between the various positions/organizations

b. Qualification of personnel responsible for fire protection at Fermi 2

c. Composition, duties, and qualifications of the plant fire brigade

d. Establishment and maintenance of the fire protection training program

e. Administrative controls to minimize the amount of combustibles that safety-related areas may be exposed to and the control of potential ignition sources

f. Fire-fighting strategies for safety-related areas

g. Periodic inspection, maintenance, and testing of fire detection and protection systems

h. Training of necessary plant personnel for fire watch duty

i. Assurance that necessary actions are taken to minimize fire risk and repairs are made as soon as practical when fire equipment is taken out of service

j. Procedures that establish a method for design control, procurement, installation, and testing for fire protection in safety-related areas

k. A quality assurance (QA) program so that the requirements for design, procurement, installation, testing, and administrative controls for fire protection in safety-related areas are satisfied

l. The necessary fire protection equipment, communications equipment, and emergency lighting which has been installed in accordance with the fire hazards analysis contained in this appendix.

9A.1.3.3 Organizational Responsibilities

a. The senior onsite nuclear manager is responsible for the operation of Fermi 2 and therefore has overall responsibility for the fire protection program

b. The senior onsite nuclear manager in charge of engineering has been delegated management responsibility for the formulation and effectiveness of the fire protection program

c. Nuclear Engineering is directly responsible for:

   1. Having a qualified fire protection engineer within Nuclear Engineering. This engineer assists in the formation, maintenance, and periodic review of the fire protection program

   2. Establishing and maintaining the overall fire protection program description

   3. Developing and maintaining the fire detection/ protection design and configuration control for onsite facilities and location of the safe-shutdown equipment for fires

   4. Reviewing fire protection practices and evaluating design-related sections of insurance inspections

   5. Ensuring that the fire protection program associated with safety-related systems, components, and structures conforms to NRC requirements by:

      (a) The performance of fire hazards analyses, and evaluations as required

      (b) The review and evaluation of designs in accordance with current fire codes and standards for applicability to the plant

      (c) The evaluation of operating experience reports (i.e., License Event Reports, Safety Evaluation Reports [SERs], Inspection and Enforcement Bulletins, Circulars, and Notices) for the potential impact on plant fire safety.

d. The Executive Director – Nuclear Production has been delegated the responsibility for:

   1. Implementing and coordinating the Fermi 2 fire protection program

   2. Having a fire protection specialist

   3. Organizing and implementing the plant fire brigade. The fire brigade is composed of a minimum of five Plant personnel and shall be maintained onsite at all times.* The fire brigade shall not include the Shift Manager, the Shift Technical Advisor/Operations Shift Engineer, nor the two other members of the minimum shift crew necessary for safe shutdown of the unit nor any personnel required for other essential functions during a fire

* The fire brigade composition may be less than the minimum requirements for a period of time not to exceed 2 hr, in order to accommodate unexpected absences, provided immediate action is taken to fill the required positions.

emergency. To be a fire brigade member, personnel must first complete the required fire brigade training, rad-worker training, and respirator training, and be physically qualified

4. Managing fixed and transient combustibles; flammable and combustible liquids, cutting, welding, and grinding activities, and other ignition sources to minimize associated fire hazards
5. Housekeeping and fire inspection performance
6. Assisting Nuclear Training in development of training programs for the plant fire brigade, fire watch, and site personnel
7. Maintaining, operating, and inspecting fire protection systems, components, and equipment
8. Developing and implementing the fire "Pre-Plans"
9. Developing the maintenance, surveillance, and administrative procedures for the fire protection program.

e. Nuclear Quality Assurance is directly responsible for audits, surveillances, and inspections of the fire protection program including operations, maintenance, and modifications of fire prevention components, equipment, and systems to ensure compliance with procedural and regulatory requirements

f. Nuclear Training is responsible for maintaining the Fire Protection Training Program as follows:

1. Training both onsite and offsite fire brigade personnel.
2. Conducting and evaluating required plant fire drills.
3. Developing plant fire evacuation plans.
4. Training fire protection inspectors.
5. Training fire watch personnel.

g. Onsite Review Organization (OSRO) is responsible for review of changes to the Fire Protection Program per Section 17.2.

9A.1.3.4 Drill

The Frenchtown Fire Department will participate with the plant fire brigade in a drill at least once per year. This requirement may be satisfied as part of the Radiological Emergency Response Preparedness Plan program.

9A.1.3.5 Audits

Audits of the fire protection program shall be performed as specified in Section 17.2.

9A.2 METHODOLOGY - FIRE HAZARDS ANALYSIS

9A.2.1 Introduction

A fire hazards analysis of the Fermi 2 fire protection provisions was originally conducted in accordance with Appendix A to Branch Technical Position (BTP) APCSB 9.5-1. The original fire hazards analysis was based on the design as of April 1977. The original fire hazards analysis concentrated on buildings housing shutdown equipment. The objective of the analysis was to determine the potential effects of a fire at a given location within the plant and then to judge whether a fire at a given location would adversely affect the ability to safely shut down the plant. Specific fire hazards in other buildings and areas were evaluated to determine the effect of a fire on the 3-hr-rated walls separating these buildings and areas from the buildings containing safe-shutdown equipment. Where it was determined that a single fire might jeopardize plant safe shutdown, a design change was implemented. The final analysis and conclusions, as presented in Section 9A.4, were based on the design that incorporated these changes. Subsequent revisions have been made to keep the fire hazards analysis current. Subsequent analyses were due to the change in the rule. These analyses were performed to verify Fermi 2 compliance with the new technical requirements of 10 CFR 50, Appendix R, Sections III.G, J, and O. In this effort Edison reassessed the Fermi 2 fire protection program and performed additional safe-shutdown analyses that resulted in the design and installation of the alternative shutdown system and dedicated shutdown panel. Also, Edison requested deviations from specific conditions of Appendix R. The results of the fire protection evaluations and subsequent analyses of Fermi 2 are included in Section 9A.4.

A deviation is a condition which when analyzed/evaluated does not strictly adhere to the rule but does have conditions which provide an equivalent level of protection to that of the requirements.

The deviations of Fermi 2 from Appendix R are addressed in Reference 1. These deviations provide justification that an equivalent level of protection to that of the technical requirements of Section III.G of Appendix R exists for Fermi 2.

At Fermi 2, fire hazards analyses have been and are performed in two phases: the first is that of an information collection process; the second is the actual analysis and effects evaluation.

9A.2.2 Information Collection

Before a fire hazards analysis can be performed, Fermi 2 plant information is obtained such as plant shutdown equipment, inventory of combustibles, structural fire barriers, and existing and planned fire detection/protection equipment. This information is then reviewed and documented in the fire hazards analysis. As required, the information is then incorporated on the fire protection layout drawings, Figures 9A-1 through 9A-18.

9A.2.2.1 Plant Shutdown Equipment

Plant safe-shutdown operation starts with the reactor at normal full power and terminates with the reactor in the cold-shutdown condition with long-term cooling in operation. Plant safe- shutdown equipment is defined as mechanical, electrical, and ventilation equipment, including instrumentation, controls, and cables, required for the shutdown operation. Shutdown is from the main control room, under normal and abnormal conditions, with certain exceptions. For these exceptions, such as a fire in the control center complex (control room, relay room, and cable spreading room), the plant can be shut down from outside the control room using the alternative shutdown system. Additional information concerning the safe-shutdown sequence is presented in Section 9A.3.

9A.2.2.2 Inventory of Combustibles

The inventory of combustibles and calculation of combustible (fire) loading for all fire zones in the plant is contained in a detailed engineering design calculation. The major types of combustibles inventoried for the fire hazards analysis are petroleum products, electrical insulation, charcoal filters, Thermo-Lag material, and maintenance and operating supplies. The fire loading values (Btu/ft^2) determined in the inventory process are used to calculate the total fire loading of the zone as described in Subsection 9A.2.3.3. The resultant calculated total fire loading for each fire zone is then classified as low, moderate, or high, and this descriptive quantitative term is utilized in the Fire Hazards Analysis in Section 9A.4. These terms are being used as discussed in the Fire Protection Handbook. A <u>low</u> fire load is one that does not exceed an average of 100,000 Btu per square foot of net floor area; a <u>moderate</u> fire load exceeds an average of 100,000 Btu per square foot of net floor area but does not exceed an average of 200,000 Btu per square foot; a <u>high</u> fire load exceeds an average of 200,000 Btu per square foot of net floor area but does not exceed an average of 400,000 Btu per square foot. These terms were developed in British Fire Loading Studies and assume (or allow) even higher load limits in limited isolated areas for each level (low, moderate, or high) but only these average fire load limits are being used for the Fermi 2 Fire Hazards Analysis in order to add conservatism to the analysis.

Petroleum products are defined, for the purposes of the fire hazards analysis, as lubricants and fuel oil. Lubricants are tabulated for all equipment containing 1 gal, or more, of oil. Lubrication of equipment requiring smaller quantities of oil is normally accomplished through sealed bearings or oil/grease cup arrangements that require very small quantities of lubricant. These small quantities are not considered significant to the fire hazards analysis and are not included in specific area/zone fire loadings. Fuel oil for diesel-driven equipment and the auxiliary boiler is discussed in the individual zone analyses.

Transformers inside plant buildings are of dry-type construction and contain no petroleum products.

Electrical insulation consists primarily of cable insulation and jackets. Small quantities of other combustible materials are used in switchgear and control panels. The type of cable insulation used in construction was primarily ethylene propylene. Cables have overall fire-retardant jackets of Neoprene or Hypalon. For purposes of the fire hazards analysis, all cable insulation was assumed to be combustible and to have a heat content of 10,000 Btu/lb (Reference 2). Cables have been type tested in accordance with the flame test of Edison's Specification 3071-80 (Reference 3) and are certified to be of fire-retardant construction. This is equivalent to the IEEE-383 test. Metal cable trays are of either the ladder type without covers or the solid-bottom type with covers (see Subsection 9A.2.3.1.8). Control, instrument, and small power cables installed in trays are random and lie in multiple layers.

Large power cables are installed in a single layer and are spaced. Conduits contain one or more cables. Although some delay in fire propagation through conduits can be expected, no credit is taken for such delay in this evaluation.

Electric Power Research Institute (EPRI) tests have demonstrated that an electrical short will not propagate a fire in the type of cable installed at Fermi 2. Therefore, an exposure fire would be required for propagation of a cable fire. The EPRI test "NP 1881" documents that a minimum of 4 gal of flammable liquid burning for 10 minutes is necessary to cause a cable fire to slowly propagate. In the test, the cable fire self-extinguished after approximately 30 minutes. This indicates the EPR/Hypalon-jacketed cable has a high resistance to fire.

For the fire hazards analysis, cable insulation quantities were estimated using the following procedure:

a. A representative cable size was established for each tray class, based on tray classification (power, control, instrument, etc.)

b. The cable fill percentage per tray was determined from the cable routing database.

c. The insulation quantity was obtained by multiplying the tray length, weight of insulation of the cable size representative of the tray loading and actual tray fill percentage for all areas.

The total insulation weight was obtained through a summation of all trays in the fire zone. The cable tray lengths given in the cable routing database were used rather than measuring the tray length existing in each fire zone. This was a conservative simplifying assumption because the tray numbers do not automatically change where they pass through fire barriers or across fire zones boundaries. Therefore, the full length of the tray is added to the fire zones on both sides of the barrier or boundary. In most areas of the plant, cable in conduit was ignored based on the facts that it is a small percentage of the total cable and that the conservatism in the estimating procedure would offset the cable in conduit.

Insulation in motors is a small quantity in comparison to the quantity of cable insulation. Combustible materials inside instrumentation, control, and relay cabinets mainly consist of cable insulation, bakelite in relay housings, and small quantities of miscellaneous materials.

The Btu content of electrical and instrument cabinets was established based on an investigation of combustibles within several electrical panels at Fermi.

Electrical insulation in motor control centers and switchgear consists mainly of cable insulation. The Btu content was determined by a review of several MCC at Fermi.

Charcoal quantities were estimated based on the size of charcoal filters having comparable flow rates.

Maintenance and operating supplies consist of lube oil, hydraulic fluid, paper, cloth, plastic, and other items required for normal plant operations. In contrast to petroleum products, electrical insulation, and charcoal, which are permanent and are part of the plant design, these combustibles are nonpermanent, may vary with time, and can be moved. For the fire hazards analysis, it is assumed that plant housekeeping procedures will keep nonpermanent combustibles in general plant areas to limited quantities. In those areas where it is known that maintenance and operating supplies must be maintained, estimates are based on previous operational experience.

For fire hazards analyses performed subsequent to the original, the inventory of combustibles has been and is being addressed in accordance with the National Fire Protection Association (NFPA) "Fire Protection Handbook," latest edition. This document was used to determine the criteria for evaluating additions to the combustible inventory in each zone at Fermi 2.

The purpose of the inventory of combustibles (fire loading/ combustible loading descriptive level) is to provide the evaluating fire protection engineer with an approximation of the quantity of combustible hazards within the fire zone or area being evaluated or analyzed. The combustible loading is just one of several factors considered when performing a fire hazards analysis or evaluation. The fire protection engineer also considers the type of combustible, its use, its location, ignition sources, and fire detection and suppression systems within the given zone. These are more important to the evaluation than is the quantity of combustibles. Therefore, these factors are given greater consideration when performing fire hazards analyses and evaluations for Fermi 2.

When new cables, single or in conduit, are added to the plant, their fire loading values are not added to the fire zone's fire loading value because the fire loading value presented by them is insignificant compared to the existing estimates. Cables in conduit are accepted as not contributing to the fire loading of a fire zone or area.

When significant amounts of combustibles as described above or cable trays are added to a fire zone, the combustible loading is reviewed accordingly and its effects evaluated for the affected fire zones.

9A.2.2.3 Review of Structural Fire Barriers

For the original fire hazards analysis, walls, floors, and ceilings were assigned fire-resistance ratings based on their construction. Door ratings were established to conform with the fire rating of the walls in which they are installed. Each penetration in a designated fire barrier is fire stopped with the appropriately rated firestop. Cable tray penetrations through non-rated walls, floors, and ceilings are fire stopped (see Figures 9A-1 through 9A-18). See Subsection 9A.2.3.1.1 for a discussion on internal seals inside electrical conduits penetrating rated fire barriers.

Subsequent design and analysis ensures that the barriers separating safety-related zones will prevent the propagation of fires.

9A.2.2.4 Existing Fire Detection/Protection Equipment

For the original fire hazards analysis, the following information was reviewed concerning existing fire detection and protection equipment:

a. Type and location of fire detector

b. Configuration of fire protection (water) system

c. Type and location of valving

d. Type, capacity, and location of fire pump

e. Type and location of hose reel

f. Type and location of fire extinguisher

g. Location and configuration of permanently installed water sprinkler or deluge systems

h. Location and configuration of permanently installed gaseous fire suppression systems

i. Type of actuation for fire protection systems.

In addition to the above, sprinkler system densities are taken into account in performing fire hazards analyses and evaluations.

9A.2.2.5 Fire Protection Layout Drawings

Fire protection layout drawings (Figures 9A-1 through 9A-18) have been developed to present information related to the fire hazards analysis. The drawings show each safety-related building, including equipment not required for safe shutdown from a fire, fire barriers within each building, the plant shutdown equipment found within each building, and fire detection and suppression equipment. These drawings support the basis for the fire hazards analysis.

9A.2.3 Fire Hazards Analyses and Evaluations

Following information collection and drawing preparation, the original fire hazards analysis was performed.

Subsequent fire hazards analyses are performed using a similar process plus new considerations that have been learned or identified as requiring evaluation. The steps used to perform these analyses and general considerations are discussed below. The detailed analysis for each fire zone, with results, is presented in Section 9A.4.

9A.2.3.1 Identification of Fire Areas/Zones

To provide a systematic analysis that can be updated in the future, the plant is divided into fire areas in accordance with the definitions of BTP APCSB 9.5-1. The fire areas are: fire area RB, reactor building; fire area AB, auxiliary building; fire area TB, turbine building; and fire area RHR, residual heat removal complex. For analytical purposes, the fire areas have been further subdivided into fire zones. Fire zone boundaries occur at existing physical features of buildings such as floors/ ceilings and walls.

Although certain rooms are enclosed by rated fire walls, floors, and ceilings, which by definition makes them fire areas, they are considered zones or parts of a zone for this analysis.

The analysis, discussed in Section 9A.4, is presented on a building-by-building basis.

9A.2.3.1.1 Fire Barrier Penetrations

Fire barrier penetrations are provided with approved rated seals or have been evaluated via a specific fire hazards analysis.

The acceptability of the relay room stairwell seal design for cable tray crossover penetrations is based on fire tests and engineering analysis. This approach was found acceptable in SSER No. 5.

The conduit fire protection research program final report (Reference 11), submitted to the USNRC in 1987 by the Wisconsin Electric Power Company, provides the acceptance criteria to determine if an internal conduit seal is required for electrical conduits routed through rated fire barriers. This acceptance criteria which has been accepted by the USNRC (Reference 9 and Reference 10) is used at Fermi 2 to determine if and when an internal conduit seal is required for those electrical conduits routed through rated fire barriers. This criteria which evaluates each side of the fire barrier separately, is as follows:

a. Conduits that terminate in junction boxes or other noncombustible closure need no additional sealing

b. Conduits that run through an area but do not terminate in that area need not be sealed in that area

c. Conduits smaller than 2" diameter that terminate 1 foot or greater from the barrier need not be sealed

d. Open conduits of 2" diameter that terminate 3 feet or greater from the barrier need not be sealed

Consequently, electrical conduits which do not meet the criteria outlined above, and are routed through rated fire barriers, are provided with rated internal seals as required.

9A.2.3.1.2 Fire Boundaries

Fermi 2 has fire zones that are not enclosed by 3-hr-rated fire barrier boundaries. The barriers were reviewed by the NRC in 1981 and found to provide an acceptable level of protection, as stated in SSER No. 2.

As part of the 10 CFR 50, Appendix R, deviation submittal (Reference 1), additional information and analyses of these unrated boundaries were provided. SSER No. 5 reaffirms the acceptability of the zone boundaries. The unrated boundaries have unsealed openings such as pipe and duct chases, hatches, and open stairwells. Generally, the unrated boundaries are acceptable for one or more of the following reasons:

a. The Fermi 2 design separates Division I and Division II safe-shutdown cables and equipment in the reactor building

b. The lack of combustible materials in the stairwells and open penetrations

c. The large volume of the reactor building wherein heat can be dissipated

d. The installation of automatic sprinklers in areas considered to present a fire hazard and in areas to prevent fire propagation

e. The administrative control of combustible materials and ignition sources within the plant

f. Early-warning smoke detection provides assurance of prompt fire brigade response

g. Cable tray penetrations are fire stopped at boundaries, thereby eliminating cable trays as a means of fire propagation between zones.

The unrated boundaries are: All Reactor Building floors and ceilings; the walls between Reactor Building Fire Zones 01RB and 02RB, 02RB and 03RB, and 03RB and 04RB, as shown in Figures 9A-2 and 9A-3; and the walls between Auxiliary Building zones 14AB and 15AB and the floor between Auxiliary Building zones 13AB and 15AB.

9A.2.3.1.3 One-Hour Protective Envelope

The 1-hr barrier is composed of 3M fire barrier material. Initially, there were some questions whether the 3M material design and installation configuration met NRC requirements. Subsequently, this fire-retardant material was rated by the Underwriters Laboratories as a 1-hr protective envelope. In Reference 4 submittal justification was demonstrated for the 3M material and the design was found acceptable in SSER No. 5.

The 3M material is being used as a 1-hr protective envelope to protect safe-shutdown cables in specific fire zones as delineated in the fire hazards analysis. Also, it has been installed throughout the plant on cables, conduit, and supports of equipment no longer required to be protected for safe shutdown. Therefore, when it is removed for maintenance purposes, it will not be replaced.

3M material has been added to the Auxiliary Building basement to protect cable trays and supports. This protective envelope has been tested by a nationally recognized testing laboratory and qualified as a 1-hour envelope in accordance with current NRC requirements. In addition, tested fire breaks have been added to trays in the Auxiliary Building Basement to ensure that a postulated fire cannot spread through these cable trays in such a manner as to damage redundant safe shutdown components. The specific areas and cable trays protected are described in the fire hazards analysis.

9A.2.3.1.4 TSI Three-Hour Barrier

Thermo-Lag 330-1 material is not used on site as a fire rated material; rather it is used in the following locations as a nonrated continuous smoke and gas barrier as defined in NFPA 101:

a. As a barrier between the Relay room (Fire Zone 03AB) and the control center northeast stairwell on elevation 613’-6” (also Fire Zone 03AB)

b. As a HVAC chase floor on elevation 613”-6” at column H-11 above the cable tray area (Fire Zone 02AB) on 603’-6”

c. As a HVAC chase floor on elevation 630’-6” in the southwest corner of the cable spreading room above the relay room (Fire Zone 05AB)

9A.2.3.1.5 Fire Doors

Doors in rated barriers are either listed or labeled by a nationally recognized laboratory; or have been evaluated via a specific fire hazards analysis. Fire doors R3-13, R3-27, R1-11, and R1-8 have approved deviations as listed in Section 9A.4 and SSERs No. 5 and No. 6.

In this appendix, as related to fire doors, "A" means the door has a 3-hr fire-resistance rating; "B" means the door has a 1-1/2-hr fire-resistance rating; and “C” means the door has a 3/4 hour fire resistance rating.

9A.2.3.1.6 Fire Dampers

Fire dampers installed in fire barrier boundaries at Fermi 2 are 3-hr rated or have been evaluated via a specific fire hazards analysis. In some instances, there are single 1-1/2-hr dampers, two 1-1/2-hr dampers installed in series, and ganged dampers. These conditions and installations have been evaluated and documented (Reference 7 and SSER No. 5).

The fire dampers have been justified based on manufacturer's tests of similar installations, the negligible fire loading on each side of the barrier of concern, and the installation of early-warning fire detection on each side of the barrier of concern.

For more information on fire dampers installed at Fermi 2, see Subsection 9.5.1.2.

9A.2.3.1.7 12-In. Concrete Block Walls

In certain areas of the auxiliary building, 12-in. concrete block walls have been erected to provide separation from other parts of the building. These walls are removable to facilitate equipment changeout and repairs. Edison has evaluated these walls and considers them equal to a 3-hr barrier. Although a specific rating test does not exist for this design, the 12-in. block wall will prevent any postulated fire from spreading and therefore provides protection equivalent to a 3-hr-rated barrier. (See Reference 3.)

9A.2.3.1.8 Solid-Metal Trays With Covers

Solid-metal trays with solid-metal covers are installed throughout the plant. Generally, these trays contain small instrumentation cables, and the trays are usually sparsely filled. Under such conditions, Edison has taken credit for the solid-metal tray with cover as a mechanism that restricts or eliminates the propagation of a fire. The NRC has accepted this as equivalent to a fire break in cable trays. (See SSER No. 5.)

9A.2.3.2 Review of Shutdown Equipment Within Fire Areas/Zones

A shutdown analysis was originally performed as part of the overall fire protection evaluation. With the issuance of 10 CFR 50, Appendix R, Edison performed other shutdown analyses to assess compliance to the requirements of Appendix R. The original shutdown analysis was used as a starting point. The new analyses determined the circuits that needed protection due to required fire protection separation requirements for redundant and associated circuits and for the prevention of spurious operation. A summary is provided in Section 9A.3.

An important aspect of reviewing shutdown equipment is the consideration of its function and the location of redundant or other equipment capable of performing the same function. In some cases, two or more sets of redundant equipment are located in the same fire zone. When this occurs, it is necessary to evaluate actual separation, barriers, combustibles in the immediate vicinity of the equipment, ignition sources, and fire detection and suppression equipment in the fire zone. In cases where other equipment capable of performing the same function is located in a different fire zone, it is necessary to perform an analysis to demonstrate that the equipment in the fire zone under consideration could be destroyed by a fire without adversely affecting plant shutdown capability.

9A.2.3.3 Calculation of Fire Loading

For the original fire hazards analysis and subsequent analyses, combustible materials located within each fire zone have been listed and the fire loading, in Btu/ft^2, has been calculated, and the current loadings are documented in a detailed engineering design calculation.

This loading, along with the type of combustibles and the anticipated rate of burn, is used to verify the adequacy of existing fire barriers. For fire-barrier ratings as related to heat load (Btu/ft^2), see Table 9A.2-1.

9A.2.3.4 Review of Ventilation Systems

Ventilation equipment required to cool rooms containing plant shutdown equipment is considered safe-shutdown equipment. Ventilation systems have been designed and installed as described in Section 9.4.

9A.2.3.5 Examination of Fire Detection and Suppression

The examination of fire detection and suppression consists of determining how a fire within a fire zone will be detected and extinguished. It is assumed that permanently installed fire-detection, fire-suppression, and fire-fighting equipment will function as designed.

The types of combustibles and their fire loadings are reviewed to determine the type of suppression and detection equipment required to provide early warning and contain or extinguish a fire within the zone. The effect of water on electrical components and safe-shutdown equipment is a consideration in the selection of the design and type of suppression system that was or will be installed at Fermi 2.

9A.2.3.5.1 Fire Detection Systems

Fermi 2 fire detection systems consist of the detectors, associated electrical power supplies, and the annunciator panels. The types of detectors used are: ionization, thermal, infrared, and photoelectric. The fire detection systems provide local and remote audible and visual alarms. The remote alarms are in the main control room. The fire detection systems are installed in areas having safety-related equipment and/or safety-related cables.

The fire detection systems are installed in accordance with NFPA 72D except that a permanent recording device is not installed as required. A deviation was granted in SSER No. 5 based on the fact that the operators continually man the control room and log each fire alarm received in the control room. Also, control room alarms can only be reset manually at the local fire alarm panel.

Fire detection systems that are used to actuate suppression systems in the reactor/auxiliary building are Class A systems as defined in NFPA 72D. All other redundant safety-related division areas have a cross-zoned Class B detection system.

Edison performed an evaluation of the fire detection system to verify installation with NFPA 72E. The evaluation included assessing detector spacing, location, ceiling types and construction, interferences by heating, ventilation, and air conditioning (HVAC) airflow patterns, and accessibility for testing and maintenance. As a result, some detectors were added in specific areas as described in Reference 7 and a deviation was requested for spacing of the detectors in the torus area. The deviation was approved in SSER No. 5.

Note: Fire detection in the Security Diesel Generator enclosures utilize both infrared and thermal detectors which actuate a FM-200 clean agent system and sends a signal to the security Central Alarm Station which is continually manned.

For more details on the Fermi 2 fire detection systems, see Subsection 9.5.1.2.

9A.2.3.5.2 Fire Protection Systems

Fermi 2 fire protection systems consist of automatic suppression systems including water sprinkler, CO_2, Clean Agent, and Halon systems, the water supply system, yard hydrants, fire pumps, standpipes, and hose stations. For details on these systems, see Subsection 9.5.1.2.

FM-200 Clean Agent extinguishing systems are used in certain areas of Fermi 2. These systems are activated by a NFPA-72 and NFPA-70 compliant fire detection system. These clean agent systems were designed, installed, and tested in accordance with NFPA-2001 requirements.

Halon 1301 total flooding systems are used in certain areas of Fermi 2. These systems are activated by ionization detectors of a Class A fire alarm circuit or photoelectric detectors. These systems were designed and installed using NFPA 12A as guidance.

Hose stations are located throughout the plant. The hose stations were installed using NFPA 14 as guidance. They are equipped with 1-1/2-in. approved lined hose and adjustable pattern fog nozzles. Pressure reducing devices are not installed as required by NFPA-14 at all hose station outlets where the pressure exceeds 100 psig, to reduce the pressure with required flow at the outlet to 100 psig. This is acceptable because the hose stations and fire hose are only used by trained fire brigade members, and adjustable pattern fog nozzles are provided at all hose stations, except for the fifth (refueling) floor of the reactor building where solid stream nozzles are provided. Pressure reducing devices that significantly reduce pressure are provided for hose station outlets on the fifth floor of the reactor building and on floors below the grade floor of 583 ft 6 in., due to excessively high pressure at those hose stations. The reason for utilizing a higher pressure at hose stations is to be able to more effectively fight fires at the ceiling height where cable trays are located. These reducers maintain pressure at the hose at approximately 130 psi. The higher pressure is needed for the hose stream's reach. A fire at ceiling height, 20 to 30 ft, would otherwise be difficult to extinguish. To compensate for the higher pressures, the fire brigade is trained in handling hose streams with higher pressures and signs have been placed on the hose cabinets in safety-related buildings restricting their use to the fire brigade. General employee training covers the use of and restrictions on the fire hose stations (Reference 8).

9A.2.3.6 Evaluation/Conclusions

An evaluation is performed to determine whether the plant is adequately protected in the event of a design-basis fire within a fire zone. This evaluation is based on all the previously noted information. The primary objective is to determine if a fire will jeopardize plant safe shutdown.

Questions addressed in the fire hazards analysis or evaluation of the safe shutdown fire area/zones are typically the following:

a. Is there safe-shutdown equipment within the fire zone?

b. Can the function be fulfilled by redundant equipment in other fire zones?

c. Is this a single item of equipment or are both divisions of redundant equipment involved in this fire zone?

d. Does the ventilation system contribute to the spread of the fire and/or products of combustion to other fire zones that would be otherwise unaffected?

e. How will a fire in the fire zone be detected?

f. What is the response time of the detection devices or scheme? Is this adequate?

g. How will a fire in the fire area/zone be extinguished?

h. How quickly can the suppression equipment be placed into service and what is its effectiveness? Is this adequate?

i. Can the plant be shut down despite the design-basis fire and fire hazards identified within the fire zone?

If the answer to question i. is YES after all the other questions are addressed, it is concluded that the individual fire zone is adequately protected against fire from the standpoint of plant safe shutdown.

If the answer to question i. based on the preceding analyses is NO, design changes are implemented to ensure that adequate protection is available to allow plant safe shutdown.

9A.2.3.7 Containment of Radioactivity

The reactor, radwaste, and turbine buildings house equipment that normally contains significant concentrations of radioactivity. The methods of containing radioactive leakage and releases within these buildings are as follows:

a. Gaseous activity

Gaseous release or leakage inside the buildings will be retained and controlled within the buildings by their respective ventilation systems. These systems are described in Section 9.4. Radiation monitors are located in the exhaust points. On detection of high radioactivity in the effluents, these monitors actuate an alarm in the main control room and simultaneously trip the ventilation fans and close the isolation dampers. The consequences of a fire in an area capable of releasing radioactive gases are less severe than the most significant gaseous release from the failure of the offgas system, described in Subsection 15.11.4

b. Liquid activity

Liquid spillage or leakage from equipment within these buildings drains into the respective building floor drain sump. Subsection 9.3.3 provides a description of the floor drain systems in the various buildings. From these sumps, it is pumped to the radioactive waste floor drain collection tank for normal liquid waste processing. Section 11.2 details the handling and containment of liquid radioactive waste. The consequences of a fire in an area capable of releasing radioactive liquids are less severe than the most significant release resulting from failure of the liquid radwaste system described in Subsection 11.2.3.1.

Radioactive liquids and gases are normally contained within piping and process equipment, such as tanks, pumps, demineralizers, filters, and evaporator packages. The major source of radioactivity is process equipment that is located in shielded cubicles having very low fire loadings.

A possible problem resulting from a fire is that water used to fight the fire may become radioactively contaminated. However, such contamination does not result in uncontrolled releases. The fire-fighting water will be contained and controlled in the same manner as spillage or leakage described above.

9A.2 METHODOLOGY – FIRE HAZARDS ANALYSIS

REFERENCES

1. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Submittal of Deviations From Staff Interpretations of Fire Protection Features in 10 CFR 50, Appendix R and Justification, dated August 3, 1984 (EF2-72717).
2. American National Standards Institute, 1976. Draft-Generic Requirements for Nuclear Power Plant Fire Protection, ANSI N18.10.
3. Detroit Edison Company, Fermi 2 Project Specification 3071-80, "Special Wire and Cable," March 1972.
4. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Qualification of 3M Fire Wrap, dated October 22, 1984 (EF2-72266).
5. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Additional Information Concerning "Cross-Over" Cable Fire Stops and Use of Vinyl Tile in the Control Center, dated September 27, 1984 (EF2-72260).
6. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Transmittal of Fire Protection Information, dated August 4, 1984 (EF2-69218).
7. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Additional Fire Protection Information, dated February 4, 1985 (NE-85-0275).
8. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Additional Fire Protection Information, dated February 18, 1985 (EF2-70391).
9. Letter from C. E. McCracken, NRC, to C. W. Fay, Wisconsin Electric Power Company, Subject: Review of Draft Safety Evaluation of Conduit Fire Seal Topical Report for Proprietary Content, dated October 23, 1989.
10. Enclosure to Reference 9, Technical Evaluation Report, Conduit Fire Protection Research Program submitted by Wisconsin Electric Power Company TAC 66623; by Science Applications International Corporation, dated May 12, 1989 under contract NRC-03-87-029, Task 3, SAIC 88/1824.
11. Conduit fire test program final report; prepared by Professional Loss Control, Inc., for the Wisconsin Electric Power Company; dated June 1, 1987. Document number: DTC:TDDATA; DSN: 1797E.
12.

TABLE 9A.2-1 REQUIRED BARRIER RATINGS FOR FIRE LOADINGS[a]

Fire Loading (Btu/ft^2)	Required Barrier Rating
40,000	30 minutes
80,000	1 hr
120,000	1-1/2 hr
160,000	2 hr
200,000	2-1/2 hr
240,000	3 hr

[a] National Fire Protection Association Handbook, 14 Edition, pages 6-81.

9A.3 PLANT SAFE SHUTDOWN

The primary objective of the fire hazards analysis is to evaluate plant design and modifications to ensure the ability to achieve and maintain safe shutdown in the event of a fire in accordance with the fire protection license condition. The safe-shutdown analysis starts with the reactor at normal full power and ends with the reactor in a cold-shutdown condition with long-term cooling in progress, using the residual heat removal (RHR) system.

Safe-shutdown analyses are maintained in controlled engineering documents performed for Fermi 2 to evaluate compliance to 10 CFR 50, Appendix R, Section III.G. These analyses included safe-shutdown capability evaluations and associated circuits of concern, for example, common power supply, common enclosure, spurious operation, and high/low-pressure interfaces. For fires in most of the fire zones, safe shutdown is accomplished from the main control room using one of the divisions of safe shutdown equipment in accordance with the technical requirements of Section III.G.2 of Appendix R. For fires occurring in one of the dedicated shutdown areas of concern (Fire Zones 03AB, 07AB, 08AB, 09AB, 11AB or 13AB), safe shutdown is accomplished from outside the main control room using the alternative shutdown system (including the dedicated shutdown panel) as described in Section 7.5.2.5 in accordance with the technical requirements of Sections III.G.3 and III.L of Appendix R.

Subsection 9A.3.1 outlines the shutdown sequence on which the fire hazards analyses were based. Subsection 9A.3.2 lists the systems required to accomplish plant shutdown. Subsection 9A.3.3 discusses the method of safe-shutdown analysis.

9A.3.1 Shutdown Sequence

9A.3.1.1 Shutdown from the Main Control Room Using One of the Safe Shutdown Divisions

For the fire hazards analysis, the shutdown sequence starts with the detection of a fire of a magnitude such that plant shutdown is required. Depending on the location and magnitude of the fire, the plant may be quickly brought to hot shutdown or tripped by the plant operator. For the fire hazards analysis, it is assumed that plant shutdown is initiated with an automatic or manual scram of the reactor from the main control room. Once a scram is initiated, no further control rod motion is required.

It was also determined that, although fire damage might cause the plant to trip, no fire could negate the ability to manually trip the reactor.

There are two normal offsite ac power sources available as well as two redundant Class 1E power sources. However, for the purpose of the fire hazards analysis, a loss of offsite power is assumed to occur. The emergency diesel generators (EDGs) for the division credited for shutdown are assumed to start and restore the required portions of the emergency onsite electrical system.

It was assumed, for analytical purposes, that control of reactor pressure by the main turbine pressure regulators through the bypass valves to the condenser was lost. Therefore, the reactor was isolated from the normal heat sink and feedwater flow was stopped at the pressure associated with normal full power. In this condition, reactor pressure is relieved through the safety/ relief valves (SRVs) to the suppression pool.

Additional information pertaining to the safe shutdown systems for main control room shutdowns using one of the normal post-fire shutdown divisions, as well as information related to the safe shutdown analysis are provided in Sections 9A.3.2 and 9A.3.3. Analysis results for applicable fire zones are provided in Section 9A.4.

Manual activation of SRVs and the reactor core isolation cooling (RCIC), the HPCI, or manual activation of SRVs and low pressure coolant injection (RHR or Core Spray) system, brings the reactor to a hot-shutdown condition. During this phase of shutdown, the suppression pool is cooled by operating the RHR system in the suppression pool cooling mode. Reactor pressure is controlled and core decay and sensible heat are rejected to the suppression pool by the HPCI or RCIC turbines or by manually relieving steam pressure through the relief valves. Reactor water inventory is maintained by the high-pressure RCIC or HPCI systems or by the Core Spray or RHR system in conjunction with manual operation of two or more SRVs.

The depressurization, caused by operation of the HPCI or RCIC turbines or manual operation of the relief valves, cools the reactor and reduces its pressure at a controlled rate until the reactor pressure becomes so low that the RCIC or HPCI system discontinues operation. This condition is reached at 50 to 100 psig reactor pressure. The RHR system is then operated in a shutdown cooling mode wherein the RHR system heat exchanger is used to bring the reactor to a cold, low-pressure condition. The cooldown process is ended when long-term decay heat removal operation is established.

For fires in the control center complex and other selected zones, the reactor is tripped in the control room and safe shutdown is completed using the alternative shutdown system described in Subsection 7.5.2.5.

The alternative shutdown system has been designed and installed to meet the technical requirements of 10 CFR 50, Appendix R, Sections III.G.3 and L. This system provides safe-shutdown capability separate and remote from the control center complex and other plant fire zones. The system is used when a fire within the complex or other dedicated shutdown areas of concern is determined to have significantly damaged the safe-shutdown equipment/cabling within these zones. The alternative shutdown system consists of a dedicated shutdown panel (past correspondence with the NRC referred to this panel as the 3L panel) and selected systems that were already installed at Fermi 2. For details on alternative shutdown system capability, including the dedicated shutdown panel, system parameter monitoring, and transfer switches, see Subsection 7.5.2.5.

9A.3.1.2 Shutdown from the Dedicated Shutdown Panel Using the Alternative Shutdown System

As with the control room shutdown described in the previous subsection, the reactor is scrammed from the control room before it is abandoned and a concurrent loss of offsite power is assumed for the limiting analysis. However, the emergency diesels, HPCI, RCIC and multiple SRVs for rapid depressurization may not be available due to fire damage. The Standby Feedwater System, powered by CTG 11-1, or an alternate CTG using the standby diesel generator that provides high pressure RPV makeup and controls for a single SRV are available on the dedicated shutdown panel to provide RPV pressure control for hot shutdown conditions.

Additional information pertaining to the systems used to support the alternative shutdown system utilizing the dedicated shutdown panel and the related safe shutdown analysis are provided in Sections 9A.3.2, 9A.3.3 and applicable fire zones in Section 9A.4.

9A.3.2 Shutdown Systems

The following table is a summary of the Fermi 2 plant systems required to achieve and maintain safe shutdown following a fire. The entries in the table differentiate whether the given system is used for hot shutdown, cold shutdown, or both. It should be noted that for a specific fire zone, not all of the systems listed in the table are required. For example, the hot shutdown RPV makeup function can be performed by HPCI, RCIC, SBFW, or RHR in conjunction with SRVs. In addition, separate columns are provided for shutdown from the control room using one of the normal post-fire shutdown divisions and for shutdown from outside the control room using the alternative shutdown capability including the dedicated shutdown panel. The list of systems includes both systems that directly provide a post-fire shutdown function such as RPV makeup, as well as systems that are required to support these "front-line" systems. For example, RHR Service Water is required to support the RHR when it is aligned for shutdown cooling during the cold shutdown phase. The Appendix R safe shutdown system, component, cable list, and the basis for inclusion in the safe shutdown analysis are maintained in a controlled design calculation.

ID	System Name	Divisional Shutdown from the Control Room	Dedicated Shutdown from Outside the Control Room
B21	MSIVs (manual closure)	Hot/Cold	Hot/Cold
B21	SRVs	Hot/Cold	Hot/Cold
B21	RPV pressure & level instrumentation	Hot/Cold	Hot/Cold
B31	Recirculation (valve lineup for shutdown cooling)	Cold	Cold
C11	CRD hydraulic control units	Hot/Cold	Hot/Cold
C36	Dedicated Shutdown Panel Controls	NA	Hot/Cold
C36	Dedicated Shutdown Panel Instrumentation	Hot/Cold	Hot/Cold
C36	Dedicated Shutdown Support Systems & Components	NA	Hot/Cold
E11	RHR - suppression pool cooling	Hot	Hot
E11	RHR - low pressure RPV makeup	Hot	Hot

ID	System Name	Divisional Shutdown from the Control Room	Dedicated Shutdown from Outside the Control Room
E11	RHR - shutdown cooling	Cold	Cold
E11-51	RHR Service Water (RHRSW)	Hot/Cold	Hot/Cold
E11-56	RHRSW Cooling Towers	Hot/Cold	Hot/Cold
E21	Core Spray	Hot	NA
E41	High Pressure Coolant Injection (HPCI)-Div 2	Hot	NA
E51	Reactor Core Isolation Cooling (RCIC)- Div 1	Hot	NA
N21/R11/ R32	Standby Feedwater (SBFW), CTG 11-1 and associated BOP ac & dc	NA	Hot/Cold
P44	Emergency Equipment Cooling Water (EECW)	Hot/Cold	Hot/Cold
P45	Emergency Equipment Service Water (EESW)	Hot/Cold	Hot/Cold
P50-02	Control Air for Control Center HVAC air path (dampers)	Hot/Cold	NA
R30/R14/ R16	ESF ac distribution for shutdown equipment	Hot/Cold	Hot/Cold
R30-01	Emergency Diesel Generators (EDGs) & auxiliaries	Hot/Cold	NA
R32	ESF dc system	Hot/Cold	Hot/Cold
T41	Control Center HVAC	Hot/Cold	NA
T41	ESF fan coil units	Hot/Cold	Hot/Cold
T47	Drywell Cooler Fans	NA	Hot/Cold
T49	Drywell Pneumatics	Hot/Cold	NA
X41-03	EDG & EDG Switchgear Room HVAC	Hot/Cold	NA

Systems, components and cables that are vulnerable to causing adverse consequences from hot shorts caused by cable damage have been associated with specific scenarios of concern such as loss of RPV inventory, loss of suppression pool inventory, SRV actuation, etc. Such cables and components that are not associated with the safe shutdown systems listed above are analyzed separately in the safe shutdown analysis as described in Section 9A.3.3.

9A.3.3 Method of Safe-Shutdown Analysis

To maintain a safe-shutdown capability, Fermi 2 was designed and built with the concept of keeping Division I cables and equipment separate from those of Division II. The dividing line is column line 12 for the reactor building. Division I cables and equipment are normally routed and located on the north side while those of Division II are normally on the south side of the line. The auxiliary building was designed differently. Therefore, analyses were performed and protection provided as required. In some instances where Division I and II cables cross over into the opposite division's side of the building and the cables/equipment are within 20 ft of their redundant cables, they are provided with a 1-hr-fire-rated protective envelope, to achieve or maintain 20 ft of separation with no intervening combustibles, or an analysis is performed to show that a loss of the interacting redundant divisional circuit(s) will not affect plant safe-shutdown capability.

An important requirement relevant to the fire hazards analysis is that regarding separation of cables and cable trays. Since most of the safety-related cables are also required for plant shutdown, separation of redundant safety-related cables in cable trays has been evaluated within each fire zone.

Each plant area is systematically evaluated for the ability to achieve and maintain safe shutdown, assuming that all of the equipment and cables within it are subject to fire damage. One of three shutdown strategies, Division 1 shutdown from the control room, Division 2 shutdown from the control room, or dedicated shutdown from outside the control room, is assigned to each. The dedicated shutdown strategy in accordance with the technical requirements of Appendix R Section III.G.3 and III.L is used only when divisional shutdown from the control room is not feasible. In general, these strategies were developed as part of the original plant licensing basis, and provide the framework for the NRC-approved deviations documented in docketed NRC correspondence, the plant SER, and its supplements. The inventory of safe shutdown equipment and cables, including associated circuit cables and equipment, is established, and conflicts between the shutdown strategy and the affected equipment are identified. The resolution of each of these shutdown conflicts is documented in a controlled engineering analysis. Examples of acceptable resolutions include protecting shutdown division cables with fire barriers, evaluating the electrical schematics to show that the electrical fault of concern is not applicable for the fire location being evaluated, use of NRC-approved deviations, or removal of certain fuses during power operation.

For spurious operation due to hot shorts, cables and equipment that can adversely affect safe shutdown systems (e.g., flow diversion paths from cooling systems) are evaluated, as are those that can adversely affect the safe shutdown functions or performance requirements independent of the safe shutdown systems (e.g., loss of RPV isolation or spurious SRV opening). In addition to evaluating single hot shorts between two conductors, the analysis includes any number of conductor-to-conductor shorts with a single cable and cable-to-cable shorts for any two cables within the area, in accordance with the NRC Regulatory Issue Summary RIS 2004-03 (Reference 1). For the RHR shutdown cooling letdown path high-low pressure interface, the division 2 outboard containment isolation valve is closed and de-energized.

9A.3 PLANT SAFE SHUTDOWN

REFERENCES

1. NRC Regulatory Issue Summary 2004-03, Risk-Informed Approach for Post-Fire Safe Shutdown Associated Circuit Inspections, dated March 2, 2004

9A.4 FIRE HAZARDS ANALYSIS

9A.4.1 Reactor Building

9A.4.1.1 General Description

The reactor building is a multilevel structure, separated from all other buildings by 3-hr-rated fire barriers. For purposes of this fire hazards analysis, the reactor building has been designated as fire area RB. It is bounded on the north, south, and west by outside walls and on the east by the auxiliary building.

The outage building is located four (4) inches south of the south wall of the reactor and auxiliary building. The outage building is of completely noncombustible construction; additionally no safe shutdown systems or equipment are located in this building. The outage building is structurally separated from plant structures, however, nonstructural flashing is attached to both the reactor and auxiliary building to seal and protect the four-inch gap between it and the outage building.

The north, south, and west exterior walls (below the metal siding on elevation 684′−6″) are constructed of at least 18 inches of reinforced concrete which will prevent an exposure fire in the yard area from propagating into the Reactor Building. Except as detailed below, these three walls are 3-hr-rated fire barriers.

The walls of the personnel airlock (on the south side of the reactor building) are constructed of 18 inches of reinforced concrete. The airlock itself, is separated from the yard area by two 1½-hr rated fire doors (R1-6 and R1-7) which together provide a level of protection at least equivalent to a 3-hr-rated fire door. In addition, as demonstrated above, the airlock walls are 3-hr-rated barriers.

The railroad bay pressure resistant door (also on the south side of the reactor building) is not a rated fire door; however, it is constructed of heavy steel channels covered with metal sheeting on both sides. This door is of much more substantial construction than the typical 3-hr-rated fire doors because of its pressure resistance rating. In addition, heat detectors and an automatic sprinkler system are provided in the railroad bay to further ensure that a fire originating outside the plant will not propagate into the reactor building via the railroad bay. These features and combustible loading in the vicinity of both the inside and outside door have been evaluated and found to provide adequate assurance that a fire will not propagate from outside the building or inside the railroad bay airlock into the southwest corner first floor of the reactor building.

The south and west walls of the reactor building contain six (6) removable plug sleeves which are 1-hr-rated penetration seals. These sleeves are either sealed with solid steel plates or contain steel plates with capped pipes and conduits passing through the penetrations from the interior of the reactor building. The sleeve openings on the exterior of the reactor building are closed with steel blind flanges. In addition, the space between these plates is totally devoid of combustible materials. Therefore, although they are not tested and approved seal configurations they are of substantial steel construction and will prevent flame propagation into the reactor building.

The fifth floor of the reactor building (elevation 684′-6″) is not being provided with fire rated exterior walls because its three exterior walls are constructed of insulated metal siding which is not a tested and rated construction. However, the siding will protect the fifth floor from the heat and smoke which would be generated from a fire in the yard. The base of the metal-sided walls is 100 feet above the yard grade level - well above any postulated exposure fire in the yard areas adjacent to the reactor building. Therefore, the as-built construction of these walls is sufficient to protect the fifth floor of the reactor building from a fire in the yard area.

The reactor building houses the reactor, reactor drywell and suppression pool, fuel handling equipment and storage pool, and other reactor auxiliary equipment.

With the exception of the drywell, ventilation of the reactor building is provided by the reactor/auxiliary building ventilation system. The drywell cooling system is provided for the drywell. These ventilation systems are discussed briefly in the individual zone descriptions. Additional details for these ventilation systems are presented in Subsections 9.4.2 and 9.4.5.

For purposes of this fire hazards analysis, the reactor building has been divided into 10 Fire Zones as follows:

a. Torus room, Fire Zone 01RB, Elevation 540 ft 0 in.

b. Northeast, northwest, southeast, and southwest basement corner rooms, Fire Zone 02RB, Elevations 540 ft 0 in. and 562 ft 0 in.

c. High pressure coolant injection (HPCI) pump and turbine and control rod drive (CRD) pump rooms, Fire Zone 03RB, Elevations 540 ft 0 in. and 562 ft 0 in.

d. Corridor area, Fire Zone 04RB, Elevations 562 ft 0 in and 564 ft 0 in.

e. First Floor, Fire Zone 05RB, Elevation 583 ft 6 in.

f. Second Floor, Fire Zone 06RB, Elevation 613 ft 6 in.

g. Third Floor, Fire Zone 07RB, Elevation 641 ft 6 in.

h. Fourth Floor, Fire Zone 08RB, Elevation 659 ft 6 in.

i. Fifth Floor, Fire Zone 09RB, Elevation 684 ft 6 in. (including the Auxiliary Building stairwell enclosure and duct space)

j. Drywell, Fire Zone 10RB, Elevation 562 ft 0 in. to 684 ft 6 in.

As discussed in Subsection 9A.3.3, the reactor building Division I cables and equipment are normally routed and located on the north side of the building (north of column line 12) and Division II cables and equipment are normally routed and located on the south side of the building (south of column line 12).

Division I is used to achieve plant safe shutdown when a fire occurs south of column line 12. Division II is used to achieve plant safe shutdown when a fire occurs north of column line 12.

9A.4.1.2 Torus Room, Fire Zone 01RB, El. 540 Ft 0 In.

9A.4.1.2.1 Description

The torus room, shown in Figures 9A-2 and 9A-3, is an octagonally shaped room which extends from the reactor building mat at Elevation 540 ft 0 in. up to Elevation 583 ft 6 in. It is bounded on the north by an outside wall; on the northeast by Fire Zone 02RB; on the east by a below-grade wall up to Elevation 551 ft 0 in. and Fire Zone 04RB thereafter; on the southeast by Fire Zone 02RB; on the south by an outside wall; on the southwest by Fire Zone 02RB; on the west by an outside wall; on the northwest by Fire Zone 02RB; and in the center by the drywell (Fire Zone 10RB), which it surrounds.

This zone houses the suppression pool (torus) and piping and cabling.

The walls (36 in.) and floor of this zone are constructed of reinforced concrete. The ceiling is constructed of 24-in.- reinforced concrete over steel beams. All penetrations through that portion of the ceiling separating this zone from the steam tunnel portion of the turbine building fire area are sealed with non-tested fire seals in the fire rated separation barrier. These seals have been evaluated and provide an adequate assurance that a fire in the Reactor Building Fire Zone 01RB will not propagate through these penetrations into the steam tunnel, or from the steam tunnel to the reactor building. Electrical penetrations through the remainder of the ceiling have fire stops. Division I cables, located in the south portion of the room, are enclosed with a 1-hr-rated fire barrier, as are Division II cables, in the north portion of the room. The doors to the corner rooms are 8-in.-thick steel watertight doors and will stop the propagation of any fire foreseen in the torus room.

Ventilation for this zone is provided by air from the four basement corner rooms (Fire Zone 02RB) abutting the northeast, southeast, southwest, and northwest walls of this zone. Air is drawn through 20 in. x 20 in. wall openings into the torus room and is directly exhausted through ductwork to the main exhaust system.

Divisions I and II redundant cables enter the torus room on the east side and traverse the room toward the west and above the center line of the torus. Division I cables are to the north and Division II cables are to the south.

Balance-of-plant (BOP) cable trays enter and traverse parallel to Divisions I and II cable trays around the torus. On the west side, the BOP trays continue around the torus, encircling the drywell above the torus and linking Divisions I and II with intervening combustibles.

Shutdown equipment located within this zone consists of the following:

a. Suppression pool (torus)

b. Divisions I and II cables

c. Divisions I and II, residual heat removal (RHR), core spray, HPCI, suppression pool instrumentation and reactor core isolation cooling (RCIC) valves, racks or equipment.

Fire detection in the torus area consists of eight ionization smoke detectors that are located adjacent to the exhaust duct grills. These detectors do not conform to the spacing requirements of NFPA 72E (beam pocket criteria). See Subsection 9A.4.1.2.4. The torus area has an automatic sprinkler system that protects the entire area. This system will protect any exposed structural steel from thermal degradation during any fire condition. The water flow alarm for the sprinkler system transmits signals to the main control room upon actuation. Fire extinguishers and manual water hose stations are located in adjacent Fire Zones.

9A.4.1.2.2 Analysis

Shutdown is achieved from the main control room. Division I is used to achieve plant safe shutdown when a fire occurs south of column line 12. Division II is used to achieve plant safe shutdown when a fire occurs north of column line 12.

There are no protective envelopes required for cables/equipment in this zone.

Redundant valves that are not backed up by functionally redundant equipment in another Fire Zone are spatially separated by more than 20 ft. The other valves, required for shutdown and located within this zone, are backed up by functionally redundant equipment in other Fire Zones.

Cable trays, which present intervening combustibles between redundant cables, have a fire break installed in them or are solid-metal trays with covers to prevent the propagation of fire within them.

Three 12-in. BOP cable trays interconnecting Divisions I and II on the west side are considered intervening combustibles. The trays are OP-016, OC-790 and OK-097. Two, OP-016 and OC-790, have fire breaks installed at about column line 12±3 ft. Cable tray OK-097 is an instrumentation cable tray and is an enclosed solid-metal tray with cover.

The automatic sprinkler system will protect the exposed steel from being adversely affected by a fire in this zone.

Inadvertent operation of the automatic fire suppression equipment will have no adverse effect on shutdown capability. Combustibles within this zone consist primarily of electrical insulation. Total fire loading for this zone is low.

9A.4.1.2.3 Conclusion

The objective for this zone is to prevent a fire from damaging redundant shutdown valves and cable and from spreading to other zones. This objective is achieved through barriers, the provision of fire detection equipment, an automatic sprinkler system, fire breaks in cable trays, and separation of redundant equipment. In addition, fire extinguishers and manual water hose stations are provided in adjacent zones.

9A.4.1.2.4 Deviations

Deviations have been approved for the following:

a. Intervening combustibles, cable trays OP-016, OC-790, and OK-097 based on area-wide sprinklers and fire stops in cable trays OP-016 and OC-790 at about column line 12 and solid-metal tray and cover for OK-097 (Reference 1, SSER No. 5 VI [1])

b. Early-warning fire detectors are not installed in accordance with NFPA 72E based on area with automatic sprinklers, alarms to the main control room, and response by the fire brigade (Reference 1, Reference 2, SSER No. 5, II.D).

9A.4.1.3 Basement Corner Rooms, Fire Zone 02RB, El. 540 Ft 0 In. and 562 Ft 0 In.

9A.4.1.3.1 Description

The basement corner rooms, shown in Figures 9A-2 and 9A-3, consist of four unconnected, triangular-shaped rooms, one of which is located in each corner of the reactor building. Each room is composed of two floors, one at Elevation 540 ft 0 in., the other at Elevation 562 ft 0 in. An open stairwell in each room connects each floor.

The zone houses the RHR pumps (Division I pumps in the northwest corner room, Division II pumps in the southwest corner room), the RCIC pump and turbine, and Division I core spray pumps (northeast corner room), and the Division II core spray pumps (southeast corner room).

Walls surrounding each room of the zone are constructed of 36-in. reinforced concrete. The doors to the torus room are 8-in.-thick steel watertight doors that will stop the propagation of fire.

The floor of the lower elevation is a reinforced-concrete mat. The floor at Elevation 562 ft 0 in. is constructed of reinforced concrete and contains unsealed penetrations and unprotected openings for stairwells and hatches. The ceilings at both elevations are 24-in. reinforced concrete and contain unsealed penetrations and other unprotected openings. Electrical penetrations through the floor and ceiling are provided with fire stops.

Ventilation air enters each room through stairwells from Elevation 583 ft 6 in. (Fire Zone 05RB). Ventilation air leaves each room through wall openings in the walls abutting the torus room (Fire Zone 01RB) on Elevation 540 ft 0 in. Each corner room has a local air-handling unit (emergency equipment room cooler) for cooling the room ambient air.

Shutdown equipment located in this zone consists of the following:

a. RHR pumps and associated valves (Divisions I and II)

b. RHR instrument racks (Divisions I and II)

c. Emergency equipment room coolers (Divisions I and II)

d. RCIC pump and turbine and associated valves (Division I)

e. Instrument racks (Division I and II)

f. Core spray pumps and associated valves (Divisions I and II)

g. Core spray instrument racks (Divisions I and II).

h. 120 V ac distribution panel (Divisions I and II)

Fire detection equipment in this zone consists of an ionization detection system in each room at each elevation. Fire suppression equipment in this zone consists of an automatic sprinkler system in the northeast room on Elevation 540 ft 0 in. and manual hose and portable fire extinguishers as shown in Figures 9A-2 and 9A-3.

9A.4.1.3.2 Analysis

Shutdown is achieved from the main control room. There is no functionally redundant equipment located in any one room within this zone. Divisions I and II RHR pumps, instrument racks, and associated valves and room coolers are located in separate rooms. Division I RHR equipment is located on Elevation 540 ft 0 in. of the room located in the northwest corner of the building. Division II pumps are located on Elevation 540 ft 0 in. of the room located in the southwest corner of the building. Division II core spray equipment is located on Elevation 540 ft 0 in. of the room located in the southeast corner of the building. Division I core spray equipment is located on Elevation 540 ft 0 in. of the room located in the northeast corner of the building. Functional redundancy for the RCIC pump located in this zone is provided by the HPCI pump located in Zone 3 of this fire area.

Division I will be used to achieve safe shutdown for fires in the southeast and southwest corner rooms and Division II will be used to achieve safe shutdown for fires in the northeast and northwest corner rooms of the zone.

Inadvertent operation of the automatic sprinkler system in the room containing the RCIC pump and turbine will have no adverse effect on shutdown capability.

The oil contained in the RCIC turbine represents a specific fire hazard in this zone due to high operating temperatures of the turbine and related piping.

Combustibles within this zone consist primarily of the following:

a. Electrical insulation

b. Lubricating oil

Total zone fire loading is low, and the fire loading in any one room is low.

9A.4.1.3.3 Conclusion

The objective for this zone is to prevent the spread of a fire in this zone to another zone containing redundant shutdown equipment and/or from damaging redundant shutdown equipment within this zone. Redundant shutdown equipment located within this zone is located in separate rooms, each located in a corner of the building. The ventilation openings to the torus room do not represent a significant potential path for fire spread due to the low fire loading within the rooms. The objective is achieved through barriers, the adequate spatial separation of redundant equipment, and the provision of early-warning detection equipment in each room, and an automatic sprinkler system on the specific fire hazard (RCIC turbine). In addition, manual water hose stations and portable fire extinguishers are provided.

9A.4.1.3.4 Deviations

Deviations have been approved for the following:

a. Installation of partial suppression in the northeast corner room, Elevations 540 ft 0 in. and 562 ft 0 in., based on cables required to achieve a safe shutdown being provided with a 1-hr fire barrier in this zone, fire detection, and low combustible loading (Reference 1, SSER No. 5, VI [13])

b. Lack of suppression in the southeast corner room, Elevations 540 ft 0 in. and 562 ft 0 in., based on low combustible loading and 1-hr fire barriers for cables required to achieve safe shutdown (Reference 1, SSER No. 5, VI [14]).

9A.4.1.4 High Pressure Coolant Injection Pump and Turbine and Control Rod Drive Pump Room, Fire Zone 03RB, El. 540 Ft 0 In. and 562 Ft 0 In.

9A.4.1.4.1 Description

This zone, shown in Figures 9A-2 and 9A-3, consists of two rooms, the HPCI pump and turbine room at Elevation 540 ft 0 in. and the CRD pump room at Elevation 562 ft 0 in. This zone is bounded on the north by a below-grade wall up to Elevation 551 ft and Fire Zone 04RB thereafter; on the east and south by a below-grade wall up to Elevation 551 ft and the auxiliary building above Elevation 551 ft; and on the west by the room containing the Division II core spray pumps (Fire Zone 02RB).

The zone houses the HPCI turbine, pump, and related valves and controls, and an emergency equipment room cooler on Elevation 540 ft 0 in., and the CRD pumps on Elevation 562 ft 0 in.

The walls and ceiling separating this zone from the auxiliary building are constructed of reinforced concrete having a fire-resistance rating of 3 hr. The door to the Division II CS pump room is watertight. The door separating this zone from the auxiliary building is a Class A fire door. Penetrations through the rated walls and the fire-rated portion of the ceiling of the 562 ft 0 in. elevation are sealed to provide a 3-hr fire-resistance rating. The floor at Elevation 540 ft 0 in. is a reinforced-concrete mat. The floor at Elevation 562 ft 0 in. is constructed of reinforced concrete with an unprotected equipment hatch. Electrical cable tray penetrations through the floor between the two elevations are provided with fire stops. Floor drains are provided on both floors.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Air is ducted directly to the CRD pump room and exhausted through ducts from the HPCI pump and turbine room directly to the auxiliary building main exhaust system. The HPCI pump and turbine room has an emergency equipment room cooler for cooling the room ambient air.

Shutdown equipment located in this zone consists of the following:

a. HPCI turbine, pump, and associated valves and instrument rack (Division II)

b. Emergency equipment room cooler (Division II).

No protective envelopes are required for safe-shutdown components in this zone. Fire detection equipment in this zone consists of an ionization detection system at each elevation.

Fire suppression equipment for this zone consists of a partial area automatic sprinkler system for the HPCI turbine and pump room. The hatch and stairwell opening between the two elevations of fire zone 03RB are not protected by automatic sprinklers. Manual hose stations and portable fire extinguishers are provided as shown in Figures 9A-2 and 9A-3.

9A.4.1.4.2 Analysis

Shutdown is achieved from the main control room. All of the equipment and cables in fire zone 03RB are assumed damaged due to a fire. Division I equipment outside this fire zone will be used to achieve safe shutdown for fires in this zone. The RCIC turbine and pump, and the core spray and RHR pumps located in other zones, are functionally redundant to the HPCI turbine, pump, and associated equipment in this zone. A partial area suppression system is provided in the area between the divisions in 04RB.

The lubricating oil in the HPCI turbine represents a specific fire hazard in this zone. This equipment is surrounded by curbing of sufficient height to contain any oil spills. A partial area sprinkler system has been provided for the HPCI turbine and pump room. The sprinkler system is not required for compliance with Appendix R when determining if safe shutdown can be achieved in the event of a fire in 03RB.

Inadvertent operation of the automatic sprinkler system will have no adverse effect on shutdown capability.

Combustibles within this zone consist primarily of the following:

a. Electrical insulation

b. Lubricating oil

Total zone fire loading is low.

9A.4.1.4.3 Conclusion

The objective for this zone is to prevent a fire in this zone from damaging functionally redundant equipment such as RCIC equipment and/or Division I cable located in an adjacent zone. This objective is achieved through the adequate spatial separation of redundant equipment and provision of early-warning detection equipment for the entire zone, a partial area suppression system provided in the area between the divisions in 04RB, and an approved deviation for the intervening combustibles crossing between the divisions in 04RB. In addition, manual hose stations and portable fire extinguishers are provided.

9A.4.1.5 Corridor Area, Fire Zone 04RB, El. 562 Ft 0 In. and 564 Ft 0 In.

9A.4.1.5.1 Description

This zone, shown in Figure 9A-3, consists of a north-south corridor at the Elevation 562 ft 0 in. and an east-west corridor leading to the turbine building at the Elevation 564 ft 0 in. The zone is bounded on the north by the auxiliary building; on the east by the auxiliary and turbine buildings; on the south by the auxiliary building and CRD pump room (Fire Zone 03RB); and on the west by the torus room (Fire Zone 01RB).

The zone houses electrical cables. Divisions I and II cables are all located in the north-south corridor.

The walls, floors, and ceiling separating this zone from the auxiliary and turbine buildings are constructed of reinforced concrete having a fire-resistance rating of 3 hr. The door to the turbine building is a Class A fire door. Penetrations through the rated walls, floors, and ceiling are sealed to provide a 3-hr fire-resistance rating. At the north end of the north-south corridor is a metal pressure-relieving hatch in the ceiling. The hatch is designed for steam venting of a pipe break outside the containment. Because of the light fire loading on each side of the hatch, the partial automatic sprinkler system in this zone, and the availability of manual suppression equipment, the metal hatch provides the necessary fire resistance for the zone.

Ventilation air for this zone is from the reactor/auxiliary building ventilation system. Air is duct exhausted from the zone.

Shutdown equipment located in this zone consists of Divisions I and II cables and a RCIC valve.

No protective envelopes are required for safe-shutdown components in this zone.

Fire detection equipment consists of a photoelectric and ionization detection system. Fire suppression equipment consists of an automatic sprinkler system in the 562-ft corridor, portable fire extinguishers, and manual hose.

9A.4.1.5.2 Analysis

By plant design, the reactor building Division I cables and equipment are normally routed and located on the north side of the building (north of column line 12) and Division II cables and equipment are normally routed and located on the south side of the building (south of column line 12). The RCIC valve is located on the south side of this zone.

Shutdown is achieved from the main control room. Division I will be used to achieve plant safe shutdown for fires on the south side and Division II will be used to achieve plant safe shutdown for fires on the north side of the zone.

Automatic sprinklers are installed in the north-south corridor, (562 ft) in the area of the cable trays (combustible loading for the room is concentrated in this area). There is no automatic sprinkler system in the east-west corridor (combustible loading is insignificant in this area). There are no shutdown cables in the area where automatic sprinkler protection has not been provided.

Cable trays, which present intervening combustibles between redundant cables, have fire breaks installed in them or are solid-metal trays with covers to prevent the propagation of fire. The intervening combustibles in this zone consist of two 12-in. non-Appendix R (non-R) trays (OP-020 and OC-785). Additionally, a 12-in. non-R instrument tray (OK-034) is located approximately 10 ft south of the two 12-in. non-R trays. Since the instrument tray is an enclosed solid-metal tray with cover, it is not considered an intervening combustible. An approximate 10-ft clear space exists between Division II R tray 2K-007 and of the 2 non-R trays. Also, tray 2K-007 is an enclosed solid-metal tray with cover.

All trays run horizontally, which causes a slow-burning fire with smaller heat releases.

These non-R trays represent the only in-situ intervening combustible path between Divisions I and II cables. For a single fire to affect both Divisions I and II cables, a cable tray fire must burn more than 20 ft and must traverse a clear space of approximately 10 ft.

Trays (2) OP-020 and OC-785 have a fire break installed at approximately column line 12 ±5 ft north.

Additional sprinkler heads have been installed below the pipe obstructions to improve sprinkler coverage of the area.

Combustibles located in this zone consist primarily of electrical insulation. The total zone fire loading is low.

9A.4.1.5.3 Conclusion

The objective for this zone is to prevent a fire from affecting both Divisions I and II cables located within this Fire Zone and to prevent a fire from crossing the boundaries of the zone. This is achieved through the provision of an automatic sprinkler system, barriers, fire detection system, portable fire extinguishers, and manual hose.

9A.4.1.5.4 Deviations

Deviations have been approved for the following:

a. Intervening combustibles between redundant trains based on fire stops in trays OP-020 and OC-785 (Reference 1, SSER No. 5, VI[2])

b. Partial automatic sprinklers based on the provisions of additional automatic sprinkler coverage (Reference 1, SSER No. 5, VI[2]).

9A.4.1.6 First Floor, Fire Zone 05RB, El. 583 Ft 6 In.

9A.4.1.6.1 Description

This zone, shown in Figure 9A-4, consists of the large open floor area surrounding the drywell (Fire Zone 10RB), the RHR heat exchanger rooms, railroad bay, drywell access air-lock area, and a partial height equipment room adjacent to and west of the drywell. It is bounded on the north, south, and west by outside walls; and on the east by the auxiliary building and the steam tunnel.

This zone houses the CRD hydraulic controls, RHR heat exchangers, railroad bay, neutron monitoring system (NMS) cabinets, and other auxiliary equipment. The RHR heat exchanger rooms extend up to Elevation 641 ft 6 in.

The walls and ceiling separating this zone from the auxiliary building and the steam tunnel are constructed of reinforced concrete having a 3-hr fire-resistance rating. The door opening between this zone and the steam tunnel is protected by a heavy pressure-resistant metal door. The pressure-resistant door, in combination with the labyrinth access passage, will prevent the spread of a fire from the steam tunnel area to this zone. Penetrations through rated walls and ceiling are sealed to provide 3-hr fire-resistance ratings except for the pressure equalizing line between the steam tunnel and this Fire Zone. The ability of the fire barrier to perform its function has been evaluated and determined to provide an adequate assurance that a fire in this Fire Zone will not propagate to the steam tunnel. The partial height equipment room is accessible from the south portion of the zone, and is separated from the remainder of the zone by a shield wall and ceiling. The portion of the room boundary north of column 12 has been evaluated to provide adequate separation from the north portion of the Fire Zone. The floor and unrated portion of ceiling of this zone are constructed of reinforced concrete and steel beams, and contain open stairwells, unprotected hatches, pipe chases, and unsealed penetrations. Cable tray penetrations through the floor and unrated portion of ceiling, and unrated walls are provided with fire stops.

Ventilation air for this zone is ducted directly from the reactor/auxiliary building ventilation system and is relieved to the neutron monitoring equipment room and to an area outside the personnel air lock. Air also enters the zone through the stairwells from the floor above and from the RHR heat exchanger rooms through pressure relief dampers.

Shutdown equipment located in this zone consists of the following:

a. RHR heat exchangers (Divisions I and II) and associated valves

b. CRD hydraulic control units (HCUs)

c. Instrument racks and motor control centers (Division I and II)

d. The following valves:

    1. RHR to recirculation inboard isolation valve, E1150F015A (Division I) and B (Division II)

    2. Reactor recirculation extraction to outboard isolation valve, E1150F008

    3. EECW system isolation valves, P4400F601A, P4400F603A (Division I) and P4400F601B, P4400F603B (Division II).

e. 120 V ac distribution panel

f. Standby feedwater and CTG 11-1 supervisory cables

Fire detection equipment in this zone consists of an ionization detection system. Fire suppression equipment consists of an automatic sprinkler system in the railroad bay and manual water hose stations and portable fire extinguishers as shown in Figure 9A-4.

NFPA 13 noncompliances with this sprinkler system include sprinkler protection areas exceeding the limit for ordinary hazard occupancy and sidewall sprinklers around the open equipment hoistway not installed in a staggered arrangement (in addition to those discussed and evaluated in 9.5.1.2.3.3). These noncompliances would not adversely affect the required function of this system because the large safety margin in the water supply hydraulic design calculations would adequately compensate for these and provide the required sprinkler performance. In addition, the exceptionally deep beams would result in partially obstructed discharge patterns for some sprinklers, but the sprinkler system would still prevent any fire or fire effects from traveling any significant distance north or south from the point of origin.

9A.4.1.6.2 Analysis

By plant design, the reactor building Division I cables and equipment are normally routed and located on the north side of the building (north of column line 12) and Division II cables and equipment are normally routed and located on the south side of the building (south of column line 12).

One-hour rated protective envelopes are provided for Division I cables when routed south of Column line 12.

Shutdown is achieved from the main control room. Division I will be used to achieve plant safe shutdown for fires on the south side and Division II will be used to achieve plant safe shutdown for fires on the north side of the zone.

Because of a potential high/low-pressure interface (associated circuits), E1150F008 shutdown cooling valve is required to be electrically disabled. The two sets of CRD HCUs, both of which are required for shutdown, are located on opposite sides of the drywell structure. The RHR heat exchangers and related valves are located in separate rooms located on opposite sides of the building. The redundant EECW isolation valves and Division I and II cables located within the zone are separated either by the drywell or steam tunnel structure or are separated spatially by a minimum of 40 ft.

The steel beams installed above the railroad bay area (also known as the truck bay) are evaluated based on the worst case fire in the railroad bay area. This analysis demonstrates that a fire in the truck bay area will not damage the steel beams supporting the Division 1 EECW Heat Exchanger. As a result, fire coating the steel beams in the truck bay area is not required to ensure safe shutdown of the plant during all Appendix R scenarios.

During refueling the railroad bay could represent a possible fire hazard; however, this area is protected by an automatic sprinkler system and a continuous firewatch when a refueling vehicle containing a combustible fuel is parked in the bay.

The automatic sprinkler system is installed in the railroad bay (column A-B, 9-13).

A heat detection system is installed in the railroad bay (column lines A-B, 9-13).

There is a greater than 20 ft separation with no intervening combustibles between Divisions I and II shutdown circuits in the railroad bay within the zone between column lines A-B, 11-13. The drywell and steam tunnel walls provide fire barriers at least equivalent to 3-hr-rated barriers.

Combustibles located within this zone consist primarily of electrical insulation.

The total zone fire loading is low.

9A.4.1.6.3 Conclusion

The objective for this zone is to prevent a fire from affecting both sets of redundant equipment located within this zone, and from spreading to other zones. This objective is achieved through barriers, spatial separation, the location of redundant equipment in separate rooms, the provision of early-warning detection equipment throughout the zone and a partial automatic sprinkler system over the railroad bay, a continuous firewatch when a refueling vehicle containing a combustible fuel is parked in the bay, and low fire loading.

Due to the low fire loading in the areas of both CRD HCUs and the presence of the early-warning detection equipment, it is considered unlikely that the function of the CRD HCUs (i.e., to scram the reactor) would be affected by a fire.

In addition, manual hose and portable fire extinguishers are provided.

9A.4.1.6.4 Deviations

Deviations have been approved for the following:

a. Partial suppression system based on 20-ft combustible free zone on west side of the reactor building at column line 12, high ceilings, and low combustibles (Reference 1, SSER No. 5, VI[3])

b. Lack of 3-hr fire-rated barriers separating redundant equipment based on 20-ft combustible free zone on the west side of the reactor building at column line 12, high ceilings, and low combustibles (Reference 1, SSER No. 5, VI[3]).

c. Non rated doors R1-8 and R1-11 on the first floor reactor building are special-purpose doors constructed of heavy weight, reinforced steel plates and are either blast-resistant (R1-11) or water-tight (R1-8) in addition to providing fire protection. (Reference 1, Reference 3, SSER No. 6, III.B)

9A.4.1.7 Second Floor, Fire Zone 06RB, El. 613 Ft 6 In.

9A.4.1.7.1 Description

This zone, shown in Figure 9A-6, consists of the floor area outside the drywell (Fire Zone 10RB), excluding the RHR heat exchanger rooms, at Elevation 613 ft 6 in.

It is bounded on the north, south, and west by outside walls and on the east by the auxiliary building and the steam tunnel. The west wall of the RHR Heat Exchanger Room on the Reactor Building 2nd Floor provides a three-hour fire barrier between the Division II RHR heat exchanger and the Division I EECW heat exchanger P4400B001A.

This zone houses the reactor water cleanup (RWCU) heat exchangers, phase separators, and pumps; the EECW pumps, heat exchangers, area coolers, makeup tanks and makeup pumps; instrument racks; motor control centers (MCCs); and the H_2-O_2 Division I analyzer and associated test gas cylinders.

The walls separating this zone from the auxiliary building and the steam tunnel are constructed of reinforced concrete having a fire-resistance rating of 3 hr. The door opening leading to the auxiliary building is protected by a Class A fire door. Penetrations through the rated wall are sealed to provide a 3-hr fire-resistance rating. The floor and ceiling are constructed of reinforced concrete and contain open stairwells, unprotected hatches, and unsealed penetrations. Cable tray penetrations through the floor and ceiling are provided with fire stops. Division I shutdown cables within 20 ft of Division II shutdown cables near F-11 are enclosed by a 1-hr-rated fire barrier.

Ventilation air for this zone is provided directly from the reactor/auxiliary building ventilation system supply to the general floor area. Air flows to the RWCU pump rooms, RHR heat exchanger rooms, water sample station, water sludge discharge pump room, holding area, and RWCU heat exchanger room from the general floor area. Air to or from these areas is controlled by backdraft dampers in the walls. Air in these areas is exhausted to the reactor/auxiliary building ventilation system exhaust. The EECW pump areas have local air-handling units (pump room cooling units) to cool the area ambient air.

Shutdown equipment located in this zone consists of the following:

a. Divisions I and II cables

b. Divisions I and II reactor vessel level and pressure instrument racks

c. Divisions I and II EECW pumps, heat exchangers, pump area cooling units, makeup tanks and makeup pumps, nitrogen tanks (Division I only), EESW to EECW makeup lines, and associated valves and MCCs

d. Divisions I and II drywell monitoring instrument racks

e. Divisions I and II MCCs

f. Divisions I and II core spray and RHR valves

g. Standby feedwater and CTG 11-1 supervisory control cables

h. 120 V ac distribution panel (Division I)

i. Emergency Equipment Room Coolers (Division I and II)

j. Swing bus MCC

k. Drywell pneumatic racks (Division II)

One-hour protective envelopes are required for certain cable trays in this zone.

Fire detection equipment in this zone consists of an ionization detection system. Fire suppression equipment consists of automatic sprinklers over cable trays along the east wall between columns 10 and 12 and on the west side between column lines A and C, at column line 12 and in the area near P4400B001A between columns lines A and B and 9 and 10. In addition, manual water hose stations and portable fire extinguishers are provided as shown in Figure 9A-6.

NFPA 13 noncompliances with the west side sprinklers include some sprinkler locations exceeding the maximum allowable distance below the ceiling, lack of baffles between sprinklers that are less than 6 ft apart, and some sprinklers partially obstructed by supports. These noncompliances do not prevent these west side sprinklers from providing the required fire protection for this area.

9A.4.1.7.2 Analysis

By plant design, the reactor building Division I cables and equipment are normally routed and located on the north side of the building (north of column line 12) and Division II cables and equipment are normally routed and located on the south side of the building (south of column line 12).

Shutdown is achieved from the main control room. Division I will be used to achieve plant safe shutdown for fires on the south side and Division II will be used to achieve plant safe shutdown for fires on the north side of the zone.

No protective envelopes are required for cable routed on the north side of the zone. One-hour protective envelopes are provided for cable trays 1C-033, 1P-038, 1P-040, and 1P-051 when routed on the south side of the zone.

Divisions I and II EECW equipment located within this zone is separated spatially by a minimum distance of approximately 50 ft. In addition, the drywell structure functions as a radiant-energy barrier between the redundant pumps.

The Division I EECW Heat Exchanger P4400B001A is located south of Column 12, above the railroad bay hatch at Column 9 between Columns A and B. The backup Division 1 EECW Heat Exchanger P4400B001C is located slightly north of column line 12 between columns A and B. Fire suppression is provided in these areas. In addition, all Division II conduit located within 20 feet of the Division I heat exchanger P4400B001A is protected with a one-hour protective envelope. The Division II RHR heat exchanger is separated from the Division I EECW heat exchanger P4400B001A by a three-hour fire barrier (RHR Heat Exchanger Room West wall between Columns 9 and 10 at Column B).

The abandoned tubing left within the three hour fire resistant penetration to the auxiliary building is evaluated to show that the seal is adequate for fires in the zone.

Reactor vessel level and pressure instrument racks are separated by the drywell structure.

Drywell monitoring instrument racks are located on opposite sides of the heat exchanger vault.

The RWCU equipment located in this zone contains significant amounts of concentrated radioactivity. This equipment is located in separate shielded cubicles with negligible fire loadings.

There are three non-safe-shutdown trays (OP-037, OC-060, and OK-066), which are routed north-south along column line B. Three cable trays (OP-047, OC-793, and OK-069) traverse the Fire Zone along the east wall near column line F. These trays represent the only intervening combustibles that could propogate a fire between Divisions I and II shutdown circuits on the east and west side respectively.

For a single fire to affect both divisions, a cable tray fire would have to burn a minimum of 35 ft.

On the east side of the reactor building, fire breaks have been installed in cable trays OP-047 and OC-793 approximately 3 ft south of column line 12.

On the west side of the reactor building, fire breaks have been installed in cable trays OP-037 and OC-060 approximately 12 ft south of column line 12.

The two instrument trays, OK-069 and OK-066, are solid-metal trays with covers.

Combustibles located within this zone consist primarily of electrical insulation.

The total zone fire loading is low.

9A.4.1.7.3 Conclusion

The objective for this zone is to prevent a fire from affecting redundant equipment, cable, and instrumentation and from spreading to other zones. This objective is achieved through barriers, early-warning detection equipment, spatial separation between redundant equipment, and low fire loading. Automatic sprinklers are provided in the area with concentrated fire loading of Divisions I and II cable trays and in the areas with the Division I EECW Heat Exchangers. In addition, manual water hose stations and portable fire extinguishers are provided.

9A.4.1.7.4 Deviations

Deviations have been approved for the following:

a. Partial suppression at column line 12 based on intervening open cable trays having fire stops and separation of Divisions I and II cables (north and south) within the zone (Reference 1, SSER No. 5, VI[4])

b. Intervening combustibles in cable trays OP-047, OC-793, OP-037, and OC-060 which are provided with fire stops (Reference 1, SSER No. 5, VI[4]).

9A.4.1.8 Third Floor, Fire Zone 07RB, El. 641 Ft 6 In.

9A.4.1.8.1 Description

This zone, shown in Figure 9A-8, consists of the floor area at Elevation 641 ft 6 in., with the exception of the drywell and fuel storage pool.

It is bounded on the north, south, and west by outside walls and on the east by the auxiliary building.

This zone houses the hydrogen recombiners, contaminated equipment storage area, CRD decontamination and repair area, the fuel storage pool heat exchangers and pumps, and the H_2-O_2 Division II analyzer and test gas cylinders.

Safe shutdown equipment located in this zone consists of the following:

a. Division I and II cables

b. Standby Feedwater cables

The wall separating this zone from the auxiliary building is constructed of reinforced concrete having a fire-resistance rating of 3 hr. Penetrations through rated walls are sealed to provide a 3-hr fire-resistance rating. The floor and ceiling are constructed of 12-in. reinforced concrete and contain open stairwells, unprotected hatches, and unsealed penetrations. Floor penetrations are sealed to provide a 3-hr fire barrier for that portion of the floor in the southeast corner which separates this zone from Zone 8 of the auxiliary building. Cable tray penetrations through the floor and ceiling are provided with fire stops.

Ventilation air for this zone is provided directly from the reactor/auxiliary building ventilation system supply to the general floor area and the area north of the fuel storage pool. Air flows to the contaminated equipment storage area, CRD decontamination and repair area, and the fuel storage pool heat exchanger and pump room from the general floor area. Air enters these areas through backdraft dampers located in the room walls and is exhausted through ducts to the reactor/auxiliary building ventilation system exhaust. Air exhausted from the contaminated equipment storage and CRD decontamination and repair areas passes through high-efficiency particulate air (HEPA) filters.

Fire detection equipment located in this zone consists of an ionization detection system. Fire suppression equipment consists of manual water hose stations and portable fire extinguishers as shown in Figure 9A-8.

9A.4.1.8.2 Analysis

By plant design, the reactor building Division I cables and equipment are normally routed and located on the north side of the building (north of column line 12) and Division II cables and equipment are normally routed and located on the south side of the building (south of column line 12).

Shutdown is achieved from the main control room. Division I will be used to achieve plant safe shutdown for fires on the south side and Division II will be used to achieve plant safe shutdown for fires on the north side of the zone.

There are no Division I shutdown cables on the west side of the reactor building. Any large openings that communicate with second floor, Division I shutdown cables, are located approximately 50 ft away. Any fire in this area will affect only Division II equipment. Therefore, protection is not necessary.

No protective envelope is required for safe-shutdown components in this zone.

The fuel storage pool heat exchangers and pumps contain significant amounts of concentrated radioactivity. This equipment is located in a separate shielded cubicle with a negligible fire loading.

Vertical cable tray risers are solid-metal trays with covers. These are located at approximately column lines F-13 (trays OP-123, OC-071, and OP-049).

Combustibles located within this zone consist primarily of electrical insulation. The total zone fire loading is low.

9A.4.1.8.3 Conclusion

The objective for this zone is to prevent the spread of a fire in this zone to another Fire Zone. This objective is achieved through barriers, low zone fire loading, and provision of early-warning detection equipment, manual water hose stations, and portable fire extinguishers.

9A.4.1.8.4 Deviations

Lack of a 3-hr barrier separating the next floor based on metal covers on vertical cable trays near column line F-13, no intervening combustibles, and the low combustible loading of the zone (Reference 1, SSER No. 5, VI[5]) .

9A.4.1.9 Fourth Floor, Fire Zone 08RB, El. 659 Ft 6 In.

9A.4.1.9.1 Description

This zone, shown in Figure 9A-9, consists of two floor areas at Elevation 659 ft 6 in. These floor areas are separated by the drywell, the dryer/separator storage pool and the fuel storage pool.

The western portion of the zone is bounded on the north, south, and west by outside walls and on the east by the drywell, dryer/ separator storage pool, and the fuel storage pool. The eastern portion of the zone is bounded on the north and south by outside walls; on the east by the auxiliary building; and on the west by the drywell, dryer/separator storage pool, and the fuel storage pool.

The western portion of the zone houses motor-generator (M-G) sets and oil cooler, dress-out facilities, and RWCU equipment. The eastern portion of the zone houses the standby liquid control system (SLCS).

The walls separating this zone from the auxiliary building are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Penetrations through rated walls are sealed to provide a 3-hr fire-resistance rating. The floor is constructed of reinforced concrete and contains open stairwells, unprotected hatches, and unsealed penetrations. Floor drains are provided and trapped at the collection sumps. The ceiling is also constructed of reinforced concrete and contains unprotected hatches and unsealed penetrations. Cable tray penetrations through the floor and ceiling are provided with fire stops.

Ventilation air is supplied directly to the area around the M-G sets and the storage areas north and east of the fuel storage pool. Air then flows from these areas to the clean area, the RWCU pump room, and the RWCU south and north demineralizer rooms. Air also flows from the clean area to the personnel change area. Supply air to the RWCU holding pump room and demineralizers is controlled by backdraft dampers. With the exception of air exhausted from the area around the M-G sets, exhaust air is ducted to the reactor/ auxiliary building ventilation system exhaust. The M-G set area is locally cooled by air ducted directly to the M-G sets from three recirculating fancoil units.

Safe shutdown equipment located in this zone consists of the following:

a. Division II cables

b. Standby Feedwater cables

c. Division II 480 V ac distribution panel

Fire detection equipment located in this zone consists of an ionization detection system and heat detectors. Fire suppression equipment consists of an automatic sprinkler system in the area of the M-G sets and oil coolers, manual hose, and portable fire extinguishers as shown in Figure 9A-9.

9A.4.1.9.2 Analysis

Reactor water cleanup equipment located in this zone contains significant amounts of concentrated radioactivity. This equipment is located in separate shielded cubicles with negligible fire loadings.

Shutdown is achieved from the main control room. Division I will be used to achieve safe shutdown for fires in the south side and Division II will be used to achieve safe shutdown for fires in the north side of the zone.

Except for Standby Feedwater flow indication cables located in the south side of the zone, there are no Division I or II Appendix R cables or equipment in the zone.

Lubricating oil in the couplings and cooling units of the two M-G sets located in this zone represents a specific fire hazard. This equipment is surrounded by curbing of sufficient height to contain any oil spills.

Combustibles located within this zone consist of the following:

a. Lubricating oil

b. Electrical insulation

c. Ordinary combustibles

The total fire loading for this zone is low.

9A.4.1.9.3 Conclusion

The objective for this zone is to prevent a fire from spreading to another zone. This objective is achieved through barriers, low fire loading in the area of the SLCS, the provision of early-warning detection systems for the entire zone, curbing and an automatic sprinkler system for the M-G sets and oil coolers, and manual hose and portable fire extinguishers.

9A.4.1.10 Fifth Floor, Fire Zone 09RB, El. 684 Ft 6 In.

9A.4.1.10.1 Description

This zone, shown in Figure 9A-10, consists of the floor area at Elevation 684 ft 6 in., including the fuel storage pool, dryer/ separator pool, and decontamination area, along with the Auxiliary Building stairwell enclosure.

The zone is bounded on the north, south, and west by outside walls and on the east by the auxiliary building.

This zone houses the fuel storage pool and associated equipment, dryer/separator pool, and the decontamination area.

The east wall abutting the auxiliary building is constructed of reinforced concrete up to Elevation 701 ft 0 in. and provides a 3-hr-rated fire barrier. Penetrations in rated walls are sealed to provide a 3-hr fire rating. The east wall above Elevation 701 ft 0 in. and the north, south, and west walls are constructed of steel frame and siding. The stairwell leading to the auxiliary building is enclosed by a 3-hr-rated fire barrier to provide separation between the auxiliary building and the reactor building. The floor is constructed of reinforced concrete and contains unprotected hatches and unsealed penetrations. Cable tray penetrations through the floor are fire stopped. The roof is constructed of steel frame and deck with insulation and builtup roofing that conforms to Factory Mutual Class I requirements.

Ventilation air is supplied directly through ducts to the floor area. Air then flows from the floor area to the dryer/separator pool, reactor well, and fuel storage pool. Air is exhausted from these areas through ducts to the reactor/auxiliary building ventilation system exhaust. The elevator machine room fan draws air from the refueling area through the machine room and discharges it back to the refueling area.

Equipment located in this Fire Zone is not required for shutdown.

Safe shutdown equipment located in this zone consists of the following:

a. Division I and II cables

Fire detection equipment located in this zone consists of an infrared detection system. Fire suppression equipment in this zone consists of manual hose with solid stream nozzles and portable fire extinguishers as shown in Figure 9A-10.

The combustible loading in the Auxiliary Building stairwell enclosure is extremely low. In addition future storage of combustibles in this area is not considered for the purpose of this analysis because the storage of combustibles in stairwells is controlled. Based on the extremely low combustible loading in this area, fire detection instrumentation is not installed since it would not be expected to alarm due to the small amounts of smoke/heat that could be produced by a fire in this area. The stairwell contains two (2) Division II cables routed in the same conduit above the 677′-6″ elevation which are required for safe shutdown.

9A.4.1.10.2 Analysis

Shutdown is achieved from the main control room. Division I will be used to achieve safe shutdown for fires on the south side because there are no Appendix R Division I cables located on the south side of this zone. On the north side of this zone, Division II will be used to achieve safe shutdown. There are no Appendix R Division II cables (nor are there Appendix R Division I cables) located on the north side of this zone. Combustibles located in this zone consist primarily of the reactor building and fuel-handling crane and gear box lubricating oil. The total zone fire loading is low.

9A.4.1.10.3 Conclusion

The objective for this Fire Zone is to prevent the spread of a fire in this zone to another Fire Zone. This objective is achieved through low zone fire loading, and the provision of an early-warning detection system and manual hose and portable fire extinguishers.

9A.4.1.11 Drywell, Fire Zone 10RB, El. 562 Ft 0 In. to 684 Ft 6 In.

9A.4.1.11.1 Description

This zone, shown in Figures 9A-3, 9A-4, 9A-6, 9A-8 through 9A-10, consists of a containment vessel in the shape of an inverted light bulb.

The zone is surrounded by reactor building Fire Zones 01RB through 09RB.

This zone houses the reactor pressure vessel (RPV), reactor recirculation pumps, and associated equipment.

The drywell consists of a steel pressure vessel surrounded by reinforced concrete for shielding. External to the drywell vessel but in the Fire Zone above elevation 572 ft. 1 in., the drywell is separated from the concrete biological shield by a gap of approximately 2 inches. The gap is filled with polyurethane foam material. The bottom portion of the shell is totally embedded in concrete, and the transition zone is backed by compacted sand. Access to the drywell is through an air lock located in Zone 4 at Elevation 583 ft 6 in.

Cooling of air within the drywell is provided by 14 fan-coil units located at various elevations within the drywell. These units recirculate and cool the drywell ambient air. Cooling water for these units is normally supplied from the reactor building closed cooling water system (RBCCWS). Under other than normal conditions, cooling water is supplied from the EECW system. Thermocouples located in various drywell areas actuate control room alarms on detection of high temperature.

Shutdown equipment located in this zone consists of the following:

a. Nuclear pressure relief system (NPRS) safety/relief valves (SRVs) B21-F013A, B, C, D, E, F, G, H, J, K, L, M, N, P, and R and instruments

b. Reactor recirculation shutdown cooling to RHR inboard isolation valves E11-F009 and E11-F608

c. Reactor recirculation discharge valves B31-F031A, B31-F031B, B3105F023A and B3105F023B.

d. Division 1 and 2 cables, located in drywell penetrations passing through the drywell gap area.

e. SRV accumulators (Division I and II)

f. Valves (Division I and II)

g. T50 instrumentation (Division I and II)

For maintenance operations, fire suppression equipment, consisting of manual hoses and portable fire extinguishers, is located at the drywell access air lock in Zone 4 at Elevation 583 ft 6 in. The drywell gap area is not provided with either fire detection or automatic suppression. Fire suppression consists of manual hoses located on the first and second floor level.

9A.4.1.11.2 Analysis

The drywell atmosphere is inerted with nitrogen. The concentration of nitrogen is maintained at 97 percent. Oxygen and hydrogen content is monitored. For a more detailed description, refer to Subsection 9.3.6. Fire damage is not assumed to occur under Appendix R Section III.G.2.

Combustibles within this zone consist primarily of the following:

a. Electrical insulation

b. Lubricating oil

c. Polyurethane foam in the drywell gap area

d. Silicone rubber impregnated fiberglass fabric covering permanently installed lead blankets

Because the polyurethane foam is located in the drywell gap outside the steel drywell vessel, the foam does not contribute to the total zone Btu content of the drywell.

Total zone fire loading is low.

If a fire occurs in the drywell gap area, hot shutdown can be maintained using HPCI; cold shutdown can be attained by manual operation of valves in the drywell to achieve shutdown cooling lineup.

9A.4.1.11.3 Conclusion

The objective of this zone is to prevent a fire from occurring. During reactor operation, this is achieved through the maintenance of a nitrogen atmosphere. During maintenance operation, fire suppression equipment is used. Although Division 1 and 2 cables are present in the drywell gap, redundant hot shutdown equipment is not affected by a fire in the gap area. Hot and cold shutdown can be achieved following the assumptions of 10 CFR 50, Appendix R.

9A.4.2 Auxiliary Building

9A.4.2.1 General Description

The auxiliary building is a multilevel structure. For purposes of this fire hazards analysis, the auxiliary building has been designated as fire area AB. It is bounded on the north and south by outside walls; on the east by the turbine building; and on the west by the reactor building.

The outage building is located four (4) inches south of the south wall of the reactor and auxiliary building. The outage building is of completely noncombustible construction; additionally no safe shutdown systems or equipment are located in this building. The outage building is structurally separated from plant structures, however, nonstructural flashing is attached to both the reactor and auxiliary building to seal and protect the four-inch gap between it and the outage building.

The north and south exterior walls are constructed of 24 inches of reinforced concrete which will prevent an exposure fire in the yard area from propagating into the auxiliary building. Except as noted below, these walls are 3-hr-rated fire barriers.

The auxiliary building south wall also contains five (5) non-rated removable plugs filled with at least twelve (12) inches of grout and are acceptable for use as penetration seals in a 3-hr-rated fire barrier based on their construction.

The auxiliary building also contains a sixth removable plug seal. This sleeve has six (6) 1-inch thick steel plates held into the penetration with a locked steel bar such that they are flush with the exterior plane surface of the fire barrier. A seventh 1-inch thick steel plate is bolted into the exterior wall of the auxiliary building. In addition, the eighteen (18) inches between these sets of plates is totally devoid of combustible materials. Therefore, although they are not tested and approved seal configurations they are of substantial steel construction and prevent flame propagation into the auxiliary building.

The metal-sided control center air conditioning intake is located on the south side of the auxiliary building. The base of the air intake is at elevation 643′-6″ while the actual opening into the auxiliary building is a 6′ x 20′ opening at elevation 681′-6″. Since this opening itself is 98′ above grade elevation (583′-6″), an exposure fire threat to the opening itself is not postulated based on the types, amounts, and locations of the combustible materials that could be in close proximity of the air intake either during normal operation or outages. Should the control room operators detect smoke coming into the control center because of a fire in the yard, or receive notification of a fire in the yard, the operators can switch from the air intake on the south side of the auxiliary building to the air intake on the north side of the building. This is done by placing the air conditioning system in the recirculation mode.

The auxiliary building houses reactor auxiliary systems and equipment.

With the exception of the control room, relay room, cable spreading room, standby gas treatment system (SGTS) room, and control center air conditioning equipment rooms, ventilation of the auxiliary building is provided by the reactor/auxiliary building ventilation system. Ventilation for the control room, relay room, cable spreading room, and control center air conditioning equipment room is provided by the control center heating, ventilation, and air conditioning (HVAC) system. These ventilation systems are discussed briefly in the individual Fire Zone descriptions. Additional details for these ventilation systems are presented in Subsections 9.4.1 and 9.4.2.

For the purpose of this fire hazards analysis, the auxiliary building has been divided into the following Fire Zones:

a. Basement, Fire Zone 01AB, Elevations 551 ft 0 in. and 562 ft 0 in.

b. Mezzanine and cable tray area, Fire Zone 02AB, Elevations 583 ft 6 in. and 603 ft 6 in.

c. Relay room, Fire Zone 03AB, Elevation 613 ft 6 in.

d. Switchgear room, Fire Zone 04AB, Elevation 613 ft 8 1/2 in.

e. Cable tunnel, Fire Zone 05AB, Elevation 613 ft 6 in.

f. Second floor, miscellaneous rooms, Fire Zone 06AB, Elevation 613 ft 6 in.

g. Cable spreading room, Fire Zone 07AB, Elevation 630 ft 6 in.

h. Cable tray area, Fire Zone 08AB, Elevation 631 ft 0 in.

i. Control room, Fire Zone 09AB, Elevations 643 ft 6 in. and 655 ft 6 in.

j. Divisions I and II battery rooms, Fire Zone 10AB, Elevation 643 ft 6 in.

k. Miscellaneous rooms, Fire Zone 11AB, Elevation 643 ft 6 in.

l. Switchgear room, Fire Zone 12AB, Elevation 643 ft 6 in.

m. Ventilation equipment area, Fire Zone 13AB, Elevation 650 ft 6 in.

n. Control center ventilation equipment rooms and standby gas treatment rooms, Fire Zone 14AB, Elevation 677 ft 6 in.

o. Ventilation equipment area, Fire Zone 15AB, Elevation 677 ft 6 in.

9A.4.2.2 Basement, Fire Zone 01AB, El. 551 Ft 0 In. and 562 Ft 0 In.

9A.4.2.2.1 Description

The basement, shown in Figure 9A-3, encompasses the entire floor area at Elevation 551 ft 0 in. and the floor area bounding CRD pump room on the east and south at Elevation 562 ft 0 in. The zone is bounded on the north and south by outside walls; on the east by the turbine building; and on the west by the reactor building.

This zone houses Divisions I and II control air equipment and cables. Walls and ceiling separating this zone from the reactor building, turbine building, and other zones of the auxiliary building are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Door openings are protected by Class A fire doors. Penetrations through rated walls and ceilings are sealed to provide 3-hr fire-resistance ratings. Division I and II shutdown cables within 20 ft of the opposite Division's shutdown cables are enclosed with a 1-hr-rated fire barrier or an analysis has been performed to show that loss or misactivation of any interacting redundant divisional circuits does not affect plant safe shutdown. Fire breaks have been installed in trays which contain intervening combustibles in order to ensure that a postulated fire cannot spread through these cable trays in such a manner as to damage redundant safe shutdown components.

Ventilation supply air from the reactor/auxiliary building ventilation system is ducted to both control air equipment areas and to the cable tray space. Exhaust from these spaces is by direct duct connection to an exhaust main passing through these spaces. Both control air equipment areas have local air-handling units for cooling the room ambient air.

Shutdown equipment located in this zone consists of the following:

a. Divisions I and II control air equipment, fan coil units, and associated isolation valves

b. Divisions I and II cable.

For Fire Zone 01AB, Division II is primarily utilized for safe shutdown except for certain Division I areas. Division I is utilized for shutdown between 10-12, and in the southwest corner near G-9.

Fire detection equipment in this zone consists of an ionization detection system. Fire suppression equipment consists of an automatic sprinkler system for floor Elevations 551 ft 0 in. and 562 ft 0 in. and manual water hose stations and portable fire extinguishers as shown in Figure 9A-3.

9A.4.2.2.2 Analysis

Shutdown is achieved from the main control room. Division II cable trays required for shutdown (2C-027, 2C-030, 2C-036, 2P-019, and DC2P-019) are provided with a 1-hr protective envelope when they are within 20 ft of Division I circuits. Division II cable trays 2C-035, 2P-026, and DC2P-026 are partially protected along column line 11. These trays no longer require protection as the Division 1 circuits are protected in this area. Division 1 trays 1P-069, DC1P-069, 1P-024, and 1C-005 are protected between column lines H10 and H13.

The cable tray supports, along the west side, between column lines H12 and H13 are wrapped for their full height. The cable tray supports, along the west side, between column lines H11 and H12 are wrapped to approximately elevation 566'. The cable tray supports, along the west side, between column lines H10 and H11 do not require fire wrap. The cable tray support wrap was evaluated and determined to be required to protect the tray supports from direct flame impingement in the event of a transient combustible fire occurring beneath these trays.

Division II trays 2K-011 and 2K-020 are not protected, between column lines 11 and 12, because these trays are not required since they are in an area where Division I will be used to achieve shutdown.

In areas where Division I is not protected, Division II is used for shutdown.

Intervening combustibles exist between the two shutdown divisions. Between column lines 12 and 13, trays 0C-018, 0C-017, 0C-027, and 0C-028 are provided with fire breaks, and trays 1K-022, 2K-020 and 0K-001 are solid metal bottom trays with covers. Between column lines 10 and 11 trays 0P-005, 0C-018, 0C-017, 0C-027, 0C-028, and 0P-002 constitute intervening combustibles with fire breaks, and tray 1K-022 is a solid metal bottom tray with covers. The empty tray 0P-006 is not an intervening combustible. These fire breaks provide a minimum of 20 feet free of intervening combustibles and therefore meet the requirements for 20 foot separation with no intervening combustibles and with detection and suppression.

At the south end, mezzanine area 562 ft 0 in., of the zone (column line G-H, 9-11) intervening combustibles in the form of cable trays exist within the 20-ft separation zone between the divisions. Cable tray fire breaks have been installed in trays OP-005, OC-017, and OC-018. Cable tray 2K-015 is enclosed within the fire barrier in the vicinity of these breaks and thus is not an intervening combustible.

Specific fire hazards exist in the southeast and northeast portions of the zone where both Divisions I and II cables are concentrated.

The amount of lubricating oil in the control air equipment is not sufficient to allow propagation of a fire between Division I and II equipment through the floor drain system in the zone.

Combustibles located within this zone consist primarily of electrical insulation.

The total zone fire loading is low.

9A.4.2.2.3 Conclusion

The safe-shutdown analysis performed verified that either Division I or II will be available for plant safe shutdown in the event of a fire in this zone. The Division I or II power and control circuits are provided with a 1-hr-rated protective envelope, as listed above, or are separated from the redundant division's unprotected cables by at least 20 ft. Cable tray fire breaks are provided in various Balance of Plant cable trays to provide 20 ft. zones free of intervening combustibles.

9A.4.2.2.4 Deviations

Deviations have been approved for the following: intervening combustibles--based on fire stops in cable trays OP-005, OC-017, and OC-018 at column lines 9 and 11 (Reference 1, SSER No. 5, VI [15]).

9A.4.2.3 Mezzanine and Cable Tray Area, Fire Zone 02AB, El. 583 Ft 6 In. and 603 Ft 6 In.

9A.4.2.3.1 Description

This zone, shown in Figures 9A-4 and 9A-5, is divided into three sections and encompasses two floor elevations, with a common ceiling under Elevation 613 ft 6 in. The first floor elevation is at 583 ft 6 in. and is divided into two sections, a north section and a south section, separated by an extension of the turbine building. The southern section of the zone consists of a cable entry room, which extends partially along the outside of the south wall, and a cable tray area. The northern section of the zone consists of a cable tray area. The mezzanine area, the third section of the zone, is at Elevation 603 ft 6 in. above the turbine building extension. The zone is bounded on the south by an outside wall, except at the cable entry area, where a portion of the zone bounds the reactor building; on the east by the turbine building; on the north by an outside wall; on the west by the reactor building, steam tunnel, and an outside wall at the cable entry area; and is divided by an extension of the turbine building from the 583 ft 6 in. elevation up to the floor of the 603 ft 6 in. elevation.

This zone serves primarily as a cable routing area.

The walls, floor, and ceiling bounding this zone are constructed of reinforced concrete having a fire-resistance rating of 3-hr. Penetrations are sealed to provide 3-hr fire-resistance ratings except for 16 cable tray penetrations in the mezzanine area at the 603 ft 6 in. elevation east wall. These penetrations are open to the enclosed 4-inch gap area between the auxiliary and turbine buildings. Door openings leading to the turbine building extension and between the Divisions I and II cable entry rooms are protected by Class A fire doors. Division II shutdown cables within 20 ft of Division I shutdown cables in the north end of the area are enclosed with a 1-hr-rated fire barrier, as are Division I shutdown cables within 20 ft of Division II shutdown cables in the south end of the area. The equipment hatch in the southern section of the zone is provided with a reinforced-concrete cover.

The HVAC/pipe chase along column H between 10 and 11 extends from the floor opening at elevation 613’-6” to the ventilation equipment area on elevation 677’-6” (Fire Zone 15AB) and is completely devoid of combustibles for is entire 64-foot height. Additionally, the walls of this chase are constructed and sealed as 3-hour rated barriers. Finally, Thermo-Lag material was used to construct the floor of this chase. Given, that as detailed below, automatic sprinkler coverage is provided for the area around the base of this opening and that the combustible loading on the 677’-6” elevation open top of this chase is negligible (reference Section 9A.4.2.16.2), flame propagation via this combustible material free vertical chase is not a credible event. Therefore, the chase itself provides the required separation between auxiliary building Fire Zones 2 and 15. Additionally, the Thermo-Lag material used to seal the chase at elevation 613'-6" is a nonfire rated smoke and gas barrier. For identification purposes, the chase is considered as being part of Fire Zone 02AB.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Supply air is ducted to each section of the zone. Exhaust air returns unducted from the northern section of the zone to the mezzanine area where air is exhausted through ducts to the auxiliary building main exhaust system. Exhaust air from the southern section of the zone is ducted to the auxiliary building main exhaust system.

Shutdown equipment contained in this zone consists of the following:

a. Divisions I and II cables

b. Offsite power cables affecting CTG 11-1 feed to standby feedwater

Division II cable will be used to achieve plant safe shutdown for fires in the north half of the zone. For fires in the south half of the zone, Division I will be used to achieve plant safe shutdown.

Fire breaks have been installed in cable trays within this zone.

Fire detection equipment in this zone consists of an ionization detection system. Fire suppression equipment consists of an area-wide automatic sprinkler system and selected cable tray protection, manual water hose stations, and portable fire extinguishers as shown in Figures 9A-4 and 9A-5.

NFPA 13 noncompliances with this sprinkler system include sprinkler protection areas exceeding the limit for extra hazard occupancy, spacing between branch lines exceeding the 12 ft limit, sprinklers farther from the wall than the 6 ft limit, sprinkler spray patterns partially obstructed, and discrepancies with cable tray sprinklers (in addition to those discussed and evaluated in 9.5.1.2.3.3). These noncompliances would not adversely affect the required function of this system because the extremely conservative extra hazard occupancy water application density would adequately compensate for these and provide the required sprinkler system performance.

9A.4.2.3.2 Analysis

Shutdown is achieved from the main control room. For this zone, Division I and II cables are routed and located on the north side of the building (north of column line 12) and Division I and II cables are routed and located on the south side of the building (south of column line 12). Where redundant shutdown trains are not separated by more than 20 ft, a 1-hour fire wrap is applied to one division.

The sixteen cable tray penetrations in the east auxiliary building wall Fire Rated Separation Barrier have been analyzed. Credit is taken for the sealed turbine building wall penetrations adjacent to the auxiliary building wall, the metallic cover plates over the seismic gap opening between the buildings and the lack of signifi-cant combustibles or ignition sources in the gap as sufficient barriers to prevent the propagation of fire through the unsealed openings in the auxiliary building wall Fire Rated Separation Barrier.

Cable trays 1K-014, 1K-029, 1K-034, 2C-012 and 2C-030, and conduit JA001-1K (north end) and 1C-006, 1P-045, 1P-041, and DC1P-044 (south end) have been provided with a 1-hr protective envelope.

Because of the intervening combustibles in the form of cable trays, fire breaks have been installed in cable trays OC-617, OC-618, OC-611, OC-614, OC-582, OC-585, OC-640, OC-636, OC-916, OC-570, OC-645, OC-592, OC-671, and OC-672 which are located on the north end, Elevation 603 ft 0 in.

Combustibles located within this zone consist primarily of electrical insulation.

The total zone fire loading is moderate.

9A.4.2.3.3 Conclusion

The safe-shutdown analysis performed verified that, for a fire in this zone, plant safe shutdown will be performed using Division II equipment for fires in the north half. For fire in the south half, Division I equipment will be used to achieve plant safe shutdown. The objective for this zone to minimize the potential for the occurrence of a fire and to minimize the spread and damage, should a fire occur, has been achieved through spatial separation of control and instrument components, rated barriers, and the provision of early-warning detection, manual water hose stations, and portable fire extinguishers.

Safe-shutdown capability is protected via the above and provisions of fire breaks and 1-hr protective envelopes as required in the zone.

9A.4.2.3.4 Deviations

Deviations have been approved for the following: intervening combustibles based on area-wide sprinklers, cable tray sprinklers, and fire stops (Reference 1, and SSER No. 5, VI[6]).

9A.4.2.4 Relay Room, Fire Zone 03AB, El. 613 Ft 6 In., 630 Ft 6 In. and 643 Ft 6 In.

9A.4.2.4.1 Description

This zone, shown in Figure 9A-6, consists of the relay room and the control center northeast stairwell located in the northern portion of the building. The zone is bounded on the north by an outside wall; on the east by the turbine building; on the south by Fire Zone 05AB, an extension of the turbine building, and the steam tunnel; and on the west by the reactor building. The relay room is a part of the control center complex.

The zone houses relay cabinets, instrument racks, and cables.

Unless noted below, the walls, floor, and ceiling surrounding this zone are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Penetrations are sealed to provide a 3-hr fire-resistance rating. Door openings are protected by Class A fire doors. The stairwell is enclosed by 3-hr fire-rated walls with a Class A fire door. In the control center stairwell, a 3-hr-rated fire barrier is provided for cables of one division. The access stairway to the cable tray area on Elevation 603’-6” is protected by 3-hr fire walls and a Class A fire door. The barrier wall between the relay room itself and the northeast stairwell is a nonfire rated continuous smoke and gas barrier constructed of Thermo-Lag material. This barrier is used to provide containment as a boundary for the halon suppression system in the relay room.

An HVAC chase is located in the southwest corner of the relay room ceiling which extends up to elevation 654’-0” which is above the control room suspended ceiling (Fire Zone 09AB). There are no combustible materials in this 23-foot vertical chase. The HVAC ducts entering this chase from the relay room are provided with fire and smoke and gas dampers. The 23-foot high walls and the ceiling (at elevation 654’-0”) between the existing metal HVAC ducts of this chase are constructed and sealed as 3-hour rated barriers. However, Thermo-Lag material was used in two (2) places to seal around the HVAC ducts in the floor of this chase at elevation 630’-6” as a nonfire rated smoke and gas seal to prevent the escape of discharged halon. Given, as detailed below, that automatic halon suppression is provided for the relay room and that the combustible loading in the control room ceiling is negligible, flame propagation via this combustible material-free vertical chase and out through the metal HVAC ductwork is not a credible event. At this time, it should be noted that NFPA 90 considers metal HVAC ductwork in walls as equivalent to one-hour rated fire barriers. Therefore, this chase provides the required separation between auxiliary building Fire Zones 03AB and 09AB. Additionally, the Thermo-Lag material used to seal the chase at elevation 630’-6” is a nonfire rated smoke and gas barrier. For identification purposes, the chase is considered as being part of auxiliary building Fire Zone 03AB.

Ventilation for this zone is provided by the control center HVAC system. Conditioned air is ducted directly to the relay room. Air is exhausted by ducts from the relay room.

Shutdown equipment located in this zone consists of the following:

a. Division I and II relay panels and termination cabinets

b. Division I and II cables

c. Standby feedwater and CTG 11-1 related cables

Fire detection equipment located in this zone consists of a Class A cross-zoned ionization smoke detection system and a smoke detector in the stairwell. Fire suppression equipment for this zone consists of an automatic Halon system, manual water hose stations, portable fire extinguishers, and a CO_2 hose reel station located outside the room at the south door, as shown in Figure 9A-6.

9A.4.2.4.2 Analysis

Shutdown is achieved from outside the main control room. An alternative shutdown system, independent of the control center complex, has been designed and installed to achieve plant safe shutdown for a fire in this zone.

Cable tray 1K-034 is provided with a 3-hr barrier in the northeast stairwell area.

Inadvertent operation of the automatic Halon system would have no adverse effect on safe-shutdown equipment located in this zone.

Combustibles located in this zone consist primarily of electrical insulation.

Total zone fire loading is moderate.

9A.4.2.4.3 Conclusion

For a fire in this zone, plant safe shutdown will be achieved using the alternative shutdown system.

The objective for this zone is to prevent a fire within the zone from affecting both Divisions I and II equipment and to prevent a fire from crossing the zone's barriers. This objective is achieved through spatial separation, barriers, the provision of an early-warning detection system, an automatic Halon system, manual hose, portable fire extinguishers, and a CO_2 hose reel station.

9A.4.2.4.4 Deviations

There are no deviations for this zone.

9A.4.2.5 Switchgear Room, Fire Zone 04AB, El. 613 Ft 8-1/2 In.

9A.4.2.5.1 Description

This zone, shown in Figure 9A-6, consists of one room located in the southern portion of the building. The zone is bounded on the north by Fire Zone 06AB of this fire area; on the east by the turbine building; on the south by an outside wall; and on the west by the reactor building. Within this zone, a room is constructed to enclose the Division II cables.

The zone houses Division I switchgear and the Division I remote shutdown panel.

The walls, floor, and ceiling of this zone are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Penetrations are sealed to provide 3-hr fire-resistance ratings. The door opening leading to Fire Zone 06AB is protected by Class A fire doors. The stairwell is enclosed by 2-hr-rated fire walls with a Class B fire door. The room containing the Division II cables is enclosed by a 3-hr-rated fire barrier with a Class A fire door.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Air is ducted directly to the switchgear room and exhausted through ducts to the auxiliary building main exhaust system. In addition, the switchgear room contains two local, recirculating-type cooling units.

This zone contains the following shutdown equipment:

a. Division I switchgear
b. Division I and II cable
c. Offsite power cables affecting CTG 11-1 feed to standby feedwater
d. Switchgear room cooling units (Division I)
e. 120 V ac modular power units (Division I and BOP)
f. 130 V dc distribution panel (Division I)

Fire detection equipment located within this zone (including the Division II cable enclosure) consists of an area ionization detection system. Fire suppression equipment consists of a manual hose and portable fire extinguishers as shown in Figure 9A-6. The manual hose station and CO_2 hose reel are located in Fire Zone 06AB.

9A.4.2.5.2 Analysis

Division II cables and equipment will be used to achieve plant safe shutdown for fires in this zone except for the enclosed room near column line G-9. In this room, Division I equipment and cables are used for safe shutdown.

The abandoned tubing left within the three hour fire resistant penetration to the reactor building is evaluated to show that the seal is adequate for fires in the zone.

Combustibles located within this zone consist primarily of electrical insulation. Total zone fire loading is moderate.

9A.4.2.5.3 Conclusion

The objective for this zone is to prevent a fire in this zone from spreading to other zones and to Division II cable. This objective is achieved through fire barriers between other zones and redundant equipment, an early-warning detection system, a manual hose, portable fire extinguishers, and a CO_2 hose reel.

9A.4.2.6 Cable Tunnel, Fire Zone 05AB, El. 613 Ft 6 In.

9A.4.2.6.1 Description

This zone, shown in Figure 9A-6, consists of one room located in the central portion of this elevation adjacent to the steam tunnel. It is bounded on the north by the relay room (Fire Zone 03AB); on the east and south by Fire Zone 06AB and on the west by the steam tunnel.

This zone serves as a cable routing area for Divisions I, Division II, and BOP cable. The Division I cables are located along the east side of the tunnel while the Division II cables are located along the west wall.

The walls, floor, and ceiling separating this zone from the relay room (Fire Zone 03AB) and the turbine building extension are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Penetrations through rated walls, floor, and ceiling are sealed to provide a 3-hr fire-resistance rating. The door openings leading from the cable tunnel are protected by Class A fire doors. The tunnel is divided by a 3-hr fire-rated gypsum wall that separates Divisions I and II cables.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Air is ducted directly to the cable tunnel and exhausted through ducts to the auxiliary building main exhaust system. Relief air flows unducted from the cable tunnel to the corridor leading to the turbine building. Airflow entering the corridor is controlled by a backdraft damper.

Shutdown equipment located in this zone consists of the following:

a. Division I and II cables

b. Standby feedwater power supply control cables

Fire detection equipment located in this zone consists of an area ionization detection system. Fire suppression equipment located in this zone consists of a manual CO_2 system. Manual water hose stations and portable fire extinguishers are available in adjacent zones, as shown in Figure 9A-6.

9A.4.2.6.2 Analysis

Shutdown is achieved from the main control room. Only Division I and standby feedwater control cables are present in the east cable tunnel. Therefore, Division II will be available for plant safe shutdown in the event of a fire in the east tunnel. Division II circuits are present in the west tunnel. The Division I systems will be used to achieve plant safe shutdown in the event of fire in the west tunnel.

The total quantity of combustibles on both sides of the wall consists primarily of electrical insulation. The resultant fire loading for the west side of the tunnel is high. The east side fire loading is also high.

The inadvertent operation of the CO_2 suppression system will have no adverse effect on the cables.

9A.4.2.6.3 Conclusion

The objective for this zone is to prevent a fire from affecting Divisions I and II cables within the zone and from spreading to another zone. The objective is achieved through the provision of a 3-hr-rated fire barrier, early-warning detection, manual CO_2 suppression equipment, and manual hose and portable fire extinguishers.

9A.4.2.6.4 Deviations

Deviations have been approved for the following: to maintain a 3-hr-rated barrier between redundant divisions and provide a manually actuated CO_2 system. (Reference 1, SSER No. 5, VI [910]).

9A.4.2.7 Second Floor, Miscellaneous Rooms, Fire Zone 06AB, El. 613 Ft 6 In.

9A.4.2.7.1 Description

This zone, shown in Figure 9A-6, consists of the personnel air lock, dress-out area, and corridor space. Generally, it is bounded on the north by the steam tunnel, cable tunnel, and the turbine building extension; on the east by the turbine building extension; on the south by the switchgear room; and on the west by the reactor building and the cable tunnel.

The zone houses instrumentation and control calibration equipment and welding equipment.

The walls, floor, and ceiling separating this zone are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Door openings between this zone and the switchgear room, the turbine building extension, and the reactor building are protected by Class A fire doors. Penetrations through the rated walls, floor, and ceiling are sealed to provide 3-hr fire-resistance ratings.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Air is ducted directly to the personnel change room and the welding equipment area. Exhaust from the personnel change room is ducted directly to the auxiliary building main exhaust system. Relief air flows unducted from the welding equipment area to the personnel change room.

Fire detection equipment located within this zone consists of an ionization detection system. Fire suppression equipment in this zone consists of a manual hose station, a CO_2 hose reel, and portable fire extinguishers as shown in Figure 9A-6.

9A.4.2.7.2 Analysis

Only Division I and BOP instrumentation power supply cables are routed through this zone.

Combustibles located within this zone consist primarily of electrical insulation and protective clothing. The total zone loading is low.

9A.4.2.7.3 Conclusion

Division II will be used to achieve plant safe shutdown for a fire in this zone.

The objective for this Fire Zone is to prevent a fire in this zone from spreading to another Fire Zone. This is accomplished through barriers and provision of an early-warning detection system, and manual hose and portable fire extinguishers.

9A.4.2.8 Cable Spreading Room, Fire Zone 07AB, El. 630 Ft 6 In.

9A.4.2.8.1 Description

This zone, shown in Figure 9A-7, consists of one room. It is bounded on the north by an outside wall; on the east by the turbine building; on the south by the steam tunnel; and on the west by the reactor building. The cable spreading room is a part of the control center complex.

The zone serves as a cable routing area for both Divisions I and II and standby feedwater cables.

Unless otherwise noted below, the walls, floor, and ceiling of this zone are constructed of reinforced concrete with a fire-resistance rating of 3 hr. Penetrations through rated walls, floor, and ceiling are sealed to provide a 3-hr fire-resistance rating. The stairwells are enclosed by 3-hr-rated fire walls with Class A fire doors.

Ventilation for this zone is provided by the control center HVAC system. Conditioned air is ducted to and from the zone.

Shutdown equipment located in this zone consists of both Divisions I and II cables.

Fire detection equipment in this zone consists of two ionization detection systems. One of the detection systems is strictly early warning, with the other a Class A cross-zoned ionization detection system providing automatic actuation of the Halon system. Fire suppression equipment consists of an automatic Halon system, manual fusible link sprinkler system, manual water hose station, and portable fire extinguishers, as shown in Figure 9A-7.

9A.4.2.8.2 Analysis

Shutdown is achieved from outside the control room. The alternative shutdown system, independent of the control center complex, has been designed and installed to achieve plant safe shutdown for a fire in this zone.

No protective envelopes are required in this zone.

Inadvertent operation of the automatic Halon fire suppression system will have no adverse effect on the cables in this zone.

Combustibles within this zone consist primarily of cable insulation. Total zone loading is high.

9A.4.2.8.3 Conclusion

The objective for this zone is to prevent a fire within the zone from affecting both Divisions I and II cables and to prevent a fire from crossing the boundaries of this zone. This objective is achieved through spatial separation, barriers, and the provision of an early-warning detection system, an automatic Halon fire suppression system, manual fusible link sprinkler system, manual water hose station, and portable fire extinguishers.

9A.4.2.9 Cable Tray Area, Fire Zone 08AB, El. 631 Ft 0 In.

9A.4.2.9.1 Description

This zone, shown in Figure 9A-7, consists of one room. It is bounded on the north by the steam tunnel; on the east by the turbine building; on the south by an outside wall; and on the west by the reactor building. The zone serves primarily as a cable routing area for Division II cable. A small amount of Division I cable is routed through this zone.

The walls, floors, and ceiling of this zone are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Penetrations through the walls, floor, and ceiling are sealed to provide 3-hr fire-resistance ratings or have been evaluated to contain an acceptable penetration seal. Penetrations that are not installed in a configuration that provides 3-hr protection are evaluated to be acceptable if the installed detail provides adequate protection to prevent spread of fire across the barrier. The stairwell is enclosed by a 2-hr-rated fire barrier with a Class B fire door.

Ventilation air is provided by the reactor/auxiliary building ventilation system. Supply air is ducted directly to this zone. Exhaust air is ducted to the auxiliary building main exhaust system.

The alternative shutdown system is used to achieve plant safe shutdown for a fire in this zone.

Shutdown equipment located in this zone consists of Divisions I and II and standby feedwater cables.

Fire detection equipment in this zone consists of an ionization detection system. Fire suppression equipment located in this zone consists of an automatic CO_2 system, manual water hose stations, and portable fire extinguishers, as shown in Figure 9A-7.

9A.4.2.9.2 Analysis

Shutdown is achieved from outside the main control room. For a fire in this zone, the alternative shutdown system will be used to bring the plant to a safe-shutdown condition. Conduit RI 005-2P/wireway RI-069 contains circuits required for the alternative shutdown system. When the conduit is routed in the zone, a 1-hr protective envelope has been provided on the circuit/wireway.

Inadvertent operation of the automatic CO_2 fire suppression system will have no adverse effect on the cables.

Combustibles located within this zone consist primarily of cable insulation. Total zone fire loading is low.

9A.4.2.9.3 Conclusion

For a fire in this zone, the alternative shutdown system will be used to achieve plant safe shutdown. The objective for this zone is to prevent a fire within the zone from spreading to another Fire Zone. This objective is achieved through spatial separation, barriers, and the provision of early-warning detection, automatic CO_2 fire suppression, manual water hose stations, and portable fire extinguishers.

9A.4.2.9.4 Deviations

There are no deviations for this zone.

9A.4.2.10 Control Room, Fire Zone 09AB, El. 643 Ft 6 In., 655 Ft 6 In, and 677 Ft 6 In.

9A.4.2.10.1 Description

This zone, shown in Figures 9A-8, 9A-9, and 9A-10 consists of the main control room, office, conference room, kitchen, and lavatory on Elevation 643 ft 6 in.; the computer equipment area on Elevation 655 ft 6 in.; and the small air conditioning room located between columns H-13 to 15 on Elevation 677 ft 6 in. The zone is bounded on the north by an outside wall; on the east by the turbine building; on the south by the turbine building corridor and battery rooms; and on the west by the reactor building.

This zone houses the main control panel, computer, and associated auxiliary equipment.

The outside walls, floor, and ceiling of this zone are constructed of reinforced concrete having a fire-resistance rating of 3 hr. The computer room is cut off from the main control room by a barrier that will prevent the propagation of fire. The remainder of the peripheral rooms to the control room, except for the Shift Supervisor's room, have walls and doors that will prevent a fire from spreading out of the room. Electrical and piping penetrations are sealed to provide the same rating as the fire barrier. Supply and return ducts for control room ventilation are provided with fire dampers at the 3-hr fire barriers. See Fire Zone 13AB and

14AB for a discussion of fire dampers F099, F0100, F0101, and F0102, which interface between the Division II control center HVAC and control rooms. Supply and return ducts for the cable spreading and relay rooms that pass through the control room are not provided with dampers at the floor or ceiling. Door openings leading into the turbine building are protected by 1.5-hr fire doors. The northeast stairwell is enclosed by a 3-hr fire barrier with a Class A fire door. A portion of the ceiling of the northeast stairwell is the underside of the stairwell leading up to the computer equipment area (elevation 655'-6") which has been provided with a 3- hour protective barrier on the underside only. Refer to Subsection 9A.4.2.4.2 for additional details.

Refer to Subsection 9A.4.2.4.1 for a discussion of the HVAC chase between the southwest corner of the relay room on elevation 613'-6" (Fire Zone 03AB) and the area above the control room ceiling. The chase is located at column F-13.

The surface burning characteristics of the glazed block walls, duct insulation, central workstation counters, and ceiling panels in the control room area are rated 25 or less in accordance with the ASTM E-84 test method. The smoke and fuel contribution of the walls, duct insulation, central workstation counters and ceiling panels is also rated 50 or less in accordance with the ASTM E-84 test method. Both the carpeting and counter top meet the criterion requirements for critical radiant heat flux rating and smoke density rating for Class I materials as defined by NFPA standards.

Ventilation for this zone is provided by the control center HVAC system. Conditioned air is ducted directly to and from the control room and associated offices and facilities.

Shutdown equipment located in this zone consists of Division I and II main control board panels, Division I and II cables and standby feedwater cables. The shutdown circuits in the control room are contained within three pairs of cabinets. The control cabinets are mounted on a 4-in.-high concrete pad. The redundant division is contained in the adjacent cabinet. Each set of cabinets is separated from the other sets by several feet. Redundant components in adjacent cabinets are separated from each other by steel panels that have no unsealed penetrations. On the front of the cabinet, the portion below the operating panel is louvered; however, a panel of 1-in.-thick marinite has been fastened on the inside of the panel to close these openings. The annunciator windows are glass for the panels required for shutdown. The heat load and cooling requirements of the panels are satisfied by natural radiative cooling.

Fire detection for the control room is provided by ionization and photoelectric detectors above the drop ceiling and photoelectric detectors in the computer room under-floor area, ionization and/or heat detectors in the peripheral rooms, ionization detectors behind the control room panels below the drop ceiling, ionization detectors within the control boards and continuous manning of the control room (SSER No. 6). Ionization detectors are also located within the central operators consoles, which also provide detection coverage within the adjacent raised floor area. Fire suppression equipment located in this zone consists of an automatic Halon suppression system for the computer room and underfloor area and portable fire extinguishers, as shown in Figures 9A-8 and 9A-9.

The combustible loading in the air conditioning room on elevation 677′-6″ (columns H-13 to 15) is extremely low. In addition future storage of combustibles in this area is not considered for the purpose of this analysis because the area is heavily congested with non-combustible duct work with little floor space. Based on the extremely low combustible loading in this area, fire detection instrumentation is not installed since it would not be expected to alarm due to the small amounts of smoke/heat that could be produced by a postulated fire in this room.

9A.4.2.10.2 Analysis

Shutdown is achieved from outside the main control room. An alternative shutdown system and dedicated shutdown panel independent of the control center complex has been designed and installed to achieve plant safe shutdown for a fire in this zone.

Inadvertent operation of the automatic Halon suppression system in the computer room would have no adverse effect on equipment located in this zone.

Smoke removal from the control room can be accomplished using the control center HVAC system as described in Subsection 9.5.1.2.2. Total fire loading for this zone is low. Total fire loading for this zone is low. Combustibles located in this zone consist of the following:

a. Permanently installed combustibles in the computer room consist primarily of computer wiring insulation and components. In the control room, permanently installed combustibles consist primarily of wiring insulation and components, fire-retardant carpet, counter tops and paper. Paper in this category includes paper in file cabinets and shelves, and chart, recorder, terminal, and plotter paper in use at their respective machines.

b. Anticipated transient combustibles in the computer room consist primarily of paper. The remaining peripheral rooms contain primarily paper, wood, and plastic. The transient combustibles in the main control room are low. Paper not in use will be stored in enclosed metal cabinets.

9A.4.2.10.3 Conclusion

For a fire in the control room, plant safe shutdown will be achieved using the alternative shutdown system and dedicated shutdown panel. The objective for this zone is to minimize the potential for the occurrence of a fire in this zone and, should a fire occur in the zone, minimize the extent of the fire and also to prevent a fire from another zone from spreading into this zone. This objective is achieved through spatial separation of control and instrument components, barriers, and the provision of early-warning detection, automatic Halon suppression in the computer room and computer underfloor area, manual water hose stations, and portable fire extinguishers.

9A.4.2.10.4 Deviations

Deviations have been approved for the following:

a. Installing 1-1/2-hr versus 3-hr-rated fire doors for doors numbered R3-27 and R3-13 based on early-warning detection in the turbine building extension, the Turbine Building low combustible loading in the vicinity of the doors, and the construction of the doors themselves (Reference 3, Reference 2, Appendix E SSER No. 6 III.B)

b. Lack of a fixed suppression system in the control room based on continuous manning of the control room (Reference 1, SSER No. 5-VI [12] and VII).

9A.4.2.11 Divisions I and II Battery Rooms, Fire Zone 10AB, El. 643 Ft 6 In.

9A.4.2.11.1.1 Description

This zone, shown in Figure 9A-8, consists of two rooms. It is bounded on the north by the main control room; on the east and south by Fire Zone 11AB of this fire area; and on the west by the reactor building.

This zone houses the Divisions I and II engineered safety features (ESF) batteries fuse cabinets and cables.

The walls, floor, and ceiling of this zone are constructed of reinforced concrete having a minimum fire-resistance rating of 3 hr. Penetrations are sealed to provide 3-hr-rated fire barriers. The door openings in the south wall are protected by Class A fire doors.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Supply and exhaust are ducted separately to and from each room. Each room is provided with redundant exhaust fans.

The Division I or II batteries contained in these rooms are required for shutdown.

Fire detection equipment located in this zone consists of an area ionization detection system. Fire suppression equipment consists of portable fire extinguishers and manual water hose stations, as shown in Figure 9A-8.

9A.4.2.11.2 Analysis

Shutdown is achieved from the main control room. Divisions I and II batteries located in this zone are separated by a 3-hr fire barrier.

Combustibles in this zone consist primarily of battery cases, electrical insulation, and shock absorbers between batteries. Total zone fire loading is low.

9A.4.2.11.3 Conclusion

The objective for this zone is to prevent a fire in one battery room from spreading to the other battery room and to prevent a fire outside the zone from spreading into the zone. This objective is achieved through barriers, low fire loading, and the provision of early-warning detection, manual water hose stations, and portable fire extinguishers.

9A.4.2.12 Miscellaneous Rooms, Fire Zone 11AB, El. 643 Ft 6 In.

9A.4.2.12.1 Description

This zone, shown in Figure 9A-8, is bounded on the north by the turbine building corridor; on the east by the turbine building; on the south by the Division II switchgear room; and on the west by the battery rooms and reactor building.

This zone houses the reactor protection system (RPS) M-G sets, battery chargers, dc MCCs, and distribution cabinets. The walls, floor, and ceiling of this zone are constructed of reinforced concrete and are rated as 3-hr fire barriers. Penetrations are sealed to provide a fire-resistance rating equivalent to that of the walls, floor, or ceiling in which they are found or have been evaluated to contain an acceptable penetration seal. Penetrations that are not installed in a configuration that provides 3-hr protection are evaluated to be acceptable if the installed detail provides adequate protection to prevent spread of fire across the barrier. The ceiling has a metal hatch cover. The subject steel hatch cover has been evaluated as adequate, as a part of the fire barrier between fire zones 11ABE and 13AB, to prevent the propagation of fire based on the physical configuration of the subject hatch cover in the ceiling/floor, the very low combustible loadings, the fire detection provided in both fire zones, the automatic suppression system provided in Fire Zone 11ABE and the control of transient combustibles in procedures. Door openings are protected by Class B fire doors except in the walls abutting the turbine building corridor and the Division II switchgear room, which have Class A fire doors. Divisions I and II battery chargers are located outside their respective battery rooms on the south side in Fire Zone 11AB. The battery chargers are separated by a 4-in. concrete brick wall with a Class A door installed in it. The wall provides a minimum fire rating of 1-1/2-hr.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Supply air is ducted directly to the battery room air-conditioning unit and circulated through the area or exhausted to the ventilation system.

Shutdown equipment consists of the Divisions I and II battery chargers, dc MCCs, dc distribution cabinets and cables, SRV control cabinets and fan coil units.

Fire detection equipment in this zone consists of two area ionization detection systems. Fire suppression equipment consists of an automatic CO_2 suppression system in the dc MCC room, manual water hose stations, portable fire extinguishers, and a CO_2 hose reel, as shown in Figure 9A-8.

9A.4.2.12.2 Analysis

The Divisions I and II battery chargers and dc distribution cabinets are located in separate rooms.

Division I will be used to achieve plant safe shutdown from the main control room for fires in the west battery charger room.

The alternative shutdown system will be used to achieve plant safe shutdown from outside the control room for a fire in the east side of the zone.

Inadvertent operation of the automatic CO_2 suppression system would have no adverse effect on equipment located in this zone.

Combustibles within this zone consist primarily of electrical insulation. Total zone fire loading is low.

9A.4.2.12.3 Conclusion

The alternative shutdown system is used to achieve plant safe shutdown for a fire in this zone except for the west battery charger room where Division I will be available for shutdown.

The objective for this zone is to prevent a fire within this zone from spreading to another zone. This objective is achieved through barriers and the provision of early-warning detection, an automatic CO_2 suppression system, manual water hose stations, and portable fire extinguishers.

9A.4.2.12.4 Deviations

Deviations have been approved for the following: lack of a 3-hr-rated barrier separating redundant equipment based on a 4-in. solid concrete brick wall with a 3-hr rated door, smoke detection, CO_2 for Division I side, and low combustible loading (less than six cable trays) (Reference 1, SSER No. 5, VI [11]).

9A.4.2.13 Switchgear Room, Fire Zone 12AB, El. 643 Ft 6 In.

9A.4.2.13.1 Description

This zone, shown in Figure 9A-8, consists of one room. It is bounded on the north by Fire Zone 11AB of this fire area; on the east by the turbine building; on the south by an outside wall; and on the west by the reactor building.

The zone houses the Division II switchgear.

The walls, floor, and ceiling are constructed of reinforced concrete having a fire-resistance rating of 3 hr. The door openings in the north wall are protected by Class A fire doors. The door opening at the stairwell is protected by a Class B fire door. Penetrations in the walls, floor, and ceiling are sealed to provide 3-hr-rated fire barriers.

Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Air is ducted directly to the switchgear room and exhausted through ducts to the auxiliary building main exhaust system. In addition, the switchgear room contains two recirculating-type cooling units.

Shutdown equipment located in this zone consists of the following:

a. Division II switchgear

b. Division I, Division II and standby feedwater cable

c. Switchgear room cooling units (Division II)

d. 120 V ac modular power unit (Division II)

e. 130 V dc distribution panels (Division II)

Fire detection equipment located in this zone consists of an area ionization detection system. Fire suppression equipment consists of manual water hose stations, portable fire extinguishers, and a CO_2 hose reel, as shown in Figure 9A-8.

9A.4.2.13.2 Analysis

Shutdown is achieved from the main control room. Functional redundancy for the Division II switchgear located in this zone is provided by Division I equipment located in another Fire Zone.

Combustibles located within this zone consist primarily of electrical insulation. Total zone fire loading is low.

9A.4.2.13.3 Conclusion

The objective for this zone is to prevent a fire within the zone from spreading to other zones. This objective is achieved through barriers and the provision of an early-warning detection system, manual water hose stations, and portable fire extinguishers.

Division I will be used to achieve plant safe shutdown for a fire in this zone.

No protective envelope is required in this zone.

9A.4.2.14 Ventilation Equipment Area, Fire Zone 13AB, El. 659 Ft 6 In.

9A.4.2.14.1 Description

This zone, shown in Figure 9A-9, consists of one room. It is bounded on the north by the control room Fire Zone 09AB; on the east by the turbine building; on the south by an outside wall; and on the west by the reactor building.

This zone houses the reactor/auxiliary building ventilation system exhaust unit.

The walls surrounding this zone and the floor of this zone are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Penetrations through rated walls and floors are sealed to provide 3-hr fire-resistance ratings. Dampers FO-85 and FO-90 are 1.5-hr-rated dampers while FO-81A and B, FO-82A and B, FO-83A and B, and FO-84A and B are two 1.5-hr-rated dampers in series. These dampers are located in the zone's west and north 3-hr boundary walls but are acceptable because of low fire loading and the presence of fire detection. Fire damper FO-90 is located in a wall separating Fire Zone 13AB from a pipe/HVAC duct chase in the southwest corner. Fire damper FO-85 is located in the wall separating the control room (Fire Zone 09AB) from Fire Zone 13AB. The floor also has a metal hatch cover which will prevent the propagation of fire. The subject steel hatch cover has been evaluated as adequate, as a part of the fire barrier between Fire Zones 11ABE and 13AB, to prevent the propagation of fire based on the physical configuration of the subject hatch cover in the ceiling/floor, the very low combustible loadings, the fire detection provided in both Fire Zones, the automatic suppression system provided in Fire Zone 11ABE and the control of transient combustibles in procedures. The ceiling is constructed of reinforced concrete and contains unprotected hatches and unsealed penetrations, except that all electrical and piping penetrations are sealed to provide a 3-hr fire barrier for that portion of the ceiling separating this zone from Fire Zone 14AB at Elevation 677’-6” and the reactor building southeast access stairs at Elevation 677’-6”. Cable tray penetrations are provided with fire stops. A radiant energy shield of 1-hr fire-rating construction has been installed from floor to ceiling on the west side of the room, the southwest corner wall of the northwest stairwell, south to approximately 3 ft beyond the south end of the Division II testability cabinets.

The pipe chase is a 12-in. concrete block wall (3-hr equivalent). The wall separating the main control room from the fourth floor auxiliary building is reinforced concrete and has a 3-hr fire rating.

The stairwell in the northwest quadrant of the zone is enclosed by a 3-hr-rated barrier with a Class A door that opens to the reactor building's Fire Zone 09AB.

Ventilation for this building area is provided by the reactor/ auxiliary building ventilation system. Supply and exhaust air is ducted to and from this area.

Shutdown equipment in this zone consists of Divisions I and II cables, and Divisions I and II instrument racks.

Fire detection equipment located in this zone consists of an ionization detection system. Fire suppression equipment consists of manual water hose stations and portable fire extinguishers, as shown in Figure 9A-9.

9A.4.2.14.2 Analysis

Shutdown is achieved from outside the main control room. Safe-shutdown capability for the zone is achieved by use of the alternative shutdown system.

Combustibles located within this zone consist primarily of electrical insulation. Total zone fire loading is low.

A radiant energy shield from floor to ceiling has been installed to separate the Divisions I and II equipment from a common heat source.

9A.4.2.14.3 Conclusion

For fires in this zone, the alternative shutdown system will be used to achieve plant safe shutdown.

The objective for this zone is to prevent a fire from spreading to another Fire Zone. This objective is achieved through adequate spatial separation, low fire loading, rated barriers, and the provision of early-warning detection, manual water hose stations(s), and portable fire extinguishers.

9A.4.2.14.4 Deviations

Deviations have been approved for the following:

a. Lack of automatic suppression based on a 1-hr radiant energy shield being installed in front of the cabinet (Reference 1, SSER No. 5 VI [16]).

b. Installation of 1-1/2-hr fire-rated dampers in 3-hr fire-rated barriers based on negligible fuel load and early-warning detection on each side of the barrier (Reference 1, SSER No. 5 III.B).

9A.4.2.15 Control Room Ventilation Equipment Room and Standby Gas Treatment Rooms, Fire Zone 14AB, El. 677 Ft 6 In.

9A.4.2.15.1 Description

This zone, shown in Figure 9A-10, consists of five rooms located in the northern half of Elevation 677 ft 6 in. of the auxiliary building. It is bounded on the north by an outside wall; on the east by the turbine building; on the south by the ventilation equipment room; and on the west by the reactor building.

This zone houses the SGTS charcoal filter units and the control center ventilation equipment.

The walls surrounding this zone are constructed of reinforced concrete. The east and west boundary walls are rated as 3-hr fire barriers. A 1-hr-rated fire barrier with Class A fire doors separates Division I and II air conditioning equipment. A 1-hr-rated fire barrier separates Divisions I and II cables. Penetrations through rated walls are sealed to provide a fire resistance equivalent to the walls in which they are located. The floor is constructed of reinforced concrete and provides a 3-hr fire-rated barrier. Electrical and piping penetrations in the floor are sealed. Ducts are encased by 3-hr-rated fire barriers. Dampers FO-99, FO-100, FO-101, and FO-102 are 1-1/2-hr rated fire dampers. These dampers separate the control room from this zone. The dampers are acceptable because of low fire loading and the presence of fire detection (see SSER No. 5). The ceiling is constructed of reinforced concrete over unprotected steel.

Ventilation for this zone is provided by the control center air conditioning system (CCACS). Conditioned air is supplied through ducts to the control room air conditioning equipment room and by an extension of the duct to the north standby gas treatment room. Exhaust air from the control room air conditioning equipment room is drawn through a return duct opening to the control center air-conditioning units located in the room. Additionally, local cooling and recirculation units in the control room air conditioning equipment room maintain suitable room ambient temperature when the CCACS is operating in the emergency recirculation mode. During operation in the emergency recirculation mode, flows of supply and return air to and from the control center air conditioning equipment room are stopped. There are 1.2 air changes per hour.

A fire in either ventilation equipment room may result in closure of fire damper T4100F903. This damper is located in common ductwork on the discharge of the Division I and Division II CCACS return air fans and is part of the 3-hour fire barrier between the ventilation equipment room and the Control Room. Closure of this damper will result in loss of CCACS return air flow for both divisions and will result in a reduction of cooling air flow to the various ventilation zones served by the CCACS. Once the fire is extinguished, plant procedures have been established to detect closure of fire damper T4100F903 and to manually open it to reestablish the return air flow path. There is sufficient time to open the damper and to start the CCACS Division that did not experience the fire prior to exceeding maximum temperature limits in the zones served by the CCACS.

This zone contains the following shutdown equipment:

a. Division I and II control center air conditioning equipment

b. Divisions I and II control and power cables for control center HVAC fan coil units and drywell pneumatics.

Cable trays 1P-070 and 1C-037 are provided with a 1-hr rated fire barrier within the Division II control center ventilation equipment room when they are within 20 ft of their redundant cables.

Fire detection equipment located within this zone consists of an area ionization detection system. Fire suppression equipment located in this zone consists of an automatic low-pressure CO_2 system for the SGTS charcoal filters, manual water hose stations, and portable fire extinguishers, as shown in Figure 9A-10.

9A.4.2.15.2 Analysis

Shutdown is achieved from the main control room.

Combustibles located within this zone consist primarily of the following:

a. Lubricating oil

b. Charcoal filter material

c. Electrical insulation

Area fire loading is low.

9A.4.2.15.3 Conclusion

Division I will be used to achieve plant safe shutdown for fires in the Division II control center ventilation equipment room and standby gas treatment rooms.

Division I cable trays required for safe shutdown are protected with a 1-hr rated fire barrier when in the Division II control center ventilation equipment room.

Division II will be used to achieve plant safe shutdown for fires in the Division I control center ventilation equipment room.

The objective for this zone is to prevent a fire in the zone from spreading to another Fire Zone and from affecting both Divisions I and II equipment located within the zone. The objective is achieved through fire barriers, low fire loading, and provision of an early-warning detection system, automatic CO_2 fire suppression equipment, manual water hose stations, and portable fire extinguishers.

9A.4.2.15.4 Deviations

Deviations have been approved for the lack of automatic suppression based on 1-hr wrap being provided and low combustible loading (Reference 1, SSER No. 5 VI [9]).

9A.4.2.16 Ventilation Equipment Area, Fire Zone 15AB, El. 677 Ft 6 In.

9A.4.2.16.1 Description

This zone, shown in Figure 9A-10, consists of one room comprising the southern half of Elevation 677 ft 6 in. of the auxiliary building. It is bounded on the north by Fire Zone 14AB; on the east by the turbine building; on the south by an outside wall; and on the west by the reactor building.

The walls surrounding this zone are constructed of reinforced concrete. The east and west bounding walls are rated as 3-hr fire barriers. Penetrations through these walls are sealed to provide 3-hr-rated fire barriers. The door opening leading to the reactor building is protected by a Class A fire door. The floor is constructed of reinforced concrete with unprotected openings. Cable tray penetrations are provided with fire stops. The ceiling is constructed of reinforced concrete over unprotected steel. Ventilation for this zone is provided by the reactor/auxiliary building ventilation system. Supply air is ducted directly to the zone. Exhaust air is ducted to the auxiliary building main exhaust system.

Refer to Subsection 9A.4.2.3.1 for a discussion of the open chase from the mezzanine and cable tray area on the 603’-6” elevation (Fire Zone 02AB) and this area. The opening is located along column H between 10 and 11.

Shutdown equipment located in this zone consists of Divisions I and II HVAC equipment and cables.

Fire detection equipment located in this zone consists of an ionization detection system. Fire suppression equipment located in this zone consists of a manually actuated water flooding system for the charcoal filters, manual water hose stations, and portable fire extinguishers as shown in Figure 9A-10.

9A.4.2.16.2 Analysis

Shutdown is achieved from the main control room. For a fire in this zone, Division II safe shutdown capability is maintained/protected by the installation of isolation devices (fuses) for Division II associated circuits within the zone.

Combustibles located in this zone consist primarily of charcoal filter material and electrical insulation. Total zone fire loading is low.

9A.4.2.16.3 Conclusion

The objective for this zone is to prevent the spread of a fire within this zone to another zone and from affecting both Divisions I and II equipment located within this zone. This objective is achieved through low fire loading and provision of early-warning detection, a manual water flooding system, manual water hose stations, and portable fire extinguishers and isolation devices.

9A.4.2.16.4 Deviations

Deviations have been approved for the lack of automatic suppression based on a 1-hr rated fire barrier, low combustible loading, and charcoal filters having a suppression system(s) (Reference 1, SSER No. 5 VI [7]).

9A.4.3 Residual Heat Removal Complex

9A.4.3.1 General Description

The RHR complex, shown in Figures 9A-13 through 9A-17 inclusive, is a separate reinforced-concrete structure located 230 ft west of the reactor building. The complex is divided at its east-west centerline by a reinforced-concrete wall that has a minimum fire-resistance rating of 3 hr. Each half of the complex contains essentially the same equipment with Division I equipment in the southern portion and Division II equipment in the northern portion of the complex.

Each half of the complex houses a reservoir, cooling tower and service water pump and equipment rooms which comprise the plant's ultimate heat sink. Each half of the complex also houses one set of emergency diesel generators (EDGs), diesel-fuel-oil storage tanks, and switchgear, which are utilized to provide ac power to the plant during a loss of offsite power.

Rated walls, floors, and ceilings are constructed of reinforced concrete having a fire-resistance rating of 3 hr. Doors in rated walls are Class A fire doors. Penetrations in rated walls, floors, and ceilings are sealed.

Floor drains in rooms containing oil are connected to a common manway which is connected by an overflow line to the liquid waste holding pond. Floor drains in other rooms are connected to a different manway which is connected by an overflow line to the circulating water reservoir.

Ventilation for the north diesel generator rooms is provided by outside air drawn by two fans through a louver in the west wall above the 617 ft 0 in. elevation and from there through a motorized outside air damper in the west wall of the fan room at the same elevation. Each diesel room is then supplied by two fans located above the 617 ft 0 in. elevation. Air is relieved through grating in the diesel room ceiling and then through a motorized damper back to the fan room.

Ventilation for the north service water pump room is provided by outside air drawn through a filter plenum by two fans and distributed to the pump room by ductwork along the room's west wall. Room air is relieved through the roof in the northeast and southeast corners of the room. The filter plenums are located at grade along the northeast and southeast corners of the complex.

Ventilation supply air for the north diesel-fuel-oil storage room is drawn by room exhaust fans through an opening in the north CO_2 storage room wall. Exhaust air from the north diesel-fuel-oil storage room is fan exhausted through ducts.

Ventilation for the north CO_2 storage room is provided by continuous exhaust through the space. Exhaust air from the EDG room enters through dampers in the east wall. Exhaust air leaves the room through a damper located in the west wall of the room.

The north switchgear room and ventilation equipment rooms are cooled by outside air. The switchgear room ventilation air is drawn through a filter plenum by two fans and is distributed to the switchgear room by ductwork located along the west wall. This air also supplies the switchgear ventilation equipment room through an outlet in the supply duct main. Air is relieved from the switchgear room through two separate relief openings in the west wall of the room. One of these openings relieves to the switchgear ventilation equipment room. The second of these openings relieves to an air relief room and the EDG room. Air is relieved from the air relief room through dampers to the outside or to the diesel equipment room for recirculation.

The north ventilation equipment room is ventilated by ducted exhaust air from the diesel-fuel-oil storage tank room.

The north diesel generator air intake filter area is ventilated by outside air drawn through fixed louvers located in the west wall by the switchgear and diesel room ventilation fans. Air flows from the louvers, along the west wall housing the diesel intake filters, to the west wall of the switchgear and diesel room ventilation equipment rooms.

Ducts or openings penetrating rated walls are provided with fire dampers.

Ventilation of the south portion of the RHR complex is the same as that for the north portion of the complex. There are no interconnections between north and south ventilation systems.

Shutdown equipment located in the RHR complex consists of the following Divisions I and II equipment:

a. EDGs and auxiliary equipment

b. EDG fuel-oil storage tanks, day tanks, and transfer pumps

c. RHR service water pumps

d. EESW pumps

e. EDG service water pumps

f. RHR complex ventilation equipment

g. RHR cooling towers

h. Switchgear and MCCs.

Fire detection equipment provided in each half of the RHR complex consists of ionization detection systems for the service water pump rooms, switchgear rooms, and ventilation equipment rooms. Fire suppression equipment consists of an automatic, low-pressure CO_2 system in the EDG rooms, automatic sprinkler systems in the fuel-oil storage tank rooms, and portable fire extinguishers and manual water hoses throughout the complex, as shown in Figures 9A-13 through 9A-15.

NFPA 13 noncompliances with these sprinkler systems include location of sprinklers in excess of the maximum allowable distance below the ceiling and distance between some sprinklers under tanks in excess of the maximum allowable distance for extra hazard occupancies (in addition to those discussed and evaluated in 9.5.1.2.3.3). These noncompliances would not prevent the sprinkler systems from fulfilling their required function of controlling a fire and confining it to the room of origin.

9A.4.3.2 Analysis

Shutdown is achieved from the main control room, using Division I systems for a fire in the north half of the RHR Complex and Division II systems for a fire in the south half of the RHR Complex. Divisions I and II equipment is separated by a 3-hr-rated fire barrier.

Fuel-oil storage within the complex represents a specific fire hazard. Tanks are surrounded by rated walls to contain oil in the event of a tank rupture. In addition, tanks can be remote manually drained. Further details are discussed in Subsection 9.5.4. Fuel oil accounts for the major portion of combustible materials. Other combustibles consist primarily of electrical insulation and lubricating oil. The total fire loading for each half of the complex is greater than the high classification.

Because diesel fuel oil is delivered to the valve station near the northwest corner of the RHR complex at regular intervals, the unlikely possibility exists for a catastrophic failure of one of these delivery trucks resulting in an oil spill fire in close proximity to the RHR complex itself. It should be noted plant personnel escort the truck at all times when it is being driven within the protected area and will provide prompt notification of an oil spill/fire.

The actual exposure fire threat to the RHR complex from an oil spill fire such as described above is very low. The exterior walls are constructed of reinforced concrete with an equivalent fire resistance rating of at least three hours. All openings in the exterior walls above elevation 590′-0″ (which is six feet above grade level and the possible oil spill/fire) are protected by heavy steel plates/doors or are within the reinforced concrete RHR cable vaults. All safety related equipment and cables in the RHR complex are located on or above elevation 590′-0″. Four overflow pipe penetrations are provided below elevation 590′-0″. These openings are not provided with any type of covering. However, there are no combustibles in the RHR complex below the 590′-0″ elevation; thus flame propagation through these openings is not postulated. Finally, any heat postulated to enter the complex via the air intakes or non fire rated penetration assemblies will be quickly dissipated by the HVAC system.

The north side of RHR complex, near a postulated fire at the valve station only contains Division II equipment therefore, no credible exposure to both divisions exists and, Division I equipment would be available for safe shutdown.

Because no other combustible materials are stored or located adjacent to the RHR complex, a diesel fuel oil fire is considered the worst case transient combustible exposure fire that the RHR complex could be postulated to receive therefore, the plant's ability to achieve and/or maintain safe shutdown would not be adversely affected by an exposure fire to the RHR complex.

9A.4.3.3 Conclusion

The objective for the RHR complex is to prevent a fire in one half of the complex from spreading to the other half of the complex. This is accomplished by the rated fire barrier between halves of the complex, existing fire detection and suppression equipment, and the ability to drain fuel oil from the storage tanks to a remote area.

9A.4.4 Radwaste Building

9A.4.4.1 General Description

The radwaste building is structurally part of the turbine building and has, for purposes of this fire hazards analysis, been designated as a single, separate fire area. The building is bounded on the north by an outside wall, on the south and west by the turbine building and office and service building, and on the east by the onsite storage building.

The radwaste building houses the liquid and solid waste processing equipment.

The walls, floor, and ceiling are constructed of reinforced concrete and concrete block. Door openings to the turbine building are equipped with Class A, B, and C fire doors. Penetrations through walls of the turbine building and office service building are sealed to provide a 3-hr barrier. Cable trays passing through floors are fire stopped.

The alternative/dedicated shutdown system panels are located on the second floor of this building.

Shutdown equipment contained in this zone consists of the following:

a. Offsite power cables affecting CTG 11-1 feed to standby feedwater

b. RHR Instrumentation equipment and cable

c. Standby feedwater and CTG 11-1 equipment and cable

Fire detection equipment consists of thermal, photoelectric, and ionization type fire detection instruments throughout the building for early warning. Fire suppression equipment for the radwaste building consists of an automatic sprinkler system for the chemical stores room, the two oil-coalescer rooms, the extruder-evaporator room, the drum-turntable room, the drum-capper room, the drum-transfer-conveyor room (all on the first floor), and the main corridor, the drum-conveyor room, the main corridor west of the drum decontamination room and storage room (both on the third floor); an automatic deluge system for the roof-mounted voltage regulator; Clean Agent extinguishing systems for various administrative areas; and a manual hose and portable fire extinguishers. The radwaste building ventilation system is completely separate from other plant areas or buildings.

9A.4.4.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. The building is separated from the turbine and the office service buildings by 3-hr-rated fire barriers, except for the opening placed in the south wall of the radwaste building which has wet pipe sprinkler protection installed to separate the office and service building fire zone from the new storage area. The fire barrier separating the Radwaste and Turbine Buildings contains class A, B, and C fire doors. The class B fire doors were constructed without windows and in the exact same manner as class A doors; and are therefore considered equivalent to class A doors. The three (3) class C (3/4 hour fire rated) doors are located along column line K at elevation 583’-6” and form part of the separation between the Radwaste Building control room and office area and the Turbine Building. Because the office and control room area is provided with automatic fire detection and the combustible loading on both sides of these doors is low, these doors do not prevent the fire barrier separating the Turbine and Radwaste Buildings from performing its intended design function. Therefore, fire in this building will not affect plant safe-shutdown capability because of the separation and isolation of plant equipment. This arrangement meets the system interface requirements of BTP-CMEB 9.5-1.

Inadvertent operation of automatic fire suppression systems provided for this fire area will have no adverse effect on the ability to shut down the plant. The floor drain system is contained within the building; therefore, combustible liquid spills cannot travel outside the radwaste building.

Combustibles within the radwaste building have been protected by automatic suppression systems as noted in Subsection 9A.4.4.1.

The Conveyor system area of the radwaste building is converted to a storage are. It is isolated from the radwaste building with 3-hr rated fire walls. A cutout in the south wall connects this room to the office and service building. A sprinkler curtain was installed on both sides of the cutout. Effectively, this room is part of the office and service building. Therefore, the radwaste building compliance with Branch Technical Position APCSB 9.5-1 is not impacted by this change.

9A.4.4.3 Conclusion

A fire in the radwaste building will not adversely affect plant shutdown. The 3-hr fire-resistance rating of the walls separating the turbine and the office and service buildings from the radwaste building is adequate, based on the fire hazards and the protection provided for the specific fire hazards in the radwaste building.

9A.4.5 Turbine Building

9A.4.5.1 General Description

The turbine building, which for purposes of this fire hazards analysis includes the steam tunnel and a portion of the auxiliary building at Elevation 583 ft 6 in., comprises one fire area. This fire area is bounded on the north by the radwaste building; on the east by the office and service buildings; on the south by an outside wall; and on the west by the auxiliary building, reactor building, and transformer area.

The west wall of the turbine building is a 3-hr-rated barrier below elevation 679′-6″. This rated barrier serves to protect the turbine building from an exposure fire originating in one of the adjacent oil-filled transformers. In addition, fixed automatic water spray systems are provided for these transformers to reduce their exposure fire hazard. Therefore, the turbine building is adequately protected from a transformer oil exposure fire.

The turbine building houses the turbine generator and related auxiliary equipment. Also located in the turbine building is equipment for the condenser offgas system.

Walls separating the turbine building from other buildings are constructed of reinforced concrete and concrete block. These walls have a 3-hr fire-resistance rating. Doorways in boundary walls separating the turbine building from the auxiliary and reactor buildings are equipped with Class A fire doors. As detailed in Section 9A.4.4.2, doorways in boundary walls separating the turbine building from the radwaste building contain class A, B, and C fire doors. All other penetrations in these boundary walls are sealed to provide 3-hr-rated fire barriers except for the pressure equalizing line between the first floor of the reactor building and this Fire Zone. The ability of the fire barrier to perform its function has been evaluated and determined to provide an adequate assurance that a fire in this Fire Zone will not propagate to the reactor building first floor. Two penetrations in the west wall at approximately 603 ft elevation that contain the Calvert Cable Buses are not sealed with a tested configuration design. However, the lack of combustibles in the area adjacent to and below these openings, the configuration of the Calvert Cable Buses and the rated seals on the auxiliary building wall have been evaluated and provide adequate assurance that a fire in the turbine building will not propagate through these penetrations into the auxiliary building. The floor penetrations in the steam tunnel are provided with a non-tested configuration in the fire rated separation barrier. These seals have been evaluated and provide an adequate assurance that a fire in the Reactor Building Fire Zone 01RB will not propagate through these penetrations into the steam tunnel, or from the steam tunnel to the reactor building.

Safe shutdown equipment consists of the following:

a. Offsite power cables affecting CTG 11-1 feed to standby feedwater
b. Standby feedwater and CTG 11-1 equipment and cables
c. HPCI and RCIC cables, Division I and Division II
d. RHR instrumentation cables
e. HPCI and RCIC equipment and cables, Division I and Division II, in the TB Steam Tunnel

Fire suppression equipment is provided as follows:

a. Automatic water sprinkler systems for the reactor feed pump turbines and turbine-oil reservoir, main lube-oil reservoir, oil storage and turbine-oil tank rooms, the second floor pipe space, and the equipment hatch area and decontamination room on the first floor
b. Automatic water deluge systems for the hydrogen seal oil unit.

In addition to the above automatic systems, manual fire hoses and portable fire extinguishers are provided.

9A.4.5.2 Analysis

Shutdown is achieved from the main control room. Division II is used to achieve shutdown in the turbine building, except for the steam tunnel. In the turbine building steam tunnel, Division I is used to achieve safe shutdown.

Combustibles within the turbine building are typical for a turbine generator complex. The major fire hazard in this fire area is the large quantity of oil required for turbine bearing lubrication and the oil required for the generator hydrogen seals. This hazard is protected against by the fixed suppression systems noted in Subsection 9A.4.5.1.

Inadvertent operation of automatic fire suppression systems provided for this fire area will have no adverse effect on the ability to shut down the plant.

There are no combustibles in the steam tunnel. The major source of fire in the turbine building is remotely located from the valves in the steam tunnel. This distance, coupled with the fixed fire suppression systems provided, protects against a fire hazard to equipment in the steam tunnel. In addition, both shutdown valves (RCIC and HPCI pump discharge isolation valves) are backed up by the automatic depressurization, LPCI, and core spray systems.

The HWC System introduces hydrogen into the turbine building through supply piping at the north end. This piping is routed along the inner east and north walls of the turbine building, bordering the radwaste building. A barrier installed between the northeast stairwell and the hydrogen skid assembly will provide protection for personnel using the stairs in the event of a fire. The elevator shaft is enclosed by a 12-inch thick hollow concrete block wall, which will provide protection and prevent the spread of a fire into the shaft. The quantity of hydrogen which could be released into the turbine building in the event of a pipe break will be limited to that amount contained in the 1.5-inch hydrogen piping (between the upstream automatic isolation valve module and the downstream automatic isolation valves on the injection skid; these will all close on detection of high hydrogen levels). These valves are located inside the turbine building, and will isolate the piping in the building from the hydrogen supply facility. Because of the highly flammable nature of the gas, local area monitors are installed above each heater feed pump injection point, at the hydrogen skid assembly, and at the isolation module at the turbine building entrance. The detection of small amounts of hydrogen (about 1% concentration in air) will result in a local alarm at the HWC control panel, and the detection of levels above 2% in air will result in a system trip and isolation. Since the flammability limit is 4% hydrogen in air, the leak detection system should provide isolation before a flammable mixture can result.

9A.4.5.3 Conclusion

A fire emergency in the turbine building would not adversely affect the ability to shut down the plant. The 3-hr fire- resistance rating of the walls separating the auxiliary, reactor, and radwaste buildings from the turbine building is adequate, based on the fire hazards and the protection provided against specific fire hazards in the turbine building.

9A.4.5.4 Deviations

Deviations for the steam tunnel have been approved for the following:

a. Lack of automatic suppression based on negligible fuel load, heat monitoring instrumentation in place of detectors, and 7 ft separation of redundant valves (Reference 1, SSER No. 5 VI[8]).

b. Lack of 20 ft separation (Reference 1, SSER No. 5 VI).

9A.4.6 Office and Service Building

9A.4.6.1 General Description

The office and service building is primarily a single story structure; however, the office portion of this building consists of two stories. For purposes of this fire hazards analysis, the office and service building has been designated as a single fire area. This building is bounded on the north by a portion of the radwaste building and an outside wall; on the east and south by outside walls; and on the west by the turbine building.

Housed within the office and service building are office spaces, locker rooms, kitchen and dining areas, shops, and warehouse space.

The walls separating this building from adjoining buildings are constructed of reinforced concrete. Penetrations in these walls are sealed to provide a fire stop. Doorways to adjoining buildings are equipped with metal doors, except for the opening placed in the south wall of the radwaste building which has wet pipe sprinkler protection installed to separate the office and service building fire zone from the new storage area.

Shutdown cables contained in this area include cables associated with diversion of inventory from the Condensate Storage Tank, which is the source of water for the SBFW pumps.

Fire suppression equipment for this fire area consists of an automatic water pre-action sprinkler system for the warehouse loading dock, an automatic water sprinkler system in the office storage and fill areas, tool crib and warehouse, and manual hose and portable fire extinguishers.

9A.4.6.2 Analysis

Safe shutdown is achieved from the main control room using Division I or Division II systems. Shutdown cables lost are associated with SBFW. The SBFW system is not required for a fire in the Office and Service Building. The building is separated from adjacent buildings by fire barriers. Along the northern boundary of the OSB on elevation 589’-6”, row line 13A between column lines S and V, there is an unrated opening to the Radwaste building. This opening has an automatic water curtain sprinkler system installed around it to prevent the passage of fire from one zone into the other. This along with the Radwaste and Office and Service Buildings automatic sprinkler systems, early warning fire detection, and low combustible loading in the vicinity of the opening justify that the unrated boundary is acceptable. Additionally, the adjacent buildings house no shutdown equipment nor is there shutdown equipment nearby.

Inadvertent operation of automatic fire suppression systems provided for this fire area will have no adverse effect on ability to shut down the plant.

Combustibles within the office and service buildings have not been quantified since they consist primarily of transient materials typical of office and service buildings.

9A.4.6.3 Conclusion

The objective for this fire area is to prevent fire in this building from jeopardizing the ability to shut down the plant. This objective is achieved by adequate separation from shutdown equipment by barriers, use of automatic, partial coverage fire suppression systems, and manual hose and portable fire extinguishers.

9A.4.7 Yard Area

9A.4.7.1 General Description

The yard area, shown in Figure 9A-1, includes the open areas of the plant site not occupied by buildings. Equipment located in this area includes, but is not limited to, the following:

a. Condensate storage tanks

b. Auxiliary boiler fuel-oil storage tank

c. Auxiliary boiler house

d. Transformers

e. Storage facility for hydrogen

f. Underground safety related cable ducts

g. HWC gas supply facility

h. CTG 11-1 and auxiliaries and 120 kV Mat Equipment located at Fermi 1

i. Offsite power cables affecting CTG 11-1 feed to SBFW

j. Egress area between Reactor Building and RHR complex

See the following subsections for individual analyses of each of the above.

9A.4.7.2 Condensate Storage Tanks

9A.4.7.2.1 Description

The condensate storage tanks are located approximately 100 ft east of the services building and approximately 112 ft south of the auxiliary boiler house.

The tanks are located inside a lined diked area which is designed to collect the contents of a tank spill/overflow. The dike around the tanks is a three foot high concrete wall.

These tanks are used as the supply of water for SBFW, HPCI and RCIC. HPCI and RCIC pumps can be supplied from the suppression pool as another source of water. Fire suppression equipment in this portion of the yard area consists of a fire hydrant, supplied from the fire service water system, and manual hose.

9A.4.7.2.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. One of the two condensate storage tanks and associated level instrumentation are used for shutdown operations using HPCI or RCIC. However, should the tanks be damaged as a result of fire, the suppression pool can be used as an alternative water source. SBFW does not have another water source. Safe shutdown for the fires in the yard where these tanks could be damaged does not rely on SBFW.

The three foot high concrete wall surrounding the condensate storage tank (to contain the tank contents) will prevent an exposure fire or the heat from an exposure fire in the yard area adjacent to the storage tanks from affecting the tanks themselves. This includes a postulated oil spill/fire due to a catastrophic failure of an oil truck enroute to the RHR complex. In the case of the oil truck, the concrete walls will prevent the burning oil from getting within 25 feet of the storage tanks. In addition, the oil truck is escorted by plant personnel (while the truck is being driven within the protected area) who will promptly notify the Control Room in the event of an oil spill/fire.

9A.4.7.2.3 Conclusion

The objective for this portion of the yard area is to prevent damage to the condensate storage tanks as a result of fire in nearby equipment or buildings. The minimum spatial separation (approximately 100 ft) between these tanks and nearby buildings is adequate. The objective is achieved by this spatial separation and provision of manual fire protection equipment. Additionally, an alternative source of water is provided through connections between the suppression pool and the RCIC, HPCI, low pressure coolant injection (LPCI), and core spray systems.

9A.4.7.3 Auxiliary Boiler Fuel-Oil Storage Tank

9A.4.7.3.1 Description

The auxiliary boiler fuel-oil storage tank is located approximately 200 ft from the service building and approximately 100 ft north of the auxiliary boiler house.

This tank is above ground and surrounded by a dike; therefore, should leakage occur, it would be contained in the diked area.

This tank is not shutdown equipment.

Fire suppression equipment in this portion of the yard area consists of a fire hydrant, supplied by the fire service water system, and manual hose.

9A.4.7.3.2 Analysis

Since this tank is not required for shutdown operation, functional redundancy is not a consideration. Separation by more than 200 ft between this tank and the condensate storage tanks is adequate.

9A.4.7.3.3 Conclusion

The objective for this portion of the yard is to prevent fire in this area from spreading to buildings housing shutdown equipment. This objective is achieved by a dike surrounding the tank, the remote location of the tank, and the fire hydrant in the vicinity.

9A.4.7.4 Auxiliary Boiler House

9A.4.7.4.1 Description

The auxiliary boiler house is located approximately 90 ft east of the service building and approximately 110 ft north of the condensate storage tanks.

This structure houses the auxiliary boiler. The auxiliary boiler is not required for shutdown.

Fire suppression equipment in this portion of the yard area consists of a fire hydrant, supplied from the fire service water system, and manual hose.

9A.4.7.4.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. Since the auxiliary boiler is not required for safe shutdown, functional redundancy is not a consideration. Separation of this building from other buildings is adequate.

9A.4.7.4.3 Conclusion

The objective of this portion of the yard area is to prevent a fire in the auxiliary boiler house from spreading to other buildings or adversely affecting the condensate storage tanks. This objective is achieved by spatial separation and the fire hydrant in the vicinity.

9A.4.7.5 Transformers

9A.4.7.5.1 Description

Transformers are located in a portion of the yard area adjacent to the west wall of the turbine building and south of the auxiliary building. The main and auxiliary transformers are located in this area, which is surrounded on the north, south, and west sides by a curb to contain any oil leakage from the transformers. Fire barriers are provided between the transformers.

Except for SS #64, none of these transformers are necessary for shutdown operation since required electrical power can be supplied by the EDGs. SS #64 is utilized as part of the SBFW power supply from CTG 11-1 to the SBFW pumps.

Fire suppression equipment for this portion of the yard area consists of automatic deluge systems for the transformers. Fire hydrants, supplied from the fire service water system, and manual hose are also provided.

9A.4.7.5.2 Analysis

Shutdown is achieved from the main control room utilizing either Division I or Division II. SS #64 can affect the ability to power SBFW pumps from the CTG, but SBFW is not necessary for shutdown in the yard area. Since the transformers located in this portion of the yard area are not required for shutdown, functional redundancy is not a consideration. Separation is adequate in light of the fire suppression systems provided.

9A.4.7.5.3 Conclusion

The objective for this portion of the yard area is to prevent a fire spreading from this area to other buildings or yard areas containing shutdown equipment. This objective is achieved by automatic deluge systems, fire hydrants, and a curb around three sides of the area (the turbine building west wall encloses the fourth side).

9A.4.7.6 Hydrogen Storage Facility

9A.4.7.6.1 Description

The hydrogen storage area is located approximately 80 ft south of the turbine building.

Hydrogen is not required for shutdown.

Fire suppression equipment for this area consists of fire hydrants, supplied from the fire service water system, and manual hoses.

9A.4.7.6.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. Spatial separation of this area from buildings containing shutdown equipment is adequate. Additionally, gas storage cylinders in this storage area are oriented to minimize the probability of striking a safety-related building should an explosion occur.

9A.4.7.6.3 Conclusion

The objective is to prevent fire in the hydrogen storage area from causing damage to shutdown equipment in other buildings. This objective is achieved by the remote location of the hydrogen storage area, the orientation of gas storage cylinders away from safety-related buildings, and fire hydrants in the vicinity.

9A.4.7.7 Underground Safety Related Cable Ducts

9A.4.7.7.1 Description

There are two sets of Category I 4160-V ductbanks between the RHR complex and the Reactor/Auxiliary building, with a Division I and Division II ductbank in each set.

The first set of ductbanks was installed during plant construction. These two underground safety related cable ducts run parallel to each other and carry safe shutdown cables between the RHR complex and the Auxiliary Building cable vault. The most northerly duct carries Division II safe shutdown cables while the other carries Division I safe shutdown cables. The cables in each of these ducts are routed in approximately 30 fiber pipes. The spaces between and around these pipes are filled with approximately 3″ of concrete and the entire structure is reinforced with steel.

Each of the ducts is provided with a manhole structure which is also of reinforced concrete construction and an integral part of the duct. The opening which is approximately 30″ in diameter, is covered by a tight fitting malleable iron cover with cast iron ring. These underground ducts are separated by at least 10′ of soil and are covered by at least 2 feet of soil. The top of the manhole structures are approximately one foot below grade and the manhole covers are covered with soil and gravel.

Immediately adjacent to each manhole is a handhole structure, which is physically independent of the manhole structure but it does become part of the underground duct as it ties into it on both sides of the manhole structure. These handholes provide access to communication cables which are separated by concrete from fiber pipes carrying safety related cables.

The second set of ductbanks and associated manholes is installed above the maximum ground water elevation of 576.0 ft with ducts sloped to the manholes, such that circuits contained are not subject to continuous wetting. These are cast-in-place, rectangular reinforced concrete ductbanks, located with the ductbank top approximately six inches below the surface and manhole covers at grade level. The spaces around the ducts are filled with a minimum of five inches of reinforced concrete. The portion of the ductbanks located below the ISFSI Transfer Pad is covered by the two foot thick reinforced concrete roadway and are separated by a minimum of 7'-8" of soil and reinforced concrete. In the balance of the ductbanks, the ducts are covered with a minimum of 12 ½" of reinforced concrete above the ducts and 18" of reinforced concrete along the sides of the outside ducts.

Three manholes are provided in each of the two ductbank runs. The manholes are 8'-0" long x 6'-0" wide (inside dimension) with 18" thick reinforced concrete walls and 16" thick bottom slab/mat. The top of the manholes is at the finished grade elevation. The manhole covers consist of a 12 ½" thick reinforced concrete removable top slab with two equal 4'-6" x 7'-0" overlapping sections. The manhole cover interface surfaces are provided with joint sealant at the vertical surface and an additional gasket at the horizontal surfaces to avoid the entry of water or other fluids.

The ductbanks rise above grade for a length of approximately six feet in an area of thickened reinforced concrete at the entrance to the RHR cable vaults and for a length of approximately thirteen feet at the entrance to the Reactor/Auxiliary building cable vault. At the Reactor/Auxiliary building entrance, the ducts are covered with eight inches of reinforced concrete and a 1" thick steel plate.

Category I ductbanks from manholes 16946C and 16947C to the RHR complex terminate in RHR cable vaults with 18" thick reinforced concrete walls and 12 ½" thick reinforced concrete roofs. The cable vaults have access openings measuring 2'-6" x 2'-6" and covered with 1 ½" thick steel plate in the north and south walls. The RHR cable vaults are separated by 80 feet. The walls extend 6" below grade, which has a cover of approximately six inches of bituminous pavement. The cable vault floors are gravel to allow drainage.

9A.4.7.7.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. The underground ducts are separated from each other by distance, construction and soil and gravel. A fire involving solid combustibles stored outside the posted area does not pose a threat to the safe shutdown cables within the manholes because of the insulating properties of the soil and gravel or concrete and the fact that most of the heat will be dissipated into the atmosphere. A combustible liquid fire is not a viable threat to cables inside the manholes because the burning liquid will be extinguished due to the absence of oxygen, as it soaks into the soil and gravel over the manhole. The manholes with reinforced concrete slab covers are equipped with barriers on both the vertical and horizontal surfaces to minimize the possibility of liquid entry.

In addition, the top of the manhole structure is a reinforced concrete slab approximately 12″ thick and the manhole opening is covered by either a tight fitting iron plate that lays inside of a cast iron ring or a 12 ½" thick reinforced concrete slab in two overlapping sections, provided with sealant and gaskets.

The RHR cable vaults for Division I and Division II cables are separated by 80 feet and are constructed of reinforced concrete, with steel covers for the access openings.

9A.4.7.7.3 Conclusion

The objective is to prevent a fire in the yard area from impacting the safe shutdown cables in manholes 16946 and 16947, manholes 16946A, B, and C and 16947A, B, and C, or the RHR cable vaults, and to prevent a fire in either divisional manhole or cable vault from spreading to a manhole or cable vault of the other division.. These objectives are achieved by the insulating capabilities of soil, gravel, and concrete and by physical separation (location).

9A.4.7.8 HWC Gas Supply Facility

9A.4.7.8.1 Description

The HWC gas supply facility is located approximately 1100 feet northwest of the nearest safety-related structure (RHR Complex).

Neither the HWC system nor the gases at the supply facility are required for safe shutdown.

Fire suppression equipment in the area includes yard area fire hydrants supplied from the fire service water system and manual hoses. The hydrogen supply system contains fire control valves which will isolate the hydrogen supply in the event of a fire.

9A.4.7.8.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. The HWC gas supply facility is located far enough away to prevent fires or explosions from affecting safety-related structures and to prevent the formation of combustible mixtures at safety-related intakes in the event of a release of tank contents without fire or explosion. Therefore, the spatial separation of the gas supply facility from buildings containing safe shutdown equipment is adequate.

9A.4.7.8.3 Conclusion

The objective is to prevent fire in the HWC gas supply facility area from causing damage to shutdown equipment in other buildings. The objective is achieved by the remote location of the gas supply facility and yard area fire hydrants.

9A.4.7.9 CTG 11-1 and Auxiliaries, 120 kV Mat Breakers at Fermi 1

9A.4.7.9.1 Description

At the 120 kV mat area of Fermi 1 and the Fermi 1 building, the CTG 11-1 and auxiliaries and certain breakers are used to provide power to SBFW if offsite power is lost to Fermi 2.

Safe shutdown equipment contained in the 120 kV mat and Fermi 1 zones are as follows:

a. CTG 11-1 and CTG 11-1 starting diesel engine

b. Peaker fuel oil storage tank and delivery system to the CTGs

c. 120 kV offsite breakers, 13.8 kV and 13.2 kV breakers

d. Battery power supplies for the CTG, breakers and supervisory control equipment

Fire suppression equipment for this portion of the yard area consists of automatic CO_2 suppression on the CTG units, fire hydrants and manual hose.

9A.4.7.9.2 Analysis

Shutdown is achieved from the Fermi 2 main control room using either Division I or Division II equipment. Damage to the equipment identified above can affect the power supply to the SBFW pumps, but will not cause loss of power to other divisional shutdown equipment. Use of SBFW is not required for a fire in the yard zone involving the CTG 11-1 or Fermi 1.

9A.4.7.10 Offsite Power Cables

9A.4.7.10.1 Description

The power cables from the 120 kV mat breakers to SS Transformer #64 are run in underground cable ducts. The power cables from SS Transform #64 run in an underground cable duct into the cable entry vault outside the auxiliary building Fire Zone 02AB, and then in an enclosed cable bus along the outside of the auxiliary building until it enters the Division 1 Switchgear Room (Fire Zone 04AB). This power train of cables provides power from CTG 11-1 to the SBFW pumps if offsite power is lost.

The power cables from SS Transformer #65 run in an enclosed cable bus along the outside of the turbine building and the auxiliary building until it enters the Division 2 Switchgear Room (Fire Zone 12AB). The offsite power feed from the 345 kV Mat and SS Transformer #65 are not credited for required or system shutdown.

9A.4.7.10.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II. SBFW is not required for shutdown for fires in the yard that damage either SS Transformer #64 or the enclosed cable bus outside the buildings.

9A.4.7.11 Egress Area between Reactor Building and RHR Complex

9A.4.7.11.1 Description

In the process of shutting down the plant due to a fire using the alternative dedicated shutdown system, the operators cross the yard area to the RHR complex.

9A.4.7.11.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. The yard area is lighted for safeguard purposes but is not battery-backed.

However, backup power is available from the combustion turbine generator (CTG 11-1 or an alternate CTG using the standby diesel generator) which supplies power for alternative shutdown. An analysis showed that the CTG can provide power for the yard lights required for shutdown without adversely affecting plant safe-shutdown capability.

9A.4.7.11.3 Deviations

Justification for a deviation from the technical requirements of Section III.J of Appendix R has been documented in a deviation approval request letter dated February 20, 1986, for yard lighting from CTGs versus 8-hr battery packs (Reference 4).

9A.4.8 General Service Water Pump House

9A.4.8.1 General Description

The general service water (GSW) pump house consists of a metal-clad steel building founded on a reinforced-concrete intake structure. This structure is located on the west shore of Lake Erie, south of the main group of plant buildings.

This structure houses the circulating water makeup pumps, GSW pumps, and associated mechanical and electrical equipment. Also housed in this structure are the two fire service pumps. One fire service pump is diesel-engine driven; the other, electric-motor driven.

The diesel-engine driven fire service pump is located in a cubicle surrounded by a 3-hr-rated barrier. The doorways between the diesel-engine-driven pump cubicle and the remaining floor area of this building are equipped with Class A fire doors. The roof of this building satisfies Factory Mutual Class I requirements.

No shutdown equipment is located within the GSW pump house.

Fire suppression equipment for the GSW pump house consists of an automatic water sprinkler system for the diesel-engine-driven fire service pump cubicle, manual hose, and portable fire extinguishers.

9A.4.8.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. The electric-motor-driven and diesel-engine-driven fire service pumps are redundant. Separation of these pumps is accomplished by enclosure of the diesel-engine-driven fire service pump within a 3-hr-rated fire barrier. The electric-motor-driven fire service pump is separated from other equipment by a minimum distance of approximately 15 ft.

The diesel-driven fire service pump fuel-oil tank represents the only significant concentration of combustible material. This tank is located outside, at grade, adjacent to the north wall of the building housing the fire service pumps.

9A.4.8.3 Conclusion

The objective for the GSW pump house is to prevent fire from damaging both fire service pumps. The objective is achieved through location of the diesel-engine-driven fire service pump within a 3-hr-rated fire barrier, the provision of an automatic sprinkler system for protection of this pump, and the outdoor location of the fuel-oil tank.

9A.4.9 Office Building Annex and Technical Support Center

9A.4.9.1 General Description

The technical support center (TSC) is described in Subsection 7.8.1. The remainder of the building is a two-story steel frame office service building. This portion of the building houses office space and a computer room.

No shutdown equipment is located within the office building.

Fire detection equipment consists of an ionization detection system.

Fire suppression for the office building annex consists of an automatic Halon extinguishing system for the computer room and portable extinguishers.

In addition to the suppression systems listed above, an automatic sprinkler system is installed in the TSC's records room.

9A.4.9.2 Analysis

Shutdown is achieved from the main control room using Division I or Division II systems. No shutdown equipment is jeopardized by a fire in the annex portion of the office building. Inadvertent operation of the automatic fire suppression system will have no adverse effect on ability to shut down the plant.

Combustibles within the office portion have not been qualified since they consist primarily of transient materials typical of an office building.

9A.4.9.3 Conclusion

The objective for this area is to prevent fire in this building from jeopardizing the ability to shut down the plant. This objective is achieved by spatial separation from necessary safety systems.

9A.4.10 Onsite Storage Building

This building is described in Section 11.7.

9A.4.11 Outage Building

9A.4.11.1 General Description

The outage building is primarily a two story structure; however, a one story breezeway connects the turbine building with the outage building. For the purpose of fire hazard analysis, the outage building is designated as a single fire area. The outage building is a free standing structure located four inches south of the reactor and auxiliary buildings.

The outage building contains a radiation protection control point area and access into the Plant Radiologically Controlled Area (RCA), as well as lunch room and rest room facilities.

The building is of completely noncombustible construction. The walls separating this building from the safety-related areas of the plant are constructed of reinforced concrete and contain fire rated doors.

No shutdown equipment is located within the outage building. The drywell pneumatic valves and connection lines are located in the yard between the reactor building and the one-story breezeway connecting the turbine building and the outage building.

Fire suppression equipment for this structure consists of a fire hydrant, supplied by the fire service water system, and manual hose. Fire detection is also provided in the outage building.

9A.4.11.2 Analysis

Shutdown is achieved from the main control room using Division I or Division II systems. No shutdown equipment is jeopardized by a fire in the outage building. The building is separated by reinforced concrete walls and fire rated doors from the safety-related areas of the plant.

Combustibles within the outage building have not been quantified since they consist primarily of transient materials consistent with lunchrooms, offices, and protective clothing storage areas.

9A.4.11.3 Conclusion

The object for this zone is to prevent fire from spreading to buildings housing shutdown equipment. This objective is achieved by the reinforced concrete walls and fire rated doors between the outage building and the safety-related areas of the plant.

9A.4.12 ISFSI Equipment Storage Building

9A.4.12.1 General Description

The Independent Spent Fuel Storage Installation (ISFSI) equipment storage building is located just north of the 345 KV switchyard, approximately 158 feet west of the RHR Complex.

This structure houses the equipment (e.g. – the Vertical Cask Transporter) required for ISFSI cask loading campaigns when not in use and also provides part-time office space and functions as an ISFSI crew briefing/turnover meeting area. This structure is not required for shutdown.

Fire suppression equipment in this structure consists of a wet pipe sprinkler system, supplied from the fire service water system and portable fire extinguishers.

9A.4.12.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. Since the ISFSI equipment is not required for safe shutdown, functional redundancy is not a consideration. Separation for this building from other buildings is adequate.

9A.4.12.3 Conclusion

The objective is to prevent a fire in the ISFSI equipment storage building from spreading to other buildings and jeopardizing the ability to shut down the plant. This objective is achieved by spatial separation from necessary safety systems.

9A.4.13 FLEX Storage Facility #1 and #2

9A.4.13.1 General Description

There are two FLEX Storage Facilities (FSF) installed at Fermi. FSF#1 is located inside the protected area approximately 150 feet north of the Reactor Building and approximately 240 feet N-E of the RHR complex. FSF#2 is located outside the protected area in the owner controlled area approximately 200 feet west of the Circulating Water Pump House and approximately 210 feet S-E of the south Cooling Tower.

These structures provide storage for equipment that is designated to mitigate the consequences of a Beyond Design Basis External Event. The buildings are made of reinforced concrete and designed to withstand events including Seismic, External Floods, High Winds, Snow/Ice and High/Low Temperatures. Buildings are heated as required to prevent freezing of wetted components.

Fire suppression equipment consists of a dry pipe sprinkler system.

9A.4.13.2 Analysis

Shutdown is achieved from the main control room using either Division I or Division II systems. The equipment stored in FSF#1 and FSF#2 is not safety related and not required for safe shutdown. Separation between the two FLEX Storage Facilities and other plant buildings is adequate.

9A.4.13.3 Conclusion

The objective is to prevent a fire in either of the two FLEX Storage Facilities from spreading to adjacent buildings/SSC's jeopardizing the ability of these buildings/SSC's to bring the plant to safe shutdown. FSF#1 and #2 are sufficiently separated from systems credited with safe shutdown.

9A.4 FIRE HAZARDS ANALYSIS

REFERENCES

1. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Submittal of Deviations From Staff Interpretations of Fire Protection Features in 10 CFR 50, Appendix R and Justification, dated August 3, 1984 (EF2-72717).
2. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Additional Fire Protection Information, dated February 4, 1985 (NE-85-0275).
3. Letter from W. H. Jens, Detroit Edison, to B. J. Youngblood, NRC, Subject: Additional Clarification Concerning Fire Doors and Fire Detectors, dated June 18, 1985 (VP-85-0142).
4. Letter from F. E. Agosti, Detroit Edison, to E. G. Adensam, NRC, Subject: Deviation Request - Emergency Lighting, dated February 20, 1986 (VP-86-0006).

9A.5 POINT-BY-POINT COMPARISON

This section contains a point-by-point comparison with Appendix A to NRC Branch Technical Position APCSB 9.5-1, dated August 23, 1976.

Position For Plants Under Construction and Operating Plants	EF-2 Response
Positions	
a. Overall Requirements of Nuclear Plant Fire Protection Program	
1. Personnel	
Responsibility for the overall fire protection program should be assigned to a designated person in the upper level of management. This person should retain ultimate responsibility even though formulation and assurance of program implementation is delegated. Such delegation of authority should be to staff personnel prepared by training and experience in fire protection and nuclear plant safety to provide a balanced approach in directing the fire protection programs for nuclear power plants. The qualification requirements for the fire protection engineer or consultant, who will assist in the design and selection of equipment, inspect and test the completed physical aspects of the system, develop the fire protection program, and assist in the fire-fighting training for the operating plant should be stated. Subsequently, the FSAR should discuss the training and the updating provisions such as fire drills provided for maintaining the competence of the station firefighting and operating crew, including personnel responsible for maintaining and inspecting the fire protection equipment.	Fermi 2 has agreed to implement the fire protection program contained in the staff supplemental guidance, "Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance," dated August 29, 1977, including (1) fire protection organizations (2) fire brigade training (3) control of combustibles (4) control of ignition sources (5) fire-fighting procedures.
The fire protection staff should be responsible for: (a) Coordination of building layout and systems design with fire area requirements, including consideration of potential hazards associated with postulated design basis fires, (b) Design and maintenance of fire detection, suppression, and extinguishing systems, (c) Fire prevention activities, (d) Training and manual fire-fighting activities of plant personnel and the fire brigade. (NOTE: NFPA 6 - Recommendations for Organization of Industrial Fire Loss Prevention, contains useful guidance for organization and operation of the entire fire loss prevention program.)	

Position For Plants Under Construction and Operating Plants	EF-2 Response
2. Design Bases	
The overall fire protection program should be based upon evaluation of potential fire hazards throughout the plant and the effect of postulated design basis fires relative to maintaining ability to perform safety shutdown functions and minimize radioactive releases to the environment.	Section 9A.4 (Fire Hazards Analysis) provides this comparison. Likewise, plant emergency procedures are based on maintaining the plant in a safe condition.
3. Backup	
Total reliance should not be placed on a single automatic fire suppression system. Appropriate backup fire suppression capability should be provided.	In areas where automatic suppression systems are provided, adequate manual suppression equipment, including fire-hose stations and/or portable fire extinguishers, is available.
4. Single-Failure Criterion	
A single failure in the fire suppression system should not impair both the primary and backup fire suppression capability. For example, redundant fire water pumps with independent power supplier and controls should be provided. Postulated fires or fire protection system failures need not be considered concurrent with other plant accidents or the most severe natural phenomena. The effects of lightning strikes should be included in the overall plant fire protection program.	The fire suppression systems satisfy this requirement and are described in Position E.
5. Fire Suppression Systems	
Failure or inadvertent operation of the fire suppression system should not incapacitate safety related systems or components. Fire suppression systems that are pressurized during normal plant operation should meet the guidelines specified in APCSB Branch Technical Position 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."	Failure or inadvertent operation of any fire suppression system will not incapacitate more than one division of safety-related systems or components. Analysis of fire protection piping failures was included in the moderate energy piping break evaluation, UFSAR Subsection 3.6.2.3.
6. Fuel Storage Areas	
Schedule for implementation of modifications, if any, will be established on a case-by-case basis.	The fire protection system as described in the FSAR in the fuel storage areas is operational
7. Fuel Loading	
Schedule for implementation of modifications, if any, will be established on a case-by-case basis.	The Fermi 2 Fire Protection System as described in UFSAR Subsection 9.5.1 and in this appendix in safety-related areas is operational.
8. Multiple-Reactor Sites	
On multiple-reactor sites where there are operating	N/A

Position For Plants Under Construction and Operating Plants	EF-2 Response
reactors and construction of remaining units is being completed, the fire protection program should provide continuing evaluation and include additional fire barriers, fire protection capability, and administrative controls necessary to protect the operating units from construction fire hazards. The superintendent of the operating plant should have the lead responsibility for site fire protection.	
9. Simultaneous Fires	
Simultaneous fires in more than one reactor need not be postulated, where separation requirements are met. A fire involving more than one reactor unit need not be postulated except for facilities shared between units.	N/A
b. Administrative Procedures, Controls and Fire Brigade	
1. Administrative procedures consistent with the need for maintaining the performance of the fire protection system and personnel in nuclear power plants should be provided. Guidance is contained in the following publications: NFPA 4 - Organization for Fire Services NFPA 4A - Organization for Fire Department NFPA 6 - Industrial Fire Loss Prevention NFPA 7 - Management of Fire Emergencies NFPA 8 - Management Responsibility for Effects of Fire on Operations	Fermi 2 has agreed to implement the fire protection program contained in the staff supplemental guidance, "Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance," dated August 29, 1977, including: (1) fire protection organizations (2) fire brigade training (3) control of combustibles (4) control of ignition sources (5) fire-fighting procedures.
NFPA 27 Private Fire Brigades	NFPA codes containing information on the above topics were used for guidance.
2. Effective administrative measures should be implemented to prohibit bulk storage of combustible materials inside or adjacent to safety related buildings or systems during operation or maintenance periods. Regulatory Guide 1.39, "Housekeeping Requirements for Water-Cooled Nuclear Power Plants," provides guidance on housekeeping, including the disposal of combustible materials.	
3. Normal and abnormal conditions or other anticipated operations such as modifications (e.g., breaking fire stops, impairment of fire detection and suppression systems) and refueling activities should be reviewed by appropriate levels of management and appropriate special actions and procedures such as fire watches or temporary fire barriers implemented to assure adequate fire protection and reactor safety. In particular:	

Position For Plants Under Construction and Operating Plants	EF-2 Response
(a) Work involving ignition sources such as welding and flame cutting should be done under closely controlled conditions. Procedures governing such work should be reviewed and approved by persons trained and experienced in fire protection. Persons performing and directly assisting in such work should be trained and equipped to prevent and combat fires. If this is not possible, a person qualified in fire protection should directly monitor the work and function as a fire watch.	
(b) Leak testing, and similar procedures such as air flow determination, should use one of the commercially available aerosol techniques. Open flames or combustion generated smoke should not be permitted.	
(c) Use of combustible material, e.g., HEPA and charcoal filters, dry ion exchange resins or other combustible supplies, in safety related areas should be controlled. Use of wood inside buildings containing safety related systems or equipment should be permitted only when suitable noncombustible substitutes are not available. If wood must be used, only fire retardant treated wood (scaffolding, lay down blocks) should be permitted. Such materials should be allowed into safety related areas only when they are to be used immediately. Their possible and probable use should be considered in the fire hazard analysis to determine the adequacy of the installed fire protection systems.	
4. Nuclear power plants are frequently located in remote areas, at some distance from public fire departments. Also, first response fire departments are often volunteer. Public fire department response should be considered in the overall fire protection program. However, the plant should be designed to be self-sufficient with respect to fire fighting activities and rely on the public response only for supplemental or backup capability.	
5. The need for good organization, training and equipping of fire brigades at nuclear power plant sites requires effective measures be implemented to assure proper discharge of these functions. The guidance in Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants," should be followed as applicable.	

Position For Plants Under Construction and Operating Plants	EF-2 Response
(a) Successful fire fighting requires testing and maintenance of the fire protection equipment, emergency lighting and communication, as well as practice as brigades for the people who must utilize the equipment. A test plan that lists the individuals and their responsibilities in connection with routine tests and inspections of the fire detection and protection systems should be developed. The test plan should contain the types, frequency and detailed procedures for testing. Procedures should also contain instructions on maintaining fire protection during those periods when the fire protection system is impaired or during periods of plant maintenance, e.g., fire watches or temporary hose connections to water systems.	
(b) Basic training is a necessary element in effective fire fighting operation. In order for a fire brigade to operate effectively, it must operate as a team. All members must know what their individual duties are. They must be familiar with the layout of the plant and equipment location and operation in order to permit effective fire fighting operations during times when a particular area is filled with smoke or is insufficiently lighted. Such training can only be accomplished by conducting drills several times a year (at least quarterly) so that all members of the fire brigade have had the opportunity to train as a team, testing itself in the major areas of the plant. The drills should include the simulated use of equipment in each area and should be preplanned and post-critiqued to establish the training objective of the drills and determine how well these objectives have been met. These drills should periodically (at least annually) include local fire department participation where possible. Such drills also permit supervising personnel to evaluate the effectiveness of communications within the fire brigade and with the on scene fire team leader, the reactor operator in the control room, and the off-site command post.	
(c) To have proper coverage during all phases of operation, members of each shift crew should be trained in fire protection. Training of the plant fire brigade should be coordinated with the local fire department so that responsibilities and duties are delineated in	

Position For Plants Under Construction and Operating Plants	EF-2 Response
advance. This coordination should be part of the training course and implemented into the training of the local fire department staff. Local fire departments should be educated in the operational precautions when fighting fires on nuclear power plant sites. Local fire departments should be made aware of the need for radioactive protection of personnel and the special hazards associated with a nuclear power plant site.	
(d) NFPA 27, “Private Fire Brigade” should be followed in organization, training, and fire drills. This standard also is applicable to the inspection and maintenance of firefighting equipment. Among the standards referenced in this document, the following should be utilized: NFPA 194, "Standard for Screw Threads and Gaskets for Fire Hose Couplings," NFPA 196, "Standard for Fire Hose," NFPA 197, "Training Standard on Initial Fire Attacks," NFPA 601, "Recommended Manual of Instructions and Duties for the Plant Watchman on Guard." NFPA booklets and pamphlets listed on page 27-11 of Volume 8, 1971-72 are also applicable for good training references. In addition, courses in fire protection and fire suppression which are recognized and/or sponsored by the fire protection industry should be utilized.	

Position For Plants Under Construction and Operating Plants	EF-2 Response
c. Quality Assurance Program	
Quality assurance (QA) programs of applicants and contractors should be developed and implemented to assure that the requirements for design, procurement, installation, and testing and administrative controls for the fire protection program for safety-related areas as defined in this Branch Position are satisfied. The program should be under the management control of the QA organization. The QA program criteria that apply to the fire protection program should include the following:	The Quality Assurance Program for Plant Operation governs all activities which may affect safety-related structures, systems, and components at the plant. This program is described in Section 17.2 (QAPD) In view of the fact that safety-related structures, systems, and components are protected by the fire protection systems, portions of the Quality Assurance Program for Plant Operation are designed to ensure that fire protection in safety-related areas is maintained through requirements on design, procurement, installation, testing, and administrative controls. The QA program is under the management control of the Nuclear Quality Assurance (NQA) Department. The NQA Department verifies that the fire protection program incorporates suitable requirements and is acceptable to the senior onsite nuclear manager and also verifies its effectiveness through review, surveillance, and audits. All portions of the fire protection program that impact safety-related areas of the plant are programmatically defined in the Fermi Conduct Manuals and meet the guidtance as addressed in Appendix A of NRC Branch Technical Position APCSB 9.5-1 with the following stipulation. The fire protection system was not originally designed to be safety related.
1. Design Control and Procurement Document Control	
Measures should be established to assure that all design-related guidelines of the Branch Technical Position are included in design and procurement documents and that deviations there from are controlled.	These measures are part of the QA Program.
2. Instructions, Procedures and Drawings	
Inspections, tests, administrative controls, fire drills and training that govern the fire protection program should be prescribed by documented instructions, procedures or drawings and should be accomplished in accordance with these documents.	These items have been developed in accordance with the Fermi Conduct Manuals.

Position For Plants Under Construction and Operating Plants	EF-2 Response
3. Control of Purchased Material, Equipment and Services	
Measures should be established to assure that purchased material, equipment and services conform to the procurement documents.	This item is included in the QA Program.
4. Inspection	
A program for independent inspection of activities affecting fire protection should be established and executed by, or for, the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.	This item is included in the QA Program.
5. Test and Test Control	
A test program should be established and implemented to assure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.	The test program is developed according to the requirements of the QA Program. The test results are reviewed by NQA through inspections, surveillances, or audits.
6. Inspection, Test and Operating Status	
Measures should be established to provide for the identification of items that have satisfactorily passed required tests and inspections.	These measures are part of Edison's tagging system and are part of the QA Program.
7. Non-Conforming Items	
Measures should be established to control items that do not conform to specified requirements to prevent inadvertent use or installation.	These measures are part of Edison's tagging system and are part of the QA Program.
8. Corrective Action	
Measures should be established to assure that conditions adverse to fire protection, such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible material, and nonconformances are promptly identified, reported and corrected	This item is included in the QA Program.

Position For Plants Under Construction and Operating Plants	EF-2 Response
9. Records	
Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities affecting the fire protection program.	Fire protection records are being maintained for this purpose according to the requirements of the QA Program.
10. Audits	
Audits should be conducted and documented to verify compliance with the fire protection program including design and procurement documents; instructions; procedures and drawings; and inspection and test activities.	Audits conducted by the NQA Department include the fire protection program.
d. General Guidelines for Plant Protection	
1. Building Design	
(a) Plant layouts should be arranged to:	The fire hazards analysis (Section 9A.4) identifies the fire areas and the safe-shutdown equipment within each area.
(1) Isolate safety related systems and	
(2) Separate redundant safety related systems from each other so that both are not subject to damage from a single fire hazard. Alternatives:	
(a) Redundant safety related systems that are subject to damage from a single fire hazard should be protected by a combination of fire retardant coatings and fire detection and suppression systems, or (b) a separate system to perform the safety function should be provided.	Locations where redundant systems are exposed to a single fire hazard are identified in the fire hazards analysis (Section 9A.4). Adequate fire protection is provided for these areas.
(b) In order to accomplish 1(a) above, safety related systems and fire hazards should be identified throughout the plant. Therefore, a detailed fire hazard analysis should be made. The fire hazards analysis should be reviewed and updated as necessary. Additional fire hazards analysis should be done after any plant modification.	See the fire hazards analysis, Section 9A.4.
(c) Alternative guidance for constructed plants is shown in Section E.3, "Cable Spreading Room."	

Position For Plants Under Construction and Operating Plants		EF-2 Response
(d)	Interior wall and structural components, thermal insulation materials and radiation shielding materials and sound-proofing should be noncombustible or listed by a nationally recognized testing laboratory, such as Factory Mutual or Underwriters Laboratory, Inc. for flame spread, smoke and fuel contribution of 25 or less in its use configuration (ASTM E-84 Test, "Surface Burning Characteristics of Building Materials").	Plant structural components satisfy thie criterion or have approved deviations.
(e)	Metal deck roof construction should be noncombustible (see the building materials directory of the Underwriters Laboratory, Inc.) or listed as Class I by Factory Mutual System Approval Guide. Where combustible material is used in metal deck roofing design, acceptable alternatives are (i) replace combustibles with non-combustible materials, (ii) provide an automatic sprinkler system, or (iii) provide ability to cover roof exterior and interior with adequate water volume and pressure.	All metal deck roof construction is noncombustible and is listed as Class I by the Factory Mutual System Approval Guide.
(f)	Suspended ceilings and their supports should be of noncombustible construction. Concealed spaces should be devoid of combustibles. Adequate fire detection and suppression systems should be provided where full implementation is not practicable.	Plant areas satisfy these criteria.
(g)	High voltage - high amperage transformers installed inside buildings containing safety related systems should be of the dry type or insulated and cooled with non-combustible liquid. Safety related systems that are exposed to flammable oil filled transformers should be protected from the effects of a fire by: (i) replacing with dry transformers or transformers that are insulated and cooled with noncombustible liquid; or (ii) enclosing the transformer with a three-hour fire barrier and installing automatic water spray protection.	Inside transformers are dry type.

	Position For Plants Under Construction and Operating Plants	EF-2 Response
(h)	Buildings containing safety related systems, having openings in exterior walls closer than 50 feet to flammable oil filled transformers should be protected from the effects of a fire by: (i) closing of the opening to have fire resistance equal to three hours (ii) constructing a three-hour fire barrier between the transformers and the wall openings; or (iii) closing the opening and providing the capability to maintain a water curtain in case of a fire.	Outdoor oil-filled transformers are within 50 ft of openings in the turbine building wall. Transformers are adequately protected by fixed automatic water spray systems. A solid metal door is provided for the turbine building west wall
(i)	Floor drains, sized to remove expected fire fighting water flow should be provided in those areas where fixed water fire suppression systems are installed. Drains should also be provided in other areas where hand hose lines may be used if such fire-fighting water could cause unacceptable damage to equipment in the area. Equipment should be installed on pedestals, or curbs should be provided as required to contain water and direct it to floor drains. (See NFPA 92M, "Waterproofing and Draining of Floors.") Drains in areas containing combustible liquids should have provisions for preventing the spread of fire throughout the drain system. Water drainage from areas which may contain radioactivity should be sampled and analyzed before discharge to the environment. In operating plants or plants under construction, if accumulation of water from the operation of new fire suppression systems does not create unacceptable consequences, drains need not be installed.	Floor drains are designed to remove the expected fire-fighting water flow from areas where fixed fire suppression systems are installed or where fire hose may be used. Equipment is installed on pedestals. Drains in areas containing combustible liquids are designed to prevent the spread of fire throughout the drain system. Water drainage from areas that may contain radioactivity is collected in the floor drain collection tank for normal liquid waste. Subsection 9.3.3 of the UFSAR describes the floor drain system in all the buildings. Section 11.2 of the UFSAR describes the handling and processing of liquid radioactive waste.

Position For Plants Under Construction and Operating Plants	EF-2 Response
(j) Floors, walls and ceilings enclosing separate fire areas should have minimum fire rating of three hours. Penetrations in these fire barriers, including conduits and piping, should be sealed or closed to provide a fire resistance rating at least equal to that of the fire barrier itself. Door openings should be protected with equivalent rated doors, frames and hardware that have been tested and are approved by a nationally recognized laboratory. Such doors should be normally closed and locked or alarmed with alarm and annunciation in the control room. Penetrations for ventilation system should be protected by a standard "fire door damper" where recognized. (Refer to NFPA 80, "Fire Doors and Windows.") The fire hazard in each area should be evaluated to determine barrier requirements. If barrier fire resistance cannot be made adequate, fire detection and suppression should be provided, such as: (i) water curtain in case of fire, (ii) flame retardant coatings, (iii) additional fire barriers.	The fire hazards analysis identifies the fire barriers and determines the requirements for maintaining their integrity. As detailed in Section 9A.4, door openings are protected with equivalent rated doors, frames, and hardware that have been tested and approved by a nationally recognized laboratory. Such doors are normally closed and alarmed with alarm and annunciation in the control room (a continuously manned location), or checked daily, or alarmed with annunciation to Security (a continuously manned location), or locked and checked weekly, all of which are acceptable monitoring methods described in Branch Technical Position CMEB 9.5-1, Revision 2. Penetrations for ventilation systems are protected by fire dampers where deemed necessary as a result of the fire hazards analysis. Electrical conduits penetrating rated fire barriers are provided with internal seals unless they meet the criteria of 9A.2.3.1.1 for not requiring internal seals for fire.
2. Control of Combustibles	
(a) Safety related systems should be isolated or separated from combustible materials. When this is not possible because of the nature of the safety system or the combustible material, special protection should be provided to prevent a fire from defeating the safety system function. Such protection may involve a combination of automatic fire suppression, and construction capable of withstanding and containing a fire that consumes all combustibles present. Examples of such combustible materials that may not be separable from the remainder of its system are: (1) Emergency diesel generator fuel oil day tanks (2) Turbine-generator oil and hydraulic control fluid systems (3) Reactor coolant pump lube oil system	The fire hazards analysis identifies these hazards and the protection afforded.

Position For Plants Under Construction and Operating Plants	EF-2 Response
(b) Bulk gas storage (either compressed or cryogenic), should not be permitted inside structures housing safety-related equipment. Storage of flammable gas such as hydrogen, should be located outdoors or in separate detached buildings so that a fire or explosion will not adversely affect any safety related systems or equipment. (Refer to NFPA 50A, "Gaseous Hydrogen Systems.")	Bulk gas is stored in outside areas. A fire or explosion will not adversely affect any safety-related systems or equipment.
Care should be taken to locate high pressure gas storage containers with the long axis parallel to building walls. This will minimize the possibility of wall penetration in the event of a container failure. Use of compressed gases (especially flammable and fuel gases) inside buildings should be controlled. (Refer to NFPA 6, "Industrial Fire Loss Prevention.")	High-pressure gas storage containers will be located with the long axis parallel to the adjacent safety-related building wall.
(c) The use of plastic materials should be minimized. In particular, halogenated plastics such as polyvinyl chloride (PVC) and neoprene should be used only when substitute non-combustible materials are not available. All plasticmaterials, including flame and fire retardant materials, will burn with an intensity and BTU production in a range similar to that of ordinary hydrocarbons. When burning, they produce heavy smoke that obscures visibility and can plug air filters, especially charcoal and HEPA. The halogenated plastics also release free chlorine and hydrogen chloride when burning which are toxic to humans and corrosive to equipment.	Plastic materials throughout the plant are negligible.
(d) Storage of flammable liquids should, as a minimum, comply with the requirements of NFPA 30, "Flammable and Combustible Liquids Code."	NFPA 30 was used as a guideline for storage of flammable liquids.
3. Electric Cable Construction, Cable Trays and Cable Penetrations	
(a) Only non-combustible materials should be used for cable tray construction.	Cable trays are of non-combustible metal construction.
(b) See Section F.3 for fire protection guidelines for cable spreading rooms.	

	Position For Plants Under Construction and Operating Plants	EF-2 Response
(c)	Automatic water sprinkler systems should be provided for cable trays outside the cable spreading room. Cables should be designed to allow wetting down with deluge water without electrical faulting. Manual hose stations and portable hand extinguishers should be provided as backup. Safety related equipment in the vicinity of such cable trays, that does not itself require water fire protection, but is subject to unacceptable damage from sprinkler water discharge, should be protected from sprinkler system operation or malfunction. When safety related cables do not satisfy the provisions of Regulatory Guide 1.75, all exposed cables should be covered with an approved fire retardant coating and a fixed automatic water fire suppression system should be provided.	Automatic water sprinkler systems will be provided in areas of concentrated cable loading of redundant channels in accordance with the fire hazards analysis. Manual hose stations and portable hand extinguishers are provided as backup. Potential water damage will be considered where water sprays are used. Safety-related and balance-of-plant (BOP) cables are in compliance with IEEE 383/1974 for flame-retardant cable. This standard is referenced in Regulatory Guide 1.75. As addressed in UFSAR Subsection A.1.75, the noncompliance with Regulatory Guide 1.75 is in the identification of associated circuits only. (NOTE: For Exceptions, See Section 8.3.1.4.2)
(d)	Cable and cable tray penetration of fire barriers (vertical and horizontal) should be sealed to give protection at least equivalent to that fire barrier. The design of fire barriers for horizontal and vertical cable trays should, as a minimum, meet the requirements of ASTM E-119, "Fire Test of the Building Construction and Materials, "including the hose stream test, Where installed penetration seals are deficient with respect to fire resistance, these seals may be protected by covering both sides with an approved fire retardant material. The adequacy of using such material should be demonstrated by suitable testing.	Cable penetrations in fire barriers are sealed with silicone foam consistent with fire barrier fire resistance requirements.
(e)	Fire breaks should be provided as deemed necessary by the fire hazards analysis. Flame or flame retardant coatings may be used as a fire break for grouped electrical cables to limit spread of fire in cable ventings. (Possible cable derating owing to use of such coating materials must be considered during design.)	Fire breaks are provided where electrical cables penetrate walls and floors. Also, fire breaks are installed in cable trays of intervening combustibles. Instrument cable trays are enclosed solid-metal trays with covers which serve as radiant energy barriers.

	Position For Plants Under Construction and Operating Plants	EF-2 Response
(f)	Electric cable constructions should as a minimum pass the current IEEE No. 383flame test. (This does not imply that cables passing this test will not require additional fire protection.) For cable and plants under construction that do not meet the IEEE No. 383 flame test requirements, all cables must be covered with an approved flame-retardant coating and properly derated.	Safety-related and BOP cable* satisfies Edison Specification 3071-80 flame test requirements. This specification required a flame test setup on both ladder and solid bottom trays at a horizontal/vertical joint. The test used a 120,000 Btu, 14-in. wheel-type propane burner with a contact flame at 1500°F. Trays were loaded with a single layer of cable spread 1/2 diameter apart. On the ladder tray, the fire could not be self-propagating nor could the cable fail electrically after 5 minutes. On the solid bottom tray, the fire could not be self-propagating after 10 minutes of burner operation. In December 1988, Detroit Edison Specification 3071-080 was revised to require flame tests in accordance with IEEE 383-1974.
(g)	To the extent practical cable construction that does not give off gases while burning should be used. Applicable to new cable installations.	New cables will satisfy Edison Specification 3071-80 test requirements. (NOTE: For Exceptions, See Section 8.3.1.4.2)
(h)	Cable trays, raceways, conduit, trenches, or culverts should be used only for cables. Miscellaneous storage should not be permitted, nor should piping for flammable or combustible liquids or gases be installed in these areas. Installed equipment in cable tunnels or culverts, need not be removed if they present no hazard to the cable runs as determined by the fire hazards analysis.	This criterion is satisfied.
(i)	The design of cable tunnels, culverts and spreading rooms should provide for automatic or manual smoke venting as required to facilitate manual fire fighting capability.	The cable spreading areas are not provided with automatic or manual smoke venting. A low-pressure carbon dioxide system or Halon system is installed to provide extinguishment prior to generation of any appreciable amount of smoke. Portable fans would be used to exhaust smoke from affected areas.
(j)	Cables in the control room should be kept to the minimum necessary for operation of the control room. All cables entering the control room should terminate there. Cables should not be installed in floor trenches or culverts in the control room. Existing cabling installed in concealed floor and ceiling spaces should be protected with an automatic total flooding halon system.	Cables in the control room come from the cable spreading area and terminate in control panels, consoles, or equipment. However, some cabling is installed in the concealed floor of the computer area. An automatic Halon suppression system is provided for the protection of the concealed floor and the computer room.

Position For Plants Under Construction and Operating Plants	EF-2 Response
4. Ventilation	
(a) The products of combustion that need to be removed from a specific fire area should be evaluated to determine how they will be controlled. Smoke and corrosive gases should generally be automatically discharged directly outside to a safe location. Smoke and gases containing radioactive materials should be monitored in the fire area to determine if release to the environment is within the permissible limits of the plant Technical Specifications. The products of combustion which need to be removed from a specific fire area should be evaluated to determine how they will be controlled.	Ventilation for critical areas is evaluated in Sections 9A.2 and 9A.4 of this report. Areas having potential for release of radioactive material are also outlined. Monitoring of radioactive contamination is discussed in UFSAR Subsection 12.2.4.
(b) Any ventilation system designed to exhaust smoke or corrosive gases should be evaluated to ensure that inadvertent operation or single failures will not violate the controlled areas of the plant design. This requirement includes containment functions for protection of the public and maintaining habitability for operations personnel.	No systems are designed solely for smoke removal. Existing ventilation systems that would be used for smoke removal satisfy these criteria.
(c) The power supply and controls for mechanical ventilation systems should be run outside the fire area served by the system.	The power supply and controls for the mechanical ventilation systems used to cool redundant safe-shutdown equipment have been run in the same area as the applicable equipment. These controls satisfy the separation requirements
(d) Fire suppression systems should be installed to protect charcoal filters in accordance with Regulatory Guide 1.52, "Design Testing and Maintenance Criteria for Atmospheric Cleanup Air Filtration."	Charcoal filters are protected with manual deluge or carbon dioxide suppression systems.
(e) The fresh air supply intakes to areas containing safety related equipment or systems should be located remote from the exhaust air outlets and smoke vents of other fire areas to minimize the possibility of contaminating the intake air with the products of combustion.	Fresh air supply intakes are remotely located with respect to exhaust air outlets. Thus the possibility of contaminating the intake air with the products of combustion is minimized.

	Position For Plants Under Construction and Operating Plants	EF-2 Response
(f)	Stairwells should be designed to minimize smoke infiltration during a fire. Staircases should serve as escape routes and access routes for fire fighting. Fire exit routes should be clearly marked. Stairwells, elevators and chutes should be enclosed in masonry towers with minimum fire rating of three hours and automatic fire doors at least equal to the enclosure construction, at each opening into the building. Elevators should not be used during fire emergencies. Where stairwells or elevators cannot be enclosed in three hours fire rated barrier with equivalent fire doors, escape and access routes should be established by a pre-fire plan and practiced in drills by operating and fire brigade personnel.	Some of the stairwells are enclosed. (See the fire protection layout drawings attached to this report.) Stairwells serve as escape routes and access routes for fire fighting. Escape and access routes will be established by pre-fire plan and will be practiced in drills by operating and fire brigade personnel.
(g)	Smoke and heat vents may be useful in specific areas such as cable spreading rooms and diesel fuel oil storage areas and switchgear rooms. When natural-convection ventilation is used, a minimum ratio of 1 sq. foot of venting area per 200 sq feet of floor area should be provided. If forced-convection ventilation is used, 300 CFM should be provided for every 200 sq feet of floor area. See NFPA No. 204 for additional guidance on smoke control.	Natural convection heat venting of 1 ft^2 per 200 ft^2 is used in the turbine room floor area. Forced convection ventilation is provided in all other areas with a minimum design of one air change per hour. The control center smoke purge mode provides 250 cfm per 200 ft^2 floor area for the cable spreading room.

	Position For Plants Under Construction and Operating Plants	EF-2 Response
(h)	Self-contained breathing apparatus, using full face positive pressure masks, approved by NIOSH (National Institute for Occupational Safety and Health - approval formerly given by the U.S. Bureau of Mines) should be provided for fire brigade, damage control and control room personnel. Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir if practical. Service or operating life should be a minimum of one-half hour for the self-contained units. At least two extra air bottles should be located onsite for each self-contained breathing unit. In addition, an onsite 6-hour supply of reserve air should be provided and arranged to permit quick and complete replenishment of exhausted supply air bottles as they are returned. If compressors are used as a source of breathing air, only units approved for breathing air should be used. Special care must be taken to locate the compressor in areas free of dust and contaminants.	The plant will use full-face positive-pressure breathing masks, approved by NIOSH. Masks will be available for the fire brigade, damage control, or other control room personnel. The plant breathing air system provides a manifold on the south wall of the control room which will supply breathing air to five connection points. Each self-contained breathing unit will have at least two extra fully charged bottles onsite at all times. The plant will have an onsite air compressor for charging the breathing air bottles.
(i)	Where total flooding gas extinguishing systems are used, area intake and exhaust ventilation dampers should close upon initiation of gas flow to maintain necessary gas concentration. (See NFPA 12, "Carbon Dioxide Systems," and 12A, "Halon 1301 Systems.")	Where required, ventilation dampers close on actuation of gaseous extinguishing systems to maintain the necessary gas concentration.
5.	Lighting and Communication Lighting and two way voice communication are vital to safe shutdown and emergency response in the event of fire. Suitable fixed and portable emergency lighting and communication devices should be provided to satisfy the following requirements:	
(a)	Fixed emergency lighting should consist of sealed beam units with individual 8-hour minimum battery power supplies.	Fixed emergency lighting with 8-hr battery power supplies is provided for the control room, safety-related equipment areas, and means of egress except in the yard area route to the residual heat removal (RHR) complex where yard security lights are used to provide a lighted pathway.
(b)	Suitable sealed beam battery powered portable hand lights should be provided for emergency use.	Automatically operated, sealed-beam battery-powered lights and sealed-beam battery-powered portable hand lights will be provided for emergency use.

		Position For Plants Under Construction and Operating Plants	EF-2 Response
	(c)	Fixed emergency communication should use voice powered head sets at preselected stations.	Emergency communications capability is provided by telephones, public address systems, and radio communications equipment powered from redundant power sources.
	(d)	Fixed repeaters installed to permit use of portable radio communication units should be protected from exposure to fire damage.	Repeater stations are installed to improve the quality of radio communication. Loss of a particular repeater will not result in a loss of communication capability in the area adjacent to the repeater.
e.	Fire Detection and Suppression		
1.	Fire Detection		
	(a)	Fire detection systems should as a minimum comply with NFPA 72D, "Standard for the Installation Maintenance and Use of Proprietary Protective Signaling Systems." Deviations from the requirements of NFPA 72D should be identified and justified.	Fire detection systems were installed using NFPA 72D as guidance. No recorder is provided in the main control room. This deviation has been approved because adequate records are kept.
	(b)	Fire detection system should give audible and visual alarm and annunciation in the control room. Local audible alarms should also sound at the location of the fire.	Plant fire detectors will alarm in the control room on the fire protection control panel that will designate general fire location (detector subpanels). Local alarms will sound at the sub-panels that will pinpoint individual room and/or detector location.
	c)	Fire alarms should be distinctive and unique. They should not be capable of being confused with any other plant system alarms.	Fire alarms will be distinctive and unique and should not be confused with any other plant system alarms.
	(d)	Fire detection and actuation systems should be connected to the plant emergency power supply.	Fire detection and actuation systems are connected to the plant emergency power supply.
2.	Fire Protection Water Supply Systems		
	(a)	An underground yard fire main loop should be installed to furnish anticipated fire water requirements. NFPA 24 - Standard for Outside Protection - gives necessary guidance for such installation. It references other design codes and standards developed by such organizations as the American National Standards Institute (ANSI) and the American Water Works Association (AWWA). Lined steel or cast iron pipe should be used to reduce internal tuberculation. Such tuberculation deposits in an unlined pipe over a period of years can significantly reduce water flow through the	The underground yard fire main loop was installed using NFPA 24 for guidance. Subsection 9.5.1.2.1 of the UFSAR gives a detailed description of the system. Underground carbon steel pipe is coated, wrapped and provided with cathodic protection. Above-ground pipe is carbon steel. Flushing is accomplished using Fire hydrants. No means for treatment is available. Sectional control valves (post indicator valves) are provided to isolate portions of the fire main for maintenance or repair without shutting down the entire system. Position indicators are provided with the sectional control valves. Branch lines outside the protected area

	Position For Plants Under Construction and Operating Plants	EF-2 Response
	combination of increased friction and reduced pipe diameter. Means for treating and flushing the systems should be provided. Approved visually indicating sectional control valves, such as Post Indicator Valves, should be provided to isolate portions of the main for maintenance or repair without shutting off the entire system. Visible location marking signs for underground valves is acceptable. Alternative valve position indicators should also be provided.	include coated, wrapped and cathodically protected carbon steel, cement lined ductile iron, asbestos-cement and poly vinyl chloride pipe.
	The fire main system piping should be separate from service or sanitary water system piping. For operating plants, fire main system piping that can be isolated from service or sanitary water system piping is acceptable.	The fire main system piping is connected to the general service water system. Isolation valves are provided.
(b)	A common yard fire main loop may serve multi-unit nuclear power plant sites, if cross-connected between units. Sectional control valves should permit maintaining independence of the individual loop around each unit. For such installations, common water supplies may also be utilized. The water supply should be sized for the largest single expected flow. For multiple reactor sites with widely separated plants (approaching 1 mile or more), separate yard fire main loops should be used. Sectionalized systems are acceptable.	N/A
(c)	If pumps are required to meet system pressure or flow requirements, a sufficient number of pumps should be provided so that 100% capacity will be available with one pump inactive (e.g., three 50% pumps, two 100% pumps). The connection to the yard fire main loop from each fire pump should be widely separated, preferably located on opposite sides of the plant. Each pump should have its own driver with independent power supplies and control. At least one pump (if not powered from the emergency diesels) should be driven by non-electrical means, preferably diesel engine. Pumps and drivers should be located in rooms separated from the remaining pumps and equipment by a minimum three-hour fire wall. Alarms indicating pump running, driver availability, or failure to start should be provided in the control room.	Two fire pumps (2500 gpm at 150 psig; one diesel driven and one electric motor driven) are provided for the plant. Connections to the yard fire main loop are 2.68 ft apart. The diesel-driven fire pump is separated from the electric-motor-driven fire pump by a 3-hr-rated fire barrier in the general service water pump house. Alarms indicating pump running, driver availability, and failure to start are provided in the control room.

	Position For Plants Under Construction and Operating Plants	EF-2 Response
	Details of the fire pump installation should as a minimum conform to NFPA 20, "Standard for the Installation of Centrifugal Fire Pumps."	The fire pump installation conforms to the intent of NFPA 20, except for certain deviations, with supporting justifications, identified in section 9.5.1.2.3.2.
(d)	Two separate reliable water supplies should be provided. If tanks are used, two 100% (minimum of 300,000 gallons each) system capacity tanks should be installed. They should be so interconnected that pumps can take suction from either or both. However, a leak in one tank or its piping should not cause both tanks to drain.	Water supply is from Lake Erie.
	The main plant fire water supply capacity should be capable of refilling either tank in a minimum of eight hours. Common tanks are permitted for fire and sanitary or service water storage. When this is done, however, minimum fire water storage requirements should be dedicated by means of a vertical standpipe for other water services.	N/A
(e)	The fire water supply (total capacity and flow rate) should be calculated on the basis of the largest expected flow rate for a period of two hours, but not less than 300,000 gallons. This flow rate should be based (conservatively) on 1,000 gpm for manual hose streams plus the greater of: (1) all sprinkler heads opened and flowing in the largest designed fire area; or (2) the largest open head deluge system(s) operating.	The maximum flow demand is estimated to be less than 1500 gpm to the most remote deluge system, plus 500 gpm for manual hose streams. A single pump is designed to operate at 150 percent of rated capacity and provide 3750 gpm. The capabilities of the Diesel Fire Pump and diesel engine driver are described in section 9.5.1.2.3.2.
(f)	Lakes or fresh water ponds of sufficient size may qualify as sole source of water for fire protection, but require at least two intakes to the pump supply. When a common water supply is permitted for fire protection and the ultimate heat sink, the following conditions should also be satisfied:	Lake Erie is the source of fire service water.
	(1) The additional fire protection water requirements are designed into the total storage capacity; and	N/A
	(2) Failure of the fire protection system should not degrade the function of the ultimate heat sink.	N/A
(g)	Outside manual hose installation should be sufficient to reach any location with an effective hose stream. To accomplish this	Fire hydrants are located not more than 300 ft apart around the perimeter of the plant. The lateral to each fire hydrant is provided with a

Position For Plants Under Construction and Operating Plants	EF-2 Response
hydrants should be installed approximately every 250 feet on the yard main system. The lateral to each hydrant from the yard main should be controlled by a visually indicating or key operated (curb) valve. A hose house, equipped with hose and combination nozzle, and other auxiliary equipment recommended in NFPA 24, "Outside Protection," should be provided as needed but at least every 1,000 feet.	valve. The system is designed so that the sectional control valves (post-indicator valves) can isolate one, two, or three fire hydrants. Selected fire hydrants are provided with hose houses which contain 250 ft of 2-1/2 in. hose, 200 ft of 1-1/2 in. hose, combination fog nozzle, and auxiliary equipment, as deemed necessary.
Threads compatible with those used by local fire departments should be provided on all hydrants, hose couplings and standpipe risers.	The thread size used on hydrants, hose couplings, and standpipe risers is compatible with the Frenchtown Township Fire Department.
3. Water Sprinklers and Hose Standpipe Systems	
(a) Each automatic sprinkler system and manual hose station standpipe should have an independent connection to the plant underground water main. Headers fed from each end are permitted inside buildings to supply multiple sprinkler and standpipe systems. When provided, such headers are considered an extension of the yard main system. The header arrangement should be such that no single failure can impair both the primary and backup fire protection systems.	Underground connections are provided to various buildings to supply standpipe and sprinkler systems as shown on Figure 9A-1. Headers fed from both ends are not provided in the buildings. In the reactor/auxiliary building, two connections (feeds) are provided from the plant underground water main. All standpipes are fed from one connection; all sprinkler systems are fed from the other connection. Isolation valves are provided to separate the primary (automatic) sprinkler systems from the secondary (standpipe) systems.
Each sprinkler and standpipe system should be equipped with OS&Y (outside screw and yoke) gate valve, or other approved shut off valve, and water flow alarm. Safety related equipment that does not itself require sprinkler water fire protection, but is subject to unacceptable damage if wetted by sprinkler water discharge should be protected by water shields or baffles.	Each sprinkler and standpipe system is equipped with an OS&Y gate valve. Each sprinkler system is equipped with a water flow alarm. Standpipe systems are equipped with a water flow alarm. Safety-related equipment has been protected from water damage.
(b) All valves in the fire water systems should be electrically supervised. The electrical supervision signal should indicate in the control room and other appropriate command locations in the plant. (See NFPA 26, "Supervision of Valves.") When electrical supervision of fire protection valves is not practicable, an adequate management supervision program should be provided. Such a program should include locking valves open with strict key control; tamper proof seals; and periodic, visual check of all valves.	Shutoff valves controlling sprinkler and deluge systems are electrically supervised and actuate alarms in the control room or other normally manned security area. Sectional and divisional valves of the underground fire main and major valves inside the building will be locked open. Routine fire inspection by the plant operations engineer delegate will check valve positions, status, and seals.

	Position For Plants Under Construction and Operating Plants	EF-2 Response
(c)	Automatic sprinkler systems should as a minimum conform to requirements of appropriate standards such as NFPA 13, "Standard for the Installation of Sprinkler Systems," and NFPA 15, "Standard for Water Spray Fixed Systems."	Sprinkler systems throughout the plant were installed using NFPA 13 and/or NFPA 15 for guidance. Certain noncompliances to NFPA 13 have been evaluated in accordance with Generic Letter 86-10 and are referenced in section 9.5.1.1.2.
(d)	Interior manual hose installation should be able to reach any location with at least one effective hose stream. To accomplish this, standpipes with hose connections equipped with a maximum of 75 feet of 1-1/2 inch woven jacket lined fire hose and suitable nozzles should be provided in all buildings, including containment, on all floors and should be spaced at not more than 100-foot intervals. Individual standpipes should be at least 4-inch diameter for multiple hose connections and 2-1/2-inch diameter for single hose connections. These systems should follow the requirements of NFPA No. 14 for sizing, spacing and pipe support requirements (NELPIA).	Hose reels are provided throughout the plant as indicated on the fire protection layout drawings. Fire hose is approved 1-1/2 in. lined hose. Individual standpipes are 4-in.-diameter for multiple hose connections and 2-1/2-in.-diameter for single hose connections. NFPA 14 was used for guidance for sizing, spacing, and pipe supports.
	Hose stations should be located outside entrances to normally unoccupied areas and inside normally occupied areas. Standpipes serving hose stations in areas housing safety-related equipment should have shutoff valves and pressure-reducing devices (if applicable) outside the area.	Hose stations are mainly located outside entrances to normally unoccupied areas. Shutoff valves are provided at each hose station where required. Pressure-reducing devices are provided on the 5th floor of the reactor building and below grade, 583 ft 6 in., due to excessive system pressure. Since fog nozzles, which act as effective pressure-reducing devices, are used throughout the remainder of the plant and since fire brigade members who use the hose stations are trained to use the higher outlet pressures in excess of 100 psi, pressure-reducing devices are not provided elsewhere.
(e)	The proper type of hose nozzles to be supplied to each area should be based on the fire hazard analysis. The usual combination spray/straight-stream nozzle may cause unacceptable mechanical damage (for example, the delicate electronic equipment in the control room) and be unsuitable. Electrically safe nozzles should be provided at locations where electrical equipment or cabling is located.	All areas are provided with adjustable pattern fog nozzles, except for the refueling floor, which has solid stream nozzles. Personnel are adequately trained to make proper use of hose stations.
(f)	Certain fires such as those involving flammable liquids respond well to foam suppression. Consideration should be given to use of any of the available foams for such	There are no major flammable liquid hazards in the plant. Areas involving combustible liquids are adequately protected with a sprinkler or deluge system.

Position For Plants Under Construction and Operating Plants	EF-2 Response
specialized protection application. These include the more common chemical and mechanical low expansion foams, high expansion foam and the relatively new aqueous film forming foam (AFFF).	
4. Halon Suppression Systems	
The use of Halon fire extinguishing agents should as a minimum comply with the requirements of NFPA 12A and 12B, "Halogenated Fire Extinguishing Agent Systems-Halon 1301 and Halon 1211." Only UL or FM approved agents should be used.	NFPA 12A was used for guidance for the Installation of Halon systems.
In addition to the guidelines of NFPA 12A and 12B, preventative maintenance and testing of the systems, including check weighing of the Halon cylinders should be done at least quarterly. Particular consideration should also be given to:	Liquid level measurement of the cylinders and testing of the system will conform to the fire protection conditions for operation, Section 9A.6.
(a) minimum required Halon concentration and soak time (b) toxicity of Halon (c) toxicity and corrosive characteristics of thermal decomposition products of Halon.	Consideration will be given to items (a), (b), and (c).
5. Carbon Dioxide Suppression Systems	
The use of carbon dioxide extinguishing systems should as a minimum comply with the requirements of NFPA 12, "Carbon Dioxide Extinguishing Systems."	Carbon dioxide systems are provided for protection of certain cable tray areas outside the control center complex, the EDG rooms, and SGTS charcoal filters. The carbon dioxide systems are designed using NFPA Standard 12 for guidance.
Particular consideration should also be given to: (a) minimum required CO_2 concentration and soak time; (b) toxicity of CO_2; (c) possibility of secondary thermal shock (cooling) damage; (d) offsetting requirements for venting during CO_2 injection to prevent over-pressurization versus sealing to prevent loss of agent; (e) design requirements from over-pressurization; and (f) possibility and probability of CO_2 systems being out-of-service because of personnel safety consideration. CO_2 systems are disarmed whenever people are present in an area so protected. Areas entered frequently (even though duration time for any visit is short) have often been found with CO_2 systems shut off.	Consideration has been given to items (a) through (f).

Position For Plants Under Construction and Operating Plants	EF-2 Response
6. Portable Extinguishers	
Fire extinguishers should be provided in accordance with guide lines of NFPA 10 and 10A, "Portable Fire Extinguishers, Installation, Maintenance and Use." Dry chemical extinguishers should be installed with due consideration given to cleanup problems after use and possible adverse effects on equipment installed in the area.	Portable fire extinguishers are provided using NFPA 10 as guidance.
F. Guidelines for Specific Plant Areas	
1. Primary and Secondary Containment	
(a) Normal Operation	
Fire protection requirements for the primary and secondary containment areas should be provided on the basis of specific identified hazards. For example: a. Lubricating oil or hydraulic fluid system for the primary coolant pumps b. Cable tray arrangements and cable penetrations c. Charcoal filters	
Fire suppression systems should be provided based on the fire hazards analysis. Fixed fire suppression capability should be provided for hazards that could jeopardize safe plant shutdown. Automatic sprinklers are preferred. An acceptable alternate is automatic gas (Halon or CO_2) for hazards identified as requiring fixed suppression protection. An enclosure may be required to confine the agent if a gas system is used. Such enclosure should not adversely affect safe shutdown, or other operating equipment in containment. Automatic fire suppression capability need not be provided in the primary containment atmospheres that are inerted during normal operation. However, special fire protection requirements during refueling and maintenance operations should be satisfied as provided below.	The fire hazards analysis outlines the protection for containment areas.

Position For Plants Under Construction and Operating Plants	EF-2 Response
(b) Refueling and Maintenance	
Refueling and maintenance operations in containment may introduce additional hazards such as contamination control materials, decontamination supplies, wood planking, temporary wiring, welding and flame cutting (with portable compressed fuel gas supply). Possible fires would not necessarily be in the vicinity of fixed detection and suppression systems. Management procedures and controls necessary to assure adequate fire protection are discussed in Section 3a. In addition, manual fire fighting capability should be permanently installed in containment. Standpipes with hose stations, and portable fire extinguishers, should be installed at strategic locations throughout containment for any required manual fire fighting operations. Equivalent protection from portable systems should be provided if it is impractical to install standpipes with hose stations. Adequate self-contained breathing apparatus should be provided near the containment entrances for fire fighting and damage control personnel. These units should be independent of any breathing apparatus or air supply systems provided for general plant activities	It is impractical to provide a standpipe system inside the plant Mark I containment. During refueling, portable extinguishers and self-contained breathing apparatus will be located outside primary containment and portable extinguishers will be located inside containment at various work locations. Hose stations with hose reels are located nearby in the reactor building.
2. Control Room	
The control room is essential to safe reactor operation. It must be protected against disabling fire damage and should be separated from other areas of the plant by floors, walls and roofs having minimum fire resistance ratings of three hours.	The control room is separated from other areas of the plant by fire rated floor, walls, and ceiling. Section 9A.4 discusses fire-resistance ratings of these barriers and outlines the protection for the control room.
Control room cabinets and consoles are subject to damage from two distinct fire hazards: (a) Fire originating within a cabinet or console; and (b) Exposure fire involving combustibles in the general room area	
Hose stations adjacent to the control room with portable extinguishers in the control room are acceptable.	A hose station is provided adjacent to the control room. Fire extinguishers are provided adjacent to or in the control room.
Nozzles that are compatible with the hazards and equipment in the control room should be provided for the manual hose station. The nozzles chosen should satisfy actual fire fighting needs, satisfy electrical safety and minimize physical damage to electrical equipment from hose stream impingement.	Adjustable pattern fog nozzles are provided. Personnel are trained in their safe use.

Position For Plants Under Construction and Operating Plants	EF-2 Response
Fire detection in the control room cabinets, and consoles should be provided by smoke and heat detectors in each fire area. Alarm and annunciation should be provided in the control room. Fire alarms in other parts of the plant should also be alarmed and annunciated in the control room.	Ionization detectors are provided in the ceiling of the room as well as in the control room cabinets and consoles. Additional protection is outlined in the fire hazards analysis. Fire alarms in other plant locations are annunciated and actuate alarms in the control room.
Breathing apparatus for control room operators should be readily available. Control room floors, ceilings, supporting structures, and walls, including penetrations and doors, should be designed to a minimum fire rating of three hours. All penetration seals should be air tight.	Breathing apparatus for the control room operators will be readily available in the control room. Control room floors, ceiling, supporting structures, and walls, including penetrations and doors, are fire rated as discussed in Section 9A.4. All penetration seals will be airtight.
Manually operated ventilation systems are acceptable.	The ventilation system will automatically be placed in the smoke purge mode by confirmed activation of the Halon system in the cable spreading room or relay room. The smoke purge mode can also be manually initiated.
Cables should not be located in concealed floor and ceiling spaces. If such concealed spaces are used, however, they should have fixed automatic total flooding halon protection. All cables that enter the control room should terminate in the control room. That is, no cabling should be simply routed through the control room from one area to another.	The concealed space beneath the computer room subfloor will be provided with a Halon system.
3. Cable Spreading Room	
(a) The preferred acceptable methods are:	
(1) Automatic water system such as closed head sprinklers, open head deluge, or open directional spray nozzles.	The cable spreading room is protected by an automatic Halon system.
Deluge and open spray systems should have provisions for manual operation at a remote station; however, there should also be provisions to preclude inadvertent operation. Location of sprinkler heads or spray nozzles should consider cable tray sizing and Arrangements to assure adequate water coverage. Cable should be designed to allow wetting down with deluge water without electrical faulting. Open head deluge and open directional spray systems should be zoned so that a single failure will not deprive the entire area of automatic fire suppression capability. The use of foam is acceptable, provided it is of a type capable of being delivered by a sprinkler or deluge system, such as an Aqueous Film Forming Foam (AFFF).	In addition, a manually actuated automatic sprinkler system is installed for backup capability.

Position For Plants Under Construction and Operating Plants	EF-2 Response
(2) Manual hoses and portable extinguishers should be provided as backup.	Manual hose and portable fire extinguishers are provided.
(3) Each cable spreading room of each unit should have divisional cable separation, and be separated from the other and the rest of the plant by a minimum three-hour rated fire wall (refer to NFPA 251 or ASTM E-119 for fire test resistance rating).	Section 9A.4 discusses the fire rating of barriers
(4) At least two remote and separate entrances are provided to the room for access by fire brigade personnel; and	Two remote entrances are provided to the room. (See Figure 9A-7.)
(5) Aisle separation provided between tray stacks should be at least three feet wide and eight feet high.	Aisles 3 ft wide and 8 ft high are not provided.
(b) For cable spreading rooms that do not provide divisional cable separation of a(3), in addition to meeting a(1), (2), (4), and (5) above, the following should also be provided:	Cable separation has been provided adequately to permit safe plant shutdown in case of a fire in the cable spreading room. See Subsection 9A.4.2.8.
(1) Divisional cable separation should meet the guidelines of Regulatory Guide 1.75, "Physical Independence of Electric Systems."	
(2) All cabling should be covered with a suitable fire retardant coating.	
(3) As an alternate to a(1) above, automatically initiated gas systems (Halon or CO_2) may be used for primary fire suppression, provided a fixed water system is used as a backup.	
(4) Plants that cannot meet the guidelines of Regulatory Guide 1.75, in addition to meeting a(1), (2), (4), and (5) above, an auxiliary shutdown system with all cabling independent of the cable spreading room should be provided.	
4. Plant Computer Room	
Safety related computers should be separated from other areas of the plant by barriers having a minimum three-hour fire resistant rating. Automatic fire detection should be provided to alarm and annunciate in the control room and alarm locally. Manual hose stations and portable water and halon fire extinguishers should be provided.	Plant computers are not safety related.

Position For Plants Under Construction and Operating Plants	EF-2 Response
5. Switchgear Rooms	
Switchgear rooms should be separated from the remainder of the plant by minimum three-hour rated fire barriers to the extent practicable. Automatic fire detection should alarm and annunciate in the control room and alarm locally. Fire hose stations and portable extinguishers should be readily available.	Safety-related switchgear rooms are separated from the remainder of the plant by walls, floors, and ceilings which have fire-resistant barriers. (See Section 9A.4, which discusses the fire rating of the barriers.) Automatic fire detection devices, which actuate alarms and annunciate in the control room, are provided. Fire hose and portable fire extinguishers are readily available.
Acceptable protection for cables that pass through the switchgear room is automatic water or gas agent suppression. Such automatic suppression must consider preventing unacceptable damage to electrical equipment and possible necessary containment of agent following discharge.	
6. Remote Safety Related Panels	
The general area housing remote safety related panels should be provided with automatic fire detectors that alarm locally and alarm and annunciate in the control room. Combustible materials should be controlled and limited to those required for operation. Portable extinguishers and manual hose stations should be provided.	Areas housing remote safety-related panels are provided with automatic fire detectors that alarm in the control room. Combustible materials are controlled in these areas. Manual fire suppression equipment is provided for these areas. The fire hazards analysis details these areas.
7. Station Battery Rooms	
Battery rooms should be protected against fire explosions. Battery rooms should be separated from each other and other areas of the plant by barriers having a minimum fire rating of three hours inclusive of all penetrations and openings. (See NFPA 69, "Standard on Explosion Prevention Systems.") Ventilation systems in the battery rooms should be capable of maintaining the hydrogen concentration well below 2 vol. % hydrogen concentration. Standpipe and hose and portable extinguishers should be provided.	The battery rooms are separated from other areas by at least 1-1/2 hr fire-resistance-rated walls, floors, and ceiling. The fire hazards analysis outlines the protection provided for these areas. The ventilation system will maintain the hydrogen concentration well below 2 percent by volume. Portable fire extinguishers and a hose reel are provided.
Alternatives:	
(a) Provide a total fire rated barrier enclosure of the battery room complex that exceeds the fire load contained in the room.	
(b) Reduce the fire load to be within the fire barrier capability of 1-1/2 hours.	
OR	
(c) Provide a remote manual actuated sprinkler	

Position For Plants Under Construction and Operating Plants	EF-2 Response
system in each room and provide the 1-1/2 hour fire barrier separation.	
8. Turbine Lubrication and Control Oil Storage and Use Areas	
A blank fire wall having a minimum resis-tance rating of three hours should separate all areas containing safety related systems and equipment from the turbine oil system. When a blank wall is not present, open head deluge protection should be provided for the turbine oil hazards and automatic open head water curtain protection should be provided for wall openings.	N/A
9. Diesel Generator Areas	
Diesel generators should be separated from each other and other areas of the plant by fire barriers having a minimum fire resistance rating of three hours.	Emergency diesel generators of opposite divisions are separated by a 3-hr fire barrier.
When day tanks cannot be separated from the diesel-generator one of the following should be provided for the diesel generator area:	Day tanks are separated from the diesel generator by 3-hr fire barrier walls. The day tanks are also protected by a wet pipe sprinkler system.
(a) Automatic open head deluge or open head spray nozzle system(s)	
(b) Automatic closed head sprinklers	
(c) Automatic AFFF that is delivered by a sprinkler deluge or spray system	
(d) Automatic gas system (Halon or CO_2) may be used in lieu of foam or sprinklers to combat diesel generator and/or lubricating oil fires.	
10. Diesel Fuel Oil Storage Areas	
Diesel fuel oil tanks with a capacity greater than 1100 gallons should not be located inside the buildings containing safety related equipment. They should be located at least 50 feet from any building containing safety related equipment, or if located within 50 feet, they should be housed in a separate building with construction having a minimum fire resistance rating of three hours. Buried tanks are considered as meeting the three hour fire resistance requirements. See NFPA 30, "Flammable and Combustible Liquids Code," for additional guidance.	Diesel fuel-oil tanks are separated from the EDG by construction having a 3-hr fire-resistance rating. The fire hazards analysis (Section 9A.4) discusses the diesel fuel storage room fire protection.

Position For Plants Under Construction and Operating Plants	EF-2 Response
When located in a separate building, the tank should be protected by an automatic fire suppression system such as AFFF or sprinklers.	
In operating plants where tanks are located directly above or below the diesel generators and cannot reasonably be moved, separating floors and main structural members should, as a minimum, have fire resistance rating of three hours. Floors should be liquid tight to prevent leaking of possible oil spills from one level to another. Drains should be provided to remove possible oil spills and fire fighting water to a safe location.	
One of the following acceptable methods of fire protection should also be provided: (a) Automatic open head deluge or open head spray nozzle system(s) (b) Automatic closed head sprinklers; or (c) Automatic AFFF that is delivered by a sprinkler system or spray system	
11. Safety Related Pumps	
Pump houses and rooms housing safety related pumps should be protected by automatic sprinkler protection unless a fire hazards analysis can demonstrate that a fire will not endanger other safety related equipment required for safe plant shutdown. Early warning fire detection should be installed with alarm and annunciation locally and in the control room. Local hose stations and portable extinguishers should also be provided.	The fire hazards analysis outlines fire protection for safety-related pumps.
Equipment pedestals or curbs and drains should be provided to remove and direct water away from safety related equipment.	Equipment is installed on concrete pads. Adequate water drainage is provided.
Provisions should be made for manual control of the ventilation system to facilitate smoke removal if required for manual fire fighting operation.	Smoke removal will be provided by portable fans, if required.
12. New Fuel Area	
Hand portable extinguishers should be located within this area. Also, local hose stations should be located outside but within hose reach of this area. Automatic fire detection should alarm and annunciate in the control room and alarm locally. Combustibles should be limited to a minimum in the new fuel area. The storage area should be provided with a drainage system to preclude accumulation of water.	Manual suppression equipment, such as hose stations and portable fire extinguishers, is provided. Automatic fire detection is provided.
The storage configuration of new fuel should always be so maintained as to preclude criticality for any	

Position For Plants Under Construction and Operating Plants	EF-2 Response
water density that might occur during fire water application.	
13. Spent Fuel Pool Area	
Protection for the spent fuel pool area should be provided by local hose stations and portable extinguishers. Automatic fire detection should be provided to alarm and annunciate in the control room and to alarm locally.	Manual suppression equipment, such as hose stations and portable fire extinguishers, is provided. Automatic detection is provided.
14. Radwaste Building	
The radwaste building should be separated from other areas of the plant by fire barriers having at least three-hour ratings. Automatic sprinklers should be used in all areas where combustible materials are located. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally. During a fire, the ventilation systems in these areas should be capable of being isolated. Water should drain to liquid radwaste building sumps. Acceptable alternative fire protection is automatic fire detection to alarm and annunciate in the control room, in addition to manual hose stations and portable extinguishers consisting of hand held and large wheeled units.	Except as noted in section 9A.4.4.2, the radwaste building is separated from the turbine building by fire barriers having a 3-hr fire-resistance rating. For a discussion of the onsite storage building, see Section 11.7 of the UFSAR. Automatic sprinklers are provided as discussed in Subsection 9A.4.4. Automatic fire detection annunciates and alarms in the control room. The ventilation system can be isolated during a fire. The building water drains are discussed in Section 9A.4.4.2
15. Decontamination Areas	
The decontamination areas should be protected by automatic sprinklers if flammable liquids are stored. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally. The ventilation system should be capable of being isolated. Local hose stations and hand portable extinguishers should be provided as backup to the sprinkler system.	No significant quantity of flammable liquids is stored in the decontamination areas. Automatic fire detection alarms and annunciates in the control room. Hose stations and portable extinguishers are provided.
16. Safety Related Water Tanks	
Storage tanks that supply water for safe shutdown should be protected from the effects of fire. Local hose stations and portable extinguishers should be provided. Portable extinguishers should be located in nearby hose houses. Combustible materials should not be stored next to outdoor tanks. A minimum of 50 feet of separation should be provided between outdoor tanks and combustible materials where feasible.	Subsection 9A.4.7 of the fire hazards analysis outlines the protection for this area.

Position For Plants Under Construction and Operating Plants	EF-2 Response
17. Cooling Towers	
Cooling towers should be of noncombustible construction or so located that a fire will not adversely affect any safety related systems or equipment. Cooling towers should be of non-combustible construction when the basins are used for the ultimate heat sink or for the fire protection water supply. Cooling towers of combustible construction, so located that a fire in them could adversely affect safety related systems or equipment should be protected with an open head deluge system installation with hydrants and hose houses strategically located.	Residual heat removal cooling towers are of noncombustible construction. Circulating water cooling towers are located such that a fire will not affect safety related equipment.
18. Miscellaneous Areas	
Miscellaneous areas such as records storage areas, shops, warehouses, and auxiliary boiler rooms should be so located that a fire or effects of a fire, including smoke, will not adversely affect any safety related systems or equipment. Fuel oil tanks for auxiliary boilers should be buried or provided with dikes to contain the entire tank contents.	The record storage areas, shops, outage building and warehouse are separated from safety-related systems or equipment by fire barriers. Therefore, fire or smoke would not affect safety-related systems or equipment. The fuel-oil tank for the auxiliary boiler is provided with a dike.
G. Special Protection Guidelines	
1. Welding and Cutting, Acetylene-Oxygen Fuel Gas Systems	
This equipment is used in various areas throughout the plant. Storage locations should be chosen to permit fire protection by automatic sprinkler systems. Local hose stations and portable equipment should be provided as backup. The requirements of NFPA 51 and 51B are applicable to these hazards. A permit system should be required to utilize this equipment. (Also refer to 2f herein.)	Storage of welding and cutting acetylene-oxygen gas bottles will be in the warehouse areas protected by automatic sprinklers. A permit system is used to control open flames in the plant as explained previously in Section B.3(a).
2. Storage Areas for Dry Ion ExchangeResins	
Dry ion exchange resins should not be stored near essential safety related systems. Dry unused resins should be protected by automatic wet pipe sprinkler installations. Detection by smoke and heat detectors should alarm and annunciate in the control room and alarm locally. Local hose stations and portable extinguishers should provide backup for these areas. Storage areas of dry resin should have curbs and drains. (Refer to NFPA 92M, "Waterproofing and Draining of Floors.")	Dry ion exchange resins will be stored in the warehouse which is removed from safety-related areas and protected by an automatic wet pipe sprinkler system. The warehouse area is also provided with a fire detector system that provides local and control room alarms. Local hose stations and portable extinguishers are provided in the warehouse as backup to the sprinkler system. A curb and drain system is not necessary in the warehouse as the entire area is sprinkled.

Position For Plants Under Construction and Operating Plants	EF-2 Response
3. Hazardous Chemicals	
Hazardous chemicals should be stored and protected in accordance with the recommendations of NFPA 49, "Hazardous Chemicals Data." Chemicals storage areas should be well ventilated and protected against flooding conditions since some chemicals may react with water to produce ignition.	Minor amounts of hazardous chemicals may be stored in the laboratory or shop areas. NFPA 49, "Hazardous Chemicals Data," is used as a guideline for storage. Portable extinguishers and hose stations are provided in these areas.
4. Materials Containing Radioactivity	
Materials that collect and contain radioactivity such as spent ion exchange resins, charcoal filters, and HEPA filters should be stored in closed metal tanks or containers that are located in areas free from ignition sources or combustibles. These Materials should be protected from exposure to fires in adjacent areas as well. Consideration should be given to requirements for removal of isotopic decay heat from entrained radioactive materials.	Materials that collect and contain radioactivity are stored in the radwaste area until processed. Spent resins are stored (wet) in the phase separator tanks until processed. Spent charcoal filter material and HEPA filters will be stored in metal containers in the radwaste bailed waste storage room. This room removes the material from other areas of the radwaste building. This area is provided with fire detectors.

9A.6 FIRE PROTECTION CONDITIONS FOR OPERATION

The Fire Protection Conditions For Operation portion of Appendix 9A is in the Technical Requirements Manual.

Figure Intentionally Removed
Refer to Plant Drawing A-2400

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-1

FIRE PROTECTION EVALUATION PLOT PLAN

Figure Intentionally Removed
Refer to Plant Drawing A-2401

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-2

FIRE PROTECTION EVALUATION
REACTOR BUILDING SUBBASEMENT PLAN
(ELEVATION 540.0 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-2402

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-3

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
BASEMENT PLAN (ELEVATION 562.0 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-2403

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-4

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
FIRST FLOOR PLAN
ELEVATION 583.5 FT

Figure Intentionally Removed
Refer to Plant Drawing A-2404

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-5

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
CABLE TRAY AREA PLAN (ELEVATION 603.5 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-2405

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-6

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
SECONG FLOOR PLAN (ELEVATION 613.5 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-2406

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-7

**FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
CABLE SPREADING AREA PLAN
(ELEVATION 630.5 FT)**

Figure Intentionally Removed
Refer to Plant Drawing A-2407

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-8

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
THIRD FLOOR PLAN
ELEVATION 641.5 FT AND 643.5 FT

Figure Intentionally Removed
Refer to Plant Drawing A-2408

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-9

**FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
FOURTH FLOOR (ELEVATION 659.5 FT)**

Figure Intentionally Removed
Refer to Plant Drawing A-2409

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-10

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
FIFTH FLOOR PLAN
(ELEVATIONS 677.5 FT AND 684.5 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-2410

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-11

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
ROOF PLAN (ELEVATION 697.5 FT AND 735.5 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-2411

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-12

FIRE PROTECTION EVALUATION
REACTOR AND AUXILIARY BUILDINGS
SECTION D-D

Figure Intentionally Removed
Refer to Plant Drawing A-N-2040

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-13

FIRE PROTECTION EVALUATION
RESIDUAL HEAT REMOVAL COMPLEX
BASEMENT FLOOR PLAN (ELEVATION 554.25 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-N-2041

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-14

FIRE PROTECTION EVALUATION
RESIDUAL HEAT REMOVAL COMPLEX
GRADE FLOOR PLAN (ELEVATION 590.0 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-N-2042

Fermi 2

UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-15

FIRE PROTECTION EVALUATION
RESIDUAL HEAT REMOVAL COMPLEX
UPPER FLOOR PLAN (ELEVATION 617.0 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-N-2043

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-16

FIRE PROTECTION EVALUATION
RESIDUAL HEAT REMOVAL COMPLEX
ROOF PLAN (ELEVATIONS 617.0 FT AND 637.0 FT)

Figure Intentionally Removed
Refer to Plant Drawing A-N-2044

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-17

**FIRE PROTECTION EVALUATION
RESIDUAL HEAT REMOVAL COMPLEX
SECTION A-A AND SECTION B-B**

Figure Intentionally Removed
Refer to Plant Drawing A-N-2045

Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 9A-18

FIRE PROTECTION EVALUATION
RESIDUAL HEAT REMOVAL COMPLEX
SECTION C-C