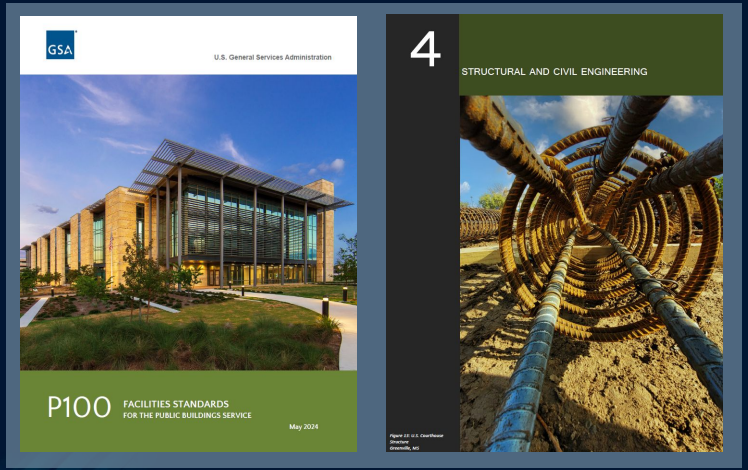
Training

Chapter 4
Structural and Civil Engineering



This session is being recorded.

Presenters

William (Bill) Earl
Structural Engineer

Hani Rimawi
Civil Engineer

Chapter 4

Structural Engineering

Sections 4.1, 4.2, 4.3, 4.4, and 4.5

Civil Engineering

Sections 4.6, 4.7, 4.8, and 4.9

P100 Chapter 4 Structural Engineering Technical Committee

The Structural Technical Committee is composed of Regional structural engineering SME's from across the country

- R2 - Karin Reed
- R3 - Timothy Sisson
- R4 - Christopher Hector
- R7 - Guru Gurusamy
- R9 - Medi Givechian
- R9 - Ron Larsen
- R10 - Chalese Smartt
- R11 - Dawit Zena

ONLY MINOR EDITS TO CHAPTER 4

01

GENERAL

Minor improvements to wording for clarification of intent

02

NEW TOPICS

Previously included information highlighted for better emphasis

03

TIERS

Consistent alignment with building code risk categories

General

- Grammar and readability
- Updated references
- Consistency
- Ordering of subjects

4.2 STRUCTURAL PERFORMANCE ATTRIBUTES

The structural design of new or modification of existing buildings, structures, and portions thereof must follow the latest edition of the International Code Council *IBC Code and Commentary*, except as modified in this chapter. Generally, the baseline and tier performance levels are intended to align with the structure risk categories as defined by the IBC.

4.2.1 LOADS AND NATURAL HAZARDS

Loads must be governed by the latest edition of American Society of Civil Engineers & Structural Engineering Institute *ASCE/SEI 7 Minimum Design Loads and Associated Criteria for Buildings and Other Structures*.

The designer must verify local regulations that require loads exceeding those specified by ASCE 7 and coordinate with the GSA Structural Engineer to determine if they should be incorporated.

Design loads must be itemized and categorized in calculations and on construction documents.

4.2.1.1 LIVE LOAD

Floor framing members supporting general office space must be designed using a uniform live load of 100 pounds per square foot (psf) over the entire floor for all elevated slabs unless the tabulated uniform live load required by the ASCE 7 is higher than 100 psf. This includes a nominal partition load of 15 pounds per square foot but excludes heavy loads like the planned use of heavy file systems, book racks, ammunition storage, sliding room partitions, safes, and other similar items. Some projects may require that the designer not use live load reductions for 1) horizontal framing members, 2) transfer girders supporting columns, or 3) columns or walls supporting roofs where mechanical equipment can be located. The designer will discuss this issue with the GSA structural engineer early in the project development. Live load reductions must be considered in the design of foundation members regardless of the restrictions placed on individual members.

For buildings having plaza areas where there is a possibility of vehicular traffic these loads, including impact must be provided for in the design.

4.2.1.2 SEISMIC LOAD

Seismic design of new buildings and building additions must be governed by the latest edition of American Society of Civil Engineers Structural Engineering Institute ASCE/SEI 7 Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Retrofit of existing buildings must conform to the Basic Performance Objectives defined by the latest edition of American Society of Civil Engineers Structural Engineering Institute ASCE/SEI 41 Seismic Evaluation and Retrofit of Existing Buildings based on the facility Risk Category.

New Topics

Previously incorporated into other portions of the chapter. Important enough to have a specific section.

- **Non-Structural Components**
- **Geotechnical Requirements**
- **Special Durability Requirements**
- **Forced Entry Resistance**
- **Storage of Hazardous Materials**
- **Delegated Designs**

4.3.9 SPECIAL DURABILITY REQUIREMENTS

The designer must incorporate the use of more durable construction materials and detailing for structures supporting vegetative roofs, plaza areas and other structural elements exposed to weather and/or exterior environmental conditions.

Performance Tiers

Now aligned with building code risk categories. This will provide a consistent level of design.

4.1.2 Seismic	
	Structure
Baseline	Risk Category I & II Structures
Tier 1	Risk Category III Structures
Tier 2	Risk Category IV Structures
Tier 3	N/A

	Non-Structural
Baseline	Risk Category I & II Structures
Tier 1	Risk Category III Structures
Tier 2	Risk Category IV Structures
Tier 3	N/A

4.1.3 Wind	
	Structure
Baseline	Risk Category I & II Structures
Tier 1	Risk Category III Structures
Tier 2	Risk Category IV Structures
Tier 3	N/A

4.4.1 Security	
	Physical Security Performance
Baseline	ISC Level I or II
Tier 1	ISC Level III
Tier 2	ISC Level IV
Tier 3	ISC Level V

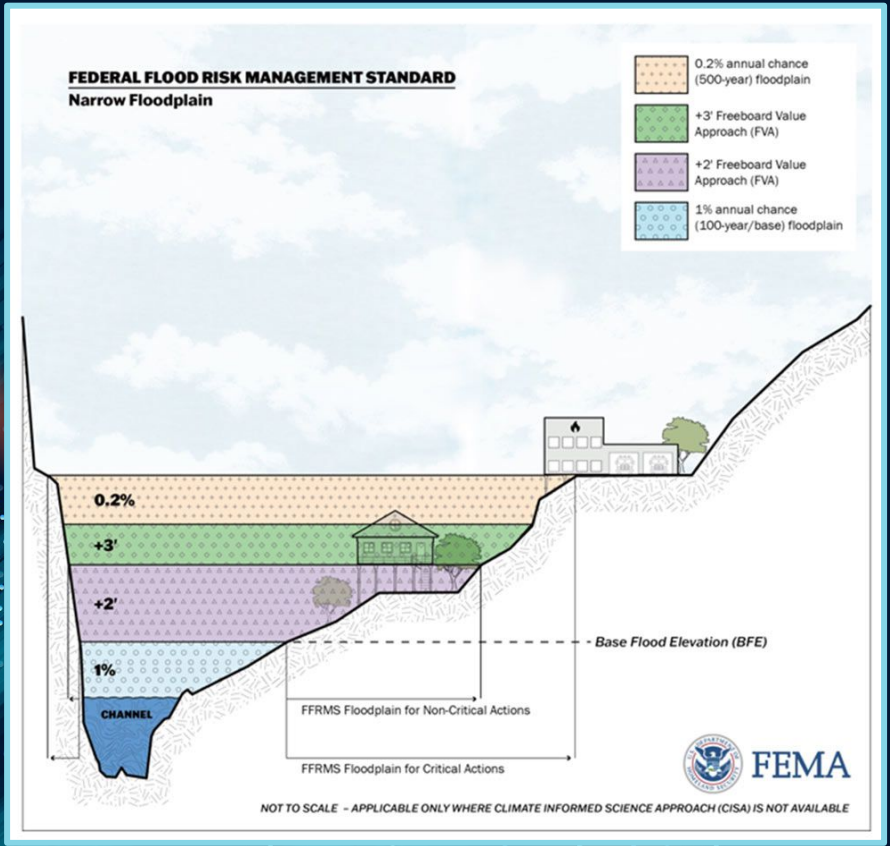
P100 Chapter 4 Civil Engineering Technical Committee

- P100 Steering Committee voted and approved the creation of the Civil Engineering Technical Committee on 9/5/2024
- To be composed of Regional civil engineer SME's with zone coverage:
  - Zone A - Regions 1, 2, 3, and NCR
  - Zone B - Regions 4, 5, 6, and 7
  - Zone C - Regions 8, 9, and 10

Civil Engineering Section Updates

- 4.6 - Replaced Flood Mitigations with new section
- 4.7.1 - Replaced Flood Mitigations with new section
- 4.8.1 - New storm and drainage requirements
- 4.8.2 - Added water recycling
- 4.8.4 - Updated requirements for coal tar sealant
- 4.8.5 - Moved Low Embodied Carbon Concrete to Chapter 1
- 4.8.6 - Moved Environmentally Preferable Asphalt to Chapter 1

Terminology



- Design Flood Elevation (DFE) - ASCE 24
- Flood Design Class (FDC) - ASCE 24
- Risk Category (RC) - ASCE 7
- Base Flood Elevation (BFE) = 100-year Flood Elevation = 1.0 Percent-Annual-Chance Flood Elevation
- 500-year Flood = 0.2 Percent-Annual-Chance Flood
- Climate-Informed Science Approach (CISA)
- Federal Flood Risk Management Standard (FFRMS)
- National Flood Insurance Program (NFIP)

1.3.9.1 ESSENTIAL FACILITIES

The International Building Code (IBC) has defined essential facilities as "Any building
that are intended to remain operational in the event of extreme environmental loading fr
snow or earthquake". Buildings and other structures designated as essential facilities include
limited to: Group I-2 occupancies that have surgery or emergency treatment facilities, aviation co
towers, or fire and police stations.

1.3.9.2 CRITICAL ACTION FACILITIES

The Department of Homeland Security Federal Emergency Management Agency has defined a facility as "Critical Action" when even a slight chance of flooding is too great. If critical action structures must be located within a 1-percent-annual-chance (also known as the 100-year), 0.2-percent-annual-chance (500-year) or the Federal Flood Risk Management Standard (FFRMS) floodplain (i.e., there are no practicable alternatives), critical infrastructure must be elevated above the applicable floodplain elevation. Critical actions include, but are not limited to:

- storage of irreplaceable records
- the production, use, or storage of highly volatile, flammable, explosive, toxic, or water-reactive materials
- hospitals and nursing homes, and housing for the elderly, which are likely to contain occupants who may not be sufficiently mobile to avoid the loss of life or injury during flood and storm events.

The critical action designation is established under the decision-making process outlined in the accompanying Desk Guide for GSA Order PBS 1095.8A, Floodplain Management. The U.S. Courts has determined that all new court houses are critical action facilities. Refer to Chapter 4, Flood Resistant Design Requirements.

1.3.9.3 MISSION CRITICAL FACILITIES

The tenant will determine this designation during project development. A mission critical facility conta
any operation that, if electrical supply is interrupted, will cause a negative impact on business activi
ranging from losing revenue to jeopardizing legal conformity, and loss of life. Examples may inclu
centers, hospitals, laboratories, public safety centers, court houses, land ports of entry, resea
facilities, law enforcement, and critical file and payroll centers. See Chapter 1, Resilience
Enclosure, Chapter 5, Wildfire Smoke Mode, and Chapter 6, Primary Distribution for

The Federal Data Center Enhancement Act notes a "growing need for Fed

1.3.9 Facility Definitions

Required for Flood Resistant Design

- Critical Action
- Non-Critical Action

3.1 ENCLOSURE PERFORMANCE TABLE

Envelope – Natural Hazard	
	Flood Resistant
Baseline	Locate above the 100-year base flood elevation + 2 feet. Critical Action facilities must be elevated above the 1% annual chance (100-year) base flood elevation + 3 feet, or the 0.2% annual chance flood (500-year) elevation, whichever is higher.
Tier 1	Flood Hazard Areas not identified as Coastal High Hazard Areas and Coastal A Zones: ASCE 24 Flood Design Class
Tier 2	High Risk Flood Hazard Areas including Coastal High Hazard Area and Coastal A Zones: Site Specific Risk Assessment (Dam, Levee, and Floodwall Failure Hazards)
Tier 3	N/A
M & V	
Plans & Specs	Site Planning
Calculations & Analysis	FEMA Flood Maps, ASCE 24, "Flood Resistant Design and Construction", Project team Calculations & Inspection
References	
Basis of Design	Describe flood resistance design requirements
Construction Verification	Witness mockup test when provided

4.6 CIVIL PERFORMANCE TABLE

Flood	
	Flood Mitigation
Baseline	100 Year Base Flood Elevation + 2 feet
Tier 1	Higher of 500 Year Flood Elevation + 1 foot or 100 Year Flood Elevation + 3 feet
Tier 2	Determined on a Site-Specific Basis
Tier 3	N/A
M & V	N/A
Plans & Specs	N/A
Calculations & Analysis	
References	FEMA Flood Maps and ASCE 24
Basis of Design	N/A
Construction Verification	N/A

P100 (2022)

4.6 CIVIL PERFORMANCE TABLE

4.6.1 Flood Resistant Design Requirements		
	Building Enclosure and Site	
	Non-Critical Action	Critical Action
Baseline	Design Flood Elevation (DFE) = Base Flood Elevation (BFE) + 2 feet. ASCE 24 Flood Design Class (FDC) = 2. Risk Category (RC) = I & II.	DFE = BFE + 3 feet or 500-year Elevation, whichever is higher. FDC = 3. RC = III.
Tier 1	DFE = BFE + 3 feet or 500-year Elevation, whichever is higher. FDC = 3. RC = III.	DFE = BFE + 4 feet or 500-year Elevation, whichever is higher. FDC = 4. RC = IV.
Tier 2	DFE = higher than Tier 1. FDC = 4. RC = IV.	DFE = higher than Tier 1. FDC = 4. RC = IV.
Tier 3	N/A	N/A
M & V	N/A	
Plans & Specs	Yes, and included in the Emergency Action Plan.	
Calculations & Analysis	Project team must provide calculations showing requirements for all performance levels.	
References	Flood Study and Mapping, ASCE 24, ASCE 7 Supplement on Flood Loads, ANSI/FM 2510.	
Basis of Design	Describe flood resistance design requirements.	
Construction Verification	N/A	

P100 (2024)

5.3 MECHANICAL PRESCRIPTIVE REQUIREMENTS

All mechanical and electrical equipment within the building or on the property must be in areas not subject to flooding and 1.6 meters (5 ft.) above the 100-year flood plain. Refer to the ISC for mechanical system requirements per the facility security level.

P100 (2022)

4.6 CIVIL PERFORMANCE TABLE

4.6.1 Flood Resistant Design Requirements

Mechanical		
	Non-Critical Action	Critical Action
Baseline	DFE = BFE + 5 feet. FDC = 2. RC = I & II.	DFE = 500-year elevation + 5 feet, or BFE + 8 feet, whichever is lower. FDC = 3. RC = III.
Tier 1	DFE = 500-year elevation + 5 feet, or BFE + 8 feet, whichever is higher. FDC = 3. RC = III.	DFE = 500-year elevation + 5 feet, or BFE + 8 feet, whichever is higher. FDC = 4. RC = IV.
Tier 2	DFE = higher than Tier 1. FDC = 4. RC = IV.	DFE = higher than Tier 1. FDC = 4. RC = IV.
Tier 3	N/A	N/A
M & V	N/A	
Plans & Specs	Yes, and included in the Emergency Action Plan.	
Calculations & Analysis	Project team must provide calculations showing requirements are met. Calculations required at all performance levels.	
References	Flood Study and Mapping, ASCE 24, ASCE 7 Supplement on Flood Loads, ANSI/FM 2510.	
Basis of Design	Describe flood resistance design requirements.	
Construction Verification	N/A	

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6.5.5.8 FLOOD PLAIN CLEARANCE

Electrical equipment must be located at five feet above the 100-year flood plain. Electrical equipment for facilities classified as Critical Action Facilities must be located five feet above the 500 year flood plain. The electrical engineer must determine from local jurisdictions any additional freeboard requirements above this base level.

6.5.9.2 GENERATOR SYSTEM

If possible, locate the generators outside and on grade. If installed outdoors, they must be provided with a suitable reach-in acoustic enclosure and jacket water heaters to ensure reliable starting in cold weather. In harsh weather environments, walk-in enclosures should be considered. If critical action structures must be located within a floodplain, generators must be elevated above the 500-year base flood elevation.

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4.6 CIVIL PERFORMANCE TABLE

4.6.1 Flood Resistant Design Requirements

Electrical and Generator System		
	Non-Critical Action	Critical Action
Baseline	DFE = BFE + 5 feet. FDC = 2. RC = I & II.	DFE = 500-year elevation + 5 feet, or BFE + 8 feet, whichever is lower. FDC = 3. RC = III.
Tier 1	DFE = 500-year elevation + 5 feet, or BFE + 8 feet, whichever is higher. FDC = 3. RC = III.	DFE = 500-year elevation + 5 feet, or BFE + 8 feet, whichever is higher. FDC = 4. RC = IV.
Tier 2	DFE = higher than Tier 1. FDC = 4. RC = IV.	DFE = higher than Tier 1. FDC = 4. RC = IV.
Tier 3	N/A	N/A
M & V	N/A	
Plans & Specs	Yes, and included in the Emergency Action Plan.	
Calculations & Analysis	Project team must provide calculations showing requirements are met. Calculations required at all performance levels.	
References	Flood Study and Mapping, ASCE 24, ASCE 7 Supplement on Flood Loads, ANSI/FM 2510.	
Basis of Design	Describe flood resistance design requirements.	
Construction Verification	N/A	

P100 (2024)

4.7.1 FLOOD RESISTANT DESIGN REQUIREMENTS

- Floodplain data applicability
  - Floodplain Management Desk Guide, Order PBS 1095.8A - source options
  - Conduct Hydrologic and Hydraulics analysis
    - No available data or outdated data (more than 15 years)
    - Complies with FEMA NFIP mapping standards + PE certified
  - 500-year elevation = BFE + 3 feet
    - When the 500-year elevation is not available
    - BFE is available and up-to-date
  - CISA elevation (coastal areas)
    - May be substituted for baseline DFE (BE and Site only)
    - Apply FFRMS Job Aid recommendations
- Application of ASCE 24, Flood Resistant Design and Construction and ASCE 7, supplement on flood loads
  - Per flood hazard area designation: Flood Hazard, High Risk Flood Hazard, or Coastal High Hazard and Coastal A Zones
  - Dry or wet floodproofing - products to meet ANSI/FM 2510 standard
- No Adverse Impact (NAI) - demonstrate compliance
- Flood resistance documentation: design narrative, plans, specification, and emergency action plan

4.8.1 SITE GRADING AND DRAINAGE

- Storm drainage system requirements
  - Moved from 4.8.2
  - Locate in unpaved areas to the extent possible
- Comply with state and local stormwater management requirements
  - In addition to EISA 438 compliance (law requirement)
- Performance analysis of proposed drainage system for 100-year and 500-year storm events
  - Mitigate adverse impacts for proposed drainage conditions
- Inlet and catch basins to include bicycle safe grates
- Drainage pipe velocities:
  - Minimum 2 ft/s "flowing full" with a desired minimum "self-cleaning" velocity of 3 ft/s.
  - Maximum velocity must not exceed 10 ft/s.

4.8.2 SITE UTILITIES

- Addition of Water Recycling requirement
  - Follow local and state requirement
  - Reference to Chapter 1, Water Net-Zero and Chapter 2, Rainwater Catchment

4.8.4 PAVEMENTS

- Addition of non-coal tar sealant requirement
  - Inline with Chapter 2

Questions

Contact speakers at:

- William (Bill) Earl - william.earl@gsa.gov
- Hani Rimawi - hani.rimawi@gsa.gov