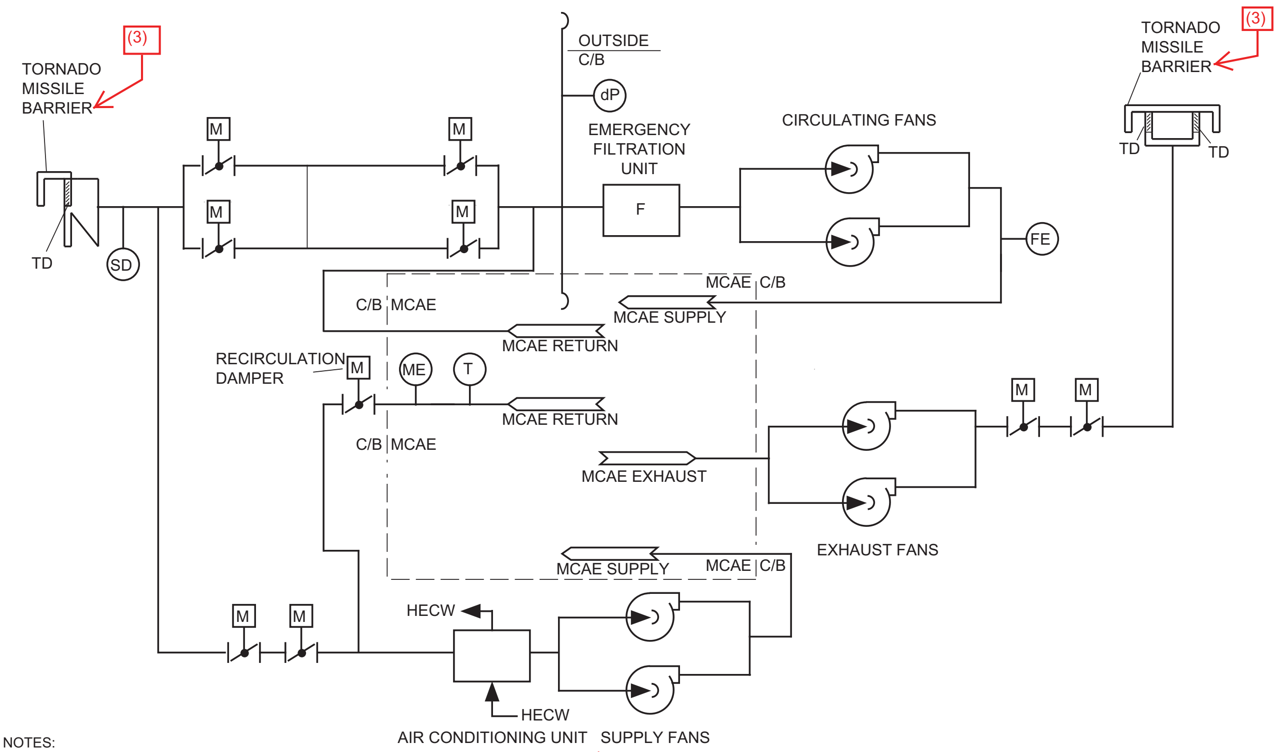
Enclosure 2

MFN 14-075

GEH Response to RAI 02-1

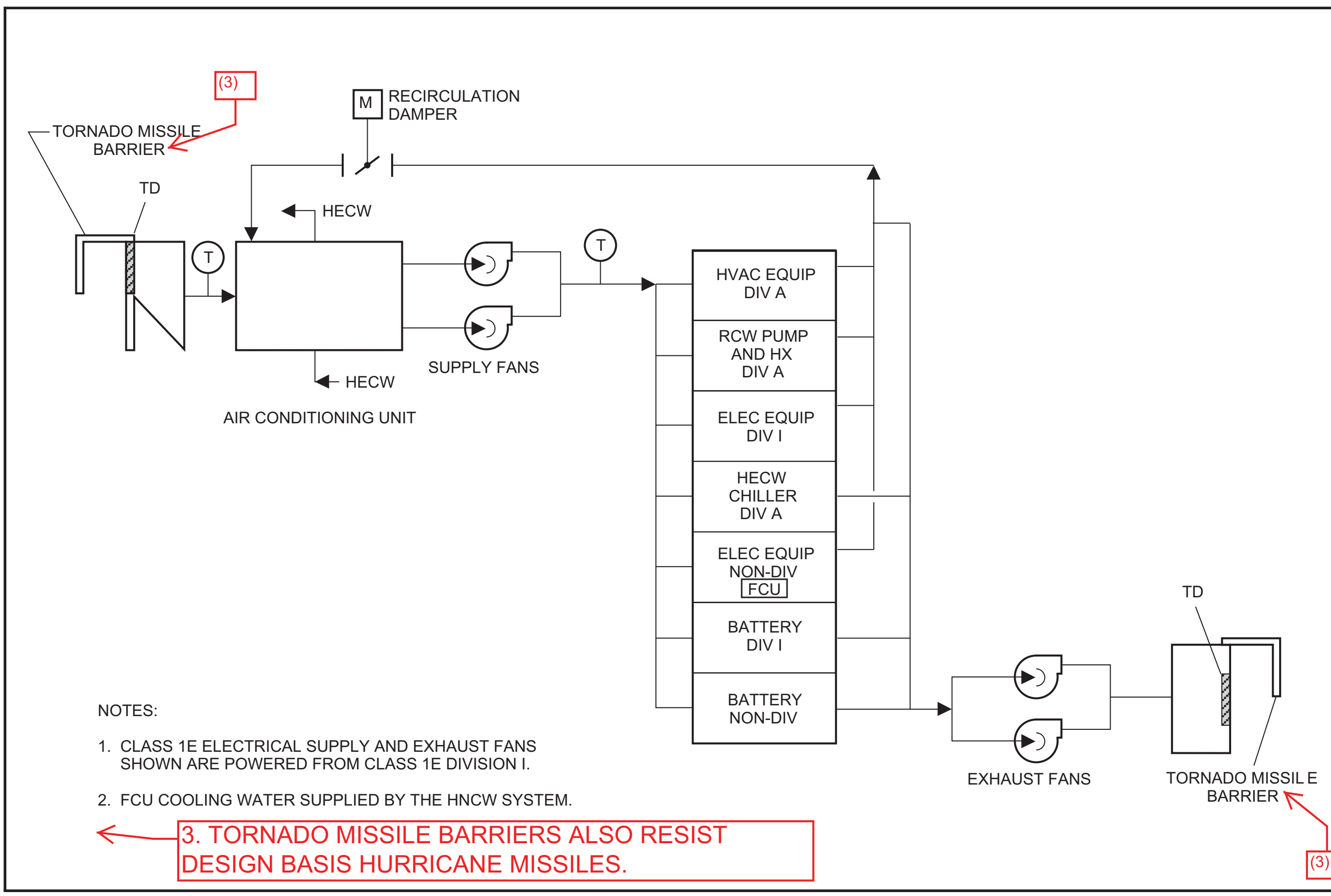
ABWR DCD DRAFT Revision 6 Markups



NOTES:

1. THIS FIGURE SHOWS ONE OF TWO IDENTICAL DIVISIONS. ELECTRICAL POWER LOADS FOR THE COMPONENTS OF DIVISION B EXCEPT MOTOR OPERATED ISOLATION DAMPERS ARE POWERED FROM CLASS 1E DIVISION II. ELECTRICAL POWER LOADS FOR THE COMPONENTS OF DIVISION C EXCEPT MOTOR OPERATED ISOLATION DAMPERS ARE POWERED FROM CLASS 1E DIVISION III.
2. EACH PAIR OF MOTOR OPERATED ISOLATION DAMPERS HAS ONE DAMPER POWERED FROM CLASS 1E DIVISION II AND THE OTHER DAMPER FROM CLASS 1E DIVISION III
3. TORNADO MISSILE BARRIERS ALSO RESIST DESIGN BASIS HURRICANE MISSILES.

Figure 2.15.5a Control Room Habitability Area HVAC System



NOTES:

1. CLASS 1E ELECTRICAL SUPPLY AND EXHAUST FANS SHOWN ARE POWERED FROM CLASS 1E DIVISION I.
2. FCU COOLING WATER SUPPLIED BY THE HNCW SYSTEM.

3. TORNADO MISSILE BARRIERS ALSO RESIST DESIGN BASIS HURRICANE MISSILES.

Figure 2.15.5b Control Building Safety-Related Equipment Area HVAC System (Division A)

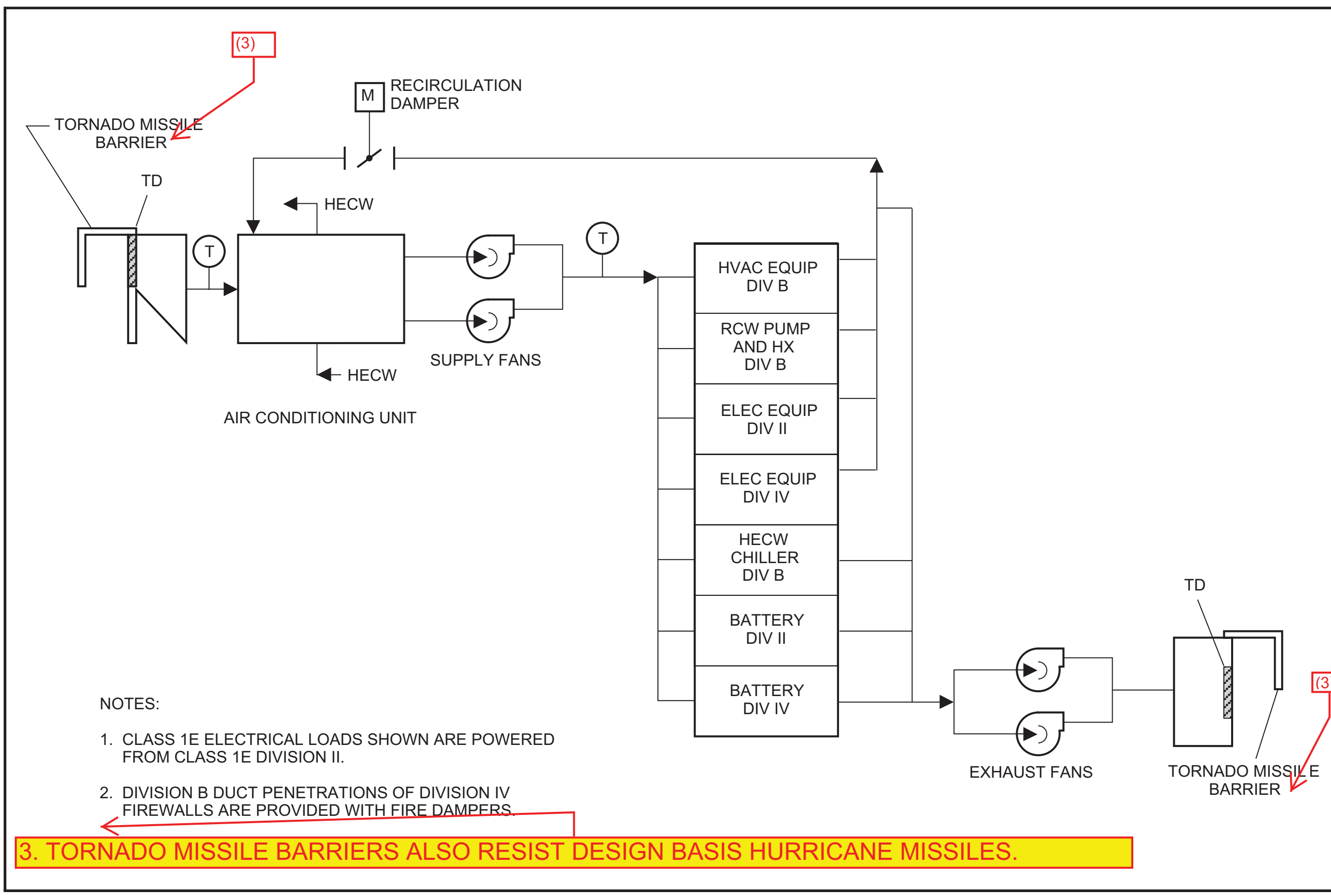


Figure 2.15.5c Control Building Safety-Related Equipment Area HVAC System (Division B)

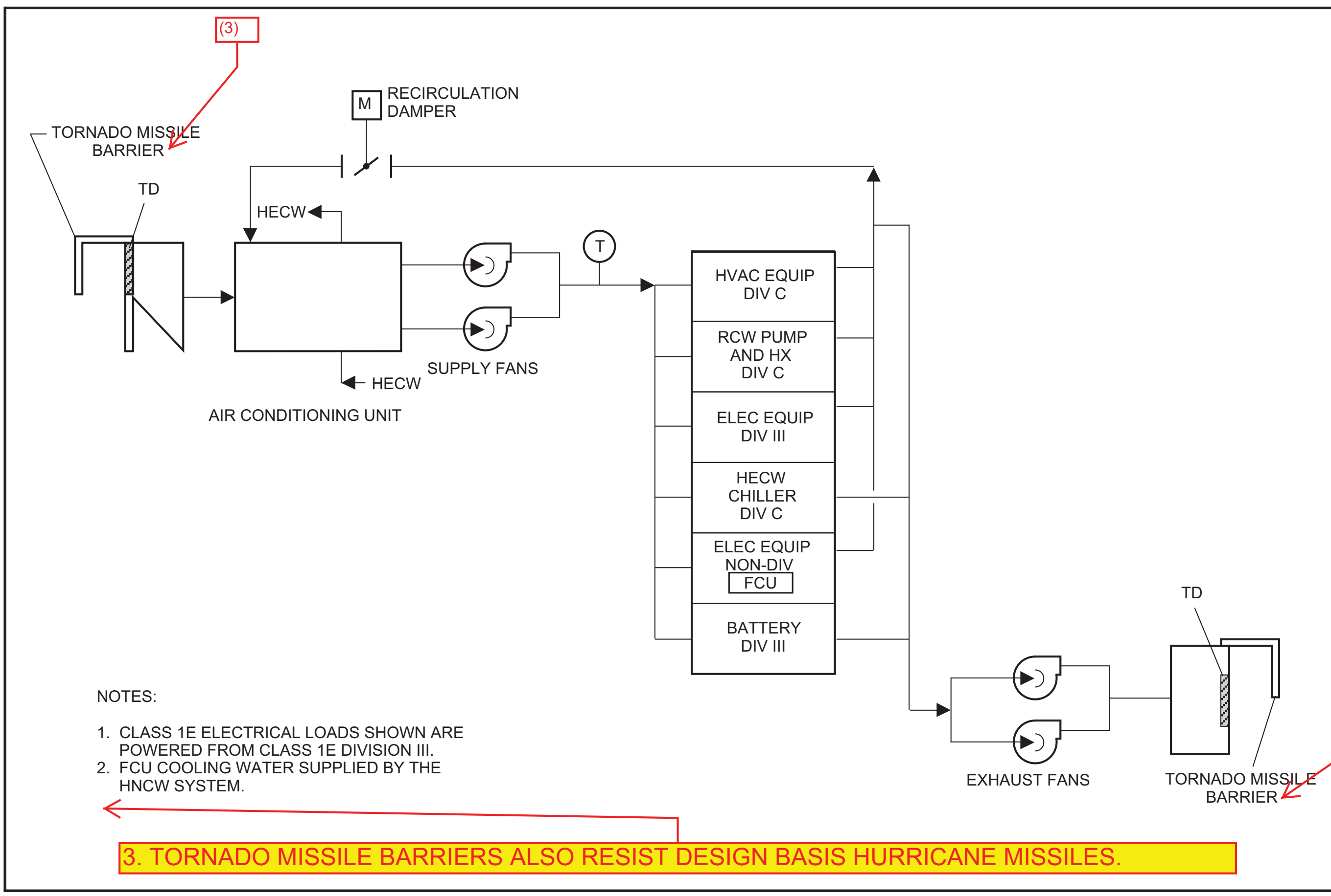
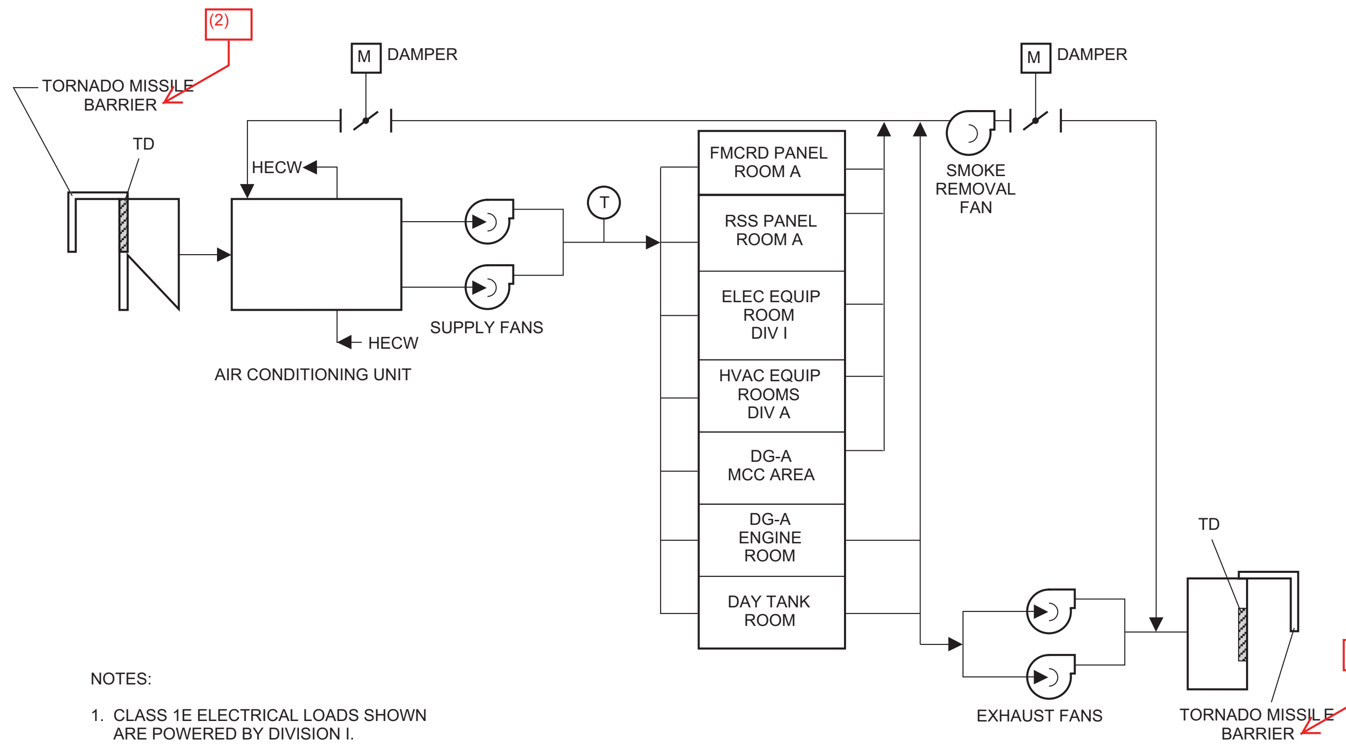


Figure 2.15.5d Control Building Safety-Related Equipment Area HVAC System (Division C)



NOTES:

1. CLASS 1E ELECTRICAL LOADS SHOWN ARE POWERED BY DIVISION I.

2. TORNADO MISSILE BARRIERS ALSO RESIST DESIGN BASIS HURRICANE MISSILES.

Figure 2.15.5f Reactor Building Safety-Related Electrical Equipment HVAC System (Division A)

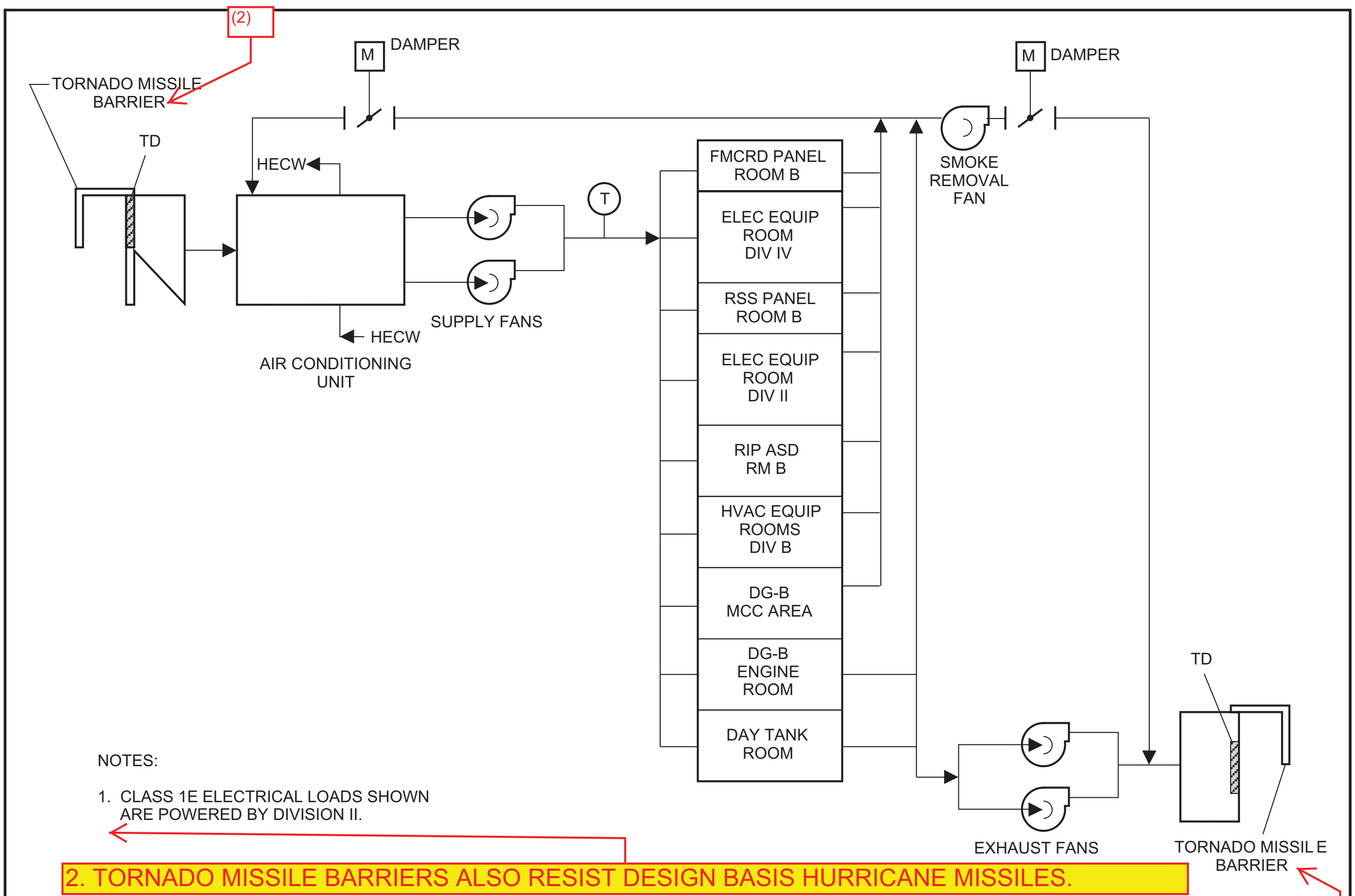


Figure 2.15.5g Reactor Building Safety-Related Electrical Equipment HVAC System (Division B)

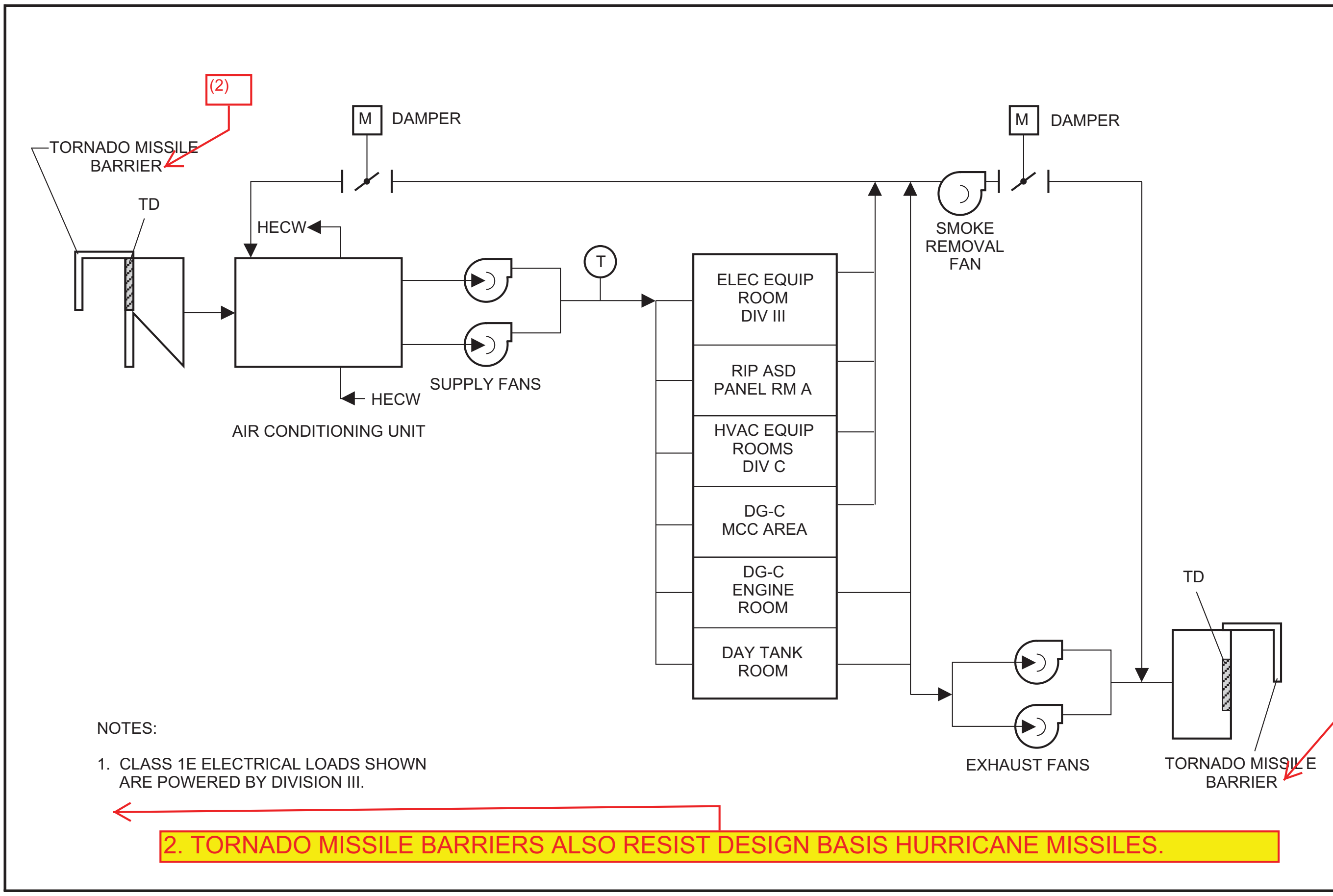
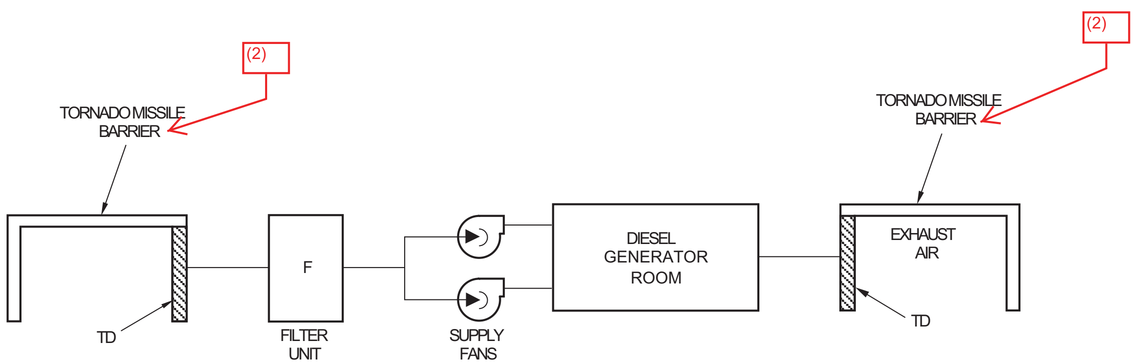


Figure 2.15.5h Reactor Building Safety-Related Electrical Equipment HVAC System (Division C)



NOTES:

1. THIS FIGURE SHOWS ONE OF THREE IDENTICAL DIVISIONS. ELECTRICAL POWER LOADS FOR DIVISIONS A, B, AND C ARE POWERED FROM CLASS 1E DIVISIONS I, II, AND III, RESPECTIVELY.

2. TORNADO MISSILE BARRIERS ALSO RESIST DESIGN BASIS HURRICANE MISSILES.

Figure 2.15.5i Reactor Building Safety-Related Diesel Generator HVAC System

The R/B is protected against external flood. The following design features are provided:

(1) External walls below flood level are equal to or greater than 0.6 meters thick to prevent ground water seepage.

(2) Penetrations in the external walls below flood level are provided with flood protection features.

(3) A tunnel connects the Radwaste Building, Turbine Building, Control Building and Reactor Building for the liquid radwaste system piping. The penetrations from the tunnel to the Reactor Building are watertight.

The R/B is protected against the pressurization effects associated with postulated rupture of pipes containing high-energy fluid that occur in subcompartments of the R/B.

There are three divisionally separated tunnels for routing Oil Storage and Transfer (OST) System piping and cable from the fuel oil storage tanks to the R/B. These tunnels are configured so that any fuel oil leakage does not accumulate at the R/B boundary. Tunnel flooding due to site flood conditions is precluded by protecting the entrances against water entry.

The R/B and oil transfer tunnels are classified as Seismic Category I. They are designed and constructed to accommodate the dynamic and static loading conditions associated with the various loads and load combinations which form the structural design basis. The loads are (as applicable)those associated with:

(1) Natural phenomena—wind, floods, tornados (including tornado missiles), hurricane (including hurricane missiles), earthquakes, rain and snow.

(2) Internal events—floods, pipe breaks and missiles.

(3) Normal plant operation—live loads, dead loads, temperature effects and building vibration loads.

Systems, structures, and components located in the R/B and classified as safety-related are protected against inter-divisional flooding that results from postulated failures in Seismic Category I or non-nuclear safety (NNS) components located in the R/B or from external flooding events. Each postulated flooding event is documented in a Flood Analysis Report which concludes the reactor can be shutdown safely and maintained in a safe, cold shutdown condition without offsite power.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.15.10 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the R/B.

The basement area level sensors are powered from their respective divisional Class 1E power supply. Independence is provided between the Class 1E divisions for these sensors and also between the Class 1E divisions and non-Class 1E equipment.

To protect the C/B against an external flood the following design features are provided:

(1) External walls below flood level are equal to or greater than 0.6m thick to prevent ground water seepage.

(2) Penetrations in the external walls below flood level are provided with flood protection features.

Within the C/B, the steam tunnel has no penetrations from the steam tunnel into other areas of the C/B. The concrete thickness of the steam tunnel walls, floor and ceiling within the C/B is equal to or greater than 1.6m.

The C/B is classified as Seismic Category I. It is designed and constructed to accommodate the dynamic and static loading conditions associated with the various loads and load combinations which form the structural design basis. The loads are those associated with:

(1) Natural phenomena—wind, floods, tornadoes (including tornado missiles), hurricane (including hurricane missiles), earthquakes, rain and snow.

(2) Internal events—floods, pipe breaks and missiles.

(3) Normal plant operation—live loads, dead loads and temperature effects.

The steam tunnel is protected against pressurization effects that occur in the steam tunnel as a result of postulated rupture of pipes containing high energy fluid.

Systems, structures and components located in the C/B and classified as safety-related are protected against inter-divisional flooding that results from postulated failures in Seismic Category I or non-nuclear safety (NNS) components located in the C/B or from external flooding events. Each postulated flooding event is documented in a Flood Analysis Report which concludes the reactor can be shutdown safely and maintained in a safe, cold shutdown condition without offsite power.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.15.12 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Control Building.

2.15.13 Radwaste Building

Design Description

The Radwaste Building (RW/B) is a structure which houses the solid and liquid radwaste treatment systems. The RW/B is classified as non-safety-related.

Flood conditions in the RW/B are prevented from propagating into the Reactor Building and Turbine Building by providing the penetrations in external walls below flood level with flood protection features.

A tunnel connects the Radwaste Building, Turbine Building, Control Building and Reactor Building for the liquid radwaste system piping. The penetrations from the tunnel to the Radwaste Building are watertight.

The external walls of the RW/B below grade and the basemat are classified as Seismic Category I. The exterior walls above grade, the floor slabs, the interior columns, and the roof are classified as non-seismic.

The external walls of the RW/B below grade and the basemat are designed and constructed to accommodate the dynamic and static loading conditions associated with the various loads and load combinations which form the structural design basis. The loads are those associated with:

(1) Natural phenomena—wind, floods, tornados, hurricanes, earthquakes, rain and snow.

(2) Internal event—floods.

(3) Normal plant operations—live loads, dead loads and temperature effects.

The exterior walls above grade, the floor slabs, the interior columns and the roof are designed such that damage to safety-related functions does not occur under seismic loads corresponding to the safe shutdown earthquake (SSE) ground acceleration.

The tunnel connecting the Radwaste Building, Turbine Building, Control Building and Reactor Building is designed such that damage to penetration seals at the interface with safety-related structures does not occur under ~~siesmic~~seismic loads corresponding to the safe shutdown ~~earthqake~~earthquake (SSE) ground acceleration. Flooding of this tunnel during design basis site flood conditions is prevented.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.15.13 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Radwaste Building.

Table 5.0 ABWR Site Parameters

Maximum Ground Water Level:
61.0 cm below grade

Maximum Flood (or Tsunami) Level:
30.5 cm below grade

Precipitation (for Roof Design):
- Maximum rainfall rate: 49.3 cm/h[3]
- Maximum snow load: 2.394 kPa

Ambient Design Temperature:
1% Exceedance Values
- Maximum: 37.8°C dry bulb
  25°C wet bulb (coincident)
  26.7°C wet bulb (non-coincident)
- Minimum: –23.3°C–

0% Exceedance Values (Historical Limit)
- Maximum: 46.1°C dry bulb
  26.7°C wet bulb (coincident)
  27.2°C wet bulb (non-coincident)
- Minimum: –40°C

Exclusion Area Boundary (EAB): An area whose boundary has a Chi/Q less than or equal to $1.37 \times 10^{-3} s/m^3$.

Extreme Wind: Basic Wind Speed:
177 km/h[1]/197 km/h[2]

Tornado
- Maximum tornado wind speed: 483 km/h
- Maximum pressure drop: 13.827 kPaD
- Missile spectra: Spectrum I[4]

Hurricane
- Maximum hurricane wind speed[8]: 286.5 km/h
- Maximum pressure drop: 0 kPaD
- Missile spectra: Spectrum I[4]

Soil Properties:
- Minimum static bearing capacity: 718.20 kPa
- Minimum shear wave velocity: 305 m/s[6]
- Liquefaction potential: None at plant site resulting from site specific SSE ground motion

Seismology:
- SSE response spectra: See Figures 5.0a and 5.0b[7]

Meteorological Dispersion (Chi/Q):
- Maximum 2-hour 95% EAB $1.37 \times 10^{-3} s/m^3$
- Maximum 2-hour 95% LPZ $4.11 \times 10^{-4} s/m^3$
- Maximum annual average (8760 hour) LPZ $1.17 \times 10^{-6} s/m^3$

(1) 50-year recurrence interval; value to be utilized for design of non-safety-related structures only.

(2) 100-year recurrence interval; value to be utilized for design for safety-related structures only.

(3) Maximum value for 1 hour over 2.6 km^2 probable maximum precipitation (PMP) with ratio of 5 minutes to 1 hour PMP of 0.32. Maximum short-term rate: 15.7cm/5 min.

(4) Spectrum I missiles consist of a massive high kinetic energy missile which deforms on impact, a rigid missile to test penetration resistance, and a small rigid missile of a size sufficient to just pass through any openings in protective barriers. These missiles consists of an ~~1800~~1810 kg automobile, a ~~125~~130 kg, 20 cm diameter armor piercing artillery shell, and a 2.54 cm diameter solid steel sphere, all impacting at 35% of the maximum horizontal windspeed of the design basis tornado or a 59% of the maximum horizontal wind speed of the design basis hurricane. The first two missiles are assumed to impact at normal incidence, the last to impinge upon barrier openings in the most damaging directions.

(5) At foundation level of the reactor and control buildings.

(6) This is the minimum shear wave velocity at low strains after the soil property uncertainties have been applied.

(7) Free-field, at plant grade elevation.

(8) Maximum hurricane wind speed is the nominal 3-second gust wind speed measured at 10 m above ground over open terrain.

Table 1.8-20 NRC Regulatory Guides Applicable to ABWR (Continued)

RG No.	Regulatory Guide Title	Appl. Rev.	Issued Date	ABWR Applicable?	Comments
1.59	Design Basis Floods for Nuclear Power Plants	2	8/77	Yes	
1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants	1	12/73	Yes	
1.61	Damping Values for Seismic Design of Nuclear Power Plants	0	10/73	Yes	
1.62	Manual Initiation of Protective Actions	0	10/73	Yes	
1.63	Electric Penetration Assemblies in Containment Structures of Nuclear Power Plants	3	2/87	Yes	
1.64	Quality Assurance Requirements for the Design of Nuclear Power Plants		Superceded		See Table 17.0-1
1.65	Materials and Inspections for Reactor Vessel Closure Studs	0	10/73	Yes	
1.68	Initial Test Programs for Water-Cooled Reactor Power Plants	2	8/78	Yes	
1.68.1	Preoperational and Initial Startup Testing of Feedwater and Condensate Systems for Boiling Water Reactor Power Plants	1	1/77	Yes	
1.68.2	Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants	1	7/78	Yes	
1.68.3	Preoperational Testing of Instrument and Control Air Systems	0	4/82	Yes	
1.69	Concrete Radiation Shields for Nuclear Power Plants	0	12/73	Yes	
1.70	Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants	3	11/78	Yes	
1.71	Welder Qualifications for Areas of Limited Accessibility	0	12/73	---	COL Applicant
1.72	Spray Pond Piping Made From Fiberglass-Reinforced Thermosetting Resin	2	11/78	Yes	
1.73	Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants	0	1/74	Yes	
1.74	Quality Assurance Terms and Definitions		Super-ceded		See Table 17.0-1
[*1.75*	*Physical Independence of Electric Systems*	*2*	*9/78*	*Yes*][(4)]	
1.76	Design Basis Tornado for Nuclear Power Plants	~~0~~1	~~4/74~~3/07	Yes	

Table 1.8-20 NRC Regulatory Guides Applicable to ABWR (Continued)

RG No.	Regulatory Guide Title	Appl. Rev.	Issued Date	ABWR Applicable?	Comments
1.142	Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)	1	11/81	Yes	
1.143	Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants	1	10/79	Yes	
1.144	Auditing of Quality Assurance Programs Nuclear Power Plants		Super-ceded		See Table 17.0-1
1.145	Atmospheric Dispersion Models for Potential Accident Consequences Assessments at Nuclear Power Plants	1	12/82	Yes	
1.146	Qualification of Quality Assurance Program Audit Personnel for Nuclear Power Plants		Super-ceded		See Table 17.0-1
1.147	Inservice Inspection Code Case Acceptability-ASME Section XI, Division 1	8	11/90	Yes	
1.148	Functional Specifications for Active Valve Assemblies in Systems Important to Safety in Nuclear Power Plants	0	4/81	Yes	
1.149	Nuclear Power Plant Simulation Facilities for Use in Operator License Examinations	1	5/87	---	COL Applicant
1.150	Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservice Examinations	1	2/83	Yes	
1.151	Instrument Sensing Lines	0	7/83	Yes	
[*1.152*	*Criteria for Programmable Digital Computer System Software in Safety-Related Systems of Nuclear Power Plants*	*0*	*11/85*	*Yes*]$^{(4)}$	
[*1.153*	*Criteria for Power, Instrumentation, and Control Portions of Safety Systems*	*0*	*12/85*	*Yes*]$^{(4)}$	
1.154	Format and Contents of Plant-Specific Pressurized Thermal Shock Safety Analysis Reports for Pressurized Water Reactors	0	3/87	No	PWR only
1.155	Station Blackout	0	8/88	Yes	
1.160	Monitoring the Effectiveness of Maintenance at Nuclear Power Plants	0	6/93	Yes	
1.221	Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants	0	10/11	Yes	
5.1	Serial Numbering of Fuel Assemblies for Light-Water-Cooled Nuclear Power Plants	0	12/72	Yes	

Table 2.0-1
Envelope of ABWR Standard Plant Site Design Parameters

Maximum Ground Water Level:	61.0 cm below grade	
Extreme Wind:	Basic Wind Speed: 177 km/h[*]/ 197 km/h[†]	
Maximum Flood (or Tsunami) Level:[‡]	30.5 cm below grade	
Tornado:	– Maximum Tornado Wind Speed:	483 km/h
	– Maximum Rotational Speed:	386 km/h
	– Translational Velocity:	97 km/h
	– Radius:	45.7m
	– Maximum Pressure Drop:	13.827 kPaD
	– Rate of Pressure Drop:	8.277 kPa/s
	– Missile Spectra:	Spectrum I[f]
Hurricane:	– Maximum Hurricane Wind Speed[***]:	286.5 km/h
	– Maximum Rotational Speed:	261.5 km/h
	– Translational Velocity:	25 km/h
	– Radius:	1500 m
	– Maximum Pressure Drop:	0 kPaD
	– Missile Spectra:	Spectrum I
Precipitation (for Roof Design):	– Maximum Rainfall Rate:	49.3 cm/h[**]
	– Maximum Snow Load:	2.394 kPa
Ambient Design Temperature:	1% Exceedance Values	
	– Maximum: 37.8°C dry bulb	
	25°C wet bulb (coincident)	
	26.7°C wet bulb (non-coincident)	
	– Minimum: –23.3°C	
	0% Exceedance Values (Historical limit)	
	– Maximum 46.1°C dry bulb	
	26.7°C wet bulb (coincident)	
	27.2°C wet bulb (non-coincident)	
	– Minimum: –40°C	
Soil Properties:	– Minimum Static Bearing Capacity:	718.20 kPa[††]
	– Minimum Shear Wave Velocity:	305 m/s[‡‡]
	– Liquification Potential:	None at plant site resulting from site specific SSE ground motion

Table 2.0-1
Envelope of ABWR Standard Plant Site Design Parameters (Continued)

Seismology:	– SSE Peak Ground Acceleration:	0.30g[ƒƒ]
	– SSE Response Spectra:	per RG 1.60
	– SSE Time History:	Envelope SSE Response Spectra
Hazards in Site Vicinity:	– Site Proximity Missiles and Aircraft	
	– Toxic Gases	≤10^{-7} per year
	– Volcanic Activity	None
Exclusion Area Boundary: (EAB)	– An area whose boundary has a Chi/Q less than or equal to 1.37 x 10^{-3} s/m^3	None
Meteorological Dispersion (Chi/Q):	– Maximum 2-hour 95% EAB	1.37×10^{-3} s/m^3
	– Maximum 2-hour 95% LPZ	4.11×10^{-4} s/m^3
	– Maximum annual average (8760 hour) LPZ	1.17×10^{-6} s/m^3

* 50–year recurrence interval; value to be utilized for design of non-safety-related structures only.

† 100–year recurrence interval; value to be utilized for design for safety-related structures only.

‡ Probable maximum flood level (PMF), as defined in ANSI/ANS-2.8, “Determining Design Basis Flooding at Power Reactor Sites.”

ƒ Spectrum I missiles consist of a massive high kinetic energy missile which deforms on impact, a rigid missile to test penetration resistance, and a small rigid missile of a size sufficient to just pass through any openings in protective barriers. These missiles consists of an ~~1800~~1810 kg automobile, a ~~125~~130 kg, 20 cm diameter armor piercing artillery shell, and a 2.54 cm diameter solid steel sphere, all impacting at 35% of the maximum horizontal windspeed of the design basis tornado or at a 59% of the maximum horizontal speed of the design basis hurricane. The first two missiles are assumed to impact at normal incidence, the last to impinge upon openings in the most damaging directions.

** Maximum value for 1 hour over 2.6 km^2 probable maximum precipitation (PMP) with ratio of 5 minutes to 1 hour PMP of 0.32 as found in National Weather Source Publication HMR No. 52. Maximum short term rate: 15.7 cm/5 min.

†† At foundation level of the reactor and control buildings.

‡‡ This is the minimum shear wave velocity at low strains after the soil property uncertainties have been applied.

ƒƒ Free-field, at plant grade elevation.

*** Maximum hurricane wind speed is the nominal 3-second gust wind speed measured at 10 m above ground over open terrain.

Chapter 3
Table of Contents

3.3 ~~Wind and Tornado Loadings~~Severe Wind and Extreme Wind (Tornado and Hurricane) Loadings

ABWR Standard Plant structures which are Seismic Category I are designed for tornado and extreme wind phenomena.

3.3.1 ~~Wind Loadings~~Severe Wind Loads

3.3.1.1 Design Wind Velocity

Seismic Category I structures are designed to withstand a design wind velocity of 177 km/h with a recurrence interval of 50 years and 197 km/h with a recurrence interval of 100 years at an elevation of 10m above grade (see Subsection 3.3.3.1 and 3.3.3.3 for COL license information requirements).

3.3.1.2 Determination of Applied Forces

The design wind velocity is converted to velocity pressure in accordance with Reference 3.3-1 using the formula:

q_z = $4.94 \times 10^{-5} K_z (IV)^2$

where K_z = The velocity pressure exposure coefficient which depends upon the type of exposure and height (z) above ground per Table 6 of Reference 3.3-1

I = The importance factor which depends on the type of structure; appropriate values of I are listed in Table 3.3-1

V = Design wind velocity with a recurrence interval of 50 years, in km/h, and

q_z = Velocity pressure in kPa

The design wind pressures and forces for buildings, components and cladding, and other structures at various heights above the ground are obtained, in accordance with Table 4 of Reference 3.3-1 by multiplying the velocity pressure by the appropriate pressure coefficients and gust factors. Gust factors are in accordance with Table 8 of Reference 3.3-1. Appropriate pressure coefficients are in accordance with Figures 2, 3a, 3b, 4, and Tables 9 and 11 through 16 of Reference 3.3-1. Reference 3.3-2 is used to obtain the effective wind pressures for cases which Reference 3.3-1 does not cover. Since the Seismic Category I structures are not slender or flexible, vortex-shedding analysis is not required and the above wind loading is applied as a static load.

Applied forces for the Reactor, Control and Radwaste Buildings are found in Appendices 3H.1, 3H.2 and 3H.3, respectively.

3.3.2 ~~Tornado Loadings~~Extreme Wind Loads (Hurricanes and Tornados)

3.3.2.1 Applicable Design Parameters

Extreme wind loads include loads from design basis hurricane and design basis tornado.

The design basis hurricane is described by the following parameters:

(1) A maximum hurricane wind speed of 286.5 km/h at a radius of 1500 m from the center of the hurricane.

(2) A maximum translational velocity of 25 km/h.

(3) A maximum tangential velocity of 261.5 km/h, based on the translational velocity of 25 km/h.

(4) A maximum atmospheric pressure drop of 0 kPa with a rate of the pressure change of 0 kPa/s.

(5) The spectrum of hurricane generated missile and their pertinent characteristics as given in Table 2.0-1.

The design basis tornado is described by the following parameters:

(1) A maximum tornado wind speed of 483 km/h at a radius of 45.7m from the center of the tornado.

(2) A maximum translational velocity of 97 km/h.

(3) A maximum tangential velocity of 386 km/h, based on the translational velocity of 97 km/h.

(4) A maximum atmospheric pressure drop of 13.8 kPa with a rate of the pressure change of 8.3 kPa/s.

(5) The spectrum of tornado-generated missiles and their pertinent characteristics as given in Table 2.0-1.

See Subsection 3.3.3.2 for COL license information.

3.3.2.2 Determination of Forces on Structures

The procedures of transforming the tornado loading into effective loads and the distribution across the structures are in accordance with Reference 3.3-3. The procedure for transforming the tornado-generated missile impact into an effective or equivalent static load on structures is given in Subsection 3.5.3.1. The loading combinations of the individual tornado loading components and the load factors are in accordance with Reference 3.3-3. Per RG 1.221, in areas where effects of design basis tornado missiles do not bound the effects of site-specific hurricane missiles, the site-specific hurricane loadings should replace tornado loadings. These areas are limited to certain coastal regions along Southwestern Atlantic and Gulf of Mexico.

The reactor building and control building are not vented structures. The exposed exterior roofs and walls of these structures are designed for the 13.8 kPa pressure drop. Tornado dampers are provided on all air intake and exhaust openings. These dampers are designed to withstand a negative13.8 kPa pressure.

3.3.2.3 Effect of Failure of Structures, Systems or Components Not Designed for Tornado Loads

All safety-related systems and components are protected within tornado-resistant or hurricane-resistant structures.

See Subsection 3.3.3.4 for COL license information requirements.

3.3.3 COL License Information

3.3.3.1 Site-Specific Design Basis Wind

The site-specific design basis wind shall not exceed the design basis wind given in Table 2.0-1 (Subsection 2.2.1).

3.3.3.2 Site-Specific Design Basis Tornado and Hurricane

The site-specific design basis tornado and hurricane shall not exceed the design basis tornado and hurricane given in Table 2.0-1 (Subsection 2.2.1).

3.3.3.3 Effect of Remainder of Plant Structures, Systems and Components Not Designed for Wind Loads

All remainder of plant structures, systems and components not designed for wind loads shall be analyzed using the 1.11 importance factor or shall be checked that their mode of failure will not effect the ability of safety-related structures, systems or components performing their intended safety functions.

3.3.3.4 Effect of Remainder of Plant Structures, Systems, and Components Not Designed for Tornado Loads

All remainder of plant structures, systems, and components not designed for tornado loads and hurricane loads shall be analyzed for the site-specific loadings to ensure that their mode of failure will not effect the ability of the Seismic Category I ABWR Standard Plant structures, systems, and components to perform their intended safety functions. (See Subsection 3.3.2.3)

Non-Seismic Category I items and systems inside containment are considered as Follows:

(1) Cable Tray

All cable trays for both Class 1E and non-Class 1E circuits are seismically supported whether or not a hazard potential is evident.

(2) Conduit and Non-Safety Pipe

Non-Class 1E conduit is seismically supported if it is identified as a potential hazard to safety-related equipment. All ABWR Standard Plant non-safety related piping that is identified as a potential hazard is seismically analyzed per Subsection 3.7.3.13.

(3) Equipment for Maintenance

All other equipment, such as hoists, that is required during maintenance will either be removed prior to operation, moved to a location where it is not a potential hazard to safety-related equipment, or seismically restrained to prevent it from becoming a missile. See Subsection 3.5.4.6 for COL license information.

3.5.1.3 Turbine Missiles

See Subsection 3.5.1.1.1.3.

3.5.1.4 Missiles Generated by Natural Phenomena

~~Tornado-generated missiles have been determined to be the~~The limiting natural phenomena hazard in the design of all structures required for safe shutdown of the nuclear power plant has been determined to be either design basis tornado-generated missiles or site-specific hurricane-generated missiles. ~~Since tornado missiles are used in the design basis, it is not necessary to consider missiles generated from other natural phenomena.~~ The design basis tornado/hurricane for the ABWR Standard Plant is the maximum ~~tornado~~ windspeed corresponding to a probability of l0E-7 per year ~~(483 km/h)~~. The other characteristics of ~~this tornado~~tornados/hurricanes are summarized in Subsection 3.3.2.1. The design basis tornado/hurricane missiles are per SRP 3.5.1.4, Spectrum I.

Using the design basis tornado and missile spectrum as defined above with the design of the Seismic Category I buildings, compliance with all of the positions of Regulatory Guide 1.117, “Tornado Design Classification,” Positions C.1 and C.2 is assured.

The SGTS charcoal absorber beds are housed in the tornado resistant reactor building and, therefore, are protected from the design basis tornado/hurricane missiles. The offgas system charcoal absorber beds are located deep within the Turbine Building and it is considered very unlikely that these beds could be ruptured as a result of a design basis tornado missile. These features assure compliance with Position C.3 of Regulatory Guide 1.117.

See Subsections 3.5.4.2 and 3.5.4.4 for COL license information requirements.

3.5.1.5 Site Proximity Missiles Except Aircraft

External missiles other than those generated by tornados or hurricanes are not considered as a design basis (i.e. < 10^{-7} per year).

3.5.1.6 Aircraft Hazards

Aircraft hazards are not a design basis event for the ABWR Standard Plant (i.e. ≤ 10^{--7} per year). See Subsection 3.5.4.3 for COL license information requirements.

3.5.2 Structures, Systems, and Components to be Protected from Externally Generated Missiles

The sources of external missiles which could affect the safety of the plant are identified in Subsection 3.5.1. Certain items in the plant are required to safely shut down the reactor and maintain it in a safe condition assuming an additional single failure. These items, whether they be structures, systems, or components, must therefore all be protected from externally generated missiles.

These items are the safety-related items listed in Table 3.2-1. Appropriate safety classes and equipment locations are given in this table. All of the safety-related systems listed are located in buildings which are designed as tornado resistant. Since the tornado/hurricane missiles are the design basis missiles, the systems, structures, and components listed are considered to be adequately protected. Provisions are made to protect the charcoal delay tanks against tornado missiles.

See Subsection 3.5.4.1 and 3.5.4.7 for COL license information requirements.

3.5.3 Barrier Design Procedures

The procedures by which structures and barriers are designed to resist the missiles described in Subsection 3.5.1 are presented in this section. Structures and barriers that are designed for design basis tornado missile features described in Tier 1 and Tier 2 are also protected from design basis hurricane missiles. For areas where the effects of design basis tornado missiles do not bound site-specific hurricane missiles, the site-specific hurricane-generated missiles need to meet the criteria specified in RG. 1.221 (see COL information in Section 3.5.4.2). The following procedures are in accordance with Section 3.5.3 of NUREG-0800 (Standard Review Plan). Missile protection design features described in Tier 1 and Tier 2, even if indicated as tornado missile protection, also resist hurricane missiles.

3.5.3.1 Local Damage Prediction

The prediction of local damage in the impact area depends on the basic material of construction of the structure or barrier (i.e., concrete or steel). The corresponding procedures are presented separately. Composite barriers are not utilized in the ABWR Standard Plant for missile protection.

3.5.3.1.1 Concrete Structures and Barriers

Empirical equations, such as the modified Petry formula (Reference 3.5-3) or the TM 5-855-1 formula (Reference 3.5-4), may be used to estimate missile penetration into concrete. The resulting thickness of concrete required to prevent perforation, spalling, or scabbing should in no case be less than those for Region II listed in Table 1 of SRP 3.5.3 for protection against tornado missiles.

3.5.3.1.2 Steel Structure and Barriers

The Stanford equation (Reference 3.5-5) is applied for steel structures and barriers.

3.5.3.2 Overall Damage Prediction

The overall response of a structure or barrier to missile impact depends largely upon the location of impact (e.g., near mid-span or near a support), dynamic properties of the structure/barrier and missile, and on the kinetic energy of the missile. In general, it has been assumed that the impact is plastic with all of the initial momentum of the missile transferred to the structure or barrier and only a portion of the kinetic energy absorbed as strain energy within the structure or barrier.

After demonstrating that the missile does not perforate the structure or barrier, an equivalent static load concentrated at the impact area is determined. The structural response to this load, in conjunction with other appropriate design loads, is evaluated using an analysis procedure similar to that in Reference 3.5-6 for rigid missiles, and the procedure in Reference 3.5-7 for deformable missiles.

3.5.4 COL License Information

3.5.4.1 Protection of Ultimate Heat Sink

Compliance with Regulatory Guide 1.27 as related to the ultimate heat sink and connecting conduits being capable of withstanding the effects of externally generated missiles shall be demonstrated (Subsection 3.5.2).

3.5.4.2 Missiles Generated by ~~Other~~Site-Specific Natural Phenomena

The COL applicant shall identify missiles generated by ~~other~~ site-specific natural phenomena that may be more limiting than those considered in the ABWR design and shall provide protection for the structures, systems, and components against such missiles. The COL applicant will provide this information to the NRC (Subsection 3.5.1.4).

3.5.4.3 Site Proximity Missiles and Aircraft Hazards

Analyses shall be provided that demonstrate that the probability of site proximity missiles (including aircraft) impacting the ABWR Standard Plant and causing consequences greater than 10CFR100 exposure guidelines is $\leq 10^{-7}$ per year (Subsection 3.5.1.6).

3.5.4.4 Impact of Failure of Out of ABWR Standard Plant Scope Non-Safety-Related Structures, Systems, and Components Due to a Design Basis ~~Tornado~~Extreme Wind (Tornado and Hurricane)

An evaluation of all out of ABWR Standard Plant Scope non-safety-related structures, systems, and components (not housed in a tornado/hurricane structure) whose failure due to a design basis tornado/hurricane missile that could adversely impact the safety function of safety-related systems and components will be provided to the NRC by the COL applicant (Subsection 3.5.1.4).

3.5.4.5 Turbine System Maintenance Program

A turbine system maintenance program, including probability calculations of turbine missile generation meeting the minimum requirement for the probability of missile generation, shall be provided to the NRC (Subsection 3.5.1.1.1.3).

3.5.4.6 Maintenance Equipment Missile Prevention Inside Containment

The COL applicant will provide procedures to ensure that all equipment inside containment, such as hoists, that is required during maintenance will either be removed prior to operation, moved to a location where it is not a potential hazard to safety-related equipment, or seismically restrained to prevent it from becoming a missile [Subsection 3.5.1.2.3 (3)].

3.5.4.7 Failure of Structures, Systems, and Components Outside ABWR Standard Plant Scope

Any failure of structures, systems and components outside ABWR Standard Plant scope which may result in external missile generation shall not prevent safety-related structures, systems and components from performing their intended safety function. The COL applicant will provide an evaluation of the adequacy of these designs for external missile protection for NRC review (Subsection 3.5.2).

3.5.5 References

3.5-1 K. Karim-Panahi et. al, “Recirculation MG Set Missile Generation Study”, PED-18-0389, March 1989. (Proprietary).

3.5-2 F. J. Moody, “Prediction of Blowdown Thrust and Jet Forces”, ASME Publication 69-HT-31, August 1969.

or component resulting from collapse of an adjacent non-Category I structure, because of its size and mass, are either negligible or smaller than those considered in the design (e.g., loads associated with tornado/hurricane, including missiles).

(3) The non-Category I structures, systems or components will be analyzed and designed to prevent their failure under SSE conditions in a manner such that the margin of safety of these structures, systems or components is equivalent to that of Seismic Category I structures, systems or components.

The COL applicant will describe the process for completion of the design of balance-of-plant and non-safety related systems to minimize interactions and propose procedures for an inspection of the as-built plants for interactions. (See Subsection 3.7.5.4 for COL license information requirements).

3.7.2.9 Effects of Parameter Variations on Floor Response Spectra

Floor response spectra calculated according to the procedure described in Subsection 3.7.2.5 are peak broadened to account for uncertainties associated with the material properties of the structure and soil and approximations in the modeling techniques used in the analysis. If no parametric variation studies are performed, the spectral peaks associated with each of the structural frequencies are broadened by ±15%. If a detailed parametric variation study is made, the minimum peak broadening ratio is ±10%. In lieu of peak broadening, the peak shifting method of Appendix N of ASME Section III, as permitted by Regulatory Guide 1.84, can be used.

3.7.2.10 Use of Constant Vertical Static Factors

Since all Seismic Category I structures and the RPV are subjected to a vertical dynamic analysis, no constant vertical static factors are utilized.

3.7.2.11 Methods Used to Account for Torsional Effects

Torsional effects for two-dimensional analytical models are accounted for in the following manner. The locations of the center of mass are calculated for each floor. The centers of rigidity and rotational stiffness are determined for each story. Torsion effects are introduced in each story by applying a rotational moment about its center of rigidity. The rotational moment is calculated as the sum of the products of the inertial force applied at the center of mass of each floor above and a moment arm equal to the distance from the center of mass of the floor to the center of rigidity of the story plus 5% of the maximum building dimension at the level under consideration. To be conservative, the absolute values of the moments are used in the sum. The torsional moment and story shear are distributed to the resisting structural elements in proportion to each individual stiffness. For the Reactor and Control Buildings, the actual eccentricities are negligible and the torsional moments are due to accidental torsion only.

3.8.4.1.2 Control Building

The Control Building (C/B) is located between the Reactor Building and the Turbine Building (see Section 1.2).

The C/B houses the essential electrical, control and instrumentation equipment, the control room for the Reactor and Turbine Buildings, the C/B HVAC equipment, R/B cooling water pumps and heat exchangers, the essential switchgear, essential battery rooms, and the steam tunnel.

The C/B is a Seismic Category I structure that houses control equipment and operation personnel and is designed to provide missile and tornado/hurricane protection. The C/B is constructed of reinforced concrete. The C/B has two stories above the ground level and four stories below. Its shape is a rectangle of 56m by 24m, and a height of about 30.4m from the top of the basemat.

The C/B is a shear wall structure designed to accommodate all seismic loads with its walls and the connected floors. Therefore, frame members such as beams or columns are designed to accommodate deformations of the walls in case of earthquake conditions.

The summary report for the control building is in Section 3H.2. This report contains a description of the control building, the loads, load combinations, reinforcement stresses, and concrete reinforcement details for the basemat, seismic walls, steam tunnel, and floors.

3.8.4.1.3 Radwaste Building Substructure

The Radwaste Building (RWB) Substructure is shown in Section 1.2.

The Radwaste Building is a reinforced concrete structure 60.4m by 41.2m and a height of 29.5m from the top of the basemat. The building consists of a below grade substructure consisting of walls (1.2m thick) and slabs of reinforced concrete forming a rigid box structure which serves as a container to hold radioactive waste in case of an accident. This substructure is located below grade to increase shielding capability and to maximize safety. It is supported on a separate foundation mat whose top is 13.5m below grade. In addition, a reinforced concrete superstructure 15.7m high extends above grade floor level and houses the balance of the radwaste equipment.

The RWB Substructure houses the high and low conductivity tanks, clean-up phase separators, spent resin storage tanks, a concentrated waste storage tank, distillate tank and associated filters, and pumps for the radioactive liquid and solid waste treatment systems.

Although the radwaste superstructure is not a Seismic Category I structure, its major structural concrete walls, slabs, columns and roof are designed to resist Seismic Category I loads.

(n) Regulatory Guide 1.221 - "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants"

(9) ANSI:

(a) ANSI/ASCE 7 - "Minimum Design Loads for Buildings and Other Structures"

(b) ANSI N5.12 - "Protective Coatings (Paint) for the Nuclear Industry"

(c) NQA-1 - "Quality Assurance Program Requirements for Nuclear Facilities and NQA-1a, Addenda to ANSI/ASME NQA-1"

(d) Not Used

(e) Not Used

(f) ANSI N45.4 - "Leakage-Rate Testing of Containment Structures for Nuclear Reactors"

(g) ANSI N101.2 - "Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities"

(h) ANSI N101.4 - "Quality Assurance for Protective Coatings Applied to Nuclear Facilities"

(10) Steel Structures Painting Council Standards

(a) SSPC-PA-1 - "Shop, Field and Maintenance Painting"

(b) SSPC-PA-2 - "Measurement of Paint Film Thickness with Magnetic Gages"

(c) SSPC-SP-1 - "Solvent Cleaning"

(d) SSPC-SP-5 - "White Metal Blast Cleaning"

(e) SSPC-SP-6 - "Commercial Blast Cleaning"

(f) SSPC-SP-10 - "Near-White Blast Cleaning"

(11) ACI-ASCE Committee 326 - "Shear and Diagonal Tension, ACI Manual of Concrete Practice, Part 2."

(12) Applicable ASTM Specifications for Materials and Standards.

(13) "AASHTO Standard Specifications for Highway Bridges for truck loading area."

3.8.4.2.2 Control Building

[*Refer to Subsection 3.8.4.2.1.*]*

* See Subsection 3.8.3.2.

Y_m = Missile impact equivalent static load on a structure generated by or during the postulated break, like pipe whipping, and including a calculated dynamic factor to account for the dynamic nature of the load.

W = Wind force (Subsection 3.3.1).

W_t = Tornado load (Subsection 3.3.2) (tornado-generated missiles are described in Subsection 3.5.1.4, and barrier design procedures in Subsection 3.5.3). The design basis tornado winds and missile loads bound those of the design basis hurricane.

P_a = Internal negative pressure of 13.73 kPaD due to tornado; accident pressure at main steam tunnel piping embedment.

B = Uplift forces created by the rise of the ground water table.

F = Internal pressures resulting from flooding of compartments.

E' = Safe shutdown earthquake (SSE) loads as defined in Section 3.7.

T_o = Thermal effects — load effects induced by normal thermal gradients existing through the R/B wall and roof. Both summer and winter operating conditions are considered. In all cases, the conditions are considered of long enough duration to result in a straight line temperature gradient. The temperatures are as follows:

(1) Summer operation:

(a) Air temperature inside building — 49°C

(b) Exterior temperature — 46°C

(2) Winter operation:

(a) Air temperature inside building — 21.1°C

(b) Exterior temperature — (-) 40°C

(3) Winter shutdown

(a) Air temperature inside building - 46°C

(b) Exterior temperature — (-) 40°C

For all cases, as-constructed temperature is 15.6°C.

T_a = Thermal effects (including T_o) which may occur during a design accident at 74°C maximum 30 minutes after LOCA.

Thus, two methods are used in design and analysis of cable tray supports.

(1) Rigid Support with Flexible Tray — In this method, trays are modeled as flexible elastic systems and analyzed by the response spectrum method. The resulting reactions are used for the design of the supports.

(2) Flexible Support with Flexible Tray — In this method, the composite system of trays and supports is modeled and analyzed by computer as a multidegree of freedom elastic system. The support motions can be prescribed by the appropriate floor response spectrum. The resulting responses are used to obtain design loads for the supports.

3.8.4.4.3.2 Conduit Supports

The design and analysis of conduit supports are basically the same as for cable tray supports. Since conduits are more flexible and have comparatively less dead load, a rigid support approach is used as described in method (1) of cable tray support design.

3.8.4.5 Structural Acceptance Criteria

3.8.4.5.1 Reactor Building

3.8.4.5.1.1 General Criteria

The first criterion is that the Reactor Building shall provide biological shielding for plant personnel and the public outside of the site boundary. This criterion dictates the minimum wall and roof thicknesses.

The second criterion is that the Reactor Building shall protect the reinforced concrete containment from environmental hazards such as tornado, hurricane and other site proximity-generated missiles. The shielding thicknesses are sufficient for this purpose.

The Reactor Building provides a means for collection of fission product leakage from the reinforced concrete containment following an accident.

The Reactor Building SGTS is designed to keep the compartments surrounding the reinforced concrete containment at a negative pressure even after a LOCA. In order to achieve a maximum in-leakage rate of 50% per day under a pressure differential of 6 mm of water, the reinforcing steel is designed to remain elastic during the SSE load combinations.

3.8.4.5.1.2 Structural and Materials Criteria

[*Structural acceptance criteria are defined in ANSI/AISC-N690 and ACI 349 Codes*.]*

Refer to the materials criteria established in Subsection 3.8.4.2.1 for the strength and materials requirements for the reinforced concrete Reactor Building.

3.8.4.5.2 Control Building

[*Structural acceptance criteria are defined in ANSI/AISC-N690 and ACI 349 Codes.*]* In no case does the allowable stress exceed 0.9 F_y, where F_y is the minimum specified yield stress. The design criteria preclude excessive deformation of the Control Building. The clearances between adjacent buildings are sufficient to prevent impact during a seismic event. The ~~tornado~~extreme (tornado and hurricane) load analysis for this building is the same as the analysis for the Reactor Building.

3.8.4.5.3 Radwaste Building Substructure

[*Structural acceptance criteria are defined in ANSI/AISC-N690 and ACI 349 Codes.*]* In no case does the allowable stress exceed 0.9 F_y, where F_y is the minimum specified yield stress. The design criteria preclude excessive deformation of the Reactor Building. The clearances between adjacent buildings are sufficient to prevent impact during a seismic event.

3.8.4.5.4 Seismic Category I Cable Trays and Conduit Supports

Structural acceptance criteria if the analysis option is selected are defined in ANSI/AISC-N690 Code. In no case does the allowable stress exceed 0.9 F_y where F_y is the minimum specified yield stress.

3.8.4.5.5 Seismic Category I HVAC Duct and Supports

The structural acceptance criteria for HVAC ducts if the analysis option is selected will be in accordance with ANSI/ASME AG-1 Code. The HVAC supports will be in accordance with the ANSI/AISC-N690 code.

3.8.5 Foundations

This section describes foundations for all Seismic Category I structures of the ABWR Standard Plant.

3.8.5.1 Description of the Foundations

The foundations of the Reactor Building and Control Building are reinforced concrete mat foundations.

These two foundation mats are separated from each other by a separation gap of 2m wide to minimize the structural interaction between the buildings.

The Reactor Building foundation is a rectangular reinforced concrete mat 56.6m by 59.6m and 5.5m thick. The foundation mat is constructed of cast-in-place conventionally reinforced concrete. It supports the Reactor Building, the containment structure, the reactor pedestal, and other internal structures. The top of the foundation mat is 20.2m below grade.

* See Subsection 3.8.3.2.

Table 3.8-7 Load Combinations for Foundation Design

Load Combination No.	Load Condition							
	D	L	H	F	F’	E’	W	W’
1	1.0	1.0	1.0	1.0				
2	1.0		1.0	1.0			1.0	
3	1.0	1.0	1.0	1.0		1.0		
4	1.0		1.0	1.0				1.0
5	1.0				1.0			

Nomenclature:

D	Dead Load
F	Buoyant Force of Design Ground Water
F’	Buoyant Force of Design Basis Flood
H	Lateral Earth Pressure
L	Live Load
E’	Basic SSE Seismic Load
W	Wind Load
W’	Tornado Wind

Note:

Load combinations 1 and 3 shall be evaluated for two cases where:

1. Live load is considered to have its full value, and
2. Live load is considered completely absent.
3. For extreme wind loads, the design basis tornado winds and missile loads bound those of the design basis hurricane.

3H Design Details and Evaluation Results of Seismic Category I Structures

3H.1 Reactor Building

3H.1.1 Objective And Scope

The objective of this subsection is to document the structural design and analysis of the ABWR Reactor Building. The scope includes the design and analysis of the structure for normal, severe environmental, extreme environmental, abnormal, and construction loads.

This subsection addresses all applicable items included in Appendix C to USNRC Standard Review Plan, NUREG-0800, Section 3.8.4.

3H.1.2 Conclusions

The following are the major summary conclusions on the design and analysis of the Reactor Building:

- Based on the design drawings identified in Subsection 3H.1.5, stresses and strains in concrete, reinforcement, and the liner are less than the allowable stresses and strains per the applicable codes listed in Subsection 3H.1.4.1.
- The factors of safety against flotation, sliding, and overturning of the structure under various loading combinations are higher than the required minimum.
- The thickness of the roof slabs and exterior walls are more than the minimum required to preclude penetration, perforation or spalling resulting from impact of design basis tornado missiles. For extreme wind loads, the design basis tornado whose winds and missile loads bound the design basis hurricane are as specifies in 3H.1.4.3.1.

3H.1.3 Structural Description

3H.1.3.1 Description of the Containment and the Reactor Building

The ABWR containment is integrated with, and fully contained within, the Reactor Building. The containment and the Reactor Building are supported by a 5.5m thick common foundation mat. The bottom of the foundation mat is embedded in the ground approximately 26m below grade. Figure 1.2-1 shows the location of the Reactor Building in relation to other plant structures. Figures 1.2-2 through 1.2-13k show the arrangement of the Reactor Building.

The containment structure is a right circular cylinder, 2m thick, with an inside radius of 14.5m and has a height of 29.5m measured from the top of the foundation mat to the bottom of the containment top slab.

The containment top slab is integral with the fuel pool girders and the containment wall. The top slab is nominally 2.2m thick. The slab thickness is increased to 2.4m beneath the fuel pool,

- Radius: 45.7m
- Maximum Pressure Drop: 13.83 kPa
- Maximum Rate of Pressure Drop: 8.28 kPa/s
- Missile Spectrum: See Table 2.0-1.

(9) Hurricane:

- Maximum Hurricane Wind Speed***: 286.5 km/h
- Maximum Rotational speed: 261.5 km/h
- Translational Velocity: 25 km/h
- Radius: 1500 m
- Maximum Pressure Drop: 0 kPaD

(10) Maximum Rainfall:

- Design rainfall is 493 mm/h. Roof parapets are furnished with scuppers to supplement roof drains, or are designed without parapets so that excessive ponding of water cannot occur. Such roof design meets the provisions of ASCE 7, Section 8.0.

Fuel pool floor shall also be designed for the following high-density storage racks loads.

Liner and Racks	= 53.0 kPa
Water	= 115.7 kPa
Consolidated Fuel	= 139.3 kPa
Total:	308.0 kPa

3H.1.4.3.1.2 Snow Load

Snow load shall be taken as 2.39 kPa. Snow load shall be reduced to 75% when snow load is combined with seismic loads.

3H.1.4.3.1.3 Wind Load (W)

Wind load based on basic wind speed of 177 km/h (Subsection 3H.1.4.2).

3H.1.4.3.1.4 Tornado Load (W_t)

For extreme wind loads, the design basis tornado winds and missile loads bound those of the design basis hurricane.

The tornado characteristics are defined in Subsection 3H.1.4.2. The tornado load, W_t is further defined by the following combinations:

$W_t = W_w$

$W_t = W_p$

$W_t = W_m$

$W_t = W_w + 0.5W_p$

$W_t = W_w + W_m$

$W_t = W_w + 0.5W_p + W_m$

where

$W_t =$ Total Tornado Load

$W_w =$ Tornado Wind Load

$W_p =$ Tornado Differential Pressure Load

$W_m =$ Tornado Missile Load

3H.1.5.5.3.3 R/B Floor Slabs

Sections 30 to 32 were selected for the floor slabs at elevations TMSL –1,700, TMSL 4,800 and TMSL 12,300 (see Figure 3H.1-21) at their junction with the Containment Wall. The forces and moments at these sections are shown in Tables 3H.1-10 to 3H.1-13. The resulting rebar and concrete stresses are shown in Tables 3H.1-15 to 3H.1-18. The rebar stresses are within the allowable stress limits. The slabs at elevation TMSL – 1,700 and TMSL 4,800 were also evaluated for buckling under the lateral soil pressure loads and were found to be adequate.

3H.1.5.5.3.4 Steam Tunnel Floors

Sections 33 and 34 were analyzed for the steam tunnel. The pipe break accident pressure load was applied to the steam tunnel wall and floor elements. No thermal gradient was applied across the wall thickness.

The sections are shown in Figure 3H.1-21 The forces and moments are given in Tables 3H.1-10 to 3H.1-13. The rebar and concrete stresses are shown in Tables 3H.1-15 to 3H.1-18. The stresses are all within the allowable limits.

3H.1.5.6 Foundation Stability

The Reactor Building was evaluated for stability against overturning, sliding and floatation. The energy approach was used in calculating the factor of safety against overturning.

The factors of safety against overturning, sliding and floatation are given in Table 3H.1-23. All of these meet the acceptance criteria.

Maximum soil bearing stress was found to be 700.2 kPa due to dead plus live loads which was found to increase to 2336.0 kPa when seismic and other loads are included.

3H.1.5.7 Tornado Missile Evaluation

The minimum thickness required to prevent penetration and concrete spalling was evaluated. The US Army Technical Manual TM-5-855-1 was used to calculate penetration by a tornado missile. This result was doubled to arrive at the minimum spalling thickness. The minimum thickness required is 384 mm and 335 mm for wall and slab respectively, which are less than that provided. The winds and missile loads of design basis tornado bound those of design basis hurricane.

Table 3H.1-5b Selected Load Combinations for the Reactor Building

	Concrete Structures Including Fuel Pool Girders	
Event	**Load Combination**	**Acceptance Criteria**
	1.4D + 1.7L	U
	$D + L + T_o + R_o + SRV + W_t$	U
	$D + L + P_t$ (1)	
LBL (30 min)	$D + L + 1.5 (P_a + CO) + T_a$	U
LBL/SBL (6 h)	$D + L + 1.5 (P_a + CO) + \cancel{+} 1.25 SRV + T_a$	U
LBL (30min) + SSE	$D + L + P_a + CO + T_a + SSE + R_a + Y$	U
IBL/SBL (6 h) + SSE	$D + L + P_a + CO + SRV + T_a + SSE$	U
W_t =	Tornado loading including effect of missile impact.	
R_o =	Pipe reaction during normal operating condition.	
T_o =	Normal operating thermal load.	
U =	Section strength required to resist design loads based on strength design methods described in ACI-349 Code.	
Notes:	1) L includes lateral earth pressure on the external walls. 2) The design basis tornado winds and missile loads bound those of the design basis hurricane.	

3H.3 Radwaste Building

3H.3.1 Objective Scope

The objective of this subsection is to document the structural design and analysis of the ABWR Radwaste Building. The scope includes the design and analysis of the basemat and exterior walls of the building for the normal, severe environmental, extreme environmental and construction loads.

This subsection addresses all applicable items included in Appendix C to USNRC Standard Review Plan, NUREG-0800, Section 3.8.4

3H.3.2 Conclusions

The following are the major summary conclusions on the design and analysis of the Radwaste Building:

- Based on the design drawings identified in Subsection 3H.3.5, stresses in concrete, reinforcement, and structural steel are less than the allowable stresses per the applicable codes listed in Subsection 3H.3.4.1.
- The factors of safety against flotation, sliding, and overturning of the structure under various loading combinations are higher than the required minimum.
- The building has been evaluated for the design basis tornado/hurricane. Welded studs are provided for the roof structural steel to provide required resistance for negative pressure.

3H.3.3 Structural Description

The basemat and exterior walls of the Radwaste Building which are at and below grade are Seismic Category I structures. The portions which are above grade are not Seismic Category I structures; however major structural concrete walls and slabs of these above grade structures are designed to resist Seismic Category I loads. The Radwaste Building houses the liquid, solid, and gaseous radwaste treatment and storage facilities, offgas monitoring, and maintenance areas.

The Radwaste Building is a 60.4m long (0°-180° direction) x 41.2m wide (90°-270° direction) structure that is 29.5m in height above the top of the 2.5m thick basemat. It consists of four floors, two of which are below grade. The total building embedment is 16m. The Radwaste Building is a reinforced concrete structure consisting of walls and slabs and is supported by a mat foundation. Steel framing is used to support the slabs for construction loads. Steel deck is used as form work to support the slabs during construction.

The location of the Radwaste Building in relation to other plant structures is shown on the Figure 1.2-1. Figures 1.2-23a through 1.2-23e show the arrangement of the building.

3H.3.4.3.1.3 Snow Load

A value of 2.39 kPa is used for snow live load (L). The snow load (L_o) is reduced to 75%, when it is combined with seismic loads.

3H.3.4.3.1.4 Lateral Soil Pressures (H and H')

The following soil parameters are used in the computation of lateral soil pressures:

Dry unit weight:	1.9 to 2.2 t/m^3
Shear wave velocity:	305 m/s
Internal friction angle:	30° to 40°

The dynamic lateral soil pressure increment due to SSE is calculated in accordance with the Mononobe-Okabe method.

The design of the structure is based on the at rest soil pressure. Figure 3H.3-1 shows the at rest lateral soil pressure H (excluding the dynamic soil pressure increment) and H' (including the dynamic soil pressure increment). Active and passive soil pressures are used in the evaluation of the structure. Figure 3H.3-2 shows these pressures.

3H.3.4.3.2 Severe Environmental Loads

The severe environmental load considered in the design is that generated by wind. The following parameters are used in the computation of wind loads.

Basic wind speed:	177 km/h
Exposure:	D
Importance factor:	1.1

Wind loads are calculated per the provisions of ASCE 7.

3H.3.4.3.3 Extreme Environmental Loads

Extreme environmental loads consist of loads generated by the tornado and safe shutdown earthquake. The design basis tornado whose wind and missile loads bound the design basis hurricane are as specified in 3H.1.4.3.1.

3H.3.4.3.3.1 Tornado Loads (W_t)

The following tornado load effects are considered in the design:

Table 3H.3-16 Maximum Soil Bearing Pressures

Load Case Name	Load Combination	Max. Soil Bearing Pressure kPa
Service		
90°–270°	D + L + H	73.75
0°–180°	D + L + H	73.75
Wind		
90°–270°	D + L + H + W_X	107.78
0°–180°	D + L + H + W_Y	123.07
Tornado (Wind Only)		
90°–270°	D + L + H + W_{WX}	116.11
0°–180°	D + L + H + W_{WY}	132.49
Tornado (Wind + 1/2PD)		
90°–270°	D + L + H + W_{WX} + 1/2 W_{wp}	109.34
0°–180°	D + L + H + W_{WY} + 1/2 W_{wp}	127.98
Tornado (Press. Drop)		
90°–270°	D + L + H + W_{WP}	92.57
0°–180°	D + L + H + W_{WP}	107.87
Seismic		
90°–270°; E_Z (down)	D + L + H’ + E_X + E_Z	237.71
0°–180°; E_Z (down)	D + L + H’ + E_y + E_Z	404.43

Note: For extreme wind loads, the design basis tornado whose winds and missile loads bound the design basis hurricane are as specified in 3H.1.4.3.1.

3H.2 Control Building

3H.2.1 Objective and Scope

The objective of this subsection is to document the structural design and analysis of the ABWR Control Building. The scope includes the design and analysis of the structure for the normal, severe environmental, extreme environmental, abnormal, and construction loads.

This subsection addresses all applicable items included in Appendix C to USNRC Standard Review Plan, NUREG-0800, Section 3.8.4.

3H.2.2 Conclusions

The following are the major summary conclusions on the design and analysis of the Control Building:

- Based on the design drawings identified in Subsection 3H.2.5, stresses in concrete, reinforcement, structural steel, and steel deck are less than the allowable stresses per the applicable codes listed in Subsection 3H.2.4.1.
- The factors of safety against flotation, sliding, and overturning of the structure under various loading combinations are higher than the required minimum.
- The thickness of the roof slabs and exterior walls are more than the minimum required to preclude penetration, perforation, or spalling resulting from impact of design basis tornado/hurricane missiles.
- The building has been evaluated for the design basis tornado/hurricane. Welded studs are provided for the roof structural steel to provide required resistance for negative pressure.

3H.2.3 Structural Description

The Control Building is a Seismic Category I structure which houses the control room, computer facility, electrical panels, electrical switchgear, Reactor Building cooling water facilities, electrical battery and motor control center (MCC) rooms, and HVAC facilities. The main steam tunnel from the Reactor Building to the Turbine Building is located in the top portion of the Control Building.

The Control Building is a 56m long xþ24m wide structure that is 30.4m high above the top of the 3m thick base mat. It consists of six floors, four of which are below grade. The total building embedment is 23.2m. It is a reinforced concrete structure consisting of walls and slabs and is supported by a mat foundation. Steel framing is used to support the slabs for construction loads. Steel deck is used as formwork to support the slabs during construction.

Figure 1.2-1 shows the location of the Control Building in relation to other plant structures. Figures 1.2-14 through 1.2-22 show the arrangement of the building.

3H.2.4.3.1.5 Normal Thermal Load (T_o)

The normal operating temperatures used in the design are as follows:

- Inside steam tunnel: 57°C
- Below steam tunnel: 18°C
- On either side of steam tunnel: 10°C
- Outside Control Building: 38°C Max.
  –23°C Min.

3H.2.4.3.2 Severe Environmental Loads

The severe environmental load considered in the design is that generated by wind. The following parameters are used in the computation of wind loads:

- Basic wind speed: 177 km/h
- Exposure: D
- Importance factor: 1.11

Wind loads are calculated per the provisions of ASCE 7. Figure 3H.2-16 shows wind loads used in the design.

3H.2.4.3.3 Extreme Environmental Loads

Extreme environmental loads consist of loads generated by the tornado and safe shutdown earthquake and, for extreme wind loads, the design basis tornado whose winds and missile loads bound the design basis hurricane, as specified in 3H.1.4.3.1.

3H.2.4.3.3.1 Tornado Loads (W_t)

The following tornado load effects are considered in the design:

- Wind pressure (W_w)
- Differential pressure (W_p)
- Missile impact (W_m)

and are used to resist lateral loads, like soil earth pressure, seismic loads, wind loads and tornado loads. Minimum thicknesses for the exterior walls and roof are provided to preclude concrete penetration, perforation, and spalling and to prevent local damage due to the tornado generated missiles. For extreme wind loads, the design basis tornado whose winds and missile loads bound the design basis hurricane are as specified in 3H.1.4.3.1.

All loads as described in Subsection 3H.2.4 are considered. The horizontal SSE seismic loads, as described in Subsection 3H.2.4.3.3.2, are the equivalent static loads as provided in Table 3H.2-1. The horizontal seismic loads applied at different elevations of the structural model are given as shear forces and moments. These forces are distributed to the nodal points at the appropriate elevations in proportion to the nodal point masses. The vertical SSE seismic loads are applied as pressure loads which are computed by multiplying the acceleration 'g' values by the total floor masses. The horizontal torsional moment has been considered by calculating the center of mass in each direction. A distance equal to 5% of the building dimension perpendicular to the direction of the force for each level multiplied by the mass generated the torsional moment.

Velocity pressure loading due to wind and tornado is determined by using the method and procedures contained in ASCE 7. Velocity pressure is assumed not to vary with height. All significant openings are considered sealed, i.e. the structure is non-vented.

Loads from Subsection 3H.2.4 are applied to the model as plate pressure and nodal loads and these loads are combined in accordance with the load combinations described in Subsection 3H.2.4.3.6.

3H.2.5.3 Structural Design

The Control Building is essentially a reinforced concrete structure consisting of walls and slabs and is supported by a mat foundation. Steel framing is used to support the slabs. Steel deck is used as form work to support the slabs during construction.

The reinforced concrete elements of the structure along with the steel framing form the vertical load resisting system. The vertical loads are carried by the slabs and steel framing to the walls and columns. The walls and columns transmit the loads to the base mat which then transfers them to the foundation soil.

The lateral load resisting system is composed of only the reinforced concrete elements. The roof and floor slabs act as diaphragms to transfer the lateral loads to the walls. The loads are transmitted to the base mat from the walls and then to the foundation soil. The design evaluation of the Control Building structure is divided into the following parts:

- Reinforced concrete elements
- Structural steel framing

3H.2.5.3.1.3 Walls

The exterior walls, i.e., walls on column lines A, D, 1, and 7 are divided into two segments for design purposes:

- Top segment between roof and elevation 17,150 mm TMSL
- Bottom segment between elevation 17,150 mm TMSL and the basemat.

The two segments differ in thickness. The design forces, and concrete thickness, required reinforcement, and provided reinforcement are shown in Table 3H.2-4.

Tornado/hurricane missile effect on exterior walls above grade has been assessed for local damage. The minimum design wall thickness is 600 mm, which is greater than the 384 mm minimum wall thickness required to preclude penetration, perforation, and spalling.

The interior walls are located on column lines 3 and 5. Table 3H.2-4 shows the design forces, concrete thickness, required reinforcement, and provided reinforcement.

3H.2.5.3.2 Structural Steel Framing

Structural steel framing consists of beams and columns. The steel framing with deck is required to support the steam tunnel floor and roof slabs when the concrete is wet. Once the concrete has attained its design strength, the slab will resist the load, and the steel framing is then redundant.

High-strength, low-alloy ASTM A572 steel with a yield strength (f_y) of 345 MPa is considered in the design. The choice of this high-strength steel over ASTM A36 steel is that it enables the use of less shallow beam sections, thereby increasing head room. Steel framing supporting floors at elevations 13,100 mm TMSL and 18,250 mm TMSL and roof at elevation 22,750 mm TMSL are encased in concrete to increase headroom. Columns are also of ASTM A572 steel so that smaller sections can be used.

Connections of steel framing supporting roof slabs at elevation 22,000 mm TMSL are designed to resist pullout due to tornado/hurricane suction.

Steel beams are supported by the concrete walls and steel columns. The columns are supported by base plates attached to the base mat by ASTMþA36 anchor bolts. The columns are designed as concentrically loaded compression members. The anchor bolts provided are nominal since they are not subjected to shear or tension.

The allowable stress design method is used for design of structural steel. AISC S-335 and ANSI/AISC-N690 govern the design. The number of different steel section sizes is kept to a minimum to optimize fabrication cost.

(4) The weight of the fuel assembly or bundle is supported axially by the rack lower support.

(5) The racks are fabricated from materials used for construction, in accordance with the latest applicable ASTM specifications.

(6) Lead-in guides at the top of the storage spaces provide guidance of the fuel during insertion.

(7) The racks are designed to withstand, while maintaining the nuclear safety design basis, the impact force generated by the vertical free-fall drop of a fuel assembly from a height of 1.8 meters.

(8) The rack is designed to withstand a pullup force of 17.79 kN and a horizontal force of 4.45 kN.

(9) The new-fuel storage racks require no periodic special testing or inspection for nuclear safety purposes.

9.1.1.3.3 Protection Features of the New-Fuel Storage Facilities

The new-fuel storage vault is housed in the Reactor Building. The vault and Reactor Buildings are Seismic Category I, and are designed to withstand natural phenomena such as tornadoes/hurricanes, tornado/hurricane missiles, floods and high winds. Fire protection features are described in Subsection 9.5.1 and Appendix 9A.

Procedural fuel-handling requirements and equipment design dictate that no more than one bundle at a time can be handled over the storage racks and at a maximum height of 1.8m above the upper rack. Therefore, the racks cannot be displaced in a manner causing critical spacing as a result of impact from a falling object.

The auxiliary hoist on the Reactor Building crane can traverse the full length of the refueling floor. This hoist is used to move new fuel from the entry point into the Reactor Building, up the main equipment hatch to the refueling floor and from there to the new-fuel storage vault. This hoist can move fuel to the new-fuel inspection stand and rechanneling area at the end of the spent-fuel storage pool.

Should it become necessary to move major loads along or over the pools, administrative controls require that the load be moved over the empty portion of the spent-fuel pool and avoid the area of the new-fuel storage vault. The shipping cask cannot be lifted or moved above the new-fuel vault because of their relative locations on the refueling floor.

to the spent-fuel pool are Seismic Category I, safety-related. The manual valves which permit the RHR System to take suction from the spent-fuel storage pool and cool the pool are accessible following an accident in sufficient time to permit an operator to align the RHR System to prevent the spent-fuel storage pool from boiling.

Furthermore, fire hoses can be used as an alternate makeup source. The fire protection standpipes in the Reactor Building and their water supply (yard main, one diesel engine driven pump and water source) are seismically designed. A second fire pump, driven by a motor powered from the combustion turbine generator, is also provided. Engineering analysis indicates that, under the maximum abnormal heat load with the pool gates closed and no pool cooling taking place, the pool temperature will reach about 100°C in about 16 hours. This provides sufficient time for the operator to hook up fire hoses for pool makeup. The COL applicant will develop detailed procedures and operator training for providing firewater makeup to the spent-fuel pool. See Subsection 9.1.6.9 for COL license information.

The FPC components, housed in the Seismic Category I Reactor Building, are Seismic Category I, Quality Group C, including all components except the filter-demineralizer. These components are protected from the effects of natural phenomena, such as: earthquake, external flooding, wind, tornado/hurricane and external missiles. The FPC System is non-safety-related with the exception of the RHR System connections for safety-related makeup and supplemental cooling. The RHR System connections will be protected from the effects of pipe whip, internal flooding, internally generated missiles, and the effects of a moderate pipe rupture within the vicinity. See Subsection 9.1.6.10 for COL license information.

From the foregoing analysis, it is concluded that the FPC System meets its design bases.

9.1.3.4 Inspection and Testing Requirements

No special tests are required because, normally, one pump, one heat exchanger and one filter-demineralizer are operating while fuel is stored in the pool. The spare unit is operated periodically to handle abnormal heat loads or to replace a unit for servicing. Routine visual inspection of the system components, instrumentation and trouble alarms is adequate to verify system operability.

9.1.3.5 Radiological Considerations

The water level in the spent-fuel storage pool is maintained at a height which is sufficient to provide shielding for normal building occupancy. Radioactive particulates removed from the fuel pool are collected in filter-demineralizer units which are located in shielded cells. For these reasons, the exposure of plant personnel to radiation from the FPC System is minimal. Further details of radiological considerations for this and other systems are described in Chapters 11, 12, and 15.

9.2.5.5 Spray Pond Thermal Performance (Conceptual Design)

9.2.5.5.1 Design Meteorology

The COL applicant shall obtain and use conservative site-specific design meteorological data in the detailed design of the spray pond.

9.2.5.5.2 Spray Pond Water Requirements

The COL applicant shall determine the water requirements used in selecting spray pond design volume and used in the pond thermal performance analysis. These requirements include:

(1) Evaporation Due to Plant Heat Load

(2) Natural Evaporation

(3) Drift Loss

(4) Seepage

(5) Sedimentation

(6) Water Quality

(7) Minimum Water Level for Operation

9.2.5.6 Evaluation of UHS Performance (Interface Requirements)

The COL applicant shall analyze the UHS performance to assure that UHS is adequate for 30 days of cooling without makeup or blowdown and that the cooling water temperature does not exceed the design limit for design basis heat input and site conditions.

9.2.5.7 Safety Evaluation (Interface Requirements)

9.2.5.7.1 Thermal Performance

The COL applicant shall demonstrate by analysis that the UHS is capable of providing cooling water within the design temperature limit for at least 30 days for the design basis event using conservative meteorology and assumptions.

9.2.5.7.2 Effects of ~~Severe~~Extreme Natural Events or Site-Related Events

The COL applicant shall demonstrate by analysis that the UHS is capable of fulfilling its safety function concurrent with any of the following events: SSE, tornado/hurricane, flood, drought, transportation accident, or fire.

9.2.9.3 Safety Evaluation

Operation of the MUWC System is not required to assure any of the following conditions:

(1) Integrity of the reactor coolant pressure boundary.

(2) Capability to shut down the reactor and maintain it in a safe shutdown condition.

(3) Ability to prevent or mitigate the consequences of events that could result in potential offsite exposures.

The MUWC System is not safety-related. However, the system incorporates features that assure reliable operation over the full range of normal plant operations.

9.2.9.4 Tests and Inspections

The MUWC System is proved operable by its use during normal plant operation. Portions of the system normally closed to flow can be tested to ensure operability and the integrity of the system.

9.2.10 Makeup Water Purified System

9.2.10.1 Design Bases

(1) The Makeup Water Purified (MUWP) System shall provide makeup water purified for makeup to the reactor coolant system and plant auxiliary systems.

(2) The MUWP System shall provide purified water to the uses shown in Table 9.2-2.

(3) The MUWP System shall provide water of the quality shown in Table 9.2-2a. If these water quality requirements are not met, the water shall not be used in any safety-related system. The out-of-spec water shall be reprocessed or discharged.

(4) The MUWP System is not safety-related.

(5) All piping and other equipment shall be made of corrosion-resistant materials.

(6) The system shall be designed to prevent any radioactive contamination of the purified water.

(7) The interfaces between the MUWP System and all safety-related systems are located either in the Control Building or Reactor Building, which are Seismic Category I, tornado-~~missile~~/hurricane missile resistant and flood protected structures. The interfaces with safety-related systems are safety-related valves which are part of the safety-related systems. The portions of the MUWP System, which upon their failure

(5) Safety-related portions of the RCW System shall be protected from flooding, spraying, steam impingement, pipe whip, jet forces, missiles, fire, and the effect of failure of any non-Seismic Category I equipment, as required.

(6) The safety-related portion of the RCW System shall be designed to meet the foregoing design bases during a loss of preferred power (LOPP).

(7) The safety-related electric modules and safety-related cables for the RCW System are in the Control Building and Reactor Building, which are Seismic Category I, tornado~~-missile~~/hurricane missile resistant and flood protected structures.

(8) Protection from being impacted adversely by missiles generated by any non-safety-related component shall be provided as discussed in Subsection 3.5.1.

(9) Protection against high-energy and moderate-energy line failures will be provided in accordance with Section 3.6.

(10) Piping within the Control Building shall be fabricated and installed as all welded piping. Major components may have flange bolted or welded connections to the piping system. No expansion joints or bellows assemblies shall be used within the Control Building.

9.2.11.1.2 Power Generation Design Bases

The RCW System shall be designed to cool various plant auxiliaries as required during: (a) normal operation; (b) emergency shutdown; (c) normal shutdown; (d) testing; and (e) loss of preferred power (LOPP).

9.2.11.2 System Description

The RCW System distributes cooling water during various operating modes, during shutdown, and during post-LOCA operation. The system removes heat from plant auxiliaries and transfers it to the Reactor Service Water System (Subsection 9.2.15). Figures 9.2-1, sheets 1 through 9, show the piping and instrumentation diagram. Design characteristics for RCW System components are given in Table 9.2-4d.

The Control and Service Building general arrangement drawings, Figures 1.2-14 through 1.2-17 (and companion Fire Protection drawings, Figure 9A.4-11 through 9A.4-13, and Radiation Protection drawings Figures 12.3-42, 43, 48 and 64) show the location of the RCW pumps and heat exchangers. (Note: the heat exchangers are depicted as shell-and-tube type; however, the alternate plate-type can be accomodated in the same area of the Control Building in a horizontal arrangement at elevation -8200mm, the same elevation as the pumps).

The RCW system serves the auxiliary equipment listed in Tables 9.2-4a, 9.2-4b, and 9.2-4c.

Some of the cooling loads are serviced by only one or two RCW divisions. These components may be reassigned to other RCW divisions if redundancy and divisional alignment of supported

(9) The system piping design will take into account unacceptable nil-ductility-temperature conditions associated with normal and transient operation.

9.2.13.2 System Description

The HECW System consists of subsystems in three divisions. Divisions A, B and C have two refrigerator units, two pumps, instrumentation and distribution piping and valves to corresponding cooling coils. A chemical addition tank is shared by all HECW divisions. Each HECW division shares a surge tank with the corresponding division of the RCW System. The refrigerator capacity is designed to cool the Reactor Building safety-related electrical equipment HVAC Systems and Control Building safety-related equipment area HVAC Systems.

The system is shown in Figure 9.2-3. The refrigerators are located in the Control Building as shown in Figures 1.2-20 and 1.2-21. Each refrigerator unit consists of a evaporator, a compressor, refrigerant, piping, and package chiller controls. This system shares the RCW surge tanks which are in the Reactor Building (Figure 1.2-12). Equipment is listed in Table 9.2-8. Each cooling coil is controlled by a room thermostat. Alternately, flow may be controlled by a temperature control valve. Condenser cooling is from the corresponding division of the RCW System.

Piping and valves for the HECW System, as well as the cooling water lines from the RCW System, designed entirely to ASME Code, Section III, Class 3, Quality Group C, Quality Assurance B requirements. The extent of this classification is up to and including drainage block valves. There are no primary or secondary containment penetrations within the system. The HECW System is not expected to contain radioactivity.

High temperature of the returned cooling water causes the standby refrigerator unit to start automatically. Makeup water is supplied from the MUWP System, at the surge tank. Each surge tank has the capacity to replace system water losses for more than 100 days during an emergency. The only non-safety-related portions of the HECW divisions are the chemical addition tank and the piping from the tank to the safety-related valves which isolate the safety-related portions of the system.

Also, see Subsection 9.2.17.1 for COL license information requirements.

9.2.13.3 Safety Evaluation

The HECW System is a Seismic Category I system, protected from flooding and tornado/hurricane missiles. All components of the system are designed to be operable during a loss of normal power by connection to the ESF buses (Tables 8.3-1 and 8.3-2). Redundant components are provided to ensure that any single component failure does not preclude system operation. The system is designed to meet the requirements of Criterion 19 of 10CFR50. The refrigerators of each division are in separate rooms.

tied such that operation of any one of each results in successful operation of the system. The SLCS also has test capability. A special test tank is supplied for providing test fluid for the yearly injection test. Pumping capability, injection valve operability and suction valve operability may be tested at any time.

The SLCS is evaluated against the applicable regulatory guides as follows:

Regulatory Guide 1.26—Because the SLCS is a reactivity control system, all mechanical components are at least Quality Group B. Those portions which are part of the reactor coolant pressure boundary are Quality Group A (Table 3.2-1).

Regulatory Guide 1.29—All components of the SLCS which are necessary for injection of neutron absorber into the reactor are Seismic Category I (Table 3.2-1).

ASB 3-1 and MEB 3-1—Since the SLCS is located within its own compartment inside the secondary containment, it is adequately protected from flooding, tornadoes, hurricanes, and internally/externally generated missiles. SLCS equipment is protected from pipe break by providing adequate distance between the seismic and nonseismic SLCS equipment, where such protection is necessary. In addition, appropriate distance is provided between the SLCS and other high-energy piping systems.

Barriers have been considered to assure SLCS protection from pipe break (Section 3.6).

It should be noted that the SLCS is not required to provide a safety function during any postulated pipe break event. This system is only required under an extremely low probability event, where all of the control rods are assumed to be inoperable while the reactor is at normal full power operation. Therefore, the protection provided is considered over and above that required to meet the intent of ASB 3-1 and MEB 3-1.

This system is used in special plant capability demonstration events cited in Appendix A of Chapter 15; specifically, Events 54 and 56, which are extremely low probability non-design-basis postulated incidents. The analyses given there are to demonstrate additional plant safety considerations far beyond reasonable and conservative assumptions.

9.3.5.4 Testing and Inspection Requirements

Operational testing of the SLCS is performed in at least two parts to avoid inadvertently injecting boron into the reactor.

With the valves to the reactor and from the storage tank closed, and the valves to and from the test tank opened, condensate water in the test tank can be recirculated by locally starting either pump.

9.4 Air Conditioning, Heating, Cooling and Ventilating Systems

9.4.1 Control Building HVAC

The Control Building (C/B) Heating, Ventilating and Air-Conditioning (HVAC) System is divided into two separate systems: (1) an HVAC System for the main control area envelope within two floors, and (2) an HVAC System for safety-related electrical and RCW heat exchange equipment.

9.4.1.1 Control Room Habitability Area HVAC

9.4.1.1.1 Design Basis

(1) The control room habitability area (CRHA)HVAC System is designed with sufficient redundancy to ensure operation under emergency conditions assuming the single failure of any one active component. Independence is provided between Class 1E divisions and also between Class 1E divisions and non-class 1E equipment.

(2) Provisions are made in the system to detect and limit the introduction of airborne radioactive material in the main control area envelope (MCAE).

(3) Provisions are made in the system to detect and remove smoke and radioactive material from the MCAE.

(4) The control room habitability area HVAC System is designed to provide a controlled temperature environment to ensure the continued operation of safety-related equipment under accident conditions.

(5) The control room habitability area HVAC System and components are located in the Seismic Category I Control Building, a structure that is tornado-missile, and flood protected.

(6) Tornado/hurricane missile barriers and tornado dampers are provided at each intake and exhaust structure.

(7) Protection from exterior smoke, toxic chemical and chlorine releases are discussed in Section 6.4.

9.4.1.1.2 Power Generation Design Basis

(1) The control room habitability area HVAC System is designed to provide an environment with controlled temperature and humidity to ensure both the comfort and safety of the operators. The range of design conditions for the control room environment are 21°C to 26°C and 10% to 60% relative humidity.

(2) The system is designed to permit periodic inspection of the principal system components.

Differential pressure-indicating controllers modulate dampers in the exhaust air ducts to maintain positive pressure of at least 3.2 mm water gauge.

Manual start of an air conditioning unit supply fan provides a start signal to the HECW pump and an interlock signal to open the cooling coil chilled water valve. A temperature indicating controller installed in the MCR modulates the chilled water valve to maintain space temperatures. A moisture sensor controls the operation of a humidifier. The exhaust fan starts automatically when the supply fan starts.

During winter, the electric unit heaters in the equipment rooms are cycled by temperature-indicating control switches, located within the filter rooms and the air-conditioner rooms.

The supply, return and exhaust air ducts have manual balancing dampers provided in the branch ducts for balancing purposes. The dampers are locked in place after the system is balanced.

9.4.1.1.7 Regulatory Guide 1.52 Compliance Status

The control room habitability area emergency filter units comply with all applicable provisions of Regulatory Guide 1.52, Section C, except as noted below.

The revisions of ANSI N509 and ANSI/ASME AG-1 listed in Table 1.8-21 are used for ABWR ESF filter train design; the Regulatory Guide references older revisions of these standards.

9.4.1.1.8 Standard Review Plan 6.5.1 Compliance Status

The control room habitability area emergency filtration units comply with SRP 6.5.1, Table 6.5.1-1.

9.4.1.2 C/B Safety-Related Equipment Area HVAC

9.4.1.2.1 Design Basis

(1) The C/B safety-related equipment area C/B SREA HVAC System is designed with sufficient redundancy to ensure operation under emergency conditions, assuming the failure of any one active component.

(2) The C/B SREA HVAC System is designed to provide a controlled temperature environment to ensure the continued operation of safety-related equipment under accident conditions.

(3) The C/B SREA HVAC System and components are Seismic Category I and are located in a Seismic Category I control building structure that is tornado-missile, and flood protected.

(4) Tornado/hurricane missile barriers and tornado dampers are provided at each intake and exhaust structure.

containment HVAC System during the normal operating mode, and by standby gas treatment system in isolation mode.

The systems and components are Seismic Category I and are located in the Reactor Building, separate and independent compartments of a Seismic Category I structure that is tornado-/hurricane missile, and flood protected.

Fire protection has been evaluated and is described in Subsection 9.5.1.

9.4.5.2.1.2 Power Generation Design Bases

The system is designed to provide an environment with controlled temperature and humidity to ensure both the comfort and safety of plant personnel and the integrity of Reactor Building equipment. The systems are designed to facilitate periodic inspection of the principal system components.

9.4.5.2.2 System Description

The R/B Safety-Related Equipment HVAC System consists of 12 safety-related fan coil units (FCU) of division A, B, or C. Each FCU has the responsibility to cool one safety-related equipment room in the secondary containment. The safety-related equipment HVAC (fan coil units) system P&ID is shown in Figure 9.4-3. Space temperatures are maintained less than 40°C normally and less than 66°C during pump operation:

(1) RHR(A) pump room

(2) RHR(B) pump room

(3) RHR(C) pump room

(4) HPCF(B) pump room

(5) HPCF(C) pump room

(6) RCIC pump room

(7) FCS(B) room

(8) FCS(C) room

(9) SGTS(B) room

(10) SGTS(C) room

(11) CAMS(A) room

(12) CAMS(B) room

9.4.5.2.2.1 RHR, HPCF and RCIC Pump Room HVAC Systems

The FCU's automatically start when RHR pumps, HPCF pumps, and RCIC turbine are started. These rooms are normally cooled by the Secondary Containment HVAC System. The fan coil units are open ended and recirculate cooling air within the space served. Space heat is removed by cooling water passing through the coil section. Divisional Reactor Building Cooling Water (RCW) is used as the cooling medium. The units are fed from the same divisional power as that for the equipment being served. Drain pan discharge (condensate) is routed to a floor drain located within the room.

9.4.5.2.2.2 FCS Room HVAC Systems

Cooling of the FCS rooms are automatically initiated upon receipt of a secondary containment isolation signal or a manual FCS start signal.

These rooms are cooled by the Secondary Containment HVAC System during normal conditions. The units are open ended and recirculate cooling air within the space served. Space heat is removed by cooling water passing through the coil section. Divisional RCW is used as the cooling medium. The units are fed from the same divisional power as that for the FCS being served. Humidity is not specifically maintained at a set range, but is automatically determined by the surface temperature of the cooling coil. Drain pan discharge (condensate) is routed to a floor drain located within the room.

9.4.5.2.2.3 SGTS and CAMS HVAC Systems

Cooling of the SGTS and CAMS rooms are automatically initiated upon receipt of a secondary containment isolation signal.

These rooms are cooled by the Secondary Containment HVAC System during normal conditions. The units are open ended and recirculate cooling air within the space served. Space heat is removed by cooling water passing through the coil section. Divisional RCW is used as the cooling medium. The units are fed from the same divisional power as that for the equipment being served. Drain pan discharge (condensate) is routed to a floor drain located within the room.

9.4.5.2.3 Safety Evaluation

All equipment is located completely in a Seismic Category I structure that is tornado~~ missile,~~/hurricane missile and flood protected. All equipment is designed to Engineered Safety Feature requirements.

9.4.5.2.4 Inspection and Testing Requirements

All major components are tested and inspected as separate components prior to installation to ensure design performance. The system is preoperationally tested in accordance with the requirements of Chapter 14.

determined by the surface temperature of the cooling coil. Drain pan discharge (condensate) is routed to a drain sump located within the room.

9.4.5.3.3 Safety Evaluation

Operation of the R/B Non-safety-related Equipment HVAC System is not a prerequisite to assurance of either of the following:

(1) Integrity of the reactor coolant pressure boundary

(2) Capability to safely shut down the reactor and to maintain a safe shutdown condition

However, the system does incorporate features that provide reliability over the full range of normal plant operations.

9.4.5.3.4 Inspection

The system is designed to permit periodic inspection of important components, such as fans, motors, belts, coils, and valves, to assure the integrity and capability of the system.

All major components are tested and inspected as separate components prior to installation to ensure design performance. The system is preoperationally tested in accordance with the requirements of Chapter 14.

9.4.5.3.5 Instrumentation Application

The R/B Non-safety-related Equipment HVAC System starts manually.

9.4.5.4 R/B Safety-Related Electrical Equipment HVAC System

9.4.5.4.1 Design Bases

9.4.5.4.1.1 Safety Design Bases

The R/B Safety-Related Electrical Equipment HVAC System is designed to provide a controlled temperature environment to ensure the continued operation of safety-related equipment under accident conditions. The rooms cooled by the R/B Safety-Related Electrical Equipment HVAC System are maintained at positive pressure relative to atmosphere during normal and accident conditions. This is achieved by sizing intake fans larger than exhaust fans.

The power supplies to the HVAC systems for the R/B safety-related electrical equipment rooms allow uninterrupted operation in the event of loss of normal offsite power.

The system and components are located in a Seismic Category I structure that are tornado/hurricane ~~-~~missile, and flood protected, including tornado missile barriers on intake and exhaust structures.

For compliance with code standards and regulatory guides, see Sections 3.2 and 1.8.

HVAC system Division A serves electrical Division I, Division B serves electrical Divisions II and IV, and Division C serves electrical Division III of the electrical equipment rooms. Also, non-safety-related reactor internal pumps ASD rooms are cooled by the Electrical Equipment HVAC system.

9.4.5.4.3 Safety Evaluation

All safety-related equipment is located in a Seismic Category I structure that is tornado/hurricane missile ~~missile,~~ and flood protected. All HVAC equipment is designed to Engineered Safety Feature requirements.

9.4.5.4.4 Inspection and Testing Requirements

The systems are designed to permit periodic inspection of important components, such as fans, motors, coils, filters, ductwork, dampers, piping, and valves to assure the integrity and capability of the system. Standby components can be tested periodically to ensure system availability.

The medium-grade filter differential pressure instrumentation is provided to determine the appropriate filter change out period. All major components are tested and inspected as separate components prior to installation to ensure design performance. The system is preoperationally tested in accordance with the requirements of Chapter 14.

9.4.5.4.5 Instrumentation Application

The R/B Safety-Related Electrical Equipment HVAC Systems of each division are started manually from a station located in the main control room. Air-flow failure is sensed by a flow switch which automatically starts the standby fan and activates an alarm in the control room to indicate the fan failure. The safety-related electrical equipment area exhaust fans start automatically when the air conditioning unit supply fan starts.

Temperature control is accomplished by monitoring the air temperature leaving the cooling coils. Temperature and flow are set for maximum operating loads. HECW flow is controlled by the temperature indicating controller.

Fire dampers separating electrical Divisions II and IV rooms that use fusible links in HVAC ductwork will close under airflow conditions after fusible links melt.

9.4.5.5 R/B Safety-Related Diesel Generator HVAC System

9.4.5.5.1 Design Bases

9.4.5.5.1.1 Safety Design Bases

The R/B Safety-Related Diesel Generator HVAC System P&ID is shown in Figure 9.4-3. The R/B Safety-Related Diesel Generator HVAC System flow rates are given in Table 9.4-3 and the system component descriptions are given in Table 9.4-4. The R/B Safety-Related Diesel

Generator HVAC System is designed to provide filtered outdoor cooling air to ensure the continued operation of safety-related diesels under accident conditions. The power supplies to the outdoor cooling air supply systems for the safety-related diesel generator allow uninterrupted operation in the event of loss of normal offsite power.

Each division of three HVAC system divisions and components are Seismic Category I and are located in separate and independent compartments of the Reactor Building, a Seismic Category I structure that is tornado/hurricane missile~~-missile~~, and flood protected, including tornado/hurricane missile barriers on intake and exhaust structures.

For compliance with code standards and regulatory guides, see Sections 3.2 and 1.8.

For information on fire protection and smoke removal methods for the Safety-related Diesel Generator HVAC Systems, see Subsection 9.4.5.4.1.1.

9.4.5.5.1.2 Power Generation Design Bases

The system is designed to provide outdoor air to ensure the integrity of the safety-related diesel generators. The system is designed to facilitate periodic inspection of the principal system components.

9.4.5.5.2 System Description

The R/B Safety-Related Diesel Generated HVAC System for each of three diesel generator divisions consists of a filter and two supply fans and associated ductwork. They both take air from the outside through a tornado damper and a fire damper and distribute it to the diesel generator room. The exhaust air is forced out the exhaust louvers and a tornado damper.

9.4.5.5.3 Safety Evaluation

The diesel generator rooms are designed to the requirements specified in Section 3.2. The systems are connected to their corresponding division Class 1E bus, are independent, physically separated, and are operable after loss of offsite power supply.

The diesel generator compartments ventilated by the R/B safety-related Diesel Generator HVAC System are maintained at positive pressure relative to atmosphere when the diesel generators are operating. This is achieved by only using supply fans. At other times the diesel generator compartments are maintained at positive pressure relative to atmosphere by the R/B SREE HVAC System.

The intake louvers are located at 11.5m above grade and exhaust louvers are at 8.5m above grade (see general arrangement drawing, Figures 1.2-11 and 1.2-12).

All HVAC equipment is designed to Engineered Safety Feature requirements.

A set of transfer pumps may be operated with manual control switches from the main control room and locally. However, they are normally operated automatically by level switches on the day tanks. A "low" level switch starts the first transfer pump, a "low-low" level switch starts the standby transfer pump and a "high" level switch stops both pumps.

Capability analyses will be performed in accordance with acceptable industry practice to assure the seven day and eight hour storage and day tank capacities, respectively.

An engine-driven fuel oil pump increases the fuel pressure to the diesel engine fuel manifold. Fuel oil transfer system piping is ASME Code Section III, Class 3, Seismic Category I. A motor driven fuel oil booster pump is also provided for priming purpose, and for added reliability.

9.5.4.3 Safety Evaluation

The overall diesel-generator fuel oil storage and transfer system is designed so that failure of any one component may result in the loss of fuel supply to only one diesel-generator. The loss of one diesel-generator does not preclude adequate core cooling under accident conditions.

Day tank fuel oil feed to the fuel pump is by gravity. There are no powered components to fail. A duplex suction strainer prevents foreign matter from entering the pump and causing malfunction. The system is safety-related and all piping and components up to the engine skid connection are designed and constructed in accordance with the ASME Code Section III, Class 3, and Seismic Category I requirements.

The diesel-generator fuel oil storage and transfer system is designed to withstand the adverse loadings imposed by earthquakes, tornadoes and winds. For extreme wind loads, the design basis tornado whose winds and missile loads bound the design basis hurricane are as specified in 3H.1.4.3.1. Earthquake protection is provided by the Seismic Category I construction. Tornado and wind protection is provided by locating system components either underground or within the reactor building. All underground piping is covered with protective coating and wrapping to guard against corrosion. The Seismic Category I portions of diesel-generator fuel oil piping will be routed in tunnels between the storage tanks and the Reactor Building. The system will be provided with a protection against external and internal corrosion. The buried portion of the tanks and piping will be provided with waterproof protective coating and an impressed current-type cathodic protection, to control the external corrosion of underground piping system. The impressed current-type cathodic protection system will be designed to prevent the ignition of combustible vapors or fuel oil present in the fuel oil system, in accordance with Regulatory Guide 1.137, Paragraph C.1.g.

All storage and day tanks are located at a sufficient distance away from the plant control room to preclude any danger to control room personnel or equipment resulting from an oil tank explosion and/or fire. The fuel oil day tank is located in a separate room with 3-hr fire rated concrete walls. The quality of the fuel oil used for diesel engine will be ensured per Appendix

9.5.5 Diesel-Generator Jacket Cooling Water System

9.5.5.1 Design Bases

All essential components of the diesel-generator cooling water system shall be qualified to Seismic Category I requirements and to 10CFR50 Appendix B. All engine-skid mounted pumps, valves, tanks, piping and heat exchangers shall be designed in accordance with ASME Code, Section III, Class 3, Quality Group C. Failure of the cooling system in any one engine shall not affect the readiness or operability of any other engine. Each cooling system rejects its heat to the Reactor Building Cooling Water (RCW) System of the corresponding division. Diesel-generators DG-A, DG-B and DG-C are located in Seismic Category I structures, protected from tornado/hurricane~~-generated~~ missiles and flood waters. The jacket water cooling system shall be able to operate at full load for seven days without any makeup.

The diesel engine shall be capable of operating for two minutes without secondary cooling to ensure that the engine can operate at full load in excess of the time required to restore cooling water (RCW and RSW), which are sequenced onto the Class 1E power supply within one minute following a loss of preferred power (see Table 8.3-4).

9.5.5.2 System Description

Although specific suppliers may differ in the final design, a typical P&ID is provided as Figure 9.5-7.(See Subsection 9.5.13.6 for COL license information).

Each diesel-generator unit is supplied with a complete closed loop cooling system mounted integrally with the engine generator package. Included in each cooling package are a jacket water heater and keep-warm pump, temperature-regulating valve, lube oil cooler, motor and/or engine-driven jacket water pumps, jacketed manifold and a jacket water cooler, which is furnished with RCW from the essential portion of the system. RCW supply is from the same division as that of the diesel generator served.

The jacket cooling water passes through a three-way temperature control valve which modulates the flow of water through or around the jacket water heat exchangers (coolers), as necessary, to maintain required water temperature. Jacket water cools the turbocharger, the governor, the air cooler, the exhaust manifold and the lube oil cooler. The three-way valve, whose service is crucial, is designed and qualified as stated in Subsection 9.5.5.1.

An electric heater is installed in each system for the purpose of keeping the engine jacket water at a temperature near the normal operating level during plant normal operation. The heater water is circulated (via the keep-warm pump) through the engine to assure temperature uniformity in the engine while in standby. Two jacket water circulating pumps are provided to circulate the cooling water through the system during diesel-generator operation. During the standby mode, the jacket water temperature is maintained at 48.9°C based on 15.6°C normal ambient temperature.

will trip on high-high cooling water temperature. See Subsection 8.3.1.1.8.5 for complete alarms.

9.5.6 Diesel-Generator Starting Air System

9.5.6.1 Design Bases

The Diesel-Generator Starting Air System provides a supply of compressed air for starting the emergency generator diesel engines without external power. In order to meet the single-failure criterion, each diesel-generator set is provided with two complete, redundant starting air systems. Each starting air system has enough air storage capacity for five consecutive starts of the engine, and performs its starting function in such a way that the time interval between signal to start and "ready to load" status will not exceed 20 sec. The air storage tanks, valves and piping between tank and up to first connection on the engine skid are designed to Seismic Category I requirements, and in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Class 3. The system is located in a Seismic Category I structure, protected against tornado, external missiles and flood waters. For extreme wind loads, the design basis tornado whose winds and missile loads bound the design basis hurricane are as specified in 3H.1.4.3.1.

9.5.6.2 System Description

Although specific suppliers may differ in the final design, a typical P&ID is provided as Figure 9.5-8 (see Subsection 9.5.13.5 for COL license information).

The diesel-generator starting air system provides a separate and independent starting facility for each of the diesel-generating units. Each facility includes two 100% capacity sections, each section consisting of an air compressor, after cooler, air dryer and air receiver. Two redundant starting air admission valves in each of two engine starting air manifolds are provided for each engine. Failure of an one starting system in no way affects the ability of any other system to perform its required safety-related function. Normally, the compressors are fully automatic in operation, controlled by pressure switches located on their respective air receivers. The pressure switches signal the start and stop of the compressors, as necessary to maintain the required system pressure. Manual override of the automatic sequence is provided for emergency situations.

To avoid depleting air start capability, following unsuccessful automatic starting of the diesel generator with and without AC external power, each diesel generator's air receiver tanks will have sufficient air remaining for three more successful starts without recharging (i.e., a total of five starts). Each motor-driven compressor has sufficient capacity to recharge the storage system in 30 min, after five starts of the diesel engine. The compressors are electric motor-driven, and receive power from the Class 1E bus within the same division.

Each air receiver is also provided with a blowdown connection. A connection at the receiver bottom will be used to blow down any water accumulated in the tank. The starting air admission

(4) Pressure gauges on the receivers to verify calibration.

(5) Air receivers to clear accumulated moisture using the blowdown connection.

9.5.6.5 Instrument Application

An air receiver low pressure alarm is provided to alert the control room operator in case of loss of starting air pressure. See Section 8.3.1.1.8.5 for complete alarms.

9.5.7 Diesel Generator Lubrication System

9.5.7.1 Design Bases

The Diesel Generator Lubrication System is a self-contained system designed to supply clean, filtered oil to the engine and generator bearing surfaces at controlled pressure and temperature. Built-in capability ensures adequate lubrication of wearing surfaces, and cooling as necessary. An electric heater and a keep-warm circulating pump maintain sufficient circulation of warm oil to help keep the engine in standby readiness. The keep-warm pump also serves as a priming pump to provide prelubrication of engine components. (See Response 430.293 in Subsection 20.3.16.) The pumps, valves, tanks and heat exchangers shall be designed in accordance with ASME Code, Section III, Class 3, Quality Group C.

The system is located in a Seismic Category I structure providing protection from tornado/hurricane- generated missiles and flood waters, as well as the effects of pipe whip and jet impingement from high and moderate energy pipe failures.

9.5.7.2 System Description

Although specific suppliers may differ in the final design, a typical P&ID is provided as Figure 9.5-9. See Subsection 9.5.13.5 for COL license information.

All components herein described are supplied as part of the diesel-generator package by the diesel-generator supplier. All three systems are nuclear safety-related except for the keep-warm heaters and pumps. In the event of the LOPP or other emergency requiring diesel generator operation, the lube oil keep-warm system is shut down.

Each of the three diesel-generator lubrication systems consists of an oil sump in the engine frame, an engine-driven positive displacement pump, an oil cooler, a main header, and oil strainer and a filter. The main engine-driven lube oil pump takes oil from the sump, passes it through the lube oil cooler and lube oil filter, through a strainer, through the main header and back to the sump. A second feed line from the strainer supplies oil to the turbos via the rocker lube system. Constant oil pressure to the main header is maintained by pressure-regulating valves, which bypasses excess oil back to the sump.

exhaust system in any one diesel generator shall not compromise the readiness or operability of any other diesel generator. Except for the exhaust silencers, the system shall be housed in a Seismic Category I and tornado/hurricane~~-generated~~ missile-protected structure. The system shall also be protected from flooding and the effects of pipe breaks.

The exhaust silencers for the diesel generators shall be seismically mounted and bolted down in the horizontal position such that the likelihood of their sustaining significant damage, or becoming missiles during a tornado or hurricane event is extremely remote. However, the probability of the silencers themselves being damaged due to externally generated missiles is acceptable. This is because the silencer can be lost without affecting the operation of the diesel unless debris from the damaged silencer clogs the exhaust pipe. In this highly unlikely scenario, the diesel would be assumed lost and the plant shutdown could still be accomplished with either of the remaining two diesels.

The design basis for the Diesel Generator Combustion Air Intake and Exhaust System, regarding protection from the effects of contaminating substances related to the facility site, systems, and equipment is as follows:

(1) There are no contaminating substances available within the ABWR buildings to the combustion air intake in quantities which could degrade the diesel engine performance.

(2) Restriction or contaminating substances from the plant site, which may be available to the combustion air intake is COL license information requirement (Subsection 9.5.13.1).

(3) The diesel engine exhaust system is capable of exhausting the products of combustion to the atmosphere.

9.5.8.2 System Description

Although specific suppliers may differ in the final design, a typical P&ID is provided as the center portion of Figure 9.5-6. See Subsection 9.5.13.5 for COL license information.

Each engine DG-A, DG-B and DG-C takes combustion air from its own inlet air cubical above the diesel generator room. The air is filtered as it enters the cubical through the outside wall above. See Section 9.4.5.5 for a description of the diesel-generator HVAC system.

Engine exhaust gases are ducted out of the building. The exhaust is ducted up through the Reactor Building to the roof where the silencers are mounted. Each engine has its own exhaust system.

In order to protect the crank case from accumulation of fumes and possible consequent fire and explosion, the crank case is kept at negative pressure by vacuum blowers. The gases are exhausted to an outside vent via a 150 A pipe which passes through the Reactor Building wall

(4) Doors, in general, are 3-hour rated, complying with NFPA ratings. There are also doors, not labeled, which provide building separation. Typical of these are the doors for the personnel air lock into the reactor containment and the missile/tornado/hurricane doors at the equipment access entrance to the reactor building. The term “doors,” where used in the analysis, shall mean doors, frames and hardware.

(5) The fireproofing of structural steel members is accomplished by application of a UL-listed or FM-approved cementicious or ablative material, or by a UL- or FM-approved boxing design. The required fire rating, utilizing gypsum board, determines the fireproofing material thickness.

(6) Surface finishes are specified to have a flame spread, fuel-contributed and smoke-evolved index of 25 or less (Class A), as determined by ASTM-E84 (NFPA 255).

(7) The use of plastic materials, including electrical cable insulation, has been minimized in the ABWR design.

(8) Suspended ceilings are used in some areas of the plant. The ceilings, including the lighting fixtures, are of noncombustible construction.

(9) The electrical cable fire-stops are tested to demonstrate a fire rating equal to the rating of the barrier they penetrate. As a minimum, the penetrations meet the requirements of ANI. The tests are performed or witnessed by a representative of a qualified, independent testing laboratory. The documented test results for the acceptable fire-stops are made a part of the plant design records.

(10) Not Used

(11) Control, power or instrument cables of redundant systems that are used for bringing the reactor to safe, cold shutdown, or of any other divisional system, are separated by 3-hour fire barriers.

(12) Certain areas of the plant have trays in stacked array. Where stacking of trays occurs, power cable, which is the most susceptible to internally generated fires, is routed in the uppermost tray to the greatest extent possible to provide maximum isolation from other trays in the stack.

The fire loadings of electrical cable in trays is based on flame-retardant, cross-linked polyethylene insulation (XLPE-FR) having a calorific value of 32.56×10^3 J/g.

The cable trays have been estimated at the maximum design fill to contain between 11.91 and 15.63 kg of insulation per running meter of tray.

9A.3.6 Wall Deviations

The wall descriptions below represent a tested and approved 3-hour fire-resistive assembly and an anticipated possible deviation. Though specific applications for these walls have not been identified at this time, it is anticipated that applications will develop as the detail design of the plant is completed.

The Type 1 wall design is the UL tested and approved design U463. The type 2 assembly will require a UL test.

(1) Type 1 wall is UL tested and approved 3-hour fire barrier wall with three layers of fire code Gypsum wallboard on each side of the studs.

(2) Type 2 wall is a variation of type 1 wall with three layers of gypsum wall board on one side and a 1.25 cm thick steel plate for bullet resistance and two layers of fire code gypsum wall board on the other side.

9A.3.7 Door Deviations

Certain doors throughout the facility have a multipurpose function such as fire, tornado, hurricane, pressure, missile, seismic, watertight and airlocks. Where possible, these doors are specified to rated and labeled criteria and are then identified as rated doors.

When other criteria require the manufacturer to delete the label, the door is identified as equivalent. These doors, except for the Reactor Building equipment access door are required to have a UL or FM label.

Where the door is not constructed as a fire door, such as a containment personnel airlock, it is identified by its main function.