CHAPTER A-2

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STRUCTURAL

INDEX

CHAPTER 2

STRUCTURAL

2.1 GENERAL

2.1.1 Mission and Function. The structural engineer is responsible for the investigation, design, and selection of the force resisting and load supporting members and their connections in a structure. Typical examples are foundations, walls, columns, slabs, girders, trusses, beams, diaphragms, and similar members. The investigation, design, and selection requires a knowledge of engineering laws, formulae, and practice; a knowledge of the physical properties of the materials used for such members; and a knowledge of the methods used in their erection.

2.1.2 Scope. This chapter states criteria, requirements, and guidance for structural design. Specific submittal requirements contained in this chapter supplement the requirements contained elsewhere in other volumes. All required documents, including the drawings and the design analysis, shall be prepared in accordance with applicable instructions. The Exhibits referenced in this chapter are located in Volume II, Chapter 2, STRUCTURAL.

2.2 APPLICABLE PUBLICATIONS

The publications listed below, referred to hereafter by basic designation only, form a part of this manual and contain criteria to be used in the structural design. The publications can be separated into two divisions: industry publications (AASHTO, ACI, ASTM, ASCE, AISC, IBC, and NDS) and government publications (Unified Facilities Criteria, or UFC). UFC publications may be accessed from the Whole Building Design Guide website: www.wbdg.org. In the case that UFC publications are For Official Use Only (FOUO), they may be accessed from the Protective Design Center website after registering for an account: www.pdc.usace.army.mil.

The applicable version of all UFC publications shall be the most recent version at the time the contract is awarded. The applicable version of industry publications shall be established using UFC 1-200-01, General Building Requirements. Additionally, UFC 1-200-01 describes how industry publications shall be modified by UFC publications.

The applicable version of industry and government publications shall include all addendums, supplements, and changes. This section is not intended to be an exhaustive listing of all publications that may be required for a particular project; additional criteria may be applicable.

2.2.1 American Association of State Highway and Transportation Officials (AASHTO)

AASHTO	LRFD Bridge Design Specifications

2.2.2 American Concrete Institute (ACI)

ACI 318	Building Code Requirements for Structural Concrete
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 308R	Guide to Curing Concrete
ACI 360R	Guide to Design of Slabs-on-Ground
ACI 530	Building Code Requirements and Specification for Masonry Structures

2.2.3 American Society for Testing and Materials (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steels
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 33, 55, and 105-ksi Yield Strength

2.2.4 American Society of Civil Engineers (ASCE)

ASCE 7	Minimum Design Loads for Buildings and Other Structures

2.2.5 American Institute of Steel Construction (AISC)

AISC 360	Specification for Structural Steel Buildings
AISC 341	Seismic Provisions for Structural Steel Buildings
SCM	Steel Construction Manual

2.2.6 International Code Council (IBC)

IBC	International Building Code

2.2.7 American Wood Council

NDS	National Design Specification for Wood Construction

2.2.8 Unified Facilities Criteria

UFC 1-200-01	General Building Requirements
UFC 3-301-01	Structural Engineering
UFC 3-310-04	Seismic Design for Buildings
UFC 3-310-08	Non-Expeditionary Bridge Inspection, Maintenance, and Repair
UFC 3-320-06A	Concrete Floor Slabs on Grade Subjected to Heavy Loads
UFC 3-320-07N	Weight Handling Equipment
UFC 3-340-01	Design and Analysis of Hardened Structures to Conventional Weapons Effects (FOUO)
UFC 3-340-02	Structures to Resist the Effects of Accidental Explosions
UFC 3-710-01A	Code 3 Design with Parametric Estimating
UFC 4-010-01	DoD Minimum Antiterrorism Standards for Buildings
UFC 4-023-03	Design of Buildings to Resist Progressive Collapse

2.2.9 Guide Specifications:

UFGS	TITLE
31 62 13.20	Precast/Prestressed Concrete Piles
31 62 23.13	Cast-In-Place Concrete Piles, Steel Casing
31 62 16.16	Steel H-Piles
31 62 19	Timber Piles
31 62 21	Piling: Composite, Wood and Cast-In-Place Concrete
31 63 16	Auger Cast Grout Piles
31 63 26	Drilled Caissons
03 11 13.00 10	Structural Cast-In-Place Concrete Forming
03 20 00.00 10	Concrete Reinforcing
03 30 00	Cast-In-Place Concrete
03 30 53	Miscellaneous Cast-In-Place Concrete
03 51 01	Precast Roof Decks
03 55 16	Gypsum Concrete Floor Planks
05 05 23	Welding, Structural
05 05 23.13 10	Ultrasonic Inspection of Weldments
41 36 30.00 10	Ultrasonic Inspection of Plates
05 12 00	Structural Steel
05 21 19	Open Web Steel Joist Framing
05 30 00	Steel Decks
05 40 00	Cold-Formed Metal Framing

2.2.10 Structural Related Guide Specifications. The following guide specifications are prepared by other disciplines but frequently require structural review and input:

UFGS	TITLE
03 33 00	Cast-In-Place Architectural Concrete
03 45 00	Precast Architectural Concrete
04 20 00	Masonry
05 50 13	Miscellaneous Metal Fabrications
06 10 00	Rough Carpentry
07 11 13	Bituminous Dampproofing
07 12 00	Built-Up Bituminous Waterproofing
07 42 13	Metal Wall Panels
07 61 14.00 20	Steel Standing Seam Roofing
08 33 23	Overhead Coiling Doors
08 36 13	Sectional Overhead Doors
13 48 00	Seismic Protection for Miscellaneous Equipment
13 34 19	Metal Building Systems
33 16 15	Water Storage Steel Tanks
14 21 00.00 20	Electric Traction Elevators
14 24 00	Hydraulic Elevators
41 22 13.14	Bridge Cranes, Overhead Electric, Top Running
41 22 13.15	Bridge Cranes, Overhead Electric, Under Running

2.3 **PRECONCEPT SUBMITTAL REQUIREMENTS** No submittal requirements.

2.4 **CODE 3 DESIGN REQUIREMENTS**

2.4.1 Submittal. Submittal content and format shall be as described in UFC 3-710-01A, "Code 3 Design with Parametric Estimating."

2.5 **CONCEPT/EARLY PRELIMINARY (35%) DESIGN SUBMITTAL REQUIREMENTS**

The structural portion of the concept brochure must outline the proposed methods and materials of design and construction for approval. An outline of the required brochure is shown in Exhibit A-2-3. The design submittal shall include the following:

2.5.1 Structural Narrative:

2.5.1.1 General: Use present tense wording for all paragraphs. Provide a general description of the scope of the project and all of the major structures. Give overall building dimensions and a description of the principal features such as wall and roof construction. If the building is irregularly shaped, explain where seismic joints will be placed to create regular shapes or provide a statement that a dynamic analysis of the building will be performed (seismic joints are preferred for most structures designed by the Savannah District).

2.5.1.2 Framing System: Provide a brief description of the gravity framing system and lateral framing system chosen and the reasons why. Provide a brief description of how the lateral forces will be transmitted into the foundations. If a Structural System Comparative Selection Analysis (Section 2.5.3) is required then this paragraph should summarize the results of that analysis. The analysis will appear later in the outline and shall justify the system selection.

2.5.1.3 Foundation: Give a brief description of the anticipated foundations based on similar construction in the area.

2.5.1.4 Special Design Features: Briefly describe special features of the structural design including, but not limited to, resistance to progressive collapse and blast resistant glazing.

2.5.1.5 Fire Resistance Statement: State the required fire resistance criteria for all portions of the structural system and the proposed method of meeting these requirements.

2.5.1.6 Outstanding Structural Information: List the information that is needed from other disciplines to complete the final structural design.

2.5.2 Concept/Early Preliminary Structural Design Analysis:

2.5.2.1 Load Assumptions: State the dead and live loads for which the facility is to be designed, including roof loads, floor loads, and crane loads. Calculate the wind loads, lateral earth pressure loads, seismic loads, etc., as applicable.

2.5.2.1.1 Dead Loads: tabulate all dead loads used and provide references for atypical materials.
2.5.2.1.2 Live Loads: tabulate all relevant live loads using the APPLICABLE PUBLICATIONS.

2.5.2.1.3 Wind Loads: Provide both main wind force resisting system (MWFRS) wind pressures and components and cladding (C&C) wind pressures. Both positive and negative wind pressures

shall be included with the controlling pressures summarized in tabular form.

2.5.2.1.4 Seismic Loads: calculate the seismic loadings for the lateral load resisting system and contrast them with the comparable wind loads. Detailed calculations for seismic loads on diaphragm connections and other parts and portions are not required at this submittal level. Insert sheet indicating that detailed calculations will be furnished for the preliminary (60%) design package.

2.5.2.1.5 Crane Loads: provide crane loads if applicable.

2.5.2.2 Material Strength & Allowable Stresses: tabulate the values to be used for material strength (for LRFD design) and/or allowable stress (for ASD design) of the principal structural materials such as concrete, structural steel, reinforcing steel, concrete masonry, and others.

2.5.2.3 Calculations: provide all calculations for wind loading, seismic loading, and snow loading. No additional structural calculations are required to be completed at this submittal, but any additional calculations that have been performed must be included in the submittal for review.

2.5.3 Structural System Comparative Selection Analysis: For all projects with a construction value of $500,000 or greater furnish a comparative analysis of at least three competitive structural systems. These structural system alternatives are defined as the consideration of different structural materials and different framing systems supporting the loads imposed on the structure. Different structural systems are not the variations of the same framing scheme (i.e. changing bay widths of a steel frame). A portion of each facility, large enough to be representative of the entire structure, shall be designed in enough detail to provide for an estimate that will be the basis of the structural system selection. The portion of the structure selected for comparing alternate system costs shall include framing for at least one typical bay of the roof, floor, and foundation systems. Additional costs due to nonstructural systems but attributable to a structural alternative shall be included in the comparative cost estimate for that alternative. Determination of these additional costs must be based upon a concept of the complete building configuration, including architectural, mechanical, electrical, and other systems. Hence, the main structural members must be sized to check for compatibility with ceiling, duct, lighting, and all other space demands. The method of providing the required degree of fire resistance shall be determined for each alternative, and the costs included. The submittal shall include the following items:

a. A complete description, with sketches, of each structural system considered.

b. Design calculations supporting the member sizes used for the cost estimate.

c. A comparative cost for each system, clearly showing all costs and quantities used.

d. An analysis of the study results, with justification for the system selected.

2.5.4 Concept Drawings. Furnish sufficient framing plans for roof and floors, as applicable, to indicate the layout of principal members including the locations of lateral force resisting elements. Typical sections should be furnished through roof, floor, and foundation indicating materials and type of construction proposed. These details may be shown on the architectural plates. Furnish a plan identifying the location of all seismic joints, if necessary. Concept structural drawings must include general notes.

2.5.5 Outline Specifications: The Engineer shall review the list of guide specifications in this

section and shall list those sections he or she proposes to use at the end of his concept narrative.

2.5.6 Specific Instructions: Furnish a copy of the Specific Instructions with the 35% submittal.

2.6 PRELIMINARY (OVER THE SHOULDER) (60%) SUBMITTAL REQUIREMENTS

2.6.1 Submittal: refer to SDDM Volume I Chapter 9.3.1 for submittal requirements.

2.7 PRELIMINARY (60%) DESIGN SUBMITTAL REQUIREMENTS

The preliminary design will represent approximately 60 percent of the total structural design effort.

2.7.1 Preliminary Design Analysis: The preliminary design analysis shall include all items in the Concept design analysis and any revisions necessitated by comments from the Concept review. The design analysis will be substantially complete for all the major structural features of the primary structure and will include but not be limited to the following:

a. A brief structural narrative that provides the references, design loads, assumed material strengths, and a brief description of the structure to include type of foundation, type of framing, and method of resisting lateral loads.

b. A synopsis of special design criteria or technical requirements provided as a result of site visits or correspondence with the Army Corps of Engineers Project Managers. Copies of any letters or minutes of meetings which provide structural guidance not otherwise contained in this manual should be included in this section of the design analysis.

c. Complete calculation of seismic and wind loads for final design to include distribution of these loads to the lateral load resisting elements.

d. Design calculations for roof and floor decks, beams, joists, girders, and columns as applicable.

e. Design calculations for horizontal diaphragms and bracing to include shear transfer connections.

f. Design calculations for exterior cladding (masonry, steel, precast concrete) for flexure, shear, and overturning as appropriate.

g. Design calculations for shear walls, bracing, moment frames, and all other elements of the lateral force resisting system.

h. Checking of the design at this stage will not be required. This submittal will not normally include the design of lesser related structures such as utility vaults, pits, tanks, retaining walls, tank hold down pads, etc. The design analysis of these structures is required at final design.

2.7.2 Preliminary Drawings: This submittal will include the following as applicable:

a. Foundation plans, framing plans for each floor, and roof plans for the building. Plans must indicate locations of bracing or other lateral force resisting elements. Grid lines on center lines of columns shall be indicated on the plans for buildings framed with columns and beams.

b. Elevations of braced bays must be included if braced frames are used for lateral force resistance.

c. Layout of floor joints in slab on grade. Layout of construction joints, control joints, expansion joints, and seismic joints in foundation, floor, and building framing.

d. Typical sections through foundations, floors, and roof framing for buildings.

e. Plans and sections of structures other than buildings.

f. Additional sections and details as required illustrating any special items or methods of framing for which approval is sought.

g. General, foundation, and superstructure notes as shown in Exhibit A-2-2.

2.7.3 Preliminary Specifications: This submittal will include preliminary specifications.

2.8 **FINAL (100%) DESIGN SUBMITTAL REQUIREMENTS**

2.8.1 Design Analysis: The final design analysis shall include all items in the Preliminary design analysis and any revisions necessitated by comments from the Preliminary review. Furnish complete checked calculations for all structural members.

2.8.2 Drawings: Furnish complete final plans and details of all structural elements. Prior to this submittal, structural drawings shall be coordinated with all other design disciplines. Show on drawings a complete set of general and special notes as shown in Exhibit A-2-2. The items listed below will always be included on the final drawings if applicable:

a. Roof framing plan and details including details of any opening in the roof.

b. Intermediate floor framing plans and stair details on multiple story structures.

c. Stress or load diagrams of features to be contractor designed (i.e., connector plates on wood trusses are contractor designed based on member stress information shown by the Engineer on the structural drawings).

d. All required schedules, including but not limited to beam schedules, column schedules, slab schedules, and base plate schedules.

e. Foundation plan including any notes relative to special foundation treatment required and cross references to proper specification sections.

f. Foundation sections and details.

g. Layout of expansion, construction, and contraction joints in floor slabs; horizontal and vertical joints in foundation walls; joints in footings; and layout of control joints in masonry walls.

h. Typical and special sections as required.

i. Details of expansion, construction, and contraction joints in concrete.

j. Layout and detail of exterior entrance pads and steps.

k. Details of any special items.

l. General and special notes as required except that the term "by others" shall not be used.

2.8.3 Specifications: Submit a completed set of final specifications for review.

2.8.4 Quality Assurance: Final drawings and specifications shall be checked by the same checker who checks the final design analysis. Structural drawings shall be coordinated with the other disciplines and the specifications. Dimensions, schedules, sections, and details shall be fully checked. Designers and checkers shall initial the pages of the design analysis and on the drawings. Exhibit A-2-4 is a sample of the quality review checklist that will be used by the District to review final design. The A-E is encouraged to use this, or a similar form, to review the final checked design documents.

2.9 CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS

2.9.1 General: The corrected final submittal is not to be considered a normal design level and is required only when the final submittal must be revised or corrected due to error, omission, or outstanding review comments.

2.9.2 Design Analysis: Furnish final structural calculations, incorporating any and all changes made during the process of review and redesign. Calculations will be checked and verified by an engineer other than the original designer.

2.9.3 Drawings: Drawings will implement all comments from previous submittals. Verify that all drawings are finalized and verify consistency between the plans and specifications.

2.10 ADDITIONS OR MODIFICATIONS TO EXISTING STRUCTURES

2.10.1 New Work: When new work is added to an existing structure or an existing structure is modified, the Engineer will be responsible for determining the adequacy of the existing structure for the addition or modification.

2.10.2 Inspection Report: An inspection of the existing structure shall be performed for the purpose of determining the condition and measurements of the areas affected by the new work. The Concept Design shall include a narrative that outlines the results of this inspection to include describing the layout and details of the existing structure, stating the calculated capability of the structure to support the new loads, and describing the strengthening that will be required.

2.10.3 Seismic or Wind Upgrade: Seismic or wind upgrade of the existing structure to meet the latest criteria will not be required unless specifically stated in the Structural Specific Instructions.

2.11 SITE ADAPTS OF GOVERNMENT DESIGNS

2.11.1 Concept: The concept brochure shall be as previously described with the following clarifications:

a. A selection analysis is not required.

b. Wind and seismic calculations shall be performed to verify that the controlling lateral loads are higher or lower than the original design. Redesign of the structural features to resist the higher loads will be required and the narrative will fully describe those items to be strengthened.

2.11.2 Final Design: Final design shall consist of complete plans, specifications, and design analysis. The specifications shall be the project specifications updated to include the latest revisions to the Federal and Military guide specifications, design codes, and other criteria. The design analysis shall include a narrative explanation of all changes to the original design to accomplish the site adaptation with backup calculations.

2.12 **GENERAL DESIGN REQUIREMENTS**

2.12.1 Technical Requirements: Design will be accomplished in accordance with the basic criteria provided herein and in the Specific Instructions to the A/E.

2.12.2 Design Analysis: The design analysis shall be prepared in accordance with the general requirements contained in Volume I of this manual and the requirements in sections 2.5 to 2.11 of this chapter.

2.12.2.1 Computer Analysis: Analysis and design using computer programs is encouraged. The cover sheet of the structural calculations must identify what program(s) is (are) used. Listed below are the commercially available programs currently used in the Structural Section. These or other similar programs may be used except that use of a program not listed will necessitate the submission of the following additional information for that program:

a. The name of the program.

b. A description of the program including discussion on how the program reaches solution. This description must be sufficient to verify the validity of methods, assumptions, theories, and formulas, but does not require source code documentation or other information that would compromise the propriety rights.

c. A benchmark run validating the program that includes both a computer analysis and a hand analysis of a typical or representative problem.

2.12.2.3 District Approved Computer Programs

a. RAM Structural System (Bentley)

b. STAAD.Pro (Bentley)

c. SAP2000 (Computers and Structures, Inc.)

d. ETABS (Computers and Structures, Inc.)

e. RISA 3-D (Risa Technologies)

f. GTSTRUDL (Georgia Tech CASE Center)

g. ENERCALC (ENERCALC, Inc.)

h. FrameWorks Plus (Intergraph)

2.13 **REQUIREMENTS FOR DESIGN/BUILD RFP PACKAGES:** To be furnished with specific instructions for the contract or delivery order.

2.14 **TECHNICAL DESIGN REQUIREMENTS**

2.14.1 General Structural Requirements

2.14.1.1 Governing Code: All structures shall be designed in accordance with IBC as modified by UFC 1-200-01. UFC 3-301-01, "Structural Engineering," will be referred to henceforth in this section because it is the document that UFC 1-200-01 delegates to for structural modifications to the IBC.

2.14.1.2 Future Expansion: Where future expansion of buildings or facilities is planned, provisions for the later expansion should be shown on the drawings.

2.14.1.3 Structural Details: Structural details will be shown on the structural plans and not intermixed with architectural plans and details.

2.14.1.4 Support of Nonstructural Items: In addition to performing the design of the structural features, the structural engineer shall be responsible for ensuring that all mechanical and electrical equipment is properly supported and that all architectural features are adequately framed and connected.

2.14.1.5 Components and Cladding (C&C) Diagram: The C&C wind zones will be shown on an isometric or 2D view of the building on one of the structural plates and shall be accompanied by a table that identifies the C&C pressures for each zone. Pressures for arched and gable roof on open sheds shall be similarly shown.

2.14.2 Design Loads: Load assumptions shall be in accordance with IBC as modified by UFC 3-301-01.

2.14.2.1 Wind Load Criteria: Wind loads shall be in accordance with the IBC as modified by UFC 3-301-01.

2.14.2.1.2 Velocity: The wind velocity will be in accordance with UFC 3-301-01. Exposure Category C conditions will be used unless specifically directed otherwise.

2.14.2.2 Seismic Load Criteria

2.14.2.2.1 Spectral Acceleration Values: The seismic spectral accelerations shall be in accordance with UFC 3-301-01.

2.14.2.2.2 Bridges: Seismic criteria to be used for bridges shall be as set forth in the Standard Specification for Highway Bridges, American Association of State Highway and Transportation Officials (AASHTO).

2.14.2.2.3 All Other Structures: Seismic criteria to be used for structures other than bridges

shall be in accordance with IBC as modified by UFC 3-301-01.

2.14.2.3 Mechanical Loads: Roof systems over mechanical equipment rooms from which equipment or piping will be supported and roofs of HVAC plants, pump stations, etc., shall be designed for the equipment to be supported but not less than 60 PSF (2.9 kN/m2). Steel beams are the preferred framing members over these areas since they are not as sensitive to hanger attachment locations as are steel joists. Joists may be used over small mechanical rooms if suspended ceiling loads will not produce hanger loads in excess of 50 pounds (25 Kg) per hanger. Joists will not be used in HVAC plants, pump stations, or similar locations.

2.14.2.4 Anti-terrorism/Force Protection (ATFP): ATFP systems must be included and shall conform to UFC 4-010-01, "DoD Minimum Antiterrorism Standards for Buildings." Additional guidance may be found in UFC 4-023-03, "Design of Buildings to Resist Progressive Collapse."

2.14.3 Structural Steel: Structural steel shall be designed in accordance with IBC as modified by UFC 3-301-01.

2.14.4 Steel Joists: Steel joists shall be designed in accordance with IBC as modified by UFC 3-301-01.

2.14.5 Concrete Design: Concrete shall be designed in accordance with IBC as modified by UFC 3-301-01.

2.14.6 Standing Seam Metal Roof (SSMR): Standing seam metal roofs shall be structural SSMR with concealed clips. Architectural SSMR shall not be used. Concealed clips shall not be fastened through rigid insulation to the structure below. If rigid insulation is provided between metal roofing and deck below, sub-purlins shall be provided.

2.14.7 Concrete Masonry

2.14.7.1 Concrete Masonry Design: Concrete masonry shall be designed using approved wall types in accordance with IBC as modified by UFC 3-301-01.

2.14.7.2 Drawings: At a minimum, the following items shall be included in the drawings to properly describe the concrete masonry elements:

a. Wall elevations showing both horizontal and vertical reinforcing patterns for typical walls and typical openings.

b. Location and details of bond beams.

c. Lintels for all openings in masonry walls, including windows, doors, and mechanical work such as ducts.

d. A table of special inspections required for concrete masonry elements in accordance with IBC as modified by UFC 3-301-01.

2.14.7.3 Efflorescence: Concrete masonry that has a tendency to display efflorescence shall not be used in exterior applications.

2.14.7.4 Specification Coordination: Concrete masonry specifications shall be reviewed by the

structural engineer and the paragraphs of structural responsibility appropriately edited to include retaining or deleting testing of mortar and prisms. Testing requirements shall be based on the assumptions used for design and unnecessary tests will be deleted.

2.14.7.5 Mortar: Type N or S mortar will typically be used. One type of mortar is typically used for all wall types on a project.

2.14.7.6 Interior Masonry Partitions: Interior partitions must be supported at the top of the wall by adequate means such as angle braces to the roof system where they do not receive adequate lateral support from cross walls or columns, or where the walls are broken by control joints such that horizontal loads cannot be transferred longitudinally. Interior partitions which can be exposed to wind forces due to the opening of large doors must be designed as exterior walls. Minimum seismic provisions apply to both interior partitions and to exterior walls. The design analysis shall explain where it was necessary to design interior partitions as exterior walls.

2.14.7.7 Openings in Walls: Where walls span horizontally between columns, the lintel over the opening must be extended to the columns, and a bond beam below the opening must be extended to the columns. Steel girts may be used for this purpose if necessary. Vertical reinforcing in concrete filled cells will be used to take wind loads at large openings or to act as pilasters where heavy lintels or beams bear on the walls.

2.14.7.8 Steel Beams Bearing on Masonry Walls: Steel beams which bear on masonry walls should have sip plates and slotted holes at anchor bolts to provide for thermal movement.

2.14.7.9 Control Joints: Control joint spacing shall not be greater than recommended by the masonry associations. Joints at the normal spacing must be coordinated with additional joints required at the following locations:

a. At corners and intersections of exterior walls and partitions where roof framing would impose horizontal loads to the top of the wall if the framing was subjected to a change of length due to chance in temperature.

b. At all bond beam breaks.

c. At all large openings (10 ft or more in width or height).

d. At change in wall thickness or wall heights.

2.14.7.10 Brick Expansion Joints: Location of brick expansion joints is typically shown in plan and detail on the architectural drawings. Their location shall be approved by the structural engineer. The location of brick expansion joints and masonry control joints do not have to coincide.

2.14.7.11 Bond Beams: Bond beams shall be placed at floor and roof level of all masonry walls. Intermediate bond beam spacing between floor levels shall be in accordance with IBC, as shall minimum and maximum reinforcing in bond beams. Reinforcement in bond beams shall be continuous through control joints at all floor and roof levels.

2.14.7.12 Miscellaneous: the following miscellaneous criteria must be met for concrete masonry:

a. Masonry must be set ¾ inch (20 mm) clear of all steel columns and ¾ inch (20 mm) clear from the bottom flange of steel roof beams.

b. Lintels will be provided over all masonry openings, and slip joints will be used under lintel bearings when a control joint is located within 2 feet (600 mm) of a masonry opening.

c. If masonry is used within a rigid frame, the frame drift must be less than the allowable deflection of the masonry wall as defined in IBC.

d. All lintels shall be designed in accordance with IBC.

2.14.8 Timber Trusses: Timber trusses and trussed joists shall be designed and detailed on the structural drawings. Since connections for the truss members frequently employ proprietary type plates, the connection design shall be specified to be accomplished by the joist/truss fabricator and submitted for review by the Engineer of Record. The drawings prepared by the Engineer shall include member sizes and stress diagrams which indicate the maximum member forces for which the connections are to be designed. Support anchorage shall be specified and detailed by the Engineer on the structural drawings. Under certain circumstances, and with the prior approval of the Structural Section, the Engineer may delegate the design of the wood trusses to a truss design fabricator. In this case, the truss detail sheets and framing plan prepared by the Engineer shall number each truss, show its general configuration, and shall list the technical requirements and loading. The truss design fabricator shall then prepare the complete design of the truss and shall submit the design and design calculations to the Engineer for approval as part of the shop drawings as indicated above.

2.14.9 Foundation Design

2.14.9.1 Concrete: All concrete building foundations should be designed in accordance with IBC as modified by UFC 3-301-01.

2.14.9.2 Foundation Type and Allowable Soil Bearing: The type of foundation, allowable bearing value, and foundation depth will be furnished by the Savannah District Soils Section (EN-GS).

2.14.9.3 Foundation Notes: Foundation notes similar to those shown in Exhibit A-2-2 shall be included in the drawings.

2.14.10 Building Slab-on-Grade Design

2.14.10.1 Design: Slab-on-grade design shall be in accordance with ACI 360R as modified by UFC 3-320-06A.

2.14.10.2 Forklift and Vehicular Loads: Slabs-on-grade subject to forklift and/or vehicular loads shall have the loading described in the general notes. For such slabs-on-grade, the minimum concrete strength shall be 4,000 psi even if it is reinforced in order to achieve a durable wearing surface.

2.14.10.3 Slab-on-Grade Criteria

a. Floor joints must always be shown on the structural drawings.

b. Use a vapor barrier under all slabs on grade for buildings sensitive to moisture.

c. Use 4 inches (100 mm) gravel capillary water barrier under all building slabs on grade when directed by the soil report.

d. Use #30 felt between floor slabs on grade and foundation beams and piers.

e. Slabs on grade shall not bear on grade beams, walls, or piers except where provision is made to reinforce the slab to prevent cracking should soil settlement beneath the slab occur.

f. Refer to Exhibit A-2-2 for sample general notes for slab-on-grade.

g. Rebar or welded wire fabric (provided in sheets, not rolls) may be used. Where columns occur, floor control joints should be placed on column centerlines.

h. Slabs on grade with perimeter felt joints and with floor drains, such as in mechanical rooms, will have a rubber joint sealant on top of the felt joint.

i. In wash rack areas, joints should be minimized by use of more reinforcement. The joint between slab on grade and foundation should have a rubber joint sealant.

j. Topping over concrete slabs must be avoided where possible. Where it is not possible, it should be a minimum of 2 inches (50 mm) thick and reinforced with 0.1 percent reinforcement in bars or mesh in flat sheets. Fiber reinforcement may also be provided in accordance with manufacturer's instructions.

k. Use of expansive cement and elimination of most joints may be considered where economical. Where used, it should be at the Contractor's option.

2.14.11 Building Frame Design Considerations

2.14.11.1 Load-Bearing Walls Versus Frame Type Buildings: Some type of building frame usually is required where a building length or length between shear walls is more than three times its width, where long clear spans are required [30 m (100 feet) or more], or where the building one-story height is in excess of 5.5 m (18 feet). Provide expansion joints through building frame at 300-foot (90 m) o.c., maximum. A comparative cost estimate should accompany concept plans to show the basis for frame selection.

2.14.11.2 Concrete Building Frames: Normally, it will be most economical to use grade 60 reinforcing due to the higher allowable stress. Lightweight concrete may be used for floor framing but not for columns; 5000 psi (35 MPa) concrete may be used where economical; 4000 psi (27.5 MPa) concrete is normally used for pan joist floors. Types of concrete floors which have proved economical are flat slab, waffle slab, pan joist and precast concrete joists. Design dead loads should include the additional concrete topping required due to precast joist camber. Reinforcing in pan joist slabs should be bars or mesh in flat sheets. Minimum reinforcing should be 0.18 percent in each direction for mesh, or 0.2 percent for bars in a direction at right angles to joists, but bar spacing must not be greater than 3t. Bars must also be tied with cross bars at 18-inch (450 mm) o.c. maximum. Thickness of pan joist slab shall be 2-1/2 inch (65 mm) minimum.

2.14.11.3 Steel Building Frames: In general, shop welded, field bolted construction should be used, except that hanger straps supporting cranes or monorails shall be high strength bolted. High strength bolts for field connections may be used where economy or ease of construction dictates. ASTM A992 steel should be used for wide flange shapes. Bar joists should be K series as defined by the Steel Joist Institute. Long-span joists may be used where required by span and load. Use standard joists where possible. The attached structural steel framing notes (Exhibit A-2-2) should be used where applicable. Steel columns must be clear of masonry walls. Where steel members are anchored to masonry walls to provide support, care must be used to provide slotted holes to allow the wall to move relative to the steel. Specify a nondestructive test on 100 percent of all butt-welded beam or column connections.

Where steel beams are used to support the metal form system, the spacing can be increased up to about 2.75 m (9 feet) o.c. provided the floor slab is thickened and the metal form system is properly designed. A vibration analysis of these type floor systems is required.

2.14.11.4 Pre-engineered metal buildings (PEMB): PEMB systems may be used where indicated by the directive or as otherwise approved by the Structural Section. If negotiations assumed a custom designed building and a pre-engineered building is later approved for use, then the original design contract is subject to renegotiation for the reduction in architectural and structural effort. The attached notes in Exhibit A-2-2 relating to this type building should be used. It will be necessary to select these from a catalogue to get standard dimensions or standard structural frames. The Contractor will design the building foundation based on the criteria contained in the notes and on the drawings.

Pre-engineered metal buildings shall be procured using Guide Specification UFGS 13 34 19, METAL BUILDING SYSTEMS. The structural drawings shall include a foundation plan which indicates an estimate of the foundation requirements for a typical pre-engineered building that will meet the project requirements. The foundation plan shall be consistent with the requirements of the Government-furnished foundation report. This plan will be supported by notes that clearly define any additional requirements required by the COE.

2.14.11.5 Basements: Usually, basement floors will be slab-on-grade construction separated from basement walls by #30 felt. Basement walls should have membrane waterproofing on the outside and under the slab with a continuous perforated tile drain around the basement where required by the soils report.

2.14.11.6 Suspended ceilings on the exterior of building over entrances: These ceilings must be designed for wind loads. Structural steel angles instead of wire hangers are normally used here since uplift can be a problem. Ceilings may be considered as support for metal stud partitions.

2.14.12 Seismic Design Considerations

2.14.12.1 The basic seismic technical requirements shall be in accordance with IBC as modified by UFC 1-200-01.

2.14.12.2 The following is a list of exceptions and clarifications to the references:

a. Avoid use of tie rods for bracing. Use structural rolled shapes.
b. Precast concrete, prestressed concrete, and flat slabs do not qualify as components of ductile moment resisting elements.

c. Pre-engineered Metal Buildings. Panels thinner than 22 gauge (0.75 mm) with self-tapping screws are not permitted for diaphragms or shear walls. All roof or wall systems using siding or roofing as a diaphragm must be tested for in-plane loading for diaphragm or shear wall effects. Test reports and recommendations must be submitted for evaluation and approval. The steel deck system must have the ability to transmit diaphragm loads and is dependent upon the deck strength, stiffness, panel configuration, fastening method and condition of installation. Since approval of tests on these systems is tedious and time consuming, cross-bracing, rigid frame wind bents, or wind columns are the preferred system. Specifications for pre-engineered metal buildings must require submission of load tests on metal panel walls and roof where used as a diaphragm.

d. The allowable drift of walls, in all cases, must be considered before selecting the type of diaphragm. All story drifts must be checked so that they will be compatible with the diaphragm deflection (especially for brittle walls).

e. The criteria for separation of buildings will apply to seismic joints for parts of buildings. Portions of a building with differing dynamic responses will be separated from each other with seismic joints. Analysis of setbacks in plan and/or elevation per IBC shall be required to preclude use of seismic joints.

f. Connection of diaphragm to vertical-load-carrying precast elements is necessary to transmit the lateral force generated from the weights of the frame and other masses attached thereto to the diaphragm. Also, the response of the supporting element when subjected to earthquake motion must be in resonance with the diaphragm. Therefore, positive anchorage, such as mechanical fasteners, dowels, or welding as appropriate must be provided.

g. Prestressed, precast concrete frames are not permitted to be used as semiductile frames. The capability or performance of semiductile moment resisting frames of prestressed, precast construction is questioned. Based on our knowledge, its use has not been accepted by codes. Therefore, we cannot allow its use without any specific information or design data to confirm its performance and structural adequacy.

h. Buildings with basements or buried structures may be required to be analyzed for the effect of dynamic soil loadings.

2.14.12.3 Seismic vs. Wind: When comparing wind and seismic calculations the general perception that wind or seismic governs totally in a particular direction is not valid. Even though wind or seismic governs a particular direction based on the overall magnitude of load in that direction does not mean that the other is ruled out when considering the design of individual elements of the building that are affected by lateral load in that direction. As will be demonstrated below, wind and seismic calculations have, for different systems and elements, different factors applied to the loads on those elements. This greatly complicates a "controlling load determination," and mandates that this determination not be made on the building as a whole, but that each element of the building must be considered separately, (i.e., parts and portions of a building are to be designed individually for the highest load on them). Both seismic and wind loads should be taken to individual elements and then only after placing the proper factors to the loads should the highest load be selected.

2.14.13 Miscellaneous Structures

2.14.13.1 Manholes, Pullboxes, Surface Inlets : A minimum 3000 psi (20 Mpa) compressive strength concrete will be used. Verify location of water table with Soils Section (EN-GS) and check for uplift. Precast concrete structures are acceptable and desired where more economical. H-15 wheel loads will be used except for structures in pavement which will be designed for the wheel load for which the pavement was designed.

2.14.13.2 Headwalls and Box Culverts: Minimum 3000 psi (20 Mpa) compressive strength concrete should be used.

2.14.13.3 Transformer Pads, Condenser Pads, and Generator Pads: Concrete should be minimum 3000 psi (20 Mpa) compressive strength.

2.14.13.4 Retaining Walls, Basement Walls: Lateral earth loads on structures should be based on p = whK; where p = lateral pressure, w = wet unit weight of earth [120 psf (20 kN/m^3) minimum, may be higher in some areas], h = depth of structure, and K is a coefficient (use 0.5 for retaining walls, 0.7 for basement walls and box culverts), and verify with Soils Section (EN-GS). Surcharge loads should be included where applicable. Investigation should also be made using 100 percent hydrostatic pressure (where applicable) at one-third overstress (50 percent where drains are used). The working stress method of design is preferred with actual loads on the wall.

2.14.13.5 Monorail Design: Monorail beams shall be designed for maximum bending stress of:

$$f = \frac{3{,}000{,}000}{1d/bt}$$ but not greater than 10,000 psi (69 Mpa).

based on rated capacity of the hoist plus 25 percent impact and full dead loads for vertical loads, and 20 percent of rated capacity + 25 percent impact for horizontal loads. Deflections should be limited to L/800.

Beams shall also be checked for a maximum overload of 2.75 times the rated hoist capacity at 75 percent of the yield stress. An "I" beam, with channel on top, (T) section should be used for all but very short spans. The hangers and system supporting the monorail beam should be designed for the same loads but at normal stresses. Knee braces should be provided where applicable. Field connections should be A325 bolted connections.

2.14.13.6 Traveling Crane Runway Girders: Runway girders will normally be designed by the crane vendor and will be provided based on performance specifications. The following guidelines should be included in these specifications.

2.14.13.6.1 Continuous girders should 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 $\frac{0.003\ L}{}$ between adjacent supports. (Simply supported girders are not ordinarily affected by differential foundation movements.)

2.14.13.6.2 Limit live load deflection at midspan to "L"/1,000.

2.14.13.6.3 For continuous girders, limit ratio of length of adjacent spans to 2:1.

2.14.13.6.4 Connect ends of simply supported girders in such a manner that will allow the ends to rotate under vertical loading.

2.14.13.6.5 Proprietary hanging systems by the successful bidder are preferred over direct bolted connections.

2.14.13.7 Precast Concrete Panels: Precast concrete panels used as non-load bearing construction should have connections such that thermal expansion or contraction may occur without damage to the panels. These connections should at least allow movement at one end of the panel. These connections could be in the form of studs welded to embedded steel plates and anchored into an angle with slotted holes in the direction of expected movement. Also, when the panels bear on other members such as steel or concrete, the expansion end of the panels should bear on neoprene pads, steel or some such material that will minimize the frictional resistance to movement. The precast concrete of the shearing areas should be reinforced additionally horizontally and vertically to minimize cracking of these bearing areas. Reference is made to PCI Manual for Structural Design of Architectural Precast Concrete. Seismic connections should be in accordance with IBC.

2.14.14 Fire Walls

2.14.14.1 In order to meet fire codes, single fire walls (4-hour rating) must be self-supporting rather than depending upon steel or wood building frame for support, the idea being that if the steel or wood frame collapses due to fire, the wall will still survive. In these cases, fire walls should be designed to cantilever off the foundation and should not be connected to the building frame in any way unless the frame has a 1-1/2 hour fire rating. Reinforced pilasters, brick or CMU, are a recommended method to achieve this. The foundation must be able to take these imposed loads. If it is desirable to connect the wall to a building's steel or wood frame, then a double firewall must be provided. The lateral design load for fire walls should be 10 psf (0.5 kN/m^2) unless a portion of it serves as an exterior wall. Building framing members that have 1-1/2 hour fire rating or more may bear on fire walls and provide lateral support for them.

2.14.14.2 Walls with less than 4-hour fire rating do not have to be self-supporting. These walls are sometimes called fire partitions.

2.14.14.3 Control joints in fire walls should be well keyed, caulked with rockwool and held in place by mortar (each side). If the fire wall is reinforced, control joints can be 50-foot (15 m) o.c.

CHAPTER A-2

STRUCTURAL

APPENDIX: EXHIBITS

WIND VELOCITIES AND SEISMIC SPECTRAL ACCELERATIONS AT LOCAL INSTALLATIONS

Wind based on UFC 3-301-01

Seismic based on UFC 3-301-01

Installation	Wind Velocity (3 sec.) MPH	(m/s)	Seismic* Ss	S1
Fort Benning, Georgia	95	42	0.15	0.07
Fort Bragg, North Carolina	95	42	0.29	0.10
Charleston Army Depot, South Carolina	125	56	1.92	0.49
Dobbins AFB, Georgia	90	40	0.25	0.09
Fort Fisher AFS, North Carolina	135	60	0.31	0.10
Fort Gordon, Georgia	93	42	0.33	0.11
Fort Gillem, Georgia	90	40	0.22	0.09
Hunter AAF, Georgia	120	54	0.38	0.12
Fort Jackson, South Carolina	97	42	0.56	0.15
Kings Bay Army Terminal, Georgia	120	54	0.17	0.07
Fort McPherson, Georgia	90	40	0.22	0.09
Moody AFB, Georgia	98	45	0.13	0.06
Pope AAF, North Carolina	95	45	0.29	0.10
Robins AFB, Georgia	92	42	0.19	0.08
Seymour Johnson AFB, North Carolina	110	49	0.20	0.08
Fort Stewart, Georgia	110	51	0.29	0.10
Military Ocean Terminal Sunny Point, N. C.	135	60	0.32	0.11
Tarheel Army Missile Plant, N. C.	90	40	0.22	0.09

*Maximum Considered Earthquake, Spectral Response Accelerations for 0.2 second (Ss) and 1.0 second (S1). Values shown assume Site Class B and should be modified for different Site Classes. Values shown are for general location of each installation and should be verified for actual project site. See Spectral Response Seismic Design Maps in ASCE 7 or use USGS Seismic Design Maps Web Application: http://geohazards.usgs.gov/designmaps/us/.

GENERAL NOTES (FIO)

Note: do not directly copy the sample loading criteria shown below for any project. Loading criteria must be determined independently for each project; this sample is only intended to provide a format for the information that should be included with every submittal.

1. **DESIGN LOADS:**

ROOF LIVE LOADS:	ROOF	=	20 psf
FLOOR LIVE LOADS:	SLABS-ON-GRADE	=	150 psf
	STAIRWELLS	=	100 psf
	CORRIDORS	=	100 psf
	CLASSROOMS & STORAGE	=	100 psf
	MECHANICAL, ELECTRICAL, & ATTIC SPACE	=	150 psf
WIND LOADS:	REFERENCE: ASCE 7-05		
	VELOCITY	=	95 Mph
	I	=	1.0
	EXPOSURE	=	C
SEISMIC LOADS:	REFERENCE: ASCE 7-05		
	Ss	=	0.29
	S1	=	0.10
	I	=	1.0
	SITE CLASS	=	D
	Fa	=	1.568
	Fv	=	2.280
	Sds	=	0.303
	Sd1	=	0.197
	STEEL SYSTEM NOT SPECIFICALLY DETAILED FOR SEISMIC RESISTANCE		
	R	=	3
	Ω_o	=	3
	C_d	=	3
	Cs	=	0.101

1. WHERE A SECTION OR DETAIL IS SHOWN FOR ONE CONDITION, IT SHALL APPLY TO ALL LIKE AND SIMILAR CONDITIONS.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN AND DETAIL OF SIMPLE (SHEAR ONLY) CONNECTIONS NOT SHOWN ON THE DRAWINGS.
3. NO CORE DRILLING WILL BE PERMITTED IN THE FOUNDATION WALLS OR IN THE ELEVATED SLABS. REFER TO THE MECHANICAL, ELECTRICAL, AND PLUMBING PLATES TO LOCATE PENETRATIONS. THE PENETRATION LOCATIONS MUST BE SHOWN IN THE SHOP DRAWING SUBMITTALS.

CONCRETE MASONRY NOTES (FIO)

1. ALL CONCRETE MASONRY WORK SHALL CONFORM TO ACI 530-08.

2. ALL CMU SHALL BE TWO-CELL TYPE UNITS EXCEPT LINTELS WHICH SHALL BE U-SHAPED UNITS.
3. BOND BEAM UNITS MAY BE U-SHAPED OR TWO-CELL TYPE.
4. ALL CMU SHALL CONFORM TO ASTM C-90 OR EQUIVALENT METRIC STANDARD.
5. ALL CELLS CONTAINING REINFORCING SHALL BE FULL GROUTED.
6. USE TYPE S MORTAR WITH A MINIMUM COMPRESSIVE STRENGTH OF 1800 psi AT 28 DAYS.
7. VERTICAL CELLS TO BE FILLED SHALL HAVE VERTICAL ALIGNMENT SUFFICIENT TO MAINTAIN A CLEAR UNOBSTRUCTED CONTINUOUS VERTICAL CELL NOT LESS THAN 50 X 75mm PLAN DIMENSIONS.
8. ALL MASONRY BOND BEAMS, LINTELS, AND VERTICALLY GROUTED CELLS SHALL BE FILLED SOLIDLY WITH 2500 psi GROUT.
9. BOND BEAMS AT CMU WALLS THAT ARE PERPENDICULAR TO EACH OTHER SHALL MEET AT THE SAME ELEVATION AND THE REINFORCING SHALL BE LAPPED AS REQUIRED.
10. ALL CONCRETE MASONRY UNITS SHALL HAVE A GROSS SPECIFIED COMPRESSIVE STRENGTH OF 2000 psi AT 28 DAYS.
11. DOWELS FROM THE ATTIC SLAB SHALL BE PROVIDED. THE SPACING AND SIZE OF THE DOWELS SHALL MATCH THE VERTICAL REINFORCING BARS.
12. THE ASSUMED F'_m FOR MASONRY = 1350 psi.

CONCRETE NOTES (FIO)

1. ALL CONCRETE WORK SHALL CONFORM TO ACI 318-08, BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.
2. CONCRETE STRENGTH = 4000 psi AT 28 DAYS FOR CONCRETE MEMBERS INCLUDING FOOTINGS AND TRENCHES.
3. REINFORCING BARS SHALL CONFORM TO ASTM A615M, A184, A184M F_Y = 60 ksi.
4. ALL SPLICES SHALL BE CLASS "B" TENSION LAP SPLICES UNLESS NOTED OTHERWISE.
5. MINIMUM CONCRETE COVER FOR REINFORCING:
   FOOTINGS = 3 in; SLABS = 1.5 in
6. VERTICAL FOUNDATION WALL REINFORCING DOWELS SHALL EXTEND INTO THE FOUNDATION WITH HOOKED BARS OF THE SAME SIZE AND SPACING AS THE VERTICAL REINFORCING.
7. SLABS-ON-GRADE SHALL INCLUDE FIBER MESH REINFORCING AS PRESCRIBED IN THE SPECIFICATIONS TO CONTROL SHRINKAGE.
8. DURING PLACEMENT OF THE CONCRETE SLABS, ALL PRECAUTIONARY STEPS MUST BE TAKEN TO AVOID PLASTIC CRACKS DUE TO WEATHER CHANGES. THE CONTRACTOR SHALL COMPUTE THE PROJECTED RATE OF EVAPORATION IN ACCORDANCE WITH ACI 308R WITHIN 24 HOURS OF PLACEMENT. IF THE PROJECTED EVAPORATION RATE EXCEEDS THE MAXIMUM ALLOWABLE, THEN THE ERECTION OF SUNSHADES, WINDBREAKERS, AND OTHER SUCH MEASURES AS MAY BE REQUIRED MUST BE TAKEN TO MINIMIZE PLASTIC CRACK FORMATION.
9. THE BAR BENDING SCHEDULE FOR THE FOUNDATION MUST BE SUBMITTED FOR APPROVAL. THE BAR BENDING SCHEDULE SHALL CONFORM TO THE REQUIREMENTS OF ACI 318.

FOUNDATION NOTES (FIO)

1. REFERENCE ELEVATION 100 ft IS THE ASSUMED FIRST FLOOR FINISHED ELEVATION WITHIN S PLATES. SEE PLATE _____ FOR ACTUAL FIRST FLOOR FINISHED ELEVATION.
2. THE ALLOWABLE SOIL BEARING PRESSURE IS _____ PSF. REFER TO THE GEOTECHNICAL REPORT DATED _____ PROVIDED BY EN-GS, SAVANNAH DISTRICT.
3. CONSTRUCTION JOINTS IN CONTINUOUS FOOTINGS ARE TO BE FORMED VERTICALLY WITH MINIMUM 24 in LAPS IN CONTINUOUS REINFORCING UNLESS NOTED OTHERWISE.
4. PLACE VAPOR BARRIER AND 4 in CAPILLARY WATER BARRIER UNDER ALL SLABS-ON-GRADE (TYPICAL).
5. ALL FLOOR ISOLATION JOINTS SHALL BE No. 30 FELT.
6. FILL ALL CMU CAVITIES BELOW GRADE WITH GROUT.
7. THE ALLOWABLE SOIL BEARING CAPACITY IS ____ psf.

BUILDING SLAB ON GRADE NOTES (FIO)

1. CONCRETE FLOOR SLAB-ON-GRADE MAY BE PLACED IN EITHER CHECKERBOARD PATTERN OR IN LANES. SPACING OF JOINTS SHALL BE AS SHOWN ON THE FOUNDATION PLAN. IF CHECKERBOARD PATTERN IS USED, ALL JOINTS SHALL BE CONSTRUCTION JOINTS. IF LANE PLACEMENT IS USED, CONSTRUCTION JOINTS SHALL BE USED FOR THE JOINTS BETWEEN LANES, WHILE WEAKENED PLANE JOINTS SHALL BE USED DOWN EACH LANE. THE REINFORCING IN THE SLAB SHALL BE _____.

STRUCTURAL STEEL NOTES (FIO)

1. ALL STRUCTURAL STEEL WORK SHALL CONFORM TO THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC) SPECIFICATIONS FOR DESIGN, FABRICATION, AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS, NINTH EDITION, HEREINAFTER REFERRED TO AS AISC-9. THE SIZES OF STRUCTURAL MEMBERS SHALL BE GOVERNED BY ASTM A6/M.
2. CONNECTIONS - GENERAL:
3. ALL CONNECTIONS NOT DETAILED OR OTHERWISE NOTED SHALL BE DESIGNED AS AISC TYPE 2 BOLTED CONNECTIONS DESIGNED FOR THE FULL LOAD CAPACITY OF THE CONNECTING MEMBERS.
4. THE DESIGN AND DETAILING OF ALL CONNECTIONS SHALL CONFORM TO THE AISC SPECIFICATION CONTAINED IN AISC-9.
5. MATERIAL SPECIFICATION FOR ROLLED SECTIONS, PLATES, AND FLAT BAR STRUCTURAL STEEL SHALL CONFORM TO ASTM A 572/A 572M (GRADE 50), UNLESS NOTED OTHERWISE. TUBULAR STEEL SECTIONS SHALL CONFORM TO ASTM A500 (GRADE B).
6. MINIMUM WELD SIZE FOR STRUCTURAL STEEL CONNECTIONS IS $^{3}/_{16}$ in FILLET, UNLESS NOTED OTHERWISE.

7. STEEL ROOF DECK TO BE MINIMUM DIMENSION OF 1.5 in DEEP AND 0.0379 in THICK (20 GAGE). THE DIMENSIONS SHOWN IN THE DRAWINGS FOR STRUCTURAL STEEL BEAMS, COLUMNS, PLATES, RODS, METAL DECK, AND SCREWS ARE NOMINAL DIMENSIONS.
8. THIS STRUCTURE IS CONSIDERED A NON-SELF-SUPPORTING BRACED FRAME. THE CONTRACTOR SHALL PROVIDE ADEQUATE TEMPORARY SUPPORTS UNTIL ALL PERMANENT BRACING AND FLOOR SLABS ARE IN PLACE.

LIGHT GAGE TRUSS AND FRAMING NOTES (FIO)

1. ROOF LAYOUT AND COMPONENTS SHOWN ON THE DRAWINGS ARE FOR GENERAL CONFIGURATION ONLY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL DIMENSIONS, ELEVATIONS CONNECTION DETAILS, QUANTITIES, ETC. NECESSARY FOR THE COMPLETE DESIGN, FABRICATION, AND ERECTION OF THE METAL ROOF FRAMING SYSTEM. THE CONTRACTOR SHALL COORDINATE THE DESIGN WITH THE ARCHITECTURAL PLANS, ELEVATIONS, AND DETAILS.
2. LIGHT GAGE TRUSS AND FRAMING MEMBERS SHALL BE DESIGNED IN ACCORDANCE WITH THE AMERICAN IRON AND STEEL INSTITUTE (AISI) SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS.
3. ALL CALCULATIONS AND DRAWINGS USED IN THIS DESIGN MUST BE SIGNED AND STAMPED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF GEORGIA AND SUBMITTED TO THE GOVERNMENT FOR APPROVAL. IN ADDITION TO THE CALCULATIONS, THIS SUBMITTAL SHALL INCLUDE DETAILS OF CONNECTIONS, ERECTION PLAN, LAYOUT, OUTRIGGERS, HEADERS, BRIDGING, AND BOTH TEMPORARY AND PERMANENT BRACING.
4. THE CONTRACTOR SHALL SUBMIT COMPLETE PRODUCT CATALOGS FROM THE TRUSS MANUFACTURER FOR REVIEW PRIOR TO FABRICATION. THE CATALOGS SHALL INDICATE QUALIFICATIONS, MATERIAL SPECIFICATIONS, DESIGN REFERENCES, ETC.
5. ALL COLD-FORMED STEEL MEMBERS, THEIR COMPONENTS, AND CONNECTION MATERIAL SHALL BE HOT-DIPPED GALVANIZED.
6. ALL TOP CHORD MEMBERS SHALL HAVE A MINIMUM THICKNESS OF 0.06 in.

PRE-ENGINEERED METAL BUILDING NOTES (FIO)

1. BUILDING SHALL BE A PRE-ENGINEERED BUILDING AS SPECIFIED IN SECTION UFGS 13 34 19, METAL BUILDING SYSTEMS. THE BUILDING SHALL BE A MANUFACTURER'S STANDARD PREFABRICATED METAL STRUCTURE OF THE APPROXIMATE INSIDE AREA SHOWN, EXCEPT AS NOTED. RIGID FRAMES SHALL BE SPACED AT CENTER TO CENTER, BUT OVERALL DIMENSIONS AND CONSTRUCTION DETAILS MAY VARY TO SUIT MANUFACTURER'S STANDARD DESIGN.
2. THE BUILDING SHALL BE DESIGNED AND FABRICATED ACCORDING TO AISC AND AISI LATEST SPECIFICATIONS. THE DIMENSIONAL TOLERANCES OUTLINED IN THE AWS CODE UNDER WORKMANSHIP AND THE TOLERANCES APPLICABLE TO ROLL FORM STEEL UNDER THE AISC "STANDARD MILL

PRACTICE" SECTION SHALL BE REQUIRED IN THE FABRICATION OF THE STEEL BUILDING FRAMES.

3. A COMPLETE DESIGN ANALYSIS SHOWING ALL CALCULATIONS FOR THE RIGID FRAMES, GIRTS, AND PURLINS, AND A LAYOUT OF ANCHOR BOLTS AND OTHER EMBEDDED ITEMS SHALL BE SUBMITTED FOR APPROVAL WITH THE SHOP DRAWINGS. SHOP DRAWINGS SHALL INCLUDE DETAILS OF ALL MAIN MEMBERS, TYPICAL CONNECTIONS (SHOWING BOLT HOLES AND WELDS), AND ERECTION DRAWINGS.
4. THE BUILDING SHALL BE DESIGNED TO SUPPORT ALL MECHANICAL EQUIPMENT INCLUDING HEATERS, SPRINKLERS, EXHAUST SYSTEMS, AND ALL OTHER SUCH DEVICES. ADDITIONAL GIRTS OR PURLINS SHALL BE PLACED IN CONVENIENT LOCATIONS FOR ATTACHMENT OF ALL MECHANICAL EQUIPMENT.
5. WIND LOADS, LIVE LOADS AND LOAD COMBINATIONS SHALL BE IN ACCORDANCE WITH UFC 3-310-01, "DESIGN LOAD ASSUMPTIONS FOR BUILDINGS."
6. CROSS BRACING SHALL BE USED TO TAKE LATERAL LOADS.
7. THE FOUNDATIONS SHOWN ARE ESTIMATES FOR THE BUILDING TYPE SHOWN ON THE DRAWINGS AND ARE TO BE USED AS A GUIDE FOR THE BUILDING SUPPLIED. THE CONTRACTOR SHALL DESIGN THE FOUNDATIONS FOR THE LOADS SHOWN AND THE BUILDING SUPPLIED.
8. THE CONTRACTOR SHALL USE IN HIS DESIGN THE BASIC CRITERIA SHOWN BY THIS DRAWING, SUCH AS SLAB THICKNESS, CONTROL JOINTS, CAPILLARY WATER BARRIER, VAPOR BARRIER, DESIGN LOADS, AND MINIMUM DEPTH OF FOOTING.
9. FOOTINGS SHALL BE SIZED FOR AN ALLOWABLE SOIL BEARING VALUE OF ____PSF. THIS VALUE IS BASED ON A MINIMUM FOOTING WIDTH OF FEET AND A MINIMUM DEPTH OF FEET TO THE BASE OF THE FOOTING MEASURED FROM FINISH FLOOR OR FINISH GRADE ELEVATION, WHICHEVER IS LOWER.
10. FOUNDATION DESIGN SHALL BE PERFORMED BY A REGISTERED PROFESSIONAL ENGINEER AND SHALL BE SUBMITTED FOR APPROVAL WITH AND AS PART OF THE SHOP DRAWINGS.

ABBREVIATIONS (FIO)

ACI	AMERICAN CONCRETE INSTITUTE
AFF	ABOVE FINISHED FLOOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
ASTM	AMERICAN SOCIETY FOR TESTING MATERIALS
BRG	BEARING
CMU	CONCRETE MASONRY UNIT
CONC.	CONCRETE
CONT.	CONTINUOUS
C.J.	CONSTRUCTION JOINT
DIA.	DIAMETER
EL.	ELEVATION
EW	EACH WAY
FIN.	FINISHED
HORIZ.	HORIZONTAL, HORIZONTALLY
IN3	INCHES CUBED
IN4	INCHES TO THE FOURTH POWER
LLV	LONG LEG VERTICAL
MAX.	MAXIMUM
MIN.	MINIMUM
No.	NUMBER
o.c.	ON CENTER
OPP.	OPPOSITE
Pa	PASCAL
KPa	KILOPASCAL
PEJ	PREMOLDED EXPANSION JOINT
REINF.	REINFORCING
SIM.	SIMILAR
SLV	SHORT LEG VERTICAL
TOS	TOP OF STEEL
TYP.	TYPICAL
UNO	UNLESS NOTED OTHERWISE
VERT.	VERTICAL
w/	WITH
X	BY
WP	WORK POINT
L	ANGLE

CONCEPT/EARLY PRELIMINARY (35%) DESIGN BROCHURE OUTLINE

1. Structural Narrative

    a. General
    b. Framing System
    c. Foundation
    d. Special Design Features
    e. Fire Resistance Statement
    f. List structural information needed to complete final design.

2. Structural Design Analysis

    a. Load Assumptions

        1) Dead Loads (provide references)
        2) Live Loads
            Roof ____ psf
            Floor ____ psf
        3) Wind Load
            Velocity ____ mph
            Exposure ____
            Importance ____
        4) Seismic Load
            Seismic Force Resisting System:
            Steel Systems Not Specifically Detailed For Seismic Resistance

Ss	____ g	Sds	____ g
S1	____ g	Sd1	____ g
Importance	____	R	____
Site Class	____	Ω_o	____
Fa	____	C_d	____
Fv	____	Cs	____

        5) Crane Load

    b. Material Strengths

        1) Concrete f'_c 4,000 psi
        2) Reinforcing Steel F_y 60,000 psi
        3) Structural Steel F_y 50,000 psi
        4) Other as appropriate

    c. Calculations: per section 2.5.2.3, SDDM Volume II

3. Comparative Structural System Selection Analysis: per section 2.5.3, SDDM Volume II

4. Concept/Early Preliminary Drawings: per section 2.5.4, SDDM Volume II

5. Outline Specifications: per section 2.5.5, SDDM Volume II

6. Specific Instructions: per section 2.5.6, SDDM Volume II

STRUCTURAL SECTION
QUALITY CONTROL CHECKLIST

FOR REVIEW OF A-E AND IN-HOUSE FINAL DESIGNS

Project Title:		**Date:**
Designed by:		**Checked by:**
GENERAL		
1.	Before beginning the review, check to see that you have a complete package, check A-E Standard Procedures manual and the Specific Instructions to see if everything required was furnished. If anything is missing, see the Work Load Manager before proceeding.	☐
2.	Before beginning the review, scan the directive, 1391, instructions, prior review comments, and correspondence.	☐
3.	After beginning the review, if it appears that the submittal is unsatisfactory, do not proceed. Notify the Work Load Manager.	☐
SPECIFICATION CHECK		
4.	Verify that the required sections of the specifications are in the job by comparing the specification index to the plans.	☐
5.	Verify that the specifications have been properly edited for the project by reviewing the marked-up sections.	☐
6.	Verify that the appropriate review level is indicated for all submittals.	☐
7.	Check UFGS 04 20 00, MASONRY structural items to ensure specification is coordinated with the design. Especially check the testing and/or reinforcing requirements to verify that they are appropriate.	☐
8.	Cross check other section's specifications to ensure that any included structural information is correct, i.e., UFGS 13 34 19, METAL BUILDING SYSTEMS for pre-engineered structures, UFGS 13 48 00, SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT for seismic, etc.	☐
DESIGN CHECK		
9.	Verify that the design analysis has been signed by both the designer and the checker.	☐
10.	Verify that the live loads are in accordance with criteria, particularly over mechanical rooms.	☐

11.	Verify that the wind loads are correctly computed and applied.	☐
12.	Verify that the seismic loads are correctly calculated and applied.	☐
13.	Verify the appropriateness of the seismic design assumptions and details such as building separation, etc.	☐
14.	Verify the design of the major structural elements, i.e. columns, girders, beams, walls, etc., by spot checking the design of at least one member in each category. Investigate additional members depending upon the results of the initial spot check.	☐
15.	Verify the design of the lateral load resisting system from the roof diaphragm to the foundation.	☐
16.	Verify that the assumptions used in the foundation analysis are consistent with the foundation report.	☐
17.	Verify the adequacy of the foundation design by spot checking the design of a least one type of each foundation element used.	☐
18.	If computer programs are used, verify that the necessary backup material has been provided and the assumptions within the backup material are appropriate.	☐
DRAWING CHECK		
19.	**General Notes:**	
a)	Verify that ALL design loads are indicated, i.e., live, wind, seismic, crane, etc.	☐
b)	Verify that the strength of materials used is specified, i.e., A992 steel, 3,000 psi concrete, Grade 60 reinforcing, f'm 1,350 psi compressive strength masonry.	☐
c)	Verify that the type of mortar to be used for masonry walls is specified and matches the specifications.	☐
d)	Verify that concrete reinforcing requirements such as grade of reinforcing and splice lengths are given (i.e., Grade 60 and 40 bar diameters, respectively).	☐
e)	Verify that slab-on-grade thickness and reinforcing requirements are given.	☐
f)	Verify that slab-on-grade notes similar to those shown on Exhibit A-2-2 are provided.	☐
g)	Verify notes are provided for attachment of metal deck diaphragms to supporting members.	☐
h)	Verify that notes are provided for details on any design element not otherwise	☐

	shown on the drawings.	
20.	**Metal Building Notes:** Verify that notes similar to those shown on exhibit A-2-2 are used. Also ensure that the same design philosophy indicated on the notes is used in the design.	☐
21.	**Foundation Notes:**	
a)	Verify that the allowable soil bearing value and depth required to develop this value are shown.	☐
b)	Verify that any other soil design data for designing retaining structures is shown.	☐
c)	Verify that appropriate bracing or shoring notes are provided.	☐
d)	Verify that any special foundation conditions or requirements are described in the notes.	☐
22.	**Superstructure Notes:**	
a)	Verify that the strength of all materials used is indicated here or in the general notes.	☐
b)	Verify that the appropriate type of connections is specified, i.e., type/grade of bolts, welds with electrode types, minimum size of fillet welds where not indicated.	☐
c)	Verify that the minimum S, I, and weld requirements are given for all metal decks to include rib type (narrow, intermediate, or wide).	☐
d)	Verify that a note is added prohibiting the application of loads greater than 50 pounds (22.7 kg) to steel joists without the use of the joist strengthening detail.	☐
e)	Verify that an appropriate amount of draw is indicated for all X-bracing.	☐
23.	Verify that all depressed or raised slabs are indicated.	☐
24.	Verify that proper sizes are indicated on the drawings for structural elements by a spot check comparison of member sizes shown in the calculations and on the drawings. Include at least one type of each structural member in the spot check.	☐
25.	Verify that the drawing notes do not conflict with the specifications.	☐
26.	Verify that the slab elevations are shown and agree with architectural and site plans.	☐

27.	Verify that top-of-steel, top-of-wall bearing, etc. elevations are clearly indicated.	☐
28.	Verify that sufficient sections are cut on the plans to indicate clearly the details of construction. Verify that section cuts are properly oriented and properly referenced. Spot-check as required.	☐
29.	Verify by scanning all sections and details that no criteria violations are present, i.e., slabs resting on footings, etc.	☐
30.	Check slab-on-grade jointing to verify compliance with criteria.	☐
31.	Verify that stress diagrams are provided for all trusses.	☐
32.	Verify that waterproofing is properly shown where required by the soils report.	☐
33.	Verify that Plate S-1 has been initialed by both the designer and checker.	☐
34.	Verify that appropriate details and notes are provided to indicate CMU reinforcing, thickness, and lintel requirements. Interior walls must be designed to span horizontal or vertical under a 10 psf (48.8 kg/m2) lateral load. Verify that vertical spanning walls are properly supported at the top.	☐
35.	Verify that minimum seismic reinforcement is provided in masonry walls if required. Verify that cavity walls are properly designed and have the appropriate reinforcement, i.e., bond beams shown, joint reinforcing 3/16 diameter for seismic walls, etc.	☐
36.	Verify that masonry walls are properly jointed and that reinforcement is not continuous through joints except at floor and roof levels. Locations to be shown on the "S" plates and "A" plates with appropriate details.	☐
37.	Verify that moment connections are either detailed or that the plans indicate the moment for which the joint is to be designed.	☐
38.	Determine if the following items are required and delete them from the specifications as appropriate: capillary water barrier, floor hardener, waterproofing, floor slab reinforcing (increase joint spacing and use 4,000 psi concrete if omitted), flexural strength concrete (pavement only).	☐
39.	Verify that a roof slope greater than 1/4" (6 mm — Army) and 1/4" (6 mm — Air Force) is provided.	☐
40.	Verify that the minimum depth of the footings agrees with the soils report.	☐
41.	Verify that the structural details of vaults, arms rooms and secure areas meet criteria requirements.	☐
42.	Verify that perimeter insulation is shown along exterior walls under slabs-on-grade for all air-conditioned spaces. It should be specified in section UFGS 03	☐

	30 00, CAST-IN-PLACE CONCRETE or 03 30 53, MISCELLANEOUS CAST-IN-PLACE CONCRETE and shown on all "S" plate and "A" plate wall sections.	
43.	Verify all cells of CMU walls below grade are filled with grout.	☐
44.	Verify that drawings clearly indicate which buildings, by name, are to be constructed using specification UFGS 13 34 19, METAL BUILDING SYSTEMS.	☐
45.	Verify coordination of mechanical and electrical equipment for support details on the "S" plates.	☐
46.	Check for details when pipes through exterior foundation walls.	☐