Structural Design Criteria for US-APWR Access Building

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Revision History

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Mitsubishi Heavy Industries, Ltd.
16-5, Konan 2-chome, Minato-ku
Tokyo 108-8215 Japan

Abstract

This document presents structural design criteria for the US-APWR Nuclear Non-Safety Related, Non-Seismic Access Control Building. The criteria satisfy various requirements defined in applicable codes. The document provides guidance on the structural design of the facility.

The criteria cover in detail or by reference the following topics:

- Applicable Codes, Standards and Specifications
- Materials of Construction
- Loads and Loading Combinations
- Acceptance Criteria
- Analysis Methods
- Design Requirements and Details

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List of Acronyms

The following list defines the acronyms used in this document.

A/B	**auxiliary building**
AC/B	**access building**
DCD	**Design Control Document**
IBC	**International Building Code**
NRC	**Nuclear Regulatory Commission**
NS	**non-seismic**
PS/B	**power source building**
R/B	**reactor building**
RC	**reinforced concrete**
RCA	**radiological controlled area**
RG	**Regulatory Guide**
SRP	**Standard Review Plan**
SSCs	**structures, systems, and components**
TSC	**technical support center**
US	**United States**

1.0 INTRODUCTION

This design criteria provides the structural design criteria for the access control building (AC/B) for the US-APWR. This standard design is performed in support of the submittal to the Nuclear Regulatory Commission (NRC) of US-APWR Design Control Document (DCD) (Reference 7-1). The AC/B is one of the structures comprising the standard plant structures, but is non-seismic (NS) category and non-safety related category construction.

As a nuclear NS structure, the AC/B is not required to satisfy the requirements of 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants." Instead, the AC/B is designed to meet the seismic requirements of the International Building Code (IBC) (Reference 7-2). This document summarizes the requirements for the stress analyses and sizing of the building structure to satisfy the requirements of the DCD (Reference 7-1).

2.0 DESIGN BASIS

2.1 Safety Category

The AC/B meets the requirements as one of the remaining power block buildings in DCD (Reference 7-1) Subsection 1.2.1.7.1 that is non safety-related. The AC/B is functionally included within the US-APWR standard plant, and is designed to load conditions that envelope the probable sites within the contiguous US.

2.2 Seismic Category

The AC/B is defined as a nuclear NS structure in Table 3.2-4 of the DCD (Reference 7-1). The AC/B is therefore not required to satisfy the requirements of 10 CFR Part 50, Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants.” Instead, the AC/B is designed to satisfy seismic requirements of Occupancy Category IV in accordance with the International Building Code (IBC) (Reference 7-2).

2.3 Governing Codes and Design Standards

The following industry codes and standards are applicable for the structural design and analysis of the AC/B.

- ACI 318-08, Building Code Requirements for Structural Concrete and Commentary, American Concrete Institute, 2008 (Reference 7-3)

- ANSI/AISC 360-05, Specification for Structural Steel Buildings, American Institute of Steel Construction, Inc., 2005 (Reference 7-4)

- ASCE 7-05, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers, 2005 (Reference 7-5)

- ASCE 37-02, Design Loads on Structures During Construction, American Society of Civil Engineers, 2002 (Reference 7-6)

- ACI 224R, Control of Cracking in Concrete Structures, American Concrete Institute, 2001 (Reference 7-7)

- International Building Code (IBC), International Code Council, 2006 (Reference 7-2)

2.4 Structural Acceptance Criteria

Structural acceptance criteria are in accordance with ACI 318 (Reference 7-3). Structural acceptance criteria for any structural steel components utilized in the design of the structure shall be in accordance with AISC 360-05 (Reference 7-4). The deflections of the structural members are limited to the maximum values as specified in ACI 318 and AISC 360.

2.5 NRC Regulatory Guidance

The following NRC documents have been reviewed for applicability to the AC/B.

- Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants" (Reference 7-8)

  In RG 1.206, Section C.I.3.7.2.1 states, "The applicant should indicate which analysis method it will use for seismic Category I and non-seismic Category I (seismic Category II and non-seismic) SSCs. Seismic Category II SSCs are defined as SSCs that perform no safety-related function and the continued function of which is not required. However, the design of these SSCs should ensure that the SSE does not cause unacceptable failure of or interaction with seismic Category I items. The applicant should describe the types of soil-structure system models to be analyzed and which analysis methods it will use. The applicant should also indicate the manner in which the seismic dynamic analysis considers the maximum relative displacement among supports."

  Section C.I.3.7.2.8 states to describe the location of all plant structures (seismic category I, seismic category II, and non-seismic structures), including the distance between structures and the height of each structure. The description should provide the design criteria used to account for seismic motion of non-seismic category I (seismic category II and non-seismic) structures, or portions thereof, in the seismic design of seismic category I structures or parts thereof. The applicant should describe the seismic design of non-seismic category I structures whose continued function is not required, but whose failure could adversely affect the safety function of SSCs or result in incapacitating injury to control room occupants. The description should include the design criteria that will be applied to ensure protection of seismic category I structures from structural failure of non-seismic category I structures as a result of seismic effects.

  The AC/B design criteria is therefore required to demonstrate that the AC/B does not adversely interact with seismic category I structures. The evaluation is to include a description of the seismic analysis and design, distance to nearby structures and the height in relation to any adjoining buildings.

- NUREG-0800, Standard Review Plan (SRP) 3.7.1, "Seismic Design Parameters" (Reference 7-9)

  SRP 3.7.1 describes acceptance criteria for developing seismic design parameters to assure that they are appropriate and contain sufficient margin such that seismic analyses (reviewed under other SRP sections) accurately and/or conservatively represent the behavior of SSCs during postulated seismic events. Meeting these requirements provides assurance that seismic category I SSCs will be adequately designed to withstand the effects of earthquakes, and thus, will be able to perform their intended safety function.

  Therefore, the requirements discussed in SRP 3.7.1 are applicable only to the design of seismic category I SSCs and are not applicable to the AC/B.

- NUREG-0800, SRP 3.7.2, "Seismic System Analysis" (Reference 7-10)

  SRP 3.7.2 describes the areas of review relating to seismic system analysis for all seismic category I structures, systems, and components (SSCs). Section I.4 of SRP 3.7.2 states that the procedures used in the soil-structure interaction (SSI) analysis to account for effects of adjacent structures, if any, on structural response are reviewed.

Further, Section I.8 states the design criteria to account for the seismic motion on non-seismic category I structures (or portions thereof) in the seismic design of seismic category I structures (or portions thereof) are reviewed.

Therefore, this design criterion includes the evaluation of the location of the AC/B with relation to any nearby seismic category I SSCs to identify any effects on the structural response of the seismic category I SSCs. This is consistent with the requirements of RG 1.206 (Reference 7-8).

In SRP Acceptance Criteria in Section II.3.C.i, Lumped-Mass Stick Model, the acceptance criteria given in Subsection II.1.a.iv of this SRP are acceptable for selecting an adequate number of discrete mass degrees of freedom in the dynamic modeling to determine the response of all seismic category I and applicable non-seismic I structures. Lumped-mass stick modeling is not appropriate for seismic analysis as defined by the IBC, and therefore is not applicable to the AC/B.

• NUREG-0800, SRP 3.8.4, "Other Seismic Category I Structures" (Reference 7-11)

SRP 3.8.4 is applicable to all seismic category I structures and other safety-related structures that may not be classified as seismic category I, other than the containment and its interior structures. Specific areas of review include the relationship between adjacent structures, including the separation provided or structural ties, if any.

To define areas of review, Section I.1.F of SRP 3.8.4 describes other structures as miscellaneous seismic category I structures and other structures that may be safety related but, because of other design provision, may not be classified as seismic category I. The AC/B does not serve any safety related function, and is therefore not within the scope of Section I.1.F.

• NUREG-0696, "Functional Criteria for Emergency Response Facilities· (Reference 7-12)

NUREG-0696 describes the facilities and systems to improve responses to emergency situations. The AC/B contains the technical support center (TSC), which is discussed within Section 2 of NUREG-0696. Section 2.5 defines the structural requirements of the TSC Complex that are reasonably expected to occur during the life of the plant, including earthquakes, high winds (other than tornadoes), and floods. NUREG-0696 states the TSC need not meet the seismic category I criteria, or be qualified as an engineered safety feature (ESF). Winds and floods with a 100-year recurrence frequency are acceptable as a design basis.

3.0 LOADS AND LOAD COMBINATIONS

Loads considered in the design are in accordance with ASCE 7-05, Minimum Design Loads for Buildings and Other Structures (Reference 7-5), and as discussed below. Load combinations are discussed in Subsection 3.9.

3.1 Dead Loads (*D*)

Dead loads are taken as the weight of all permanent construction or installations, including fixed equipment and tanks. Uniform and/or concentrated dead loads are generally utilized for the design of individual members. Equivalent dead loads are used for the global analyses of the AC/B structure. Uniform distributed loads are used to simulate loads due to minor equipment items and suspended systems, including small bore piping.

Dead loads include the weight of structures such as slabs, roofs, decking, framing (beams, columns and walls), and the weight of permanently attached major equipment, tanks, machinery, cranes, elevators, etc. The deadweight of equipment is based on its bounding operating condition including the weight of fluids.

Equivalent dead load includes the weight of minor equipment not independently accounted for as dead load. This includes the weight of piping, cables and cable trays, ducts, and their supports. To account for permanently attached small equipment, piping, ductwork and cable trays, a minimum equivalent dead load of 50 psf is applied wherever floor live load is not considered applicable.

3.2 Liquid Loads (*F*)

Liquid storage tanks are not applicable in the AC/B. For the purposes of evaluating flotation, F_b is the buoyant force of the design-basis flood or high ground water table, whichever is greater.

3.3 Earth Pressure (*H*)

3.3.1 Soil Properties

Table 2.0-1 of the DCD (Reference 7-1) identifies that the maximum flood and the groundwater elevations are only 1'-0" below the grade elevation. The static earth pressure acting on the structures during normal operation, is, therefore, conservatively considered as fully saturated over the full height of the subgrade parts of the building to account for ground and flood water levels, and is included in the analysis as H. The soil has the following properties:

- Saturated Density, γ_{sat} 130 pcf
- Lateral Active Pressure Coefficient, K_a 0.33
- Lateral At-rest Pressure Coefficient, K_o 0.50
- Lateral Passive Pressure Coefficient, K_p 3.00

Soil bearing and stability shall be evaluated using the allowable stress design combinations specified in Section 1605.3.1 of the IBC (Reference 7-2). The allowable values for foundation bearing pressures, lateral bearing pressures, and coefficient of friction for lateral sliding shall be as given in Table 1804.2 of the IBC (Reference 7-2) for class 3 soils.

Per Section 1802.2.7 of the IBC (Reference 7-2), lateral soil pressures also include pressures due to dynamic events. Soil pressures may be computed by using the procedures in Section 3.5.3.2.2 of ASCE 4-98 (Reference 7-15) or some other appropriate method.

3.3.2 Foundation Stability

The AC/B foundation shall have a safety factor of 1.5 against overturning, sliding and flotation.

3.4 Live Loads (*LL*, *L*)

Live load is the load imposed by the use and occupancy of the building/structure. The floor area live load need not be applied on areas occupied by equipment whose weight is specifically included in the dead load.

The following general live load values (LL) for live loads are used in load combinations.

Offices:	50 psf
Assembly and locker rooms:	100 psf
Laboratories and laundry rooms:	100 psf
Stairs and walkways:	100 psf (or a moving concentrated load of 1,000 pounds)
Concentrated load for floor and roof designs:	2,000 lbs

The general live loads, LL, may be reduced according to section 4.8 of ASCE 7-05 (Reference 7- 5). The resulting live load is the design live load and is designated L.

In accordance with Section 4.3 of ASCE 7-05 (Reference 7-5), the concentrated live load is assumed to act over an area of 2.5 ft. square and will be placed to achieve the maximum load effects in the supporting members. The concentrated live load and uniform live loads do not act concurrently.

The roof is designed for a uniform snow live load, p_g, of 75 psf. This is the extreme winter precipitation roof load and includes rain-on-snow loads. Other extreme environmental loads, e.g., seismic and wind loads, are not considered as occurring simultaneously with this load.

The flat roof snow load, p_f, is 50 psf. The importance factor snow loads, as identified in Table 7-4 for Category IV occupancy is 1.2.

Slope roof snow loads, partially loaded, unbalanced roof snow loads, and drifts (including sliding snow) on lower roofs, as applicable, are determined in accordance with ASCE 7-05 (Reference 7-5).

The roof design live load is 40 psf, which accounts for loads produced by workers, equipment. This load does not govern the design. Roof live load is not added to roof snow load when evaluating the design load combinations.

Roof rain load is enveloped by uniform snow live load, and therefore is not evaluated as a separate load case.

In the load combination for the construction case, refer to ASCE 37-02 (Reference 7-6) for minimum design load requirements.

3.5 Wind Load (*W*)

All coefficients and equations for design wind pressures are in accordance with Chapter 6 of ASCE 7-05 (Reference 7-5).

The basic wind speed is specified as 155 mph for 3-second gusts at 33 ft above ground level based on 100-year return period, with importance factor of 1.15 based on Occupancy Category IV for power generating stations. ASCE 7-05 Commentary Section C1.4 defines tornado wind speeds as abnormal events that are not part of normal design considerations. Consistent with DCD Subsection 3.3.2.3 (Reference 7-1), tornado wind and missile impact are therefore not applicable to the non-safety related AC/B.

Wind load during construction shall be based on 70 mph wind.

3.6 Seismic Loads (E_S)

3.6.1 Seismic Loads (E_S)

Seismic requirements shall be consistent with IBC Section 1613 (Reference 7-2). All coefficients and equations for seismic design loads are in accordance with Chapter 12 of ASCE 7-05 (Reference 7-5) with the following values of key parameters:

- Spectral Response Acceleration, Ss 0.94g
- Spectral Response Acceleration, S1 0.45g
- Site Classification C
- Importance Factor for Occupancy Category IV 1.5

3.6.2 Effective Seismic Weight

Per Section 12.7.2 of ASCE 7-05 (Reference 7-5), the effective seismic weight of the AC/B structure shall include:

- 25% of the floor design live load, L (conservatively apply value for storage areas).
- Total operating weight of permanent equipment (use 50 psf if exact values are not available).

• 20% of the flat roof snow load if p_f exceeds 30 psf.

3.7 Normal Operating Loads

The normal thermal loads T_o for the exterior walls and roofs are caused by temperature variations through the concrete wall. External temperatures range for -40°F to + 115°F, with internal temperature at +70°F.

The AC/B contains process and post-accident sampling systems, as well as potable and sanitary water systems. These systems are non-safety related, and are designed for the dead load of the pipe and live load of the fluid. No operational loads are applicable for these systems.

3.8 Effects of Pipe Rupture and other Accidents

The piping systems within AC/B are low- or no-pressure systems, and therefore no pipe rupture and other accident loads are applicable.

3.9 Load Combinations

The AC/B is a reinforced concrete structure designed in accordance with ACI 318 (Reference 7-3), with the load combinations and load factors provided in Table 3-1.

Steel components designed using the Load and Resistance Factor Design (LRFD) method will be designed to the load combinations of Section 1605.2.1 of the IBC (Reference 7-2). Steel components designed using the Allowable Stress Design (ASD) method will be designed to the load combinations of Section 1605.3.1 of the IBC (Reference 7-2).

Foundation stability and soil pressure will also be evaluated using the load combinations in Section 1605.3.1 of the IBC (Reference 7-2).

4.0 BUILDING DESCRIPTION

4.1 General Description

The AC/B is a separate building that houses the equipment and control facilities associated with the entry of personnel into the Auxiliary Building (AB). The health physics facilities are located within a radiological controlled area (RCA) within the AC/B. Access to the AB is normally through the entry/exit area of the RCA of the AC/B. The health physics facility consists of hot laboratories, personnel and equipment decontamination areas, radiation monitoring areas, a count room, a protective clothing dressing room, and a stairway. The health physics facility is isolated from the rest of the AC/B by interior concrete walls, which form the boundaries of the RCA.

The other main function of the AC/B is to house the TSC that is used in the event of an emergency.

The equipment located in the AC/B is classified as non-safety, and non-seismic.

Refer to Figures 1-1 through 1-7 for a general layout of the AC/B. The west wall of the AC/B is adjacent to a portion of the east wall of the auxiliary building (A/B). The AC/B and adjoining A/B, including basemats, are structurally separated by a seismic gap of at least 4 inches at and below the grade.

4.2 Structural Geometry

The AC/B is a rectangular building having a footprint of 165'- 0" x 56'-0". The elevation of the roof at the TSC is 48'-2". It consists of five floors, two of which are below grade.

The AC/B is a low-rise, simple rigid diaphragm building which conforms to the requirements of ASCE/SEI 7-05 Subsections 6.4.1.1 and 6.4.1.2 (Reference 7-5). Therefore, the AC/B is analyzed for design wind loads using method 1 of ASCE/SEI 7-05 (Reference 7-5). Reinforced concrete shearwalls serve as the main lateral force resisting system. In some areas, interior steel frames will provide support for the floors or roofs. The floors and roof will be cast-in-place concrete diaphragms using steel deck as formwork.

The AC/B is not required by either the IBC or the DCD to be designed for tornado effects and consequently it could potentially fail due to design basis tornado loading. However, since its location is sufficiently far away from seismic category I structures, and adjacent safety-related SSCs buried in the plant yard, the collapse of the AC/B would not impact any adjacent safety-related SSCs. The AC/B may also have localized failure due to tornado loading; however, the design precludes the generation of missiles that are not bounded by DCD Subsection 3.5.1.4 (Reference 7-1). The locations of any safety-related SSCs in the plant yard adjacent to the AC/B, including those which may be field routed, are reviewed prior to installation to ensure that their distances away from the AC/B and/or burial depths are sufficient to prevent potential failure effects that could jeopardize their function and integrity. Therefore, the ability of other SSCs to perform their intended safety functions is not affected by the potential collapse or localized failure of the AC/B due to tornado loading.

5.0 STRUCTURAL MATERIAL REQUIREMENTS

5.1 Concrete

Concrete utilized in the AC/B will have the properties shown in Table 5-1.

5.2 Reinforcement

Concrete reinforcement shall be deformed bars conforming to ASTM A 615, Grade 60, or ASTM A 706, Grade 60. These bars possess the properties given in Table 5-2. Reinforcement splices shall comply with ACI 318, Chapter 12 (Reference 7-3). Welding of reinforcing steel is not anticipated, however is to be performed in accordance with American Welding Society (AWS) D1.4 (Reference 7-13) if applicable.

5.3 Structural Steel

Material properties and requirements for any structural steel components utilized in the design of the structure shall be in accordance with the following standards:

- Structural Steel: ASTM A36 (F_y = 36 ksi) or A992 (F_y = 50 ksi)
- High strength bolts: ASTM A325 or A490
- Anchor bolts (rods): ASTM A307 or F1554
- Steel floor decking: ASTM A446 with minimum F_y = 33 ksi
- Studs: ASTM A 108

6.0 ANALYSIS AND DESIGN

The analysis procedures for the AC/B, including assumptions on boundary conditions and expected behavior under loads, are in accordance with ACI 318 (Reference 7-3) and AISC 360 (Reference 7-4).

6.1 Analysis Approach

The design considers normal loads (including construction, dead, live, and thermal), and applicable seismic loads. Seismic forces are applied as pseudo-static loads in accordance with IBC (Reference 7-2).

The analysis of the AC/B is also required to demonstrate that the AC/B will resist all applied loadings without exceeding structural and deflection acceptance criteria and that does not adversely interact with seismic category I structures. The evaluation is to include a description of the seismic analysis and design, distance to nearby structures and the height in relation to any adjoining buildings.

The AC/B is structurally designed as a NS structure on reinforced concrete foundation located at the west side of the A/B (seismic category II). The AC/B is not located adjacent to any seismic category I SSCs. If the AC/B were to fail or collapse, it could impact the A/B which is a seismic category II structure. AC/B is smaller, shorter, and much less massive than the reinforced concrete A/B. In the unlikely event of impact, there would not be sufficient kinetic energy transfer to cause the A/B to displace beyond acceptable limits. Specifically, the A/B would not displace enough to impact the reactor building (R/B), PS/Bs, or any other seismic category I SSCs.

6.2 Analysis Model

The structural analysis may utilize any modeling techniques that satisfy the code requirements and level of detail consistent with the intended results.

6.3 Documentation

6.3.1 Calculations

Specific documentation for design calculations and analyses is to include, but not limited, to the following items:

- Definition of the objective of the analyses
- Definition of design inputs and their sources
- Identification of assumptions and indication of those that must be verified as the design proceeds
- Identification of any computer calculation, including computer type, computer program name, revision identification, inputs, outputs, evidence of or reference to computer program verification, and the bases (or reference thereto) supporting application of the computer program to the specific physical problem

- Structural calculations
- Identification of originator, reviewer, and approver.

6.3.2 Drawings

Structural drawings of the AC/B will include the following elements:

- Foundation Plan and Elevation
- General Bar Arrangement for Foundation
- General Bar Arrangement for Concrete Structure
- Framing Plan for Concrete Structure
- Framing Elevation for Concrete Structure
- Member List, including columns, girders, beams, slabs and walls.

7.0 REFERENCES

7-1 MUAP-DC001, "Design Control Document for the US-APWR," Revision 2, Mitsubishi Heavy Industries, Ltd., October 2009.

7-2 International Building Code (IBC), International Code Council, Inc., 2006.

7-3 ACI 318-05, "Building Code Requirements for Structural Concrete and Commentary," American Concrete Institute, 2005.

7-4 ANSI/AISC 360-05, Specification for Structural Steel Buildings, American Institute of Steel Construction, Inc., 2005.

7-4 ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," American Society of Civil Engineers, 2005.

7-6 ASCE 37-02, "Design Loads on Structures During Construction," American Society of Civil Engineers, 2002.

7-7 ACI 224R, "Control of Cracking in Concrete Structures," American Concrete Institute, 2001.

7-8 RG 1.206, "Combined License Applications for Nuclear Power Plants," Rev. 0, U.S. Nuclear Regulatory Commission, June 2007.

7-9 NUREG-0800, SRP 3.7.1, "Seismic Design Parameters, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Rev. 3, U.S. Nuclear Regulatory Commission, March 2007.

7-10 NUREG-0800, SRP 3.7.2, "Seismic System Analysis, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Rev. 3, U.S. Nuclear Regulatory Commission, March 2007.

7-11 NUREG-0800, SRP 3.8.4, "Other Seismic Category I Structures, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Rev. 2, U.S. Nuclear Regulatory Commission, March 2007.

7-12 NUREG-0696, "Functional Criteria for Emergency Response Facilities," U.S. Nuclear Regulatory Commission, February 1981.

7-13 AWS D1.4, "Structural Welding Code - Reinforcing Steel," American Welding Society, 2005.

7-14 "Roark's Formulas for Stress and Strain," 7th Edition, Young, W.C. and Budynas, R.G., 2002.

7-15 ASCE 4-98, "Seismic Analysis of Safety-Related Nuclear Structures and Commentary," American Society of Civil Engineers, 2000.

Table 3-1 Load Combinations and Load Factors for AC/B Concrete Structure

ACI 318 Load Combination:		1	2	3	4	5	6	7
Load Type								
Dead	***D***	1.4	1.4	1.05	1.05	1.05	0.9	0.9
Live(2)(3)	***L***	1.7		1.3	1.3	1.3		
Earth(4)	***H***	1.7	1.4	1.3	1.3	1.3	1.7	1.7
Normal thermal	T_o		1.4			1.05		
Wind	***W***			1.6			1.6	
Seismic	E_S				1.0			1.0
ACI 318 Equation Number		C-1	C-6	C-2	C-2	C-5	C-3	C-3

Notes:

1. Table based on the strength design load combinations of Paragraph C.2 of ACI 318 (Reference 7-3).

2. Live load includes roof live load and snow load; roof live load is not combined with roof snow load

3. For load combinations 1 and 5, snow load is the extreme winter precipitation roof load and includes rain-on-snow loads as discussed in Section 3.4 above; for load combinations 3 and 4, snow load is the roof snow load as given in Section 3.4 and includes the effects of drifting, unbalanced snow load, etc.

4. Earth loads are based on the at rest pressure loads; seismic earth pressures are included in the E_S category.

5. The required strength, U, shall be equal to or greater than the strength required to resist the factored loads and/or related internal moments and forces, for each of the load combinations shown in this table.

6. Use with the Φ factors of Paragraph C.3.2 of ACI 318 (Reference 7-3).

Table 5-1 Concrete Material Properties for the AC/B

Building	Compressive Strength f'_C (psi)	Modulus of Elasticity E_C (1) (ksi)	Shear Modulus G_C (2) (ksi)	Poisson's Ratio ν	Thermal Expansion Coefficient α (ft/ft/°F)	Unit Weight w_C (pcf)
AC/B	4,000	3,605	1,540	0.17	5.5×10^{-6}	150

Notes:

1. $E_C = 57000\sqrt{f'e}$ (Sect. 8.5.1, ref. 7-3)

2. $G_C = \frac{E_C}{2 \cdot (1+\nu)}$ (Formula 2.2-7, ref. 7-14)

Table 5-2 Concrete Reinforcement Properties

ASTM Specification	Minimum Yield Stress (psi)	Minimum Tensile Strength (psi)	Elongation(1)
A 615, Gr. 60	60,000	90,000	#3 thru #6 bars 9% #7 & #8 bars 8% #9 thru #18 bars 7%
A 706, Gr. 60	60,000	80,000	#3 thru #6 bars 14% #7 & #11 bars 8% #14 thru #18 bars 10%
A 970	60,000	80,000(2)	Same as A 706, Gr. 60(2)

Notes:

1. Elongation in 8 in, min %

2. Use A706, Gr. 60, values. Per ASTM A970 specification paragraph 5.1, for welded headed bars, the reinforcing bars shall conform to Specification A706/A706M. For forged headed bars or threaded headed bars, the reinforcing bars shall conform to Specification A615/A615M or A706/A706M, as specified by the purchaser.

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-1 AC/B Plan View at Basement Level (El. -26'-4")

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-2 AC/B Plan View at Basement Mezzanine Level (El. -8'-0")

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-3 AC/B Plan View at First Floor Level (El. 3'-7")

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-4 AC/B Plan View at First Floor Mezzanine Level (El. 17'-9")

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-5 AC/B Plan View at Second Floor Level (El. 30'-2")

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-6 AC/B Plan View at Roof Level (El. 48'-2")

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-7 AC/B Transverse Section Looking North

Security-Related Information – Withheld Under 10 CFR 2.390

Figure 1-8 AC/B Longitudinal Section Looking East