SUPERSTRUCTURE SYSTEMS

TECHNICAL GUIDE

The intent of this Technical Guide is to provide guidance to designer professionals who perform design services for southwest Division – Naval Facilities Engineering Command (Southwest Division). These services may be provided by direct contract with Southwest Division or by contract with a design-build entity. This document presents definitive requirements for ordinary design, but may not cover all situations and is not intended to restrict innovative design alternatives. This document represents minimum design requirements. Project conditions and good design practice may dictate the need for design that exceeds these minimum requirements.

STRUCTURAL DESIGN AND CONSTRUCTION

Design Criteria and Construction Requirements outlined in this Technical Guide are applicable to both Design-Build and Design-Bid-Build Projects.

1.0 NON-SEISMIC DESIGN REQUIREMENTS:

> Note: When no specific criteria reference is given in the following Seismic sections, the reference shall default to criteria referenced in this section.

All structural design other than seismic design shall be based on the loads, load combinations and loading provisions from ANSI / ASCE 7-98 "Minimum design Loads for Buildings and Other Structures" published by the American Society of Civil Engineers. Wind design requirements are contained in ANSI / ASCE 7.

Loads for locations and conditions that are beyond the scope of ANSI/ASCE 7-98 shall be obtained from Mil-Hdbk-1002/2A, dated October 1996 published by NAVFACENGCOM.

Non-seismic design may be performed using either "Allowable Stress Design" or "Strength Design (LRFD)" methods.

Design of structural elements shall comply with the requirements of the following materials criteria:

1.1 Structural Steel:

> "Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings" published by AISC - December 27, 1999 edition.
> "Load and Resistance Factor Design (LRFD) Specification for Steel Hollow Structural Sections" published by AISC – November 10, 2000 edition.
>
> "Load and Resistance Factor Design (LRFD) Specification for Single-Angle Members" published by AISC – November 10, 2000 edition.
>
> "Allowable Stress Design (ASD) and Plastic Design Specification for Structural Steel Buildings" published by AISC - June 1, 1989 edition.

"Specification for Structural Joints using ASTM A325 and A490 Bolts" published by the Research Council on Structural Connections – June 23, 2000 edition.

"Code of Standard Practice for Steel Buildings and Bridges" published by AISC – March 7, 2000 edition.

"Structural Welding Code – Steel" (D1.1- 2002) published by the American Welding Society.

Equivalent metric versions of the specifications listed immediately above may be used. For example, "Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings – Metric" published by AISC - December 1, 1994 edition.

1.2 Open web Steel Joists:

"Standard Specification, Load Tables and Weight Tables for Steel Joists and Joist Girders" published by the Steel Joist Institute – Fortieth Edition dated 1994.

1.3 Cold Formed Steel:

"Specification for the Design of Cold-Formed Steel Structural Members" published by AISI- 1996 edition.

"Structural Welding Code – Sheet Steel (D1.3-98)

"Product Technical Information" (ICBO ER-4943P) published by the Steel Stud Manufacturers Association – copyright 2000. This document is required for cold-formed steel product identification nomenclature and for generic section properties.

1.4 Steel Deck:

"Specification for Composite Steel Floor Deck", "Specification for Non-Composite Steel Form Deck", "Specification for Cellular Deck Floor Systems" and "Specification for Steel Roof Deck" as contained in Publication No. 30 dated April 2001, published by the Steel Deck Institute.

"Structural Welding Code – Sheet Steel (D1.3 –98) published by the American Welding Society.

1.5 Concrete:

"Building Code Requirements for Structural Concrete" (ACI 318- 99) published by the American Concrete Institute.

"Specifications for Structural Concrete" (ACI 301-99) published by the American Concrete Institute.

"Manual of Standard Practice" published by the Concrete Reinforcing Steel Institute (CRSI) 27th edition-2001.

"Structural Welding Code – Reinforcing Steel (D1.4-98) published by the American Welding Society.

1.6 Masonry:

"Building Code Requirements for Masonry Structures" (ACI 530-2002) published by ACI, SEI of ASCE and The Masonry Society.

"Specification for Masonry Structures" (ACI 530.1-2002) published by ACI, SEI of ASCE and the Masonry Society.

1.7 Wood:

AF&PA/ASCE 16-95 "Standard for Load and Resistance Factor Design (LRFD) for Engineered Wood Construction" published by ASCE, or the "National Design Specification for Wood Construction (NDS) – 1997 edition" published by the American Forest & Paper Association (AFPA) and by the American Wood Council (AWC). These publications shall include supplements as required.

ANSI / TPI-1 "National Design Standard for Plate Connected Wood Trusses – 1995,"

TPI HIB "Handling, Installing and Bracing Metal Plate Connected Wood Trusses."

1.8 Plywood / Structural-Use Panels:

"Plywood Design Specification – January 1997 edition" published by APA-The Engineered Wood Association.

"Design Capacities of APA Rated Structural-Use Panels" (Technical Note Number N375B) dated June 1995.

PS1-95 "Construction and Industrial Plywood" published by APA.

PSI-92 "Performance Standard for Wood-Based Structural-Use Panels" by APA.

2.0 SEISMIC DESIGN REQUIREMENTS FOR NEW BUILDINGS AND OTHER NEW STRUCTURES: Seismic design features of new structures shall comply with the requirements of the US Army Corps of Engineers publication TI 809-04 "Seismic Design for Buildings" dated December 1998. This publication references the "NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures" (FEMA 302) – 1997 edition, and must be used in conjunction with FEMA 302. TI 809-04 uses Performance Based Engineering (PBE) analysis and design principles for enhanced performance structures. Performance Based Engineering is based on the ATC methods published originally in the "NEHRP Guidelines for the Seismic Rehabilitation of Buildings" (FEMA 273) and, subsequently, in the "Prestandard and Commentary for the Seismic Rehabilitation of Buildings" (FEMA 356).

a. All seismic design must be performed using "strength design / LRFD" procedures.

b. Note that a peer review in accord with section 1-10 of TI 809-04 is required for the design of hazardous facilities (seismic use group III-H) and for essential facilities (seismic use group III-E.)

c. Design for enhanced performance (seismic use groups II, III-H and III-E) shall not produce a design with members lighter than would result from a "standard occupancy" (seismic use group I) design using importance factors of 1.5 for group III and 1.25 for group II.

d. The use of base isolation and passive energy dissipating systems shall be evaluated for designs that involve "enhanced performance" (seismic use groups II, III-H and III-E).

e. Designs for “enhanced performance” (seismic use groups II, III-H and III-E) are highly dependent on continued function of building utility systems. It is expected that such designs will involve a major effort to assure the continued operation of the building’s utility systems.

2.1 Ground Motion: Geotechnical (Soils Investigation) reports shall contain a determination of the “Site Class” as defined in Table 3-1 of TI 809-04 or section 4.1.2.1 (Site Class Definitions) of FEMA 302. Determination of Fa and Fv shall not be made without a geotechnically established site class. Minor projects that do not require geotechnical investigation reports may be designed to the FEMA 302 default site class D.

a. Site-specific determination of seismic ground motion shall be based on the guidelines presented in chapter 3-4 of TI 809-04. Note that a peer review is required for site-specific ground motion determination as defined in section 3-4.b of TI 809-04.

b. Refer to the Geotechnical portion of this Technical Guide for additional information on site-specific ground motion representation.

2.2 Architectural, Mechanical, Electrical and Other Nonstructural Components Design: As a minimum, all design shall be based on the requirements for Seismic Design Category D.

a. Seismic anchorage and restraint details shall be provided for all slab mounted equipment that exceeds 400# (180kg) in weight and for all suspended equipment that exceeds 70# (32kg) in weight. If exact weights and dimensions are unknown, details shall be based on the best information available, and may be modified during construction if original design assumptions prove to be inaccurate.

b. Support and seismic restraint shall be detailed for all ducts, pipes, suspended equipment etc. Reference to generally accepted standards such as the “SMACNA Guidelines” are acceptable for ordinary installations.

c. Support and seismic restraint of all ceiling systems shall be detailed. Details to include compression struts at all locations where diagonal restraint bracing occurs. Vertical hanger wires shall, as a minimum be 12 gage galvanized wire spaced 4’-0” o/c along the main runners. Diagonal seismic restraints shall as a minimum, be 12 gage galvanized wire at a 45 degree slope in four directions. Minimum spacing of diagonal restraints shall be 12 feet o/c in each direction, but not more than 4’-0” from edges. Compression struts shall be galvanized steel sections with a maximum l/r ratio of 200.

2.3 Foundation Design: As a minimum, all foundation design shall comply with section 7.5 (Seismic Design Categories D,E & F) of FEMA 302.

2.4 Steel Design: As a minimum, all steel design shall comply with section 8.4 (Seismic Design Categories D, E and F) of FEMA 302.
Member design shall be based on the requirements in Part 1 of the AISC publication “Seismic Provisions for Structural Steel Buildings” dated April 15 1997, including supplement no. 2, dated November 10, 2000, (AISC Seismic Provisions).

a. Design using "Special Moment Frames” (SMF) requirements shall comply with chapter 9 of the AISC Seismic Provisions with the additional design provisions of “Recommended Seismic Design Criteria For New Moment-Frame Buildings – FEMA 350.” Quality Assurance requirements from “Recommended Specifications and Quality Assurance Guidelines for Steel Moment-Frame Construction for Seismic Applications – FEMA 353” shall be incorporated into the design requirements. “Intermediate Moment Frames” (IMF) requirements – chapter 10, “Ordinary Moment Frames” (OMF) requirements – chapter 11,

or “Special Truss Moment Frames”(STMF) requirements – chapter 12 of the “AISC Seismic Provisions” will not be permitted without advance approval from Southwest Division’s senior structural engineer.

b. Design of concentrically braced frames shall comply with chapter 13 – “Special Concentrically Braced Frames" (SCBF) of the “AISC Seismic Provisions.” Attention is called to section 13.3c and commentary section C13.3c for the 2t set back exception when critical buckling is out of plane of the gusset plate. Attention is also called to section 13.4a.3 for the post buckling unbalanced vertical load on the beam.

c. Design using “Eccentrically Braced Frames” (EBF) requirements – chapter 15 of the “AISC Seismic Provisions” are permitted unconditionally unless the design involves link-to-column connections. In accord with section 15.4a, link-to-column moment connections require tests that demonstrate elastic rotation capability or adherence to FEMA 350 pre-qualified connection requirements, and, therefore, must be approved by the Southwest Division senior structural engineer.

2.5 Concrete Design: As a minimum, all concrete design shall comply with section 9.7 (Seismic Design Categories D, E or F) of FEMA 302. The exceptions to section 9.7.3 shall be excluded. Reinforced Concrete Structural Systems Composed of Interconnected Precast elements, refer to the Appendix to chapter 9 of FEMA 302, will not be permitted without advance approval from the Southwest Division senior structural engineer.

2.6 Composite Steel and Concrete Structural Design Requirements: Design per chapter 10 of FEMA 302 and Part II of the “AISC Seismic Provisions”, will not be permitted without written approval from the Southwest Division senior structural engineer.

2.7 Masonry Design: As a minimum, all masonry design shall comply with section 11.3.9 (Seismic Design Categories D, E and F) and section 11.11.5 (Special Reinforced Masonry Shear Walls) of FEMA 302. Stack Bond Construction per section 11.3.9.3 of FEMA 302, will not be permitted for structural walls without advance approval from the Southwest Division senior structural engineer. Alternate Provisions for the Design of Masonry Structures – Appendix to Chapter 11 of FEMA 302 shall NOT be used.

a. Minimum requirements for inspection and testing shall comply with the requirements of FEMA 302. It is recommended, for any significant CMU construction, that the continuous QC specialist inspection mentioned in part 1 of specification section 04230 be called for and that prism tests be used to document the required fm’ when fm’ exceeds 1500 psi.

b. Note that section 7-2-h(5)(d) of TI 809-04 calls for the use of 1.25fy for the expected lateral strength of shear wall reinforcing used in shear or flexural calculations.

2.8 Wood Design: As a minimum, all wood design shall comply with section 12.8 (Seismic Design Categories E and F) of the “NEHRP Seismic Provisions” FEMA 302. Design of members and connections shall comply with “AF&PA/ASCE 16-95, Standard for Load and Resistance Factor Design (LRFD) for Engineered Wood Construction” - reference 12-1 in the “NEHRP Seismic Provisions.” Note that section 12.8 of the “NEHRP Seismic Provisions” prohibits the use of unblocked structural-use panel sheathing diaphragms.

2.9 Seismically Isolated Structure Design: Design of seismically isolated structures shall be in accord with chapter 13 of the “NEHRP Seismic Provisions.”

a. The “Equivalent Lateral Force” procedure (reference section 13.3) shall not be used.

b. Site-specific ground motion spectra is required for all seismically isolated structural design.

c. Design using seismic isolation must receive advance approval from the Southwest Division senior structural engineer.

d. Note that a design and test program peer review, in accord with section 13.8.1 of the "NEHRP Seismic Provisions" is required.

2.10 Passive Energy Dissipation System Design: Design of passive energy dissipating systems shall be in accord with the appendix to chapter 13 of the "NEHRP Seismic Provisions."

a. Designs using passive energy dissipating systems must receive advance approval from the Southwest Division senior structural engineer.

b. Note that a design and test program peer review similar to that prescribed in section 13.8.1 of the "NEHRP Seismic Provisions" is required.

2.11 Non-building Structure Design: Design of Piers and Wharves shall comply with "Technical Report TR-2069-SHR - Design Criteria for Earthquake Hazard Mitigation of Navy Piers and Wharves" dated March 1997, distributed by NAVFACENGCOM, rather than by the provisions of the "NEHRP Seismic Provisions." All tanks and vessels shall be designed to meet the additional requirements of section 14.4.3.3 of the "NEHRP Seismic Provisions."

2.12 Cold Formed Metal Framing: Seismic design using light gage, cold formed metal framing shall comply with section 8.6 "Light-Framed Walls" of the "NEHRP Seismic Provisions" FEMA 302."

3.0 SEISMIC DESIGN REQUIREMENTS FOR EVALUATION AND RETROFIT OF EXISTING STRUCTURES: The basic requirements for seismic evaluation and retrofit are contained in "Seismic Evaluation and Rehabilitation for Buildings" (TI-809-05), dated October 1999, prepared by the U.S. Army Corps of Engineers. This document references TI-809-04, FEMA 310, FEMA 302 and FEMA 273.

Seismic evaluation of existing buildings for all Seismic Use Groups shall comply with the "Handbook for the Seismic Evaluation of Buildings – A Prestandard" (FEMA 310).

Evaluations of existing buildings using (FEMA 310) shall generally be based on the Tier 3 evaluation procedures using adaptations of design requirements from TI 809-04. No preliminary Tier 1 or Tier 2 evaluation is required. For highly irregular buildings, Tier 3 detailed evaluation using nonlinear static analysis may be required. The special URM bearing wall procedure may be used when appropriate. The requirements of FEMA 352 and / or FEMA 353 shall be adhered to for evaluation of Steel moment frames. Note that chapter 5 of (FEMA 310) permits seismic evaluations to 0.75 x new design criteria as an acceptance standard, but requires upgrades to 100% of new design criteria. No buildings are to be treated as Benchmark buildings.

For Seismic Use Group I structures, seismic retrofit design may be based on the requirements of the "NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures" (FEMA 302).

For Seismic Use Group II, III-H and III-E structures, all requirements in TI 809-05 shall be adhered to. The retrofit of structures to Seismic Use Group categories II, III-H and III-E is generally not recommended. Specific approval from the Southwest Division senior structural engineer shall be obtained for such retrofits, which must include evaluations of the use of base isolation and passive energy dissipating systems.

3.1 Ground Motion: Site characteristics may be determined from previous Geotechnical (Soils Investigation) reports if adequate information is available. Determination of the "Site Class" as defined in Table 3-1 of TI 809-04 or section 4.1.2.1 (Site Class Definitions) of FEMA 302 shall

be made by a geotechnical engineer. Determination of Fa and Fv shall not be made without a geotechnically established site class. Minor projects that do not require a geotechnical report may use the FEMA 302 default site classification D.

a. Site-specific determination of seismic ground motion shall be based on the guidelines presented in chapter 3-4 of TI 809-04. Note that a peer review is required for site-specific ground motion determination as defined in section 3-4.b of TI 809-04.

b. Refer to the geotechnical section of this Technical Guide for additional information concerning site-specific ground motion representation.

3.2 Architectural, Mechanical, Electrical and Other Nonstructural Components Design: Seismic rehabilitation shall include anchorage and restraint of all equipment that is not adequately anchored. As a minimum, all new anchorage design shall be based on the requirements for Seismic Design Category D of FEMA 302.

a. Seismic anchorage and restraint details shall be provided for all slab mounted equipment that exceeds 400# (180kg) in weight and for all suspended equipment that exceeds 70# (32kg) in weight. If exact weights and dimensions are unknown, details shall be based on the best information available, and may be modified during construction if original design assumptions prove to be inaccurate.

b. Support and seismic restraint shall be detailed for all ducts, pipes, suspended equipment etc. Reference to generally accepted standards such as the “SMACNA Guidelines” are acceptable for ordinary installations.

c. Support and seismic restraint of all ceiling systems shall be detailed. Details to include compression struts at all locations where diagonal restraint bracing occurs. Vertical hanger wires shall, as a minimum be 12 gage galvanized wire spaced 4’-0” o/c along the main runners. Diagonal seismic restraints shall as a minimum, be 12 gage galvanized wire at a 45 degree slope in four directions. Minimum spacing of diagonal restraints shall be 12 feet o/c in each direction, but not more than 4’-0” from edges. Compression struts shall be galvanized steel sections with a maximum l/r ratio of 200.

3.3 Foundation Design: As a minimum, all new foundation design for seismic rehabilitation shall comply with section 7.5 (Seismic Design Categories D,E & F) of FEMA 302.

3.4 Steel Design: As a minimum, all new steel design for seismic rehabilitation shall comply with section 8.4 (Seismic Design Categories D, E and F) of FEMA 302. Member design shall be based on the requirements in Part 1 of the AISC publication “Seismic Provisions for Structural Steel Buildings” dated April 15 1997, including supplement no. 2 dated November 10, 2000.

a. Design using "Special Moment Frames” (SMF) requirements- chapter 9, “Intermediate Moment Frames” (IMF) requirements – chapter 10, “Ordinary Moment Frames” (OMF) requirements – chapter 11, “Special Truss Moment Frames” (STMF) requirements – chapter 12 of the “AISC Seismic Provisions” or modifications to existing moment frames will not be permitted without advance approval from the Southwest Division senior structural engineer. The additional requirements of FEMA 351 and / or FEMA 352 must be adhered to.

b. Design of concentrically braced frames shall comply with chapter 13 – “Special Concentrically Braced Frames" (SCBF) of the “AISC Seismic Provisions.” Attention is called to section 13.3c and commentary section C13.3c for the 2t set back exception when critical buckling is out of plane of the gusset plate. Attention is also called to section 13.4a.3 for the post buckling unbalanced vertical load on the beam

c. Design using "Eccentrically Braced Frames" (EBF) requirements – chapter 15 of the "AISC Seismic Provisions" are permitted unconditionally unless the design involves link-to-column connections. In accord with section 15.4a, link-to-column moment connections require tests that demonstrate inelastic rotation or adherence to FEMA 350 pre-qualified connection requirements capability and therefore must be approved in advance by the Southwest Division senior structural engineer.

3.5 Concrete Design: As a minimum, all new concrete design for seismic rehabilitation shall comply with section 9.7 (Seismic Design Categories D, E or F) of FEMA 302. The exceptions to section 9.7.3 shall be excluded. Reinforced Concrete Structural Systems Composed of Interconnected Precast elements, see Appendix to Chapter 9 of FEMA 302, will not be permitted without advance approval from the Southwest Division senior structural engineer.

3.6 Composite Steel and Concrete Structural Design Requirements: New design for seismic rehabilitation per chapter 10 of FEMA 302 and Part II of the "AISC Seismic Provisions", will not be permitted without advance approval from the Southwest Division senior structural engineer.

3.7 Masonry Design: As a minimum, all new masonry designs intended for seismic rehabilitation shall comply with section 11.3.9 (Seismic Design Categories D, E and F) and section 11.11.5 (Special Reinforced Masonry Shear Walls) of FEMA 302. Stack Bond Construction per section 11.3.9.3 of FEMA 302, will not be permitted for new structural walls without written approval from the Southwest Division senior structural engineer. Alternate Provisions for the Design of Masonry Structures – Appendix to Chapter 11 of FEMA 302 shall not be used.

a. Minimum requirements for inspection and testing shall comply with the requirements of FEMA 302.

b. It is recommended, for any significant CMU construction, that the continuous QC specialist inspection mentioned in part 1 of specification section 04230 be called for and that prism tests be used to document the required fm' if fm' exceeds 1500 psi.

3.8 Wood Design: As a minimum, all wood design shall comply with section 12.8 (Seismic Design Categories E and F) of the "NEHRP Seismic Provisions." Design of members and connections shall comply with "AF&PA/ASCE 16-95, Standard for Load and Resistance Factor Design (LRFD) for Engineered Wood Construction." Note that section 12.8 of the NEHRP Seismic Provisions" prohibits the use of unblocked structural-use panel sheathing.

3.9 Seismically Isolated Structure Design: Design of seismically isolated structures shall be in accordance with chapter 13 of the "NEHRP Seismic Provisions."

a. The "Equivalent Lateral Force" procedure referenced in section 13.3 may not be used.

b. Site-specific ground motion spectra shall be used for all seismically isolated structural design.

c. Design using seismic isolation must receive advance approval from the Southwest Division senior structural engineer.

d. Note that a design and test program peer review in accordance with section 13.8.1 of the "NEHRP Seismic Provisions" is required.

3.10 Passive Energy Dissipation System Design: Design of passive energy dissipating systems shall be in accordance with the Appendix to Chapter 13 of the "NEHRP Seismic Provisions."

a. Designs using passive energy dissipating systems must receive advance approval from the Southwest Division senior structural engineer.

b. Note that a design and test program peer review similar to that prescribed in Section 13.8.1 of the "NEHRP Seismic Provisions" is required.

3.11 Nonbuilding Structure Design: Seismic rehabilitation of Piers and Wharves shall be based on the provisions of "Technical Report TR-2069-SHR - Design Criteria for Earthquake Hazard Mitigation of Navy Piers and Wharves", dated March 1997, distributed by NAVFACENGCOM, rather than by the provisions of the "NEHRP Seismic Provisions." Seismic rehabilitation of tanks and vessels shall utilize the additional requirements of section 14.4.3.3 of the "NEHRP Seismic Provisions."

3.12 Cold Formed Metal Framing: Seismic design using light gage cold formed metal framing shall comply with section 8.6, "Light-Framed Walls" of the "NEHRP Seismic Provisions."

4.0 QUALITY ASSURANCE

Minimum Quality Assurance requirements shall be as defined in the "NEHRP Seismic Provisions." More stringent requirements shall be inserted into the construction documents by the "structural engineer of record" when it is felt that additional testing and inspection are needed.

a. Structural Inspection and Testing Requirements shall be included in the individual specification sections. These requirements will become part of the contractor managed quality control program.

b. Q.C. specialists must be identified for the various inspection categories (e.g., concrete, steel, masonry, welding) in specification section 01450, and "special inspector certifications" such as ACI, AWS, ICBO shall be required. Note that the "QC Specialist" as defined in the NAVFAC specifications is equivalent to a "Special Inspector" as defined in the Uniform Building Code.

c. Structural Steel Fabricating Shops should be required to possess AISC certification in the appropriate category. ICBO and City of Los Angeles certifications will also be accepted.

d. Pre-Engineered Metal Building fabricators must be required to possess AISC certification in the MB category.

e. Structural Steel Erectors may be required, on major projects, to possess AISC certification in the appropriate category.

f. Precast concrete producers shall be required to posses PCI (Pre-cast/Pre-stressed Concrete Institute) plant certification in the appropriate category.

g. Epoxy coatings on reinforcing steel shall be produced in plants certified by CRSI (Concrete Reinforcing Steel Institute) for pre-bent fusion bonded Epoxy coatings per ASTM A934 "Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars."

h. Plant fabricated metal plate connected wood trusses shall be produced in Plants certified by the TRI (Truss Plate Institute) quality assurance inspection program.

i. On design-bid-build projects, the structural engineer of record shall perform construction field observation as defined in the project statement of work.

j. On design-build projects, the structural engineer of record shall perform construction field observation as defined in the project RFP.

5.0 CONSTRUCTION DOCUMENTATION REQUIREMENTS

Construction documents shall be prepared with sufficient detail that structural decisions and choices need not be made in the field. All construction conditions shall be fully addressed in the construction documents.

5.1 Foundation Conditions:

a. Describe site conditions, type of foundation to be used and the method employed to determine allowable soil bearing values.

b. Indicate the maximum dead load, dead + live load and combined dead + live + seismic/wind design bearing values.

c. Indicate the passive, active and at rest design pressures, the coefficient of friction and the sub-grade modulus.

d. Indicate if a site-specific design spectrum has been used in the design and give the site class in accord with the seismic design criteria used in the seismic design.

e. Identify the soils investigation reports upon which the design was based.

5.2 Basis of Design: Provide a brief basis of design that describes the type of construction, the framing systems used, the lateral load resisting elements, the foundations and all other special information needed to convey an understanding of the structural systems. This shall include definitions of the diaphragms and the process of shear transfer between diaphragms and vertical lateral load resisting elements. This shall also include definitions of the manner in which foundations and slabs on grade are used to distribute lateral forces between the structure and the ground.

5.3 Materials: Clearly define all materials for each structural element and system. All structural materials shall be competitively available and shall be produced by a domestic manufacturer unless domestically produced products are not available.

5.4 Loads:

a. List snow loads, live loads, wheel loads, equipment loads, material handling loads and any special design loads. Identify the source for all loads listed.

b. List mooring, berthing and deck loads for marine structures.

c. For wind loads list basic wind velocities, importance factors, exposure categories and topographic factors.

d. For seismic design, list the design base shears in terms of % gravitational acceleration and show the formula used to determine the base shear. List the coefficients used to compute the base shear. Design coefficients shall include R, Ω, C_d, ρ, I, S_s, S_1, Fa, Fv, C_s and T. Also identify the seismic force-resisting system.

e. Give the method of analysis used in the design. For example: Linear Elastic Static – etc.

5.5 Pre-engineered Metal Building Systems:

a. All loads and forces necessary to design the superstructure must be provided by the structural engineer designer of record. This must include all wind and seismic design requirements.

b. The structural engineer designer of record must review and approve all design calculations and shop drawings.

c. A foundation design and anchor bolt design must be provided in the contract documents. These designs will be evaluated based on the foundation reactions provided by the superstructure designer for review by the designer of record. The foundation design must provide for resisting the horizontal reactions at the column bases. It shall be stated on the construction drawings that construction of foundations shall not take place prior to design and shop drawing approval by the structural engineer of record.

d. It shall be required that all calculations and shop drawings executed by a pre-engineered metal building manufacturer be sealed by a registered structural or civil engineer.

e. It shall be required that the metal building fabricator be certified through the AISC Plant Quality Certification Program in the MB category.

f. All serviceability limit states that are to be applied to the superstructure must be stated in the contract documents.

g. The contract documents must state that fixed base column design is prohibited.

h. Provide complete dimensions that include such information as roof slopes, eave heights, floor elevations, required clearances, outside face of girts or columns and any needed reference dimensions.

i. Indicate if the building is to be designed for future expansion and indicate bays that are available for diagonal bracing.

j. If additions or interior modifications are made to pre-engineered metal buildings, new construction must be separated from the existing structure, such that no new loads are applied to existing framing.

k. If walls, other than girt and metal siding systems provided by the fabricator are used, the wall design information and the loads imposed by these walls on the building frame must be given in the construction documents.

5.6 Design/Build Elements within Design-Bid-Build (IFB) contracts:

a. All structural elements shall be completely designed and detailed in the contract documents by the structural engineer designer of record. The contractor shall not be responsible for the production of structural designs, other than deferred approval items as listed as exceptions below.

b. Examples of elements that must be designed by the structural engineer designer of record are member connections, light gage metal stud/joist framing, support and restraint of ceiling systems, support and restraint of wall systems, concrete/masonry inserts, equipment support, support and restraint of pipes and ducts and support of casework.

c. Exceptions: Items such as open web steel joists, pre-cast concrete elements, fabricated wood trusses, fabricated cold-formed steel trusses and raised access floors that are not

part of the lateral load resisting system, may be designed by the manufacturer if all loads and design conditions are clearly given in the construction documents and the structural engineer of record accepts the designs. Contractor furnished designs shall be stamped and signed by a registered civil or structural engineer. However, the structural engineer of record will still be responsible for acceptance of these designs.

5.7 Structural Notes: The drawings must contain a set of "Structural Notes" which provide critical reference information for use when future modifications and evaluations are made; e.g., Design Criteria, Design Loads, References to Design Standards, Required Material Properties, Types, Grades & Strengths of materials, Special Construction and Erection Requirements, etc.

5.8 Design Build Contracts:

a. Structural design performed under the direction of a Design-Build contractor shall conform to the level of care that is expected of designs done under direct contract to the Navy.

b. Drawings must be completely detailed such that design decisions and choices in the field are not necessary.

c. The structural engineer designer of record shall review all structural shop drawings. Shop drawings shall be stamped, accepted or rejected, by the structural engineer designer of record. Re-submittals and re-checks shall be made until a final accepted version is achieved.

d. The structural designer of record shall review deferred approval designs performed by designers of proprietary products, and accept these designs on a basis similar to shop drawing acceptance.

5.9 Welding Requirements:

a. Acceptance criteria for ultrasonic testing of groove welds shall be based on Table 6.3 of AWS D1.1.

b. All weld metal and base metal subjected to cyclic tension shall be supplied with "charpy V-notch testing in accordance with ASTM A6 supplementary requirement SS (5 specimen option). The impact test shall meet a minimum average value of 20 ft. lbs. absorbed energy @ -20 degrees F.

5.10 Construction Adjustments: Where building finishes or other building features that are supported by structural elements require close construction tolerances, attachments to the structural elements must be detailed such that adjustments may be made in the field to compensate for lack of correct fit.

6.0 STRUCTURAL STEEL PAINT RECOATING

Removal of existing steel coatings to permit application of new coatings shall not be attempted except where paint adhesion tests indicate that existing coatings do not have sufficient adhesion to allow over-coating with an encapsulating coating.

a. Adhesion tests for existing steel coatings shall be performed in accordance with ASTM D 3359 (Method A).

b. Where removal of relatively small areas of existing steel coatings is necessary, SSPC SP11 (Power Tool Cleaning to Bare Metal) or SSPC SP3 (Power Tool Cleaning) should be preferred over blast cleaning.

c. For mass removal of steel coatings, SSPC SP12 (Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultra High-pressure Water Jetting Prior to Recoating) is preferred. Pressure from 3000 to 5000 psi is recommended for limited coating removal. Up to 30,000 psi will be needed for complete removal of coatings and rust.

d. All federal, state and local environmental requirements must be adhered to in the removal and disposal of existing steel coatings. Reference section 3-20 of the A-E Guide for general paint removal requirements.

7.0 MISCELLANEOUS REQUIREMENTS

Recommendations contained in this section that represent construction requirements must be inserted into the construction documents.

7.1 Load Combinations:

a. Load combinations per ASCE-7 shall supercede comparable Load Combinations contained in materials criteria documents, however, other documents may add supplementary Load Combinations in addition to those contained in ASCE 7. Note the alternative load and strength reduction factors in Appendix C of ACI 318-99.

b. When specifically required, strength and stability shall be checked to assure that structures are capable of withstanding the effects of extraordinary (i.e., low probability) events such as fires, explosions and vehicular impact.

7.2 Loads:

a. Live Loads used in the design of buildings and other structures shall be the maximum loads expected by the intended use or occupancy, but shall in no case be less than the minimum loads required by ASCE 7 or Mil-Hdbk 1002/2A.

b. In buildings where the intended use might result in partitions being erected or rearranged, provision for partitions with a minimum weight of 20 psf shall be made, whether or not partitions are shown on the drawings.

c. Any single panel point of the lower chord of exposed trusses or any point along the length of exposed primary structural members over manufacturing, storage, warehousing or maintenance shops shall be designed for a concentrated load of 2000 pounds (8.9 kN) in addition to all other loads. For all other occupancies a concentrated load of 200 pounds (0.89 kN) shall be used.

d. Snow loads that are not covered in ASCE-7 or Mil-Hdbk 1002/2A shall be based on accepted local criteria.

7.3 Miscellaneous:

a. Design values for proprietary materials are to be obtained from ICBO Evaluation Reports.

b. Statements such as “may require, should be considered etc.” contained in referenced criteria documents shall be interpreted as “is required” unless a specific exemption is stated.

7.4 Serviceability: Serviceability limit states are not specifically defined in this Technical Guide. However, the Engineer of Record is responsible for imposing rational design limits to prevent human discomfort and damage to non-structural elements when the structure is subjected to non-seismic loads.

8.0 MINIMUM DESIGN AND CONSTRUCTION REQUIREMENTS

Recommendations contained in this section that represent construction requirements must be inserted into the construction documents. Requirements listed below are minimum. Service conditions may demand that designs exceed these minimum requirements. Design calculations shall include a source for all design forces/stresses used that are not governed by industry standards defined in this document.

8.1 Concrete and Foundations:

a. Concrete construction shall comply with the recommendations contained in ACI 301-99.

b. Concrete slabs on ground shall have a minimum thickness of 4 inches. Minimum reinforcing shall be #3 reinforcing bars at 16" on center each way or 4x4-w2.9xw2.9 welded wire fabric reinforcing. The slab reinforcing shall be placed on firm supports 1/3 the slab depth from the top of slab with a minimum cover of 1-1/2 inches.

c. Fiber reinforcement in the concrete mix shall not be considered as replacing the required steel reinforcing.

d. Concrete slabs on ground shall have construction, control or expansion joints at maximum spacings of 30 feet in each direction. The maximum length of any continuous pour shall be 100 feet between construction or expansion joints. If special circumstances make such spacing impractical, approval for deviations shall be obtained from the Southwest Division senior structural engineer. Slab reinforcing shall continue through construction and control joints.

e. All concrete slabs on ground, other than mats, shall have thickened edges with both width and depth equal to at least three times the slab thickness. Thickened slab edge members shall be reinforced with a minimum of 2-#5 continuous reinforcing bars (one top and one bottom) for each 8 inches of width.

f. Architecturally Exposed Concrete per section 6 of ACI 301, must be clearly designated in the RFP and in the construction drawings.

g. When concrete slab flatness and levelness is evaluated by ASTM E1155 methods, the following values shall be minimum requirements:

Overall – F_F = 35 and F_L = 25
Local – F_F = 24 and F_L = 17

8.2 Concrete Masonry Construction:

a. Walls constructed of concrete masonry units require control or expansion joints at maximum spacings of 30 feet unless evidence is presented that documents the use of greater lengths without detrimental effects. Design calculations for shear walls must be based on the actual wall segment lengths between joints.

b. All concrete masonry construction shall use medium weight units per ASTM C90, types M or S mortar and grout with a minimum compressive strength of at least 500 psi. higher than fm'.

c. All walls constructed of concrete masonry units shall be fully grouted (grout in all cells). The seismic design mass calculations must reflect this condition.

d. Walls must be constructed of single or double open end units. Single or double open end bond beam units must be used in courses in which horizontal reinforcing is placed. Head joints are not permitted – i.e., no two unit closed ends shall abut in a wall.

e. Columns must be constructed of closed column units or pilaster units with joints staggered from course to course. No web sections may occur within columns.

f. Running bond is required for shear walls and wall frames.

g. Horizontal joint reinforcing may be used in conjunction with reinforcing bars to meet minimum reinforcing requirements in lightly loaded walls. Joint reinforcing shall not be used to resist computed stresses.

h. In 8 inch or thinner walls, reinforcing shall be limited to one face of reinforcing in each direction located at the center of the wall thickness.

8.3 Wood Framing:

a. Plywood and oriented strand board are the only structural use panels permitted for horizontal or vertical diaphragms in wood construction. Minimum thickness to be ½ inch. All horizontal diaphragms must be blocked unless tongue and groove joints are used.

b. Connections of wood framing members shall, where possible, be made with mechanical connectors rather than toenails, endnails etc.

c. Wood stud walls shall be anchored to concrete foundations to resist design loads with minimum anchorage as follows:

(1) Exterior wood framed walls and all wood framed shear and bearing walls (interior or exterior) shall be anchored to concrete foundations with ½" round embedded anchor bolts (w/ 4" embedment) spaced 30 inches on center.

(2) Interior non-bearing, non-shear wall partitions may be anchored with 3/8" round embedded anchor bolts (w/ 3" embedment) or with 3/8" round expansion anchors (w/ 4" embedment) spaced a maximum of 48" on center. As an alternate, 0.145 inch diameter powder actuated fasteners may be used at a maximum spacing of 24" on center.

d. Trusses and glued-laminated members shall be designed and constructed using machine-graded (MSR) or machine evaluated lumber (MEL).

e. The maximum moisture content of kiln dried lumber at the time of delivery to the site shall not exceed the following values:

Dimension Lumber – 19 percent

Timbers – 25 percent

Other lumber products – The moisture content shall be in accordance with the standard under which the product is produced.

8.4 Cold Formed Steel framing:

a. Cold formed steel members with stud and joist type configurations shall be designated by the Steel Stud Manufacturers Association (SSMA) four-part product identification code.

Information on this product identification code may be found in the SSMA publication "Product Technical Information – ICBO ER-4943P".

b. Welding of light gage cold formed material is permitted for 16 gage and greater thicknesses. Designs for cold formed steel connections shall be based upon well established allowable force values for welds and mechanical fasteners.

c. Light gage steel stud wall systems shall be anchored to concrete foundations to resist design loads with minimum anchorage as follows:

(1) Exterior walls and all walls designed as shear walls to have ½" round embedded anchor bolts (with 4" embedment) spaced a maximum of 30" on center.

(2) Interior bearing walls to have ½" round embedded anchor bolts (with 4" embedment) spaced a maximum of 30" on center.

(3) Interior non-bearing, non-shearwall partitions to have 3/8" round embedded anchor bolts (with 3" embedment) or 3/8" round expansion anchors (with 4" embedment) spaced a maximum of 48" on center. As an alternate, 0.145 inch diameter powder actuated fasteners may be used at a maximum spacing of 24" on center.

8.5 Steel Framing:

a. Project documents shall call for one class of structural steel bolt throughout the entire project. For example, ASTM A307 or ASTM A325 for all connections. The locations of slip critical (friction) bolts must be clearly defined. Anchor bolts and other threaded material may differ from the standard bolts used for bolted connections.

b. Current preferred material selections are as follows:

ASTM A992 for W shapes.

ASTM A36 for M, S, HP, C, MC and L sections.

ASTM A53 for steel pipe.

ASTM A500 for HSS sections.

ASTM A36 for plates and bars.

These materials shall be used to the maximum extent possible.

c. Architecturally Exposed Structural Steel (AESS), per section 10 of the "AISC Code of Standard Practice", must be designated in the RFP and in the construction drawings.

8.6 Steel Roof Deck: Steel deck diaphragms must be welded along panel edges with side seam welds or top seam welds. Button punched seams are not permitted.

9.0 DESIGN OF CRANES AND CRANE SUPPORT SYSTEMS

Crane live loads shall be the rated capacity of the crane. Design loads for the runway beams, including connections and support brackets, of moving bridge cranes and monorails shall include the maximum wheel loads and the vertical, lateral and longitudinal impact forces induced by the moving crane or monorail. For cranes and hoists with rated loads in excess of 10 tons, the Navy

Crane Center (NCC) shall be contacted for assistance in coordinating the design and purchase of the crane.

9.1 Crane Design: The design, construction and installation of cranes and monorails is normally contracted for on a design-build basis, regardless of the type procurement used for the major construction contract. NAVFAC specifications (sections 14534, 14535, 14606, 14622, 14636 or 14637) provide instruction for design of cranes and monorails. Mil-Hdbk 1038 (Weight Handling Equipment) provides design criteria for cranes.

9.2 Crane Certification: The Navy requires annual inspections and certification of cranes based on the requirements of NAVFAC P-307 (Management of Weight Handling Equipment) as part of their safety certification program. The P-307 requirements include static and dynamic load tests and generally exceed similar commercial certification requirements. The Navy certification test requirements are contained in the crane specification sections mentioned in Paragraph 9.1 above. In order to assure start-up certification for the first year of operation for new cranes and monorails, the contractor shall be required to provide load tests and one year of certification by OSHA. The contractor is required to provide all weights needed to conduct the OSHA load tests.

9.3 Design of Crane and Monorail Support Systems: The structural engineer of record is responsible for the design of all crane and monorail supporting members except proprietary track beam for under-running cranes and monorails. Proprietary track beams shall be designed by the crane supplier.

a. Load impact factors for vertical load, side thrust and traction may be taken from ASCE-7, in which case member design shall comply with the “AISC – LRFD Specification.” The following load factors shall be used:

   Bridge weight – 1.2

   Weight of trolley and lifted load – 1.6

   Limiting vertical deflections due to working stress loads shall be:

   L/600 for Class A, B, C, D cranes (CMAA classification)

   L/1000 for Class E, F cranes

   Lateral deflections due to working stress loads shall be limited to L/400 for all crane classes.

b. Alternately, load impact factors may be taken from the AISE “Guide for the Design and Construction of Mill Buildings – Technical Report No. 13, June 1997 edition” in which case member design shall comply with the AISE document.
c. Bridge crane rails may not be supported directly by building frame members. Interconnection between the crane support system and the building frame is permitted.

d. The CMAA crane classification (A through F) shall be given in the RFP and in the construction documents.

e. All crane support systems shall be grounded.

f. Design of crane and monorail support systems shall include an investigation of lateral seismic forces and deformations in accord with the requirements of TI 809-04.

10.0 ANTITERRORISM / FORCE PROTECTION REQUIREMENTS

Antiterrorism / Force Protection (AT/FP) Guidelines and Progressive Collapse Design Requirements are contained in the AT/FP portion of this Technical Guide. When hardening of buildings to resist terrorist blast attack is required by the AT/FP Guidelines, the design basis criteria shall be provided by Southwest Division. This design basis criteria may be a “Scaled Distance”, a combination of charge weight and separation distance or incident and reflected pressures. No specific design codes or computation programs are specified for the blast analysis and design. It is required that the firm retained to perform the design, as well as the individual designer, present to Southwest Division evidence of having previously completed blast designs for a minimum of five structures that have been constructed, or are currently under construction. The blast design construction requirements shall be included in the project construction documents as either a separate entity with it’s own engineer of record, or shall be incorporated into the documents produced by the project structural engineer of record. All drawings must contain the seal of either the blast design engineer or the project structural engineer of record.

11.0 HOW TO OBTAIN DOCUMENTS

a. **FEMA:** FEMA documents may be ordered from FEMA by telephoning (800) 480-2520 or (301) 497-1873.

b. **Army Corps of Engineers**: Many documents may be downloaded from the Corps of Engineers web page. http://www.usace.army.mil/inet/usace-docs/. For TI XXX-XX publications, go to engineer instructions (TECHINFO series).

c. **NAVFAC:** Many MilHdbks may be downloaded from the LantDiv web page. http://navfacilitator.navfac.navy.mil/docs/

d.

e. **Department of Defense Specifications and Standards:** Many military publications can be obtained by writing DODSSP - Building 4, Section D - 700 Robbins Ave. - Philadelphia, PA 19111-5094. Telephone (215) 697-2179.

f. **Southwest Division:** Hard copies of many of the above documents may be obtained at Southwest Division headquarters – 921 West Broadway – San Diego at (619) 532-1649 or by E-Mail at SWDIV to check availability.

END OF SECTION