City of Everett
Seismic Assessment of Public Works Buildings

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Prepared for

City of Everett

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List of Acronyms

ASCE	American Society of Civil Engineers
ATC	Applied Technology Council
CMU	Concrete Masonry Unit
FEMA	Federal Emergency Management Agency
GWB	Gypsum wallboard
IBC	International Building Code
IO	Immediate Occupancy (Performance Level)
LFRS	Lateral Force Resisting System
LS	Life Safety (Performance Level)
PEER	Pacific Earthquake Engineering Research Center

Glossary of Terms

Axial stress: The internal force of a member distributed over the cross sectional area due to the external force of a load applied along the main axis of the member.

Brace: A diagonally placed structural member that withstands tensions and compression loads, and typically stiffens a structural against lateral loads.

Braced frame: A building frame consisting of beams, columns, and braces.

Continuous footing: A foundation that is longer than it is wide and usually supports a wall along the longitudinal axis.

Diaphragm: Horizontal structural system used to transfer lateral loads to walls or frames. Floors and roofs typically act as diaphragms.

Glulam: Glued laminated timber; A type of structural timber product composed of several layers of dimensioned lumber glued together.

Gypsum shear wall: A shear wall faced with gypsum wall board on one or both sides to resist shear forces.

Hold-down: Steel device or hardware that is installed typically at the end of a wood shear wall. The hold downs provide uplift resistance against the overturning moment imposed on the wall due to loads applied at the top of the wall.

Joist: Horizontal load bearing members that run from wall to wall, wall to beam, or beam to beam to support a ceiling, roof, or floor.

Lateral force-resisting element: Part of a building, such as a shear wall, designed and constructed to resist racking, overturning, and sliding resulting from wind or earthquake loading.

Load path: A course along which seismic inertia forces are transferred from the superstructure to the foundation.

Moment frame: Beams and columns joined by a combination of welding and bolting used to prevent any change in angle between the beam and column; used to resist lateral loads through bending of the frame elements.

Open-web steel joist: A light-weight steel truss that spans between girders and provides support for roof or floor decking.

Pre-cast concrete: A form of construction where concrete is cast in a reusable mold which is then cured in a controlled environment, transported to the construction site, and lifted into place.

Pre-engineered: Design by a manufacturer for highly efficient use of materials.

Quick Shear Check: Analysis procedure used in Tier 1 Evaluations to determine if the lateral-force-resisting system has sufficient strength and/or stiffness.

Shear strength: The ability of the internal stresses of the material to resist externally applied loads.

Shear stress: The internal force of a member distributed over the cross-sectional area due to the external force of a load applied perpendicular to the main axis of the member.

Shear wall: Wall designed to counter the effects of lateral loads (such as wind and earthquake loads) acting on a structure

Sheathing: A layer of boards or of other wood or fiber materials applied to wall studs, joists, or rafters of a building to strengthen the structure.

Spalling: Chipping and flaking of concrete or masonry material, usually caused by freeze/thaw cycles of water seeping into cracks in the material.

Spread footing: A wide, isolated foundation element usually made of reinforced concrete.

Strongback: A beam or girder that acts as a secondary support member.

Tilt-up wall: A type of concrete wall construction in which a concrete wall is pre-cast then lifted into place.

Topping slab: An additional layer of concrete used to provide a level floor surface or to increase strength if reinforced properly.

Torsional irregularity: Occurs when the distance between the story center of mass and the story center of rigidity is greater than 20 percent of the building width in either direction.

Wall anchorage: A fastener that attaches the wall to either the ceiling or the foundation in order to provide a path for loads to transfer though the building to the foundation.

1.0 Executive Summary

Reid Middleton, Inc. performed preliminary seismic evaluations for the City of Everett's Public Works Buildings 1 and 4. These two buildings house the administrative, emergency management, and response command and control capability, and are located on the same site in downtown Everett. Their functions are critical to the City of Everett's ability to coordinate a response after a seismic event. The evaluations reviewed each building's expected seismic performance, to identify potential structural deficiencies that may affect their performance during an earthquake.

Seismic evaluations were based on methods provided in the American Society of Civil Engineers (ASCE) Standard 31-03, *Seismic Evaluation of Existing Buildings* (ASCE 31). Based on this analysis, both buildings were found to have numerous lateral system deficiencies. Neither building appears likely to house ongoing operations and restoration services after a significant seismic event.

The following improvements are recommended for Building 1:

- Clean, seal and waterproof deteriorating steel and concrete cracks.
- Add steel strongbacks at existing concrete masonry unit (CMU) walls and high bay tilt-up concrete walls.
- Supplement existing wall connections with steel angles and epoxy anchors at the base of tilt-up walls.
- Perform further study of roof and high bay shear walls.

The following improvements are recommended for Building 4:

- Add approximately six steel braced frames
- Add new wood shear walls
- Convert existing gypsum wallboard (GWB) shear walls to plywood shear walls with hold-downs
- Further study of roof, roof connections and existing metal frames.
- Replace the existing roof diaphragm with a heavier-gauge steel roof.
- Add approximately four additional steel braced frames beyond those proposed for LS.

The opinion of probable cost for these improvements totals between $3 and $5.5 million. This includes construction costs and an estimate of design and permitting fees. It does not include temporary relocation costs.

As an alternative to making these upgrades, the City of Everett may choose to study other existing buildings that may offer superior seismic performance, or to consider potential new building locations.

2.0 Introduction

Reid Middleton, Inc. performed preliminary seismic evaluations for the City of Everett's Public Works Buildings 1 and 4. The evaluations reviewed the expected seismic performance of each building to identify potential structural deficiencies that may affect its performance during an earthquake.

The seismic evaluations do not consider compliance with the seismic requirements of the current building code for new construction. Buildings designed prior to the current or recent building codes often include structural configurations and detailing that do not comply with current code requirements. Buildings designed to older building code standards are evaluated using evaluation and design guidelines specifically developed for existing structures by the Federal Emergency Management Agency (FEMA) and the American Society of Civil Engineers (ASCE). The International Building Code (IBC) includes these documents as reference standards for the seismic evaluation of existing buildings.

The findings and recommendations presented in this report are primarily based on visual examinations of the buildings and a review of record drawings provided by the City of Everett. The available record documents do not contain the information necessary to confirm the structural configuration of some portions of the buildings, which is typical for pre-engineered buildings and buildings of this age.

Reid Middleton, Inc. participated in a walk-through of each building and performed limited visual observations of existing conditions. Neither destructive nor non-destructive testing was performed to confirm or supplement information shown in the record drawings. Additional review, which may include material testing and removal of some existing finishes, would be required to confirm some structural conditions and for design of seismic upgrades.

2.1 Building Use and Occupancies

Public Works Building 1 is occupied by the City of Everett Public Works and the City of Everett Building Department. Public Works is responsible for water and wastewater systems, surface and stormwater management, street maintenance, and environmental programs and associated services. The Building Department is responsible for building construction review, inspection, and permitting, zoning, and fire safety inspections. These operations are all important for ongoing operations and restoration of services within the City of Everett after an earthquake. The majority of spaces within Building 1 are for office and administrative use. Some public access spaces exist in the building. The northern end of the building is used for storage, including a parking bay for a Public Works truck and associated equipment.

Public Works Building 4 includes vehicle storage, maintenance, and shop spaces in addition to some office and administration spaces. Shops include equipment for activities including painting, welding, water meter maintenance and testing, street sign fabrication, and other public works functions. Many vehicle parking and loading bays are included in the building, requiring large openings on the building's eastern face. The office spaces include dispatch areas for crews to gather before and after their work days.

3.0 Evaluation Criteria

The current standard for the seismic evaluation of existing buildings is ASCE Standard 31-03, *Seismic Evaluation of Existing Buildings* (ASCE 31). ASCE 31 is a screening and evaluation document used to identify potential seismic deficiencies that may require additional seismic evaluation or hazard mitigation. The document presents a three-tiered review process implemented by following a series of comprehensive checklists and "quick check" calculations. Each successive tier is designed to perform an increasingly refined evaluation procedure for seismic deficiencies identified in previous tiers in the process.

TIER 1 – Screening Phase

- Checklists of evaluation statements to quickly identify potential deficiencies
- Requires field investigation and/or review of record drawings
- Analysis limited to "Quick Checks" of global elements
- May proceed to Tier 2, Tier 3, or rehabilitation design if deficiencies are identified

TIER 2 – Evaluation Phase

- "Full Building" or "Deficiency Only" evaluation
- Address all Tier 1 seismic deficiencies
- Analysis more refined than Tier 1, but limited to simplified linear procedures
- Identify buildings not requiring rehabilitation

TIER 3 – Detailed Evaluation Phase

- Component-based evaluation of entire building using reduced ASCE 41 forces
- Advanced analytical procedures available if Tier 1 and/or Tier 2 evaluations are judged to be overly conservative
- Complex analysis procedures may result in construction savings equal to many times their cost

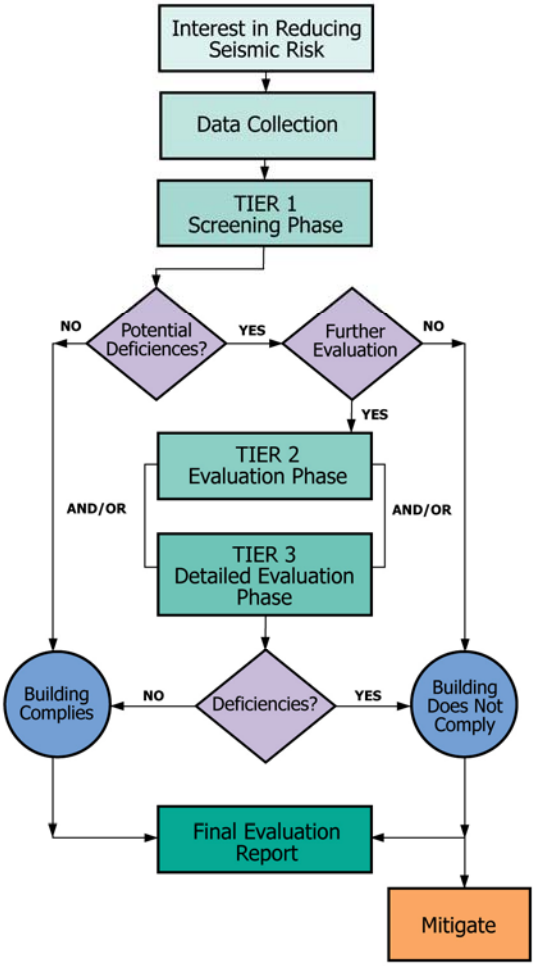

Figure 3-1. Flow Chart and Description of ASCE 31 Seismic Evaluation Procedure

Tier 1 checklists screen for potential seismic deficiencies by examining the lateral force-resisting systems and details of the structure in comparison with configurations that have historically caused poor seismic performance in similar buildings. Tier 1 includes basic analyses for primary components of the lateral system, such as columns, frames, and beams. Tier 2 provides more detailed evaluations for deficiencies identified in the Tier 1 review. Tier 3 involves analyses with a higher level of detail and review of each structural component's seismic demand and capacity.

This report presents the findings from ASCE 31-03 Tier 1 evaluations of the City of Everett Public Works Buildings 1 and 4. Because these buildings provide both routine administrative functions and also first-response capabilities and important post-disaster recovery functions for the City of Everett, the City of Everett requested that they be evaluated with respect to both Life Safety (LS) and Immediate Occupancy (IO) Performance Levels. Buildings that meet IO Performance Level are expected to be structurally functional following a seismic event, but may experience some damage to architectural finishes, mechanical systems, electrical systems, and other nonstructural items.

Also contained in this report is concept-level structural seismic upgrade information for each building, using information from the Tier 1 evaluations, experience with similar buildings, and engineering judgment. These concepts discuss schematically the extent of structural work required for the buildings to achieve IO Performance Level. More detailed seismic evaluation work and additional development of design concepts would be necessary to advance the seismic upgrade designs to a level suitable for implementation.

Preliminary planning-level cost estimates were developed for each seismic upgrade concept. These estimates are based on upgrade costs for similar buildings and suggestions provided in FEMA standards. They have been reviewed against the concept-level upgrade information generated, to determine whether these building have elements that deviate substantially from similar buildings upgraded in the past. These estimates are intended to help the City with future planning, to decide whether the buildings can be seismically upgraded in a cost-effective manner. Additional development of upgrade concepts should be performed before these cost estimates are used to establish a detailed Seismic Improvements Program budget. Additional detailed cost estimate information may also be required for grant applications that may be used to help secure funding for recommended improvements.

4.0 Seismic Evaluations

4.1 Public Works Building 1

4.1.1 Building Description

Year Built:	1971
Number of Stories:	2
Floor Area:	35,500 SF
Address:	3200 Cedar Street

Public Works Building 1 is a two-story, pre-cast concrete tilt-up wall building with metal roof framing and a concrete-on-metal-deck second floor. The building is rectangular with plan dimensions of approximately 355 by 100 feet. The maximum roof height is approximately 24 feet above adjacent grade. The north end of the building is an open high bay area with no second story. Two remodels and an entry addition were made to the original construction, including additional second-floor space with associated concrete masonry unit (CMU) shear walls. The majority of the building is office/administrative space with storage at the high bay.

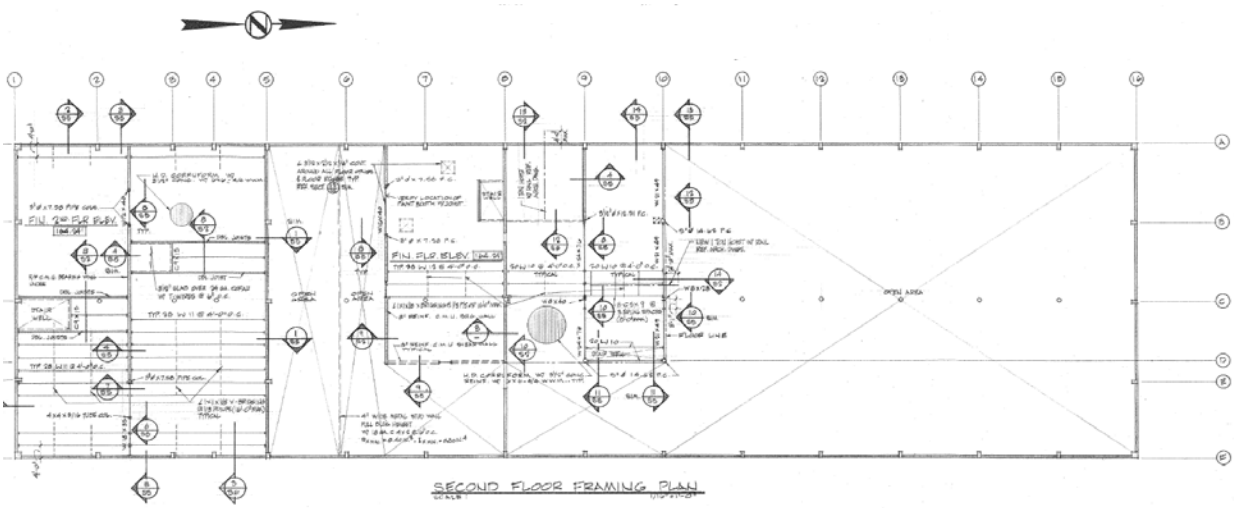

Figure 4.1-1. Public Works Building 1, Original Second Floor Plan

4.1.1.1 Structural System

The following table summarizes the building's general structural features. Commentary for each structural system is included.

Table 4.1-1. Structural System Description of Public Works Building 1

Structural System	Description
Roof	The unfilled 1½-inch metal roof deck is framed by 28-inch-deep open web steel joists spanning between steel beams running longitudinally at the perimeter and at the center of the roof.
Floor	The second floor is framed by long-span open web steel joists supporting 1½-inch metal deck with 3½-inch concrete topping.
Foundations	Foundations consist of reinforced concrete continuous footings supporting CMU and tilt-up walls, with spread footings added at cast-in-place concrete columns located at corners and between tilt-up walls. Spread footings also support steel pipe columns occurring along the center of the building.
Lateral System	The lateral system consists of reinforced concrete tilt-up walls at the perimeter and one interior tilt-up wall along the transverse direction at Grid 5. At many locations at the building interior are 6-inch and 8-inch reinforced CMU walls. Some of these CMU walls are full height and some occur only at the first floor.

4.1.2 Seismic Evaluation Findings

4.1.2.1 Seismic Deficiencies

The following table summarizes the seismic deficiencies identified during the Tier 1 evaluation. Commentary for each deficiency is included.

Table 4.1-2. Identified Seismic Deficiencies for Public Works Building 1

Deficiency	Description
Deterioration of Steel	The base connections of the tilt-up walls to the foundation were observed to be rusted in some locations at the high bay, with pieces of steel flaking off. These are the only connections of the tilt-up walls to the foundation and are therefore critical to the walls' seismic stability.
Deterioration of Concrete	Some spalling and cracking of the concrete shear walls was observed, particularly at the high bay. It appears that many cracks have been patched with epoxy sealant.
Reinforcing Steel of CMU Walls	The horizontal and vertical reinforcement is less than required by Tier 1 standards, which could lead to cracking and failing of the CMU walls.
Wall Anchorage at High Bay	At the high bay area at the north end of the building, the deck spans in the north-south (longitudinal) direction. The weak-axis connection of the deck to tilt-up wall does not meet the IO Performance Objective, but is acceptable for LS.

Table 4.1-2 (continued). Identified Seismic Deficiencies for Public Works Building 1

Deficiency	Description
Transfer to Shear Walls	The shear strength of the diaphragm and connection of the diaphragm to shear walls is unknown at many locations. Sufficient information is not provided in the Drawings.
Concrete Column Dowels	No column dowels are indicated in the Drawings, and it is unknown whether there are dowels at the cast-in-place concrete columns.
Foundation Dowels at Precast Tilt-Up Walls	Dowels and welded connections in the tilt-up walls do not have the capacity to develop the strength of the walls. As noted above, many exhibit significant deterioration.
Wall Openings in West Wall	The number of wall openings in the west wall is greater than permissible to meet the IO Performance Objective, but are acceptable for LS. Based on the higher performance requirement of IO, a more restrictive standard is provided for IO than LS.
Wall Thickness at High Bay	The unsupported wall height at the high bay requires a wall thickness of 11.5 inches to meet the IO Performance Objective's thickness/height ratio. The existing wall is approximately 6 inches thick and does not meet this criterion. Tall thin walls often exhibit poor seismic behavior.
Diaphragm Openings at Shear Walls	The open high bay area causes this deficiency, because a second floor does not occur at this location. This reduces the amount of shear wall available to resist the forces of the second floor and the roof above.
Non-Concrete Filled Diaphragms	The span of the un-topped metal roof deck is greater than permissible to meet the IO Performance Objective. Long spans of thin metal deck often perform poorly at distributing seismic forces.
Precast Panel to Diaphragm Connections	There are no anchors from precast panels to the diaphragm. An embedded plate is welded to steel deck.
Roof Panel Connections	The connection of the roof to framing is unknown.

4.1.3 Structural Upgrade Concept Design

Schematic-level upgrade concepts to improve the lateral force-resisting system (LFRS) to meet the IO Performance Objective were developed. The upgrade concept involves mitigating deteriorating building materials, adding support to existing walls and columns, and improving the roof diaphragm. The following steps would be required to address the deficiencies noted in Table 4.1-2:

- The deteriorating steel connections at the base of the tilt-up walls will require cleaning, sealing, and waterproofing at the exterior face of the wall to prevent further deterioration. This work should be performed at locations where water intrusion has been observed and at locations where exterior landscaping is immediately adjacent to the building wall. This work will also likely help inhibit the spalling observed along the exterior wall. Supplementary connections will be required at locations where existing conditions have significantly deteriorated (see below).

- Structural steel strong-backs can be anchored to the inside face of existing shear walls, to reduce spanning issues that exist due to more stringent detailing requirements of updated codes. Providing strong-backs at existing CMU walls will reduce the chance of cracking and fall-out of CMU due to out-of-plane motion. The unsupported wall height at the high bay walls can also be supported by adding strong-backs to reduce the flexure of the walls. Strong-back members are typically structural steel tube (HSS) or wide-flange sections, depending on available space and required loads.

- Adding steel angles with epoxy anchors to the base of tilt-up walls and columns can mitigate the deteriorating connection and improve the building's uplift and in-plan shear capacities.

- The identified deficiencies that involve the roof diaphragm and its connection to tilt-up walls require additional investigation. The roof diaphragm does not appear to be adequate to transfer forces to the shear walls. Although connection of the roof diaphragm to the tilt-up walls is not fully detailed in existing Drawings, it is unlikely to be strong enough based on the capacity thin-gauge decking provided.

- The shear walls at the high bay area at the north end of the building also require further study. Although the Quick Shear Check showed that the concrete walls are compliant on a global basis, it is anticipated that the shear resistance at the high bay area will not be adequate. This is due to the large door openings and reduced amount of shear walls present in this area.

The opinion of probable cost for structural upgrades to this building, based on FEMA 156, *Typical Costs for Seismic Rehabilitation of Existing Buildings*, Option 3, is approximately $50 to $100 per square feet. This totals $2.0 million to $3.5 million dollars for the entire building. An upgrade for IO standards is likely to be near the high end of this range.

4.1.4 Recommendations

Public Works Building 1 does not meet the IO or LS performance levels, as determined by the ASCE 31-03 Tier 1 Evaluation. Due to the extent of the deficiencies, extensive damage and potential failure of the lateral force-resisting system during a design-level earthquake is possible. Collapse of the structure poses a risk to building occupants, and limits the building’s ability to remain functional and provide first-response capabilities for post-earthquake recovery.

Based on this building's critical role as part of the City of Everett’s administrative center and its expected role in post-seismic recovery, it is recommended that the building be upgraded to meet the IO Performance Objective. The City of Everett may also wish to review other potential locations for staging post-earthquake recovery operations. Buildings built to more modern seismic standards may have smaller upgrade costs and could prove to be more cost-effective to upgrade.

4.2 Public Works Building 4

4.2.1 Building Description

Year Built:	1984
Number of Stories:	2
Floor Area:	14,887 SF
Address:	3125 Hill Avenue

Public Works Building 4 is a two-story, pre-engineered metal building with metal roof framing and a wood-framed second floor over much of its footprint. The structure was built in two phases, with similar framing used in each phase. In plan, the building is rectangular and approximately 200 feet by 50 feet. The lateral system is light steel moment frames and wood and gypsum shear walls. The maximum roof height is approximately 20 feet above the adjacent grade. Much of the building's center and eastern portions are open high bays with no second story.

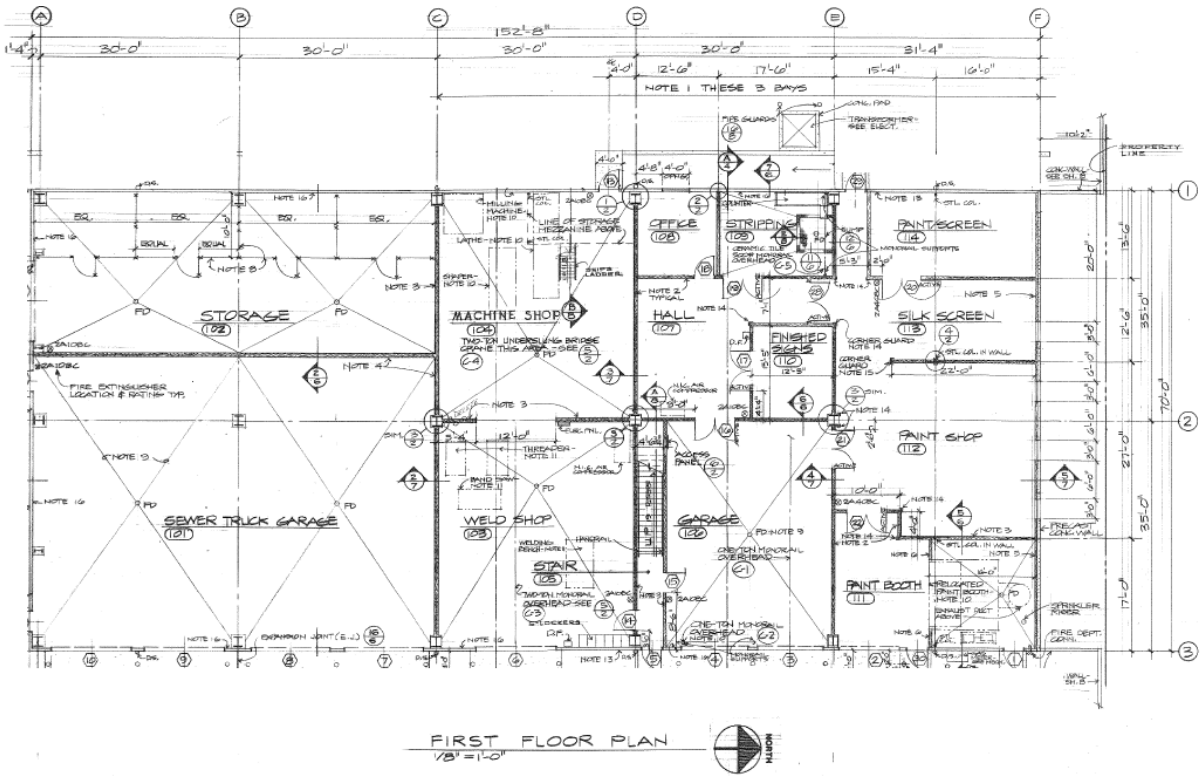

Figure 4.2-1. Public Works Building 4, Original Floor Plan

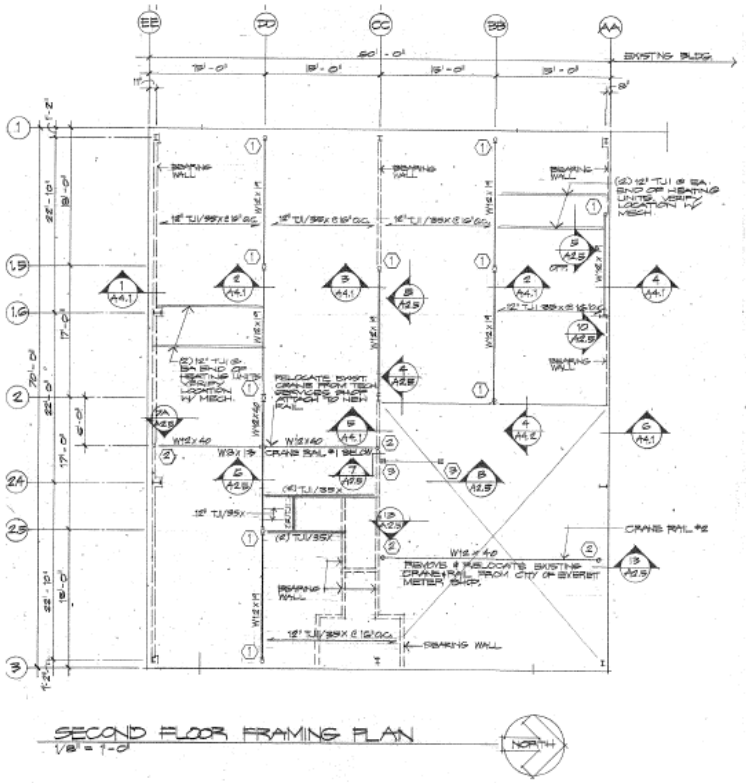

Figure 4.2-2. Public Works Building 4, 1991 Addition

4.2.1.1 Structural System

The following table summarizes the building's general structural features. Commentary for each structural system is also included.

Table 4.2-1. Structural System Description of Public Works Building 4

Structural System	Description
Roof	Pre-engineered metal roof system; untopped metal roof deck supported by purlins spanning steel moment frames. No information on the roof system is provided in record drawings.
Floor	Second-floor areas are wood-framed with glulam beams in the original construction, and engineered wood joists in the addition.
Foundations	Continuous reinforced concrete footings support interior shear walls. Spread footings are located at each pre-engineered moment frame. A reinforced thickened slab edge supports perimeter walls.
Lateral System	The lateral system at the original construction consists of pre-engineered moment frames supplemented with full and partial-height gypsum wall board shear walls and wood shear walls. One full-height concrete shear wall exists at the north face of the building. This wall is intended to make the building appear similar to Building 1 when viewed from Pacific Avenue. The addition's lateral system is mainly gypsum wall board shear walls with one wood shear wall.

4.2.2 Seismic Evaluation Findings

4.2.2.1 Seismic Deficiencies

The following table summarizes seismic deficiencies identified during the Tier 1 evaluation. Commentary for each deficiency is also included.

Table 4.2-2. Identified Seismic Deficiencies for Public Works Building 4

Deficiency	Description
Load Path at Roof	The connection between the roof diaphragm and lateral system framing is not noted in the Drawings and could not be determined.
Torsional Irregularity	The concrete shear wall at the north end of the building is much stiffer than the rest of the building and pulls the center of rigidity north of the center of mass by 25 percent of the building width. This is greater than the 20-percent limit specified by ASCE 31. Buildings with significant torsional irregularities are at risk for poor seismic performance.
Axial Stress of Bracing	Tension cables are typical in pre-engineered metal buildings, to provide resistance in the longitudinal direction. However, due to multiple large door openings at the east face, no tension cables were observed. Evidence of possible tension cables on the building's west wall was observed, but it is unknown how many (if any) are present. One tension bracing cable was observed in the transverse direction at the end of the original building construction. It was not tight and therefore will not perform as intended.

Table 4.2-2 (continued). Identified Seismic Deficiencies for Public Works Building 4

Steel Column Foundation Connection	Information on steel columns and anchorage is unknown, for determining whether the capacity is adequate to meet the IO Performance Objective. Anchors were observed during field investigation, which is sufficient to meet the LS Performance Objective.
Wall Panel Connection	Connection of the metal wall panels to the foundation is not documented in the Drawings and is unknown.
Pre-Engineered Metal Building	The steel framing system cannot be analyzed due to the lack of information provided in the Drawings. This is typical for this type of construction. Information on the system is only provided in Shop Drawings reviewed during construction. Extensive field investigation work, including removal of finishes at many locations, would be required to determine the frame capacity.
Diaphragm Reinforcement at Openings	Several openings in the second-floor diaphragm do not have the reinforcing at edges needed to drag the load to the shear walls or moment frames.
No Redundancy of Shear Walls at Second Floor	At the second floor in the original construction, there is only one shear wall in the longitudinal direction.
Shear Stress in Shear Walls	Gypsum wallboard (GWB) is not a ductile material and thus does not provide resistance for long-duration shaking. GWB shear walls will likely fail and redistribute seismic forces to wood shear walls. Most of the shear walls are GWB and will not effectively resist seismic forces on the building through many cycles of shaking. The remaining wood shear walls do not have enough capacity to resist loads if the GWB shear walls fail.
Wood Sills	Record drawings indicate wood sill anchor bolts are spaced at 6 feet on center. This does not meet the requirement for the IO Performance Objective, but is acceptable for LS. Connection of the window framing to the wood sills is not noted in the Drawings and could not be determined in the field.
Hold-Down Anchors	At the building's 1991 addition, no hold-down anchors are provided at the ends of the GWB shear walls. Lack of hold-down anchors may cause lack of continuity between floors and damage due to racking and uplift.

4.2.3 Structural Upgrade Concept Design

Schematic-level upgrade concepts to improve the lateral force-resisting system (LFRS) were developed for this evaluation. The upgrade concept is to globally improve the building's lateral resistance by adding shear capacity and stiffness to the lateral system. This would be accomplished by adding steel braced frames, adding new wood shear walls, and improving some existing GWB shear walls. The following steps would be required to address the deficiencies noted in Table 4.2-2:

- Steel braced frames can be added to several of the longitudinal and transverse frames in the building's original portion, to reduce the torsional effects and provide lateral resistance in the north-south direction. It is anticipated that approximately six frames would be required. The new braced frames would require large, concrete footings to resist seismic overturning.

- Prior to final determination of a braced frame design, removal of existing finishes along some portions of the roof-to-frame connections would be required. This would determine whether the roof has sufficient shear capacity and connection capacity to distribute seismic forces to the new frame elements. If the capacity is found to be inadequate, a new, heavier-gauge metal roof with added connections may be required to replace the existing metal roof.

- In the building’s 1991 addition, the perimeter GWB shear walls can be converted into plywood sheathed shear walls to improve the lateral force resisting system. New plywood shear walls may also be required at various locations in the building.

- Hold-downs and supplemental sill anchors can be added to the new and existing shear walls, to provide a complete load path between the second and first floors and from the first floor to the foundation.

These upgrades would bring the performance level up to LS Performance Objective. In order to provide IO performance, the roof diaphragm and existing moment frame system would require further study. As noted above, it is unclear whether the roof can resist LS seismic loads. It is anticipated, based on building type and typical construction at the time, that the roof would not be able to resist IO loads. The IO upgrade would likely require a new roof diaphragm and two to four additional steel braced frames beyond those proposed for LS, to improve the existing moment frame lateral system in the east-west direction.

The opinion of probable cost for structural upgrades to this building, based on FEMA 156, *Typical Costs for Seismic Rehabilitation of Existing Buildings*, Option 2 is approximately 66 dollars per square feet for the LS Performance Objective, totaling $1 million. To bring the building up to IO would be approximately 120 dollars per square feet, totaling approximately $2 million. As noted above, the capacity of the roof and pre-engineered frames are significant unknowns that may affect this cost.

4.2.4 Recommendations

Public Works Building 4 does not meet the LS or IO performance levels, as determined by the ASCE 31-03 Tier 1 Evaluation. Due to the extent of the deficiencies and because of the type of construction, extensive damage and potential failure of the lateral force-resisting system during a design-level earthquake is possible. Based on the building type, it is recommended that this building be upgraded to the LS Performance Objective. Achieving the IO Performance Objective on this building type does not seem likely to prove economical, due to limited documentation of the existing lateral system and difficulties involved with strengthening proprietary structural elements. Pre-engineered metal buildings do not use the same kinds of structural steel shapes and connections common in other building, and generally use shapes and geometries custom fabricated for the project. This complicates the task of analyzing and upgrading these buildings.

It is understood that the City of Everett may want to use Public Works Building 4 as a hub for coordinating public works operations required for post-seismic recovery. For this reason, it would be ideal to upgrade to meet the IO Performance Objective. However as noted above, this may not be economically feasible. Upgrading to LS Performance may be a reasonable compromise, if supplemental staging areas are available in the event that this building is severely damaged. The City of Everett may wish to review other potential locations for staging Public Works operations for post-earthquake recovery.

5.0 Conclusion

The City of Everett's Public Works Buildings 1 and 4 were seismically evaluated based on criteria provided in the American Society of Civil Engineers Standard 31-03 (ASCE 31). These evaluations found numerous deficiencies in both structures. The two buildings provide office space, storage, public access, and maintenance shops for the Public Works and Building Departments. Public works crews maintain essential City services such as water, sewer, storm drainage, and streets. For these reasons, the buildings would be important for ongoing operations and restoration of services to the City of Everett after a seismic event. Seismic upgrade of both structures is recommended. Conceptual seismic upgrade designs were prepared for both buildings.

For Public Works Building 1, the following improvements are recommended:

- Clean, seal and waterproof deteriorating steel and concrete cracks.
- Add steel strongbacks at existing CMU walls and high bay tilt-up concrete walls.
- Supplement existing wall connections with steel angles and epoxy anchors at the base of tilt-up walls.
- Further study of the roof and high bay shear walls

The total opinion of probable cost for these improvements is $2 and $3.5 million. This includes construction costs as well as an estimate of design and permitting fees. It does not include the temporary relocation costs.

For Public Works Building 4, the following improvements are recommended for Life Safety (LS):

- Add approximately six steel braced frames
- Add new wood shear walls
- Convert existing GWB shear walls to plywood shear walls with hold-downs
- Further study of the roof, roof connections, and existing metal frames.

To bring the building to IO Performance Level, the following additional improvements would be required:

- Replace the existing roof diaphragm with a heavier-gauge steel roof.
- Add approximately four additional steel braced frames beyond those proposed for LS.

The total opinion of probable cost for these improvements is $1 and $2 million. This includes construction costs as well as an estimate of design and permitting fees. It does not include the temporary relocation costs.

As an alternative to making these upgrades, the City of Everett may choose to study other existing buildings that may offer superior seismic performance, or to consider potential new building locations.

APPENDIX A

ASCE Tier 1 Checklists

General Basic Structural Checklist

This General Basic Structural Checklist shall be completed where 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 standard, 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; corresponding section numbers are in parentheses following each evaluation statement.

BUILDING SYSTEM

General

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			LOAD PATH: The structure shall contain a minimum of 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)	
X			ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	
X			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)	2nd floor is braced to the main structure.

Configuration

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	
X			SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	
X			GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	
X			VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	

X			MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	
X			TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)	The 2nd floor is 19.7 percent of the building width.

Condition of Materials

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	Wood is not present in the building construction.
		X	WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15 percent of inadequate fastening such as overdriven fasteners, omitted blocking, excessive fastening spacing, or inadequate edge distance. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.3.3.2)	Wood is not present in the building construction.
	X		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)	The base connection of the precast concrete panels is very rusted at every location in view.
	X		DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting system elements. (Tier 2: Sec. 4.3.3.4)	Some spalling and cracking of concrete shear walls
		X	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)	Post-tensioning is not present in the building construction.
	X		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)	The base connection of the precast concrete panels is very rusted at every location in view.
X			MASONRY UNITS: There shall be no visible signs of deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	
X			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)	
X			CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)	Multiple cracks in the exterior elements have been epoxy filled.

General Basic Structural Checklist

X			REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)	
		X	UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in wall elements greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy or out-of-plane offsets in the bed joint greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.11)	
		X	CRACKS IN INFILL WALLS: There shall be no existing diagonal cracks in infilled walls that extend throughout a panel greater than1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy. (Tier 2: Sec. 4.3.3.12)	
		X	CRACKS IN BOUNDRY COLUMNS: There shall be no existing diagonal cracks wider than 1/8 inch for Life Safety and 1/16 inch 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	EVALUATION STATEMENT	COMMENT
X			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	EVALUATION STATEMENT	COMMENT
		X	INTERFERING WALLS: All concrete and masonry 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	EVALUATION STATEMENT	COMMENT
		X	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)	
		X	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	EVALUATION STATEMENT	COMMENT
		X	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 $2(f'_c)^{1/2}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.1)	
		X	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)	

General Basic Structural Checklist

Precast Concrete Moment Frames

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	PRECAST CONNECTION CHECK: The precast connections at frame joints shall have the capacity to resist the shear and moment demands calculated using the Quick Check 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	EVALUATION STATEMENT	COMMENT
X			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	EVALUATION STATEMENT	COMMENT
X			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	EVALUATION STATEMENT	COMMENT
		X	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 the greater of 100 psi or $2(f'_c)^{1/2}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)	See Precast Concrete Shear Walls.
		X	REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less 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 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)	
		X	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)	

General Basic Structural Checklist

Precast Concrete Shear Walls

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			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 the greater of 100 psi or $2(f'c)^{1/2}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.1)	Shear stress is 42psi, less than 100psi.
X			REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing in the reinforcing steel shall be equal to or less than 18 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.2)	$\rho = 0.0056 > 0.0015$.

Reinforced Masonry Shear Walls

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			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 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)	Shear stress is 42 psi, less than 70psi.
	X		REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)	Horizontal and vertical reinforcement ratio does not meet the 0.002 requirement, but is larger than the minimum 0.007.

Unreinforced Masonry Shear Walls

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	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 30 psi for clay units and 70 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	EVALUATION STATEMENT	COMMENT
		X	WALL CONNECTIONS: Masonry shall be in full contact with frame for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.6.1)	

General Basic Structural Checklist

Walls in Wood-Frame Buildings

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	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: 1,000 plf Diagonal sheathing: 700 plf Straight sheathing: 100 plf All other conditions: 100 plf	
		X	STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)	
		X	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 with the exception of the uppermost level of a multi-story building. (Tier 2: Sec. 4.4.2.7.3)	
		X	NARRROW 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 in levels of moderate and high seismicity. Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of low seismicity. (Tier 2: Sec. 4.4.2.7.4)	
		X	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)	
		X	HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story due to a sloping site, 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)	
		X	CRIPPLE WALLS: Cripple walls below first-floor-level shear walls shall be braced to the foundation with wood structural panels. (Tier 2: Sec. 4.4.2.7.7)	
		X	OPENINGS: Walls with openings greater than 80 percent of the length shall be braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or shall be supported by adjacent construction through positive ties capable of transferring the lateral forces. (Tier 2: Sec. 4.4.2.7.8)	

General Basic Structural Checklist

Braced Frames

General

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	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)	
		X	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 $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)	
		X	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. 4.4.3.1.3)	

General Basic Structural Checklist

DIAPHRAGMS

Precast Concrete Diaphragms

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

CONNECTIONS

Anchorage for Normal Forces

C	NC	N/A	EVALUATION STATEMENT	COMMENT
LS	IO		WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	For BSE-1 at IO the deck-to-wall connection at high bay areas (North Wall) will not have adequate strength to resist the connection force.
		X	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)	

Shear Transfer

C	NC	N/A	EVALUATION STATEMENT	COMMENT
LS	IO		TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragm for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	Roof deck material and connection unknown.
		X	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 lesser of the strength of the frames or the diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)	
		X	TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled for transfer of forces into the shear wall or frame elements for Life Safety, and the dowels shall be able to develop the lesser of the shear strength of the walls, frames, or slabs for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)	

General Basic Structural Checklist

Vertical Components

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	STEEL COLUMNS: The columns in the lateral-force-resisting frames shall be anchored to the building foundation for Life Safety, and the anchorage shall be able to develop the lesser of the tensile capacity of the column, the tensile capacity of the lowest level column splice (if any), or the uplift capacity of the foundation, for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)	Steel columns are not part of the LFRS but are anchored to the foundation.
	X		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 reinforcement in the columns of lateral-force-resisting system for Immediate Occupancy. (Tier 2: Sec. 4.6.3.2)	The concrete column dowels are unknown.
		X	WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)	
		X	WOOD SILLS: All wood sills shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)	
	X		FOUNDATION DOWELS: Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)	The dowels do not have the capacity to develop the strength of the walls.
	X		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)	The concrete column dowels are unknown.
	X		PRECAST WALL PANELS: Precast wall panels shall be connected to the foundation for Life Safety and the connections shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.7)	The dowels do not have the capacity to develop the strength of the walls.
		X	WALL PANELS: Metal, fiberglass, or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.3.8)	

Interconnection of Elements

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	

Panel Connections

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			ROOF PANELS: Metal, plastic, or cementitious roof panels shall be positively attached to the roof framing to resist seismic forces for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.5.1)	
X			WALL PANELS: Metal, fiberglass, or cementitious wall panels shall be positively attached to the framing to resist seismic forces for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.5.2)	

General Supplemental Structural Checklist

This General Supplemental Structural Checklist shall be completed where 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	EVALUATION STATEMENT	COMMENT
		X	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)	Moment frames are not present in the building construction.
		X	PANEL ZONES: All panel zones shall have the shear capacity to resist the shear demand required to develop 0.8 times the sum of the flexural strengths of the girders framing in at the face of the column. (Tier 2: Sec. 4.4.1.3.4)	
		X	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)	
		X	STRONG COLUMN/WEAK BEAM: The percentage of strong column/weak beam joints in each story of each line of moment-resisting frames shall be greater than 50 percent for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.6)	
		X	COMPACT MEMBERS: All moment frame elements shall meet section requirements set forth by *Seismic Provisions for Structural Steel Buildings* Table I-9-1 (AISC, 1997). (Tier 2: Sec. 4.4.1.3.7)	
		X	BEAM PENETRATIONS: All openings in frame-beam webs shall be less than ¼ 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)	
		X	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)	
		X	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)	
		X	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)	

General Supplemental Structural Checklist

Concrete Moment Frames

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	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)	
		X	PRESTRESSED FRAME ELEMENTS: The lateral-load-resisting frames shall not include any prestressed or post-tensioned elements where average prestress exceeds the lesser of 700 psi or $f'_c/6$ at potential hinge locations. The average prestress shall be calculated in accordance with the Quick Check procedure of Section 3.5.3.8. (Tier 2: Sec. 4.4.1.4.4)	
		X	CAPTIVE COLUMNS: There shall be no columns at a level with height/depth ratios less than 50 percent of the normal height/depth ratio of the typical columns at that level for Life Safety and 75 percent for Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.5)	
		X	NO SHEAR FAILURES: The shear capacity of frame members shall be able to develop the moment capacity at the ends of the members. (Tier 2: Sec. 4.4.1.4.6)	
		X	STRONG COLUMN/WEAK BEAM: The sum of the moment capacity of the columns shall be 20 percent greater than that of the beams at frame joints. (Tier 2: Sec. 4.4.1.4.7)	
		X	BEAM BARS: At least two longitudinal top and two longitudinal bottom bars shall extend continuously through the length of each frame beam. At least 25 percent 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)	
		X	COLUMN-BAR SPLICES: All column bar lap splice lengths shall be greater than $35d_b$ for Life Safety and $50d_b$ for Immediate Occupancy, and shall be enclosed by ties spaced at or less than $8d_b$ for Life Safety and Immediate Occupancy. Alternatively, column bars shall be spliced with mechanical couplers with a capacity of at least 1.25 times the nominal yield strength of the spliced bar. (Tier 2: Sec. 4.4.1.4.9)	
		X	BEAM-BAR SPLICES: The lap splices or mechanical couplers for longitudinal beam reinforcing shall not be located within $1_b/4$ of the joints and shall not be located in the vicinity of potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.10)	
		X	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 $8d_b$ for Life Safety and Immediate Occupancy at all potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.11)	
		X	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 $8d_b$ or $d/4$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.12)	

		X	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)	
		X	JOINT ECCENTRICITY: There shall be no eccentricities larger than 20 percent 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)	
		X	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	EVALUATION STATEMENT	COMMENT
		X	PRECAST FRAMES: For buildings with concrete shear walls, precast concrete frame elements shall not be considered as primary components for resisting lateral forces. (Tier 2: Sec. 4.4.1.5.2)	
		X	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	EVALUATION STATEMENT	COMMENT
		X	DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the elements for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, .4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)	
		X	FLAT SLABS: Flat slabs/plates not part of the lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)	

General Supplemental Structural Checklist

Shear Walls

Concrete Shear Walls

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	COUPLING BEAMS: The stirrups in coupling beams over means of egress shall be spaced at or less than d/2 and shall be anchored into the confined core of the beam with hooks of 135° or more for Life Safety. All coupling beams shall comply with the requirements above and 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)	See Precast Concrete Shear Walls.
		X	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)	
		X	CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spiral or ties with spacing less than $8d_b$. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)	
		X	REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings with a dimension great than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)	
		X	WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)	
		X	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	EVALUATION STATEMENT	COMMENT
LS	IO		WALL OPENINGS: The total width of openings along any perimeter wall line shall constitute less than 75 percent of the length of any perimeter wall for Life Safety and 50 percent for Immediate Occupancy with wall piers having aspect ratios of less than 2-to-1 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.3)	Total width of openings at West Wall at 66 percent.
		X	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)	

X			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)	
LS	IO		WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.6)	The north end where the unsupported wall height is 24 feet requires thickness of 11.5 in and is 6 in.

Reinforced Masonry Shear Walls

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcement on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)	
X			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	EVALUATION STATEMENT	COMMENT
		X	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	
		X	MASONRY LAY-UP: Filled collar joints of multi-wythe masonry walls shall have negligible voids. (Tier 2: Sec. 4.4.2.5.3)	

Infill Walls in Frames

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	PROPORTIONS: The height-to-thickness ratio of the infill walls at each story shall be less than 9 for Life Safety in levels of high seismicity, 13 for Immediate Occupancy in levels of moderate seismicity, and 8 for Immediate Occupancy in levels of high seismicity. (Tier 2: Sec. 4.4.2.6.2)	
		X	SOLID WALLS: The infill walls shall not be of cavity construction. (Tier 2: Sec. 4.4.2.6.3)	
		X	INFILL WALLS: The infill walls shall be continuous to the soffits of the frame beams and to the columns to either side. (Tier 2: Sec. 4.4.2.6.4)	

General Supplemental Structural Checklist

Walls in Wood-Frame Buildings

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	HOLD-DOWN ANCHORS: All shear walls shall have hold-down anchors constructed per acceptable construction practices, attached to the end studs. 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	EVALUATION STATEMENT	COMMENT
		X	SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression shall have Kl/r ratios less than 120. (Tier 2: Sec. 4.4.3.1.4)	
		X	CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals. (Tier 2: Sec. 4.4.3.1.5)	
		X	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	EVALUATION STATEMENT	COMMENT
		X	K-BRACING: The bracing system shall not include K-braced bays. (Tier 2: Sec. 4.4.3.2.1)	
		X	TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70 percent of the total lateral-force-resisting capacity in structures over two stories in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.2)	
		X	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)	
		X	CONCENTRICALLY BRACED FRAME 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)	

General Supplemental Structural Checklist

DIAPHRAGMS

General

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion. (Tier 2: Sec. 4.5.1.1)	
X			CROSS TIES: There shall be continuos cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	
X			ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)	
	X		OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	Opening where 2nd floor does not exist is 42 percent of the wall length.
		X	OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25 percent of the frame length for Life Safety and 15 percent of the frame length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.5)	
		X	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 feet for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	
X			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)	
X			DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent 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	EVALUATION STATEMENT	COMMENT
		X	STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios of 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)	
		X	SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-based systems. (Tier 2: Sec. 4.5.2.2)	

		X	UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet 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)	

Metal Deck Diaphragms

C	NC	N/A	EVALUATION STATEMENT	COMMENT
LS	IO		NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans less than 40 feet and shall have span/depth ratios less than 4-to-1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	Horizontal span is more than 40 feet

Other Diaphragms

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	

CONNECTIONS

Anchorage for Normal Forces

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		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. 4.6.1.3)	No anchors to diaphragm elements
		X	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	

Vertical Components

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

		X	UPLIFT 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	EVALUATION STATEMENT	COMMENT
X			GIRDERS: Girders supported by walls or pilasters shall have at least two ties to securing the anchor bolts for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.2)	
		X	CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than 3 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.3)	
		X	CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements. (Tier 2: Sec. 4.6.4.4)	
		X	BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters shall have independent secondary columns for support of vertical loads. (Tier 2: Sec. 4.6.4.5)	

Panel Connections

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12 inches for Life Safety and 8 inches for Immediate Occupancy. (Tier 2: Sec. 4.6.5.3)	Roof panel connections unknown

Basic Nonstructural Component Checklist

This Basic Nonstructural Component Checklist shall be completed where 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 standard, 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; corresponding section numbers are in parentheses following each evaluation statement.

Partitions

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	UNREINFORCED MASONRY: Unreinforced masonry or hollow clay tile partitions shall be braced at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	

Ceiling Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			SUPPORT: The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	

Light Fixtures

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		EMERGENCY LIGHTING: Emergency lighting shall be anchored or braced to prevent falling during an earthquake. (Tier 2: Sec. 4.8.3.1)	

Cladding and Glazing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	CLADDING ANCHORS: Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.1)	
X			DETERIORATION: There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	
		X	CLADDING ISOLATION: For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	

		X	MULTI-STORY PANELS: For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.4)	
		X	BEARING CONNECTIONS: Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	
		X	INSERTS: Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or positive anchorage. (Tier 2: Sec. 4.8.4.6)	
		X	PANEL CONNECTIONS: Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	

Masonry Veneer

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	SHELF ANGLES: Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above the ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	
		X	TIES: Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing of equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	
		X	WEAKENED PLANES: Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at locations of flashing. (Tier 2: Sec. 4.8.5.3)	
		X	DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	

Parapets, Cornices, Ornamentation and Appendages

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	URM PARAPETS: There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	
	X		CANOPIES: Canopies located at building exits shall be anchored to the structural faming at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	Canopy on east side of building is framed with roof trusses at 8’-4”.

Basic Nonstructural Component Checklist

Masonry Chimneys

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	URM CHIMNEYS: No unreinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 4.8.9.1)	

Stairs

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	URM WALLS: Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	
		X	STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check Procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	

Building Contents and Furnishing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		TALL NARROW CONTENTS: Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	Storage racks in open bay areas do not appear to be anchored to the floor or walls

Mechanical and Electrical Equipment

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			EMERGENCY POWER: Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	
		X	HAZARDOUS MATERIAL EQUIPMENT: HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	

X			DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	
		X	ATTACHED EQUIPMENT: Equipment weighing over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be braced. (Tier 2: Sec. 4.8.12.4)	

Piping

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		FIRE SUPPRESSION PIPING: Fire suppression piping shall be anchored and braced in accordance with *NFPA-13* (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	Unknown.
	X		FLEXIBLE COUPLINGS: Fluid, gas and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	Unknown.

Hazardous Materials Storage and Distribution

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	TOXIC SUBSTANCES: Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec. 4.8.15.1)	

Intermediate Nonstructural Component Checklist

This Intermediate Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic Nonstructural Component Checklist shall be completed prior to completing this Intermediate Nonstructural Component Checklist.

Ceiling Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		LAY-IN TILES: Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	Unknown, however no clips observed at locations where ceiling panels were removed to view floor structure.
	X		INTEGRATED CEILINGS: Integrated suspended ceilings at exits and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	Acoustical ceiling tile called out in Record Drawings – ceiling weight is 2psf or more.
		X	SUSPENDED LATH AND PLASTER: Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forces for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	

Light Fixtures

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			INDEPENDENT SUPPORTS: Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures. (Tier 2: Sec. 4.8.3.2)	

Cladding and Glazing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		GLAZING: Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	Curtain walls at open bay do not appear to be safety glazed.

Parapets, Cornices, Ornamentation, and Appendages

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	
		X	APPENDAGES: Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	

Intermediate Nonstructural Component Checklist

Masonry Chimneys

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	ANCHORAGE: Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)	

Mechanical and Electrical Equipment

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			VIBRATION ISOLATORS: Equipment mounted on vibration isolator shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.5)	

Ducts

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	

Supplemental Nonstructural Component Checklist

This Supplemental Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic and Intermediate Nonstructural Component Checklists shall be completed prior to completing this Supplemental Nonstructural Component Checklist.

Partitions

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	DRIFT: Rigid cementititous partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementititous partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	
		X	STRUCTURAL SEPARATIONS: Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	
	X		TOPS: The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	Unknown spacing of connections.

Ceiling Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		EDGES: The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of ½ inch. (Tier 2: Sec. 4.8.2.5)	Where ceilings occur at CMU walls and exterior walls.
		X	SEISMIC JOINT: The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	

Light Fixtures

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			PENDENT SUPPORTS: Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	
	X		LENS COVERS: Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	Unknown.

Cladding and Glazing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	GLAZING: All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	

Supplemental Nonstructural Component Checklist

Masonry Veneer

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	MORTAR: The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	
		X	WEEP HOLES: In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	
		X	STONE CRACKS: There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	

Metal Stud Back-Up Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	STUD TRACKS: Stud tracks shall be fastened to structural framing at a spacing of equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	
		X	OPENINGS: Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	

Concrete Block and Masonry Back-Up Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	ANCHORAGE: Back-up shall have positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	
		X	URM BACK-UP: There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	

Building Contents and Furnishing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		FILE CABINETS: File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	Unknown.
	X		CABINET DOORS AND DRAWERS: Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	Unknown.
		X	ACCESS FLOORS: Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	
		X	EQUIPMENT ON ACCESS FLOORS: Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	

Supplemental Nonstructural Component Checklist

Mechanical and Electrical Equipment

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			HEAVY EQUIPMENT: Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	
	X		ELECTRICAL EQUIPMENT: Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	Unknown.
	X		DOORS: Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	Unknown if garage doors are detailed for story drift.

Piping

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			FLUID AND GAS PIPING: Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec. 4.8.13.3)	
	X		SHUT-OFF VALVES: Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	Unknown.
X			C-CLAMPS: One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	

Ducts

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	DUCT BRACING: Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force-resisting system. (tier 2: Sec. 4.8.14.2)	
X			DUCT SUPPORT: Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	

Hazardous Materials Storage and Distribution

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	GAS CYLINDERS: Compressed gas cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	
		X	HAZARDOUS MATERIALS: Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.15.3)	

Supplemental Nonstructural Component Checklist

Elevators

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		SUPPORT SYSTEM: All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	Not enough information on elevator provided in Record Drawings.
	X		SEISMIC SWITCH: All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	Not enough information on elevator provided in Record Drawings.
X			SHAFT WALLS: All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	
	X		RETAINER GUARDS: Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	Not enough information on elevator provided in Record Drawings.
	X		RETAINER PLATE: A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	Not enough information on elevator provided in Record Drawings.
	X		COUNTERWEIGHT RAILS: All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	Not enough information on elevator provided in Record Drawings.
	X		BRACKETS: The brackets that tie the car rails and counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	Not enough information on elevator provided in Record Drawings.
	X		SPREADER BRACKET: Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	Not enough information on elevator provided in Record Drawings.
	X		GO-SLOW ELEVATORS: The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	Not enough information on elevator provided in Record Drawings.

Basic Structural Checklist for Building Type S3: Steel Light Frames

This Basic Structural Checklist shall be completed where 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 standard, 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; corresponding section numbers are in parentheses following each evaluation statement.

Building System

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		LOAD PATH: The structure shall contain a minimum of 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)	The roof system is unknown and observation could not confirm connection between the roof diaphragm and steel framing.
X			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)	
X			VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	
X			MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	
	X		TORSION: The distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety or Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)	The concrete shear wall at the north end of the building causes a torsional irregularity.
X			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	EVALUATION STATEMENT	COMMENT
	X		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 $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)	It is unknown how many tension cable braces are present and effective; observed loose cable brace.

Basic Structural Checklist for Building Type S3: Steel Light Frames

Connections

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		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 lesser of the strength of the frames or the diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)	The roof system is unknown.
LS	IO		STEEL COLUMNS: The columns in the lateral-force-resisting frames shall be anchored to the building foundation for Life Safety, and the anchorage shall be able to develop the lesser of the tensile capacity of the column, the tensile capacity of the lowest level column splice (if any), or the uplift capacity of the foundation, for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)	The steel framing system is unknown to determine capacity; anchors to the foundations were observed .
	X		WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.3.8)	Metal panel connection to foundation is unknown; concrete panels are attached to foundation.
	X		ROOF PANELS: Metal, plastic, or cementitious roof panels shall be positively attached to the roof framing to resist seismic forces for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.5.1)	The roof system is unknown.
X			WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the framing to resist seismic forces for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.5.2)	Observed panels connected to metal framing.

Supplemental Structural Checklist for Building Type S3: Steel Light Frames

This Supplemental Structural Checklist shall be completed where 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 feet. Where 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	EVALUATION STATEMENT	COMMENT
	X		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)	Steel framing system unknown.
	X		BEAM PENETRATIONS: All openings in frame-beam webs shall be less than ¼ 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)	Steel framing system unknown.
	X		COMPACT MEMBERS: All moment frame elements shall meet section requirements set forth by *Seismic Provisions for Structural Steel Buildings* Table I-9-1 (AISC, 1997). (Tier 2: Sec. 4.4.1.3.7)	Steel framing system unknown.
LS	IO		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)	Steel framing system unknown.
X			BOTTOM FLANGE BRACING: The bottom flanges 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)	Observed knee braces at steel moment frame beams.

Diaphragms

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	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)	No plan irregularities.
LS	IO		DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent 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)	2nd-floor openings are not reinforced.
X			OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	

Connections

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	UPLIFT 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)	Pile caps not present in building construction.

Basic Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

This Basic Structural Checklist shall be completed where 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 standard, 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; corresponding section numbers are in parentheses following each evaluation statement.

Building System

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			LOAD PATH: The structure shall contain a minimum of 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)	
X			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)	
X			WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	
X			SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life-Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	
X			GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	
X			VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	
X			MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	
X			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 connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	
X			WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15 percent of inadequate fastening such as overdriven fasteners, omitted blocking, excessive fastening spacing, or inadequate edge distance. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.3.3.2)	Not anticipated.

Basic Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

Lateral Force Resisting System

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		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)	Longitudinal direction of the 2nd floor has only 1 line of shear walls.
	X		SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure in 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: 100 plf All other conditions: 100 plf	All GWB shear walls are significantly over 100 plf for IO and LS and the wood shear walls are OK for LS but overstressed at IO.
		X	STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)	No stucco present in the building construction.
	X		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 with the exception of the uppermost level of a multi-story building. (Tier 2: Sec. 4.4.2.7.3)	Most of the shear walls are one and two-sided GWB shear walls.
X			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 in levels of moderate and high seismicity. Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of low seismicity. (Tier 2: Sec. 4.4.2.7.4)	
X			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)	
		X	HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story due to a sloping site, 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)	
		X	CRIPPLE WALLS: Cripple walls below the first-floor-level shear walls shall be braced to the foundation with wood structural panels. (Tier 2: Sec. 4.4.2.7.7)	
		X	OPENINGS: Walls with openings greater than 80 percent of the length shall be braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or shall be supported by adjacent construction through positive ties capable of transferring the lateral forces. (Tier 2: Sec. 4.4.2.7.8)	

Basic Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

Connections

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)	
	X		WOOD SILLS: All wood sills shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)	Wood sills do not have a complete load path but are connected to the foundation.
X			GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	

Supplemental Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

This Supplemental Structural Checklist shall be completed where 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	EVALUATION STATEMENT	COMMENT
LS	IO		HOLD-DOWN ANCHORS: All shear walls shall have hold-down anchors constructed per acceptable construction practices, attached to the end studs. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.7.9)	In the addition, hold-down anchors are only present at the wood panel shear walls.

Diaphragms

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)	
	X		ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)	The roof system is unknown.
		X	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)	
LS	IO		DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragms openings larger than 50 percent 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)	2nd-floor openings are not reinforced.
X			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)	
X			SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet 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)	
X			UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet 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)	
X			OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	

Connections

C	NC	N/A	EVALUATION STATEMENT	COMMENT
LS	IO		WOOD SILL BOLTS: Sill bolts shall be spaced at 6 feet or less for Life Safety and 4 feet or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)	Sill anchor bolts are spaced at 6 feet to the foundations.

Basic Nonstructural Component Checklist

This Basic Nonstructural Component Checklist shall be completed where 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 standard, 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; corresponding section numbers are in parentheses following each evaluation statement.

Partitions

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	UNREINFORCED MASONRY: Unreinforced masonry or hollow clay tile partitions shall be braced at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)	

Ceiling Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			SUPPORT: The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)	

Light Fixtures

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	EMERGENCY LIGHTING: Emergency lighting shall be anchored or braced to prevent falling during an earthquake. (Tier 2: Sec. 4.8.3.1)	

Cladding and Glazing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	CLADDING ANCHORS: Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.1)	
		X	DETERIORATION: There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)	

		X	CLADDING ISOLATION: For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)	
		X	MULTI-STORY PANELS: For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.4)	
		X	BEARING CONNECTIONS: Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)	
		X	INSERTS: Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or positive anchorage. (Tier 2: Sec. 4.8.4.6)	
		X	PANEL CONNECTIONS: Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)	

Masonry Veneer

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	SHELF ANGLES: Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above the ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)	
		X	TIES: Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing of equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)	
		X	WEAKENED PLANES: Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at locations of flashing. (Tier 2: Sec. 4.8.5.3)	
		X	DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)	

Basic Nonstructural Component Checklist

Parapets, Cornices, Ornamentation and Appendages

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	URM PARAPETS: There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)	
X			CANOPIES: Canopies located at building exits shall be anchored to the structural faming at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)	

Masonry Chimneys

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	URM CHIMNEYS: No unreinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 4.8.9.1)	

Stairs

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	URM WALLS: Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)	
X			STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check Procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)	

Building Contents and Furnishing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		TALL NARROW CONTENTS: Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)	Shelves in workshop areas.

Basic Nonstructural Component Checklist

Mechanical and Electrical Equipment

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			EMERGENCY POWER: Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)	
		X	HAZARDOUS MATERIAL EQUIPMENT: HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)	
X			DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)	
X			ATTACHED EQUIPMENT: Equipment weighing over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be braced. (Tier 2: Sec. 4.8.12.4)	

Piping

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		FIRE SUPPRESSION PIPING: Fire suppression piping shall be anchored and braced in accordance with *NFPA-13* (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)	Unknown if fire suppression piping is in accordance with NFPA-13.
	X		FLEXIBLE COUPLINGS: Fluid, gas and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)	

Hazardous Materials Storage and Distribution

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	TOXIC SUBSTANCES: Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec. 4.8.15.1)	

Intermediate Nonstructural Component Checklist

This Intermediate Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic Nonstructural Component Checklist shall be completed prior to completing this Intermediate Nonstructural Component Checklist.

Ceiling Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		LAY-IN TILES: Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)	No clips were observed at ceiling panels where removed to observe structure.
	X		INTEGRATED CEILINGS: Integrated suspended ceilings at exits and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)	
		X	SUSPENDED LATH AND PLASTER: Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forces for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)	

Light Fixtures

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			INDEPENDENT SUPPORTS: Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures. (Tier 2: Sec. 4.8.3.2)	

Cladding and Glazing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	GLAZING: Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)	

Parapets, Cornices, Ornamentation, and Appendages

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)	
		X	APPENDAGES: Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)	

Intermediate Nonstructural Component Checklist

Masonry Chimneys

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	ANCHORAGE: Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)	

Mechanical and Electrical Equipment

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	VIBRATION ISOLATORS: Equipment mounted on vibration isolator shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.5)	

Ducts

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)	

Supplemental Nonstructural Component Checklist

This Supplemental Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic and Intermediate Nonstructural Component Checklists shall be completed prior to completing this Supplemental Nonstructural Component Checklist.

Partitions

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	DRIFT: Rigid cementititous partitions shall be detailed to accommodate a drift ratio of 0.02 in steel moment frame, concrete moment frame, and wood frame buildings. Rigid cementititous partitions shall be detailed to accommodate a drift ratio of 0.005 in other buildings. (Tier 2: Sec. 4.8.1.2)	
		X	STRUCTURAL SEPARATIONS: Partitions at structural separations shall have seismic or control joints. (Tier 2: Sec. 4.8.1.3)	
	X		TOPS: The tops of framed or panelized partitions that only extend to the ceiling line shall have lateral bracing to the building structure at a spacing equal to or less than 6 feet. (Tier 2: Sec. 4.8.1.4)	

Ceiling Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			EDGES: The edges of integrated suspended ceilings shall be separated from enclosing walls by a minimum of ½ inch. (Tier 2: Sec. 4.8.2.5)	
		X	SEISMIC JOINT: The ceiling system shall not extend continuously across any seismic joint. (Tier 2: Sec. 4.8.2.6)	

Light Fixtures

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			PENDENT SUPPORTS: Light fixtures on pendant supports shall be attached at a spacing equal to or less than 6 feet and, if rigidly supported, shall be free to move with the structure to which they are attached without damaging adjoining materials. (Tier 2: Sec. 4.8.3.3)	
	X		LENS COVERS: Lens covers on light fixtures shall be attached or supplied with safety devices. (Tier 2: Sec. 4.8.3.4)	Unknown

Cladding and Glazing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	GLAZING: All exterior glazing shall be laminated, annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.9)	

Supplemental Nonstructural Component Checklist

Masonry Veneer

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	MORTAR: The mortar in masonry veneer shall not be easily scraped away from the joints by hand with a metal tool, and there shall not be significant areas of eroded mortar. (Tier 2: Sec. 4.8.5.5)	
		X	WEEP HOLES: In veneer braced by stud walls, functioning weep holes and base flashing shall be present. (Tier 2: Sec. 4.8.5.6)	
		X	STONE CRACKS: There shall be no visible cracks or signs of visible distortion in the stone. (Tier 2: Sec. 4.8.5.7)	

Metal Stud Back-Up Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			STUD TRACKS: Stud tracks shall be fastened to structural framing at a spacing of equal to or less than 24 inches on center. (Tier 2: Sec. 4.8.6.1)	
X			OPENINGS: Steel studs shall frame window and door openings. (Tier 2: Sec. 4.8.6.2)	

Concrete Block and Masonry Back-Up Systems

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	ANCHORAGE: Back-up shall have positive anchorage to the structural framing at a spacing equal to or less than 4 feet along the floors and roof. (Tier 2: Sec. 4.8.7.1)	
		X	URM BACK-UP: There shall be no unreinforced masonry back-up. (Tier 2: Sec. 4.8.7.2)	

Building Contents and Furnishing

C	NC	N/A	EVALUATION STATEMENT	COMMENT
	X		FILE CABINETS: File cabinets arranged in groups shall be attached to one another. (Tier 2: Sec. 4.8.11.2)	Unknown.
	X		CABINET DOORS AND DRAWERS: Cabinet doors and drawers shall have latches to keep them closed during an earthquake. (Tier 2: Sec. 4.8.11.3)	Unknown.
		X	ACCESS FLOORS: Access floors over 9 inches in height shall be braced. (Tier 2: Sec. 4.8.11.4)	
		X	EQUIPMENT ON ACCESS FLOORS: Equipment and computers supported on access floor systems shall be either attached to the structure or fastened to a laterally braced floor system. (Tier 2: Sec. 4.8.11.5)	

Supplemental Nonstructural Component Checklist

Mechanical and Electrical Equipment

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			HEAVY EQUIPMENT: Equipment weighing over 100 pounds shall be anchored to the structure or foundation. (Tier 2: Sec. 4.8.12.6)	
X			ELECTRICAL EQUIPMENT: Electrical equipment and associated wiring shall be laterally braced to the structural system. (Tier 2: Sec. 4.8.12.7)	
	X		DOORS: Mechanically operated doors shall be detailed to operate at a story drift ratio of 0.01. (Tier 2: Sec. 4.8.12.8)	Unknown if garage doors are detailed for story drift.

Piping

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			FLUID AND GAS PIPING: Fluid and gas piping shall be anchored and braced to the structure to prevent breakage in piping. (Tier 2: Sec. 4.8.13.3)	
	X		SHUT-OFF VALVES: Shut-off devices shall be present at building utility interfaces to shut off the flow of gas and high-temperature energy in the event of earthquake-induced failure. (Tier 2: Sec. 4.8.13.4)	Unknown.
	X		C-CLAMPS: One-sided C-clamps that support piping greater than 2.5 inches in diameter shall be restrained. (Tier 2: Sec. 4.8.13.5)	

Ducts

C	NC	N/A	EVALUATION STATEMENT	COMMENT
X			DUCT BRACING: Rectangular ductwork exceeding 6 square feet in cross-sectional area, and round ducts exceeding 28 inches in diameter, shall be braced. Maximum spacing of transverse bracing shall not exceed 30 feet. Maximum spacing of longitudinal bracing shall not exceed 60 feet. Intermediate supports shall not be considered part of the lateral-force-resisting system. (tier 2: Sec. 4.8.14.2)	
X			DUCT SUPPORT: Ducts shall not be supported by piping or electrical conduit. (Tier 2: Sec. 4.8.14.3)	

Hazardous Materials Storage and Distribution

C	NC	N/A	EVALUATION STATEMENT	COMMENT
			GAS CYLINDERS: Compressed gas cylinders shall be restrained. (Tier 2: Sec. 4.8.15.2)	
		X	HAZARDOUS MATERIALS: Piping containing hazardous materials shall have shut-off valves or other devices to prevent major spills or leaks. (Tier 2: Sec. 4.8.15.3)	

Supplemental Nonstructural Component Checklist

Elevators

C	NC	N/A	EVALUATION STATEMENT	COMMENT
		X	SUPPORT SYSTEM: All elements of the elevator system shall be anchored. (Tier 2: Sec. 4.8.16.1)	No elevator.
		X	SEISMIC SWITCH: All elevators shall be equipped with seismic switches that will terminate operations when the ground motion exceeds 0.10g. (Tier 2: Sec. 4.8.16.2)	
		X	SHAFT WALLS: All elevator shaft walls shall be anchored and reinforced to prevent toppling into the shaft during strong shaking. (Tier 2: Sec. 4.8.16.3)	
		X	RETAINER GUARDS: Cable retainer guards on sheaves and drums shall be present to inhibit the displacement of cables. (Tier 2: Sec. 4.8.16.4)	
		X	RETAINER PLATE: A retainer plate shall be present at the top and bottom of both car and counterweight. (Tier 2: Sec. 4.8.16.5)	
		X	COUNTERWEIGHT RAILS: All counterweight rails and divider beams shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.6)	
		X	BRACKETS: The brackets that tie the car rails and counterweight rail to the building structure shall be sized in accordance with ASME A17.1. (Tier 2: Sec. 4.8.16.7)	
		X	SPREADER BRACKET: Spreader brackets shall not be used to resist seismic forces. (Tier 2: Sec. 4.8.16.8)	
		X	GO-SLOW ELEVATORS: The building shall have a go-slow elevator system. (Tier 2: Sec. 4.8.16.9)	

APPENDIX B

Performance-Based Earthquake Engineering (PBEE)

B. Performance-Based Earthquake Engineering

The seismic evaluation is based on performance-based earthquake engineering (PBEE) guidelines presented in ASCE 31-03 *Seismic Evaluation of Existing Buildings* (American Society of Civil Engineers, 2002). This section includes general background information on PBEE and an overview of seismic rehabilitation objectives, building performance levels, and seismic evaluation and rehabilitation procedures.

B.1 Background

Seismic analysis and building design has traditionally focused on one performance level – reducing the risk of life loss in the design earthquake. The concept of designing essential facilities that are needed immediately after an earthquake evolved after hospitals and other critical facilities were damaged in the 1971 San Fernando, California earthquake. This concept is balanced by the recognition that the cost of rehabilitating existing buildings to higher levels of seismic performance may be onerous to stakeholders and policy makers.

In 1991, a comprehensive program was started in cooperation with FEMA to develop guidelines tailored to address this variation of performance levels. The first formal applications of performance-based evaluation and design guidelines were FEMA 310 *Handbook for the Seismic Evaluation of Buildings – A Prestandard (1998)* and FEMA 273 *NEHRP Guidelines for the Seismic Rehabilitation of Buildings (1997).* ASCE 31-02 and FEMA 356 superseded these documents. The new PBEE documents reflect advancements in technology and incorporate case studies and lessons learned from recent earthquakes.

ASCE 31-03 and ASCE 41-06 provide criteria to be used in seismically evaluating and rehabilitating existing buildings, to attain a wide range of performance levels when subjected to earthquakes of varying severity. Using these criteria, relationships are established between structural response and performance-oriented descriptions such as Operational, Immediate Occupancy, Life Safety, and Collapse Prevention. As Figure 3-1 illustrates, each building performance description or objective directly relates to its expected post-earthquake damage state. Each damage state has readily identifiable consequences that include:

- Cost – economic feasibility of restoring a facility to pre-earthquake condition.
- Public Safety – number of critical injuries and casualties to building occupants.
- Downtime – length of time the building is removed from service to make repairs.

Efforts by the Applied Technology Council (ATC), Pacific Earthquake Engineering Research Center (PEER), FEMA, and others are underway to quantify these estimated losses and allow stakeholders to make more informed decisions.

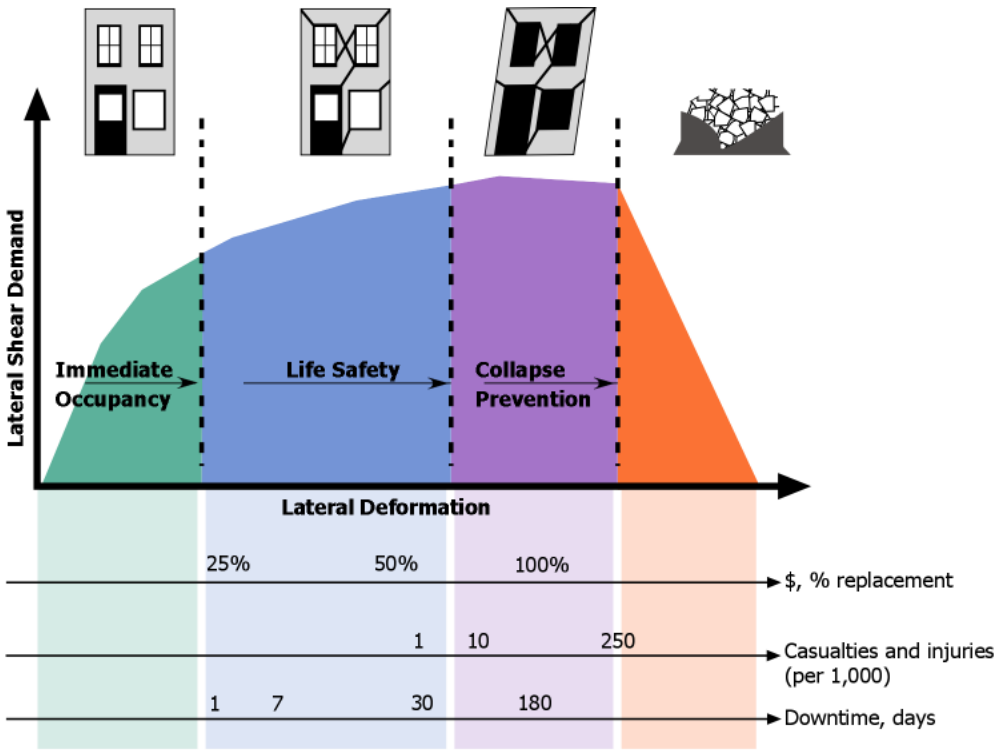

Figure B-1. Estimated Performance-Related Consequences (Moehle, 2003)

B.2 Rehabilitation Objectives

The seismic rehabilitation objective expresses the desired building behavior during an earthquake of projected severity (a design-level event). This objective consists of one or more goals, each with a target building performance level and corresponding earthquake hazard level. The four defined levels of building performance are Operational (OP), Immediate Occupancy (IO), Life Safety (LS), and Collapse Prevention (CP). Common probabilistic earthquake hazard levels and their corresponding mean return periods follow.

Table B-1. Probabilistic Earthquake Hazard Levels and Return Period

Earthquake Hazard Level	Probability of Exceedance in 50 Years	Mean Return Period (Years)
50% / 50-year	50 percent	72
20% / 50-year	20 percent	225
BSE-1 (10% / 50-year)	10 percent	474
BSE-2 (2% / 50-year)	2 percent	2,475

For each building, a decision must be made on the acceptable behavior for different seismic hazard levels. This decision must be balanced with the cost of rehabilitating the structure to obtain that behavior. Figure B-2 presents the schematic relationship between different rehabilitation objectives and probable program cost.

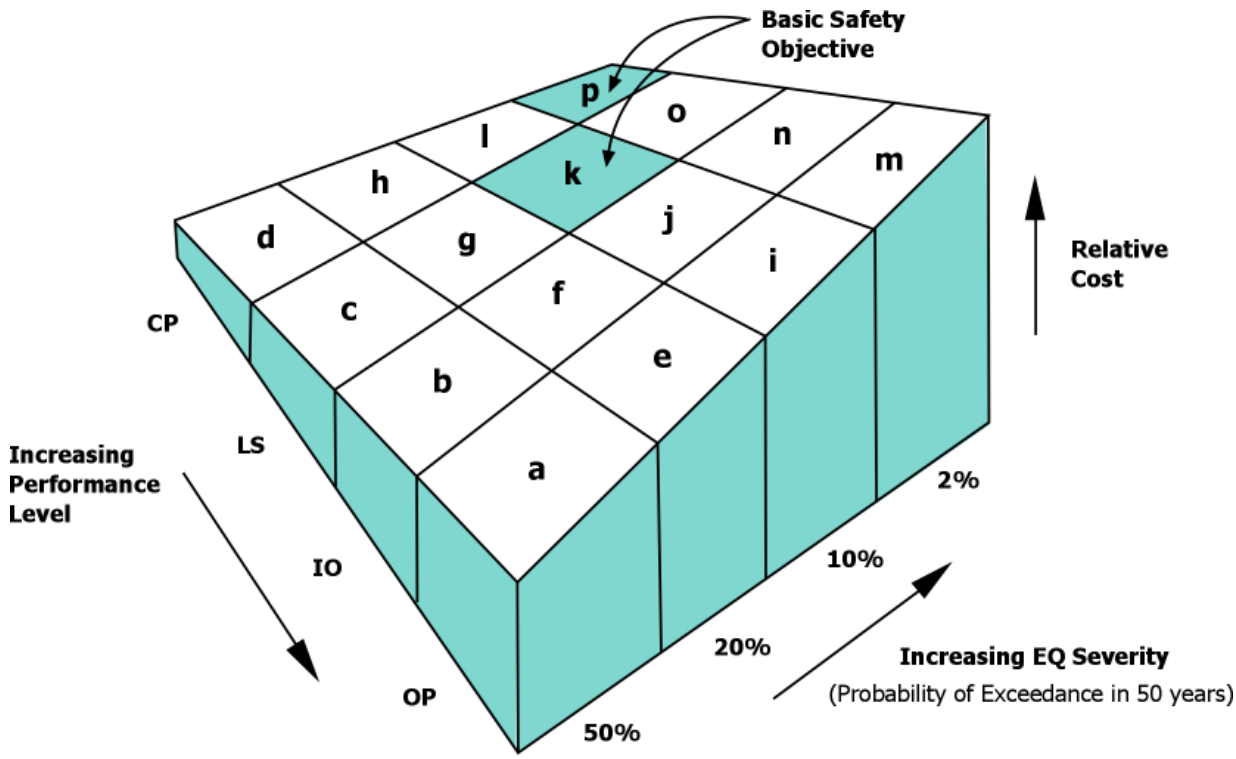

Figure B-2. Surface Matrix of Rehabilitation Objectives (FEMA, 1997)

The "baseline" performance level for a standard building is referred to as the Basic Safety Objective (BSO). The BSO is defined as providing Collapse Prevention performance at the 2% / 50-year event and Life Safety performance at the 10-percent probability of exceedance in a 50-year event (10% / 50). Higher (enhanced) or lower (limited) objectives may be selected based on the facility's essential nature, its expected remaining life, and the associated cost and feasibility. The rehabilitation objective selected as a basis for design determines the benefit to be obtained in terms of improved safety, reduction in property damage, and interruption of use in the event of future earthquakes.

B.3 Building Performance Levels

The terminology used for target building performance levels is intended to represent design goals. These target levels are discrete damage states selected from the infinite spectrum of damage states that a building could experience during an earthquake.

Because actual ground motion is seldom comparable to that used for design, the selected damage state may only determine relative performance during most events. Even given a ground motion similar to that used in design, variations from stated performance objectives should be expected. Variations in actual performance could be associated with the following:

- Differences in the level of workmanship
- Variations in actual material strengths
- Deterioration of materials
- Unknown geometry and sizes of existing members

- Differences in assumed and actual live loads in the building at the time of the earthquake
- Influence of nonstructural components
- Variations in response of soils beneath the building

Building performance is a combination of the performance of structural and nonstructural components. Structural performance is related to the amount of lateral deformation or drift of the structure and its capacity or ability to deform. In ASCE 31-03 and ASCE 41-06, it is intended that structures meeting Life Safety performance will be able to experience at least 33 percent greater lateral deformation before failure of primary elements. This equates to a safety factor of 1.33 against collapse. In the design of new buildings, somewhat better performance is expected, since structures are designed with an approximate 1.5-margin against collapse.

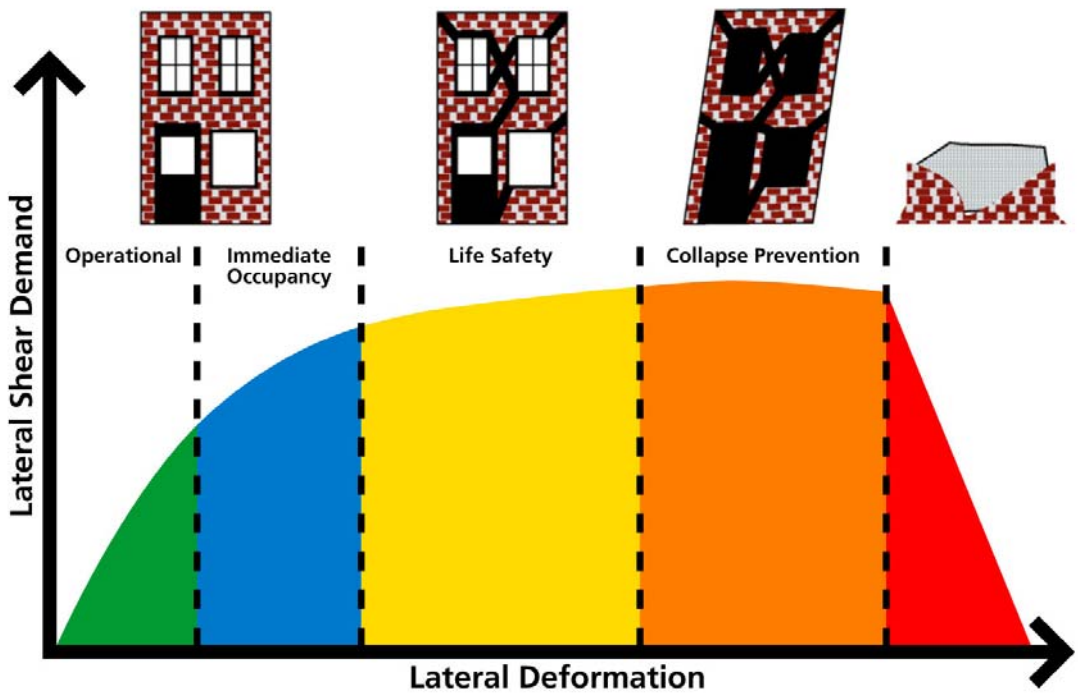

Figure B-3. Building Performance Levels

Mitigation of nonstructural seismic hazards is a complex issue that is addressed independently in the evaluation and rehabilitation guidelines. Many nonstructural components, if adequately secured to a structure, are seismically rugged. However, mitigation of some nonstructural hazards (e.g., bracing for mechanical and electrical components within suspended ceiling systems, or the improvement of ceiling systems themselves) can result in extensive disruption of occupancy and can also be costly to repair or replace post earthquake. Due to these complexities and required coordination with other disciplines (e.g., architect, mechanical engineer, electrical engineer, hazardous materials engineer), nonstructural seismic performance has not been addressed in this initial evaluation. The owner, with assistance from the design team, will select a nonstructural performance level during the rehabilitation design process that considers the cost and benefit of this type of mitigation.

Table B-2 summarizes the approximate levels of structural and nonstructural damage that may be expected of buildings rehabilitated to the defined levels.

Table B-2. Damage Control and Building Performance Levels (FEMA, 2000)

	Building Performance Levels			
	Collapse Prevention	Life Safety	Immediate Occupancy	Operational
Overall Damage	Severe	Moderate	Light	Very Light
Permanent Drift	Large: 1% to 5%.	Some: 0.3% to 1%.	Negligible.	Same as Immediate Occupancy.
Remaining Strength and Stiffness after Earthquake	Little: Gravity system (columns and walls) functions, but building is near collapse.	Some: Gravity system functions, but building may be beyond economical repair.	Substantial: Minor cracking of structural elements.	Same as Immediate Occupancy.
Examples of Damage to Concrete Framing	Extensive cracking and spalling of concrete members. Crack widths greater than 1/4 inch.	Extensive cracking and spalling of concrete. Crack widths typically less than 1/4 inch and less than 1/8 inch in columns and joints.	Crack widths typically less than 1/8 inch and less than 1/16 inch in columns and joints.	Same as Immediate Occupancy.
Examples of Damage to Steel Framing	Extensive yielding and buckling of steel members. Significant connection failures.	Local buckling of steel beams and braces. Moderate amount of connection failures.	Minor deformation of steel members. No connection failures.	Same as Immediate Occupancy.
Other General Description	Structure likely not repairable or safe for reoccupancy due to potential collapse in aftershock.	Repair may be possible but may not be economically feasible. Repairs may be required prior to reoccupancy.	Minor repairs may be required, but building is safe to occupy.	Same as Immediate Occupancy.
Nonstructural Components	Extensive damage. Some exits blocked. Infills and unbraced parapets failed or at incipient failure.	Falling hazards mitigated but many architectural, mechanical, and electrical systems are damaged.	Minor cracking of facades, partitions, and ceilings. Equipment and contents generally secure but may not operate due to lack of utilities.	Negligible damage. All systems important to normal operation functional. Power and other utilities available, possibly from standby sources.
Comparison with New Building Design	Significantly more damage and greater risk.	Somewhat more damage and slightly higher risk.	Much less damage and lower risk.	Much less damage and lower risk.

B.4 Seismic Evaluation Procedure

ASCE 31-03 provides a three-tiered evaluation procedure using performance-based criteria. Figure 3-4 shows the seismic evaluation process, which consists of three tiers: the Screening Phase (Tier 1), Evaluation Phase (Tier 2), and Detailed Evaluation Phase (Tier 3). A summary of each phase is provided.

TIER 1 – Screening Phase

- Checklists of evaluation statements to quickly identify potential deficiencies
- Requires field investigation and/or review of record drawings
- Analysis limited to "Quick Checks" of global elements
- May proceed to Tier 2, Tier 3, or rehabilitation design if deficiencies are identified

TIER 2 – Evaluation Phase

- "Full Building" or "Deficiency Only" evaluation
- Address all Tier 1 seismic deficiencies
- Analysis more refined than Tier 1, but limited to simplified linear procedures
- Identify buildings not requiring rehabilitation

TIER 3 – Detailed Evaluation Phase

- Component-based evaluation of entire building using reduced ASCE 41 forces
- Advanced analytical procedures available if Tier 1 and/or Tier 2 evaluations are judged to be overly conservative
- Complex analysis procedures may result in construction savings equal to many times their cost

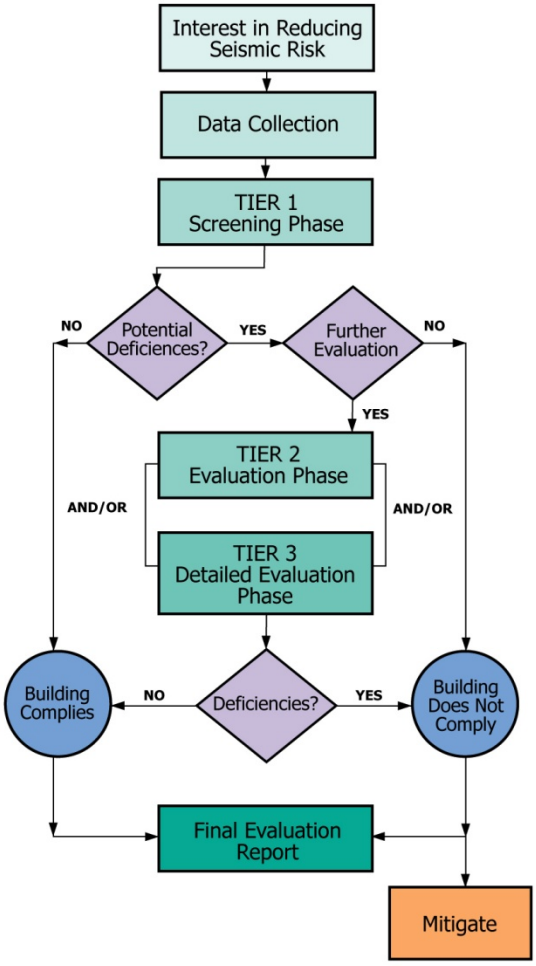

Figure B-4. Flow Chart and Description of ASCE 31 Seismic Evaluation Procedure

The Tier 3 detailed evaluation references and utilizes rehabilitation design criteria such as ASCE 41-06. Since ASCE 31-03 is an evaluation standard, it is written to accept greater damage levels within each performance level than permitted by retrofit design standards. This is consistent with the historic practice of evaluating existing buildings for slightly lower criteria than those used for design. ASCE 31-03 quantifies this difference by using a 0.75 reduction factor on demands when performing a Tier 3 evaluation. This essentially lowers the reliability of achieving the selected performance level from about 90 percent to 60 percent. This practice generally minimizes the need to rehabilitate structures with relatively modest deficiencies relative to the desired performance level.

B.5 Seismic Rehabilitation Procedure

If seismic deficiencies are identified during the evaluation process, the owner and design team should review all initial conditions before proceeding with hazard mitigation. Many conditions may affect the rehabilitation design significantly, including the results of the seismic evaluation and seismic hazard study, building use and occupancy requirements, the presence of hazardous materials, and other anticipated building remodeling. The basic process for performance-based rehabilitation design is illustrated in Figure 3-5.

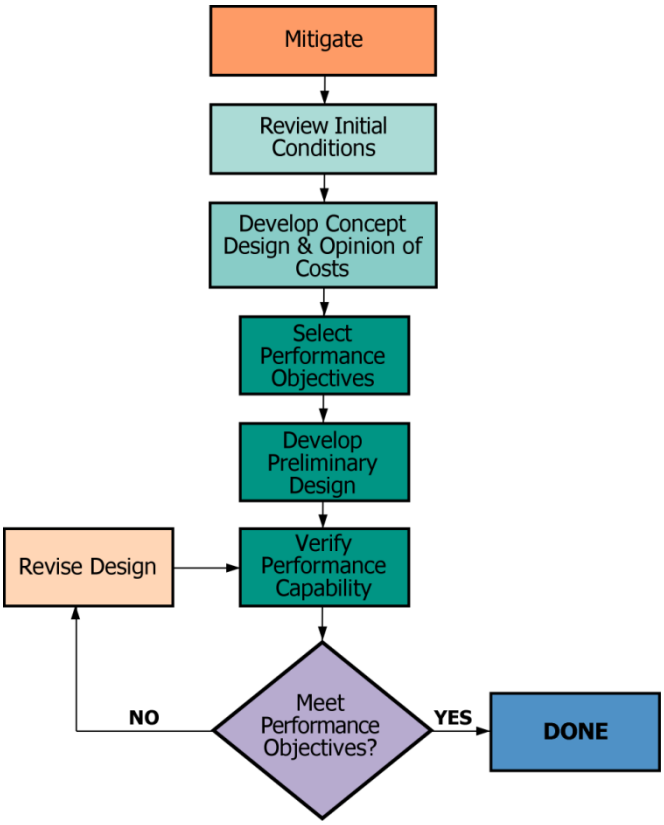

Figure B-5. Seismic Rehabilitation Flow Diagram

Following the review of initial conditions, concept designs may be performed in order to develop rough opinions of probable construction costs for one or more performance objectives. The owner and design team can then develop a rehabilitation strategy considering the associated costs and feasibility. Schematic and final design can then proceed through an iterative process until verification of acceptable building performance is obtained.

APPENDIX C

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