3.7 Structural Checklists

This section provides Basic and Supplemental Structural Checklists for the following building types:

W1:	Wood Light Frames
W1A:	Multi-Story, Multi-Unit Residential Wood Frames
W2:	Wood Frames, Commercial and Industrial
S1:	Steel Moment Frames with Stiff Diaphragms
S1A:	Steel Moment Frames with Flexible Diaphragms
S2:	Steel Braced Frames with Stiff Diaphragms
S2A:	Steel Braced Frames with Flexible Diaphragms
S3:	Steel Light Frames
S4:	Steel Frames with Concrete Shear Walls
S5:	Steel Frames with Infill Masonry Shear Walls and Stiff Diaphragms
S5A:	Steel Frames with Infill Masonry Shear Walls and Flexible Diaphragms
C1:	Concrete Moment Frames
C2:	Concrete Shear Wall Buildings with Stiff Diaphragms
C2A:	Concrete Shear Wall Buildings with Flexible Diaphragms
C3:	Concrete Frames with Infill Masonry Shear Walls and Stiff Diaphragms
C3A:	Concrete Frames with Infill Masonry Shear Walls and Flexible Diaphragms
PC1:	Precast/Tilt-up Concrete Shear Wall Buildings with Flexible Diaphragms
PC1A:	Precast/Tilt-up Concrete Shear Wall Buildings with Stiff Diaphragms
PC2:	Precast Concrete Frames with Shear Walls
PC2A:	Precast Concrete Frames without Shear Walls
RM1:	Reinforced Masonry Bearing Wall Buildings with Flexible Diaphragms
RM2:	Reinforced Masonry Bearing Wall Buildings with Stiff Diaphragms
URMA:	Unreinforced Masonry Bearing Wall Buildings with Stiff Diaphragms

General Basic Structural Checklist
General Supplemental Structural Checklist

For a description of the specific building types listed above, refer to Table 2-2.

The appropriate Basic Structural Checklist shall be completed when required by Table 3-2.

The appropriate Supplemental Structural Checklist shall be completed when required by Table 3-2. The appropriate Basic Structural Checklist shall be completed prior to completing the appropriate Supplemental Structural Checklist.

3.7.1 Basic Structural Checklist for Building Type W1: Wood Light Frames

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings are single or multiple family dwellings of one or more stories in height. Building loads are light and the framing spans are short. Floor and roof framing consists of closely spaced wood joists or rafters on wood studs. The first floor framing is supported directly on the foundation, or is raised up on cripple studs and post and beam supports. The foundation consists of spread footings constructed of concrete, concrete masonry block, or brick masonry in older construction. Chimneys, when present, consist of solid brick masonry, masonry veneer, or wood frame with internal metal flues. Lateral forces are resisted by wood frame diaphragms and shear walls. Floor and roof diaphragms consist of straight or diagonal wood sheathing, tongue and groove planks, or plywood. Shear walls consist of straight or diagonal wood sheathing, plank siding, plywood, stucco, gypsum board, particle board, or fiberboard. Interior partitions are sheathed with plaster or gypsum board.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C **NC** **N/A** OVERDRIVEN FASTENERS: There shall be no evidence of overdriven fasteners in the shear walls. (Tier 2: Sec. 4.3.3.2)

Lateral Force Resisting System

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1):

Structural panel sheathing:	1000 plf
Diagonal sheathing:	700 plf
Straight sheathing:	80 plf
All other conditions:	100 plf

C **NC** **N/A** STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)

C **NC** **N/A** GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height. (Tier 2: Sec. 4.4.2.7.3)

C **NC** **N/A** NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2 to 1 for Life Safety and 1.5 to 1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building. (Tier 2: Sec. 4.4.2.7.4)

C **NC** **N/A** WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)

C **NC** **N/A** HILLSIDE SITE: For a sloping site greater than one-half story, all shear walls on the downhill slope shall have an aspect ratio less than 1 to 1 for Life-Safety and 1 to 2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)

C **NC** **N/A** CRIPPLE WALLS: All cripple walls below first floor level shear walls shall be braced to the foundation with shear elements. (Tier 2: Sec. 4.4.2.7.7)

Connections

C **NC** **N/A** WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)

C **NC** **N/A** WOOD SILLS: All wood sill s shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)

C **NC** **N/A** GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.1S Supplemental Structural Checklist For Building Type W1: Wood Light Frames

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A OPENINGS: Walls with garage doors or other large openings shall be braced with plywood shear walls or shall be supported by adjacent construction through substantial positive ties. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.8)

C NC N/A HOLD-DOWN ANCHORS: All walls shall have properly constructed hold-down anchors. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.9)

Diaphragms

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C NC N/A SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC N/A UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C NC N/A WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft. or less for Life Safety and 4 ft. or less for Immediate Occupancy, with proper edge distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)

This Page Intentionally
Left Blank

3.7.1A Basic Structural Checklist For Building Type W1A: Multi-Story, Multi-Unit Residential Wood Frames

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings are single or multiple family dwellings of one or more stories in height with open front garages at the first story. Building loads are light and the framing spans are short. Floor and roof framing consists of closely spaced wood joists or rafters on wood studs. The first story consists of wood floor framing on wood stud walls and steel pipe columns, or a concrete slab on concrete or concrete masonry block walls. The foundation consists of spread footings constructed of concrete, concrete masonry block, or brick masonry in older construction. Chimneys, when present, consist of solid brick masonry, masonry veneer, or wood frame with internal metal flues. Lateral forces are resisted by wood frame diaphragms and shear walls. Floor and roof diaphragms consist of straight or diagonal wood sheathing, tongue and groove planks, or plywood. Shear walls consist of straight or diagonal wood sheathing, plank siding, plywood, stucco, gypsum board, particle board, or fiberboard. Interior partitions are sheathed with plaster or gypsum board.

Building System

C	**NC**	**N/A**	LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)
C	**NC**	**N/A**	WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)
C	**NC**	**N/A**	SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)
C	**NC**	**N/A**	VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)
C	**NC**	**N/A**	DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C **NC** **N/A** OVERDRIVEN FASTENERS: There shall be no evidence of overdriven fasteners in the shear walls. (Tier 2: Sec. 4.3.3.2)

Lateral Force Resisting System

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1):

Structural panel sheathing:	1000 plf
Diagonal sheathing:	700 plf
Straight sheathing:	80 plf
All other conditions:	100 plf

C **NC** **N/A** STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)

C **NC** **N/A** GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height. (Tier 2: Sec. 4.4.2.7.3)

C **NC** **N/A** NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2 to 1 for Life Safety and 1.5 to 1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building. (Tier 2: Sec. 4.4.2.7.4)

C **NC** **N/A** WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)

C **NC** **N/A** HILLSIDE SITE: For a sloping site greater than one-half story, all shear walls on the downhill slope shall have an aspect ratio less than 1 to 1 for Life-Safety and 1 to 2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)

C **NC** **N/A** CRIPPLE WALLS: All cripple walls below first floor level shear walls shall be braced to the foundation with shear elements. (Tier 2: Sec. 4.4.2.7.7)

Connections

C **NC** **N/A** WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)

C **NC** **N/A** WOOD SILLS: All wood sill s shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)

C **NC** **N/A** GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.1AS Supplemental Structural Checklist For Building Type W1A: Multi-Story, Multi-Unit Residential Wood Frames

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A OPENINGS: Walls with garage doors or other large openings shall be braced with plywood shear walls or shall be supported by adjacent construction through substantial positive ties. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.8)

C NC N/A HOLD-DOWN ANCHORS: All walls shall have properly constructed hold-down anchors. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.9)

Diaphragms

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C NC N/A SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC N/A UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C NC N/A WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft. or less for Life Safety and 4 ft. or less for Immediate Occupancy, with proper edge distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)

This Page Intentionally
Left Blank

3.7.2 Basic Structural Checklist For Building Type W2: Wood Frames, Commercial And Industrial

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings are commercial or industrial buildings with a floor area of 5,000 square feet or more. Building loads are heavier than light frame construction, and framing spans are long. There are few, if any, interior walls. The floor and roof framing consists of wood or steel trusses, glulam or steel beams, and wood posts or steel columns. Lateral forces are resisted by wood diaphragms and exterior stud walls sheathed with plywood, stucco, plaster, straight or diagonal wood sheathing, or braced with rod bracing. Large openings for storefronts and garages, when present, are framed by post-and-beam framing. Lateral force resistance around openings is provided by steel rigid frames or diagonal bracing.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C **NC** **N/A** DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C **NC** **N/A** OVERDRIVEN FASTENERS: There shall be no evidence of overdriven fasteners in the shear walls (Tier 2: Sec. 4.3.3.2)

Lateral Force Resisting System

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1):

Structural panel sheathing:	1000 plf
Diagonal sheathing:	700 plf
Straight sheathing:	80 plf
All other conditions:	100 plf

C **NC** **N/A** STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)

C **NC** **N/A** GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height. (Tier 2: Sec. 4.4.2.7.3)

C **NC** **N/A** NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2 to 1 for Life Safety and 1.5 to 1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building. (Tier 2: Sec. 4.4.2.7.4)

C **NC** **N/A** WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)

C **NC** **N/A** HILLSIDE SITE: For a sloping site greater than one-half story, all shear walls on the downhill slope shall have an aspect ratio less than 1 to 1 for Life-Safety and 1 to 2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)

C **NC** **N/A** CRIPPLE WALLS: All cripple walls below first floor level shear walls shall be braced to the foundation with shear elements. (Tier 2: Sec. 4.4.2.7.7)

Connections

C **NC** **N/A** WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)

C **NC** **N/A** WOOD SILLS: All wood sill s shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)

C **NC** **N/A** GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.2S Supplemental Structural Checklist For Building Type W2: Wood Frames, CommercialAnd Industrial

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A OPENINGS: Walls with garage doors or other large openings shall be braced with plywood shear walls or shall be supported by adjacent construction through substantial positive ties. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.8)

C NC N/A HOLD-DOWN ANCHORS: All walls shall have properly constructed hold-down anchors. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.9)

Diaphragms

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C NC N/A SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC N/A UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C NC N/A WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft. or less for Life Safety and 4 ft. or less for Immediate Occupancy, with proper edge distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)

This Page Intentionally
Left Blank

3.7.3 Basic Structural Checklist For Building Type S1: Steel Moment Frames With Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of steel beams and steel columns. Floor and roof framing consists of cast-in-place concrete slabs or metal deck with concrete fill supported on steel beams, open web joists or steel trusses. Lateral forces are resisted by steel moment frames that develop their stiffness through rigid or semi-rigid beam-column connections. When all connections are moment resisting connections the entire frame participates in lateral force resistance. When only selected connections are moment resisting connections, resistance is provided along discrete frame lines. Columns are oriented so that each principal direction of the building has columns resisting forces in strong axis bending. Diaphragms consist of concrete or metal deck with concrete fill and are stiff relative to the frames. When the exterior of the structure is concealed, walls consist of metal panel curtain walls, glazing, brick masonry, or precast concrete panels. When the interior of the structure is finished, frames are concealed by ceilings, partition walls and architectural column furring. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC N/A SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC N/A GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of moment frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of bays of moment frames in each line shall be greater than or equal to 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.1.1)

C NC N/A INTERFERING WALLS: All infill walls placed in moment frames shall be isolated from structural elements. (Tier 2: Sec. 4.4.1.2.1)

C NC N/A DRIFT CHECK: The drift ratio of the steel moment frames, calculated using the Quick Check procedure of Section 3.5.3.1, shall be less than 0.025 for Life Safety and 0.015 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.1)

C NC N/A AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10F_y$ for Life Safety and Immediate Occupancy. Alternatively, the axial stress due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30F_y$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.2)

Connections

C NC N/A TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety and the connections shall be able to develop the shear strength of the frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)

C **NC** **N/A** STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

3.7.3S Supplemental Structural Checklist For Building Type S1: Steel Moment Frames With StiffDiaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C **NC** **N/A** MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. (Tier 2: Sec. 4.4.1.3.3)

C **NC** **N/A** PANEL ZONES: All panel zones shall have the shear capacity to resist the shear demand required to develop $0.8\Sigma M_p$ of the girders framing in at the face of the column. (Tier 2: Sec. 4.4.1.3.4)

C **NC** **N/A** COLUMN SPLICES: All column splice details located in moment resisting frames shall include connection of both flanges and the web for Life Safety and the splice shall develop the strength of the column for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.5)

C **NC** **N/A** STRONG COLUMN/WEAK BEAM: The percent of strong column/weak beam joints in each story of each line of moment resisting frames shall be greater than 50% for Life Safety and 75% for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.6)

C **NC** **N/A** COMPACT MEMBERS: All moment frame elements shall meet compact section requirements set forth by the *Load and Resistance Factor Design Specification for Structural Steel Buildings* (AISC, 1993). This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.7)

C **NC** **N/A** BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.8)

C **NC** **N/A** GIRDER FLANGE CONTINUITY PLATES: There shall be girder flange continuity plates at all moment-resisting frame joints. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.9)

C **NC** **N/A** OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.10)

C **NC** **N/A** BOTTOM FLANGE BRACING: The bottom flange of beams shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.11)

Diaphragms

C **NC** **N/A** PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.3A Basic Structural Checklist For Building Type S1A: Steel Moment Frames With Flexible Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of steel beams and steel columns. Floor and roof framing consists of wood framing or untopped metal deck supported on steel beams, open web joists or steel trusses. Lateral forces are resisted by steel moment frames that develop their stiffness through rigid or semi-rigid beam-column connections. When all connections are moment resisting connections the entire frame participates in lateral force resistance. When only selected connections are moment resisting connections, resistance is provided along discrete frame lines. Columns are oriented so that each principal direction of the building has columns resisting forces in strong axis bending. Diaphragms consist of wood sheathing or untopped metal deck, and are flexible relative to the frames. When the exterior of the structure is concealed, walls consist of metal panel curtain walls, glazing, brick masonry, or precast concrete panels. When the interior of the structure is finished, frames are concealed by ceilings, partition walls and architectural column furring. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC N/A GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of moment frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of bays of moment frames in each line shall be greater than or equal to 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.1.1)

C NC N/A INTERFERING WALLS: All infill walls placed in moment frames shall be isolated from structural elements. (Tier 2: Sec. 4.4.1.2.1)

C NC N/A DRIFT CHECK: The drift ratio of the steel moment frames, calculated using the Quick Check procedure of Section 3.5.3.1, shall be less than 0.025 for Life Safety and 0.015 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.1)

C NC N/A AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10F_y$ for Life Safety and Immediate Occupancy. Alternatively, the axial stresses due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30F_y$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.2)

Connections

C NC N/A TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety and the connections shall be able to develop the shear strength of the frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)

C NC N/A STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

3.7.3AS Supplemental Structural Checklist For Building Type S1A: Steel Moment Frames With Flexible Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C **NC** **N/A** MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. (Tier 2: Sec. 4.4.1.3.3)

C **NC** **N/A** PANEL ZONES: All panel zones shall have the shear capacity to resist the shear demand required to develop $0.8\Sigma M_p$ of the girders framing in at the face of the column. (Tier 2: Sec. 4.4.1.3.4)

C **NC** **N/A** COLUMN SPLICES: All column splice details located in moment resisting frames shall include connection of both flanges and the web for Life Safety and the splice shall develop the strength of the column for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.5)

C **NC** **N/A** STRONG COLUMN/WEAK BEAM: The percent of strong column/weak beam joints in each story of each line of moment resisting frames shall be greater than 50% for Life Safety and 75% for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.6)

C **NC** **N/A** COMPACT MEMBERS: All moment frame elements shall meet compact section requirements set forth by the *Load and Resistance Factor Design Specification for Structural Steel Buildings* (AISC, 1993). This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.7)

C **NC** **N/A** BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.8)

C **NC** **N/A** GIRDER FLANGE CONTINUITY PLATES: There shall be girder flange continuity plates at all moment-resisting frame joints. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.9)

C **NC** **N/A** OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.10)

C **NC** **N/A** BOTTOM FLANGE BRACING: The bottom flange of beams shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.11)

Diaphragms

C **NC** **N/A** CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C **NC** **N/A** PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C NC N/A SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC N/A UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC N/A NON-CONCRETE DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft. and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

C NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.4 Basic Structural Checklist For Building Type S2: Steel Braced Frames With Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of steel beams and steel columns. Floor and roof framing consists of cast-in-place concrete slabs or metal deck with concrete fill supported on steel beams, open web joists or steel trusses. Lateral forces are resisted by tension and compression forces in diagonal steel members. When diagonal brace connections are concentric to beam column joints, all member stresses are primarily axial. When diagonal brace connections are eccentric to the joints, members are subjected to bending and axial stresses. Diaphragms consist of concrete or metal deck with concrete fill and are stiff relative to the frames. When the exterior of the structure is concealed, walls consist of metal panel curtain walls, glazing, brick masonry, or precast concrete panels. When the interior of the structure is finished, frames are concealed by ceilings, partition walls and architectural furring. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C **NC** **N/A** TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C **NC** **N/A** DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

C **NC** **N/A** DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

Lateral Force Resisting System

C **NC** **N/A** AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10F_y$ for Life Safety and Immediate Occupancy. Alternatively, the axial stress due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30F_y$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.2)

C **NC** **N/A** REDUNDANCY: The number of lines of braced frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of braced bays in each line shall be greater than 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.1)

C **NC** **N/A** AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 3.5.3.4, shall be less than 18 ksi or $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)

C **NC** **N/A** COLUMN SPLICES: All column splice details located in braced frames shall develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.5)

Connections

C **NC** **N/A** TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety and the connections shall be able to develop the shear strength of the frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)

C **NC** **N/A** STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

3.7.4S Supplemental Structural Checklist For Building Type S2: Steel Braced Frames With Stiff Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C **NC** **N/A** MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. (Tier 2: Sec. 4.4.1.3.3)

C **NC** **N/A** COMPACT MEMBERS: All moment frame elements shall meet compact section requirements set forth by the *Load and Resistance Factor Design Specification for Structural Steel Buildings* (AISC, 1993). This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.7)

C **NC** **N/A** STIFFNESS OF DIAGONALS: All diagonal elements required to carry compression shall have Kl/r ratios less than 120. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.3)

C **NC** **N/A** CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.4)

C **NC** **N/A** OUT-OF-PLANE BRACING: Braced frame connections attached to beam bottom flanges located away from beam-column joints shall be braced out-of-plane at the bottom flange of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.6)

C **NC** **N/A** K-BRACING: The bracing system shall not include K-braced bays. (Tier 2: Sec. 4.4.3.2.1)

C **NC** **N/A** TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70% of the total lateral-force-resisting capacity in structures over two stories in height. (Tier 2: Sec. 4.4.3.2.2)

C **NC** **N/A** CHEVRON BRACING: The bracing system shall not include chevron, or V-braced bays. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.3)

C **NC** **N/A** CONCENTRIC JOINTS: All the diagonal braces shall frame into the beam-column joints concentrically. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.4)

Diaphragms

C **NC** **N/A** OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25% of the frame length for Life Safety and 15% of the frame length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.5)

C **NC** **N/A** PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.4A Basic Structural Checklist For Building Type S2A: Steel Braced Frames With Flexible Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of steel beams and steel columns. Floor and roof framing consists of wood framing or untopped metal deck supported on steel beams, open web joists or steel trusses. Lateral forces are resisted by tension and compression forces in diagonal steel members. When diagonal brace connections are concentric to beam column joints, all member stresses are primarily axial. When diagonal brace connections are eccentric to the joints, members are subjected to bending and axial stresses. Diaphragms consist of wood sheathing or untopped metal deck and are flexible relative to the frames. When the exterior of the structure is concealed, walls consist of metal panel curtain walls, glazing, brick masonry, or precast concrete panels. When the interior of the structure is finished, frames are concealed by ceilings, partition walls and architectural furring. Foundations consist of concrete spread

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC N/A GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

Lateral Force Resisting System

C NC N/A AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10F_y$ for Life Safety and Immediate Occupancy. Alternatively, the axial stress due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30F_y$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.2)

C NC N/A REDUNDANCY: The number of lines of braced frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of braced bays in each line shall be greater than 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.1)

C NC N/A AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 3.5.3.4, shall be less than 18 ksi or $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)

C NC N/A COLUMN SPLICES: All column splice details located in braced frames shall develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.5)

Connections

C NC N/A TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety and the connections shall be able to develop the shear strength of the frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)

C NC N/A STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

3.7.4AS Supplemental Structural Checklist For Building Type S2A: Steel Braced Frames With Flexible Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C **NC** **N/A** MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. (Tier 2: Sec. 4.4.1.3.3)

C **NC** **N/A** COMPACT MEMBERS: All moment frame elements shall meet compact section requirements set forth by the *Load and Resistance Factor Design Specification for Structural Steel Buildings* (AISC, 1993). This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.7)

C **NC** **N/A** STIFFNESS OF DIAGONALS: All diagonal elements required to carry compression shall have Kl/r ratios less than 120. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.3)

C **NC** **N/A** CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.4)

C **NC** **N/A** OUT-OF-PLANE BRACING: Braced frame connections attached to beam bottom flanges located away from beam-column joints shall be braced out-of-plane at the bottom flange of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.6)

C **NC** **N/A** K-BRACING: The bracing system shall not include K-braced bays. (Tier 2: Sec. 4.4.3.2.1)

C **NC** **N/A** TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70% of the total lateral-force-resisting capacity in structures over two stories in height. (Tier 2: Sec. 4.4.3.2.2)

C **NC** **N/A** CHEVRON BRACING: The bracing system shall not include chevron, or V-braced bays. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.3)

C **NC** **N/A** CONCENTRIC JOINTS: All the diagonal braces shall frame into the beam-column joints concentrically. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.4)

Diaphragms

C **NC** **N/A** CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C **NC** **N/A** OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25% of the frame length for Life Safety and 15% of the frame length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.5)

C **NC** **N/A** PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C **NC** **N/A** STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C **NC** **N/A** SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C **NC** **N/A** UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C **NC** **N/A** NON-CONCRETE DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft. and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

Connections

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.5 Basic Structural Checklist For Building Type S3: Steel Light Frames

This Basic Structural Checklist shall be completed when required by Table 3-2. This Basic Structural Checklist shall not be used for a structure with a roof dead load greater than 25 psf or a building area greater than 20,000 ft. When either limit is exceeded, a Steel Moment Frame Basic Structural Checklist (Type S1 or S1A) shall be used.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings are pre-engineered and prefabricated with transverse rigid steel frames. They are one-story in height. The roof and walls consist of lightweight metal, fiberglass or cementitious panels. The frames are designed for maximum efficiency and the beams and columns consist of tapered, built-up sections with thin plates. The frames are built in segments and assembled in the field with bolted or welded joints. Lateral forces in the transverse direction are resisted by the rigid frames. Lateral forces in the longitudinal direction are resisted by wall panel shear elements or rod bracing. Diaphragm forces are resisted by untopped metal deck, roof panel shear elements, or a system of tension-only rod bracing.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C **NC** **N/A** DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

Lateral Force Resisting System

C **NC** **N/A** AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 3.5.3.4, shall be less than 18 ksi or $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)

Connections

C **NC** **N/A** TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety and the connections shall be able to develop the shear strength of the frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)

C **NC** **N/A** STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

C **NC** **N/A** WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and the attachment shall be able to develop the shear capacity of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.3.8)

C **NC** **N/A** ROOF PANELS: Metal, plastic, or cementitious roof panels shall be positively attached to the roof framing to resist seismic forces for Life Safety and the attachment shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.5.1)

C **NC** **N/A** WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the framing to resist seismic forces or Life Safety and the attachment shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.5.2)

3.7.5S Supplemental Structural Checklist For Building Type S3: Steel Light Frames

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist. This Supplemental Structural Checklist shall not be used for a structure with a roof dead load greater than 25 psf or a building area greater than 20,000 ft. When either limit is exceeded, a Steel Moment Frame Supplemental Structural Checklist (Type S1 or S1A) shall be used.

Lateral Force Resisting System

C NC N/A MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. (Tier 2: Sec. 4.4.1.3.3)

C NC N/A BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.8)

C NC N/A COMPACT MEMBERS: All moment frame elements shall meet compact section requirements set forth by the *Load and Resistance Factor Design Specification for Structural Steel Buildings* (AISC, 1993). This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.7)

C NC N/A OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.10)

C NC N/A BOTTOM FLANGE BRACING: The bottom flange of beams shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.11)

Diaphragms

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

This Page Intentionally
Left Blank

3.7.6 Basic Structural Checklist For Building Type S4: Steel Frames With Concrete Shear Walls

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of steel beams and steel columns. The floors and roof consist of cast-in-place concrete slabs or metal deck with or without concrete fill. Framing consists of steel beams, open web joists or steel trusses. Lateral forces are resisted by cast-in-place concrete shear walls. These walls are bearing walls when the steel frame does not provide a complete vertical support system. In older construction the steel frame is designed for vertical loads only. In modern dual systems, the steel moment frames are designed to work together with the concrete shear walls in proportion to their relative rigidity. In the case of a dual system, the walls shall be evaluated under this building type and the frames shall be evaluated under S1 or S1A, Steel Moment Frames. Diaphragms consist of concrete or metal deck with or without concrete fill. The steel frame may provide a secondary lateral-force-resisting system depending on the stiffness of the frame and the moment capacity of the beam-column connections.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C **NC** **N/A** TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C **NC** **N/A** DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

C **NC** **N/A** DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C **NC** **N/A** CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

Lateral Force Resisting System

C **NC** **N/A** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system. (Tier 2: Sec. 4.4.1.6.1)

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)

C **NC** **N/A** REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

C **NC** **N/A** COLUMN SPLICES: Steel columns encased in shear wall boundary elements shall have splices that develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.9)

Connections

C **NC** **N/A** TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C **NC** **N/A** WALL REINFORCING: Walls shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

C **NC** **N/A** SHEAR-WALL-BOUNDARY COLUMNS: The shear wall boundary columns shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the column for Immediate Occupancy. (Tier 2: Sec. 4.6.3.6)

3.7.6S Supplemental Structural Checklist For Building Type S4: Steel Frames With Concrete Shear Walls

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A COUPLING BEAMS: The stirrups in all coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the core with hooks of 135° or more for Life Safety and Immediate Occupancy. In addition, the beams shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC N/A OVERTURNING: All shear walls shall have aspect ratios less than 4 to 1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)

C NC N/A CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2.0, the boundary elements shall be confined with spirals or ties with spacing less than 8 d_b. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)

C NC N/A REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

C NC N/A WALL CONNECTIONS: There shall be a positive connection between the shear walls and the steel beams and columns for Life Safety and the connection shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.8)

Diaphragms

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

This Page Intentionally
Left Blank

3.7.7 Basic Structural Checklist For Building Type S5: Steel Frames With Infill Masonry Shear Walls And Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the user may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

This is an older type of building construction that consists of a frame assembly of steel beams and steel columns. The floors and roof consist of cast-in-place concrete slabs or metal deck with concrete fill. Framing consists of steel beams, open web joists or steel trusses. Walls consist of infill panels constructed of solid clay brick, concrete block, or hollow clay tile masonry. Infill walls may completely encase the frame members, and present a smooth masonry exterior with no indication of the frame. The seismic performance of this type of construction depends on the interaction between the frame and infill panels. The combined behavior is more like a shear wall structure than a frame structure Solidly infilled masonry panels form diagonal compression struts between the intersections of the frame members. If the walls are offset from the frame and do not fully engage the frame members, the diagonal compression struts will not develop. The strength of the infill panel is limited by the shear capacity of the masonry bed joint or the compression capacity of the strut. The post-cracking strength is determined by an analysis of a moment frame that is partially restrained by the cracked infill. The diaphragms consist of concrete floors and are stiff relative to the walls.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C **NC** **N/A** TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C **NC** **N/A** DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

C **NC** **N/A** DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C **NC** **N/A** MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C **NC** **N/A** MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec.4.3.3.8)

C **NC** **N/A** CRACKS IN INFILL WALLS:There shall be no existing diagonal cracks in infill walls that extend throughout a panel , are greater than 1/8" for Life Safetyand 1/16" for Immediate Occupancy, or have out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy. (Tier 2: Sec. 4.3.3.12)

Lateral Force Resisting System

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3,shall be less than 50 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls,calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 15 psi for clay units and 30 psi for concrete units for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.1)

C **NC** **N/A** WALL CONNECTIONS: All infill walls shall have a positive connection to the frame to resist out-of-plane forces for Life Safety and the connection shall be able to develop the out-of-plane strength of the wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.6.1)

Connections

C **NC** **N/A** TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C **NC** **N/A** STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

3.7.7S Supplemental Structural Checklist For Building Type S5: Steel Frames With Infill Masonry Shear Walls And Stiff Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)

C NC N/A PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)

C NC N/A SOLID WALLS: The infill walls shall not be of cavity construction. (Tier 2: Sec. 4.4.2.6.3)

Diaphragms

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A ANCHOR SPACING: Exterior masonry walls shall be anchored to the floor and roof systems at a spacing of 4 ft. or less for Life Safety and 3 ft. or less for Immediate Occupancy. (Tier 2: Sec. 4.6.1.3)

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

This Page Intentionally
Left Blank

3.7.7A Basic Structural Checklist For Building Type S5A: Steel Frames With Infill Masonry Shear Walls And Flexible Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

This is an older type of building construction that consists of a frame assembly of steel beams and steel columns. The floors and roof consist of untopped metal deck or wood framing between the steel beams and are flexible relative to the walls. Framing consists of steel beams, open web joists or steel trusses. Walls consist of infill panels constructed of solid clay brick, concrete block, or hollow clay tile masonry. Infill walls may completely encase the frame members, and present a smooth masonry exterior with no indication of the frame. The seismic performance of this type of construction depends on the interaction between the frame and infill panels. The combined behavior is more like a shear wall structure than a frame structure Solidly infilled masonry panels form diagonal compression struts between the intersections of the frame members. If the walls are offset from the frame and do not fully engage the frame members, the diagonal compression struts will not develop. The strength of the infill panel is limited by the shear capacity of the masonry bed joint or the compression capacity of the strut. The post-cracking strength is determined by an analysis of a moment frame that is partially restrained by the

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC N/A SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC N/A GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

C NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C NC N/A CRACKS IN INFILL WALLS: There shall be no existing diagonal cracks in infill walls that extend throughout a panel, are greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy, or have out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy. (Tier 2: Sec. 4.3.3.12)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 50 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 15 psi for clay units and 30 psi for concrete units for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.1)

C NC N/A WALL CONNECTIONS: All infill walls shall have a positive connection to the frame to resist out-of-plane forces for Life Safety and the connection shall be able to develop the out-of-plane strength of the wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.6.1)

Connections

C **NC** **N/A** TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C **NC** **N/A** STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

3.7.7AS Supplemental Structural Checklist For Building Type S5A: Steel Frames With Infill Masonry Shear Walls And Flexible Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)

C NC N/A PROPORTIONS: The height-to-thickness ratio of the infill walls at each story shall be less than 9 for Life Safety in regions of high seismicity, 13 for Immediate Occupancy in regions of moderate seismicity, and 8 for Immediate Occupancy in regions of high seismicity. (Tier 2: Sec. 4.4.2.6.2)

C NC N/A SOLID WALLS: The infill walls shall not be of cavity construction. (Tier 2: Sec. 4.4.2.6.3)

Diaphragms

C NC N/A CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C NC N/A SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC N/A UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC N/A ASPECT RATIO: All wood diaphragms with an aspect ratio greater than 3 to 1 for Life Safety and 2 to 1 for Immediate Occupancy shall have nonstructural walls connected to all diaphragm levels at a spacing less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy. (Tier 2: Sec. 4.5.2.4)

C NC N/A NON-CONCRETE DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft. and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

C **NC** **N/A** OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C **NC** **N/A** ANCHOR SPACING: Exterior masonry walls shall be anchored to the floor and roof systems at a spacing of 4 ft. or less for Life Safety and 3 ft. or less for Immediate Occupancy (Tier 2: Sec. 4.6.1.3)

C **NC** **N/A** STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to prevent movement between the wall and the diaphragm. If bolts are present, the size of the bolt holes in both the connector and framing shall be a maximum of 1/16" larger than the bolt diameter. This statement shall apply to the Immediate Occupancy Performance Level only.(Tier 2: Sec. 4.6.1.5)

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.8 Basic Structural Checklist For Building Type C1: Concrete Moment Frames

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of cast-in-place concrete beams and columns. Floor and roof framing consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Lateral forces are resisted by concrete moment frames that develop their stiffness through monolithic beam-column connections. In older construction, or in regions of low seismicity, the the moment frames may consist of the column strips of two-way flat slab systems. Modern frames in regions of high seismicity have joint reinforcing, closely spaced ties, and special detailing to provide ductile performance. This detailing is not present in older construction. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of moment frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of bays of moment frames in each line shall be greater than or equal to 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.1.1)

C NC N/A INTERFERING WALLS: All infill walls placed in moment frames shall be isolated from structural elements. (Tier 2: Sec. 4.4.1.2.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the concrete columns, calculated using the Quick Check procedure of Section 3.5.3.2, shall be less than 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.1)

C NC N/A AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10f'_c$ for Life Safety and Immediate Occupancy. Alternatively, the axial stresses due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30f'_c$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.2)

Connections

C NC N/A CONCRETE COLUMNS: All concrete columns shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the tensile capacity of the column for Immediate Occupancy. (Tier 2: Sec. 4.6.3.2)

3.7.8S Supplemental Structural Checklist For Building Type C1: Concrete Moment Frames

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C **NC** **N/A** FLAT SLAB FRAMES: The lateral-force-resisting system shall not be a frame consisting of columns and a flat slab/plate without beams. (Tier 2: Sec. 4.4.1.4.3)

C **NC** **N/A** PRESTRESSED FRAME ELEMENTS: The lateral-load-resisting frames shall not include any prestressed or post-tensioned elements. (Tier 2: Sec. 4.4.1.4.4)

C **NC** **N/A** SHORT CAPTIVE COLUMNS: There shall be no columns at a level with height/depth ratios less than 50% of the nominal height/depth ratio of the typical columns at that level for Life Safety and 75% for Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.5)

C **NC** **N/A** NO SHEAR FAILURES: The shear capacity of frame members shall be able to develop the moment capacity at the top and bottom of the columns. (Tier 2: Sec. 4.4.1.4.6)

C **NC** **N/A** STRONG COLUMN/WEAK BEAM: The sum of the moment capacity of the columns shall be 20% greater than that of the beams at frame joints. (Tier 2: Sec. 4.4.1.4.7)

C **NC** **N/A** BEAM BARS: At least two longitudinal top and two longitudinal bottom bars shall extend continuously throughout the length of each frame beam. At least 25% of the longitudinal bars provided at the joints for either positive or negative moment shall be continuous throughout the length of the members for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.8)

C **NC** **N/A** COLUMN-BAR SPLICES: All column bar lap splice lengths shall be greater than 35 d_b for Life Safety and 50 d_b for Immediate Occupancy and shall be enclosed by ties spaced at or less than 8 d_b for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.9)

C **NC** **N/A** BEAM-BAR SPLICES: The lap splices for longitudinal beam reinforcing shall not be located within $l_b/4$ of the joints and shall not be located within the vicinity of potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.10)

C **NC** **N/A** COLUMN-TIE SPACING: Frame columns shall have ties spaced at or less than d/4 for Life Safety and Immediate Occupancy throughout their length and at or less than 8 d_b for Life Safety and Immediate Occupancy at all potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.11)

C **NC** **N/A** STIRRUP SPACING: All beams shall have stirrups spaced at or less than d/2 for Life Safety and Immediate Occupancy throughout their length. At potential plastic hinge locations stirrups shall be spaced at or less than the minimum of 8 d_b or d/4 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.12)

C **NC** **N/A** JOINT REINFORCING: Beam-column joints shall have ties spaced at or less than $8d_b$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.13)

C **NC** **N/A** JOINT ECCENTRICITY: There shall be no eccentricities larger than 20% of the smallest column plan dimension between girder and column centerlines. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.4.14)

C **NC** **N/A** STIRRUP AND TIE HOOKS: The beam stirrups and column ties shall be anchored into the member cores with hooks of 135° or more. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.4.15)

C **NC** **N/A** DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall have ductile detailing for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

C **NC** **N/A** FLAT SLABS: Flat slabs/plates classified as secondary components shall have continuous bottom steel through the column joints for Life Safety. Flat slabs/plates shall not be permitted for the Immediate Occupancy Performance Level. (Tier 2: Sec. 4.4.1.6.3)

Diaphragms

C **NC** **N/A** DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C **NC** **N/A** PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.9 Basic Structural Checklist For Building Type C2: Concrete Shear Wall Buildings With Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings have floor and roof framing that consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Floors are supported on concrete columns or bearing walls. Lateral forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced, but often extend throughout the building. In more recent construction, shear walls occur in isolated locations and are more heavily reinforced with boundary elements and closely spaced ties to provide ductile performance. The diaphragms consist of concrete slabs and are stiff relative to the walls. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting-system in any story shall not be less than 80% of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting-system in any story shall not be less than 70% of the stiffness in an adjacent story above or below, or less than 80% of the average stiffness of the three stories above or below for Life Safety and Immediate Occupancy.

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

C NC N/A CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

Lateral Force Resisting System

C NC N/A COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system. (Tier 2: Sec. 4.4.1.6.1)

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)

C NC N/A REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

Connections

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C NC N/A WALL REINFORCING: Walls shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

3.7.9S SupplementalStructural Checklist For Building Type C2: Concrete Shear Wall Buildings With Stiff Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall have ductile detailing for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

C NC N/A FLAT SLABS: Flat slabs/plates classified as secondary components shall have continuous bottom steel through the column joints for Life Safety. Flat slabs/plates shall not be permitted for the Immediate Occupancy Performance Level. (Tier 2: Sec. 4.4.1.6.3)

C NC N/A COUPLING BEAMS: The stirrups in all coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the core with hooks of 135° or more for Life Safety and Immediate Occupancy. In addition, the beams shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC N/A OVERTURNING: All shear walls shall have aspect ratios less than 4 to 1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)

C NC N/A CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2.0, the boundary elements shall be confined with spirals or ties with spacing less than 8 d_b. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)

C NC N/A REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

Diaphragms

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.9A Basic Structural Checklist For Building Type C2A: Concrete Shear Wall Buildings With Flexible Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings have floor and roof framing that consists of wood sheathing on wood framing and concrete beams. Floors are supported on concrete columns or bearing walls. Lateral forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced, but often extend throughout the building. In more recent construction, shear walls occur in isolated locations and are more heavily reinforced with boundary elements and closely spaced ties to provide ductile performance. The diaphragms consist of wood sheathing or have large aspect ratios and are flexible relative to the walls. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting-system in any story shall not be less than 80% of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting-system in any story shall not be less than 70% of the stiffness in an adjacent story above or below, or less than 80% of the average stiffness of the three stories above or below for Life Safety and Immediate Occupancy.

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

C NC N/A CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)

C NC N/A REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

Connections

C NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C NC N/A WALL REINFORCING: Walls shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

3.7.9AS Supplemental Structural Checklist For Building Type C2A: Concrete Shear Wall Buildings With Flexible Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A COUPLING BEAMS: The stirrups in all coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the core with hooks of 135° or more for Life Safety and Immediate Occupancy. In addition, the beams shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC N/A OVERTURNING: All shear walls shall have aspect ratios less than 4 to 1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)

C NC N/A CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2.0, the boundary elements shall be confined with spirals or ties with spacing less than 8 d_b. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)

C NC N/A REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

Diaphragms

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C **NC** **N/A** SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C **NC** **N/A** UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C **NC** **N/A** NON-CONCRETE DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft. and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

C **NC** **N/A** OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.10 Basic Structural Checklist For Building Type C3: Concrete Frames With Infill Masonry Shear Walls And Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

This is an older type of building construction that consists of a frame assembly of cast-in-place concrete beams and columns. The floors and roof consist of cast-in-place concrete slabs. Walls consist of infill panels constructed of solid clay brick, concrete block, or hollow clay tile masonry. The seismic performance of this type of construction depends on the interaction between the frame and infill panels. The combined behavior is more like a shear wall structure than a frame structure Solidly infilled masonry panels form diagonal compression struts between the intersections of the frame members. If the walls are offset from the frame and do not fully engage the frame members, the diagonal compression struts will not develop. The strength of the infill panel is limited by the shear capacity of the masonry bed joint or the compression capacity of the strut. The post-cracking strength is determined by an analysis of a moment frame that is partially restrained by the cracked infill. The shear strength of the concrete columns, after cracking of the infill, may limit the semiductile behavior of the system. The diaphragms consist of concrete floors and are stiff relative to the walls.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C **NC** **N/A** TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C **NC** **N/A** DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C **NC** **N/A** MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C **NC** **N/A** MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C **NC** **N/A** CRACKS IN INFILL WALLS:There shall be no existing diagonal cracks in infill walls that extend throughout a panel , are greater than 1/8" for Life Safetyand 1/16" for Immediate Occupancy, or have out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy. (Tier 2: Sec. 4.3.3.12)

C **NC** **N/A** CRACKS IN BOUNDARY COLUMNS: There shall be no existing diagonal cracks wider than 1/8" for Life Safety and 1/16" for Immediate Occupancy in concrete columns that encase masonry infills. (Tier 2: Sec. 4.3.3.13)

Lateral Force Resisting System

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 50 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 15 psi for clay units and 30 psi for concrete units for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.1)

C **NC** **N/A** WALL CONNECTIONS: All infill walls shall have a positive connection to the frame to resist out-of-plane forces for Life Safety and the connection shall be able to develop the out-of-plane strength of the wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.6.1)

Connections

C **NC** **N/A** TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C **NC** **N/A** CONCRETE COLUMNS: All concrete columns shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the tensile capacity of the column for Immediate Occupancy. (Tier 2: Sec. 4.6.3.2)

3.7.10S Supplemental Structural Checklist For Building Type C3: Concrete Frames With Infill Masonry Shear Walls And Stiff Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall have ductile detailing for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

C NC N/A FLAT SLABS: Flat slabs/plates classified as secondary components shall have continuous bottom steel through the column joints for Life Safety. Flat slabs/plates shall not be permitted for the Immediate Occupancy Performance Level. (Tier 2: Sec. 4.4.1.6.3)

C NC N/A REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)

C NC N/A PROPORTIONS: The height-to-thickness ratio of the infill walls at each story shall be less than 9 for Life Safety in regions of high seismicity, 13 for Immediate Occupancy in regions of moderate seismicity, and 8 for Immediate Occupancy in regions of high seismicity. (Tier 2: Sec. 4.4.2.6.2)

C NC N/A SOLID WALLS: The infill walls shall not be of cavity construction. (Tier 2: Sec. 4.4.2.6.3)

C NC N/A INFILL WALLS: The infill walls shall be continuous to the soffits of the frame beams. (Tier 2: Sec. 4.4.2.6.4)

Diaphragms

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

This Page Intentionally
Left Blank

3.7.10A Basic Structural Checklist For Building Type C3A: Concrete Frames With Infill Masonry Shear Walls And Flexible Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

This is an older type of building construction that consists of a frame assembly of cast-in-place concrete beams and columns. The floors and roof consist of wood sheathing on wood framing between concrete beams. Walls consist of infill panels constructed of solid clay brick, concrete block, or hollow clay tile masonry. The seismic performance of this type of construction depends on the interaction between the frame and infill panels. The combined behavior is more like a shear wall structure than a frame structure Solidly infilled masonry panels form diagonal compression struts between the intersections of the frame members. If the walls are offset from the frame and do not fully engage the frame members, the diagonal compression struts will not develop. The strength of the infill panel is limited by the shear capacity of the masonry bed joint or the compression capacity of the strut. The post-cracking strength is determined by an analysis of a moment frame that is partially restrained by the cracked infill. The shear strength of the concrete columns, after cracking of the infill, may limit the semiductile behavior of the system. Diaphragms consist of wood sheathing, or have large aspect ratios and are flexible relative to the walls.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC N/A SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC N/A GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C NC N/A CRACKS IN INFILL WALLS:There shall be no existing diagonal cracks in infill walls that extend throughout a panel , are greater than 1/8" for Life Safetyand 1/16" for Immediate Occupancy, or have out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy. (Tier 2: Sec. 4.3.3.12)

C NC N/A CRACKS IN BOUNDARY COLUMNS: There shall be no existing diagonal cracks wider than 1/8" for Life Safety and 1/16" for Immediate Occupancy in concrete columns that encase masonry infills. (Tier 2: Sec. 4.3.3.13)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 50 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 15 psi for clay units and 30 psi for concrete units for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.1)

C NC N/A WALL CONNECTIONS: All infill walls shall have a positive connection to the frame to resist out-of-plane forces for Life Safety and the connection shall be able to develop the out-of-plane strength of the wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.6.1)

Connections

C **NC** **N/A** TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C **NC** **N/A** CONCRETE COLUMNS: All concrete columns shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the tensile capacity of the column for Immediate Occupancy. (Tier 2: Sec. 4.6.3.2)

3.7.10AS Supplemental Structural Checklist For Building Type C3A: Concrete Frames With Infill Masonry Shear Walls And Flexible Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C **NC** **N/A** REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)

C **NC** **N/A** PROPORTIONS: The height-to-thickness ratio of the infill walls at each story shall be less than 9 for Life Safety in regions of high seismicity, 13 for Immediate Occupancy in regions of moderate seismicity, and 8 for Immediate Occupancy in regions of high seismicity. (Tier 2: Sec. 4.4.2.6.2)

C **NC** **N/A** SOLID WALLS: The infill walls shall not be of cavity construction. (Tier 2: Sec. 4.4.2.6.3)

C **NC** **N/A** INFILL WALLS: The infill walls shall be continuous to the soffits of the frame beams. (Tier 2: Sec. 4.4.2.6.4)

Diaphragms

C **NC** **N/A** DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C **NC** **N/A** CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C **NC** **N/A** OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C **NC** **N/A** PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C **NC** **N/A** STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C **NC** **N/A** SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC N/A UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC N/A NON-CONCRETE DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft. and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

C NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C NC N/A ANCHOR SPACING: Exterior masonry walls shall be anchored to the floor and roof systems at a spacing of 4 ft. or less for Life Safety and 3 ft. or less for Immediate Occupancy (Tier 2: Sec. 4.6.1.3)

C NC N/A STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to prevent movement between the wall and the diaphragm. If bolts are present, the size of the bolt holes in both the connector and framing shall be a maximum of 1/16" larger than the bolt diameter. This statement shall apply to the Immediate Occupancy Performance Level only.(Tier 2: Sec. 4.6.1.5)

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

3.7.11 Basic Structural Checklist For Building Type PC1: Precast/Tilt-Up Concrete Shear Wall Buildings With Flexible Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings are one or more stories in height and have precast concrete perimeter wall panels that are cast on site and tilted into place. Floor and roof framing consists of wood joists, glulam beams, steel beams or open web joists. Framing is supported on interior steel or concrete columns and perimeter concrete bearing walls. The floors and roof consist of wood sheathing or untopped metal deck. Lateral forces are resisted by the precast concrete perimeter wall panels. Wall panels may be solid, or have large window and door openings which cause the panels to behave more as frames than as shear walls. In older construction, wood framing is attached to the walls with wood ledgers. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C **NC** **N/A** DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C **NC** **N/A** PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections. (Tier 2: Sec. 4.3.3.6)

Lateral Force Resisting System

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the precast panels, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.1)

C **NC** **N/A** REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.2)

Connections

C **NC** **N/A** WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

C **NC** **N/A** PRECAST WALL PANELS: Precast wall panels shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.7)

C **NC** **N/A** GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.11S Supplemental Structural Checklist For Building Type PC1: Precast/Tilt-Up Concrete Shear Wall Buildings With Flexible Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A COUPLING BEAMS: The stirrups in all coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the core with hooks of 135° or more for Life Safety and Immediate Occupancy. In addition, the beams shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC N/A WALL OPENINGS: Openings shall constitute less than 75% of the length of any perimeter wall for Life Safety and 50% for Immediate Occupancy with the wall piers having aspect ratios of less than 2. (Tier 2: Sec. 4.4.2.3.3)

C NC N/A CORNER OPENINGS: Walls with openings at a building corner larger than the width of a typical panel shall be connected to the remainder of the wall with collector reinforcing. (Tier 2: Sec. 4.4.2.3.4)

C NC N/A PANEL-TO-PANEL CONNECTIONS: Adjacent wall panels shall be interconnected to transfer overturning forces between panels by methods other than welded steel inserts. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.5)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.6)

Diaphragms

C NC N/A CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C NC N/A SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C **NC** **N/A** UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C **NC** **N/A** OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C **NC** **N/A** WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)

C **NC** **N/A** PRECAST PANEL CONNECTIONS: There shall be at least two anchors from each precast wall panel into the diaphragm elements for Life Safety and the anchors shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.1.4)

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

C **NC** **N/A** GIRDERS: Girders supported by walls or pilasters shall have at least two additional ties to secure the anchor bolts for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.6.4.2)

3.7.11A Basic Structural Checklist For Building Type PC1A: Precast/Tilt-Up Concrete Shear Wall Buildings With Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings are one or more stories in height and have precast concrete perimeter wall panels that are cast on site and tilted into place. The floors and roof consist precast elements, cast-in-place concrete, or metal deck with concrete fill, and are stiff relative to the walls. Framing is supported on interior steel or concrete columns and perimeter concrete bearing walls. Lateral forces are resisted by the precast concrete perimeter wall panels. Wall panels may be solid, or have large window and door openings which cause the panels to behave more as frames than as shear walls. Foundations consist of concrete spread footings or deep pile foundations.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

C NC N/A PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections. (Tier 2: Sec. 4.3.3.6)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the precast panels, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.1)

C NC N/A REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.2)

Diaphragms

C NC N/A TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)

Connections

C NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C NC N/A TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled into the shear wall or frame elements for Life Safety and the dowels shall be able to develop the shear strength of the walls or frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)

C **NC** **N/A** PRECAST WALL PANELS: Precast wall panels shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.7)

C **NC** **N/A** GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.11AS Supplemental Structural Checklist For Building Type PC1A: Precast Tilt-Up Concrete Shear Wall Buildings With Stiff Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall have ductile detailing for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

C NC N/A COUPLING BEAMS: The stirrups in all coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the core with hooks of 135° or more for Life Safety and Immediate Occupancy. In addition, the beams shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC N/A WALL OPENINGS: Openings shall constitute less than 75% of the length of any perimeter wall for Life Safety and 50% for Immediate Occupancy with the wall piers having aspect ratios of less than 2. (Tier 2: Sec. 4.4.2.3.3)

C NC N/A CORNER OPENINGS: Walls with openings at a building corner larger than the width of a typical panel shall be connected to the remainder of the wall with collector reinforcing. (Tier 2: Sec. 4.4.2.3.4)

C NC N/A PANEL-TO-PANEL CONNECTIONS: Adjacent wall panels shall be interconnected to transfer overturning forces between panels by methods other than welded steel inserts. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.5)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.6)

Diaphragms

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A PRECAST PANEL CONNECTIONS: There shall be at least two anchors from each precast wall panel into the diaphragm elements for Life Safety and the anchors shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.1.4)

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

C **NC** **N/A** GIRDERS: Girders supported by walls or pilasters shall have at least two additional ties to secure the anchor bolts for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.6.4.2)

This Page Intentionally
Left Blank

3.7.12 Basic Structural Checklist For Building Type PC2: Precast Concrete Frames With Shear Walls

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of precast concrete girders and columns with the presence of shear walls. Floor and roof framing consists of precast concrete planks, tees or double-tees supported on precast concrete girders and columns. Lateral forces are resisted by precast or cast-in-place concrete shear walls. Diaphragms consist of precast elements interconnected with welded inserts, cast-in-place closure strips, or reinforced concrete topping slabs.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

C NC N/A CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

Lateral Force-Resisting System

C NC N/A COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system. (Tier 2: Sec. 4.4.1.6.1)

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)

C NC N/A REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

Diaphragms

C NC N/A TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)

Connections

C NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C **NC** **N/A** TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled into the shear wall or frame elements for Life Safety and the dowels shall be able to develop the shear strength of the walls or frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)

C **NC** **N/A** WALL REINFORCING: Walls shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

C **NC** **N/A** GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.12S Supplemental Structural Checklist For Building Type PC2: Precast Concrete Frames With Shear Walls

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A PRECAST FRAMES: For buildings with concrete shear walls, lateral forces shall not be resisted by precast concrete frame elements. (Tier 2: Sec. 4.4.1.5.2)

C NC N/A PRECAST CONNECTIONS: For buildings with concrete shear walls, the connection between precast frame elements such as chords, ties, and collectors in the lateral-force-resisting system shall develop the capacity of the connected members. (Tier 2: Sec. 4.4.1.5.3)

C NC N/A DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall have ductile detailing for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

C NC N/A COUPLING BEAMS: The stirrups in all coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the core with hooks of 135° or more for Life Safety and Immediate Occupancy. In addition, the beams shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC N/A OVERTURNING: All shear walls shall have aspect ratios less than 4 to 1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)

C NC N/A CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2.0, the boundary elements shall be confined with spirals or ties with spacing less than 8 d_b. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)

C NC N/A REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

Diaphragms

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C **NC** **N/A** LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

C **NC** **N/A** CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than3" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.3)

C **NC** **N/A** CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements. (Tier 2: Sec. 4.6.4.4)

3.7.12A Basic Structural Checklist For Building Type PC2A: Precast Concrete Frames Without Shear Walls

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings consist of a frame assembly of precast concrete girders and columns without the presence of concrete shear walls. Lateral forces are resisted by precast concrete moment frames that develop their stiffness through beam-column joints rigidly connected by welded inserts or cast-in-place concrete closures. Diaphragms consist of precast elements interconnected with welded inserts, cast-in-place closure strips, or reinforced concrete topping slabs. This type of construction is not permitted in regions of high seismicity for new construction.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of moment frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of bays of moment frames in each line shall be greater than or equal to 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the concrete columns, calculated using the Quick Check procedure of Section 3.5.3.2, shall be less than 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.1)

C NC N/A AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10f'_c$ for Life Safety and Immediate Occupancy. Alternatively, the axial stresses due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30f'_c$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.2)

C NC N/A PRECAST CONNECTION CHECK: The precast connections at frame joints shall have the capacity to resist the shear and moment demands calculated using the Quick Procedure of Section 3.5.3.5 (Tier 2: Sec. 4.4.1.5.1)

Diaphragms

C NC N/A TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)

Connections

C NC N/A TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled into the shear wall or frame elements for Life Safety and the dowels shall be able to develop the shear strength of the walls or frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)

C NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.12AS Supplemental Structural Checklist For Building Type PC2A: Precast Concrete Frames Without Shear Walls

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A PRESTRESSED FRAME ELEMENTS: The lateral-load-resisting frames shall not include any prestressed or post-tensioned elements. (Tier 2: Sec. 4.4.1.4.4)

C NC N/A SHORT CAPTIVE COLUMNS: There shall be no columns at a level with height/depth ratios less than 50% of the nominal height/depth ratio of the typical columns at that level for Life Safety and 75% for Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.5)

C NC N/A JOINT REINFORCING: Column ties shall extend at their typical spacing through all beam-column joints at exterior columns. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.4.13)

C NC N/A DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall have ductile detailing for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

Diaphragms

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

C NC N/A GIRDERS: Girders supported by walls or pilasters shall have at least two additional ties to secure the anchor bolts for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.2)

C NC N/A CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than 3" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.3)

C NC N/A CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements. (Tier 2: Sec. 4.6.4.4)

This Page Intentionally
Left Blank

3.7.13 Basic Structural Checklist For Building Type RM1: Reinforced Masonry Bearing Wall Buildings With Flexible Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings have bearing walls that consist of reinforced brick or concrete block masonry. Wood floor and roof framing consists of wood joists, glulam beams and wood posts or small steel columns. Steel floor and roof framing consists of steel beams or open web joists, steel girders and steel columns. Lateral forces are resisted by the reinforced brick or concrete block masonry shear walls. Diaphragms consist of straight or diagonal wood sheathing, plywood, or untopped metal deck, and are flexible relative to the walls. Foundations consist of brick or concrete spread footings.

Building System

C	**NC**	**N/A**	LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)
C	**NC**	**N/A**	ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)
C	**NC**	**N/A**	MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)
C	**NC**	**N/A**	WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)
C	**NC**	**N/A**	SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)
C	**NC**	**N/A**	GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C NC N/A REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 50 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C NC N/A REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and 0.003 for Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and 0.001 for Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48" for Life Safety and 24" for Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)

Connections

C NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C NC N/A WALL REINFORCING: Walls shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

C NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.13S Supplemental Structural Checklist For Building Type RM1: Reinforced Masonry Bearing Wall Buildings With Flexible Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C **NC** **N/A** REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)

C **NC** **N/A** PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)

Diaphragms

C **NC** **N/A** CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C **NC** **N/A** OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C **NC** **N/A** OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 ft. long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)

C **NC** **N/A** PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C **NC** **N/A** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

C **NC** **N/A** STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C **NC** **N/A** SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C **NC** **N/A** UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C **NC** **N/A** NON-CONCRETE DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft. and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

C **NC** **N/A** OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

Connections

C **NC** **N/A** WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)

C **NC** **N/A** ANCHOR SPACING: Exterior masonry walls shall be anchored to the floor and roof systems at a spacing of 4 ft. or less for Life Safety and 3 ft. or less for Immediate Occupancy (Tier 2: Sec. 4.6.1.3)

C **NC** **N/A** STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to prevent movement between the wall and the diaphragm. If bolts are present, the size of the bolt holes in both the connector and framing shall be a maximum of 1/16" larger than the bolt diameter. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.6.1.5)

3.7.14 Basic Structural Checklist For Building Type RM2: Reinforced Masonry Bearing Wall Buildings With Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings have bearing walls that consist of reinforced brick or concrete block masonry. Diaphragms consist of metal deck with concrete fill, precast concrete planks, tees, or double-tees, with or without a cast-in-place concrete topping slab, and are stiff relative to the walls. The floor and roof framing is supported on interior steel or concrete frames or interior reinforced masonry walls.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C NC N/A REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)

Lateral Force-Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 50 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C NC N/A REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and 0.003 for Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and 0.001 for Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48" for Life Safety and 24" for Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)

Diaphragms

C NC N/A TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)

Connections

C NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C NC N/A TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled into the shear wall or frame elements for Life Safety and the dowels shall be able to develop the shear strength of the walls or frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)

C **NC** **N/A** WALL REINFORCING: Walls shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

C **NC** **N/A** GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.14S Supplemental Structural Checklist For Building Type RM2: Reinforced Masonry Bearing Wall Buildings With Stiff Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C NC N/A PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)

Diaphragms

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 ft. long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A ANCHOR SPACING: Exterior masonry walls shall be anchored to the floor and roof systems at a spacing of 4 ft. or less for Life Safety and 3 ft. or less for Immediate Occupancy. (Tier 2: Sec. 4.6.1.3)

This Page Intentionally
Left Blank

3.7.15A Basic Structural Checklist For Building Type URMA: Unreinforced Masonry Bearing Wall Buildings With Stiff Diaphragms

This Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Commentary:

These buildings have perimeter bearing walls that consist of unreinforced clay brick masonry. Interior bearing walls, when present, also consist of unreinforced clay brick masonry. Diaphragms are stiff relative to the unreinforced masonry walls and interior framing. In older construction or large, multistory buildings, diaphragms consist of cast-in-place concrete. In regions of low seismicity, more recent construction consists of metal deck and concrete fill supported on steel framing.

Building System

C **NC** **N/A** LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C **NC** **N/A** MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C **NC** **N/A** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C **NC** **N/A** SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C **NC** **N/A** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C **NC** **N/A** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C **NC** **N/A** MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C NC N/A UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in wall elements greaterthan 1/8" for Life Safety and 1/16" for Immediate Occupancy or out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy. (Tier 2: Sec. 4.3.3.11)

Lateral Force Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

C NC N/A SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 15 psi for clay units and 30 psi for concrete units for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.1)

Connections

C NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

3.7.15AS Supplemental Structural Checklist For Building Type URMA: Unreinforced Masonry Bearing Wall Buildings With Stiff Diaphragms

This Supplemental Structural Checklist shall be completed when required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral Force Resisting System

C NC N/A PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than the following for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.2):

Top story of multi-story building:	9
First story of multi-story building:	15
All other conditions:	13

C NC N/A MASONRY LAY-UP: Filled collar joints of multiwythe masonry walls shall have negligible voids. (Tier 2: Sec. 4.4.2.5.3)

Diaphragms

General

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 ft. long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A ANCHOR SPACING: Exterior masonry walls shall be anchored to the floor and roof systems at a spacing of 4 ft. or less for Life Safety and 3 ft. or less for Immediate Occupancy. (Tier 2: Sec. 4.6.1.3)

This Page Intentionally
Left Blank

3.7.16 General Basic Structural Checklist

This General Basic Structural Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

BUILDING SYSTEM

General

C NC N/A LOAD PATH: The structure shall contain one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C NC N/A ADJACENT BUILDINGS: An adjacent building shall not be located next to the structure being evaluated closer than 4% of the height for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C NC N/A MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

Configuration

C NC N/A WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above, or below, for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC N/A SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the stiffness in an adjacent story above or below or less than 80% of the average stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC N/A GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses. (Tier 2: Sec. 4.3.2.3)

C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A MASS: There shall be no change in effective mass more than 50% from one story to the next for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.5)

C NC N/A TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

Condition of Materials

C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members and none of the metal accessories shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A OVERDRIVEN FASTENERS: There shall be no evidence of overdriven fasteners in the shear walls (Tier 2: Sec. 4.3.3.2)

C NC N/A DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

C NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

C NC N/A PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections. (Tier 2: Sec. 4.3.3.6)

C NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C NC N/A CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

C NC N/A REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)

C NC N/A UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in wall elements greaterthan 1/8" for Life Safety and 1/16" for Immediate Occupancy or out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy. (Tier 2: Sec. 4.3.3.11)

C NC N/A CRACKS IN INFILL WALLS: There shall be no existing diagonal cracks in infill walls that extend throughout a panel , are greater than 1/8" for Life Safetyand 1/16" for Immediate Occupancy, or have out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy. (Tier 2: Sec. 4.3.3.12)

C NC N/A CRACKS IN BOUNDARY COLUMNS: There shall be no existing diagonal cracks wider than 1/8" for Life Safety and 1/16" for Immediate Occupancy in concrete columns that encase masonry infills. (Tier 2: Sec. 4.3.3.13)

LATERAL FORCE RESISTING SYSTEM

Moment Frames

General

C **NC** **N/A** REDUNDANCY: The number of lines of moment frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of bays of moment frames in each line shall be greater than or equal to 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.1.1)

Moment Frames with Infill Walls

C **NC** **N/A** INTERFERING WALLS: All infill walls placed in moment frames shall be isolated from structural elements. (Tier 2: Sec. 4.4.1.2.1)

Steel Moment Frames

C **NC** **N/A** DRIFT CHECK: The drift ratio of the steel moment frames, calculated using the Quick Check procedure of Section 3.5.3.1, shall be less than 0.025 for Life Safety and 0.015 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.1)

C **NC** **N/A** AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10F_y$ for Life Safety and Immediate Occupancy. Alternatively, the axial stress due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30F_y$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.2)

Concrete Moment Frames

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the concrete columns, calculated using the Quick Check procedure of Section 3.5.3.2, shall be less than 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.1)

C **NC** **N/A** AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10f'_c$ for Life Safety and Immediate Occupancy. Alternatively, the axial stresses due to overturning forces alone, calculated using the Quick Check Procedure of Section 3.5.3.6, shall be less than $0.30f'_c$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.2)

Precast Concrete Moment Frames

C **NC** **N/A** PRECAST CONNECTION CHECK: The precast connections at frame joints shall have the capacity to resist the shear and moment demands calculated using the Quick Procedure of Section 3.5.3.5 (Tier 2: Sec. 4.4.1.5.1)

Frames Not Part of the Lateral-Force-Resisting System

C **NC** **N/A** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system. (Tier 2: Sec. 4.4.1.6.1)

Shear Walls

General

C **NC** **N/A** REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

Concrete Shear Walls

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)

C **NC** **N/A** REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

C **NC** **N/A** COLUMN SPLICES: Steel columns encased in shear wall boundary elements shall have splices that develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.9)

Precast Concrete Shear Walls

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the precast panels, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt{f'_c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.1)

C **NC** **N/A** REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be greater than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.2)

Reinforced Masonry Shear Walls

C **NC** **N/A** SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 50 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C **NC** **N/A** REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and 0.003 for Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and 0.001 for Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48" for Life Safety and 24" for Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)

Unreinforced Masonry Shear Walls

C NC N/A SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 15 psi for clay units and 30 psi for concrete units for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.1)

Infill Walls in Frames

C NC N/A WALL CONNECTIONS: All infill walls shall have a positive connection to the frame to resist out-of-plane forces for Life Safety and the connection shall be able to develop the out-of-plane strength of the wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.6.1)

Walls in Wood-Frame Buildings

C NC N/A SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1):

Structural panel sheathing:	1000 plf
Diagonal sheathing:	700 plf
Straight sheathing:	80 plf
All other conditions:	100 plf

C NC N/A STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)

C NC N/A GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height. (Tier 2: Sec. 4.4.2.7.3)

C NC N/A NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2 to 1 for Life Safety and 1.5 to 1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building. (Tier 2: Sec. 4.4.2.7.4)

C NC N/A WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)

C NC N/A HILLSIDE SITE: For a sloping site greater than one-half story, all shear walls on the downhill slope shall have an aspect ratio less than 1 to 1 for Life-Safety and 1 to 2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)

C NC N/A CRIPPLE WALLS: All cripple walls below first floor level shear walls shall be braced to the foundation with shear elements. (Tier 2: Sec. 4.4.2.7.7)

Braced Frames

General

C NC N/A REDUNDANCY: The number of lines of braced frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of braced bays in each line shall be greater than 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.1)

C NC N/A AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 3.5.3.4, shall be less than 18 ksi or $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)

C NC N/A COLUMN SPLICES: All column splice details located in braced frames shall develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.5)

DIAPHRAGMS

Precast Concrete Diaphragms

C NC N/A TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)

CONNECTIONS

Anchoragefor Normal Forces

C NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. (Tier 2: Sec. 4.6.1.1)

Shear Transfer

C NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be reinforced and connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the shear strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)

C NC N/A TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety and the connections shall be able to develop the shear strength of the frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)

C NC N/A TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled into the shear wall or frame elements for Life Safety and the dowels shall be able to develop the shear strength of the walls or frames for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)

Vertical Components

C NC N/A STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

C NC N/A CONCRETE COLUMNS: All concrete columns shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the tensile capacity of the column for Immediate Occupancy. (Tier 2: Sec. 4.6.3.2)

C NC N/A WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)

C NC N/A WOOD SILLS: All wood sill s shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)

C NC N/A WALL REINFORCING: Walls shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

C NC N/A SHEAR-WALL-BOUNDARY COLUMNS: The shear wall boundary columns shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the tensile capacity of the column for Immediate Occupancy. (Tier 2: Sec. 4.6.3.6)

C NC N/A PRECAST WALL PANELS: Precast wall panels shall be doweled into the foundation for Life Safety and the dowels shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.7)

C NC N/A WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and the attachment shall be able to develop the shear capacity of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.3.8)

Interconnection of Elements

C NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

Panel Connections

C NC N/A ROOF PANELS: Metal, plastic, or cementitious roof panels shall be positively attached to the roof framing to resist seismic forces for Life Safety and the attachment shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.5.1)

C NC N/A WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the framing to resist seismic forces or Life Safety and the attachment shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.5.2)

3.7.16S General Supplemental Structural Checklist

This General Supplemental Structural Checklist shall be completed when required by Table 3-2. The General Basic Structural Checklist shall be completed prior to completing this General Supplemental Structural Checklist.

LATERAL FORCE RESISTING SYSTEM

Moment Frames

Steel Moment Frames

C NC N/A MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. (Tier 2: Sec. 4.4.1.3.3)

C NC N/A PANEL ZONES: All panel zones shall have the shear capacity to resist the shear demand required to develop $0.8\Sigma M_p$ of the girders framing in at the face of the column. (Tier 2: Sec. 4.4.1.3.4)

C NC N/A COLUMN SPLICES: All column splice details located in moment resisting frames shall include connection of both flanges and the web for Life Safety and the splice shall develop the strength of the column for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.5)

C NC N/A STRONG COLUMN/WEAK BEAM: The percent of strong column/weak beam joints in each story of each line of moment resisting frames shall be greater than 50% for Life Safety and 75% for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.6)

C NC N/A COMPACT MEMBERS: All moment frame elements shall meet compact section requirements set forth by the *Load and Resistance Factor Design Specification for Structural Steel Buildings* (AISC, 1993). This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.7)

C NC N/A BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.8)

C NC N/A GIRDER FLANGE CONTINUITY PLATES: There shall be girder flange continuity plates at all moment-resisting frame joints. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.9)

C NC N/A OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.10)

C NC N/A BOTTOM FLANGE BRACING: The bottom flange of beams shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.11)

Concrete Moment Frames

C NC N/A FLAT SLAB FRAMES: The lateral-force-resisting system shall not be a frame consisting of columns and a flat slab/plate without beams. (Tier 2: Sec. 4.4.1.4.3)

C NC N/A PRESTRESSED FRAME ELEMENTS: The lateral-load-resisting frames shall not include any prestressed or post-tensioned elements. (Tier 2: Sec. 4.4.1.4.4)

C NC N/A SHORT CAPTIVE COLUMNS: There shall be no columns at a level with height/depth ratios less than 50% of the nominal height/depth ratio of the typical columns at that level for Life Safety and 75% for Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.5)

C NC N/A NO SHEAR FAILURES: The shear capacity of frame members shall be able to develop the moment capacity at the top and bottom of the columns . (Tier 2: Sec. 4.4.1.4.6)

C NC N/A STRONG COLUMN/WEAK BEAM: The sum of the moment capacity of the columns shall be 20% greater than that of the beams at frame joints (Tier 2: Sec. 4.4.1.4.7)

C NC N/A BEAM BARS: At least two longitudinal top and two longitudinal bottom bars shall extend continuously throughout the length of each frame beam. At least 25% of the longitudinal bars provided at the joints for either positive or negative moment shall be continuous throughout the length of the members for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.8)

C NC N/A COLUMN-BAR SPLICES: All column bar lap splice lengths shall be greater than 35 d_b for Life Safety and 50 d_b for Immediate Occupancy and shall be enclosed by ties spaced at or less than 8 d_b for Life Safety and Immediate Occupancy.(Tier 2: Sec. 4.4.1.4.9)

C NC N/A BEAM-BAR SPLICES: The lap splices for longitudinal beam reinforcing shall not be located within $l_b/4$ of the joints and shall not be located within the vicinity of potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.10)

C NC N/A COLUMN-TIE SPACING: Frame columns shall have ties spaced at or less than d/4 for Life Safety and Immediate Occupancy throughout their length and at or less than 8 d_b for Life Safety and Immediate Occupancy at all potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.11)

C NC N/A STIRRUP SPACING: All beams shall have stirrups spaced at or less than d/2 for Life Safety and Immediate Occupancy throughout their length. At potential plastic hinge locations stirrups shall be spaced at or less than the minimum of 8 d_b or d/4 for Life Safety and Immediate Occupancy.(Tier 2: Sec. 4.4.1.4.12)

C NC N/A JOINT REINFORCING: Beam-column joints shall have ties spaced at or less than 8d_b for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.13)

C NC N/A JOINT ECCENTRICITY: There shall be no eccentricities larger than 20% of the smallest column plan dimension between girder and column centerlines This statement shall apply to the Immediate Occupancy Performance Level only.(Tier 2: Sec. 4.4.1.4.14)

C NC N/A STIRRUP AND TIE HOOKS: The beam stirrups and column ties shall be anchored into the member cores with hooks of 135° or more. This statement shall apply to the Immediate Occupancy Performance Level only.(Tier 2: Sec. 4.4.1.4.15)

Precast Concrete Moment Frames

C **NC** **N/A** PRECAST FRAMES: For buildings with concrete shear walls, lateral forces shall not be resisted by precast concrete frame elements. (Tier 2: Sec. 4.4.1.5.2)

C **NC** **N/A** PRECAST CONNECTIONS: For buildings with concrete shear walls, the connection between precast frame elements such as chords, ties, and collectors in the lateral-force-resisting system shall develop the capacity of the connected members. (Tier 2: Sec. 4.4.1.5.3)

Frames Not Part of the Lateral-Force-Resisting System

C **NC** **N/A** DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall have ductile detailing for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

C **NC** **N/A** FLAT SLABS: Flat slabs/plates classified as secondary components shall have continuous bottom steel through the column joints for Life Safety. Flat slabs/plates shall not be permitted for the Immediate Occupancy Performance Level. (Tier 2: Sec. 4.4.1.6.3)

Shear Walls

Concrete Shear Walls

C **NC** **N/A** COUPLING BEAMS: The stirrups in all coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the core with hooks of 135° or more for Life Safety and Immediate Occupancy. In addition, the beams have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C **NC** **N/A** OVERTURNING: All shear walls shall have aspect ratios less than 4 to 1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)

C **NC** **N/A** CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2.0, the boundary elements shall be confined with spirals or ties with spacing less than $8\,d_b$. This statement shall apply to the Immediate Occupancy Performance Level only.(Tier 2: Sec. 4.4.2.2.5)

C **NC** **N/A** REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C **NC** **N/A** WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

C **NC** **N/A** WALL CONNECTIONS: There shall be a positive connection between the shear walls and the steel beams and columns for Life Safety and the connection shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.8)

Precast Concrete Shear Walls

C **NC** **N/A** WALL OPENINGS: Openings shall constitute less than 75% of the length of any perimeter wall for Life Safety and 50% for Immediate Occupancywith the wall piers having aspect ratios of less than 2. (Tier 2: Sec. 4.4.2.3.3)

C **NC** **N/A** CORNER OPENINGS: Walls with openings at a building corner larger than the width of a typical panel shall be connected to the remainder of the wall with collector reinforcing (Tier 2: Sec. 4.4.2.3.4)

C **NC** **N/A** PANEL-TO-PANEL CONNECTIONS: Adjacent wall panels shall be interconnected to transfer overturning forces between panels by methods other than welded steel inserts. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.5)

C **NC** **N/A** WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the minimum unsupported height or length, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.6)

Reinforced Masonry Shear Walls

C **NC** **N/A** REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)

C **NC** **N/A** PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than 30. this statement shall apply to the immediate occupancy performance level only. (Tier 2: sec. 4.4.2.4.4)

Unreinforced Masonry Shear Walls

C **NC** **N/A** PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than the following for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.2)

Top story of multi-story building:	9
First story of multi-story building:	15
All other conditions:	13

C **NC** **N/A** MASONRY LAY-UP: Filled collar joints of multiwythe masonry walls shall have negligible voids. (Tier 2: Sec. 4.4.2.5.3)

Infill Walls in Frames

C **NC** **N/A** PROPORTIONS: The height-to-thickness ratio of the infill walls at each story shall be less than 9 for Life Safety in regions of high seismicity, 13 for Immediate Occupancy in regions of moderate seismicity, and 8 for Immediate Occupancy in regions of high seismicity. (Tier 2: Sec. 4.4.2.6.2)

C **NC** **N/A** SOLID WALLS: The infill walls shall not be of cavity construction. (Tier 2: Sec. 4.4.2.6.3)

C **NC** **N/A** INFILL WALLS: The infill walls shall be continuous to the soffits of the frame beams. (Tier 2: Sec. 4.4.2.6.4)

Walls in Wood-Frame Buildings

C **NC** **N/A** OPENINGS: Walls with garage doors or other large openings shall be braced with plywood shear walls or shall be supported by adjacent construction through substantial positive ties. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.8)

C **NC** **N/A** HOLD-DOWN ANCHORS: All walls shall have properly constructed hold-down anchors. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec 4.4.2.7.9)

Braced Frames

General

C **NC** **N/A** STIFFNESS OF DIAGONALS: All diagonal elements required to carry compression shall have Kl/r ratios less than 120. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.3)

C **NC** **N/A** CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.4)

C **NC** **N/A** OUT-OF-PLANE BRACING: Braced frame connections attached to beam bottom flanges located away from beam-column joints shall be braced out-of-plane at the bottom flange of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.6)

Concentrically Braced Frames

C **NC** **N/A** K-BRACING: The bracing system shall not include K-braced bays. (Tier 2: Sec. 4.4.3.2.1)

C **NC** **N/A** TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70% of the total lateral-force-resisting capacity in structures over two stories in height. (Tier 2: Sec. 4.4.3.2.2)

C **NC** **N/A** CHEVRON BRACING: The bracing system shall not include chevron, or V-braced bays. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.3)

C **NC** **N/A** CONCENTRIC JOINTS: All the diagonal braces shall frame into the beam-column joints concentrically. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.4)

Diaphragms

General

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

C NC N/A ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)

C NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC N/A OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25% of the frame length for Life Safety and 15% of the frame length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.5)

C NC N/A OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 ft. long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50% of the building width in either major plan dimension . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Wood Diaphragms

C NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2 to 1 for Life Safety and 1 to 1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C NC N/A SPANS: All wood diaphragms with spans greater than 24 ft. for Life Safety and 12 ft. for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC N/A UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

C NC N/A ASPECT RATIO: All wood diaphragms with an aspect ratio greater than 3 to 1 for Life Safety and 2 to 1 for Immediate Occupancy shall have nonstructural walls connected to all diaphragm levels at a spacing less than 40 ft. for Life Safety and 25 ft. for Immediate Occupancy. (Tier 2: Sec. 4.5.2.4)

Metal Deck Diaphragms

C NC N/A NON-CONCRETE DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft. and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

Other Diaphragms

C NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than those described in Section 4.5. (Tier 2: Sec. 4.5.7.1)

CONNECTIONS

Anchoragefor Normal Forces

C NC N/A WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)

C NC N/A ANCHOR SPACING: Exterior masonry walls shall be anchored to the floor and roof systems at a spacing of 4 ft. or less for Life Safety and 3 ft. or less for Immediate Occupancy (Tier 2: Sec. 4.6.1.3)

C NC N/A PRECAST PANEL CONNECTIONS: There shall be at least two anchors from each precast wall panel into the diaphragm elements for Life Safety and the anchors shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.1.4)

C NC N/A STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to prevent movement between the wall and the diaphragm. If bolts are present, the size of the bolt holes in both the connector and framing shall be a maximum of 1/16" larger than the bolt diameter. This statement shall apply to the Immediate Occupancy Performance Level only.(Tier 2: Sec. 4.6.1.5)

Vertical Components

C NC N/A WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft. or less for Life Safety and 4 ft. or less for Immediate Occupancy, with proper edge distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)

C NC N/A LATERAL LOAD AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

Interconnection of Elements

C **NC** **N/A** GIRDERS: Girders supported by walls or pilasters shall have at least two additional ties to secure the anchor bolts for Life Safety and Immediate Occupancy.(Tier 2: Sec. 4.6.4.2)

C **NC** **N/A** CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than 3" for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.3)

C **NC** **N/A** CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements. (Tier 2: Sec. 4.6.4.4)

Panel Connections

C **NC** **N/A** ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12" for Life Safety and 8" for Immediate Occupancy. (Tier 2: Sec. 4.6.5.3)

This Page Intentionally
Left Blank