**CESPA Structural Engineering Instruction Manual (SEIM) (Vertical Construction)**

Version 201x.xx.xx

[**Notes for Design-Build RFP** **Writing**. This SEIM document shall also be used as a template for creating the structural paragraph of the 01 10 10 section of a Design-Build RFP. Use the following instructions when editing this document for RFP use:

* Change the above title heading with the project name, engineer’s name, and date edited. For a draft RFP submittal use “Track Changes” to produce a red-lined document for ease of review. **If “Track Changes” is not used, the RFP submittal will be returned for re-submittal.**
* Delete all items from this document that do not relate to the respective project and add any items that need to be added for the scope of the respective project.
* Edit or delete (if not needed) all items enclosed in brackets [ ], and delete the brackets.]
1. **STRUCTURAL DESIGN**
	1. **Purpose of Structural Criteria**. The criteria described below specify U.S. Army Corps of Engineers Albuquerque District (CESPA) minimum requirements for various structural systems and structural elements. These criteria are not intended to prescribe a specific structural system (for example steel framing vs. concrete framing), unless specifically stated herein. The purpose of these criteria is to create uniformity in CESPA structural vertical (buildings) construction documents. The criteria herein will be used as a checklist for design reviews by CESPA. Requests for variations to these criteria require approval from CESPA before design begins.
	2. **One-Time Referencing.** The CESPA Structural Unit has a requirement of designing, detailing and specifying structural elements only once in the structural documents. This helps to eliminate conflicting information in the documents. The design engineer is encouraged to use this same approach in the creation of the documents for this project. A number of the design and detailing requirements in this document are geared toward this approach. The CESPA Structural Unit will review and comment on the structural documents using this criteria.
	3. **Structural Design Criteria Description**. The structural criteria established herein shall be used for structural loadings, design and installation of all structural systems and foundations, including manufacturing, erection, supervision, testing, and quality assurance of the completed installation of this project. All structural calculations shall be checked and initialed as such by a registered structural engineer other than the original design engineer. All structural calculations shall be sequentially numbered for ease of referencing all stages of design submittal. The structural work includes, but is not necessarily limited to, design and construction of the following items:

Building Foundations.

Slabs on Ground.

Load Bearing and Non-Load Bearing Masonry Walls.

Load Bearing, Non-Load Bearing and Soffit or Fascia Steel Stud Walls.

Vertical Framing Members.

Horizontal Framing Members, including roof and floor decks and diaphragms, and roof and floor framing members.

Connection details of structural materials.

Special conditions, such as expansion, construction, and contraction joints, changes in floor levels, miscellaneous structures such as antenna platforms, catwalks, fall protection support system, etc.

Connection provisions for architectural, mechanical, and electrical elements.

Site screen and security walls and foundations.

Interior and exterior equipment pads.

Site structures – retaining walls, loading docks, waste bin pads, etc.

[RFP Editor’s Note: Retain the following paragraph only for a Design-Build RFP. Edit to suit project, adding sub-paragraphs to emphasize unique features to the project. Include information that requires interpretation of codes and standards]

* 1. **[Facility Specific Structural Requirements**.
		1. **Occupancy Category**. For structural design purposes, the building shall be classified as Occupancy Category “[]”, per UFC 3-301-01, Table 2-2.
		2. **Anti-Terrorism Design Building Category.** For structural design purposes this facility shall be classified as “[]” per UFC 4-010-01.
		3. **Aircraft Clear Zone**. See Architectural requirements for dimensions of aircraft clear zones in aircraft hangars. The structure shall not intrude on the aircraft clear zones.
		4. **Bridge Cranes**. See Architectural and Mechanical for bridge crane load capacity and travel area requirements.]
	2. **Units of Measurement**. English inch-pound (I-P) values shall be used by for drawings, specifications and calculations. Products that are manufactured to Metric dimensions or have an industry recognized Metric designation should be given in Metric (SI) values.
	3. **Specifications.**
		1. **General**. CESPA Structural Guide Specifications (CESPA Guide Specs) shall be used in the design and construction documents. Use only the CESPA Guide Specs, all others (including UFGS specs) will be rejected. Download electronic versions (Specsintact files) of the CESPA Guide Specs at <http://www.spa.usace.army.mil/Missions/EngineeringandConstruction/ORGANIZATION/DESIGNBRANCH/FacilitiesDesignSection.aspx> (scroll down to "Reference Links" and then click on "CESPA Structural Guide Specs”). These specifications shall be edited as applicable to fit project specific requirements. At the mid-level submittal of the project (e.g. 65% submittal) using the “Tracking” edit feature to produce red lining of deletions and additions. The requirements set forth in the CESPA Guide Specs are a minimum standard and shall not be relaxed without CESPA approval. If additional structural related guide specification sections are needed that are not included in the CESPA Guide Specs, the Unified Facilities Guide Specifications (UFGS) shall be used. UFGS can be found at <http://www.wbdg.org/ccb/browse_cat.php?c=3>
		2. **Submittals**. [RFP Editor’s Note. Delete following for a Design-Build RFP.][The paragraph “Submittals” for all specification sections shall reads as follows:

“Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.”]

[RFP Editor’s Note. The following applies only for a Design-Build RFP.] [Remove all “G” designations from submittals when editing the specifications. All submittals shall be “For Information Only”.]

* 1. **CESPA Standard Structural Drawings.** The requirements set forth in the CESPA Standard Structural Drawings are a minimum standard that shall be incorporated into the structural drawings of the project. The CESPA Standard drawings may be used directly. Alternatively, the design engineer’s own standard drawings may be used in lieu of the CEPSA Standard Drawings, provided the CESPA Standard Drawings minimum notes and detailing requirements are met. CESPA Standard General Notes and Typical Details Drawings CAD files used by the CESPA Structural Unit are available for download at <http://www.spa.usace.army.mil/Missions/EngineeringandConstruction/CADStandards/Disciplines/Structural.aspx>.

* 1. **Structural Drafting Standards.** These structural drafting standards shall take precedence over all other referenced drafting standards in this RFP document.
		1. **Scale of Foundation and Framing Plans.** All foundation and framing plans and overall building sections shall be drawing to a scale of at least 1/8”= 1’-0”.
		2. **Foundation and Framing Plan Dimensioning.** All structural foundation and framing plans shall be FULLY dimensioned. No dimensions shall be referred back to the drawings of another discipline. Also, no dimensions shall be referenced back to a foundation plan from a framing plan or vice versa. All plans shall contain overall dimensions for the major parts of the building and the overall length of the building.
		3. **Grid Lines.** All foundation and framing plans shall contain grid lines in both directions identifying the locations of columns.
		4. **Scale of Sections and Details**. All foundation sections and details shall be drawn at a minimum scale of 3/4” = 1’-0”. All roof sections and details shall be drawn at a minimum scale of 1-1/2” = 1’-0”.
		5. **Lettering.** All lettering shall be uppercase and at least 1/8-inch in height when plotted at full size. This includes lettering contained within reference bubbles.
	2. **References.** Structural design shall be in accordance with current DoD Unified Facilities Criteria (UFC), U.S. Army Corps of Engineers (USACE) publications (Engineering regulations ER-, Engineering Technical Letters ETL-, etc.), and industry standard codes and specifications (AISC, ACI, SJI, etc.). USACE publications are available at http://www.publications.usace.army.mil/. DoD UFC documents are available at web site <http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4>. Recommendations made in the codes, specifications and industry standards in this paragraph are requirements of this document, unless specified otherwise. The references used for the project design and contract documents shall be included in any design analysis required for this project.
		1. **Government Criteria and Regulations.**
			1. UFC 1-200-01 – General Building Requirements 20 June 2016.
			2. UFC 3-301-01 – Structural Engineering with Change 3, 1 June 2013, 12 September 2016.
			3. UFC 3-310-04 – Seismic Design for Buildings with Change 1, 1 June 2013, 20 June 2016.
			4. UFC 3-320-06A - Concrete Floor Slabs on Grade Subjected to Heavy Loads, 1 March 2005.
			5. UFC 4-010-01 – DOD Minimum Antiterrorism Standards for Buildings with Change 1, 9 Feb 2012.
			6. UFC 4-023-03 - Design Of Buildings To Resist Progressive Collapse with Change 3, 14 July 2009, 1 November 2016.
			7. ER 1110-1-12 – Quality Management, USACE Engineering Regulation, 21 July 2006.
			8. ER 1110-345-53 – Structural Steel Connections, USACE Engineer Regulation, 22 July 1994.
		2. **Industry Codes and Specifications.**
			1. Manual of Steel Construction by the American Institute of Steel Construction (AISC), Fourteenth Edition.
			2. Metal Building Systems Manual by the Metal Building Manufacturers Association (MBMA), 2012 Edition.
			3. AISC 811-97, Design Guide 11, Floor Vibration Due to Human Activity, Design Guide 11.
			4. International Building Code (IBC) 2015, International Code Council.
			5. ACI 318-14/318R-2014, Building Code Requirements for Structural Concrete, American Concrete Institute (ACI).
			6. 43rd Edition Standard Specifications and Load Tables for Steel Joists and Joist Girders by the Steel Joist Institute (SJI), 2010.
			7. Technical Digest No. 5, Vibration of Steel Joist-Concrete Slab Floors by the Steel Joist Institute (SJI), January 2015.
			8. ASCE/SEI 7-10 - Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers (ASCE).
			9. AISI-D100-10-KIT, Cold-Formed Steel Design Manual and Specification Bundle, American Iron and Steel Institute (AISI), 2010.
			10. AISI S213-07 w/S1-09 (2012) - AISI North American Standard for Cold-Formed Steel Framing - Lateral Design, 2007 Edition with Supplement 1. American Iron and Steel Institute (AISI).
			11. AWS D1.1/D1.1M, Structural Welding Code - Steel, American Welding Society (AWS), 2015.
			12. Diaphragm Design Manual – DDM04 – Fourth Edition, Steel Deck Institute (SDI), September 2015.
			13. SDI - Design Manual for Composite Decks, Form Decks and Roof Decks - No. 31, November 2007.
			14. AWWA D-100-11 - Welded Carbon Steel Tanks for Water Storage, American Water Works Association (AWWA), 2011.
			15. API 650 - Welded Tanks for Oil Storage, Twelfth Edition, American Petroleum Institute (API), March 2013.
			16. PCI MNL‑116-99 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, Fourth Edition, Precast/Prestressed Concrete Institute (PCI).
			17. PCI MNL‑117-13 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, Fourth Edition.
			18. PCI MNL-120-10, PCI Design Handbook, Seventh Edition.
			19. PCI MNL‑122-07 - Architectural Precast Concrete, Third Edition.
			20. PCI MNL-126-98 - Manual for the Design of Hollow Core Slabs.
			21. PTI DC10.1-08 Design and Construction of Post-Tensioned Slabs-on-Ground by the Post Tensioning Institute (PTI), Third Edition with 2008 Supplement, 2008.
			22. CMAA Specification No. 70-2010, Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes, Crane Manufacturers Association of America, Inc. (CMAA)
			23. CMAA Specification No. 74-2010, Specifications for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist, Crane Manufacturers Association of America, Inc. (CMAA)
			24. AASHTO LRFD Bridge Design Specifications (7th Ed.) with 2016 Interim Revisions, American Association of State Highway and Transportation Officials (AASHTO).
	3. **General Criteria.**
		1. **Engineer-of-Record (EOR)**. The EOR shall be in charge of, and responsible for, all aspects of structural design including connections (Reference ER1110-1-12). This responsibility is not transferable to the construction contractor. Pre-fabricated systems such as pre-engineered metal buildings, precast/prestresed concrete, open web steel joists, wood roof trusses, lightgage steel roof trusses, and proprietary systems will be considered an extension of the EOR’s design. All Pre-fabricated systems and their design shall be reviewed and approved by the EOR.

[RFP Editor’s Note. The following applies only for a Design-Build RFP.]

* + 1. **[Construction Submittals**. All Structural submittals shall be reviewed and approved by the EOR, and affixed with their standard review stamp before being submitted for Government review.]
		2. **Design Loads.**
			1. **General.** For DoD facilities, design loads shall be calculated in accordance with UFC 3-301-01. For all other facilities, design loads shall be calculated in accordance with the IBC. Design loads shall be included in the General Structural Notes on the contract drawings as shown in CESPA Standard Structural Drawings.
			2. **Dead Loads**.

General. The structural system shall be designed and constructed to safely support all dead loads, permanent or temporary, including but not limited to self-weight, partitions, insulation, ceiling, floor covering, and all equipment that is fixed in position. All loads and load case combinations shall be in accordance with ASCE 7.

* + - 1. **Live Loads**.

Roof Loads.

Roof Live Loads. Roof Live load shall be a minimum 20 psf. Roof live load reduction is not allowed.

Snow Load. Roofs shall be designed to support balanced snow load, unbalanced snow load, drifting snow, sliding snow, and rain on snow. At DoD installations use the ground snow load provided in UFC 3-301-01.

Floor Live Loads. Floor live load reduction is not allowed. At DoD installations use the live loads provided in UFC 3-301-01.

Fall Protection Loads. Fall protection system loads including load shall be applied as live loads per UFC 3-301-01.

* + - 1. **Wind Loads**.

Basic Wind Speed. At DoD installations use the basic wind speed provided in UFC 3-301-01.

[Aircraft Hangar and Vehicle Maintenance Building Wind Loads. Aircraft hangars and maintenance buildings shall be designed to resist wind loads resulting from the basic wind speed with aircraft/vehicle access doors both open and closed.]

* + - 1. **Seismic Loads**.

* + - * 1. **Spectral Accelerations**. For DoD installations, the 0.2 second spectral acceleration (Ss) and the 1.0 second spectral acceleration (S1) coefficients can be obtained from UFC 3-301-01. Alternatively, the Ss and S1 coefficients may be determined using the zip code or the longitude and latitude of the project location using the U.S. Geological Survey Earthquake Hazards Maps and Tools.
				2. **Seismic Bracing Requirements for Mechanical and Electrical Equipment**. Reference ASCE 7, Paragraph 13.6 – “Mechanical and Electrical Components” and UFC 3-310-04, Paragraph 1621 – “Architectural, Mechanical, and Electrical Component Seismic Design Requirements” for Minimum Seismic Bracing Requirements for Mechanical and Electrical Equipment. When seismic bracing is required, include CESPA Structural Guide Specs Section 13 48 00 - SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT. Coordinate editing of 13 48 00.00 10 - SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT and 26 05 48.00 10 - SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT with the mechanical, fire protection, and electrical designers.
		1. **Serviceability.**
			1. **Foundation Settlement**.
				1. An adequate level of protection against structural failure due to uniform and/or differential foundation settlement shall be provided.
				2. [Additions to Existing Buildings. For additions to existing buildings do not support new floor or roof structures on any part of the existing building structure. The new building load on the existing structure could cause settlement of the existing structure and thus damage to the existing structure components.]
			2. **Vertical Deflection of Suspended Horizontal Framing Members**.
				1. Vertical Deflections. Building serviceability shall not be impaired by vertical deflections.
				2. Vertical deflections shall be limited to the following criteria.

L/240 for roof live loads.

L/600 for masonry walls and lintels, and supports of masonry walls.

L/360 for floor live loads and L/240 for floor total loads.

[Deflection of structure supporting aircraft hangar door guides shall be as required by hangar door manufacturer.]

* + - 1. **Floor Structure Vibrations**. Provide structural floor vibration calculations as part of the structural calculations in the Design Analysis. Concrete slab/steel deck systems supported on open web steel joists shall comply with the vibration criteria of SJI Technical Manual No.5, “VIBRATION of Steel Joist-Concrete Slab Floors”. For open web steel joists, the human response domains shall be in the “slightly perceptible” range or stiffer. For steel floor beams and support girders, follow the criteria in AISC Design Guide 11, “Floor Vibration Due to Human Activity” paragraph titled “Recommended Criteria for Structural Design”.
			2. **Horizontal Deflection (drift)**.
				1. Horizontal deflections shall not exceed the limits set forth in UFC 3-301-01 when the structure is subjected to the required seismic and wind criteria.
				2. **Building Expansion Joints**. Provide expansion joints through buildings at a maximum 200 feet on center.
		1. **Antiterrorism Design**. Antiterrorism standards shall be followed for all DoD projects in accordance with the structural requirements of the UFC 4-010-01 – DoD Minimum Antiterrorism Standards for Buildings.
		2. **Construction Tolerances**. Allowable variations from level, or specific slopes, shall be as follows:
			1. For overall length of 10-feet or less plus or minus 1/8-inch.
			2. For overall length of 20-feet or less plus or minus 1/4-inch.
			3. For overall length of above 20-feet plus or minus 3/8‑inch.
			4. Floor Flatness. Flatness and levelness of the floor slab surfaces on-ground and on-deck shall be measured by the F-Number System in accordance with ASTM E 1155, “Determining Floor Flatness and Levelness Using the F‑Number System”. The requirements for the F-Number System shall be as specified in CESPA structural guide specifications for concrete. A flatness and levelness tolerance measured by the “Straightedge System” is not allowed.
		3. **Durability - Time Reliability.**
			1. Structural components shall be protected from condensed moisture that could impair their structural adequacy through deterioration.
			2. Special attention shall be given to protection against corrosion or oxidation of metals, decay of wood and wood base materials, spalling of concrete, leaching of mortar, and deterioration of adhesives. Prevention of these hazards shall be especially important.
			3. The materials used in structural elements, components, and assemblies shall be resistant to or protected from damage by exposure to normal climatic conditions.
	1. **Materials Requirements.**
		1. **Concrete**.
			1. **General**. Concrete materials and mix design shall comply with ACI 318. Concrete strength shall be as required in ACI 318 Chapter 19, “Concrete: Design and Durability Requirements”, Table 19.3.2.1, but shall have a specified strength of at least 3,000 psi.
			2. **ASR Reduction.**
				1. All concrete shall contain an approved flyash. The minimum percent of flyash required shall be determined per specification Section – 03 10 00 - ALKALI-SILICA REACTIVITY REDUCTION FOR CONCRETE.
				2. Coarse and fine aggregates shall have a minimum percent of pozzolan added to mitigate Alkali-Silica Reactivity (ASR) to be determined per specification Section 03 10 00 - ALKALI-SILICA REACTIVITY REDUCTION FOR CONCRETE.
			3. **Testing**.Testing of concrete work shall be done at the contractors expense by a USACE Materials Testing Center validated independent testing laboratory, and be of the frequency as stated in the CESPA Structural Guide Specifications.
			4. **Forms**. Materials for forms shall be plywood, metal, metal-framed, aluminum, reinforced fiberglass, or plywood-faced to provide continuous, straight, smooth, exposed surfaces. The classes of formed concrete finishes to be used on this project shall be edited as such in the CESPA Structural Guide Specifications.
			5. **Reinforcing Materials**. Reinforcing bars shall meet the requirements of ASTM A 615, Grade 60, deformed. Reinforcing bars to be welded shall meet the requirements of ASTM A 706 Grade 60.
			6. **Concrete Materials**.

Cement. [ASTM C 150, Type I-II Portland cement low alkali (0.6% or less).\*\*\* delete this paragraph for HAFB projects]

Fine Aggregate. ASTM C 33.

Coarse Aggregate. ASTM C 33.

Air-Entraining Admixture. ASTM C 260.

Flowing Concrete Admixture. ASTM C 1017, Type 1 or 2.

Calcium Chloride shall not be permitted in any material or admixture.

Fly Ash. ASTM C 618, Class "F".

* + - 1. **[Special Concrete Requirements at Holloman AFB**. To alleviate deterioration of concrete due to soil sulfate action at Holloman AFB, New Mexico and in the Tularosa Basin of New Mexico, the following requirements shall be applied for all concrete used at these locations.

Shall wash all coarse and fine aggregates.

Shall not use calcium chloride or admixtures containing chloride salts.

Shall contain Type V, low alkali (0.6% or less) cement.

Shall have a compressive strength of 4,000 PSI at 28 days.

Shall have maximum water to cementitious materials ratio, by weight, of 0.45.

Except for interior floor slabs-on-ground and slabs-on-ground areas to receive special toppings whose performance would be adversely affected by air in the concrete, all concrete shall contain an air entrainment admixture. If an air entrainment admixture is used, the air content shall have by volume 5.0 to 7.0 percent for nominal maximum aggregate size of 3/4-inch or less, or 4.0 to 6.0 percent for nominal maximum aggregate size greater than 3/4-inch.

Shall have a minimum percent of pozzolan added to mitigate Alkali-Silica Reactivity (ASR) to be determined per specification Section 03 10 00 - ALKALI-SILICA REACTIVITY REDUCTION FOR CONCRETE.

Shall not exceed a slump of 3 inches.

Shall be moist cured for 4 days.

Shall not use recycled concrete for fill material or concrete aggregates.]

* + - 1. **Curing Concrete**. Concrete curing shall be as specified in the CESPA Structural Guide Specifications.
			2. **Capillary Water Barrier**. Provide 6-inch capillary water barrier under all concrete floor slabs-on-ground. Reference CESPA Standard Structural Drawing Sheets for the capillary water barrier gradation and compaction requirements.
			3. **Vapor** **Retarder**. A vapor retarder shall be placed under all interior concrete floor slabs-on-ground. The vapor retarder shall comply with ASTM E-1745, Class A, and have a minimum thickness of 10 mils. Polyethylene membrane will not be allowed. A sand layer between the bottom of the floor slab-on-ground and the vapor retarder will NOT be allowed, no exceptions.
		1. **Precast Prestressed Concrete**. Reference the requirements of CESPA Structural Guide Specifications unless noted otherwise in this document. Acceptance of precast units shall depend on, but not necessarily be limited to the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing.
		2. **Post-Tensioned Concrete**. Reference the requirements of CESPA Structural Guide Specifications unless noted otherwise in this document.
		3. **Concrete Masonry Units (CMU)**. Reference the requirements of CESPA Structural Guide Specifications unless noted otherwise in this document.
			1. Design Strength. The design strength of CMU structures shall be Fm’=1500 psi as determine by the IBC unit strength method.
			2. CMU. Concrete masonry units shall have a minimum 28 day compressive strength of 1900 psi on net area.
			3. Grout. Grout shall conform to ASTM C476 and have a minimum strength of 2000 psi.
			4. Mortar. The mortar shall be Type “S” conforming to the proportion specification of ASTM C 270.
			5. Water Repellant. All mortar and concrete masonry units shall contain a water repellant admixture. Integral water repellant shall be a liquid polymeric admixture. The mortar shall contain the manufacturers recommended amount of liquid polymeric integral water repellant mortar admixture for water repellency and assure proper bond strength.

* + 1. **Structural Steel**.

Wide Flange Shapes: ASTM A 992.

Miscellaneous Shapes: ASTM A 36 or ASTM A 572 Grade 50.

Structural Tubing: ASTM A 500 Grade B.

Structural Pipe: ASTM A 53 Grade B.

Connection Bolts: ASTM A 325.

Anchor Bolts or Rods: ASTM A307 or ASTM F 1554 grades 36, 55, & 105.

* + 1. **Cold-Formed Steel Framing Members**. Reference the requirements of CESPA Structural Guide Specifications unless noted otherwise in this criteria document.
	1. **Foundation Requirements.**
		1. **Foundation Type**. The foundation type, allowable bearing pressure, foundation depth, expansive/settlement parameters, etc. shall be as specified in the government approved final Foundation Design Analysis (FDA), unless otherwise required in this document.
		2. **Design Loads**. Allowable foundation bearing pressures shall be given in the FDA and will normally be given as "net" values; intended for use with service loads consisting of dead loads plus that portion of live loads that act continuously plus wind or seismic loads as applicable. Use IBC live load reduction factors to calculate the continuous live load. The "continuous live load" concept does not apply to certain foundations with high transient loads, such as crane loads, where the full live load should be considered in the foundation load. Since allowable bearing values are net values, do not include the weight of footings, piers or overburden in the design loads. Lateral loads on foundations shall be accounted for due to wind, seismic, rigid frame thrust, etc.
		3. **Foundation Notes**. Foundation notes shall be included in the structural drawings as shown in CESPA Standard Structural Drawing Sheets.
		4. **Slabs-on-Ground**. Floor slabs-on-ground shall be a minimum of 5-inches thick, bar reinforced with a minimum #4 bars with a minimum area of reinforcing of 0.2% of the slab cross sectional area and located 1 1/2-inches clear from the top surface of the slab. Minimum slab-on-ground reinforcing is #4 bars at 18-inches on center each way for a 5-inch thick slab-on-ground. Welded wire mesh and/or fiber reinforcing shall not be substituted for the minimum reinforcing. There shall be a minimum 3/8-inch expansion joint material installed between the foundation walls and the slabs-on-ground. Reentrant corners shall be reinforced with a minimum (2) #4 bars by 48-inches long at 45 degrees to the corner.
		5. **Minimum Compacted Engineered Fill Under Building Slabs-on-Ground**. Provide a minimum of 24” compacted non-expansive fill under all building slabs-on-ground below the Capillary Water Barrier.
		6. **Slab-on-Ground Joints**. Slab-on-ground joints shall be located no greater than 15-feet on center each direction. The joints can be either construction or contraction joints (weakened plane joints) as detailed in CESPA Standard Structural Drawing Sheets. Reinforcing shall be discontinuous at all construction and contraction joints. All construction and contraction joints shall be doweled with bar or plate dowels. Bar dowels shall be placed no closer than 12 inches from joint intersections. Plate dowels shall be placed no closer than 6 inches from joint intersections. Tension tie reinforcing and/or “hairpin” ties in the slab are not allowed. Only saw cut joints shall be performed by the early-entry dry-cut (soft cut) saw-cut method. The EOR shall provide drawings showing the locations of all slab-on-ground joints.
			1. **Early-Entry Dry-Cut (Soft Cut) Saw Cut Method**. Saw cut shall be performed as soon as the slab can support the weight of the operator and the machine without disturbing the finish (usually within 2 hours after final finishing time when the concrete’s initial set stage is between 150 psi to 800 psi). The saw cut shall produce a joint of 1-inch minimum depth or depth recommended by saw-cut machine manufacturer. The saw cut machine shall have a depth control device to assure a constant-depth cut is maintained, and a means to prevent the raveling of concrete.
		7. **Foundation and Slab-On-Ground Underlying Soil Moisture Control**. Controlling foundation moisture is critical for the success of the building foundation. A number of items should be considered for the control of water infiltration around the building perimeter. These items are as follows:
			1. Surface Water. The structural designer should coordinate with the site designer and landscape designer on the importance of measures to control water near the perimeter of the building. All surface water flowing into the building site should be diverted around the structure so that it will not infiltrate the building foundation subgrade soils.
			2. Roof Water. Water from rainfall should be prevented from entering the ground near the perimeter of the structure, by providing paving where adequate drainage slopes are not possible and diverting gutter downspouts away from the foundation.
			3. Perimeter Drains. Use interceptor or perimeter drains when surface or underground water cannot be diverted away from the building. Foundation drainage systems should be carefully designed to prevent them from introducing water into the building foundation subgrade soils.
			4. Landscaping. Landscape plantings and irrigation systems should be planned so that watering of beds or lawns does not introduce water to the building foundation subgrade soils or, drying of the foundation does not occur due to withdrawal of soil moisture by roots from large plants near the building perimeter.
			5. Floor Joints and Drains. All floors slabs-on-ground subjected to water shall be sloped to drains to prevent water from entering the sub-grade soils through joints in the floors slabs-on-ground. All joints shall be sealed as specified on the joint details specified on the CESPA Standard Structural Drawing Sheets. All floor drains shall be pressure tested for leaks.
		8. **[Floor Slabs-on-Ground Subjected to Vehicular Loading.** Where floor slabs-on-ground are subjected to vehicular or forklift loading, the floor slab-on-ground must be designed in accordance with reference UFC 3-320-06A. Slabs‑on‑ground subjected to vehicular loading should be designed using a minimum flexural strength of 700 psi. The Geotechnical Engineer should provide subgrade modulus, K, for slab design when there are wheel loads. The minimum floor slab-on-ground thickness shall be 6-inches.]
		9. **[Floor Slabs-on-Ground Subjected to Aircraft Loading.** Slabs-on-ground subject to Aircraft loading shall be designed as airfield pavement according to the requirements of the Geotechnical Design portion of this RFP document. A strip of structural slab-on-ground, width approximately equal to the aircraft clear zone, shall be provided around the perimeter of the hangar floor, thus providing a regular rectangular area of airfield pavement for the aircraft. The hangar floor airfield pavement shall be designed to support point loads from the aircraft jack stands. All other interior slabs-on-ground shall be designed according to the requirements of the Structural Design portion.]
		10. **Interior Mechanical Equipment Foundation Pads.** Interior and foundation pads shall be shown on the contract drawings as specified in CESPA Standard Structural Drawing Sheets.
		11. **Pits.** All foundation pits shall have concrete floor slabs-on-ground. Pits shall be designed for buoyancy forces where they are placed within a water table. The pits can be fabricated as cast-in-place or precast concrete units. If the pit has a concrete top slab, the top slab shall be a removable precast concrete slab with lifting inserts. The top slab shall contain a minimum 24-inch diameter manhole cover and shall be designed for a minimum H-10 wheel loading or as required for the location.
		12. **Walls Mostly Below Grade**. Walls mostly below grade that are supported laterally at or near the top and bottom, shall be designed using loads based on at-rest soil pressures.
		13. **Basements**. [Basements are not allowed][Basement floors will be concrete slabs‑on‑ground separated from the basement walls by a minimum 3/8-inch expansion joint material. Basement walls shall have membrane waterproofing on the outside and under the slab with a continuous perimeter drain around basement. The slab-on-ground vertical joint to the basement wall shall be waterproofed at the membrane under the slab. Basement walls shall be designed for lateral hydrostatic pressure as well as lateral soil pressure. In such cases, the perimeter drains are usually assumed to be 50 percent effective; i.e., the water table in soil against the wall is assumed to be located at one‑half the difference between the site design water table elevation and the elevation of the wall drain.]
		14. **Footings and Foundation Walls**.
			1. **Column Spot Footings**. Column spot footing sizes shall be determined by design but shall not be less than 24-inches in any direction and a minimum thickness of 12-inches. The spot footings shall be reinforced per design requirements with a minimum number and size of 3-#4 bars each way or 12-inches on center bottom reinforcement whichever provides the greater number of bars. Specify footing reinforcement by number of bars equally spaced and not by spacing
			2. **Column Block-outs**. Slab-on-ground block-outs for columns which bear below the top of the slab shall be detailed on the contract drawings as shown in CESPA Standard Structural Drawing Sheets. The top of the footing or pedestal supporting the column shall be at least 8” below the top of the slab-on-ground..
			3. **Continuous Footings**. The foundation continuous footings shall be reinforced concrete with a minimum thickness of 12-inches with a minimum 2-#4 bars continuous and minimum #4 bars at 48-inches on center transverse bottom reinforcement. The footing width shall be determined by design and shall be at least 8-inches wider than the foundation wall (minimum 4-inches on each side of the foundation wall). All load-bearing and shear walls, no matter the wall material, shall be founded on a continuous footing.
			4. **Foundation Walls**. The foundation walls shall be a minimum 8 inches thick reinforced concrete. The walls shall be reinforced with a minimum #4 bars with a minimum vertical reinforcing area of 0.15 percent and a minimum horizontal reinforcing area of 0.25 percent of the wall cross sectional area. Provide continuous perimeter rigid insulation on the interior surface of the exterior foundation walls adjacent to all heated areas. The insulation shall provide an R-Value of 4 and be 24 inches deep or to the top of the footing; whichever is the least, from the top of the slab-on-ground. The minimum depth of the foundation wall from the top of footing to the top of the slab-on-ground shall be 18-inches.
		15. **Pier-Grade Beam Slab-on-Ground Foundation System**.
			1. **General**. This type of foundation system is normally used for expansive soil conditions, or where over-excavation requirements are cost prohibitive.
			2. **Structural Grade Beam Design**. Grade beams shall be designed per ACI 318 requirements.
			3. **Isolation Joint**. A continuous minimum 3/8-inch wide isolation joint shall be placed in the slab-on-ground at the interface of all vertical surfaces.
			4. **Void Forms and Retainers**. A 6‑inch high carton formed voids with void retainers will be required under all structural grade beams.
			5. **Masonry Walls**. Masonry walls, including masonry partitions, within the structure shall be placed on structural grade beams in order to reduce wall cracking problems due to soil movements.
			6. **Soil Retaining Exterior Grade Beams**. In buildings with slabs‑on‑ground floors where the finished floor is more than 24-inches above outside grade, special attention shall be given to design of exterior grade beams to withstand lateral soil pressure from the fill under the floor slabs-on-ground.
			7. **Drilled Pier Design**.
				1. **General**. The piers shall be designed as short, tied columns with minimum vertical reinforcement per ACI requirements. Note that since pier shaft diameters are often larger for Geotechnical reasons than required for structural loads, the provisions of ACI 318 that allow a reduced concrete area to determine reinforcement may apply. This document shall govern for any conflicts that may occur with the requirement for the piers between the FDA and this document.
				2. **Piers Through Expansive Soils**. Piers that extend through expansive soils may be subjected to tension loads caused by soil friction on the shaft as the soil expands. The FDA will give either recommended pier design tension or minimum shaft tension reinforcement and minimum bell size to anchor the pier when expansive soils cause pier tension. Pier tension reinforcing should be sized for net load obtained by subtracting the pier load due to the building dead weight from the tension due to soil heave.
				3. **Pier Diameters**. Minimum pier diameters are 18 inches for piers up to 40 feet in depth and 24 inches for piers deeper than 40 feet.
				4. **Bell Sizes**. Bell diameters should be specified in increments of 6 inches. Size bells for dead load plus the portion of live load that acts continuously.
				5. **Vertical Loads**. Pier loads should be computed only to grade. Weight of pier, bell and earth above base of footing will be taken into account in determining "net" allowable bearing pressure given in the FDA.
				6. **Lateral Loads on Grade Beams and Piers**. Ties between piers may be necessary in seismic regions as required by the IBC. The structural designer shall see the FDA and/or consult with the geotechnical engineer for recommended lateral soil design parameters.
			8. [**Future Expansion Areas.** Design and construct foundations and subgrade preparation adjacent to designated future expansion areas to accommodate the future expansion with minimal disruption to the building in this project, and minimum cost for the future expansion project. For example, provide sufficient over-excavation and compaction of soil beyond the building perimeter to prevent undermining the foundations during construction of the future project, and minimize foundation protrusions into the expansion area.]
	2. **General Superstructure Requirements.**

The system shall provide vertical and lateral load carrying capacity and shall provide durability, maintainability and cost effectiveness. Roof openings and all supports for ventilators, fuel tanks, electrical bus ducts, unit heaters and other mechanical equipment must be detailed or adequately described on the drawings or in the specifications. The structural designer shall ensure that all mechanical and electrical equipment is properly supported and that architectural features are adequately framed and connected.

* 1. **Steel Superstructure Construction Requirements**.
		1. **Structural Steel Framing**.
			1. **General**. The structural system shall be designed for both the vertical and horizontal loads required by UFC 3-301-01, but not less than any dead loads and live loads specified in this document. Structural calculations shall be submitted for all vertical, horizontal and connection designs.
			2. **Structural Steel Notes**. Provide superstructure structural steel notes on the contract drawings as shown in CESPA Standard Structural Drawing Sheets.
			3. **Steel Fabricator Certification**. The fabricating plant shall be certified under the AISC quality certification program category, STD. See specification Section 05 12 00 - STRUCTURAL STEEL, paragraph “FABRICATION”.
			4. **Structural Steel Connections**. When seismic controls the design of the main frame, fully restrained moment connections shall comply with requirements of UFC 3-301-01 and UFC 3-310-04. Connection design shall be in accordance with Manual of Steel Construction and shall be 100% designed and detailed by the EOR. It will be acceptable to use the connection tables in the Manual of Steel Construction for design of the connections if applicable. If standard Manual of Steel Construction tables are used for the connection designs then these connections shall be specified on the drawings through the use of connection tables. It is not acceptable for the structural designer to provide the connection loadings on the drawings and have the steel fabricator design and detail the connections. Structural calculations shall be submitted for all structural steel framing and connection designs.
			5. **Steel Column Base Plates**. All steel column base plates shall have a minimum four bolt pattern with leveling nuts on the anchor bolts and a minimum 2-inches thickness of non-shrink high-strength non-metallic grout under the base plates.
			6. **Steel Beams Bearing on Masonry or Concrete Walls**. All main supporting steel beams that rest on masonry or concrete walls, pilasters or columns shall bear on expansion connections unless the steel beam is a drag strut or a roof purlin. The expansion connections shall consist of steel backed Teflon bearing pads attached to the beam and to the steel bearing plate respectively. Reference CESPA Standard Structural Sheets for a detail of this expansion connection.
			7. **Steel Trusses**. Trusses shall be designed with web member arrangement such that members are symmetrically loaded in the plane of the truss.
			8. **Structural Steel Roof Framing**.

**General**. See the Architectural requirements for roof slope pitch(es), sound attenuation and any other criteria not covered below.

**Flat Roofs**. Where sound attenuation is a design requirement or where a rigid diaphragm is needed, concrete may be placed over the steel deck. A minimum slope of 1/4” to 12” shall be provided for drainage. The structure shall be sloped, rather than using tapered insulation to achieve the required roof slope.

**Hip and Valley Framing**. Use light wide flange shape purlins with shear plate bolted connections when framing into hip or valley beams. Do not use steel open web bar joists where the flat bearing seats have to be shimmed on the hip or valley beams.

**Steel Roof Deck**. Steel roof deck shall be minimum 1½-inches deep wide ribbed and have a minimum thickness of 22 gage. The steel roof deck shall be designed per SDI specifications. The steel deck shall be used as a lateral diaphragm. Reference the following paragraph "Lateral Shear Diaphragm Design". All deck shall be fastened to the main supporting members with a minimum 5/8-inch diameter fusion welds, power actuated or pneumatic fasteners, or self-tapping screws spaced per the design requirements, but not less than 3 welds or fasteners per sheet width of deck. Weld washers shall not be used for the welded connections. Only button punching performed by a pneumatic machine that punches through the two layers of deck ribs, or self-tapping screws will be allowed for the sidelap attachment of the steel deck. Button punching that uses a tool that only crimps the deck panels together will not be allowed. The steel deck can have nested or interlocking side laps. Interlocking sidelap decking using a self-tapping screw side lap attachment is not allowed unless the deck has a minimum 1/2” horizontal extension past the interlock rise of the deck to take a self-tapping screw. Deck selection should include a consideration for construction and maintenance loads per the Steel Deck Institute Specification table titled “Recommended Maximum Spans for Construction and Maintenance Loads Standard for 1-1/2 Inch and 3 Inch Roof Decks”

**[Roof Deck for Asphalt Shingles**. Plywood decking or other types of wood decking are not allowed. Gypsum planks and so‑called "nailable concrete" planks can be used for this purpose.]

6.14.1.9 **Standing Seam Metal Roof System (SSMRS)**.

SSMRS roofing shall not be used as a lateral force resisting diaphragm.

* + 1. **Structural Steel Studs**.
			1. **General**. Structural steel studs may be used for interior and exterior load bearing and non-load bearing walls and for soffits and fascia framing construction in accordance with UFC 3-301-01. Design calculations for steel stud walls, soffits and fascia framing shall be included in the Design Analysis.
			2. **EOR Responsibility**. The building structural EOR has design responsibility for cold-formed steel systems. This responsibility shall not be transferred to the Construction Contractor.
			3. **Member Designation and Minimum Thicknesses**. Structural Steel Studs shall be specified on the drawings using the standard SSMA designation, e.g. 600S162-54. Studs shall be a minimum of 43 mils (18-gage) thickness material. Steel track shall be fabricated from a minimum of 68 mils (14 gage) thickness material, except 97 mils (12 gage) for vertical load bearing stud walls the top track supporting joists or trusses. Structural studs can be attached with weld or #12 self-tapping screws.
			4. **Detailing**. Structural steel stud walls, soffits and fascia should be detailed to show steel stud, steel joist spacing and required SSMA designation. Details shall show wall top and bottom track and their connections to floors or other framing. Details including required web stiffeners, foundation clips, end clips, joist hangers and the required number and size of connecting screws and/or weld size and length shall be included. Framing around openings shall be detailed to show headers, nested multiple members on sides of openings. Diagonal strap bracing is not allowed. Sheet metal shear wall panels and their connection to foundation and the steel stud assembly framing shall be fully detailed. Intermediate bridging for lateral support of studs/joists shall be fully detailed.
			5. **Slip Connections**. Design and detail the slip connections between steel stud framing and the main structural system to prevent the studs from carrying floor or roof axial or shear loads if the walls are non-load bearing.
			6. **Interior Partition Walls**. Interior partitions shall be designed to withstand minimum lateral pressures as specified in ASCE 7 and can span either vertically or horizontally. If spanning vertically, partitions must be supported at the top of the wall by the roof or floor structural components using vertical slip connections.
		2. **Light Gage Steel Roof Truss Systems**.
			1. All truss system elements shall be pre-engineered pre-fabricated light gage cold formed steel.
			2. Trusses shall be designed with web member arrangement such that members are symmetrically loaded in the plane of the truss.
			3. No truss member shall be less than 20 gage (33 mils) thickness material.
		3. **Pre-Engineered Metal Buildings (PEMB)**.

* + - 1. **General**. [PEMB and/or pre-engineered steel framing systems supplied by PEMB manufacturer are not allowed.] [The requirements of the CESPA Standard Drawings, including the S-003 “Pre-Engineered Metal Building Notes”, and the CESPA Structural Guide Specifications shall apply to pre-engineered metal building design and construction.

[RFP Editor’s Note. The following paragraph applies only for a Design-Build RFP.]

* + - 1. **[EOR Design Submittals**. The EOR shall include the PEMB manufacturer’s drawings and calculations in all design submittals.]
			2. **Fabricator Certification**. The PEMB fabrication plant shall be accredited under the International Accreditation Service (IAS) AC472 Accreditation Criteria, no matter the size of the project.
			3. **Collateral Dead Load**. Include a minimum collateral dead load of 10 psf to account for mechanical, electrical, sprinklers, and other miscellaneous loads. This collateral load is in addition to the calculated dead load of the metal building structural and architectural components.
			4. **Deflections**. Vertical and lateral deflection limits shall comply with UFC 3-301-01. Building drift shall comply with the MMBA Metal Building Systems Manual.
			5. **Building Framing**. All primary building framing such as rigid frames, beams, and columns shall be fabricated from structural steel, with minimum thickness of 3/16”. Light gage steel framing is allowed only for roof purlins, wall girts, and framing around wall or roof openings.
			6. **Lateral Force Resisting Systems**. Only rod bracing, portal frames, and rigid frames systems are allowed for resisting lateral loads. Cable bracing, wall diaphragm, or roof diaphragm systems shall not be used.
			7. **[Future Expansion**. Provide rigid frames rather than post and beam framing at endwalls adjacent to designated future expansion areas. The endwall system shall be designed so that endwall columns can be removed without affecting the structural load carrying capacity of the building.]
			8. **Conceptual Roof Framing Plan**. A conceptual roof framing plan shall be provided in the contract drawings. This roof framing plan shall show all support frames, a tentative spacing of the roof purlins (maximum 5’-0” on center), tentative horizontal roof lateral bracing, vertical X-bracing or portal frames, mechanical units, roof openings, cranes and crane supports and any other miscellaneous items associated with the roof framing plan. This plan shall contain the grid lines that are associated with the foundation plan.
			9. **Overall Building Sections**. Overall building sections for each different configuration of the building frames shall be included in the contract documents. These sections shall include the roof pitch, the height requirement to the interior intersection point of the column/beam haunch of the frames, the pertinent grid lines associated with the sections, and any special instructions to the PEMB manufacturer. The width dimensions of the frame are not needed on the sections.
			10. **[Special Structures Within a PEMB**. Special structures within and supported by a PEMB system such as mezzanines, catwalks, stairs, masonry wall supports, etc. shall be designed and detailed by the EOR. Loads from the special structures shall be provided on the drawings by the EOR for the designer of the PEMB.]
	1. **Masonry Superstructure Construction Requirements**.
		1. **General**. Masonry for buildings shall be detailed to show required thickness, vertical reinforcement size and spacing, dowels, pilaster depth, reinforcement and ties, wall stiffeners adjacent to openings, lintel depth, reinforcement and end bearing dimensions, bond beam spacing and reinforcement, joint reinforcement spacing and size, and control joint locations and details. When walls are curtain walls show details of masonry connections to the roof or floor diaphragms components.
		2. **Masonry Notes and Standard Details**. Masonry notes and standard details shall be placed on the contract drawings as shown in CESPA Standard Structural Drawing Sheets.
		3. **Walls**. Masonry walls shall be designed in accordance with UFC 3-301-01 and UFC 3-310-04, as applicable. Unreinforced masonry structural walls are not allowed.
		4. **Minimum Reinforcement**. All masonry walls shall be reinforced as specified in UFC 3-301-01 and UFC 3-310-04, as applicable. Vertical reinforcement for masonry walls, 10-inches or less in thickness shall contain no more than one reinforcing bar per grouted cell with the bar located in the center of cell. See CESPA Standard Structural Drawing Sheets for minimum reinforcement placement details.
		5. **Interior Partitions**. Masonry single wythe interior partitions and walls shall be minimum 6-inches thick and shall be reinforced.
		6. **Bond Beams at Diaphragms**. Where roof or floor diaphragms are attached to bond beams that serve as the diaphragm chord, the bond beam reinforcement shall be continuous across the wall control joints. If the wall is exposed to view, provide a "dummy joint" in the bond beam to match the control joint location. If a continuous ledger angle attached to the wall functions as the diaphragm chord, then the angle shall be continuous across the wall joints.
		7. **Control Joints**. Wall control joints and other crack control measures shall be in accordance with UFC 3-301-01 and UFC 3-310-04, as applicable. The joints shall not exceed a spacing of 25-feet on center, and shall be at least 24-inches from the edge of any wall opening and shall not be placed within the span of a lintel. Incorporate the control joint details in the contract drawings as shown in CESPA Standard Structural Drawing Sheets. All bond beam reinforcing shall stop at the wall control joints unless the bond beam is used as a diaphragm chord.
		8. **Reinforcement**. Vertical and horizontal reinforcement requirements for masonry walls shall be clearly indicated on the structural drawings. Horizontal reinforcing shall be minimum 2-#4 bars in “Knockout” bond beams. The bond beams shall be spaced at 48-inches on center maximum. With bond beams at 48-inches on center, it is not necessary to use horizontal joint reinforcing. One #4 hooked dowels shall be installed in the top of all masonry walls at each vertical wall cell containing vertical reinforcing. The dowels shall project 24-inches into the wall and hook 6-inches into the wall top bond beam. These dowels will guarantee that the wall top bond beam will be attached to the lower portion of the wall. Bond beams at sloped wall conditions shall be detailed as shown on the CESPA Standard Structural Drawing Sheets.
		9. **Clearance to Steel Members**. Masonry walls shall be kept clear of steel columns and steel beams a minimum of 1/2-inch.
	2. **Concrete Construction Requirements**.
		1. **Frames**. Cast-in-place or precast concrete frames may be used as vertical-load-carrying or lateral-load carrying moment resisting frames with restrictions on their design for use in resisting seismic forces. UFC 3-310-04 identifies the type of moment resisting concrete framing required for each Seismic Design Category. Use of precast seismic-force-resisting frames is permitted, provided the frame emulates the behavior of monolithic reinforced concrete construction or relies on demonstrated experimental evidence that seismic loading comparable to monolithic reinforced concrete is achieved. Complete documentation shall be submitted and approved by the CESPA when precast seismic-force-resisting framing is proposed for use.
		2. **Lightweight Concrete**. Structural lightweight concrete shall not be used for concrete construction.
		3. **Concrete Design.** Concrete design will be in accordance with reference ACI 318 and UFC 3-301-01 as applicable.
		4. **Precast/Prestessed Concrete Hollow Core Plank Floors and Roofs.**
			1. **General**. All design, detailing and tolerances of hollow core floor and roof (optional) planks (referred to as “plank(s)” in the rest of this document) shall be as recommended in the Manual for the Design of Hollow Core Slabs unless noted otherwise in this document.
			2. **Plank Concrete**. Plank concrete shall be a minimum 28 day compressive strength of 4000 psi.
			3. **Plank Sizes**. All planks shall be a maximum of 48-inches wide and minimum 8-inches thick. Reference CESPA standard drawings.
			4. **Diaphragm Chord Reinforcing**. All diaphragm chord reinforcing shall consist of a minimum 1-#4 continuous bar encased in the wall concrete grout space at the level of the planks.
			5. **Grouting of Planks**.
				1. Shear Keys. All grout used to bond the planks integral with each other in the shear keys shall have a minimum 28 day compressive strength of 3000 psi and shall be a sand aggregate non-shrink grout.
				2. Plank Ends. All grout used to bond the plank integrally with the supporting masonry; concrete walls or steel support beams shall have a minimum 28 day compressive strength of 3000 psi and shall be pea gravel aggregate non-shrink grout.
			6. **Shear Key Reinforcing**. The grouted shear keys between the planks shall be reinforced with 1-#4 x 4’-0” dowel with a 12” hook at each bearing end of the plank. The 48” length shall be placed in the shear key between the plank and the 12” hook shall be placed horizontally in the wall grout space containing the diaphragm chord reinforcing.
			7. **Grout Ends of Plank**. At least 12” of each hollow core in the planks shall be grouted solid with concrete grout at all bearing points and at each end of the planks to compensate for vertical shear forces.
			8. **Topping Slab**. All floor planks shall be covered with a minimum 2 1/2” thick pea gravel aggregate concrete topping slab. The topping slab concrete shall have a minimum 28 day compressive strength of 3000 psi and shall be reinforced with welded wire fabric, supplied in flat sheets, or with polypropylene fiber mesh reinforcing (steel fibers are not allowed).
			9. **Plastic Bearing Plates**. All planks shall bear on a continuous 1/8” by 3” wide minimum size plastic bearing strip on the respective bearing material.
			10. **Roof Plank**. Roof planks shall span in a direction perpendicular to the roof slope. The first plank shall be positively anchored to the supporting structure such that it will support the planks above it from sliding down due to the roof slope during erection.
		5. **Precast Concrete Walls**.

* + - 1. **General**. Precast or site‑cast (tilt up) walls may be used for curtain walls, load-bearing, and/or shear walls. The EOR shall design all precast units for in-place loadings. Any additional reinforcing for handling, shipping, transportation or erection is the responsibility of the precast unit manufacturer.
			2. **Design Requirements**. These types of walls shall be designed in accordance with PCI Design Handbook, Precast and Prestressed Concrete, and PCA Engineering Bulletin, Tilt‑up Load Bearing Walls. Also, reference CESPA structural guide specifications for CESPA specific precast concrete requirements.
			3. **Design Loads**. Precast panels will be designed for in‑place loads similar to other building elements with the required steel reinforcing.
			4. **Connections**. The connections between the panels and the building framing shall be fully designed and detailed by the EOR, or the design loads shall be provided on the drawings for the precast fabricator’s engineer.
		1. **Concrete Floor Slab on Steel Deck**.
			1. **Supporting Structure**. Concrete floor slab on steel deck shall be supported by open web steel joists or wide flange steel beams, either composite or non-composite.
			2. **Slab Thickness**. The concrete floor slab shall be comprised of a minimum 3.5-inches constant thickness normal weight concrete (lightweight concrete is not allowed) above the steel form deck. The weight of normal weight concrete is usually needed to dampen the floor system vibrations. A slab thickness greater than 3.5-inches may be required for the vibration dampening requirements of the floor structure.
			3. **Jointing**. Concrete floor slabs to be exposed (without a floor covering) shall be jointed with contraction (weakened plane) and/or construction joints at a maximum spacing of 15-feet on center each direction. The exact locations of the slab joints shall be specified on a floor slab joint plan and shall be a separate plan from the floor framing plan. Only saw cut joints performed by the “early-entry dry-cut (soft cut) saw cut method” will be allowed for slab saw cut joints. Reference to the paragraph “Early-Entry Dry-Cut (Soft Cut) Saw Cut Method.” Provide joint details on the contract drawings for these slab joints. Reference the joint details specified on the CESPA Standard Structural Drawing Sheets.
			4. **Slab Reinforcing**. The slab shall be reinforced with a minimum 0.18 percent reinforcing in each direction. The reinforcing shall be minimum #3 bar reinforcement at a maximum spacing of 17-inches on center. Welded wire fabric and/or fiber reinforcing shall not be substituted for the minimum bar reinforcing.
			5. **Steel Deck**. The steel form deck shall be a composite wide ribbed deck with a minimum 22 gage thickness and be not less than 1 1/2" deep, galvanized. The steel floor deck shall be designed per SDI specifications. All decks shall be fastened to the main supporting members with a minimum 5/8-inch diameter fusion welds, or power actuated or pneumatic fasteners spaced per the design requirements, but not less than 3 welds or fasteners per sheet width of deck. Weld washers shall not be used for the welded connections. Self-tapping screws will not be allowed for deck fastening to the main supporting members without CESPA prior approval. Only self-tapping screws and button punching performed by a pneumatic machine that punches through the deck ribs will be allowed to be used for the sidelap attachment of the steel deck. Button punching that uses a tool that only crimps the deck panels together will not be allowed. The steel deck can have nested or interlocking side laps. Interlocking sidelap decking using a self-tapping screw side lap attachment is not allowed unless the deck has a minimum 1/2” horizontal extension past the interlock rise of the deck to take a self-tapping screw.
			6. **Vibration Control**. For serviceability issues related to concrete floor slabs on steel deck see the paragraph titled “Serviceability” sub-paragraph titled “Floor Structure Vibrations”.
	1. **Special Structures Requirements**.
		1. **General**. Special structures include, but are not necessarily limited to, antenna platforms and catwalks.
		2. **Antenna Platform(s**). Special attention shall be given to any antenna platforms located on roof areas. The dead load and lateral loads of the antenna have to be coordinated with the Corps project manager during the design process.
		3. **Catwalks**. Special attention needs to be given to catwalks. Catwalks shall be constructed of structural steel and open grating.
	2. **[Monorail Hoist Requirements**.
		1. **General**. Hoist runway supporting members and lateral bracing shall be designed detailed by the structural EOR.

* + 1. **Runway Beam**. Except as specified herein, the monorail runway beam design shall be in accordance with AISC design specifications taking into account the laterally unsupported length of the beam compression flange. The monorail beam vertical service live load shall be 1.5 times the rated capacity of the hoist to account for impact and overload, and a lateral load of 0.2 times the hoist rated capacity perpendicular to the beam. The beam shall be designed for the service live load plus dead load of beam and hoist. The vertical beam deflection to length ratio shall be limited to 1/800 with a service live load equal to the rated hoist capacity. A “W” or “S shape” beam with cap channel, or proprietary runway beam shall be used for all but very short spans.
		2. **Hangers**. The service live load for hangers supporting the monorail beam shall be 2.0 times the rated capacity of the hoist and a lateral load of 0.2 times the rated hoist capacity perpendicular to the beam. The hangers shall be designed for the service live load plus dead load of the beam and hoist. Monorail beams should be braced for longitudinal forces equal to 0.1 times the rated hoist capacity.
		3. **Building Framing**. One load case for design of the building framing supporting the monorail shall be vertical service design load of 1.5 times the rated capacity of the hoist combined with all other live loads and dead loads supported by the framing. When building framing supporting the monorail is open web steel joists, the structural EOR shall designate KCS joists and provide a load diagram for custom design by the joist manufacturer. The design shall also assure proper joist loading due to the concentrated loads at the monorail hangers by requiring the hangers to be at the panel points, or adding special joist web or chord reinforcing when the hangers are not at the panel points.]
	1. **[Bridge Crane Requirements.**

* + 1. **Runway Beams**. Runway beams for top running or underhung bridge cranes may be designed as simple or continuous members with certain limitations. Continuous beams shall not be used where significant unequal foundation settlement is likely to occur. Where foundations are other than shale or hard rock, check anticipated differential settlement so that the difference is limited to 0.003 L between adjacent supports. Limit live load deflection to span length at mid‑span to 1/800. The crane supporting structural members shall be designed to comply with ASCE 7, paragraph titled “Crane Loads”. For continuous girders limit ratio of length of adjacent spans to 2:1. Connect ends of simply supported girders in such a manner as to allow the ends to rotate under vertical loading. For top running cranes Use adjustable bolted connections for fastening the rail to the girder (welded connections are not permitted).]
	1. **Elevator Shaft Framing.**

* + 1. **Guide Rail Supports.** Design and provide structural elements to support the elevator guide rails per elevator manufacturer’s requirements.
		2. **Elevator Hoist/Safety Beam.** Design and provide a hoist beam at the top of the elevator shaft per elevator manufacturer’s requirements.
	1. **Lateral Force Resisting System (LFRS) Requirements**.
		1. **Lateral Load Diaphragm Design.**
			1. **General.** Diaphragms shall have continuous chord members on all edges and shall have direct positive connections for transferring load to all members of the main lateral force resisting system. The use of transferring lateral loads through joist seats is not allowed.
			2. **Steel Deck Roof Diaphragms**. Steel deck diaphragms for both wind‑controlled and seismic‑controlled designs shall be designed in accordance with SDI Specifications and UFC 3-301-01, as applicable. For seismic designs, the criteria specified in UFC 3-301-01 and UFC 3-310-04 shall be followed, as applicable. The criteria may also be used as a guide in designing diaphragms for wind‑controlled designs. Minimum deck thickness shall be 22 gage.

The selected deck thickness, deck section properties and fastening requirements shall be placed on the drawings, as shown in CESPA Standard Structural Drawing Sheets.

Steel deck diaphragms usually fall in the flexible or semi‑flexible category and, as such, will not distribute torsional forces, i.e., diaphragm shear reactions at shear walls or frames will be computed on a tributary area basis only.

The lateral deflection of steel deck diaphragms, which furnish lateral support for masonry walls, shall be checked against the allowable wall deflection. Reference UFC 3-301-1 for the computation of the allowable deflection for masonry walls. The actual maximum wall deflection is equal to the "story drift" that is the sum of the maximum diaphragm deflection and the average of the deflections of the frames or shear walls on either side of the diaphragm span.

Structural connections of the steel deck diaphragms to the building frame, sidelap connections, perimeter chords, connector plates at ridges, shear struts/collectors buildings to carry loads to shear walls and braced frames and other details for proper behavior of the diaphragm shall be fully designed and detailed on the drawings.

All deck shall be fastened to the main supporting members with a minimum 5/8-inch diameter fusion welds, or power actuated or pneumatic fasteners spaced per the design requirements, but not less than 3 welds or fasteners per sheet width of deck. Weld washers shall not be used for the welded connections. Self-tapping screws will not be allowed for deck fastening to the main supporting members without CESPA prior approval. Only button punching performed by a pneumatic machine that punches through the deck ribs and self-tapping screws will be allowed for the sidelap attachment of the steel deck. A button punching tool that only crimps the deck panels together will not be allowed. The steel floor deck can have nested or interlocking side laps. Interlocking sidelap decking using a self-tapping screw side lap attachment is not allowed unless the deck has a minimum 1/2” horizontal extension past the interlock rise of the deck to take a self-tapping screw.

* + - 1. **Concrete Floor or Roof Diaphragms**. For seismic designs, the criteria listed in UFC 3-301-01 and UFC 3-310-04 shall be followed, as applicable. The criteria may also be used as a guide in designing diaphragms for wind‑controlled designs. Concrete diaphragms shall be designed as rigid diaphragms.
			2. **Precast Concrete Floor or Precast Concrete Roof Diaphragms**. Calculations must be included in the design analysis to demonstrate the adequacy of the side connections to transmit shear and connection of the precast concrete diaphragms to the lateral force resisting building framing or shear walls.
			3. **Shear Struts**.

Axial Loads. Shear struts, if used, shall be designed for the horizontal compressive or tensile loads from the accumulated diaphragm shear as well as vertical loads. If the strut is a joist, then provide the required axial loads on the drawings for the joist manufacturer. Use shear stud connectors for the shear strut connection to the concrete deck if a concrete deck is used as the diaphragm.

Connections. Connections between struts and shear walls or frames shall be fully designed in the structural calculations and detailed on the drawings. The connection of the shear strut to a masonry wall, if the shear strut is a steel beam, is an exception to the rule that all beams that rest on masonry walls shall have expansion joint bearing connections. See the paragraph titled “Steel beams bearing on masonry or concrete walls”.

* + 1. **Structural Steel Frames**.

* + - 1. **General**. The structural steel frame system shall utilize braced (preferable) or moment resistant frames to carry lateral loads imposed on the system by wind and seismic forces. Steel frame design will be in accordance with Manual of Steel Construction and UFC 3-301-01. Frame drift shall be limited as necessary to prevent damage to supported wall systems and brittle cladding materials.

Moment Frames. If moment resistant frames are utilized they should consist of a combination of columns that are rigidly connected to the beams with moment connections and columns with simple beam to column connections, if possible.

Column Design. For the frame design, assume the columns of both braced and moment resistant frames to be pin-connected at the foundation, if possible. The gravity only columns of both braced and moment frames may be designed for an effective length equal to their actual length, i.e. K = 1. Design of the columns with rigid connections to beams shall include second order effects. Second order effects consist of member effects and structure effects.

Open Web joist Moment Frames. For one‑story steel frame buildings bar joists or joist girders may be used in moment‑resisting frames by extending the lower chord and attaching it to columns. The bottom chord connection will not be made until all of the roof dead load is in place. Calculations must be included in the design analysis to demonstrate adequacy of such construction.

* + 1. **Shear Walls.**
			1. **Masonry or Concrete**. Masonry or concrete walls shall be designed to withstand wind and/or seismic lateral loads both in-plane and out-of-plane in combination with gravity loads.
			2. **Sheet Metal Shear Walls**. Structural steel stud walls sheathed with sheet metal can be used a shear walls in accordance with the AISI/COFS-Lateral Design Standard. Diagonal strap bracing shear wall systems are not allowed.
			3. **Gypsum Wallboard.** Gypsum wallboard shall not be used as a lateral resisting element of the building lateral force resisting system.
	1. **Exterior Site Structures Requirements**.
		1. **Manholes, Pullboxes, Surface Inlets, etc.** These structures shall comply with the requirements of the Civil and Electrical disciplines. Concrete strength shall be as required in ACI-318 Chapter 4, “Durability Requirements” but shall have a specified strength not less than 3,000 psi. Precast concrete structures are acceptable and should be used where more economical. H10 design wheel loads will be used as a minimum except structures in pavement shall be designed for the pavement design wheel loads.
		2. **Site Headwalls.** Dimensions of headwalls shall be determined from Civil requirements.
		3. **Exterior Mechanical and Electrical Equipment Foundation Pads.** Exterior foundation pads shall be shown on the contract drawings as specified in CESPA Standard Structural Drawing Sheets.
		4. **Stoops, Ramps and Porches**. Small stoops, ramps and porches shall be soil‑supported, turned‑down‑edge type slabs-on-ground and be slip‑doweled to the building foundation. Reference the CESPA Standard Structural Drawing Sheets.
		5. **Retaining Walls and Other Earth Retaining Structures**. Guidance for the design of retaining structures is furnished in EM 1110-2-2502, Retaining and Flood Walls. Lateral earth loads on structures should be based on p = whk where p = lateral pressure, w = wet unit weight of earth 120 pcf minimum, may be higher in some areas, h = depth of soil and k = coefficient of lateral earth pressure which will be furnished in the FDA or by the Geotechnical Engineer. Surcharge loads should be included where applicable. In case of high ground water table, investigation should also be made for lateral buoyant earth pressure plus 100 percent hydrostatic pressure at one‑third overstress. Where drains or weep holes are provided, the water table may be assumed to be lowered 50 percent of the difference in the water table and drain elevations. Hydrostatic uplift should also be included. Design retaining walls for the following criteria:
			1. The resultant of the vertical and horizontal loads shall fall within the middle third of the base.
			2. The bearing pressure shall not exceed the allowable bearing pressure.
			3. The safety factor against overturning shall be at least 1.5.
			4. The sliding safety factor shall be at least 1.5. Where a sloping backfill surface occurs, the Geotechnical Engineer should be contacted for adjustment of the design "K" lateral earth pressure factor. Use the working stress method of design with actual (un-factored) loads.
		6. **Freestanding Exterior Walls.**  Freestanding exterior walls shall be designed to resist lateral wind per UFC 3-301-01.
		7. **[Oil Storage Tanks**.
			1. **Foundations**. Foundations for ground level oil storage tanks shall conform to the recommendations in the Foundation Design Analysis (FDA), tank manufacturer's recommendations, API 650 - ”Welded Steel Tanks for Oil Storage”, and minimum requirements shown on CESPA Standard Structural Drawings. The width of reinforced concrete ring foundations for vertical tanks on ground shall be designed to support the load from the tank wall and roof plus weight of tank fluid directly above the ring without exceeding the allowable foundation bearing pressure. The ring circumferential reinforcement shall be designed for hoop tension caused by "at rest" lateral earth pressure acting on the inside of the ring, taking into account the surcharge from weight of fluid in the tank. When applicable, the ring shall be designed for stresses resulting from seismic forces combined with the other stresses.
			2. **Wind Design**. Tanks shall be designed for the required wind speed of the local area in accordance with, a minimum speed of 90 mph, or API - 650 whichever is the most severe condition.
			3. **Seismic Design**. Tanks shall be designed in accordance with the seismic coefficients as specified in UFC 3-301-01 or API 650 whichever is the most severe condition.]
		8. **[Water Storage Tanks**.
			1. **Ground Level Tank Foundations**. The width of reinforced concrete ring foundations for vertical tanks on ground shall be designed to support the load from the tank wall and roof plus weight of tank fluid directly above the ring without exceeding the allowable foundation bearing pressure. The ring circumferential reinforcement shall be designed for hoop tension caused by "at rest" lateral earth pressure acting on the inside of the ring, taking into account the surcharge from weight of fluid in the tank. When applicable, the ring shall be designed for stresses resulting from seismic forces combined with the other stresses. The foundation design shall also be in compliance with the design criteria of AWWA D100 Chapter 12, Foundation Design.
			2. **Elevated Tank Foundations**. Foundations shall be designed in accordance with the design criteria of AWWA D100 Chapter 12, Foundation Design, and the recommendations of the Foundation Design Analysis (FDA).
			3. **Wind Design**. Tanks shall be designed for required wind speeds of the local area in accordance with UFC 3-301-01, a minimum wind speed of 90 mph, or AWWA D100 whichever is the most severe condition.
			4. **Seismic Design**. Tanks shall be designed in accordance with the seismic coefficients as specified in UFC 3-301-01 or AWWA D100 whichever is the most severe condition.]
		9. **[Reinforced Concrete Box Culverts**. Box culvert design shall conform to the requirements in AASHTO LRFD Bridge Design Specifications. Appropriate State Highway Department standard designs that conform to AASHTO Specifications may be used.]

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