Tier 1 Seismic Evaluation of 41 Buildings

X. Degenkolb

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Tier I Seismic Evaluation of 41 Buildings
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FINAL REPORT
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Executive Summary

This Seismic Evaluation Report summarizes Tier I evaluations for 41 buildings at Lawrence Livermore National Laboratory in accordance with ASCE 31 Life Safety criteria for a 10% in 50 year earthquake. This group of buildings represents the remaining buildings on the LLNL campus that 1) have not been evaluated in the past, and 2) have not been exempted by evaluation according to the Executive Order 12941 (EO 12941) requirements.

Within the 41 buildings, there are 90 seismically independent building sectors. Evaluation results are:

- 33 building sectors are exempt from evaluation based on standard exemptions included in EO 12941. These building sectors are not included in the LLNL seismic mitigation program.
- 20 building sectors meet the structural Life-Safety criteria of ASCE 31.
- 34 building sectors do not meet the structural Life Safety criteria of ASCE 31.
- 3 building sectors were not evaluated due to lack of available structural drawings.

Evaluation of nonstructural component bracing was not included in the scope of this evaluation.

The 57 building sectors that are not exempt from evaluation are recommended to be included in the LLNL seismic mitigation program. The seismic mitigation program at LLNL is based on a prioritization system to evaluate and strengthen buildings to meet the Life-Safety performance objective in a 10% in 50 year earthquake. Recommendations for prioritization of seismic evaluation and strengthening work are based on observed behavior of similar buildings in past earthquakes, with the more vulnerable buildings given a higher prioritization.

This evaluation report contains cost projections for the 57 building sectors recommended to be included in the LLNL seismic mitigation program based on FEMA 156 and 157 methodology. These cost projections are based on historical cost data for the seismic strengthening of buildings. We recommend preparing concept level strengthening schemes as the basis for developing construction budgets.
1.0 Introduction

This Seismic Evaluation Report summarizes Tier 1 seismic evaluations of 41 buildings at the Lawrence Livermore National Laboratory (LLNL) performed as part of the LLNL seismic mitigation program. To date, all other buildings on the LLNL campus have had a seismic evaluation performed or have been exempted from evaluation by LLNL in accordance with the requirements of Executive Order 12941 (EO 12941) titled "Seismic Safety of Existing Federally Owned or Leased Buildings". Evaluation of non-structural component anchorage was not part of the scope.

There are 90 seismically independent building sectors within the group of 41 evaluated buildings included in this report. Each building sector was screened in accordance with the requirements of EO 12941, and if required, evaluated in accordance with the life safety requirements of ASCE 31, "ASCE Standard – Seismic Evaluation of Existing Buildings". This report includes the following:

1. Background information on the past seismic evaluations and the current seismic mitigation program at LLNL (Section 2).

2. Summary of site information, including seismicity (Section 3),

3. Summary of seismic screening and evaluation results for the 90 building sectors (Section 4):

4. Recommendations for prioritization of building sectors for the LLNL seismic mitigation program based on observed structural performance of similar buildings in past earthquakes (Section 5).

5. Cost projection to strengthen building sectors to meet Life-Safety performance level based on the methodology of FEMA 156 and 157, "Typical Costs for Seismic Rehabilitation of Existing Buildings" (Section 6).

6. Collection of building data in a standardized format. Building data includes building size, year constructed, description of structural system, identification of potential life safety deficiencies (if any), and preliminary seismic mitigation recommendations. See Appendix A, B, and C.

The scope of work in this evaluation included the following:

1. Coordination with LLNL personnel to obtain drawings for each non-exempt and non-evaluated building. The drawings were the basis for the seismic evaluations.

2. A walkthrough of each building to confirm that the available drawings properly identify the extent of the building, and to observe whether significant building modifications have occurred.
2.0 LLNL Seismic Mitigation Program Background

The seismic mitigation program at LLNL was initiated in 1996 to meet the requirements of EO 12941. EO 12941 required each federal agency to develop an inventory of its buildings and to estimate costs of mitigating unacceptable seismic risks in those buildings. In September 1998, LLNL submitted to the Department of Energy (DOE) an electronic database with building inventory information and a report titled “Supporting Documentation on the Implementation of EO 12941”. A summary report for LLNL building evaluations was prepared by Degenkolb in October 1998 titled “Seismic Evaluation for Compliance with Executive Order 12941”.

At the time of the 1998 EO12941 Report, there were a total of 534 buildings included in the LLNL facility database (not including multiple building sectors). Prior to the start of this evaluation, 449 of those buildings were exempt and 85 were non-exempt. 44 of the non-exempt buildings were previously evaluated. The remaining 41 non-exempt buildings make up the scope of this seismic evaluation report.

The minimum standard for evaluation and mitigation of seismic risks for federal government buildings is defined by RP4 and RP6, titled "Standards of Seismic Safety for Existing Federally Owned or Leased Buildings", which was developed by the Interagency Committee on Seismic Safety in Construction (ICSSC). RP6 is the update to RP4, which incorporated new knowledge in earthquake engineering gained from research and from observed performance of structures in recent earthquakes.

The primary objective of RP4/RP6 is to reduce the life-safety risk to occupants and to the public. Life-Safety is defined as the minimum performance level appropriate for Federal Buildings. Life-Safety building performance is described as “building performance that includes significant damage to both structural and nonstructural components during the design earthquake, though at least some margin against either partial or total structural collapse remains. Injuries may occur, but the level of risk for life threatening injury and entrapment is low. People will likely be unable to reoccupy the building for continuous use until structural repairs are completed.”

The seismic mitigation program at LLNL is based on a prioritization system to evaluate and strengthen buildings to meet the life safety performance level. We understand the prioritization system considers expected seismic performance as well as building occupancy level. The duration of the mitigation program will likely depend on the availability of funding, resources, schedule to perform the rehabilitation work, and opportunity planning to coincide with other work. Attributes of the LLNL seismic mitigation program are:

- Buildings that are “exempt” do not require further evaluation or mitigation to comply with the minimum Federal Standard for seismic safety and therefore are not included in the LLNL seismic mitigation program.
- Buildings that are "non-exempt" and have been shown by evaluation to not meet structural life safety standards of RP4/RP6 are prioritized based on observed performance of similar buildings in past earthquakes. The highest priority is for buildings that are considered "exceptionally high risk" and seismic mitigation is mandated by RP6.
- Buildings that are "non-exempt" and have been shown by evaluation to meet the structural life safety standards of RP4/RP6 are considered a low priority. Mitigation of nonstructural deficiencies will proceed as part of the ongoing facility maintenance program.
- In addition, RP6 requires seismic mitigation of "non-exempt" buildings when certain trigger events occur, such as changes in facility use, major building alterations, or when the building experience earthquake related damage.

See Appendix F for the Degenkolb letter dated June 3, 2003, which provides further description of seismic mitigation program at LLNL.
3.0 Site Information

3.1 General Site Description

The Lawrence Livermore National Laboratory is located east of Livermore, California, along the Diablo foothills of the San Francisco Bay Area. The campus is located at the southeastern edge of the city of Livermore and the easternmost edge of Alameda County.

According to the geotechnical report by John A. Blume & Associates dated 1971, the LLNL site is "underlain by poorly consolidated sandy clay at the surface and dense sands, gravels and some hard clay to a depth in excess of 400 feet." We understand that LLNL has classified this soil type as $S_D$.

There are four major active faults that pass through the Bay Area and have historically produced earthquakes strong enough to cause structural damage at LLNL. These faults are the San Andreas fault, the Hayward fault, the Calaveras fault, and the Greenville fault, which are 35, 17, 10, and 3 miles away, respectively.

The buildings evaluated are located either at the LLNL Main Site (Site 200) or the LLNL Off-Site (Site 300).
3.2 Site Plan

LLNL Site Plan
All Quadrants
3.3 Site Seismicity

The basis for evaluation of the LLNL buildings is the spectral response accelerations with a 10\% chance of exceedence in 50 years. This is equivalent to an earthquake with a 474-year return period. The shaking values were obtained from the seismic hazard maps, which show values of 5\% damped, spectral response accelerations with a 10\% chance of exceedence in 50 years. This spectral response acceleration is modified to account for Site Class effects.

The response spectrum and corresponding parameters are shown on the following page. The appropriate portions of the response spectrum were used to evaluate the structures. For comparison, the 2\% in 50-year earthquake response spectrum, the 5\% in 50-year earthquake response spectrum and the 50\% in 50-year earthquake response spectrum are also shown. These were not used for the building evaluations and are shown for information only.

![Response Spectra](image)

**Figure 2.1 – Site Response Spectra**

**Spectrum Parameters**

- Site Class: D
  - $F_a$: 1.00
  - $F_v$: 1.50
4.0 Seismic Evaluation

4.1 Procedure

The procedure for the seismic evaluation of the 41 buildings was as follows:


- Performed a walkthrough of each of the 41 building. During the site visits a total of 90 seismically independent building sectors were identified.

- Identified building sectors that meet the standard exemptions of RP6 and do not require evaluation or mitigation.

- Obtained drawings from LLNL personnel for each evaluated building sector.

- Reviewed reports, drawings and calculations from past evaluations of the non-evaluated and non-exempt buildings. The only available past evaluation data for review was for Building 326.

- Prepared building descriptions and building data sheets for each evaluated building sector. See Appendix A.

- Performed a Tier I seismic evaluation in accordance with ASCE 31 for a 10% in 50 year earthquake and identified potential structural deficiencies with respect to the Life Safety performance level for each building sector. Life Safety deficiencies are identified in the building data sheets in Appendix A.

- Identified preliminary strengthening schemes or mitigation measures each evaluated building sector. Narrative strengthening recommendations are included in the building data sheets in Appendix A.

4.1 Results

Exempt Building Sectors

33 of the 90 building sectors are exempt from seismic evaluation based on the standard exemptions allowed by EO 12941. The exemptions are for buildings that have been recently constructed, buildings that are small and have a type of lateral system with low vulnerability in earthquakes, or have low occupant usage. These building sectors are not part of the LLNL seismic mitigation program:

<table>
<thead>
<tr>
<th>Building</th>
<th>Exemption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>165, Research Building</td>
<td>E3</td>
<td>Steel light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>165, Optical Laboratory</td>
<td>E3</td>
<td>Steel light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>Building</td>
<td>E3</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>166B</td>
<td>E3</td>
<td>Steel light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>166E</td>
<td>E3</td>
<td>Steel light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>166F</td>
<td>E3</td>
<td>Steel light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>3203</td>
<td>E3</td>
<td>Wood/Steel light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>292, Addition #1</td>
<td>NA</td>
<td>No longer exists</td>
</tr>
<tr>
<td>292 Addition #2</td>
<td>NA</td>
<td>No longer exists</td>
</tr>
<tr>
<td>327, Room 1275</td>
<td>E3</td>
<td>Steel light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>4675, Addition #2</td>
<td>E3</td>
<td>Wood light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>4675, Addition #3</td>
<td>E3</td>
<td>Wood light frame less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>805</td>
<td>E8</td>
<td>Remaining useful life less than 5 years.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>According to LLNL Planned Relocation to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMPC complex within 5 years.</td>
</tr>
<tr>
<td>807</td>
<td>E8</td>
<td>Remaining useful life less than 5 years.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>According to LLNL Planned Relocation to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMPC complex within 5 years.</td>
</tr>
<tr>
<td>806, Original Building</td>
<td>E8</td>
<td>Remaining useful life less than 5 years.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>According to LLNL Planned Relocation to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMPC complex within 5 years.</td>
</tr>
<tr>
<td>806A, Lunch Room Addition</td>
<td>E8</td>
<td>Remaining useful life less than 5 years.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>According to LLNL Planned Relocation to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMPC complex within 5 years.</td>
</tr>
<tr>
<td>806B</td>
<td>E8</td>
<td>Remaining useful life less than 5 years.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>According to LLNL Planned Relocation to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMPC complex within 5 years.</td>
</tr>
<tr>
<td>812B</td>
<td>E3</td>
<td>Small metal building less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>812C, Part 1</td>
<td>E3</td>
<td>Small metal building less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>812C, Part 2</td>
<td>E3</td>
<td>Small metal building less than 3,000 sq. ft.</td>
</tr>
<tr>
<td>812 Cooling Tower</td>
<td>E1</td>
<td>Non-building structure incidental human occupancy</td>
</tr>
<tr>
<td>817B, Press Building</td>
<td>E3</td>
<td>Steel light frame less than 3,000 sq. ft.</td>
</tr>
</tbody>
</table>
817D, Machinery Building | E3 | Small metal prefabricated building less than 3,000 sq. ft.
817E, Press Building | E3 | Small metal building less than 3,000 sq. ft., no longer in use
817G | E3 | Steel light frame less than 3,000 sq. ft.
817H | E3 | Steel light frame less than 3,000 sq. ft.
817 Cooling Tower | E3 | Non-building structure
818C | E3 | Steel light frame less than 3,000 sq. ft.
836, Solvent Storage Building | NA | No longer exists
836, Shaker Building | NA | Underground Structure
851, Increment #1 Bunker Modification | NA | Underground Structure
851, Increment #2 Bunker Modification | NA | Underground Structure
851B | E3 | Steel light frame less than 3,000 sq. ft.
851D | E1 | Non-building structure – Incidental Human Occupancy

**Evaluated Building Sectors that Meet Structural Life Safety Standards**

20 of the 90 building sectors were evaluated and meet the structural Life-Safety performance criteria of ASCE 31, "ASCE Standard - Seismic Evaluation of Existing Buildings" for a 10% in 50 year earthquake. These building sectors are considered a low priority in the LLNL seismic mitigation program, with mitigation of nonstructural deficiencies proceeding as part of the ongoing facility maintenance program. The following building sectors are included in this category:

<table>
<thead>
<tr>
<th>166A*</th>
<th>281 (South Addition)</th>
<th>812E</th>
<th>519B*</th>
</tr>
</thead>
<tbody>
<tr>
<td>166D*</td>
<td>292</td>
<td>817A</td>
<td>836A</td>
</tr>
<tr>
<td>181 (Increment 2)</td>
<td>810B</td>
<td>825</td>
<td>851C</td>
</tr>
<tr>
<td>253(original Bldg)</td>
<td>298**</td>
<td>817C</td>
<td>850</td>
</tr>
</tbody>
</table>
253 (Addition)  802A  817F  851

* Buildings have potential deficiencies expected to be mitigated by detailed evaluation.

** Rating is pending completion of retrofit project currently underway.

**Evaluated Building Sectors that Do Not Meet Structural Life Safety Standards**

34 of the 90 building sectors were evaluated and do not meet the structural Life-Safety performance criteria of ASCE 31 based on the Tier I evaluation for a 10% in 50 year earthquake. Detailed evaluations were not performed as part of this scope of work. It is possible that some potential deficiencies identified by the Tier I evaluation would be eliminated based a detailed evaluation. These buildings are part of the LLNL seismic mitigation program. Recommendations for prioritization are given in Section 5 of this report. Potential structural deficiencies are identified on building data sheets in Appendix A. The following building sectors are included in this category:

<table>
<thead>
<tr>
<th>Building Sector</th>
<th>Evaluation Number</th>
<th>Description</th>
<th>Evaluation Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>041 (Office Area)</td>
<td>233</td>
<td>4675 Original &amp; Addition #1</td>
<td>827A</td>
</tr>
<tr>
<td>041 (Warehouse)</td>
<td>253 (Increment 2)</td>
<td>515</td>
<td>827D</td>
</tr>
<tr>
<td>115 (Original)</td>
<td>281 (Original)</td>
<td>519A</td>
<td>827E</td>
</tr>
<tr>
<td>115 (Addition)</td>
<td>322</td>
<td>809</td>
<td>833</td>
</tr>
<tr>
<td>115 (Vault)</td>
<td>326</td>
<td>810A</td>
<td>836B</td>
</tr>
<tr>
<td>116</td>
<td>327</td>
<td>810C</td>
<td>836D</td>
</tr>
<tr>
<td>117B</td>
<td>362</td>
<td>817C</td>
<td>870</td>
</tr>
<tr>
<td>165 (Annex)</td>
<td>363</td>
<td>818A</td>
<td></td>
</tr>
<tr>
<td>166C</td>
<td>435</td>
<td>826</td>
<td></td>
</tr>
</tbody>
</table>

Buildings 805, 806 Original, 806A, 806B and 807 do not meet Life Safety by evaluation. These buildings are exempt because functions are planned for relocation to the EMPC complex within the next 5 years according to LLNL.

**Non Evaluated Building Sectors**

Many of the building sectors did not have structural drawings available for review, but evaluations were completed based on observation of the structural system on the initial site visit. Evaluations for the following three buildings without available drawings could not be performed within the scope of this project. We recommend detailed site investigation of the following building sectors.
<table>
<thead>
<tr>
<th>117A</th>
<th>117C</th>
<th>435 (High Bay Mezzanine)</th>
</tr>
</thead>
</table>


5.0 Recommended Prioritization

The seismic mitigation program at LLNL is based on a prioritization system to evaluate and strengthen buildings to meet the Life-Safety performance objective in a 10% in 50 year earthquake. The framework for the prioritization system has recently been developed and is summarized in the June 6, 2003 letter by Degenkolb Engineers. See Appendix D. Recommendations for prioritization of seismic evaluation and strengthening work is based on observed behavior of similar buildings in past earthquakes, with the more vulnerable buildings given a higher prioritization. The prioritization system has five classifications (Class A to Class E) as described below.

Thirty-three of the 90 building sectors reviewed as part of this evaluation are exempt from evaluation and strengthening according to EO12941 and are not included in the LLNL seismic mitigation program. Fifty-seven of the 90 building sectors are included in the LLNL seismic mitigation program, with recommended prioritization classifications described below.

The recommendations for prioritization of seismic evaluation and strengthening work and descriptions of expected damage state are for an earthquake at the LLNL site with a 10% chance of exceedance in 50 years; an earthquake with a return period of 474 years. The buildings at LLNL have not been exposed to such a large earthquake in the past. However, they were exposed to a moderate sized magnitude 5.6 earthquake on January 24, 1980. According to the Consortium of Organizations for Strong-Motion Observation Systems the epicenter was in Clayton, California, approximately 10 miles North of Livermore. A peak ground acceleration of .125g was measured in this event by instrumentation at Veterans Hospital in Livermore, approximately 16 miles from the epicenter. Using attenuation equations developed by Boore, Joyner and Fumal, the peak ground acceleration (PGA) at the LLNL site during that earthquake is estimated to be between 0.15g and 0.20g. This represents an earthquake at the LLNL site with an approximate return period of between 75 and 100 years. It has been reported that the LLNL buildings sustained only minor damage in that earthquake.

5.1 Class A - Highest Priority Buildings (Zero Building Sectors)

No building sectors in this evaluation are placed in Classification A for "Exceptionally High Risk" buildings. Exceptionally high risk buildings do not meet the Life Safety for a 10% in 50 year earthquake and were defined in the 1998 evaluation on the basis that a) they have a structural system known to be especially vulnerable to earthquake induced damage, or b) they have a combination of high occupancy and high seismic risk in accordance with Approach A in the DOE Management Plan. Class A buildings have the potential for collapse and are required to be evaluated and strengthened according to RP6.
5.2 Class B - High Priority Buildings (8 Building Sectors)

Eight building sectors in this evaluation are placed in Classification B for High Priority buildings. High Priority buildings do not meet Life Safety and may sustain heavy damage and possibly local collapse conditions in a 10% in 50 year earthquake. A margin against complete collapse is expected based on observed structural performance of similar buildings in past earthquakes. Based on a Tier I rapid seismic evaluation, buildings included in this classification are:

<table>
<thead>
<tr>
<th>Building</th>
<th>115 (Original)</th>
<th>166C</th>
<th>327</th>
</tr>
</thead>
<tbody>
<tr>
<td>115 (Addition)</td>
<td>253 (Increment 2)</td>
<td>435</td>
<td></td>
</tr>
<tr>
<td>116</td>
<td>326</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RP6 currently does require action for these buildings unless they are exposed to trigger events such as a change in facility usage or a major building alteration. We recommend these buildings be evaluated and strengthened to life-safety as an "active" part of the LLNL seismic mitigation program. We recommend LLNL to determine the cost to strengthen these buildings, obtain funding and strengthen these buildings as funding becomes available.

5.3 Class C - Medium Priority Buildings (26 Building Sectors)

Twenty-six building sectors in this evaluation are placed in Classification C for Medium Priority buildings. Medium Priority buildings do not meet Life-Safety and have the potential to sustain "life threatening damage" affecting people in the vicinity of where the damage occurred in a 10% in 50 year earthquake. Complete collapse of these buildings is not likely. Based on a Tier I rapid seismic evaluation, buildings included in this classification are:

<table>
<thead>
<tr>
<th>Building</th>
<th>041 (Office)</th>
<th>322</th>
<th>809</th>
<th>827D</th>
</tr>
</thead>
<tbody>
<tr>
<td>041 (Warehouse)</td>
<td>362</td>
<td>810A</td>
<td>827E</td>
<td></td>
</tr>
<tr>
<td>115 (Vault)</td>
<td>363</td>
<td>810C</td>
<td>833</td>
<td></td>
</tr>
<tr>
<td>117B</td>
<td>4675</td>
<td>818A</td>
<td>836B</td>
<td></td>
</tr>
<tr>
<td>165 (Annex)</td>
<td>515</td>
<td>826</td>
<td>836D</td>
<td></td>
</tr>
<tr>
<td>233</td>
<td>519A</td>
<td>827A</td>
<td>870</td>
<td></td>
</tr>
<tr>
<td>281 (Original)</td>
<td></td>
<td>827C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We recommend strengthening of these buildings as they are remodeled or modernized, or as seismic mitigation funding becomes available.
5.4 Class D - Low Priority Buildings (20 Building Sectors)

Twenty building sectors in this evaluation are placed in Classification D for Lowest Priority buildings. These buildings have no structural deficiencies that require mitigation to meet the structural Life-Safety performance level. The buildings are not exempt based on EO12941 since nonstructural component bracing evaluations for these buildings was not included in the scope of work. If present, non-structural bracing deficiencies may result in life threatening damage due to falling hazards. Building sectors included in this classification are:

<table>
<thead>
<tr>
<th>166A</th>
<th>281 (South Addition)</th>
<th>810B</th>
<th>825</th>
</tr>
</thead>
<tbody>
<tr>
<td>166D</td>
<td>292</td>
<td>812E</td>
<td>836A</td>
</tr>
<tr>
<td>253 (Original)</td>
<td>298</td>
<td>817A</td>
<td>850</td>
</tr>
<tr>
<td>253 (Addition)</td>
<td>519B</td>
<td>817C</td>
<td>851</td>
</tr>
<tr>
<td>281 (Increment 2)</td>
<td>802A</td>
<td>817F</td>
<td>851C</td>
</tr>
</tbody>
</table>

We recommend that non-structural bracing deficiencies be identified and mitigated as part of ongoing facility maintenance programs for all non-exempt buildings.

5.5 Class E - Non-Evaluated Buildings (3 Building Sectors)

Many of the building sectors did not have structural drawings available for review, but evaluations were completed based on observation of the structural system on the initial site visit. Evaluations for the following three buildings without available drawings could not be performed within the scope of this project. We recommend detailed site investigation of the following building sectors.

<table>
<thead>
<tr>
<th>117A</th>
<th>117C</th>
<th>435 (High Bay Mezzanine)</th>
</tr>
</thead>
</table>
5.6 Non-Exempt Building Prioritization Matrix

Table 5.1 Non-Exempt Building Prioritization Matrix

<table>
<thead>
<tr>
<th>Classification</th>
<th>Structural Life Safety</th>
<th>Recommendations</th>
<th>Damage State</th>
<th>Performance</th>
<th>Vulnerability Rating</th>
<th>Evaluated Buildings (Tier I evaluations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>No</td>
<td>Highest Priority: Buildings are ranked as Exceptionally High Risk and require active seismic evaluation and mitigation by RPS.</td>
<td>Potential Catastrophic Collapse - Does not meet structural Life-Safety</td>
<td>Extremely Poor</td>
<td>10</td>
<td>115 (Original) 115 Addition, 116, 166C, 253 (Increment 45), 328, 327, 435</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>Potential Collapse - Does not meet structural Life-Safety</td>
<td>Very Poor</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>B</td>
<td>No</td>
<td>High Priority: Strengthen buildings as an &quot;active&quot; part of the LLNL seismic mitigation program. Determine cost to strengthen, obtain funding and strengthen as funds are allocated. RPS does not currently trigger action.</td>
<td>Heavy Damage - Does not meet structural Life-Safety</td>
<td>Very Poor</td>
<td>8</td>
<td>115 (Original) 115 Addition, 116, 166C, 253 (Increment 45), 328, 327, 435</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Life Threatening Damage, collapse not likely - Does not meet structural Life-Safety</td>
<td>Poor</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>No</td>
<td>Medium Priority: Strengthen as buildings are remodeled and modernized, or as seismic mitigation funding becomes available.</td>
<td>Life Threatening Damage, collapse not likely - Does not meet structural Life-Safety</td>
<td>Poor</td>
<td>6</td>
<td>041 (Office Area), 041 (Warehouse), 115 (Magnetic Vault), 166 (Arms), 233, 281 (Original), 322, 582, 583, 4875, 515, 519A, 535, 810A, 810C, 813A, 826, 827A, 827C, 827D, 827E, 833, 836A, 836D, 870</td>
</tr>
<tr>
<td>D</td>
<td>Yes</td>
<td>Lowest Priority: Mitigate nonstructural deficiencies as part of the ongoing facility maintenance program.</td>
<td>Potential Nonstructural Deficiencies Only; Meets Structural Life-Safety</td>
<td>Fair/Good Structural; Potentially Poor Nonstructural</td>
<td>1 to 3</td>
<td>253 (Original Building), 253 (Addition), 281 (Increment 2), 281 (Addition), 292, 298B, 802A, 810B, 812E, 817A, 166A(7), 166D (7), 519F(7), 817C, 817F, 825, 824, 836A, 850, 851D</td>
</tr>
<tr>
<td>E</td>
<td>N/A</td>
<td>Perform on-site detailed observations to complete Tier I seismic evaluations and prioritize.</td>
<td>Buildings have not been evaluated.</td>
<td></td>
<td></td>
<td>117A, 117C, 435 (High Bay Mezzanine)</td>
</tr>
</tbody>
</table>

Building Totals = 57

(1) Classifications are used to describe groupings of buildings at LLNL, with similar recommendations.

(2) A nonstructural evaluation has not been performed for any of the non-exempt buildings.

(3) Class D buildings are Life Safe for structural performance. They have not had a nonstructural evaluation and are therefore non-exempt.

(4) Buildings have not been evaluated due to lack of information.

(5) RPS is the current federal regulatory Standard that provides common minimum requirements for seismic safety of existing Federal buildings titled, "Standard of Seismic Safety for Existing Federally Owned and Leased Buildings".

(6) The seismic mitigation recommendations are for Life-Safety performance only. Buildings that require higher performance levels, including exempt buildings, should be individually evaluated for recommended strengthening.

(7) Evaluation of steel moment connections required to confirm buildings meet structural Life Safety performance level

(8) Rating is pending completion of retrofit project currently underway.
6.0 Cost Projections

Cost projections for seismic mitigation of non-exempt buildings have been developed based on the same approach used as a standard by the DOE in responding to EO 12941. Cost projections have been developed using information collected by FEMA and methodology presented in FEMA 156 and 157.

Based on the statistical methodology of FEMA 156 and 157, typical costs are available for common building types, building sizes, different seismic performance objectives, and seismicity levels. Typical costs also are provided for nonstructural finishing work (patch and repair) and project costs (project management, design, and testing).

See Appendix D for a listing of projected costs per building. The mean cost is also shown in the Appendix. Actual cost of strengthening may vary significantly from the FEMA 156 based costs. First, based on the statistical methodology included in FEMA 156, actual cost for any one building may vary by up to a factor of 3 to obtain a confidence level of 75%. For large groups of buildings the statistical variance decreases. For instance, to get a 75% confidence level for a group of 50 buildings, actual costs may be 10% to 15% higher. Second, laboratory buildings at LLNL may be inherently more costly to upgrade than considered in FEMA 156 because of the special laboratory environment. Therefore, we recommend that the concept level strengthening schemes and cost estimates for each individual building be developed before construction budgets are established.
7.0 References


Appendix A  Building Data Sheets
Class B – High Priority Buildings
Building 115, Computer Building

Building 115 is a one-story reinforced masonry bearing shear wall building. The main building structure was constructed in 3 phases. The roof structure in the first two phases of construction consists of 2" poured gypsum over 1/2" gypsum board or fiberglass formboard. The slabs are supported by open web joists, which are supported by interior and exterior steel wide flange columns and perimeter reinforced concrete shear walls. In the third phase, the roof structure consists of a lightweight concrete fill over metal deck. The slab is supported by steel wide flange beams and girders, which are supported by concrete block walls.

The primary structural deficiencies noted for Building 115 are as follows: 1) The gypsum board diaphragm cannot adequately transfer seismic loads; 2) There is no apparent out-of-plane anchorage in the first two phases of construction; and 3) There are no cross ties in the first two phases of construction.

For the building to meet life-safety requirements, we recommend replacing the gypsum board diaphragm and adding both out-of-plane anchorage and cross ties where required.
Building Name: Building 115 (A, B, AB)  
Date: July 24, 2003

Building Address: Lawrence Livermore National Laboratory  
Page: 1 of 2

Job Number: A20047.08  
Job Name: LLNL Prioritization  
By: JYF  
Checked: JEH

PRIORITIZATION BUILDING DATA SHEET

BUILDING DATA

Year Built: 1954  
Year(s) Remodeled: 1955 (added Bldg 115 B), 1961 (added Bldg 115 AB)  
UBC Zone: 4 – Type B Near Field

Area (sf): 11,600  
Length (ft): 89  
Width (ft): 139

No. Stories: 1+Basement  
Story Height: 17'-8"  
Total Height: 17'-8"

CONSTRUCTION DATA

Building 115 A: 2" poured gypsum o/ 1/2" gypsum board supported by open web joists, which span to WF columns or concrete block walls at the perimeter.

Building 115 B: 2" poured gypsum o/ 1" fiberglass formboard supported by open web joists, which span to WF columns or concrete block walls at the perimeter.

Building 115 AB: 1 1/2" lightweight concrete fill o/ Tufcor 1 5/16" deck supported by WF beams and girders, which span to concrete block walls or existing walls at Bldgs 115 A or 115 B.

Gravity Load Structural System:

Exterior Transverse Walls: 8" concrete block walls  
Exterior Longitudinal Walls: 8" concrete block walls  
Roof Framing: 2" poured gypsum o/ 1/2" gypsum board, 2" poured gypsum o/ 1" fiberglass formboard, 1 1/2" lightweight concrete fill o/ Tufcor 1 5/16" deck

Intermediate Floor Framing: None

Ground Floor: 6" concrete floor slab supported by 12"x12" or 12"x14" interior concrete columns (10' in hgt) or exterior 10" concrete walls in the basement.

Columns: WF columns

Foundation: Concrete strip footing and spread footings

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Classification: Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm) and Type 14 (Reinforced Masonry Bearing Wall Building w/ Stiff Diaphragm)</td>
<td>Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm) and Type 14 (Reinforced Masonry Bearing Wall Building w/ Stiff Diaphragm)</td>
</tr>
<tr>
<td>Vertical Elements: Open web joists, steel beams, reinforced concrete block walls; concrete columns and concrete bearing walls at basement</td>
<td>Open web joists, steel beams, reinforced concrete block walls; concrete columns and concrete bearing walls at basement</td>
</tr>
<tr>
<td>Diaphragms: 2&quot; poured gypsum o/ 1/2&quot; gypsum board, 2&quot; poured gypsum o/ 1&quot; fiberglass formboard, 1 1/2&quot; lightweight concrete fill o/ Tufcor 1 5/16&quot; deck</td>
<td>2&quot; poured gypsum o/ 1/2&quot; gypsum board, 2&quot; poured gypsum o/ 1&quot; fiberglass formboard, 1 1/2&quot; lightweight concrete fill o/ Tufcor 1 5/16&quot; deck</td>
</tr>
</tbody>
</table>

SEISMIC EVALUATION PERFORMED: Yes  
EVALUATION: Rapid Evaluation  
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 7  
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS B
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

OTHER DIAPHRAGMS
Building 115 A: 2" poured gypsum o/ 1/2" gypsum board. Building 115 B: 2" poured gypsum o/ 1" fiberglass formboard. Deck is not adequate to transfer seismic loads. There are no potential life safety deficiencies identified.

WALL ANCHORAGE
There is no out of plane anchorage for the walls in Buildings 115 A and 115 B.

CROSS TIES
Bar joists serve as the cross ties in the NS direction. There are no cross ties in the EW direction in Buildings 115 and 115 B.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Strengthen the gypsum board diaphragm with diaphragm rod bracing or another method of strengthening
Strengthen the out of plane wall anchorage
Add cross ties in the EW direction in Buildings 115A and 115B
### BUILDING SYSTEM

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>☐</td>
<td>☐</td>
<td>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.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.1.1   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.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.1.2   ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.1.3   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.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.2.1   WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.2.2   SOFT STORY: The stiffness of the lateral-force-resisting-system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.2.3   GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
</tr>
</tbody>
</table>

Building 115 A: 2" poured gypsum or 1/2" gypsum board supported by open web joists, which span to WF columns or concrete block walls at the perimeter. At the north elevation, there is steel frame w/ rod bracing. Building 115 B: 2" poured gypsum or 1" fiberglass formboard supported by open web joists, which span to WF columns or concrete block walls at the perimeter. At the south elevation, there is steel frame w/ rod bracing. Building 115 AB: 1 1/2" lightweight concrete fill or Tufcor 1 5/16" deck supported by WF beams and girders, which span to concrete block walls or existing walls at Bldgs 115 A or 115 B. The concrete block walls are dowelled into the concrete bearing walls at the basement level, which are dowelled into the concrete strip footings. Building 115AB is connected to Buildings 115 A and 115 B with angles and 1/4" fillet welds. Load is transferred from the Buildings 115 A and 115 B via the diaphragm to the concrete block walls in Building 115AB. In the evaluation, the rod bracing is assumed to take no seismic load. There are no adjacent buildings. There are no mezzanines. One story building One story building One story building
## BUILDING SYSTEM

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>4.3.2.4</th>
<th>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4.3.2.5</td>
<td>MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.3.1</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.3.7</td>
<td>MASONRY UNITS: There shall be no visible deterioration of masonry units.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.3.8</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.3.10</td>
<td>REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
</tr>
</tbody>
</table>

### Comments
- The concrete block walls are dowelled into the concrete bearing walls at the basement level, which are dowelled into the concrete strip footings.
- One story building
- Site visit made on 7/30/03. No signs of deterioration were observed.
- Site visit made on 7/30/03. No signs of deterioration were observed.
- Site visit made on 7/30/03. No eroded mortar was observed.
- Site visit made on 7/30/03. There are no cracks >1/8".

## LATERAL-FORCE-RESISTING SYSTEM

|   |   | 4.4.2.1.1 | 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. |
|   |   | 4.4.2.4.1 | 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. |
|   |   | 4.4.2.4.2 | 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. |

### Comments
- There are at least two lines of shear walls in both the longitudinal and transverse directions.
- The maximum shear stress in the concrete block wall is 26+70 psi in the transverse (EW) direction.
- Typ. reinforcement in reinforced concrete block walls:
  - Vertical Reinforcing = #4@32" o.c.: reinforcing ratio = 0.0007 ≥ 0.0007
  - Horizontal Reinforcing = #4@48" o.c. horizontal: reinforcing ratio = 0.001 > 0.0007.

  Total reinforcing steel ratio =
  \[(0.2*48/32+0.4)in^2/(48^"*8") = 0.002 = 0.002\]
CONNECTIONS

☐ ☑ ☐ 4.6.1.1 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.

There is no out of plane anchorage for the walls in Buildings 115 A and 115 B.

☐ ☐ ☑ 4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.

There are no wood ledgers.

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

1/2" diameter dowels @ 16" o.c. from slab to concrete beam and concrete block wall.

☐ ☐ ☐ 4.6.3.5 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.

#4x 4'-0" dowels @ 32" o.c. into the concrete foundation to match vertical reinforcing in the concrete block walls.

☐ ☐ ☐ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

Steel beams are connected to the WF columns w/ bolts and welds.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
<table>
<thead>
<tr>
<th>LATERAL-FORCE-RESISTING SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ ☐ ☒ 4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐ ☐ ☒ 4.4.2.4.4 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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIAPHRAGMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒ ☐ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.</td>
</tr>
<tr>
<td>☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
</tr>
<tr>
<td>☒ ☐ ☐ 4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.</td>
</tr>
<tr>
<td>☐ ☐ ☒ 4.5.1.7 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.</td>
</tr>
<tr>
<td>☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐ ☐ ☒ 4.5.2.1 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.</td>
</tr>
<tr>
<td>☐ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.</td>
</tr>
<tr>
<td>☐ ☐ ☒ 4.5.2.3 UNBLOC kED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.</td>
</tr>
<tr>
<td>☐ ☐ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
</tbody>
</table>
**ASCE 31* SUPPLEMENTAL CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS**

<table>
<thead>
<tr>
<th></th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
</table>

### DIAPHRAGMS

- **4.5.7.1** OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

  - Building 115 A: 2" poured gypsum of 1/2" gypsum board. Building 115 B: 2" poured gypsum of 1" fiberglass formboard. Deck is not adequate to transfer seismic loads.

### CONNECTIONS

- **4.6.1.4** 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 no greater than 1/8".

*— Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
**Building 115, Addition**

Building 115, Addition is approximately 2,000-sq. ft. and is a concrete bearing wall building. Building 115, Addition is not evaluated because of lack of structural information. A detailed on-site evaluation is required to conclusively determine the structural deficiencies in the building. However, based on our site visit observations, Building 115, Addition is similar in construction to Building 115, Computer Building. The deficiencies and recommendations for strengthening identified for Building 115, Computer Building are also applicable to Building 115, Addition.
ROOF PLAN

1.4. Lightweight Grit Fill
2. Steel Roof Deck, Tafcon-ER approved equal
3. Insulation: 4" Wufus-1.5x depth,
   Min T= 0.069 in./min; Min S= 0.113 gsf

ROOF FRAMING (6"=1'-0")

Excluding roof deck to remain.

 Existing roof deck to remain.
Building 116

Building 116 is a two-story concrete bearing wall building. The structure consists of a 6" thick concrete flat slab at the roof and 7" thick concrete flat slab at the floor level. The slabs are supported by concrete beams, which are supported by interior and exterior concrete columns and perimeter reinforced concrete shear walls. The shear walls are located on the East, West and South sides of the building. The North side of the building consists of only concrete columns.

The potential structural deficiencies noted for Building 116 are as follows: 1) There is no redundancy in the lateral-force-resisting system in the east-west direction; 2) There is a significant torsional issue based on the shear wall layout; 3) The concrete columns do not have ductile detailing to withstand large deformations; and 4) The shear walls in the east-west direction are overstressed.

For the building to meet life-safety requirements, we recommend adding a brace frame at the North side of the building, infilling window openings on the East and West sides of the building, and perform a more detailed analysis of the concrete columns to examine whether they can withstand seismic demands.
BUILDING DATA

Year Built: 1958
Area (sf): 7,500
No. Stories: 2

Year(s) Remodeled: 120'-10"
Length (ft): 10'-4"
Story Height: 20'-5"

UBC Zone: 4 – Type B Near Field
Width (ft): 30'-8"
Total Height: 20'-5"

CONSTRUCTION DATA

6" concrete flat slab at roof, 7" concrete flat slab at floor. Slab is supported by concrete beams, which are supported by interior and exterior 12"x12" concrete columns and perimeter reinforced concrete shear walls.

Gravity Load Structural System:
- Exterior Transverse Walls: 10" concrete shear walls
- Exterior Longitudinal Walls: 10" concrete shear walls
- Roof Framing: 6" concrete flat slab supported by 14"x20" concrete beams typ.
- Intermediate Floor Framing: 7" concrete flat slab supported by 23"x18" concrete beams typ.
- Ground Floor: 5" slab on 7" pervious fill w/ 6x6-6/6 EWWF

Columns: 12"x12" concrete columns
Foundation: Concrete strip footing and spread footings

Openings?: Door and window openings
Openings?: Door and window openings

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>System Classification</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type 9 (Concrete shear wall building w/ stiff diaphragm)</td>
<td>Type 8 (Concrete shear wall building w/ stiff diaphragm)</td>
</tr>
<tr>
<td>Vertical Elements</td>
<td>Concrete beams and columns, concrete shear walls.</td>
<td>Concrete beams and columns, concrete shear walls.</td>
</tr>
<tr>
<td>Diaphragms</td>
<td>6&quot; concrete flat slab at roof, 7&quot; concrete flat slab at floor</td>
<td>6&quot; concrete flat slab at roof, 7&quot; concrete flat slab at floor</td>
</tr>
</tbody>
</table>


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 7
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS B
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

REDUNDANCY
There are two lines of shear walls for the NS direction of loading. For loads in the EW direction, there is only one line of shear walls at Line A (south elevation of bldg). At Line C (north elevation of bldg), there is only a line of concrete frames.

TORSION
There are no concrete shear walls at the north elevation of the building

DEFLECTION COMPATIBILITY
Shear reinforcement in gravity columns is not adequate to develop the flexure capacity of the columns

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add a brace frame or another lateral-force-resisting element at the north side of the building.
Perform a detail analysis of the columns for deflection compatibility or strengthen the columns.
## BUILDING SYSTEM

<table>
<thead>
<tr>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.3.1.1 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. Seismic load is transferred from the concrete slab to the concrete beams. The concrete beams are connected to the perimeter and interior concrete shear walls. The shear walls are doweled into the concrete strip footing foundation.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.1.3 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. There are no mezzanines.</td>
</tr>
<tr>
<td>☒</td>
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<td>☐</td>
<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. The length of concrete shear wall at the 1st floor is shorter by 54&quot; than the 2nd floor in the transverse direction. Total length of shear wall in transverse direction = 80.7'. Decrease in strength = 7% &lt; 20%.</td>
</tr>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. The shear walls are doweled into the concrete strip footing foundation.</td>
</tr>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. The shear walls are doweled into the concrete strip footing foundation.</td>
</tr>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. There are no concrete shear walls at the north elevation of the building.</td>
</tr>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. Site visit made on 7/22/03. No signs of deterioration were observed.</td>
</tr>
<tr>
<td>☐</td>
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<td>☐</td>
<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. Site visit made on 7/22/03. There are no cracks &gt;1/8&quot;.</td>
</tr>
<tr>
<td>☒</td>
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<td>☐</td>
<td>4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. Site visit made on 7/22/03. There are no cracks &gt;1/8&quot;.</td>
</tr>
<tr>
<td>☐</td>
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<td>☒</td>
<td>4.3.3.5 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.</td>
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<td>☒</td>
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<td>4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
</tr>
</tbody>
</table>

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P:\Project_A02\000.099\A20047.08\Calc\Active\Worksheets\Calculations and Summary Sheets per Building\Bldg 116\116 ASCE Basic C2.doc
LATERAL-FORCE-RESISTING SYSTEM

☑ ☐ ☐ 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

☐ ☑ ☐ 4.4.2.1.1 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.

☑ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f_c}$ for Life Safety and Immediate Occupancy.

☑ ☐ ☐ 4.4.2.2.2 REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall not be 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" for Life Safety and Immediate Occupancy.

The slab is tied to the concrete beams, which are dowelled into the concrete columns.

There are two lines of shear walls for the NS direction of loading. For loads in the EW direction, there is only one line of shear walls at Line A (south elevation of bldg). At Line C (north elevation of bldg), there is only a line of concrete frames.

Maximum average shear stress is in transverse direction, 90 psi < 100 psi. Note: $2\sqrt{f_c} = 110$ psi for $f_c = 3,000$ psi.

Typ. reinforcement in reinforced concrete walls:
- Vertical Reinforcing = 2#4@16" o.c.:
  - Reinforcing ratio = 0.0025 > 0.0015
- Horizontal Reinforcing = 2#4@16" o.c.:
  - Reinforcing ratio = 0.0025 > 0.0015

Spacing of rebar at 16" o.c. < 18".

CONNECTIONS

☑ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

☑ ☐ ☐ 4.6.3.5 FOUNDATION DOWELS: Wall reinforcement shall be dowelled 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.

At the roof and 2nd floor: 2#4 @ 18" o.c.
- Typ. dowel into the walls from the slab.
- 2#5's dowel into the walls from the concrete beams (EW direction only).
- #4 dowels into concrete foundation to match vertical rebar in the concrete shear wall.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
**ASCE 31* SUPPLEMENTAL CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS**

### LATERAL-FORCE-RESISTING SYSTEM

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<th>Comments</th>
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<tbody>
<tr>
<td>☑</td>
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<td>4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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. Columns: 4#6 longitudinal bars and #3 stirrups @12&quot; o.c.. 1.25<em>Mn = 1.25(36</em>4.44<em>9) = 59.4 kip-ft. eVn = 0.85(36</em>2.11*9/12) = 5kip &lt; 5.94 kips.</td>
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<td>☑</td>
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<td>4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
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<td>4.4.2.2.3 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.</td>
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<td>☑</td>
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<td>☑</td>
<td>4.4.2.2.4 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. Life Safety Performance Level.</td>
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<td>4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
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<td>☑</td>
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<td>4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
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<td>4.4.2.2.7 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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
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</table>

### DIAPHRAGMS

| ☑ | ☑ | ☑ | 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. There are no split level floors or expansion joints. |
| ☑ | ☑ | ☑ | 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. Life Safety Performance Level. |
| ☑ | ☑ | ☑ | 4.5.1.7 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. Life Safety Performance Level. |
### DIAPHRAGMS

<table>
<thead>
<tr>
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<th>Comments</th>
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<tbody>
<tr>
<td>☑</td>
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<td>☑</td>
<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
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</table>

### CONNECTIONS

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<th>Comments</th>
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<tbody>
<tr>
<td>☑</td>
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<td>4.6.3.10 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.</td>
</tr>
</tbody>
</table>

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
**Building 166C**

Building 166C is a one-story bearing wall structure. The roof consists of a series of 6x12s bolted together that spans to the perimeter bearing walls. The bearing walls consist of 3 feet thick concrete blocks grouted together. At each joint in the wall, there are two continuous lag studs that are embedded into the foundation. The intent of the original construction was that this would be a temporary building.

The potential structural deficiencies noted for Building 166C are as follows: 1) The anchorage of the concrete block wall into the diaphragm is insufficient to resist the out-of-plane loads of the heavy wall; and 2) There are no secondary vertical supports of the roof.

For the building to meet life-safety requirements, we recommend providing additional anchorage of the concrete block walls to the diaphragm.
### BUILDING DATA

<table>
<thead>
<tr>
<th>Year Built:</th>
<th>1961</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year(s) Remodeled:</td>
<td>-</td>
</tr>
<tr>
<td>Area (sf):</td>
<td>1,345 sf</td>
</tr>
<tr>
<td>No. Stories:</td>
<td>1</td>
</tr>
</tbody>
</table>

### CONSTRUCTION DATA

Gravity Load Structural System: The roof is supported on 6x12 sections that are bolted together. The roof spans to exterior bearing concrete block wall.

Exterior Transverse Walls: 3' thick concrete blocks

Exterior Longitudinal Walls: 3' thick concrete blocks

Roof Framing: Plywood sheathing on 2x framing that is supported on 6x12 bolted timber sections.

Intermediate Floor Framing: -

Ground Floor: 6” concrete slab on grade

Columns: Bearing concrete block wall

Foundation: SOG with grade beams underneath the concrete block wall.

### LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal (W-E)</th>
<th>Transverse (N-S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM1 – Reinforced Masonry Bearing Wall Buildings with Flexible Diaphragm</td>
<td>RM1 – Reinforced Masonry Bearing Wall Buildings with Flexible Diaphragm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vertical Elements:</th>
<th>Bearing concrete block wall</th>
</tr>
</thead>
</table>

Diaphragms: Plywood sheathing

### SEISMIC EVALUATION PERFORMED? Yes EVALUATION: Rapid Evaluation YEAR: 2003

### SEISMIC EVALUATION CRITERIA:

Life Safety/ ASCE 31-02

### VULNERABILITY RATING:

7

(1=low to 10=high)

### PRIORITIZATION CLASSIFICATION: CLASS B
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

WALL ANCHORAGE
The connection of the concrete blocks into the diaphragm is insufficient for out-of-plane loads.

STIFFNESS OF WALL ANCHORS
Anchorages of wood diaphragm into concrete block wall consists of either concrete pins spaced at 4"0".

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add out-of-plane anchorage between the 6x12 roof framing and the concrete blocks.
# Building System

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒ ☐ ☐</td>
<td>4.3.1.1 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.</td>
<td>The load path consists of concrete block wall located along the entire perimeter.</td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
<td>Single story structure.</td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.1.3 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.</td>
<td>Single story structure.</td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
<td>Single story structure.</td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
<td>Single story structure.</td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
<td>Walls continuous to ground</td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
<td>Single story structure.</td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
<td></td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.3.1 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.</td>
<td></td>
</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.3.7 MASONRY UNITS: There shall be no visible deterioration of masonry units.</td>
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<tr>
<td>☑ ☐ ☐</td>
<td>4.3.3.8 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.</td>
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</tr>
<tr>
<td>☑ ☐ ☐</td>
<td>4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
<td>No observed cracks</td>
</tr>
</tbody>
</table>
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.1.1 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.

☐ ☐ ☐ 4.4.2.4.1 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.

☐ ☐ ☒ 4.4.2.4.2 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.

Very low concrete shear stress. Stress is only 8 psi due to very thick walls (3" thick blocks)

CONNECTIONS

☐ ☒ ☐ 4.6.1.1 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.

Diaphragm anchorage to wall consists of anchors / pins spaced at 4'-0" o.c.

☐ ☐ ☐ 4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.

☐ ☐ ☒ 4.6.2.1 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 diaphragms for Immediate Occupancy.

Diaphragm is connected to shear walls with anchors / pins spaced at 4'-0" o.c.

☐ ☐ ☐ 4.6.3.5 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.

There are lagstuds in between the blocks that are embedded 1'-3" into the grade beam.

☐ ☒ ☒ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

* Checklists statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
ASCE 31* SUPPLEMENTAL CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☐ ☐ 4.4.2.4.4 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.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☒ ☐ ☐ 4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.

☐ ☐ ☒ 4.5.1.7 PLAN IRRREGULARITIES: 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.

☑ ☒ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☐ ☒ 4.5.2.1 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.

☒ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☒ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☒ ☐ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.
### DIAPHRAGMS

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<tr>
<td>☒</td>
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<td>4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
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### CONNECTIONS

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<td>4.6.1.4 STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed such that they shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8&quot;. Diaphragm is connected to shear walls with anchors / pins spaced at 4'-0&quot; o.c.</td>
</tr>
</tbody>
</table>

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 253, Increment 2

Building 253, Increment 2 is a one-story reinforced masonry bearing shear wall building. The structure consists of a 3" thick concrete fill over metal deck supported by open web joists, which are supported by interior and exterior concrete block walls. The shear walls are located on the east, west and south sides of the building. The north side of the building consists of steel wide flange beams and square tube columns.

The potential structural deficiencies noted for Building 253, Increment 2 are as follows: 1) There is no redundancy in the lateral-force-resisting system in the east-west direction; 2) There is a significant torsional issue based on the shear wall layout on three sides of the building; and 3) The out-of-plane anchorage connections are not adequate.

For the building to meet life-safety requirements, we recommend adding a brace frame at the North side of the building and strengthening the out-of-plane anchorage connections.
BUILDING DATA

- Year Built: 1964
- Area (sf): 20,900
- No. Stories: 1+Mech. Penthouse
- Length (ft): 222
- Story Height: 14'-4"
- Total Height: 23'-4"

CONSTRUCTION DATA

- Concrete slab supported by open web joists. The joists are supported by 16WF40/45 @ interior and concrete block walls at exterior. At the North side of the bldg, open web joists are supported by 15C33.9 and TS4x6.
- Exterior Transverse Walls: 8" concrete block walls
- Exterior Longitudinal Walls: 8" concrete block walls
- Roof Framing: 3" concrete slab on Fenestra-Holorib Deck supported by 18" deep open web joists, which are supported by WF or channels.
- Intermediate Floor Framing: None
- Ground Floor: 6" concrete slab on grade w/ #4 @ 16" o.c. E.W.
- Columns: TS5x5 or TS4x6
- Foundation: Spread and strip footings

LATERAL-FORCE-RESISTING SYSTEM

- Longitudinal
  - System Classification: Type 14 (Reinforced concrete block walls w/ stiff diaphragm)
  - Vertical Elements: Open web joists, steel beams and channels, tube steel columns, concrete block walls
  - Diaphragms: 3" concrete slab on Fenestra-Holorib Deck

- Transverse
  - System Classification: Type 14 (Reinforced concrete block walls w/ stiff diaphragm)
  - Vertical Elements: Open web joists, steel beams and channels, tube steel columns, concrete block walls
  - Diaphragms: 3" concrete slab on Fenestra-Holorib Deck

SEISMIC EVALUATION PERFORMED?: Yes  EVALUATION: Rapid Evaluation  YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 7
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS B

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

- REDUNDANCY
  There is only one line of shear walls in the longitudinal direction. There are two lines of shear walls in the transverse direction.

- TORSION
  There are no shear walls on the North side of the building

- WALL ANCHORAGE
  Out of plane anchorage for the concrete block walls is not adequate. D/C = 1.04.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add brace frame or another lateral force resisting element on the North side of the building
Strengthen the out of plane anchorage
### BUILDING SYSTEM

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<th>Comments</th>
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<tbody>
<tr>
<td>✓</td>
<td>0</td>
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<td>4.3.1.1 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. The 3&quot; concrete slab on metal deck delivers load to the open web joists. The load is then transfer to WF girders, which are supported by the perimeter reinforced concrete block walls. The concrete block walls are dowelled into the concrete strip foundation system.</td>
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<td>4.3.1.3 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. There are no mezzanines.</td>
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<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. One story building.</td>
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<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting-system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. One story building.</td>
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<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. One story building.</td>
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<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. One story building.</td>
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<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. One story building.</td>
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<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. There are no shear walls on the North side of the building.</td>
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<tr>
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<td>4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. Site visit made on 7/30/03. No signs of deterioration were observed.</td>
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<tr>
<td>0</td>
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<td>4.3.3.7 MASONRY UNITS: There shall be no visible deterioration of masonry units. Site visit made on 7/30/03. No eroded mortar was observed.</td>
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<td>4.3.3.8 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. Site visit made on 7/30/03. No signs of deterioration were observed.</td>
</tr>
</tbody>
</table>
BUILDING SYSTEM

☒ ☐ ☐ 4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

Site visit made on 7/30/03. There are no cracks >1/8".

LATERAL-FORCE-RESISTING SYSTEM

☐ ☒ ☐ 4.4.2.1.1 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.

There is only one line of shear walls in the longitudinal direction. There are two lines of shear walls in the transverse direction.

☒ ☐ ☐ 4.4.2.4.1 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.

The max. shear stress at Line E = 63 psi < 70 psi.

☒ ☐ ☐ 4.4.2.4.2 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.

Typ. reinforcement in reinforced concrete block walls:
Vertical Reinforcing = #4@18" o.c.; reinforcing ratio = 0.0016 > 0.0007
Horizontal Reinforcing = 2@4@48" o.c. horizontal; reinforcing ratio =0.001 > 0.0007.

Total reinforcing steel ratio = (0.2*24/16+0.2)in^2/(24*48") = 0.0026 > 0.002

DIAPHRAGMS

☐ ☐ ☒ 4.5.5.1 TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab.

There is no topping slab.

CONNECTIONS

☐ ☒ ☐ 4.6.1.1 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.

Out of plane anchorage: EW walls: 3/4" diameter bolts @ 4" o.c.; NS walls: 1/2" diameter bolts at 18" o.c.

D/C = 1.04.

☒ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

#4 bars @ 18" o.c. from concrete slab are doweled into concrete block walls.
ASCE 31* BASIC CHECKLIST RM2: REINFORCED MASONRY BEARING WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

CONNECTIONS

☐ ☐ ☒ 4.6.2.3 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.

There is no topping slab.

☒ ☐ ☐ 4.6.3.5 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.

#4 @ 16" o.c. dowels into the foundation to match vertical reinforcement in concrete block wall.

☒ ☐ ☐ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

Girders are bolted to the TS columns.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.4.4 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.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☒ ☐ ☐ 4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.

☐ ☐ ☒ 4.5.1.7 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.

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 326

Building 326 is a two-story reinforced masonry bearing wall building. The structure consists of 1" diagonal sheathing supported by wood joists and wood trusses. The joists and trusses are supported by concrete pilasters and perimeter 8" thick concrete block walls.

Structural drawings for Building 326 were not available for review. The deficiencies identified and proposed vulnerability rating are based on the findings of the LLNL Seismic Safety Evaluation of B326 Report dated March 13, 2001 and our site visit on July 30, 2003. The primary structural deficiencies noted for Building 326 are as follows: 1) The diaphragm cannot adequately transfer seismic loads to the shear walls; 2) The connections between the top of the pilasters and roof trusses are non-ductile and overstressed; and 3) The roof diaphragm chords are inadequate.

For the building to meet life-safety requirements, we recommend performing a more detailed on-site evaluation to determine the location of the lateral-force-resisting-system and to observe the interconnection of elements in the structure, strengthening or replacing the roof diaphragm, and reinforcing the connections at the concrete pilasters.
Building Name: Building 326  
Building Address: Lawrence Livermore National Laboratory  
Job Number: A20047.08  
Job Name: LLNL Prioritization  
Date: August 6, 2003  
Page: 1 of 2  
By: JYF  
Checked: JEH

**BUILDING DATA**

- Year Built: 1953
- Year(s) Remodeled: None
- Area (sf): 3,386
- Length (ft): 50' 8"
- Story Height: 32' 4"
- Total Height: 32' 4"
- UBC Zone: 4 – Type B Near Field
- No. Stories: 1
- Width (ft): 50' 8"

**CONSTRUCTION DATA**

- Gravity Load Structural System: 1" diagonal sheathing supported by 2x8 joists @ 24" o.c. The joists span to wood trusses, which are supported concrete pilasters and 8" thick concrete block walls
- Exterior Transverse Walls: 8" concrete block walls
- Exterior Longitudinal Walls: 8" concrete block walls
- Roof Framing: 1" diagonal sheathing supported by 2x8 joists @ 24" o.c. The joists span to wood trusses.
- Intermediate Floor Framing: None. There is a light weight wood floor and wall framing. Part of the mezzanine floor consists of a 12" thick concrete slab.
- Ground Floor: concrete slab on grade
- Columns: 16"x16" concrete pilaster
- Foundation: Concrete strip footings
- Openings?: Door and window openings

**LATERAL-FORCE-RESISTING SYSTEM**

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
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</thead>
<tbody>
<tr>
<td>System Classification: Type 13 (Reinforced concrete block walls w/ flexible diaphragm)</td>
<td>Type 13 (Reinforced concrete block walls w/ flexible diaphragm)</td>
</tr>
<tr>
<td>Vertical Elements: 2x8 joists, 2x6 interior stud walls, exterior concrete block walls, concrete pilaster</td>
<td>2x8 joists, 2x6 interior stud walls, exterior concrete block walls, concrete pilaster</td>
</tr>
<tr>
<td>Diaphragms: 1&quot; diagonal sheathing</td>
<td>1&quot; diagonal sheathing</td>
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</table>

**SEISMIC EVALUATION PERFORMED?** No  
**EVALUATION:** Rapid Evaluation  
**YEAR:** 2001

**SEISMIC EVALUATION CRITERIA:** Life Safety/ UCBC 1991

**VULNERABILITY RATING:** 7  
(1=low to 10=high)

**PRIORITIZATION CLASSIFICATION:** CLASS B

Note: This building summary sheet has been prepared based on the information from the Seismic Safety Evaluation of B326 report prepared by LLNL dated March 13, 2001. No structural drawings are available for review. The potential deficiencies identified and proposed vulnerability rating are based on the findings of the LLNL 2001 report and a site visit by Degenkolb Engineers on 7/30/03.
POTENTIAL LIFE SAFETY DEFICIENCIES IDENTIFIED:

The following potential deficiencies were identified in the Seismic Safety Evaluation of B326 report prepared by LLNL dated March 13, 2001.

TRANSFER TO SHEAR WALLS
The diaphragm cannot adequately transfer seismic loads to the shear walls.

MASONRY JOINTS
Mortar joints at the top of the east wall appear to have been re-pointed (repaired by applying new mortar of the joints)

REINFORCED MASONRY WALL CRACKS
Numerous vertical and diagonal cracks were noticeable. The east wall show evidence of extensive repairs.

GIRDER/COLUMN CONNECTION
The connection between top of pilaster and roof trusses is non-ductile and overstressed.

DIAPHRAGM CHORDS
The roof diaphragm chords are inadequate

The following potential deficiencies were identified per Degenkolb's site visit on July 30, 2003. Photos from the site visit are attached.

OUT OF PLANE BENDING
Concrete block walls are very tall and narrow. Concrete block walls may not have adequate capacity for out of plane bending.

WALL ANCHORAGE
Out of plane anchorage may not be adequate.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

A detail on-site evaluation is recommended to determine the location of the lateral-force-resisting-system and to observe the interconnection of elements in the structure.

Without further analysis, the recommended strengthening schemes are as those recommended in the Seismic Safety Evaluation of B326 report:

- Strengthen the roof diaphragm
- Reinforce the connections at the concrete pilasters
- Repair existing cracks and deterioration of the masonry joints
**Building 327**

Building 327 consists of a two-story steel braced frame structure above grade and a two-story basement below grade. The roof consists of a 1-1/2” bare metal deck with concrete insulation and built-up roofing supported on steel beams and columns. The second floor was originally constructed as a mezzanine level but has been enlarged in subsequent remodels. The second floor consists of a 5” concrete slab supported on steel beams and columns. The lateral system consists of 2”x1” bar braces in each principle direction.

The primary structural deficiencies noted for Building 327 are as follows: 1) The lack of redundancy in the structure as there is only one tension-only bar along each line of seismic resistance; 2) Axial stresses in the braces exceed allowable; and 3) The second floor diaphragm cannot transfer seismic forces into the braced frames due to a large opening that takes up half of the length of the braced frame.

For the building to meet life-safety requirements, we recommend replacing the existing bar braces with tube steel. We also recommend performing a detailed analysis to determine the adequacy of the existing collector beams to transfer the diaphragm loads into the braced frames.
BUILDING DATA

Year Built: 1958  Year(s) Remodeled: -  UBC Zone: 4 – Type B Near Field
Area (sf): 18,200  Length (ft): 88’  Width (ft): 67'-11”
No. Stories: 2 stories + 2 Basement  Story Height: 12’  Total Height: 24’ above ground floor + 34’ below ground

CONSTRUCTION DATA

Above ground floor – Concrete slab supported on steel beams that span to WF columns.
Gravity Load Structural System: Below ground floor – Concrete slab supported on beams that span to concrete columns and bearing walls.

Exterior Transverse Walls: metal wall panels  Openings?: None
Exterior Longitudinal Walls: metal wall panels  Openings?: None
Roof Framing: Bare metal deck supported on steel beams that span to WF columns.
Intermediate Floor Framing: 5” concrete slab supported on steel beams and columns. Size of mezzanine has been increased such that it behaves like a 2nd floor.
Ground Floor: Slab at ground varies from 10” – 30” concrete slab.

Columns: Steel wide flange columns above ground. Below ground, concrete columns, pilasters, and bearing walls.

There are 2 basement levels that extend as deep as 34’ below the ground floor. Foundation consists of basement slab and thickened slab portions underneath retaining/bearing walls. Grade beams are stepped in order to tie together the 2 basement levels.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal (W-E)  Transverse (N-S)
Vertical Elements: Steel wide flange columns  Steel wide flange columns
Diaphragms: Roof – Bare metal deck with insulation and built up roofing.  2nd floor – 5” concrete slab.


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02
VULNERABILITY RATING: 7
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS B
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

REDUNDANCY
There is only a single tension brace along each line to resist seismic forces. There is no redundancy in the latera system.

AXIAL STRESS CHECK
Axial stress in braced frame is higher than allowed by quick check. 2"x1" bar braces are incapable of carrying compressive forces. Braced frame is tension only.

OPENINGS AT BRACED FRAME
Diaphragm opening in the 2nd floor along the north braced frame extend 50% of the frame length.

COMPACT MEMBERS
Low bay columns (W10x33) are not compact.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Replace existing bar braces with tube steel that can act as both tension and compression members. Perform detailed analysis to verify whether the existing diaphragm and collectors are capable of transferring the seismic loads into the braced frame.

OTHER COMMENTS:
Addition has been added to the northwest corner of the building. Addition is designated as room 1275. Room 1275 is a 600 square feet steel light frame structure and is exempt from evaluation.
## ASCE 31* BASIC CHECKLIST S2: STEEL BRACED FRAMES WITH RIGID OR STIFF DIAPHRAGMS

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<td></td>
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<td><strong>BUILDING SYSTEM</strong></td>
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</table>

☐ ☐ ☐ 4.3.1.1 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.

Lateral force resisting system consists of braced frames along the perimeter.

☐ ☐ ☐ 4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.

☐ ☐ ☐ 4.3.1.3 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.

Original construction documents show the size of the mezzanine to be about 1/2 of the floor plan. It has been remodeled and extended to cover > 3/4 of the floor plan. It is now being considered as a 2nd floor with a large opening.

☐ ☐ ☐ 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

☐ ☐ ☐ 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

☐ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☐ ☐ ☐ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

☐ ☐ ☐ 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

☐ ☐ ☐ 4.3.3.3 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.

☐ ☐ ☐ 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.
ASCE 31* BASIC CHECKLIST S2: STEEL BRACED FRAMES WITH RIGID OR STIFF DIAPHRAGMS

LATERAL-FORCE-RESISTING SYSTEM

4.4.1.3.2 AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than 0.10Fy 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 0.30Fy for Life Safety and Immediate Occupancy.

Axial stress in braced frame columns due to gravity load alone is 0.095Fy.

4.4.3.1.1 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.

There are 2 lines of braced frames in each direction. Along each line, there is only a single effective brace taking load. Braces are tension only.

4.4.3.1.2 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 0.50Fy for Life Safety and for Immediate Occupancy.

Braces consist of 2" x 1" bars. Axial stress in bars = 2.0Fy. DCR = 4.0

4.4.3.1.3 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.

Life Safety Evaluation

CONNECTIONS

4.6.2.2 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.

Steel columns anchored into the pilasters of the retaining walls below.

4.6.3.1 STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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.

* — Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
## LATERAL-FORCE-RESISTING SYSTEM

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<td>☐</td>
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<td>☐</td>
<td>4.4.1.3.7 COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997). W10x33 – braced frame columns not considered compact.</td>
</tr>
<tr>
<td>☐</td>
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<td>☐</td>
<td>4.4.3.1.4 SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression shall have K/I/r ratios less than 120. Braces consist of 2&quot; x 1&quot; bars. Considered tension only.</td>
</tr>
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<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.4.3.1.5 CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals. 2&quot; x 1&quot; bars are welded to the structure.</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>4.4.3.1.6 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. Life Safety Evaluation</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>4.4.3.2.1 K-BRACING: The bracing system shall not include K-braced bays.</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>4.4.3.2.2 TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70% of the total lateral-force-resisting capacity in structures over two stories in height. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Evaluation</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>4.4.3.2.3 CHEVRON BRACING: The bracing system shall not include chevron, or V-braced bays. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Evaluation</td>
</tr>
<tr>
<td>☐</td>
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<td>☐</td>
<td>4.4.3.2.4 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. Life Safety Evaluation</td>
</tr>
</tbody>
</table>

## DIAPHRAGMS

<table>
<thead>
<tr>
<th></th>
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<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>4.5.1.5 OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25% of the frame length for Life Safety and 15% of the frame length for Immediate Occupancy. Diaphragm opening in the 2nd floor along the north braced frame extend 50% of the frame length.</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>4.5.1.7 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. Life Safety Evaluation</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Evaluation</td>
</tr>
</tbody>
</table>
**ASCE 31* SUPPLEMENTAL CHECKLIST S2: STEEL BRACED FRAMES WITH RIGID OR STIFF DIAPHRAGMS**

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
</table>

**CONNECTIONS**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>4.6.3.10 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.</th>
</tr>
</thead>
</table>

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*– Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
Building 435, Fusion Research

Building 435 is a steel braced frame structure. The building consists of a 60-foot wide long-span truss high bay and a 40-foot wide low bay connected on each side. The building was originally constructed as a single story structure with a 30’ x 40’ mezzanine in the north low bay. Subsequent remodels have added a substantial amount of mezzanine space in the high and south low bay areas.

The roof diaphragm consists of a 1-1/2” bare metal deck with insulation and roofing. In the high bay, the roof is supported on a long span steel truss that spans to steel columns. In the low bay, the roof is supported on steel beams and girders that span to steel columns. The lateral system consists of double angle braces in both the transverse and longitudinal directions.

The primary structural deficiencies noted for Building 435 are as follows: 1) There is an insufficient number of braces in the structure. In addition, the existing double-angle braces are slender and cannot resist compressive forces; 2) The low bay is inadequately braced in the longitudinal direction because braces are located on only one side of the low bay; and 3) The concrete blocks that frame the perimeter of the 60’x60’ pit in the high bay do not have sufficient anchorage to the diaphragms and pose a potential falling hazard.

For the building to meet life-safety requirements, we recommend providing new steel tube braces along the north and south faces of the building to brace the low bays. In addition the existing double angle braces should be replaced with structural steel tubes. Anchor the concrete blocks at the pit to the slab on grade.
Building Name: Building 435
Date: July 16, 2003

Building Address: Lawrence Livermore National Laboratory
Page: 1 of 2

Job Number: A20047.08  Job Name: LLNL Prioritization
By: AK  Checked:

BUILDING DATA
Year Built: 1958  Year(s) Remodeled: -
Area (sf): 32,000 sf  Length (ft): 220'
No. Stories: 3  Story Height: 11' 1-1/2" to 26' 7"

UBC Zone: 4 – Type B Near Field  Width (ft): 140'

CONSTRUCTION DATA
Gravity Load Structural System: Structural steel framing with long span truss at high bay.
At low bay roof, framing consists of steel beams and girders that span to wide flange columns.

Exterior Transverse Walls: Insulated metal wall panels at high bay.
Openings?: None

Exterior Longitudinal Walls: Insulated metal wall panels at high bay.
Cement asbestos panels at low bay.
Openings?: Windows

Roof Framing: Steel beams and girders at low bay. Steel truss at high bay.

Intermediate Floor Framing: North Mezzanine (Low Bay) is framed with structural steel girders and 2x8 joists. Additional mezzanine space has subsequently been added in remodels. No structural drawings available for new mezzanine space.

Ground Floor: 6" – 8" concrete slab on grade.

Columns: Steel wide flange columns
Building perimeter is tied together with a continuous grade beam. Steel columns are supported on reinforced concrete stub columns with spread footings. There is a series of reinforced concrete tunnels beneath the finished slab on grade.

Foundation: In remodel, a large 60' x 60' hole was excavated from the slab on grade. Large concrete blocks were added to the perimeter of the excavated holes.

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal (W-E)</th>
<th>Transverse (N-S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Elements: Steel wide flange columns</td>
<td>Steel wide flange columns</td>
</tr>
<tr>
<td>Diaphragms: Bare metal deck + insulation at roof, Plywood Diaphragm at Mezzanine</td>
<td>Bare metal deck + insulation at roof, Plywood Diaphragm at Mezzanine</td>
</tr>
</tbody>
</table>


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: \[
\frac{8}{10} = 8
\]

PRIORITIZATION CLASSIFICATION: CLASS B
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

<table>
<thead>
<tr>
<th>AXIAL STRESS CHECK</th>
<th>DEFLECTION COMPATIBILITY</th>
<th>FALLING HAZARD AT THE CONCRETE BLOCKS AROUND EXCAVATED HOLE</th>
<th>CONNECTION STRENGTH</th>
<th>COMPACT MEMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial stress in braced frame is higher than allowed by quick check. Double angle braces are incapable of carrying compressive forces. Braced frame is tension only.</td>
<td>The low bays are braced along the interior only. The deflection at the exterior along lines A &amp; F will be much larger than the high bay.</td>
<td>Concrete blocks are anchored at the floor with anchor bolts only. There are no connections at the top of the blocks.</td>
<td>Brace connections cannot develop yield strength of doubled angle braces.</td>
<td>Low bay columns (W10x33) are not compact.</td>
</tr>
</tbody>
</table>

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Provide additional braces in the lateral system. Add new braces along lines a & f to brace the low bay. Anchor the top of the concrete blocks into the slab on grade. Replace the existing braces with tubes.

OTHER COMMENTS:
Only the original building with the small mezzanine on the north end was evaluated. Information for the additional mezzanine levels in the high bay and low bay (south) are not available.
### BUILDING SYSTEM

<table>
<thead>
<tr>
<th></th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td><strong>4.3.1.1</strong> 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.</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td><strong>ADJACENT BUILDINGS</strong>: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td><strong>MEZZANINES</strong>: Interior mezzanine levels shall be braced independently from the main structure, or be anchored to the lateral-force-resisting elements of the main structure.</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td><strong>WEAK STORY</strong>: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td><strong>SOFT STORY</strong>: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td><strong>GEOMETRY</strong>: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td><strong>VERTICAL DISCONTINUITIES</strong>: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td><strong>MASS</strong>: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td><strong>DETERIORATION OF WOOD</strong>: 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.</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td><strong>DETERIORATION OF STEEL</strong>: 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.</td>
</tr>
</tbody>
</table>

Braced frames are located at the ends in the transverse direction. In the longitudinal direction, braced frames are located on grid lines C and D only. There are no braced frames on the north and south elevations to provide lateral resistance to the low bays. Low bay diaphragms (roof & mezzanine) are required to cantilever off the high bay braced frames. No adjacent Buildings.

Mezzanine in original construction (North – low bay) is braced on one side only.

Existing braced frames are continuous to the foundation.
LATERAL-FORCE-RESISTING SYSTEM

4.4.1.3.2 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. Maximum axial load in column due to gravity loads (including crane) is 0.07F_y.

4.4.3.1.1 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.

4.4.3.1.2 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. Calculated axial stress in brace is 0.74F_y. DCR = 1.48

4.4.3.1.3 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. Life Safety Evaluation

CONNECTIONS

4.6.2.2 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. Decks welded to structural steel framing.

4.6.3.1 STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. Columns anchored into reinforced concrete stub column supported on spread footing.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☒ ☐ 4.4.1.3.7 COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).

Required compactness $52/\sqrt{F_y} = 8.67$
Low bay columns are not compact – W8x31 b/2t = 9.2

☐ ☒ ☐ 4.4.3.1.4 SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression shall have K/Ir ratios less than 120.

Braces consist of double angles. Assumed to be tension only.

☐ ☒ ☐ 4.4.3.1.5 CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals.

Brace connections consist of bolted connections using machine bolts.

☐ ☒ ☐ 4.4.3.1.6 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.

Life Safety Evaluation

☐ ☒ ☐ 4.4.3.2.1 K-BRACING: The bracing system shall not include K-braced bays.

Life Safety Evaluation

☐ ☒ ☐ 4.4.3.2.2 TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70% of the total lateral-force-resisting capacity in structures over two stories in height. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Evaluation

☐ ☒ ☐ 4.4.3.2.3 CHEVRON BRACING: The bracing system shall not include chevron, or V-braced bays. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Evaluation

☐ ☒ ☐ 4.4.3.2.4 CONCENTRICALLY BRACED FRAME JOINTS: All the diagonal braces shall braced into the beam-column joints concentrically. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Evaluation

Frames Not Part of the Lateral-Force-Resisting System

☐ ☒ ☐ 4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

The low bays are braced to the high bay along the interior only. The deflection at the exterior on lines A & F will be considerably larger than the high bay.

DIAPHRAGMS

☐ ☒ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

Typical diaphragm consists of bare metal deck / plywood sheathing connected to structural steel beams and girders.
No diaphragm openings adjacent.

☐ ☒ ☐ 4.5.1.5 OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25% of the frame length for Life Safety and 15% of the frame length for Immediate Occupancy.
**DIAPHRAGMS**

- 4.5.1.7 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.

- 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

- 4.5.2.1 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.

- 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

- 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

- 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Unopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.

**CONNECTIONS**

- 4.6.3.10 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.

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Appendix B  Building Data Sheets  
Class C – Medium Priority Buildings
Building 041, Office Area

Building 041, Office Area, is a one-story wood framed building. The building is L-shaped in plan. The framing consists of 2x4 joists with plywood sheathing that is supported by structural steel girders and columns and bearing plywood shear walls. The primary potential deficiency noted for Building 041, Office Area, is the wood sill anchorage at the shear walls cannot be confirmed. The original construction documents were not available for review and the anchorage was not visible during the site visit. For the building to meet life-safety requirements, we recommend that LLNL verify that there are existing anchors to bolt down the wood sill to the foundation.
BUILDING DATA

Year Built: 1969  Year(s) Remodeled: -  UBC Zone: 4 – Type B Near Field
Area (sf): 4,175 sf  Length (ft): 100’  Width (ft): 95’
No. Stories: 1  Story Height:  Total Height: 12’-6”

CONSTRUCTION DATA

Gravity Load Structural System: 2x joists with plywood sheathing spanning to structural steel girders that are supported on bearing plywood shear walls or pipe columns.

Exterior Transverse Walls: Plywood sheathing  Openings?: None
Exterior Longitudinal Walls: Plywood sheathing  Openings?: None

Roof Framing: 2x joists spanning to structural steel girders.
Intermediate Floor Framing: -

Ground Floor: 4” concrete SOG at Office Area.

Columns: Typical 3” diameter pipe column at Office Area.
Foundation: Footings underneath columns. Column footings tied together with grade beams.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal (W-E)  Transverse (N-S)

System Classification: W2 – Wood Frames  W2 – Wood Frames
Vertical Elements: Pipe columns / bearing walls  Pipe columns / bearing walls
Diaphragms: 2x joists with plywood sheathing  2x joists with plywood sheathing


SEISMIC EVALUATION CRITERIA:  Life Safety/ ASCE 31-02

VULNERABILITY RATING: 4
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

WOOD SILLS
No available structural drawings. Unable to verify wood sill anchorage.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Verify wood sill plate anchorage.
**BUILDING SYSTEM**

- **4.3.1.1 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.
  
  Office area is L-shaped in plan with interior and perimeter plywood shear walls.

- **4.3.1.3 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.
  
  Single story. No mezzanines.

- **4.3.2.1 WEAK STORY**: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.
  
  Single story.

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

- **4.3.2.3 GEOMETRY**: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

- **4.3.2.4 VERTICAL DISCONTINUITIES**: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

- **4.3.2.5 MASS**: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

- **4.3.3.1 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.

- **4.3.3.2 WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS**: There shall be no more than 15% 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.

**LATERAL-FORCE-RESISTING SYSTEM**

- **4.4.2.1.1 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.

**Life Safety Evaluation.**
## LATERAL-FORCE-RESISTING SYSTEM

**4.4.2.7.1** 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:

- Structural panel sheathing: 1000 psi
- Diagonal sheathing: 700 psi
- Straight sheathing: 100 psi
- All other conditions: 100 psi

- **Shear wall stresses low. Total base shear = 190 kips. 45 feet of wall required.**
- **Approximate Wall Length Available:**
  - Longitudinal – 140 feet
  - Transverse – 100 feet

- **Single story building with plywood sheathed shear walls.**

**4.4.2.7.2** STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system.

- **Building consists of plywood sheathed shear walls.**

**4.4.2.7.3** 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 multistory building.

- **Aspect ratio of walls less than 2 to 1.**

**4.4.2.7.4** 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.

- **Single story building.**

**4.4.2.7.5** WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor.

- **Flat topography.**

**4.4.2.7.6** HILLSIDE SITE: For structures that are taller on at least one side by more than half of a 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.

**4.4.2.7.7** CRIPPLE WALLS: Cripple walls below first floor level shear walls shall be braced to the foundation with wood structural panels.

**4.4.2.7.8** OPENINGS: Walls with openings greater than 80% 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.

## CONNECTIONS

**4.6.3.3** WOOD POSTS: There shall be a positive connection of wood posts to the foundation.

- **No interior posts. Floor beams span to perimeter walls. Shear wall posts are connected to pipe columns that are anchored into the foundation.**
- **No foundation bolts at the wood sills shown on the drawings. Unable to verify at site.**

**4.6.3.4** WOOD SILLS: All wood sills shall be bolted to the foundation.
ASCE 31* BASIC CHECKLIST W2: WOOD FRAMES, COMMERCIAL AND INDUSTRIAL

CONNECTIONS

☒ ☐ ☐ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
ASCE 31* SUPPLEMENTAL CHECKLIST W2: WOOD FRAMES, COMMERCIAL AND INDUSTRIAL

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.7.9 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. Life Safety Evaluation only. Shear wall posts are attached to pipe columns that are anchored into the foundation.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☒ 4.5.1.3 ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. Life Safety Evaluation only.

☒ ☒ ☒ 4.5.1.7 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. Life Safety Evaluation only.

☒ ☒ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Evaluation only.

☒ ☒ ☒ 4.5.2.1 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.

☒ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems.

☒ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☒ ☐ ☒ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☐ ☒ ☒ 4.6.3.9 WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft or less for Life Safety and 4 ft or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete. No foundation bolts at the wood sills shown on the drawings. Unable to verify at site.

*-- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
BUILDING DATA

Year Built: 1969  
Area (sf): 19,346 sf  
No. Stories: 1

CONSTRUCTION DATA

Gravity Load Structural System: Steel beams that span load to perimeter WF columns.
Exterior Transverse Walls: metal wall panels  
Exterior Longitudinal Walls: metal wall panels  
Roof Framing: WF roof beams with bare metal deck.
Intermediate Floor Framing:
Ground Floor: 5" concrete SOG at Storage Area.
Columns: Wide Flange columns
Foundation: Footings underneath columns. Column footings tied together with grade beam.

LATERAL-FORCE-RESISTING SYSTEM

System Classification: S3 – Steel Light Frames  
Vertical Elements: Steel wide flange columns  
Diaphragms: Roof – Bare metal deck with insulation and built up roofing.

SEISMIC EVALUATION PERFORMED?  Yes  
SEISMIC EVALUATION CRITERIA:  Life Safety/ ASCE 31-02  
VULNERABILITY RATING:  6  
PRIORITIZATION CLASSIFICATION:  CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

AXIAL STRESS CHECK
Axial stress in rods is higher than allowed by quick check. Braced frame is tension only.

MOMENT RESISTING CONNECTIONS
Beam splices unable to develop beam capacity.

WALL PANELS
Wall panels are not attached to steel frame. Panels are independently anchored to the foundation.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Replace existing bar braces with tube steel that can act as both tension and compression members.
Weld together existing beam splices.
ASCE 31* BASIC CHECKLIST S3: STEEL LIGHT FRAMES

BUILDING SYSTEM

☐ ☐ ☐ 4.3.1.1 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.

☐ ☐ ☐ 4.3.1.3 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.

☐ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☐ ☐ ☐ 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in each plan dimension for Life Safety and Immediate Occupancy.

☐ ☐ ☐ 4.3.3.3 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.

There are steel moment frames in the transverse direction and rod braced frames in the longitudinal direction.

Within the warehouse, there is an independently supported and plywood sheathed elevated area.

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.3.1.2 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 0.50Fy for Life Safety and for Immediate Occupancy.

Calculated axial stress in rods exceeds allowable. Fa = 110 ksi

CONNECTIONS

☐ ☐ ☐ 4.6.2.2 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.

Metal deck roof connected to the roof beams.

☐ ☐ ☐ 4.6.3.1 STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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.

Column is anchored into the building footings with anchor bolts.

☐ ☐ ☐ 4.6.3.8 WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy.

Warehouse perimeter walls consists of metal panels supported on a 4 feet high CMU block wall. Walls not attached to steel frame.

☐ ☐ ☐ 4.6.5.1 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.

P:\Project\A020000.099\A20047.08\Calcul\Active\Worksheets\Calculations and Summary Sheets per Building\B041\Warehouse Basic S3.doc
### CONNECTIONS

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>

Walls not attached to steel framing.

* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>Comments</th>
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<tbody>
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<td>☑️</td>
<td>☑️</td>
<td>☑️</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.4.1.3.3</td>
<td>MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones.</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.4.1.3.7</td>
<td>COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1987).</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.4.1.3.8</td>
<td>BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.4.1.3.10</td>
<td>OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.4.1.3.11</td>
<td>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.</td>
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<tr>
<td></td>
<td>☑️</td>
<td>4.5.1.7</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.5.1.8</td>
<td>DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.5.7.1</td>
<td>OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
</tr>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>☑️</td>
<td>4.6.3.10</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>☑️</td>
<td>4.6.5.3</td>
<td>ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12&quot; for Life Safety and 8&quot; for Immediate Occupancy.</td>
</tr>
</tbody>
</table>

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**Building 115, Magnetic Vault**

Building 115, Magnetic Vault is approximately 1,000-sq. ft. and is a dual system of a concrete bearing wall on the west face and moment-resisting frames on the remaining faces. The structure consists of a metal deck at the roof without a concrete fill. The deck spans the east-west direction and is supported by beams in the center and on the east face and by a concrete bearing wall on the west face. The columns are hollow structural sections, which are bolted to the foundation.

The primary structural deficiencies are the lack of cross ties between the concrete bearing wall and the opposite frame. This can be mitigated by adding continuous ties at the roof in the transverse direction of the building.
BUILDING DATA

Year Built: 1985  
Year(s) Remodeled:  
UBC Zone: 4 – Type B Near Field

Area (sf): 1040  
Length (ft): 40  
Width (ft): 26

No. Stories: 1  
Story Height: 14’  
Total Height: 14’

CONSTRUCTION DATA

Gravity Load Structural System:

- Metal deck roof, supported by W12 beam in the center, W10 on the east face, and block wall on the west face. Columns are TS 12x6. Wood floor supported by TS 4x6 joists. Concrete slab at grade is supported on 6 - 24” diameter concrete piers, 17’ deep. 8’ block wall on west face.

Exterior Transverse Walls: Tube steel moment frame  
Exterior Longitudinal Walls: 8” concrete block wall on west face  
Tube steel moment frame on east face

Roof Framing: 3” 18 gauge roof metal decking  
Intermediate Floor Framing: Wood sub-floor on TS 4x6 joists  
Ground Floor: 12” slab

Columns: TS 12x6  
Foundation: 6 – 24” diameter piers, 17’ deep

Openings?: Door openings  
Openings?: No openings in block wall

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 3 (Steel Moment Frame Building w/ Flexible Diaphragm) and Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm)</td>
<td>Type 3 (Steel Moment Frame Building w/ Flexible Diaphragm)</td>
</tr>
<tr>
<td>Metal deck, steel beams, reinforced concrete block wall, steel columns</td>
<td>Metal deck, steel beams, reinforced concrete block wall, steel columns</td>
</tr>
<tr>
<td>3” 18 gauge roof metal decking</td>
<td>3” 18 gauge roof metal decking</td>
</tr>
</tbody>
</table>

SEISMIC EVALUATION PERFORMED?: Yes  
EVALUATION: Rapid Evaluation  
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5  
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

DRIFT CHECK
Frames do not meet drift limits due to increased effective height attributed to a pinned base.

_PANEL ZONES
Panel zones are insufficient

CROSS TIES
No cross ties on diaphragm

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add cross ties in the east-west direction from the concrete block wall to the opposite W10x33 beam.
Demand on the building is low. Potential deficiencies identified for drift and panel zones can be mitigated through detailed analysis.
BUILDING SYSTEM

4.3.1.1 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. Metal deck is welded to a C8 x 11.5, which is bolted to concrete block wall. Wall is dowelled into the foundation.

4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy. However, the adjacent building is at the same height as the building being evaluated so pounding is not an issue.

4.3.1.3 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. There are no mezzanines.

4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy. One story building

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

4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. One story building

4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. Wall is dowelled into the concrete strip footing foundation.

4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. One story building

4.3.3.1 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. Site visit on 7/30/03. No signs of deterioration were observed.

4.3.3.7 MASONRY UNITS: There shall be no visible deterioration of masonry units. Site visit on 7/30/03. No signs of deterioration were observed.

4.3.3.8 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. Site visit on 7/30/03. No signs of eroded mortar.

4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. Site visit on 7/30/03. No visible cracks observed.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.1.1 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.

☐ ☐ ☐ 4.4.2.4.1 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.

☐ ☐ ☐ 4.4.2.4.2 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.

CONNECTIONS

☐ ☐ ☐ 4.6.1.1 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.

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

☐ ☐ ☐ 4.6.3.5 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.

☐ ☐ ☐ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

* = Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt the rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.4.4 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.

DIAPHRAGMS

☐ ☒ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☒ ☐ ☐ 4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.

☒ ☐ ☒ 4.5.1.7 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.

☒ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☒ ☐ 4.5.2.1 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.

☒ ☒ ☐ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☒ ☒ ☐ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☒ ☒ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.
**DIAPHRAGMS**

<table>
<thead>
<tr>
<th>4.5.7.1</th>
<th>OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑</td>
<td>Metal Deck is used as diaphragm</td>
</tr>
</tbody>
</table>

**CONNECTIONS**

<table>
<thead>
<tr>
<th>4.6.1.4</th>
<th>STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed falt and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8&quot;.</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑</td>
<td>Wall does not connect to wood structural elements.</td>
</tr>
</tbody>
</table>

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
## BUILDING SYSTEM

<table>
<thead>
<tr>
<th>Building System</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.3.1.1</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>4.3.1.2</strong></td>
<td>ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td><strong>4.3.1.3</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>4.3.2.1</strong></td>
<td>WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td><strong>4.3.2.2</strong></td>
<td>SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td><strong>4.3.2.3</strong></td>
<td>GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
</tr>
<tr>
<td><strong>4.3.2.4</strong></td>
<td>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
</tr>
<tr>
<td><strong>4.3.2.5</strong></td>
<td>MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
</tr>
<tr>
<td><strong>4.3.3.1</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>4.3.3.3</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>
**ASCE 31* BASIC CHECKLIST S1A: STEEL MOMENT FRAMES WITH FLEXIBLE DIAPHRAGMS**

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</thead>
<tbody>
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<td>□</td>
<td>□</td>
<td>LATERAL-FORCE-RESISTING SYSTEM</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>4.4.1.1.1 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.</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>One moment frame on each of the north and south faces, moment frame on the east face and masonry shearwall on the west face.</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>4.4.1.2.1 INTERFERING WALLS: All concrete and masonry infill walls placed in moment frames shall be isolated from structural elements.</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>No infill walls</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>4.4.1.3.1 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.</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>Frames do not meet drift limits due to increased effective height attributed to a pinned base, but shall be mitigated through a more detailed analysis.</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>4.4.1.3.2 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.</td>
</tr>
<tr>
<td>Ø</td>
<td>□</td>
<td>□</td>
<td>Frame complies with axial stress check</td>
</tr>
</tbody>
</table>

**CONNECTIONS**

| Ø | □ | □ | 4.6.2.2 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. |
| Ø | □ | □ | Metal deck is welded to moment frame and to channel connected to block wall |
| Ø | □ | □ | 4.6.3.1 STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. |
| Ø | □ | □ | Columns are welded to the base plates and base plates are bolted to the foundation. |

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
## LATERAL-FORCE-RESISTING SYSTEM

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<tr>
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<tr>
<td>X</td>
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<td></td>
<td>4.4.1.3.3 MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones.</td>
<td>Full penetration welds are capable of developing the strength of adjoining members.</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td>4.4.1.3.4 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.</td>
<td>Panel zones are insufficient, but shall be mitigated through a more detailed analysis.</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td>X</td>
<td>4.4.1.3.5 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.</td>
<td>No Column Splices</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td>X</td>
<td>4.4.1.3.6 STRONG COLUMN/WEAK BEAM: The percent of strong column/weak beam joints in each story of each line of moment resisting frames shall be greater than 50% for Life Safety and Immediate Occupancy.</td>
<td>Strong Column/weak beam does not apply on a one story building</td>
</tr>
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<td>4.4.1.3.7 COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td></td>
<td>4.4.1.3.8 BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td></td>
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<tr>
<td>X</td>
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<td></td>
<td>4.4.1.3.9 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.</td>
<td></td>
</tr>
<tr>
<td>X</td>
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<td>4.4.1.3.10 OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td></td>
<td>4.4.1.3.11 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.</td>
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## DIAPHRAGMS

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<th>Description</th>
<th>Notes</th>
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<tbody>
<tr>
<td>X</td>
<td></td>
<td>X</td>
<td>4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.</td>
<td>No cross ties on diaphragm</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td>4.5.1.7 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.</td>
<td></td>
</tr>
</tbody>
</table>
ASCE 31* SUPPLEMENTAL CHECKLIST S1A: STEEL MOMENT FRAMES WITH FLEXIBLE DIAPHRAGMS

DIAPHRAGMS

☐ ☐ ☑ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☑ 4.5.2.1 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.

☐ ☐ ☑ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☐ ☐ ☑ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☐ ☐ ☐ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☑ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☐ ☐ ☑ 4.6.3.10 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.

*-- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 117B

Building 117B is a one-story reinforced masonry bearing wall building. The structure consists of bare metal deck supported by steel wide flange beams and girders, which are supported on the perimeter 8" thick reinforced masonry block walls. On the south side, there is an additional double-angle braced frame. At the ground level, there is an access floor that is supported by vertical pipe columns. The access floor bears on steel ledger angles.

The primary structural deficiencies noted for Building 117B are as follows: 1) There are no connections for shear transfer at the access floor. The access floor does not have a positive connection to the lateral-force-resisting system; and 2) The double-angle braces are overstressed and the connection of the braces do not develop the yield capacity of the braces.

For the building to meet life-safety requirements, we recommend providing a positive connection of the access floor into the structure. Alternatively, brace the access floor independently from the main structure by adding new braces at the vertical pipe columns. A more detailed analysis is recommended to verify the actual force distribution to the braced frames. Even though the braces appear to be overstressed, there is excess capacity in the masonry shear walls.
Building Name: Building 117B

Building Address: Lawrence Livermore National Laboratory

Job Number: A20047.08

Date: July 16, 2003

Page: 1 of 2

DEGENKOLB ENGINEERS

BUILDING DATA

Year Built: 1959

Year(s) Remodeled: -

UBC Zone: 4 – Type B Near Field

Area (sf): 7,400 sf

Length (ft): 86'

Width (ft): 85'-10"

No. Stories: 1

Story Height: Average 11.5'

Total Height: Average 11.5'

CONSTRUCTION DATA

Gravity Load Structural System: Steel framed beams and girders supported on pipe columns

Exterior Transverse Walls: Reinforced masonry concrete blocks

Openings?: None

Exterior Longitudinal Walls: Reinforced masonry concrete blocks

Openings?: None

Roof Framing: Steel beams and girders with 1-1/2" bare metal deck & insulation.

Intermediate Floor Framing: None

6" concrete slab on grade in the S-W and S-E corner.

During remodel, original metal deck flooring has been replaced with an access floor in the

Ground Floor: central portion of the floor slab. Access floor is supported on vertical pipe columns anchored to the rat slab below. Pipe columns are unbraced. Access floor bears on the existing ledger angles around the concrete / masonry perimeter (no positive connection).

Columns: 6" pipe columns

Masonry walls are supported on a retaining wall with grade beams, pipe columns are

Foundation: supported on a 18" square concrete stub column with spread footings, and the access floor at the ground floor is supported on pipe columns at 4' o.c. each way.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal (W-E)

System Classification: S2 / S4 / RM1 – Steel Frames with Reinforced Masonry Shear Walls & Steel Braced Frames with Flexible Diaphragms.

Vertical Elements: Steel pipe columns

Diaphragms: Bare metal deck with insulation (roof)

Transverse (N-S)

System Classification: S4 / RM1 – Steel Frames with Reinforced Masonry Shear Walls with Flexible Diaphragms.

Vertical Elements: Steel pipe columns

Diaphragms: Bare metal deck with insulation (roof)


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5

(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

TRANSFER TO SHEAR WALLS
The remodeled access floor on the ground floor is not positively attached to the lateral force resisting system or independently braced.

DIAPHRAGM CONTINUITY
The remodeled access floor on the ground floor is not positively attached to the lateral force resisting system. The floor bears on the existing ledger angle.

CONNECTION STRENGTH
Braced Frame connection unable to develop the full yield strength of the braces.

AXIAL STRESS CHECK
Axial stress in braced frame is higher than allowed by quick check. Double angle braces are incapable of carrying compressive forces. Braced frame is tension only. This may be mitigated with detailed analysis. There is excess capacity found in the masonry shear walls.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Provide positive connection of access floor to existing ledger angle or brace independently to the foundation.
Perform detailed analysis to verify the demand and strength of the existing braces and connections. Alternatively, stiffen the existing braces to act as both tension & compression elements.

OTHER COMMENTS:
- THERE ARE 3 DIFFERENT SECTORS TO THE BUILDING. EVALUATION HAS BEEN COMPLETED FOR THE CENTER PORTION (117B) ONLY. OTHER SECTORS HAVE NOT BEEN EVALUATED.
## BUILDING SYSTEM

### General

<table>
<thead>
<tr>
<th></th>
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<th>4.3.1.1 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.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>The lateral system consists of reinforced grouted masonry blocks in both principal directions. On the south side, in lieu of the masonry walls, there is a single bay steel braced frame. On the south, the adjacent building is separated at the roof diaphragm by 1&quot;. Adjacent floor slab elevations align, pounding concern is not high. Item can be considered mitigated. No Mezzanines.</td>
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<td>4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td></td>
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<td>4.3.1.3 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.</td>
</tr>
</tbody>
</table>

### Configuration

<table>
<thead>
<tr>
<th></th>
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<th>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</th>
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<tbody>
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<td>Single Story</td>
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<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
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<td>Single Story</td>
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<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
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<td></td>
<td>Single Story</td>
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<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<td></td>
<td>Masonry Walls/braced frame are continuous to the foundation</td>
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<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
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<tr>
<td></td>
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<td></td>
<td>Single Story</td>
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<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
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<td>Lateral system symmetrically located on perimeter of square building</td>
</tr>
</tbody>
</table>

### Condition of Materials

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<tr>
<th></th>
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<th>4.3.3.3 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.</th>
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</thead>
</table>
**ASCE 31* GENERAL BASIC STRUCTURAL CHECKLIST**

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<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
</table>

## BUILDING SYSTEM

- **4.3.3.7** MASONRY UNITS: There shall be no visible deterioration of masonry units.
- **4.3.3.8** 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.
- **4.3.3.10** REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

## LATERAL-FORCE-RESISTING SYSTEM

### Frames Not Part of the Lateral-Force-Resisting System

- **4.4.1.6.1** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

### Shear Walls – General

- **4.4.2.1.1** 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. Along the East-West direction, there is only a single line of masonry shear walls on the north side. However, there is a steel braced frame on the south side. Adequate redundancy in lateral system can be considered mitigated.

### Reinforced Masonry Shear Walls

- **4.4.2.4.1** 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. Maximum Shear Stress based on the quick check procedure is ~60 psi.

- **4.4.2.4.2** 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. Horiz. Bar: #4 @ 2' o.c. maximum
  Vert. Bar: #4 @16" o.c. maximum

\[
p = (0.20)/(24" \times 8") + (0.20)/(16" \times 8") = 0.0026
\]

### Braced Frames – General

- **4.4.3.1.1** 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. Along the East-West direction, there is only a single line of braced frame on the south side. However, there is a line of masonry shear walls on the north side. Adequate redundancy in lateral system can be considered mitigated.


**ASCE 31* GENERAL BASIC STRUCTURAL CHECKLIST**

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</table>

**CONNECTIONS**

**Anchorage for Normal Forces**

|   | □  | □  | ☑  | 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. At the top of the masonry wall, there are both tension and shear anchor bolts embedded into the walls and tied back into the roof beams. |

**Shear Transfer**

|   | □  | □  | ☑  | 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 diaphragms for Immediate Occupancy. The remodeled access floor on the ground floor is not positively attached to the lateral system. Floor bears on the existing ledger angle. |
|   | □  | ☑  |   | 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. |
|   | □  | ☑  |   | 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. |

**Vertical Components**

|   | □  | □  | ☑  | STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. Masonry wall reinforcement is doweled and hooked into grade beam foundation. |
|   | □  | ☑  |   | 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. |
CONNECTIONS

Interconnection of Elements

☐ ☐ ☐ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

*– Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
### LATERAL-FORCE-RESISTING SYSTEM

#### Frames Not Part of the Lateral-Force-Resisting System

- **4.4.1.6.2** DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

- **4.4.1.6.3** FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

#### Reinforced Masonry Shear Walls

- **4.4.2.4.3** REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.

- **4.4.2.4.4** 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.

#### Braced Frames – General

- **4.4.3.1.4** SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression shall have K/r ratios less than 120.

- **4.4.3.1.5** CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals.

- **4.4.3.1.6** 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.

#### Concentrically Braced Frames

- **4.4.3.2.1** K-BRACING: The bracing system shall not include K-braced bays.

- **4.4.3.2.2** TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70% of the total lateral-force-resisting capacity in structures over two stories in height. This statement shall apply to the Immediate Occupancy Performance Level only.

- **4.4.3.2.3** CHEVRON BRACING: The bracing system shall not include chevron, or V-braced bays. This statement shall apply to the Immediate Occupancy Performance Level only.

- **4.4.3.2.4** 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.
## DIAPHRAGMS

### General

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<tr>
<td>4.5.1.1</td>
<td>DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
<td>Roof Diaphragm is continuous. A portion of the ground floor diaphragm consists of an access floor that is not positively attached to the concrete slab on grade. Roof diaphragm is framed with conventional steel beams and girders.</td>
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<tr>
<td>4.5.1.2</td>
<td>CROSS TIES: There shall be continuous cross ties between diaphragm chords.</td>
<td>Roof diaphragm is framed with conventional steel beams and girders.</td>
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<tr>
<td>4.5.1.3</td>
<td>ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation.</td>
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<td>4.5.1.6</td>
<td>OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.</td>
<td>No diaphragm openings adjacent shear walls.</td>
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<td>4.5.1.7</td>
<td>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.</td>
<td>Plan of diaphragm is a square. No re-entrant corners.</td>
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<td>4.5.1.8</td>
<td>DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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### Metal Deck Diaphragms

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<td>4.5.3.1</td>
<td>NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Evaluation</td>
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### CONNECTIONS

#### Anchorage for Normal Forces

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<td>4.6.1.3</td>
<td>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.</td>
<td>At the top of the masonry wall, there are both tension and shear anchor bolts embedded into the walls and tied back into the roof beams.</td>
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#### Vertical Components

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<td>4.6.3.10</td>
<td>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.</td>
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## CONNECTIONS

### Interconnection of Elements

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<td>4.6.4.2</td>
<td>GIRDERS: Girders supported by walls or pilasters shall have at least two ties securing the anchor bolts for Life Safety and Immediate Occupancy.</td>
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<td>4.6.4.3</td>
<td>CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than 3&quot; for Life Safety and Immediate Occupancy.</td>
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<td>4.6.4.4</td>
<td>CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements.</td>
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<td>4.6.4.5</td>
<td>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.</td>
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*— Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
Building 165, Annex

Building 165, Annex is a concrete block wall building, consisting of a concrete slab and concrete walls. A structural evaluation of the building was not completed because structural drawings were not available for review. A detailed on-site evaluation is required to conclusively determine the structural deficiencies in the building. However, based on our site visit observations and judgement, Building 165 is not life-safe. The 3' thick concrete blocks at the exterior of the building are not interconnected which present a falling hazard.
BUILDING DATA

Year Built: 1960  
Year(s) Remodeled: 1966, 1995  
UBC Zone: 4 – Type B Near Field

Area (sf): 4,900  
Length (ft): 98  
Width (ft): 50

No. Stories: 1  
Story Height: 15'-3"  
Total Height: 15'-3"

CONSTRUCTION DATA

Gravity Load Structural System: Bare metal deck supported by open web joists and WF girders, which are supported by perimeter and interior concrete block walls. There are also reinforced concrete bearing walls at the interior.

Exterior Transverse Walls: 8" concrete block walls  
Exterior Longitudinal Walls: 8" concrete block walls

Roof Framing: Bare metal deck supported by 16" deep open web joists and 10WF girders

Intermediate Floor Framing: None

Ground Floor: 6" concrete slab on grade w/ #3 @ 14" o.c., E.W.

Columns: None

Foundation: Strip footing @ concrete block walls and reinforced concrete walls

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal

System Classification: Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm) and Type 9 (Concrete Shear Wall Building w/ Flexible Diaphragm)

Vertical Elements: Open web joists, steel girders, reinforced concrete block walls @ interior and perimeter. There are also reinforced concrete walls at interior.

Diaphragms: Bare metal deck

Transverse

System Classification: Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm) and Type 9 (Concrete Shear Wall Building w/ Flexible Diaphragm)

Vertical Elements: Open web joists, steel girders, reinforced concrete block walls @ interior and perimeter. There are also reinforced concrete walls at interior.

Diaphragms: Bare metal deck


SEISMIC EVALUATION CRITERIA:  
Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5  
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

WALL ANCHORAGE  
Out of plane anchorage for the concrete block walls is not adequate. D/C = 1.15.

GIRDERS  
There are no ties securing the anchor bolts.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

Strengthen out of plane anchorage
Strength connection of girders at the walls
### BUILDING SYSTEM

#### General

- **4.3.1.1** 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. 
  
  The bare metal deck delivers load to the open web joists and WF girders, which are supported by the perimeter and interior reinforced concrete block walls. There are also reinforced concrete bearing walls at the interior of the building. The concrete block walls and reinforced concrete shear walls are doweled into the concrete strip foundation system.

- **4.3.1.2** ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.
  
  There are no adjacent buildings.

- **4.3.1.3** 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.
  
  No Mezzanines.

#### Configuration

- **4.3.2.1** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.
  
  One story building

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

- **4.3.2.3** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.
  
  One story building

- **4.3.2.4** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.
  
  Concrete block and reinforced concrete shear walls are continuous to the foundation

- **4.3.2.5** MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.
  
  One story building

- **4.3.2.6** TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.
  
  Flexible Diaphragm (Bare metal deck)
Condition of Materials

☐ ☐ ❌ 4.3.3.1 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.

☐ ☐ ❌ 4.3.3.2 WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15% 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.

☒ ☐ ☐ 4.3.3.3 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.

☒ ☐ ☐ 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

☒ ☐ ☐ 4.3.3.5 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.

☒ ☐ ☐ 4.3.3.6 PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections.

☒ ☐ ☐ 4.3.3.7 MASONRY UNITS: There shall be no visible deterioration of masonry units.

☒ ☐ ☐ 4.3.3.8 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.

☒ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

☒ ☐ ☐ 4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

☒ ☐ ☐ 4.3.3.11 UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in the wall elements greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy, and shall not form an X pattern.

Site visit made on 8/6/03. No signs of deterioration were observed.

Site visit made on 7/22/03. No signs of deterioration were observed.

Site visit made on 8/6/03. No signs of deterioration were observed.

Site visit made on 8/6/03. No signs of deterioration were observed.

Site visit made on 8/6/03. No signs of deterioration were observed.

Site visit made on 8/6/03. No eroded mortar was observed.

Site visit made on 8/6/03. There are no cracks >1/8".

Site visit made on 8/6/03. There are no cracks >1/8".
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<td>4.3.3.12 CRACKS IN INFILL WALLS: There shall be no existing diagonal cracks in the infilled walls that extend throughout a panel, greater than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy.</td>
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<td>4.3.3.13 CRACKS IN BOUNDARY COLUMNS: There shall be no existing diagonal cracks wider than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy in concrete columns that encase masonry infills.</td>
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**LATERAL-FORCE-RESISTING SYSTEM**

**Shear Walls – General**

| ☑ | ☑ | ☑ | 4.4.2.1.1 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. |

**Concrete Shear Walls**

| ☑ | ☑ | ☑ | 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or \(2\sqrt{f'c}\) for Life Safety and Immediate Occupancy. |

| ☑ | ☑ | ☑ | 4.4.2.2.2 REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall not be 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" for Life Safety and Immediate Occupancy. |

| ☑ | ☑ | ☑ | 4.4.2.2.9 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. |

**Reinforced Masonry Shear Walls**

| ☑ | ☑ | ☑ | 4.4.2.4.1 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. |

| ☑ | ☑ | ☑ | The maximum shear stress in the concrete block wall is 26 psi < 70 psi at Line A. See Building Plan. |

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LATERAL-FORCE-RESISTING SYSTEM

[ ] [ ] [ ] 4.4.2.4.2 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.

Typ. reinforcement in reinforced concrete block walls:
Vertical Reinforcing = #6@32" o.c.; reinforcing ratio = 0.0012 > 0.0007
Horizontal Reinforcing = #4@24" o.c. horizontal: reinforcing ratio =0.001 > 0.0007.

Total reinforcing steel ratio =
\[
\frac{(0.31+0.2'*32/24)*12^4/2}{(32^*8)} = 0.0023 > 0.002
\]

CONNECTIONS

Anchorage for Normal Forces

[ ] [ ] [ ] 4.6.1.1 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.

At NS walls: (2) 1/2" diameter x 12" bolts @ 5'5" at joists. At EW walls: (2) 5/8" diameter x 18" bolts @ 27'-8" at beam and 5/8" diameter @ 3" o.c. in betw. beams

D/C = 1.15.

There are no wood ledgers.

Shear Transfer

[ ] [ ] [ ] 4.6.2.1 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 diaphragms for Immediate Occupancy.

Metal deck is welded to bar joists and steel beams. The joists and beams are bolted to the concrete block walls/reinforced concrete walls w/ 1/2" or 5/8" diameter bolts. At the interface of Increment 1 and Increment 2, the deck is attached to the existing concrete block wall w/ L3x3's and 5/8" diameter expansion anchors.

[ ] [ ] [ ] 4.6.2.2 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.

[ ] [ ] [ ] 4.6.2.3 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.
# ASCE 31* GENERAL BASIC STRUCTURAL CHECKLIST

## CONNEXIONS

### Vertical Components

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- **4.6.3.1 STEEL COLUMNS**: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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.

- **4.6.3.2 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 columns of lateral-force-resisting system for Immediate Occupancy.

- **4.6.3.3 WOOD POSTS**: There shall be a positive connection of wood posts to the foundation.

- **4.6.3.4 WOOD SILLS**: All wood sills shall be bolted to the foundation.

- **4.6.3.5 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.

- **4.6.3.6 SHEAR-WALL-BOUNDARY COLUMNS**: The shear wall boundary columns shall be anchored to the building for Life Safety and the anchorage shall be able to develop the tensile capacity of the column for Immediate Occupancy.

- **4.6.3.7 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.

- **4.6.3.8 WALL PANELS**: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy.

### Interconnection of Elements

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- **4.6.4.1 GIRDER/COLUMN CONNECTION**: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

There are no columns in the building. Girders are connected to the concrete block walls w/ bolts.

* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

Concrete Shear Walls

☐ ☐ ☒ 4.4.2.2.3 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.

☐ ☐ ☒ 4.4.2.2.4 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.

☐ ☐ ☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8dL. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.7 WALL THICKNESS: Thickness of bearing walls shall not be less than 1/2 the unsupported height or length, whichever is shorter, nor less than 4". This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☐ ☒ 4.4.2.2.8 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.

Reinforced Masonry Shear Walls

☐ ☐ ☒ 4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.4.4 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.

DIAPHRAGMMS

General

☒ ☐ ☒ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☒ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

☒ ☐ ☒ 4.5.1.3 ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation.
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<td>4.5.1.5 OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25% of the frame length for Life Safety and 15% of the frame length for Immediate Occupancy.</td>
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<td>4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.</td>
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<td>4.5.1.7 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. Life Safety Performance Level.</td>
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<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
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<td>☐</td>
<td>Other Diaphragms</td>
</tr>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
</tr>
</tbody>
</table>

**CONNECTIONS**

**Anchorage for Normal Forces**

| ☒ | ☐ | ☐ | 4.6.1.3 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. |
| ☒ | ☐ | ☐ | 4.6.1.4 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 no greater than 1/8".
**ASCE 31** GENERAL SUPPLEMENTAL STRUCTURAL CHECKLIST

## CONNECTIONS

### Vertical Components

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️ 4.6.3.9</td>
<td>WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft or less for Life Safety and 4 ft or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete.</td>
</tr>
<tr>
<td>✔️ 4.6.3.10</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Interconnection of Elements

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️ 4.6.4.2</td>
<td>GIRDER: Girders supported by walls or pilasters shall have at least two ties securing the anchor bolts for Life Safety and Immediate Occupancy. There are no ties securing the anchor bolts.</td>
</tr>
<tr>
<td>✔️ 4.6.4.3</td>
<td>CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than 3&quot; for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>✔️ 4.6.4.4</td>
<td>CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements.</td>
</tr>
<tr>
<td>✔️ 4.6.4.5</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Panel Connections

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️ 4.6.5.3</td>
<td>ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12&quot; for Life Safety and 8&quot; for Immediate Occupancy.</td>
</tr>
</tbody>
</table>

---

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
Building 281, Original Building

Building 281 is a one-story reinforced concrete block wall building. There are concrete shear walls in both directions of loading. The roof consists of gypsum board or formboard supported on steel bar joists. A structural evaluation of Building 281, Original Building was not completed because structural drawings were not available for review. A detailed on-site evaluation is required to conclusively determine the structural deficiencies in the building. However, based on our site visit observations, experience and judgement, we identified the following potential deficiencies for the building: 1) The diaphragm cannot adequately transfer seismic loads to the shear walls; 2) The out-of-plane anchorage connections could not be verified on the site visit.

For the building to meet life-safety requirements, we recommend a detailed on-site evaluation of the building. Most likely, rod bracing at the roof level and strengthening of the out-of-plane anchorage connections will be required.
**BUILDING DATA**

- **Year Built:** ~1950
- **Area (sf):** 5,400
- **No. Stories:** 1
- **Year(s) Remodeled:** None
- **Length (ft):** 95
- **Story Height:** 12.5 ft
- **Width (ft):** 57
- **Total Height:** 12.5 ft
- **UBC Zone:** 4 – Type B Near Field

**CONSTRUCTION DATA**

- **Gravity Structural System:** 2" poured gypsum o/ gypsum board supported by open web joists, which are supported by perimeter and interior reinforced concrete block walls
- **Exterior Transverse Walls:** 8" concrete block walls
- **Exterior Longitudinal Walls:** 8" concrete block walls
- **Roof Framing:** 2" poured gypsum o/ gypsum board supported by open web joists
- **Intermediate Floor Framing:** None
- **Ground Floor:** Concrete slab on grade
- **Columns:** None
- **Foundation:** Strip footing @ concrete block walls
- **Openings?:** Door and window openings
- **Openings?:** Door and window openings

**LATERAL-FORCE-RESISTING SYSTEM**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Classification</td>
<td>Type 13 (Reinforced concrete block walls w/ flexible diaphragm)</td>
<td>Type 13 (Reinforced concrete block walls w/ flexible diaphragm)</td>
</tr>
<tr>
<td>Vertical Elements</td>
<td>Open web joists, reinforced concrete block walls @ perimeter and interior</td>
<td>Open web joists, reinforced concrete block walls @ perimeter and interior</td>
</tr>
<tr>
<td>Diaphragms</td>
<td>2&quot; poured gypsum o/ gypsum board</td>
<td>2&quot; poured gypsum o/ gypsum board</td>
</tr>
</tbody>
</table>

**SEISMIC EVALUATION PERFORMED?** No  **EVALUATION:** None  **YEAR:** 2003

**SEISMIC EVALUATION CRITERIA:**

- **VULNERABILITY RATING:** 6
  
  \[
  (\text{1=low to 10=high})
  \]

**PRIORITIZATION CLASSIFICATION:** CLASS C

Drawings are not available for review. This building summary has been completed based on observations of the structure made on 7/22/03-site visit with Madhu Kamath of LLNL.

Based on our site visit observations, experience and judgement, we identified the following deficiencies for the building: 1) The diaphragm cannot adequately transfer seismic loads to the shear walls; 2) The out-of-plane anchorage connections could not be verified on the site visit and therefore are deemed inadequate.

For the building to meet life-safety requirements, a detail on-site evaluation is recommended to determine the location of the lateral-force-resisting-system and to observe the interconnection of elements in the structure. Most likely, rod bracing at the roof level and strengthening of the out-of-plane anchorage connections will be required.
**Building 322**

Building 322 is a one-story reinforced masonry bearing wall building. The structure consists of metal deck supported by steel wide flange girders, which are supported by perimeter 8" thick concrete block walls. The only potential deficiency noted for Building 322 is inadequate out-of-plane wall anchorage. For the building to meet life-safety requirements, we recommend that the out-of-plane anchorage be strengthened.
Building Name: Building 322

Building Address: Lawrence Livermore National Laboratory

Job Number: A20047.08 Job Name: LLNL Prioritization

BY: JYF Checked: JEH

BUILDING DATA

Year Built: 1962 Year(s) Remodeled: 1974, 1984 UBC Zone: 4 – Type B Near Field

Area (sf): 5,800 Length (ft): 80 Width (ft): 60

No. Stories: 1 + Mezz. Story Height: 16 ft Total Height: 16 ft

CONSTRUCTION DATA

Gravity Load Structural System: Bare metal deck supported by WF beams, which are supported by perimeter reinforced concrete block walls

Exterior Transverse Walls: 8" concrete block walls

Exterior Longitudinal Walls: 8" concrete block walls

Roof Framing: Bare metal deck supported by 10B15 beams and tapered WF girders

Intermediate Floor Framing: @ mezz:5/8" plywood sheathing supported by timber joists and 2x6 stud walls

Ground Floor: 6" concrete slab on grade typ., @ plating shop area, the ground flr consists of steel grating supported by steel beams and TS columns, which are supported by 9" concrete slab on grade

Columns: None

Foundation: Strip footing @ concrete block walls. @ plating shop area: 6" steel grating floor system supported by C6's and W8's. The steel beams are supported by TS4x4 columns, which are supported by a 9" slab on grade. The grating floor system is tied back to the 6" concrete slab on grade outside the plating area w/ bolts and welded studs.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal

System Classification: Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm)

Vertical Elements: Steel beams, tapered steel girders, reinforced concrete block walls @ perimeter

Diaphragms: Bare metal deck

Transverse

System Classification: Type 13(Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm)

Vertical Elements: Steel beams, tapered steel girders, reinforced concrete block walls @ perimeter

Diaphragms: Bare metal deck


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 4

(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:

THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

WALL ANCHORAGE

Worst case: NS walls, out of plane anchorage for the concrete block walls is not adequate. D/C = 1.95.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

Strengthen out of plane anchorage.

p:\project\a02\000.099\a20047.08\calc\active\worksheets\calculations and summary sheets per building\bldg 322\bldg summary.doc
## BUILDING SYSTEM

<table>
<thead>
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<td>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.</td>
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<td>4.3.1.3</td>
<td>MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or be anchored to the lateral-force-resisting elements of the main structure.</td>
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<td>☑</td>
<td>4.3.2.1</td>
<td>WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☑</td>
<td>4.3.2.2</td>
<td>SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
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<tr>
<td>☑</td>
<td>4.3.2.3</td>
<td>GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
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<tr>
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<td>4.3.2.4</td>
<td>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<td>4.3.2.5</td>
<td>MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
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<td>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.</td>
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<td>☑</td>
<td>4.3.3.7</td>
<td>MASONRY UNITS: There shall be no visible deterioration of masonry units.</td>
</tr>
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</table>
**BUILDING SYSTEM**

- **4.3.3.8 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.  
  - Site visit made on 7/22/03. No eroded mortar was observed.

- **4.3.3.10 REINFORCED MASONRY WALL CRACKS**: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.  
  - Site visit made on 7/22/03. There are no cracks >1/8".

**LATERAL-FORCE-RESISTING SYSTEM**

- **4.4.2.1.1 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.  
  - There are two lines of shear walls in both the longitudinal and transverse directions.

- **4.4.2.4.1 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.  
  - The maximum shear stress in the concrete block wall is 11 psi < 70 psi at the south wall.

- **4.4.2.4.2 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.  
  - Typ. reinforcement in reinforced concrete block walls:  
    - Vertical Reinforcing = #5@24" o.c.:  
      - reinforcing ratio = 0.0016 > 0.0007  
    - Horizontal Reinforcing = #4@24" o.c. horizontal:  
      - reinforcing ratio =0.001 > 0.0007.  
  - Total reinforcing steel ratio =  
  \[(0.31+0.2)\times2/(24\times8\times12\times12)\times0.0027 = 0.00027 > 0.0002\]

**CONNECTIONS**

- **4.6.1.1 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.  
  - At the East and West elevations: (2) 7/8" diameter x 16" bolts w/ max. spacing @ 20" o.c. In addition, detail show the deck welded to 3/8" x 3" plates w/ 1/2" diameter L bolts into the concrete block wall @ 24" o.c. at the East and West elevations. Worst case out of plane anchorage, North and South elevations: (2) 5/8" diameter x 12" bolts. Maximum spacing of anchorage @ 10'.  
  - D/C = 1.95.

- **4.6.1.2 WOOD LEDGERS**: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.  
  - There are no wood ledgers.
ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

C | NC | N/A | Comments
---|----|-----|------------------

**CONNECTIONS**

- **4.6.2.1** 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 diaphragms for Immediate Occupancy.
  - Details show the metal deck to be screwed to 2x4 members which are connected to 3/8"x3" plates by welded 1/2" diameter studs @ 24" o.c. Welded to the plate are 1/2" diameterx6" L anchors embedded in the concrete block walls.

- **4.6.3.5** FOUNDATION DOWELS: Wall reinforcement shall be dowelled 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.
  - #5x 4'-0" dowels @ 2'-0" o.c. into the concrete foundation to match vertical reinforcing in the concrete block walls.

- **4.6.4.1** GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.
  - There are no columns in the building. Girders are connected to the concrete block walls w/bolts and welded rebar.

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
# ASCE 31* SUPPLEMENTAL CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

## LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th></th>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.4.2.4.3</td>
<td>REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.4.2.4.4</td>
<td>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.</td>
</tr>
</tbody>
</table>

## DIAPHRAGMS

| ☒ | ☐ | ☐ | 4.5.1.2 | CROSS TIES: There shall be continuous cross ties between diaphragm chords. |
| ☒ | ☐ | ☐ | 4.5.1.4 | OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. |
| ☒ | ☐ | ☐ | 4.5.1.6 | OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy. |
| ☐ | ☒ | ☐ | 4.5.1.7 | PLAN IRR Eg All openings are less than 25% of the wall length. |
| ☐ | ☒ | ☒ | 4.5.1.8 | PLAN IRRs: There shall be a plan accommodating the diaphragm opening at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. |
| ☐ | ☒ | ☒ | 4.5.2.1 | 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. |
| ☐ | ☒ | ☒ | 4.5.2.2 | SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. |
| ☐ | ☒ | ☒ | 4.5.2.3 | UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. |
| ☐ | ☒ | ☒ | 4.5.3.1 | NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. |
### DIAPHRAGMS

**4.5.7.1** OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

### CONNECTIONS

**4.6.1.4** 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 no greater than 1/8".

---

* Checklists statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Canopy identified on 7/22.
Site visit.
Bare metal deck on WF beams and HSS 4x4 cols.

Addition identified per 7/22.
Site visit.
Bare metal deck on WF beam supported by C-cols tied back to concrete block wall.
Building 362

Building 362 is a one-story reinforced masonry bearing wall building. The structure consists of 5/8" plywood sheathing supported by wood joists, which are supported by perimeter 8" thick concrete block walls and interior partition walls. Deficiencies noted for Building 362 are inadequate out-of-plane wall anchorage and the absence of cross ties in the building. For the building to meet life-safety requirements, we recommend that the out-of-plane anchorage be strengthened and that cross ties are added.
BUILDING DATA
Year Built: 1964
Area (sq ft): 3,250
No. Stories: 1

Year(s) Remodeled: 1977
Length (ft): 74
Story Height: 14'-2"

UBC Zone: 4 – Type B Near Field
Width (ft): 50'-8"
Total Height: 14'-2"

CONSTRUCTION DATA
Gravity Load Structural System: 5/8" Plywood sheathing supported by 2x12 wood joists @ 24" o.c. Joists are supported by interior partitions and exterior concrete block walls.
Exterior Transverse Walls: 8" concrete block walls
Exterior Longitudinal Walls: 8" concrete block walls

Openings?: Door and window openings

Roof Framing: 5/8" Plywood sheathing supported by 2x12 wood joists @ 24" o.c.

Intermediate Floor Framing: None
Ground Floor: 4" concrete slab on grade w/ 6x6-4/4 WWF (or 4x4-W2.9xW2.9 WWF) over 4" aggregate base
Columns: None
Foundation: Concrete strip footings

LATERAL-FORCE-RESISTING SYSTEM
Longitudinal
System Classification: Type 13 (Reinforced concrete block walls w/ flexible diaphragm)
Vertical Elements: 2x12 wood joists, 2x6 interior stud walls, exterior concrete block walls
Diaphragms: 5/8" plywood

Transverse
System Classification: Type 13 (Reinforced concrete block walls w/ flexible diaphragm)
Vertical Elements: 2x12 wood joists, 2x6 interior stud walls, exterior concrete block walls
Diaphragms: 5/8" plywood


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5 (1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

WALL ANCHORAGE
Toe nail connection for out of plane anchorage is not adequate. D/C = 7.81.

CROSS TIES
There are no cross ties in the EW direction.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add out of plane anchorage and cross ties.
### BUILDING SYSTEM

<table>
<thead>
<tr>
<th></th>
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<td>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<td>MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
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The 5/8" plywood diaphragm transfers load to the 2x12 joists, which transfers load to the exterior concrete block walls. The concrete block walls are dowelled into the foundation.

There are no adjacent buildings.

There are no mezzanines.

One story building

One story building

One story building

The concrete block walls are dowelled into the concrete strip foundation system.

One story building

Site visit made on 8/6/03. No signs of deterioration were observed.

Site visit made on 8/6/03. No signs of deterioration were observed.

Site visit made on 8/6/03. No eroded mortar was observed.
## ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

### BUILDING SYSTEM

- **4.3.3.10** REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.
  - Site visit made on 8/6/03. There are no cracks >1/8".

### LATERAL-FORCE-RESISTING SYSTEM

- **4.4.2.1.1** 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.
  - There are two lines of shear walls in both the longitudinal and transverse directions.
- **4.4.2.4.1** 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.
  - The maximum shear stress in the concrete block wall is 10 psi < 70 psi at the west elevation.
- **4.4.2.4.2** 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.
  - Typ. reinforcement in reinforced concrete block walls:
    - Vertical Reinforcing = #5@24" o.c.: reinforcing ratio = 0.0016 > 0.0007
    - Horizontal Reinforcing = 2#3@24" o.c. horizontal: reinforcing ratio =0.0011 > 0.0007.
  - Total reinforcing steel ratio = (0.31+0.22)in^2/(24"*8") = 0.0028 = 0.002

### CONNECTIONS

- **4.6.1.1** 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.
  - Out of plane wall anchorage: Blocking is toe nailed to 2x6 wood plates which are tied to the concrete block walls w/ 3/4" diameter bolts @ 4" o.c. typ.
  - D/C=7.81.
  - There are no wood ledgers.
- **4.6.1.2** WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.
- **4.6.2.1** 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 diaphragms for Immediate Occupancy.
  - Plywood diaphragm is nailed to joists and blocking. These are nailed to a 3x6 plate, which is bolted to the concrete block wall w/ 3/4" diameter bolts at 4'-0" o.c.
- **4.6.3.5** FOUNDATION DOWELS: Wall reinforcement shall be dowelled 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.
  - #5 L-dowels @ 24" o.c. into foundation to match vertical reinforcing in the concrete block walls.
ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

CONNECTIONS

☐  ☐  ☐  4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

There are no columns.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
ASCE 31* SUPPLEMENTAL CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

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<tr>
<td><strong>LATERAL-FORCE-RESISTING SYSTEM</strong></td>
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<td>4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
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<td>4.4.2.4.4 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. Life Safety Performance Level.</td>
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<td><strong>DIAPHRAGMS</strong></td>
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<td>4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords. There are no cross ties in the EW direction.</td>
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<td>4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. There are no diaphragm openings adjacent to shear walls.</td>
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<td>4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy. There are no diaphragm openings adjacent to shear walls.</td>
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<td>4.5.1.7 PLAN IRRREGULARITIES: 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. Life Safety Performance Level.</td>
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<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
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<td>4.5.2.1 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. 5/8&quot; plywood sheathing.</td>
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<tr>
<td>☐</td>
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<td>4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. 5/8&quot; plywood sheathing.</td>
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<tr>
<td>☐</td>
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<td>4.5.2.3 UNBLOTTED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. Span = 2'-0&quot;. Diaphragm aspect ratio – 1 to 1.</td>
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<td>4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.</td>
</tr>
</tbody>
</table>
ASCE 31* SUPPLEMENTAL CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

DIAPHRAGMS

☑ ☐ ☐ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☐ ☐ ☐ 4.6.1.4 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 no greater than 1/8".

*-- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
ROOF FRAMING PLAN

SCALE: 1/8" = 1'-0"

MECH. UNIT SEE SHEET M1, PROVIDE FMR. OF 2x2x12 CENTERED ON UNIT 1.

2x2x12 BLOCKING BETWEEN JOISTS.

MECH. OPENING SEE SHEET M1.

NEW 2x12 HEADER.

PLYWOOD (GRANNYS JOIST) FULLY BLOCKED W/ 2x4's @ DIAPHRAGM

BIRDSEYE PANEL EDGES, 64 & 60 GIRDER EDGES.

4x4 12" @ INT. FRAMING, DOWEBED.

MECH. OPENING 2x2x12 FOR ADDTL. WALLING & TIES.

NOTE: LAP M1 1/2" BARS 4' U.A.D.
Building 363

Building 363 is a one-story reinforced masonry bearing wall building. The structure consists of 1/2" plywood sheathing supported by wood joists, which are supported by perimeter 8" thick concrete block walls and interior partition walls. Deficiencies noted for Building 363 are inadequate out-of-plane wall anchorage and the absence of cross ties in the building. For the building to meet life-safety requirements, we recommend that the out-of-plane anchorage be strengthened and that cross ties are added.
BUILDING DATA
Year Built: 1965
Year(s) Remodeled: 1989
Area (sf): 1,590
Length (ft): 44
No. Stories: 1
Story Height: 13'
Total Height: 13'

CONSTRUCTION DATA
Gravity Load Structural System: 1/2" plywood sheathing supported by wood joists and 2x4 or 2x6 stud walls
Exterior Transverse Walls: 8" Concrete block walls
Exterior Longitudinal Walls: 8" Concrete block walls
Roof Framing: 1/2" Plywood sheathing supported by 2x14 joists @ 16" o.c.
Intermediate Floor Framing: None
Ground Floor: 6" concrete slab on grade w/ 6x6x10 ga. WWM
Columns: None
Foundation: Thicken slab at interior partitions, strip footing at exterior concrete block shear walls

LATERAL-FORCE-RESISTING SYSTEM
Longitudinal
System Classification: Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm)
Vertical Elements: Wood joists supported by stud walls at interior and concrete block walls at exterior
Diaphragms: 1/2" plywood sheathing

Transverse
System Classification: Type 13 (Reinforced Masonry Bearing Wall Building w/ Flexible Diaphragm)
Vertical Elements: Wood joists supported by stud walls at interior and concrete block walls at exterior
Diaphragms: 1/2" plywood sheathing

SEISMIC EVALUATION PERFORMED? Yes
EVALUATION: Rapid Evaluation
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

WALL ANCHORAGE
Toe nail connection for out of plane anchorage is not adequate. D/C = 6.25.

CROSS TIES
There are no cross ties in the EW direction.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add out of plane anchorage.
Add crossties in the EW direction.
ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

BUILDING SYSTEM

☒ ☐ ☐ 4.3.1.1 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.

The 1/2" plywood sheathing delivers load to the wood joists, which transfer the load to the perimeter reinforced concrete block walls. The concrete block walls are doweled into the concrete strip foundation system.

☒ ☐ ☐ 4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.

There are no adjacent buildings.

☒ ☐ ☐ 4.3.1.3 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.

There are no mezzanines.

☒ ☐ ☐ 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

One story building

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

One story building

☒ ☐ ☐ 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

The concrete block walls are doweled into the concrete strip foundation system.

☒ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

One story building

☒ ☐ ☐ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

Site visit made on 7/22/03. No signs of deterioration were observed.

☒ ☐ ☐ 4.3.3.1 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.

Site visit made on 7/22/03. No signs of deterioration were observed.

☒ ☐ ☐ 4.3.3.7 MASONRY UNITS: There shall be no visible deterioration of masonry units.

Site visit made on 7/22/03. No eroded mortar was observed.

☒ ☐ ☐ 4.3.3.8 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.
BUILDING SYSTEM

4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. Site visit made on 7/22/03. There are no cracks >1/8".

LATERAL-FORCE-RESISTING SYSTEM

4.4.2.1.1 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. There are two lines of shear walls in both the longitudinal and transverse directions.

4.4.2.4.1 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. The maximum shear stress in the concrete block wall is 5 psi < 70 psi at the east and west walls.

4.4.2.4.2 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" for Life Safety and immediate Occupancy; and all vertical bars shall extend to the top of the walls. Typ. reinforcement in reinforced concrete block walls:

Vertical Reinforcing = #4@32" o.c.
reinforcing ratio = 0.00075 > 0.0007

Horizontal Reinforcing = #4@48" o.c.
horizontal: reinforcing ratio =0.001 > 0.0007.

Total reinforcing steel ratio =
(0.2*1.5+2*0.2)in^2/2/(48in*38") = 0.0018 < 0.002.

CONNECTIONS

4.6.1.1 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.

Blocking is toe nailed to 2x6 wood plates which are tied to the concrete block walls w/ 5/8" diameter bolts @ 32" o.c. D/C for out of plane anchorage = 6.25.

4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.

1/2" plywood sheathing is nailed to 2x10 members, which are toe nailed to 2x6 redwood plates. The plates are bolted to the concrete block wall w/ 5/8" diameter bolts at 32" o.c.

4.6.2.1 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 diaphragms for Immediate Occupancy.

#4 L- dowels @ 32" o.c. into concrete foundation to match vertical reinforcing in the concrete block walls.

4.6.3.5 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.
## ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

### CONNECTIONS

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4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

There are no columns.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.4.4 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.

DIAPHRAGMS

☐ ☐ ☒ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

☒ ☐ ☒ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☒ ☐ ☒ 4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.

☐ ☐ ☒ 4.5.1.7 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.

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.5.2.1 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.

☐ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☐ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☐ ☐ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.
### DIAPHRAGMS

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<td>4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
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### CONNECTIONS

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<td>☐</td>
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<td>☒</td>
<td>4.6.1.4 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 no greater than 1/8&quot;.</td>
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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
Building 4675, Original Trailers + Addition #1

Building 4675 consists of several one-story wood framed trailers. The original trailers were constructed in 1979 and Addition #1 was constructed as an extension in 1980. The roof consists of 2x4 joists with plywood sheathing. The roof spans to the perimeter plywood sheathed bearing walls. The typical trailer dimension is 24 feet wide by 60 feet long.

The primary structural deficiency found in Building 4675, Original Trailers is the absence of sill bolting along the plywood sheathed shear walls. The trailers are susceptible of sliding off their supports in the event of an earthquake. For the building to meet life-safety requirements, we recommend that the existing wood sills be bolted down to the foundation and/or typical lateral bracing be installed between the trailers and grade.
BUILDING DATA
Year Built: - Year(s) Remodeled: 1980-1991 UBC Zone: 4 - Type B Near Field
Area (sf): 8,720 sf Length (ft): 120' Width (ft): 96'
No. Stories: 1 Story Height: Sloped Roof Total Height: ~12'

CONSTRUCTION DATA
Gravity Load Structural System: 24' x 60' trailers. 2x4 roof framing with plywood sheathing spans to exterior bearing walls.

Exterior Transverse Walls: Plywood sheathed bearing shear walls Openings?: Doors / Windows
Exterior Longitudinal Walls: Plywood sheathed bearing shear walls

Roof Framing: 2x4 joists with plywood sheathing.

Intermediate Floor Framing: -

Ground Floor: 1-1/8" T&G plywood over 4x6 girders @ 24" o.c. with intermediate supports

Columns: Bearing walls typical. In between trailers where bearing walls have been removed, timber posts provide vertical support.

Foundation: The floor is supported on steel jacks (supports located in the interior) and 3' piltwalls (2x4 studwalls with plywood sheathing along the exterior, except on the eastside. The eastern wall (60' long) is supported on a poured-in-place concrete wall with a footing. The original trailers do not have anchor bolts at the wood sills along the exterior walls.

LATERAL-FORCE-RESISTING SYSTEM

<table>
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<tr>
<th>Longitudinal (W-E)</th>
<th>Transverse (N-S)</th>
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<tr>
<td>System Classification: W2 – Wood Frames</td>
<td>W2 – Wood Frames</td>
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<tr>
<td>Vertical Elements: Bearing walls</td>
<td>Bearing walls</td>
</tr>
<tr>
<td>Diaphragms: 2x4 joists with plywood sheathing</td>
<td>2x4 joists with plywood sheathing</td>
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SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 4 (1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

WOOD SILLS
The wood sills in the original trailers are not bolted to the foundation.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Bolt down existing wood sills to foundation.
**ASCE 31* BASIC CHECKLIST W2: WOOD FRAMES, COMMERCIAL AND INDUSTRIAL**

### BUILDING SYSTEM

- **4.3.1.1 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.
  - **Comments:** Perimeter and interior plywood shear walls.

- **4.3.1.3 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.

- **4.3.2.1 WEAK STORY:** The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.
  - **Comments:** Single story cafeteria

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

- **4.3.2.3 GEOMETRY:** There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.
  - **Comments:** Single story cafeteria

- **4.3.2.4 VERTICAL DISCONTINUITIES:** All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.
  - **Comments:** Single story cafeteria

- **4.3.2.5 MASS:** There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

- **4.3.3.1 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.

- **4.3.3.2 WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS:** There shall be no more than 15% of inadequate fastening such as over-driven fasteners, omitted blocking, excessive fastening spacing, or inadequate edge distance. This statement shall apply to the Immediate Occupancy Performance Level only.
  - **Comments:** Life Safety Evaluation

### LATERAL-FORCE-RESISTING SYSTEM

- **4.4.2.1.1 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.
ASCE 31* BASIC CHECKLIST W2: WOOD FRAMES, COMMERCIAL AND INDUSTRIAL

C NC N/A Comments

LATERAL-FORCE-RESISTING SYSTEM

☒ ☐ ☐ 4.4.2.7.1 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:
- Structural panel sheathing: 1000 plf
- Diagonal sheathing: 700 plf
- Straight sheathing: 100 plf
- All other conditions: 100 plf
Shear stresses low. DCR = 0.6

☒ ☐ ☐ 4.4.2.7.2 STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system.

☒ ☐ ☐ 4.4.2.7.3 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 multistory building.

☒ ☐ ☐ 4.4.2.7.4 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.

☒ ☐ ☐ 4.4.2.7.5 WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor.

☒ ☐ ☐ 4.4.2.7.6 HILLSIDE SITE: For structures that are taller on at least one side by more than half of a 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.

☒ ☐ ☐ 4.4.2.7.7 CRIPPLE WALLS: Cripple walls below first floor level shear walls shall be braced to the foundation with wood structural panels.

☒ ☐ ☐ 4.4.2.7.8 OPENINGS: Walls with openings greater than 80% 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.

CONNECTIONS

☒ ☐ ☐ 4.6.3.3 WOOD POSTS: There shall be a positive connection of wood posts to the foundation.

☒ ☐ ☐ 4.6.3.4 WOOD SILLS: All wood sills shall be bolted to the foundation.
No sill anchor bolts found
## CONNECTIONS

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☑ ☐ ☐ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.7.9 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. Life Safety Evaluation only.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. Diaphragm across the original trailers and new addition #1 are tied together at the same elevation.

☒ ☐ ☐ 4.5.1.3 ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. Life Safety Evaluation only.

☒ ☐ ☒ 4.5.1.7 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. Life Safety Evaluation only.

☒ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Evaluation only.

☐ ☐ ☒ 4.5.2.1 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. Diaphragms are sheathed with structural panels.

☒ ☐ ☐ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. Diaphragms are blocked.

☒ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. Diaphragms are blocked.

☒ ☐ ☒ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☐ ☒ ☐ 4.6.3.9 WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft or less for Life Safety and 4 ft or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete. No sill anchor bolts found

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
**Building 515**

Building 515 is a one-story steel light framed structure. The roof consists of bare metal deck with insulation and roofing. The lateral system in the transverse direction consists of steel moment frames. In the longitudinal direction, the lateral system consists of rod braces. The total square footage for this building is 7,200 square feet.

The primary structural deficiencies noted for Building 515 are as follows: 1) There is torsion in the building because the rod braced frames are located on one side only; and 2) the rod braces are overstressed.
BUILDING DATA

Year Built: - Year(s) Remodeled: - UBC Zone: 4 – Type B Near Field
Area (sf): 7,200 sf Length (ft): 147’ Width (ft): 49’
No. Stories: 1 Story Height: Sloped Roof Total Height: 14’

CONSTRUCTION DATA

Single story steel-light-frame structure. Bare metal deck supported on steel WF roof beams. Gravity Load Structural System: The new addition consists of a truss made of galvanized steel pipes tied into the original WF roof beams

Exterior Transverse Walls: metal wall panels / Fabric at addition Openings?: none
Exterior Longitudinal Walls: metal wall panels / Fabric at addition Openings?: none

Roof Framing: Bare metal deck supported on steel roof beams / Fabric at addition

Intermediate Floor Framing: -

Ground Floor: Concrete slab on grade

Columns: Wide flange columns.

Foundation: No structural drawings available.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal (W-E) Transverse (N-S)
System Classification: S3 – Steel Light Frames S3 – Steel Light Frames
Vertical Elements: Steel wide flange columns Steel wide flange columns
Diaphragms: Bare metal deck with roofing / Fabric Bare metal deck with roofing / Fabric


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING:
\[
5 \quad \text{(1=low to 10=high)}
\]

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

TORSION
Rod braces are located on one line only in the longitudinal direction.

AXIAL STRESS CHECK
Existing rod braces are insufficient. The axial stress calculated is approximately 42 ksi.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Building usage is primarily for storage with only 2 small cubicles to serve as office space.
Recommendation is to relocate occupancy and consider this a non-building. No strengthening required.
BUILDING SYSTEM

- **4.3.1.1** 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. There are steel moment frames in the transverse direction and rod braced frames in the longitudinal direction.

- **4.3.1.3** 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.

- **4.3.2.4** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

- **4.3.2.6** TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. Rod bracing is located on one side only.

- **4.3.3.3** 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.

LATERAL-FORCE-RESISTING SYSTEM

- **4.4.3.1.1** 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.

- **4.4.3.1.2** 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 0.50 f, for Life Safety and for Immediate Occupancy. Calculated axial stress in rods is approximately 42 ksl.

CONNECTIONS

- **4.6.2.2** 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. Metal deck welded to roof beams.

- **4.6.3.1** STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. No structural drawings. From site visit, columns were observed to have anchor bolts into the slab on grade.

- **4.6.3.8** WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy.
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<tr>
<td>☒</td>
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<td>4.6.5.1 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. Roof consists of bare metal deck on steel roof beams.</td>
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<td>4.6.5.2 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.</td>
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LATERAL-FORCE-RESISTING SYSTEM

☒ ☐ ☐ 4.4.1.3.3 MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones.

☐ ☐ ☒ 4.4.1.3.7 COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).

☐ ☐ ☒ 4.4.1.3.8 BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.1.3.10 OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.1.3.11 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.

DIAPHRAGMS

☐ ☐ ☒ 4.5.1.7 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.

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☐ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

☒ ☐ ☐ 4.6.5.3 ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12" for Life Safety and 8" for Immediate Occupancy.

* — Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 519A

Building 519A is a one-story steel light framed structure. The roof consists of bare metal deck with insulation and roofing. The lateral system in the transverse direction consists of steel moment frames. In the longitudinal direction, the lateral system consists of rod braces. The total square footage for this building is 5,760 square feet.

The primary structural deficiencies noted for Building 519A are as follows: 1) There is an inadequate load path for lateral loads in the longitudinal direction because the tension-only rods are oriented in one direction only; 2) There is torsion in the building because the rod braced frames are located on one side only; and 3) The rod braces are overstressed.

For the building to meet life-safety requirements, we recommend replacing the existing rod braces with steel angles or tubes and providing braces in both longitudinal frames for symmetry.
BUILDING DATA

- Year Built: -
- Year(s) Remodeled: -
- Area (sf): 5,760 sf
- Length (ft): 96'
- No. Stories: 1
- Story Height: Sloped Roof
- UBC Zone: 4 – Type B Near Field
- Width (ft): 60'
- Total Height: -

CONSTRUCTION DATA

- Exterior Transverse Walls: metal wall panels
- Exterior Longitudinal Walls: metal wall panels
- Roof Framing: Bare metal deck supported on steel roof beams
- Intermediate Floor Framing: -
- Openings?: Roll up doors
- Openings?: Roll up doors
- Ground Floor: Concrete slab on grade
- Columns: Wide flange columns located on the perimeter.
- Foundation: No structural drawings available.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal (W-E)
- System Classification: S3 – Steel Light Frames
- Vertical Elements: Steel wide flange columns
- Diaphragms: Bare metal deck with roofing

Transverse (N-S)
- System Classification: S3 – Steel Light Frames
- Vertical Elements: Steel wide flange columns
- Diaphragms: Bare metal deck with roofing

SEISMIC EVALUATION PERFORMED? Yes

EVALUATION: Rapid Evaluation

YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 6

(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

LOAD PATH
The rod braces in the longitudinal direction are oriented in one direction only. For seismic / cyclic loading, tension-only braces are required in both directions.

TORSION
In the longitudinal direction, rod braces are located on one side only.

AXIAL STRESS CHECK
Existing rod braces are insufficient. The axial stress calculated is approximately 70 ksi.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Replace existing rod braces with angles in both directions for cyclic resistance. Locate braces on both sides for symmetry.
# ASCE 31* BASIC CHECKLIST S3: STEEL LIGHT FRAMES

## BUILDING SYSTEM

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<td>4.3.1.1 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. Rod bracing along the longitudinal frames is in one direction only. Since braces are tension only, there is no cyclic resistance in the longitudinal direction.</td>
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<td>4.3.1.3 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. No mezzanines.</td>
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<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. Longitudinal rod braces are located on one side only.</td>
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<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
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<td>□</td>
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<td>□</td>
<td>4.3.3.3 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.</td>
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## LATERAL-FORCE-RESISTING SYSTEM

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<td>4.4.3.1.2 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 0.50 ksi, for Life Safety and for Immediate Occupancy. Calculated axial stress in rods is over 150 ksi.</td>
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## CONNECTIONS

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<td>4.6.2.2 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. Metal deck welded to roof beams.</td>
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<td>4.6.3.1 STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. No structural drawings. From site visit, columns were observed to have anchor bolts into the slab on grade.</td>
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<tr>
<td>□</td>
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<td>□</td>
<td>4.6.3.8 WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy.</td>
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<tr>
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<td>□</td>
<td>4.6.5.1 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. Roof consists of bare metal deck on steel roof beams.</td>
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<td>CONNECTIONS</td>
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* = Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# LATERAL-FORCE-RESISTING SYSTEM

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<td>4.4.1.3.3</td>
<td>MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones.</td>
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<td>4.4.1.3.7</td>
<td>COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).</td>
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<td>4.4.1.3.8</td>
<td>BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.4.1.3.10</td>
<td>OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.4.1.3.11</td>
<td>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.</td>
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<td><strong>No structural drawings available.</strong></td>
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## DIAPHRAGMS

|   |   |   | 4.5.1.7 | 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. |
|   |   |   | **Life Safety Evaluation.** |
|   |   |   | 4.5.1.8 | DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. |
|   |   |   | **Life Safety Evaluation.** |
|   |   |   | 4.5.7.1 | OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing. |
|   |   |   | **Life Safety Evaluation.** |

## CONNECTIONS

|   |   |   | 4.6.3.10 | 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. |
|   |   |   | **No structural drawings. But pile foundations not typical at site.** |
|   |   |   | 4.6.5.3 | ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12" for Life Safety and 8" for Immediate Occupancy. |
|   |   |   | **No structural drawings available.** |

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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
Building 519B

Building 519B is a one-story steel light framed structure. The roof consists of bare metal deck with insulation and roofing. The lateral system in the transverse direction consists of steel moment frames. In the longitudinal direction, the lateral system consists of 4 bays of ½” diameter rods. The total square footage for this building is 3,200 square feet. The rod braces with steel angles or tubes.

Structural drawings were not available. The only potential deficiency is the ability of the moment connections to develop the strength of the adjoining connections. A detailed evaluation will likely show that moment frame connection meets the life-safety performance level. These buildings are rated Class D – Low Priority pending detailed evaluation.
BUILDING DATA

Year Built: - Year(s) Remodeled: -
Area (sf): 3,200 sf Length (ft): 80'
No. Stories: 1 Story Height: Sloped Roof

CONSTRUCTION DATA

Gravity Load Structural System: Single story steel-light-frame structure. Bare metal deck supported on steel roof beams. Beams span 60 feet to perimeter columns.

Exterior Transverse Walls: metal wall panels
Exterior Longitudinal Walls: metal wall panels
Roof Framing: Bare metal deck supported on steel roof beams
Intermediate Floor Framing: -

Ground Floor: Concrete slab on grade

Columns: Wide flange columns located on the perimeter.

Foundation: No structural drawings available.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal (W-E) Transverse (N-S)
System Classification: S3 – Steel Light Frames S3 – Steel Light Frames
Vertical Elements: Steel wide flange columns Steel wide flange columns
Diaphragms: Bare metal deck with roofing Bare metal deck with roofing


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 3
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

MEZZANINE
Mezzanine is attached to the structure on 3 sides only.
All moment connections shall be able to develop strength of adjoining members.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Provide angle braces at mezzanine.
Detailed evaluation of moment connections.
### Building System

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<td>☒</td>
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<td>☐</td>
<td>4.3.1.1</td>
<td>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.</td>
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<td>4.3.1.3</td>
<td>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.</td>
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<td>4.3.2.4</td>
<td>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<td>4.3.2.6</td>
<td>TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
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<td>4.3.3.3</td>
<td>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.</td>
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### Lateral-Force-Resisting System

|   |   |   |   |   |   |   |   |   | Comments |
|---|---|---|---|---|---|---|---|------------|
|☒ | ☐ | ☐ | 4.4.3.1.2 | 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 0.50Fy, for Life Safety and for Immediate Occupancy. |

### Connections

|   |   |   |   |   |   |   |   |   | Comments |
|---|---|---|---|---|---|---|---|------------|
|☒ | ☐ | ☐ | 4.6.2.2 | 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. |
|☐ | ☒ | ☐ | 4.6.3.1 | STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. |
|☐ | ☒ | ☐ | 4.6.3.8 | WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy. |
|☒ | ☐ | ☐ | 4.6.5.1 | 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. |

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There are steel moment frames in the transverse direction and rod braced frames in the longitudinal direction.
The mezzanine is attached to the main structure on 3 sides.
Calculated axial stress in rods is approximately 30 ksi < 36 ksi
ASCE 31* BASIC CHECKLIST S3: STEEL LIGHT FRAMES

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CONNECTIONS

☐ ☐ ☐ 4.6.5.2 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.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☒ ☐ 4.4.1.3.3 MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones.

☐ ☐ ☐ 4.4.1.3.7 COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).

☐ ☒ ☐ 4.4.1.3.8 BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☒ ☐ 4.4.1.3.10 OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☒ ☐ 4.4.1.3.11 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.

DIAPHRAGMS

☐ ☒ ☐ 4.5.1.7 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.

☐ ☒ ☐ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☒ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☐ ☒ ☐ 4.6.3.10 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.

☐ ☐ ☐ 4.6.5.3 ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12" for Life Safety and 8" for Immediate Occupancy.

No structural drawings. But pile foundations not typical at site.

No structural drawings available.

*-- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
BUILDING DATA

Year Built: 1956  Year(s) Remodeled: 1958, 1974  UBC Zone: 4 – Type B Near Field
Area (sf): 2400  Length (ft): 130’  Width (ft): 50’
No. Stories: 1  Story Height: ~17’  Total Height: ~17’ max

CONSTRUCTION DATA

Gravity Load Structural System:
Exterior Transverse Walls: Reinforced concrete & precast panels
Exterior Longitudinal Walls: Reinforced concrete & precast panels
Roof Framing: Steel beams: WF and channels
Intermediate Floor Framing: N/A
Ground Floor: 4” S.O.G. with 4 x 4 - 10/10 wire mesh, OR
6” S.O.G. with #3@9 top e.w. and #4@18 bot e.w., OR
6” S.O.G. with #4 @15 e.w.
Columns: Steel WF
Foundation: Strip footings under walls, spread footings under columns

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal
System Classification: C2A: Concrete Shear Wall Building with Flexible Diaphragm; also PC1: Precast/Tilt-up Concrete Shear Wall Buildings with Flexible Diaphragm
Vertical Elements: Reinforced concrete shear walls and Precast concrete panels
Diaphragms: Corrugated cement asbestos roofing over flat cement asbestos panel insulation over steel roof framing OR bare metal deck over steel WF framing

Transverse
System Classification: C2A: Concrete Shear Wall Building with Flexible Diaphragm; also PC1: Precast/Tilt-up Concrete Shear Wall Buildings with Flexible Diaphragm
Vertical Elements: Reinforced concrete shear walls and Precast concrete panels
Diaphragms: Corrugated cement asbestos roofing over flat cement asbestos panel insulation over steel roof framing OR bare metal deck over steel WF framing


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5

(P=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

LOAD PATH/ WALL ANCHORAGE
The wall anchorage of the transverse walls to the diaphragm in the original building is not shown on the drawings and could not be confirmed at the site visit.

LOAD PATH/ OPENINGS AT SHEAR WALLS/ OTHER DIAPHRAGMS
Roof system consists of corrugated cement asbestos roofing over cement asbestos panel insulation over steel framing. We cannot assume that the cement asbestos panels at roof act as a diaphragm.

CROSS TIES
There are continuous beams in the E-W direction with spans of 8'-18', but there are none in N-S to break up the 31' span in the 1974 addition. This is not sufficient to tie the diaphragm together.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

LOAD PATH/ WALL ANCHORAGE
Provide connection of the transverse walls to the diaphragm.

LOAD PATH/ OPENINGS AT SHEAR WALLS/ OTHER DIAPHRAGMS
Replace existing diaphragm with either rod bracing or bare metal deck.

CROSS TIES
Further analysis is required to determine if this issue is a life-safety deficiency; it is a low priority potential deficiency. A new cross in this direction may be required.
### BUILDING SYSTEM

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<tbody>
<tr>
<td>4.3.1.1 LOAD PATH:</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>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.</td>
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<tr>
<td>4.3.1.2 ADJACENT BUILDINGS:</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>4.3.1.3 MEZZANINES:</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>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.</td>
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<tr>
<td>4.3.2.1 WEAK STORY:</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
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<td>4.3.2.2 SOFT STORY:</td>
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<td>The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
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<tr>
<td>4.3.2.3 GEOMETRY:</td>
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<td>☐</td>
<td>There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
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<td>4.3.2.4 VERTICAL DISCONTINUITIES:</td>
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<td>☐</td>
<td>☐</td>
<td>All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<tr>
<td>4.3.2.5 MASS:</td>
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<td>☐</td>
<td>There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
</tr>
<tr>
<td>4.3.3.1 DETERIORATION OF WOOD:</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>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.</td>
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<td>4.3.3.4 DETERIORATION OF CONCRETE:</td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
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<td>4.3.3.5 POST-TENSIONING ANCHORS:</td>
<td>☒</td>
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<td>☐</td>
<td>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.</td>
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We cannot assume that the cement asbestos panels at roof act as a diaphragm. Also the wall anchorage of the transverse walls in the original building is not shown.

No immediately adjacent buildings.

No interior mezzanines.

One story building.

One story building.

One story building.

One story building.

One story building.
**BUILDING SYSTEM**

☐ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

VERIFY @ SITE VISIT.

**LATERAL-FORCE-RESISTING SYSTEM**

☐ ☐ ☐ 4.4.2.1.1 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.

☑ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2 \sqrt{f_{c}}$ for Life Safety and Immediate Occupancy.

$\gamma_d = 13$ psi (for 12" cast-in-place concrete walls and 6" precast panels combined)

<< 100 psi allowed.

Max spacing is 18".

12" wall: #4@12" min e.w.e.f. → 0.0027 OK
8" wall: #4@24" vert e.f. → 0.0020 OK
8" wall: #4@18" horiz e.f. → 0.0027 OK

☐ ☐ ☐ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

**CONNECTIONS**

☐ ☐ ☐ 4.6.1.1 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.

Positive connection exists in 1958 (original) building segment, such that separation of the walls and collapse of the roof is not a concern.

There are no applicable details for the 1956 segment. At the site, we observed a channel sitting on top of the wall, but could not verify any connection of the channel to the wall.

1974 Addition is adequate. See attached calculations.

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

We cannot assume that the cement asbestos panels at roof act as a diaphragm. Unable to verify connection of corrugated asbestos cement roofing to concrete walls.

☐ ☐ ☐ 4.6.3.5 FOUNDATION DOWELS: Wall reinforcement shall be dowelled 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.

Walls are dowelled to strip footings.

*— Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.2.3 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.

☐ ☐ ☒ 4.4.2.2.4 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.

☐ ☐ ☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d_y. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒ ☐ ☒ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☒ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

☒ ☐ ☒ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☒ ☐ ☒ 4.5.1.7 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.

☒ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.
**ASCE 31* SUPPLEMENTAL CHECKLIST C2A: CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS**

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<td>☐</td>
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<td><strong>4.5.2.1</strong> 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. No straight sheathing.</td>
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<td>☐</td>
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<td><strong>4.5.2.2</strong> SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. No wood diaphragms.</td>
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<td><strong>4.5.2.3</strong> UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy. No wood diaphragms.</td>
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<td>☐</td>
<td><strong>4.5.3.1</strong> NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only. Statement applies to Immediate Occupancy Performance Level only.</td>
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<tr>
<td>☐</td>
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<td>☐</td>
<td><strong>4.5.7.1</strong> OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing. Roof system consists of corrugated cement asbestos roofing over cement asbestos panel insulation over steel framing.</td>
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**CONNECTIONS**

| ☐ | ☐ | ☐ | **4.6.3.10** UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and plies 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. Statement applies to Immediate Occupancy Performance Level only. |

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*– Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING SYSTEM

☐ ☐ ☐ 4.3.1.1 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.

☒ ☐ ☐ 4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.

☐ ☐ ☒ 4.3.1.3 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.

☒ ☐ ☒ 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

☐ ☐ ☒ 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

☒ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☒ ☐ ☒ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

☐ ☐ ☒ 4.3.3.1 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.

☐ ☐ ☒ 4.3.3.6 PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections.

LATERAL-FORCE-RESISTING SYSTEM

☒ ☐ ☒ 4.4.2.1.1 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.
ASCE 31* BASIC CHECKLIST PC1: PRECAST/TILT-UP CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

C  NC  N/A  Comments

LATERAL-FORCE-RESISTING SYSTEM

☒ ☑ ☑ 4.4.2.3.1 SHEAR STRESS CHECK: The shear stress in the precast panels, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f'c}$ for Life Safety and Immediate Occupancy.

☒ ☑ ☑ $\frac{V}{b} = 13$ psi (for 12" cast-in-place concrete walls and 6" precast panels combined) << 100 psi allowed.

☒ ☑ ☑ 4.4.2.3.2 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" for Life Safety and Immediate Occupancy.

Max spacing is 18".
6" wall: #4@15" e.w. → 0.0022
OK vertical, but technically NO GOOD for horizontal. However, because the walls are lowly stressed (D/C = 0.10) and the reinforcing ratio is only 12% less than required, do not consider this a deficiency.

CONNECTIONS

☒ ☑ ☑ 4.6.1.1 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.

See attached calculations for 1974 Additio

☒ ☑ ☑ 4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.

No wood ledgers

☒ ☑ ☑ 4.6.2.1 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 diaphragms for Immediate Occupancy.

Typically $\frac{1}{2}$" x 4" studs in precast panels @ 1"-6" o.c. @ diaphragm level.

☒ ☑ ☑ 4.6.3.7 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.

Per A/S1 on 1974 drawings- wall is welded to thickened slab edge and slab is doweled to grade beam.

☒ ☑ ☑ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

*– Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
**LATERAL-FORCE-RESISTING SYSTEM**

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<td>4.4.2.2.3</td>
<td>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.</td>
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<tr>
<td>4.4.2.3.3</td>
<td>WALL OPENINGS: The total width of openings along any perimeter wall line shall constitute less than 75% of the length of any perimeter wall for Life Safety and 50% for Immediate Occupancy with the wall piers having aspect ratios of less than 2 to 1 for Life Safety and Immediate Occupancy.</td>
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<tr>
<td>4.4.2.3.4</td>
<td>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.</td>
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<tr>
<td>4.4.2.3.5</td>
<td>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.</td>
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<td>4.4.2.3.6</td>
<td>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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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**DIAPHRAGMS**

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<td>4.5.1.2</td>
<td>CROSS TIES: There shall be continuous cross ties between diaphragm chords.</td>
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<td>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.</td>
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<td>4.5.1.8</td>
<td>DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.5.2.1</td>
<td>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.</td>
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Precast panels are only along the south and west faces. Openings are minimal.

Only applicable corner is the southwest corner, which has no openings.

Statement applies to Immediate Occupancy Performance Level only.

Statement applies to Immediate Occupancy Performance Level only.

There are continuous beams in the E-W direction with spans of 8'-18', but there are none in N-S to break up the 31' span in the 1974 addition. This is not sufficient to tie the diaphragm together. Further analysis is required to determine if this issue is a life-safety deficiency; it is a low priority potential deficiency.

Statement applies to Immediate Occupancy Performance Level only.

Statement applies to Immediate Occupancy Performance Level only.

Metal deck diaphragm in the 1974 portion of the building.
ASCE 31* SUPPLEMENTAL CHECKLIST PC1: PRECAST/TILT-UP CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

DIAPHRAGMS

☐ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Metal deck diaphragm in the 1974 portion of the building.

☐ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for immediate Occupancy. Metal deck diaphragm in the 1974 portion of the building.

☐ ☐ ☒ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing. Metal deck diaphragm in the 1974 portion of the building.

CONNECTIONS

☒ ☐ ☐ 4.6.1.3 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. 8'-0" panels, with studs typically @ 1'-6" o.c. Thus, at least two studs per panel.

☐ ☐ ☒ 4.6.3.10 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. No piles.

☒ ☐ ☒ 4.6.4.2 GIRDERS: Girders supported by walls or pilasters shall have at least two ties securing the anchor bolts for Life Safety and Immediate Occupancy.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
1958 Building Segment - Sections
1956 and 1958 Building Segments

NOTE:

FLOOR & FOUNDATION PLAN

1974 Addition
BUILDING PLAN

NOTE:
Verify dimensions marked * with air conditioning unit vendor's drawing.

12" CONC. WALL (EXIST)

W8 x 13 W8 x 13 W8 x 13 W8 x 13 W8 x 13 W8 x 13 W8 x 13

W8 x 13 W8 x 13 W8 x 13

W4 x 19 W4 x 19 W4 x 19

C12 x 10.7 C12 x 10.7 C12 x 10.7

1/4" BOLTS ON WALL E

1/4" BOLTS ON WALL E

1/4" BOLTS ON WALL E

5 SPA @ 47" 12" 24" 24" 24" 24" 24" 24" 24" 24" 10'-0"

SP1 @ 8'-10" 8'-10" 8'-10" 8'-10" 8'-10" 8'-10" 8'-10" 8'-10" 8'-10" 8'-10"

CA TYP.

1974 Addition
BUILDING DATA
Year Built: 1956
Area (sf): 2800
No. Stories: 1

CONSTRUCTION DATA
Gravity Load Structural System: Steel channel purlins spanning to steel WF roof beams, spanning to concrete bearing walls and steel columns, with strip and spread footings.
Exterior Transverse Walls: Reinforced concrete
Exterior Longitudinal Walls: Reinforced concrete
Roof Framing: Steel beams: WF and channels
Intermediate Floor Framing: N/A
Ground Floor: 4” S.O.G. with 4 x 4 - 10/10 wire mesh
Columns: Steel WF
Foundation: Strip footings under walls, spread footings under columns

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>System Classification</th>
<th>Longitudinal</th>
<th>Transverse</th>
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<tbody>
<tr>
<td>Vertical Elements</td>
<td>C2A: Concrete Shear Wall Building with Flexible Diaphragm</td>
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<tr>
<td>Diaphragms</td>
<td>Reinforced concrete shear walls</td>
<td>Reinforced concrete shear walls</td>
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<td></td>
<td>Corrugated asbestos cement roofing over steel framing</td>
<td>Corrugated asbestos cement roofing over steel framing</td>
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SEISMIC EVALUATION PERFORMED? Yes
EVALUATION: Rapid Evaluation
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02
VULNERABILITY RATING: 6
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

REDUNDANCY
There is only one shear wall in the longitudinal direction.

WALL ANCHORAGE/TRANSFER TO SHEAR WALLS/ OTHER DIAPHRAGMS/ OPENINGS AT SHEAR WALLS
Along the longitudinal wall, the beams are embedded in the wall and attached with anchor bolts. This connection is expected to be sufficient. However, there is only corrugated asbestos cement roofing over steel framing; this may not act as a diaphragm. In addition, along the transverse walls, the connection of diaphragm to transverse walls for out-of-plane forces is not shown on drawings and could not be confirmed at site visit.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
REDUNDANCY
Further evaluation is required to determine if the columns that form the other longitudinal frames can resist the lateral forces at the diaphragm level on the northwest side.

WALL ANCHORAGE/TRANSFER TO SHEAR WALLS/ OTHER DIAPHRAGMS/ OPENINGS AT SHEAR WALLS
Replace existing roof with rod bracing or bare metal deck.
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<td>☒</td>
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<td>4.3.1.1 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.</td>
<td>The load path exists but may not have sufficient strength. Refer to other deficient statements for explanation.</td>
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<td>4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
<td>No immediately adjacent buildings.</td>
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<td>4.3.1.3 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.</td>
<td>No interior mezzanines.</td>
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<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.</td>
<td>One story building.</td>
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<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
<td>One story building.</td>
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<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
<td>One story building.</td>
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<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
<td>One story building.</td>
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<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
<td>One story building.</td>
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<td>4.3.3.1 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.</td>
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<td>4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
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<td>4.3.3.5 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.</td>
<td>No post-tensioning anchors.</td>
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ASCE 31* BASIC CHECKLIST C2A: CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

BUILDING SYSTEM

☐ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.1.1 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.

☐ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2\(\sqrt{f_c}\) for Life Safety and Immediate Occupancy.

☐ ☐ ☐ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

CONNECTIONS

☐ ☐ ☐ 4.6.1.1 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.

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

☐ ☐ ☐ 4.6.3.5 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.

There is only one shear wall in the longitudinal direction. Further evaluation is required to determine if the columns that form the other longitudinal frames can resist the lateral forces at the diaphragm level on the northwest side.

\(\psi_{LW} = 21 \text{ psi} \ll 100 \text{ psi}\)

Max spacing is 18".

Typical wall is 12", with #4@12" e.w.e.f. -> 0.0027. OK

Along the longitudinal wall, the beams are embedded in the wall and attached with anchor bolts. This connection is expected to be sufficient.

Along the end walls, the connection of diaphragm to transverse end walls for out-of-plane forces is not shown and could not be confirmed at the site visit. (The asbestos cannot be assumed to be a sufficient diaphragm, either.)

The asbestos cement roof cannot be assumed to be sufficient as a diaphragm. Even if it were, we are unable to verify connection of corrugated asbestos cement roofing to concrete walls.

Walls are doweled to strip footings.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# LATERAL-FORCE-RESISTING SYSTEM

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<td>4.4.2.2.3 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 1/3&quot; 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.</td>
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<td>4.4.2.2.4 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.</td>
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<td>4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.4.2.2.7 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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
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<td>4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
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<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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Roof does not have a split level or expansion joints.

Steel WF bends (welded at roof peak) are continuous across the width of the building. Channels span between WFs. There is only corrugated asbestos cement roofing over steel framing; this cannot be assumed to be sufficient as a diaphragm.

Statement applies to Immediate Occupancy Performance Level only.

No straight sheathing.
### DIAPHRAGMS

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<td>4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.</td>
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<td>4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>□</td>
<td>☒</td>
<td>□</td>
<td>4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
</tr>
</tbody>
</table>

### CONNECTIONS

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>☒</td>
<td>4.6.3.10 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.</td>
</tr>
</tbody>
</table>

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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING DATA
Year Built: 1960  Year(s) Remodeled: 1999  UBC Zone: 4 – Type B Near Field
Area (sf): 2,900  Length (ft): 85  Width (ft): 34
No. Stories: 1  Story Height: 13'  Total Height: 13'

CONSTRUCTION DATA
Gravity Load Structural System: Bare metal deck over 2" cement asbestos panel supported by L2 1/2 x 2 x 3/16 angles and 8C11.5. The steel members span to exterior and interior concrete shear walls.

Exterior Transverse Walls: 8" to 12" thick reinforced concrete shear walls
Exterior Longitudinal Walls: 8" to 12" thick reinforced concrete shear walls
KLIP-Rib 24 gage metal roof deck over 2" cement asbestos panel supported by L2 1/2 x 2 x 3/16 angles and 8C11.5. The metal deck was added in 1999 (ref: Drawings by Dick Ling, 1999). Per LLNL personnel, John Scott, the retrofit construction has not been completed.

Intermediate Floor Framing: None
Ground Floor: 6" concrete slab on grade w/ #3 @ 18" o.c. E.W.

Columns: None
Foundation: Concrete strip footing

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>System Classification</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 9 (Concrete Shear Wall Building w/ Flexible Diaphragm)</td>
<td>Type 9 (Concrete Shear Wall Building w/ Flexible Diaphragm)</td>
<td></td>
</tr>
<tr>
<td>L2 1/2 x 2 x 3/16 angles and 8C11.5, concrete shear walls</td>
<td>L2 1/2 x 2 x 3/16 angles and 8C11.5, concrete shear walls</td>
<td></td>
</tr>
</tbody>
</table>

Diaphragms: Bare metal deck

Bare metal deck


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5

(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

OTHER DIAPHRAGMS
Asbestos cement roof diaphragm.

WALL ANCHORAGE
D/C = 1.31.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add out of plane wall anchorage.
Add diagonal rod bracing or metal deck at the diaphragm.
# BUILDING SYSTEM

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>4.3.1.1 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.</th>
<th>Load is transferred from the asbestos cement deck to the exterior and interior concrete shear walls. The concrete shear walls are dowelled into the foundation system.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
<td>The lower level consists of a concrete flat slab dowelled into the main building's concrete shear walls on all four sides.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.1.3 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.</td>
<td>One story building.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
<td>One story building.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
<td>One story building.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
<td>The concrete shear walls are dowelled into the foundation system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
<td>One story building.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
<td>Site visit made on 8/11/03. No signs of deterioration were observed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.3.1 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.</td>
<td>Site visit made on 8/11/03. No signs of deterioration were observed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.3.5 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.</td>
<td></td>
</tr>
</tbody>
</table>
**BUILDING SYSTEM**

- **4.3.3.9** CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

  Site visit made on 8/11/03. There are no cracks >1/8".

**LATERAL-FORCE-RESISTING SYSTEM**

- **4.4.2.1.1** 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.

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

- **4.4.2.2.2** 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" for Life Safety and Immediate Occupancy.

There are at least 2 lines of shear walls in each direction of loading.

Maximum average shear stress is 14 psi < 100 psi. Note: \( 2 \sqrt{f'c} = 122 \) psi for \( f'c = 3,750 \) psi.

Typ. reinforcement in reinforced concrete walls:

12" wall: Reinforcing = 2@4@12" o.c.:
    reinforcing ratio = 0.0028 > 0.0025
8" wall:
    Vertical Reinforcing = 2@4@24" o.c.:
    reinforcing ratio = 0.0021 > 0.0015
    Horizontal Reinforcing = 2@4@18" o.c.:
    reinforcing ratio = 0.0028 > 0.0025.

Spacing of rebar at 24" o.c. > 18". However, the stresses are very low. The 24" spacing of the rebar is not a concern.

**CONNECTIONS**

- **4.6.1.1** 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.

Out of plane anchorage: (2) 5/8" diameter x 8" M.B. @ 8" o.c. at the NS walls. Channels run through government anchors at the EW walls.

D/C = 1.31 for NS walls.

- **4.6.2.1** 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 diaphragms for Immediate Occupancy.

The metal deck is screwed to Z-clips, which are screwed to the steel framing. The steel framing is bolted to the concrete shear walls.
**ASCE 31* BASIC CHECKLIST C2A: CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS**

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>✗</td>
<td>☐</td>
<td>☐</td>
<td>4.6.3.5 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.</td>
</tr>
</tbody>
</table>

*Vertical rebar in the shear walls is doweled into the foundation.*

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.2.3 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.

☐ ☐ ☒ 4.4.2.2.4 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.

☐ ☐ ☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☐ ☐ ☒ 4.5.1.7 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.

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.5.2.1 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.
ASCE 31* SUPPLEMENTAL CHECKLIST C2A: CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

DIAPHRAGMS

☐ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☐ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☐ ☐ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☒ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

Life Safety Performance Level.

Retrofit drawings show KLIP-Rib 24 gage metal roof deck over 2" cement asbestos panels. The metal deck was added in 1999 (ref: Drawings by Dick Ling, 1999). However, per LLNL personnel, John Scott, the retrofit construction has not been completed. On the 8/11/03 site visit, part of the exterior eave at the canopy has been blown off due to high winds.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

* — Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 809

Building 809 is a one-story reinforced concrete bearing wall building. The structure consists of a reinforced concrete roof deck in one area, and 2" insulated cement asbestos roof deck over steel roof framing in the other area, and reinforced concrete walls support both roofs. Deficiencies noted for Building 809 include potential falling hazard from concrete shielding blocks (which present a falling hazard). For the building to meet life-safety requirements, we recommend that the blocks be removed or braced.
Building Name: Building 809

Building Address: Lawrence Livermore National Laboratory

Job Number: A20047.08  Job Name: LLNL Prioritization

Date: July 24, 2003

BUILDING DATA

Year Built: 1958  Year(s) Remodeled: 1997  UBC Zone: 4 – Type B Near Field

Area (sf): 2600  Length (ft): 98'-0"

No. Stories: 1  Story Height: 9'-3" to 16'-10"

Total Height: 17'-1"

CONSTRUCTION DATA

Gravity Load Structural System: 2" insulated cement asbestos roof deck over steel roof framing over high roof, 8" reinforced concrete slab over low roof; reinforced concrete bearing walls

Exterior Transverse Walls: Reinforced concrete
Exterior Longitudinal Walls: Reinforced concrete
Roof Framing: Steel beams in high roof, concrete slab in low roof
Intermediate Floor Framing: N/A
Ground Floor: 5" slab, 4 x 4 - 6/6 W.W.F.
Columns: 2-L’s 5x5x3/8 with 3/16” fillet welds

Foundation: Spread footings under columns; concrete retaining wall with strip footing at east and west sides; 12” slab with #5@12 @ center of bldg (at earth filled room) with 5” slab-on-grade elsewhere; strip footings for keyed shielding block walls at entryways; most walls bear directly on soil.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal
System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Vertical Elements: Reinforced concrete shear walls
Diaphragms: 2" insulated cement asbestos roof deck over steel roof framing; 8" concrete slab

Transverse
System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm

Vertical Elements: Reinforced concrete shear walls
Diaphragms: 2" insulated cement asbestos roof deck over steel roof framing; 8" concrete slab

SEISMIC EVALUATION PERFORMED?: Yes  EVALUATION: Rapid Evaluation  YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5

(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:

THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

NON STRUCTURAL ISSUE- FALLING HAZARD

Portable 3' x 3' x 3' keyed concrete shielding blocks at the entrance present a potential life safety falling hazard.

TRANSFER TO SHEAR WALLS/ OPENINGS AT SHEAR WALLS

The cement asbestos panels at the high roof cannot be assumed to act as a diaphragm. However, the steel beams at high roof are closely spaced and well connected to the concrete walls with bolts that are embedded in the concrete and extend through the bottom flange of the beam. In addition, rod bracing was added to half of the building.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

NON STRUCTURAL ISSUE- FALLING HAZARD

Brace or remove these blocks.
## ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

### BUILDING SYSTEM

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒ ☐ ☐</td>
<td>4.3.1.1 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.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>4.3.1.3 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. No interior mezzanine levels.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. Building is only one story.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting-system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. Building is only one story.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. Building is only one story.</td>
</tr>
<tr>
<td>☒ ☐ ☐</td>
<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. Walls are continuous to the foundation where separate foundation elements exist.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. Building is only one story.</td>
</tr>
<tr>
<td>☒ ☐ ☐</td>
<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy. Verify at site visit.</td>
</tr>
<tr>
<td>☒ ☐ ☐</td>
<td>4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
</tr>
<tr>
<td>☒ ☐ ☐</td>
<td>4.3.3.5 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. No post-tensioning anchors.</td>
</tr>
<tr>
<td>☒ ☐ ☐</td>
<td>4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
</tr>
</tbody>
</table>
LATERAL-FORCE-RESISTING SYSTEM

☐ ☑ ☐ 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

☒ ☐ ☑ 4.4.2.1.1 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.

☒ ☐ ☑ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or \( 2\sqrt{f_c} \) for Life Safety and Immediate Occupancy.

☒ ☐ ☑ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

CONNECTIONS

☐ ☑ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

The gravity-load-carrying frame is incomplete because there are no columns cast into the wall and no columns adjacent to the wall, and the beams frame directly into the wall. However, because the beams are bolted to wall (2 bolts per connection), and sit in a grouted pocket with a large bearing area (7" deep), it is unlikely that seismic forces would cause the wall and beam to pull away from each other and cause partial collapse. The support of framing by the walls alone should be adequate for combined vertical and seismic forces.

Three lines of walls in each direction.

\[ V_{\text{max}} = 15 \text{ psi max} \]
\[ < 100 \text{ psi} \]
\[ < (2\sqrt{f_c} = 2\sqrt{3000} = 110 \text{ psi}) \]

Max spacing is 18".
24" wall: #5@10" e.w.e.f. → 0.0026 OK
14" wall: #5@18" vert e.f. → 0.0024 OK
14" wall: #6@12" horiz e.f. → 0.0053 OK
12" wall: #4@12" e.w.e.f. → 0.0027 OK
12" wall: #4@12" vert 1 side, #5@18" vert 1 side, → 0.0028 OK

The concrete diaphragm at the low roof is attached for shear transfer with continuous reinforcement.

The cement asbestos panels at the high roof cannot be assumed to act as a diaphragm. However, the steel beams at high roof are closely spaced and well connected to the concrete walls with bolts that are embedded in the concrete and extend through the bottom flange of the beam. Also rod bracing has been added to half of the building at the roof. Rod bracing should be added to the other half 76f the building.
ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

CONNECTIONS

☑ ☐ ☐ 4.6.3.5 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.

Wall dowels are continuous into footing in side retaining walls and in walls at center of building (at earth filled room). Most walls (24", 14") bear directly on soil and do not have separate footings to which to dowel, but these walls are unlikely to slide or tip over.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

☐ ☐ ☐ 4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

☐ ☐ ☐ 4.4.2.2.3 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.

☐ ☐ ☐ 4.4.2.2.4 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.

☐ ☐ ☐ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☐ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☐ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☐ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. There are no expansion joints. The high cement asbestos roof deck is 7 feet higher than the low concrete roof. However, these two roofs can be treated as separate levels rather than a split-level diaphragm.
ASCE 31* SUPPLEMENTAL CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

DIAPHRAGMS

☐ ☒ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

At the high roof, there is only insulated cement asbestos roof deck over steel framing; this deck cannot be assumed to act as a diaphragm, and its connection to the walls is not shown.

There are no apparent large diaphragm openings directly adjacent to the shear walls in the concrete slab.

Statement applies to Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.5.1.7 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.

Statement applies to Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

There are no pile caps.

* — Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
BUILDING PLANS AND SECTIONS

SECTION A

SCALE: 1/4" = 1'-0"
Building 810A

Building 810A is a one-story reinforced concrete bearing wall building. The structure consists of a reinforced concrete roof deck in one area, and 2” insulated cement asbestos panels over steel roof framing in the other area, and reinforced concrete walls support both roofs. Deficiencies noted for Building 810A are lack of a roof diaphragm and lack of a shear wall (open front) at the south face of the building. For the building to meet life-safety requirements, we recommend that rod bracing be added to the roof level, and a shear wall be added at the south entrance. Alternatively a detailed evaluation may show the existing condition meets life-safety.
BUILDING DATA
Year Built: 1958
Area (sf): 3500
No. Stories: 1

Building Name: Building 810A
Building Address: Lawrence Livermore National Laboratory
Job Number: A20047.08
Job Name: LLNL Prioritization
Date: July 25, 2003
Page: 1 of 2

BY: LKF
Checked:

PRIORITIZATION BUILDING DATA SHEET

CONSTRUCTION DATA
Gravity Load Structural System:
Exterior Transverse Walls: Reinforced concrete
Exterior Longitudinal Walls: Reinforced concrete
Roof Framing: Steel beams in high roof, concrete slab in low roof
Intermediate Floor Framing: N/A
Ground Floor: Typically 5" slab-on-grade, 4 x 4 - 6/6 W.W.F.
Columns: 6WF15 monorail columns to north of building
Foundation: Spread footings under monorail columns; strip footings under most walls; several walls bear directly on soil; small retaining walls at east side of building at ramp

Total Height: 18'-9"

2" insulated cement asbestos panels over steel roof framing over high roof, 8" reinforced concrete slab over low roof; reinforced concrete bearing walls
Length (ft): 94'
Story Height: 9'-3" to 18'-9"

Openings?: Doors and windows

LATERAL-FORCE-RESISTING SYSTEM

System Classification:
Vertical Elements: Reinforced concrete shear walls
Diaphragms: 2" insulated cement asbestos panels over steel roof framing; 8" concrete slab

Longitudinal
C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm

Transverse
C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Reinforced concrete shear walls
2" insulated cement asbestos panels over steel roof framing; 8" concrete slab


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 6
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

DEFLECTION COMPATIBILITY
The concrete beam at the south exits is not properly detailed (no 135 degree hooks; #3 stirrups at 18” o.c.).

OPENINGS AT SHEAR WALLS/ TRANSFER TO SHEAR WALLS
The cement asbestos panels at the high roof cannot be assumed to act as a diaphragm. However, the steel beams at high roof are closely spaced and well connected to the concrete walls with bolts that are embedded in the concrete and extend through the bottom flange of the beam.

TORSION
In the South portion of the building, the only longitudinal wall is along the north side. There are no lateral force resisting elements along the south side of the south portion. Torsion might cause higher stresses in transverse walls, but walls are very lowly stressed. This is a low priority deficiency.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
DEFLECTION COMPATIBILITY/ TORSION
A new shear wall at this location would mitigate this deficiency; alternatively, further evaluation may show that this beam is not a falling hazard.

OPENINGS AT SHEAR WALLS/ TRANSFER TO SHEAR WALLS
Add rod bracing to the roof level.
### Building System

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<td>☒</td>
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<td>☐</td>
<td>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.</td>
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<td>☐</td>
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<td>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.</td>
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<td>WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
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<td>SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
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<td>GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
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<td>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<td>MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
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<td>TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
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<td>☐</td>
<td>DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
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<td>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.</td>
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<td>☐</td>
<td>CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
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</table>
LATERAL-FORCE-RESISTING SYSTEM

- 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

- 4.4.2.1.1 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.

- 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or \(2\sqrt{f_c}\) for Life Safety and Immediate Occupancy.

- 4.4.2.2.2 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” for Life Safety and Immediate Occupancy.

The gravity-load-carrying frame is incomplete because there are no columns cast into the wall and no columns adjacent to the wall, and the beams frame directly into the wall. However, because the beams are bolted to wall (2 bolts per connection), and sit in a grouted pocket with a large bearing area (6” deep), it is unlikely that seismic forces would cause the wall and beam to pull away from each other and cause partial collapse. The support of framing by the walls alone should be adequate for combined vertical and seismic forces.

CONNECTIONS

- 4.6.2.1 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 diaphragms for Immediate Occupancy.

The concrete diaphragm at the low roof is attached for shear transfer with continuous reinforcement. The cement asbestos panels at the high roof cannot be assumed to act as a diaphragm, and we cannot determine the connection from the panels to the beams to transfer the diaphragm forces to the walls. However, the steel beams at high roof are closely spaced and well connected to the concrete walls with bolts that are embedded in the concrete and extend through the bottom flange of the beam. Because the steel beams form a complete load path to transfer forces at the roof level, this is a low-priority deficiency.
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<td>4.6.3.5 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. Wall dowels are continuous into footing in side retaining walls and in walls at center of building (at earth filled room). Most walls (24&quot;, 14&quot;) bear directly on soil and do not have separate footings to which to dowel, but these walls are unlikely to slide or tip over.</td>
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*-- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
LATERAL-FORCE-RESISTING SYSTEM

4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 4.4.1.4.5, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy.

4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

4.4.2.2.3 COUPLING BEAMS: The stirrups in coupling beams over means of egress shall be spaced at or less than 2d 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.

4.4.2.2.4 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.

4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.

4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

The concrete beam at the east exits is not properly detailed (no 135 degree hooks; #3 stirrups at 18" o.c.).

No flat slabs/plates that are not a part of the lateral-force-resisting system.

At the north face, the section of wall (~7 ft tall) over the exits should be sufficient to transfer shear between the wall sections. Wall segments should be able to act independently, and not induce large deformations and spalling of concrete in the connecting segments of wall at openings.

Statement applies to Immediate Occupancy Performance Level only.

Statement applies to Immediate Occupancy Performance Level only.

Statement applies to Immediate Occupancy Performance Level only.

There are no expansion joints. The high cement asbestos roof deck is 8 feet higher than the low concrete roof. However, these two roofs can be treated as separate levels rather than a split-level diaphragm.

At the high roof, there are only insulated cement asbestos panels over steel framing; these panels cannot be assumed to act as a diaphragm, and their connection to the walls is not shown.
DIAPHRAGMS

☐ ☐ ☒ 4.5.1.7 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.

Statement applies to Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

Statement applies to Immediate Occupancy Performance Level only.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

There are no pile caps.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 810C

Building 810C is a tall one-story reinforced masonry bearing wall building. The structure consists of prestressed precast hollow core concrete roof planks with concrete topping spanning to reinforced concrete block walls, with concrete grade beams and belled caissons. The primary structural deficiency noted for Building 810C is that the precast roof panels do not have any connection to the walls or to the topping slab. The only method of support is in bearing at the top of the walls. For the building to meet life-safety standards, we recommend replacing the precast panels and topping with a new diaphragm such as a bare metal deck or rod bracing, or providing positive connection between the precast planes and the walls.
BUILDING DATA

Year Built: 1982
Area (sq ft): 900
No. Stories: 1

CONSTRUCTION DATA

Gravity Load Structural System: Prestressed precast hollow core concrete roof planks with concrete topping spanning to reinforced concrete block walls, with concrete grade beams under walls and belled caissons under wall corners.

Exterior Transverse Walls: 8" thick reinforced concrete block walls
Exterior Longitudinal Walls: 8" thick reinforced concrete block walls

Openings?: Yes- doors
Yes- door and ducts

6" thick x 40" wide precast hollow core concrete roof planks with 2 1/4" thick concrete topping and 8" x 8" W1.4xW1.4 mesh

Intermediate Floor Framing: N/A
Ground Floor: Reinforced concrete slab on grade

Foundation: Strip footings under walls, caissons at wall corners.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal
System Classification: RM2: Reinforced Masonry Bearing Wall
Building with Rigid or Stiff Diaphragm
8" thick reinforced concrete block walls
6" thick x 40" wide precast hollow core concrete roof planks with 2 1/4" thick concrete topping and 8" x 8" W1.4xW1.4 mesh

Transverse
System Classification: RM2: Reinforced Masonry Bearing Wall
Building with Rigid or Stiff Diaphragm
8" thick reinforced concrete block walls
6" thick x 40" wide precast hollow core concrete roof planks with 2 1/4" thick concrete topping and 8" x 8" W1.4xW1.4 mesh

SEISMIC EVALUATION PERFORMED?: Yes
EVALUATION: Rapid Evaluation
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 6

(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

LOAD PATH/ WALL ANCHORAGE/ TRANSFER TO SHEAR WALLS

The precast panels do not appear to have any connection to the walls or to the topping slab. The only method of support is in bearing at the top of the walls. There is no method for transferring seismic forces in shear or out-of-plane between the walls and roof. Separation of the roof and walls under seismic forces could result in collapse.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

LOAD PATH/ WALL ANCHORAGE/ TRANSFER TO SHEAR WALLS

Replace existing roof with new diaphragm, using rod bracing or bare metal deck.
ASCE 31*: BASIC CHECKLIST RM2: REINFORCED MASONRY BEARING WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

Building Name: Building 810C
Building Address: Lawrence Livermore National Laboratory
Job Number: A20047.08
Job Name: LLNL Prioritization
Date: August 6, 2003
Page: 1 of 3

By: LKF  Checked:

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**BUILDING SYSTEM**

- **4.3.1.1** 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.

- **4.3.1.3** 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.

- **4.3.2.1** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.

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

- **4.3.2.3** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

- **4.3.2.4** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

- **4.3.2.5** MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

- **4.3.2.6** TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

- **4.3.3.4** DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

- **4.3.3.7** MASONRY UNITS: There shall be no visible deterioration of masonry units.

- **4.3.3.8** 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.

The precast panels do not appear to have any connection to the walls or to the topping slab. The only method of support is in bearing at the top of the walls. There is no method for transferring seismic forces in shear or out-of-plane between the walls and roof. Separation of the roof and walls under seismic forces could result in collapse.
## BUILDING SYSTEM

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<td>4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
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## LATERAL-FORCE-RESISTING SYSTEM

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<td>☒</td>
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<td>4.4.2.1.1 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.</td>
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<td>☒</td>
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<td>4.4.2.4.1 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.</td>
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<td>☒</td>
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<td>4.4.2.4.2 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&quot; for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.</td>
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### Spacing is not more than 48" o.c.  
Vertical bars extent to top block in wall.  
Typical wall is 8", with #4@16" e.w. → 0.0015 each direction  
**OK**

## DIAPHRAGMS

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<td>4.5.5.1 TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab.</td>
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## CONNECTIONS

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| ☐ | ☒  | ☐  | 4.6.1.1 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.  
The precast panels do not appear to have any connection to the walls or to the topping slab. The only method of support is in bearing at the top of the walls. There is no method for transferring seismic forces out-of-plane between the walls and roof. Separation of the roof and walls under seismic forces could result in collapse. |
| ☒ | ☒  | ☐  | 4.6.2.1 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 diaphragms for Immediate Occupancy.  
The precast panels do not appear to have any connection to the walls or to the topping slab. The only method of support is in bearing at the top of the walls. There is no method for transferring seismic forces in shear or out-of-plane between the walls and roof. Separation of the roof and walls under seismic forces could result in collapse. |
## CONNECTIONS

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<td>☒ ☐ ☐ 4.6.2.3</td>
<td><strong>TOPPING SLAB TO WALLS OR FRAMES:</strong> 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. Topping slab is doweled to concrete block walls.</td>
</tr>
<tr>
<td>☒ ☐ ☐ 4.6.3.5</td>
<td><strong>FOUNDATION DOWELS:</strong> 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.</td>
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<tr>
<td>☐ ☐ ☒ 4.6.4.1</td>
<td><strong>GIRDER/COLUMN CONNECTION:</strong> There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. No girders/columns</td>
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* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
### LATERAL-FORCE-RESISTING SYSTEM

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- **4.4.2.6** REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

- **4.4.2.4** 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.

### DIAPHRAGMS

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</tbody>
</table>

- **4.5.1.4** OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

- **4.5.1.6** OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.

- **4.5.1.7** 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.

- **4.5.1.8** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

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* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 818A

Building 818A is a one-story reinforced concrete bearing wall building. The structure consists of 2" asbestos panels. The deck is supported by steel beams. The steel beams span to interior and exterior concrete shear walls. Potential structural deficiencies noted for Building 818A are 1) The asbestos roof cannot adequately serve as a diaphragm; 2) Out of plane wall anchorage was found to be inadequate; and 3) There are no cross ties. For the building to meet life-safety requirements, we recommend that the roof be replaced or strengthened with horizontal rod bracing or metal deck. In addition, we recommend that the out of plane wall anchorage is strengthened and cross ties are added.
BUILDING DATA

Year Built: 1964  
Year(s) Remodeled: None  
Area (sf): 1,240  
Length (ft): 62  
Width (ft): 20  
No. Stories: 1  
Story Height: 11'  
Total Height: 11'

CONSTRUCTION DATA

Gravity Load Structural System: 1 9/16" thick asbestos panels supported on 8I18.4 steel beams or L2x2x3/16 ledgers. The beams are supported by interior and exterior 8" to 12" thick concrete shear walls. The canopy consists of metal deck supported by 6B12 steel beams and 3 1/2" diameter standard pipes.

Exterior Transverse Walls: 8" to 12" thick reinforced concrete shear walls. Openings?: Door and window openings

Exterior Longitudinal Walls: 8" to 12" thick reinforced concrete shear walls. Openings?: Door and window openings

Roof Framing: 1 9/16" thick asbestos panels supported on 8I18.4 steel beams or L2x2x3/16 ledgers. The canopy consists of metal deck supported by 6B12 steel beams.

Intermediate Floor Framing: None

Ground Floor: 6" concrete slab on grade w/ #4 @ 16" o.c. E.W.

Columns: None

Foundation: Concrete strip footing

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Classification:</td>
<td>Type 9 (Concrete Shear Wall Building w/ Flexible Diaphragm)</td>
</tr>
<tr>
<td>Vertical Elements:</td>
<td>8I18.4 steel beams or L2x2x3/16 ledgers; The canopy consists of 6B12 steel beams. Steel pipe columns, concrete shear walls</td>
</tr>
<tr>
<td>Diaphragms: 1 9/16&quot; thick asbestos panels</td>
<td>8I18.4 steel beams or L2x2x3/16 ledgers; The canopy consists of 6B12 steel beams. Steel pipe columns, concrete shear walls</td>
</tr>
</tbody>
</table>


SEISMIC EVALUATION CRITERIA: Lite Safety/ ASCE 31-02

VULNERABILITY RATING: 5  
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

OTHER DIAPHRAGMS
The roof consists of 1 9/16" panels. Per our site visit, the panels are asbestos cement panels.

WALL ANCHORAGE
Out of plane anchorage is not adequate. D/C = 1.33.

CROSS TIES
There are no cross ties in the NS direction.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Replace asbestos panels or add rod bracing or metal deck.
Add out of plane anchorage and cross ties.
<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td><strong>LOAD PATH:</strong> 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. Load is transferred from the 19 1/16” asbestos cement panel to I beams. The beams deliver the load to the exterior and interior concrete shear walls. The concrete shear walls are doweled into the foundation system. At the canopy, the metal deck delivers load to I beams. The I beams are connected to channels which are anchored to the concrete shear walls.</td>
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<tr>
<td>☐</td>
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<td>☒</td>
<td><strong>ADJACENT BUILDINGS:</strong> The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☐</td>
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<td>☒</td>
<td><strong>MEZZANINES:</strong> 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.</td>
</tr>
<tr>
<td>☐</td>
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<td>☐</td>
<td><strong>WEAK STORY:</strong> The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
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<tr>
<td>☐</td>
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<td>☐</td>
<td><strong>SOFT STORY:</strong> The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
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<td>☐</td>
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<td><strong>GEOMETRY:</strong> There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
</tr>
<tr>
<td>☒</td>
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<td>☐</td>
<td><strong>VERTICAL DISCONTINUITIES:</strong> All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<tr>
<td>☒</td>
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<td><strong>MASS:</strong> There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
</tr>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td><strong>DETERIORATION OF WOOD:</strong> 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. Site visit made on 8/19/03. No signs of deterioration were observed.</td>
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<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td><strong>DETERIORATION OF CONCRETE:</strong> There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. Site visit made on 8/19/03. No signs of deterioration were observed.</td>
</tr>
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<td>☒</td>
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<td>☒</td>
<td><strong>POST-TENSIONING ANCHORS:</strong> There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Col anchors shall not have been used.</td>
</tr>
</tbody>
</table>
ASCE 31* BASIC CHECKLIST C2A: CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

BUILDING SYSTEM

☐ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

Site visit made on 8/19/03. There are no cracks >1/8".

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.1.1 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.

There are at least 2 lines of shear walls in each direction of loading.

☐ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt[ ]{f'c}$ for Life Safety and Immediate Occupancy.

Maximum average shear stress is 7 psi < 81 psi. Note: 2 $\sqrt[ ]{f'c}$ = 89 psi for $f'c = 2,000$ psi.

☐ ☐ ☐ 4.4.2.2.2 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 16" for Life Safety and Immediate Occupancy.

Typ. reinforcement in reinforced concrete walls:
12" wall: Reinforcing = #4@12" o.c.: reinforcing ratio = 0.0028 > 0.0025
8" wall:
Reinforcing = #4@8" o.c. E.W., reinforcing ratio = 0.0025 = 0.0025.
Spacing of rebar at 12" o.c. < 18".

CONNECTIONS

☐ ☐ ☐ 4.6.1.1 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.

Out of plane anchorage: (2) 1/2" diameter x 8" M.B. @ 4" o.c. at the EW walls.
3/8" diameter x 6" @ 3" o.c. + 1/2" diameter x 8" @ 6" o.c. at NS walls
D/C = 1.33.

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

The panels are nailed to 2x4 wood members, which are bolted to the concrete shear walls w/ 1/2" diameter x 8" bolts @ 6'-0" o.c.

☐ ☐ ☐ 4.6.3.5 FOUNDATION DOWELS: Wall reinforcement shall be dowelled 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.

Vertical rebar in the shear walls is doweled into the foundation.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# ASCE 31* SUPPLEMENTAL CHECKLIST C2A: CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

## LATERAL-FORCE-RESISTING SYSTEM

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<tr>
<td></td>
<td>4.4.2.2.3</td>
<td>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.</td>
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<td>4.4.2.2.4</td>
<td>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.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td></td>
<td>4.4.2.2.5</td>
<td>CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
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<td></td>
<td>4.4.2.2.6</td>
<td>REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
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<tr>
<td></td>
<td>4.4.2.2.7</td>
<td>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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
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## DIAPHRAGMS

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<td>4.5.1.1</td>
<td>DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
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<td>4.5.1.2</td>
<td>CROSS TIES: There shall be continuous cross ties between diaphragm chords.</td>
<td>I-beams serve as cross ties in the EW direction. There are no cross ties in the NS direction.</td>
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<td>4.5.1.4</td>
<td>OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td></td>
<td>4.5.1.7</td>
<td>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.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
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<td>4.5.1.8</td>
<td>DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
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<td>4.5.2.1</td>
<td>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.</td>
<td></td>
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</table>
DIAPHRAGMS

☐ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☐ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☐ ☐ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

The roof consists of 1 9/16" panels. There are no information on which type of material are the panels. Site visit made on 8/19/03 indicate these panels are asbestos cement panels.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 827A

Building 827A is a reinforced concrete bearing wall building, with one level above grade and a full basement below grade. The structure consists of reinforced concrete slabs and beams spanning to concrete bearing walls.

The primary structural deficiencies noted for Building 827A are as follows: 1) Two concrete walls on the upper level are not continuous to the bottom level; there are only beams below, with no supporting walls or columns; and 2) The columns at the center of the building do not have ductile detailing to withstand large deformations.

For the building to meet life-safety standards, we recommend that a column be added at the first level to resist overturning of the discontinuous shear walls. We recommend a more detailed analysis of the concrete columns to examine whether they can withstand seismic deformations.
## BUILDING DATA

- **Year Built:** 1965 (per LLNL records; not evident on dwgs)
- **Area (sf):** 2100 + basement
- **No. Stories:** 2
- **Remodeled:** None known
- **Length (ft):** 52’
- **Story Height:** ~ 12’
- **Width (ft):** 41’
- **Total Height:** 23'-6", but only one story above grade (floor level is at grade at rear of bldg)
- **UBC Zone:** 4 – Type B Near Field

## CONSTRUCTION DATA

- **Gravity Load Structural System:** Reinforced concrete slabs over concrete beams spanning to concrete bearing walls with strip footings and to concrete columns with spread footings.
- **Exterior Transverse Walls:** Reinforced concrete, typ 8” thick
- **Exterior Longitudinal Walls:** Reinforced concrete, typ 8” thick
- **Roof Framing:** 4” concrete slab with #3@12 and #4@12 over reinforced concrete beams, typ. 20”x12”
- **Intermediate Floor Framing:** 4” concrete slab with #3@12 over reinforced concrete beams, typ. 20”x12”
- **Ground Floor:** 6” concrete slab-on-grade with #3@12 e.w.
- **Columns:** 12” sq. concrete columns
- **Openings?:** Yes
- **Foundations:** Strip footings

## LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>System Classification</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C2: Concrete Wall Building with Rigid or Stiff Diaphragm</td>
<td>C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm</td>
</tr>
<tr>
<td>Vertical Elements</td>
<td>Reinforced concrete shear walls</td>
<td>Reinforced concrete shear walls</td>
</tr>
<tr>
<td>Diaphragms</td>
<td>Reinforced concrete slab</td>
<td>Reinforced concrete slab</td>
</tr>
</tbody>
</table>

## SEISMIC EVALUATION PERFORMED?

- **Yes**

## SEISMIC EVALUATION CRITERIA:

- **EVALUATION:** Rapid Evaluation
- **YEAR:** 2003

## VULNERABILITY RATING:

- **6**

(1=low to 10=high)

## PRIORITIZATION CLASSIFICATION:

- **CLASS C**
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

VERTICAL DISCONTINUITIES
Some concrete walls on the second level do not align with any walls on the first level. This is a concern because overturning of the discontinuous walls may damage the supporting gravity beams. Structure is a concrete box in elastic seismic demands on the beams will be united since demands on perimeter concrete walls are low.

DEFLECTION COMPATIBILITY
Columns at center of building (supporting long girders) are not properly detailed, without 135-degree hooks and with #3 ties at 12". Further evaluation is required to determine whether columns can undergo the deformations associated with seismic drift. However, this is a low priority deficiency because the walls are lowly stressed and the roof diaphragm is relatively stiff, so neither the walls nor the diaphragm is expected to experience large deformations.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
VERTICAL DISCONTINUITIES
Add a column at the first level at the end of the discontinuous shear walls, to resist overturning of upper wall.

DEFLECTION COMPATIBILITY
Further evaluation would probably show that columns could undergo the deformations associated with seismic demands.
ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

BUILDING SYSTEM

☒ ☐ ☐ 4.3.1.1 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.

☐ ☐ ☐ 4.3.1.3 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.

☒ ☐ ☐ 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

☒ ☐ ☐ 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

☒ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☒ ☐ ☐ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

☒ ☐ ☐ 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

☒ ☐ ☐ 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

☐ ☐ ☐ 4.3.3.5 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.

☒ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

Comments

- No interior mezzanine levels.
- The two stories are similar.
- The two stories are similar.
- The two stories are similar.
- Some concrete walls on the second level do not align with any walls on the first level. This is a concern because overturning of the discontinuous walls may overwhelm the supporting beams below. Based on preliminary calculations (D/C beam=4), this is a high priority deficiency. The two stories are similar.
- No post-tensioning anchors.
### LATERAL-FORCE-RESISTING SYSTEM

- **4.4.1.6.1 COMPLETE FRAMES:** Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

- **4.4.2.1.1 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.

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

- **4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

- **5.4.2.2.2**

  \[ V'_{wa} = 32 \text{ psi max} < 100 \text{ psi} \]

  \( f'c \text{ unknown} \)

  Max spacing is 18".

  8" wall: #8@12" vert e.f. \(\rightarrow 0.0092 \text{ OK}\)

  8" wall: #4@18" horiz e.f. \(\rightarrow 0.0027 \text{ OK}\)

  8" wall: #4@9" e.w. \(\rightarrow 0.0027 \text{ OK}\)

### CONNECTIONS

- **4.6.2.1 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 diaphragms for Immediate Occupancy.

- **4.6.3.5 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.

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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
# ASCE 31* SUPPLEMENTAL CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

## LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Ind.</th>
<th>Details</th>
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<tbody>
<tr>
<td>☐ ☐ ☐</td>
<td>4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.</td>
<td>☐</td>
<td>Columns at center of building (supporting long girders) are not properly detailed, without 135-degree hooks and with #3 ties at 12&quot;. Further evaluation is required to determine whether columns can undergo the deformations associated with seismic drift. However, this is a low priority deficiency because the walls are lowly stressed and the roof diaphragm is relatively stiff, so neither the walls nor the diaphragm is expected to experience large deformation. No such flat slabs/plates.</td>
</tr>
<tr>
<td>☐ ☐ ☐</td>
<td>4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>☐ ☐ ☐</td>
<td>4.4.2.2.3 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.</td>
<td>☐</td>
<td>No coupling beams.</td>
</tr>
<tr>
<td>☐ ☐ ☐</td>
<td>4.4.2.2.4 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.</td>
<td>☐</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐ ☐ ☐</td>
<td>4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 6d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>☐</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐ ☐ ☐</td>
<td>4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>☐</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐ ☐ ☐</td>
<td>4.4.2.2.7 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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>

## DIAPHRAGMS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Ind.</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ ☐ ☐</td>
<td>4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
<td>☐</td>
<td>Continuous diaphragms.</td>
</tr>
<tr>
<td>☐ ☐ ☐</td>
<td>4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
<td>☐</td>
<td>No large openings immediately adjacent to shear walls.</td>
</tr>
</tbody>
</table>
## DIAPHRAGMS

☐  ☐  ☒ 4.5.1.7 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.

Statement applies to Immediate Occupancy Performance Level only.

☐  ☐  ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

Statement applies to Immediate Occupancy Performance Level only.

## CONNECTIONS

☐  ☐  ☒ 4.6.3.10 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.

There are no pile caps.

* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Buildings 827C, 827D, and 827E

Buildings 827C, 827D and 827E are one-story reinforced concrete bearing wall buildings. The structures consist of 12\" thick concrete flat slabs supported by concrete beams and shear walls. The primary structural deficiency noted for these buildings is that the mezzanine steel grating, which support mechanical equipment, is not well-connected to the steel support framing. Only clips are present, so the grating may slip off the beam supports and the equipment may become falling hazards. For the building to meet life-safety requirements, we recommend that the connections at the mezzanine gratings are strengthened.
Building Name: **Building 827C** (also valid for 827D and 827E; buildings are almost identical)  
Date: **July 31, 2003**

Building Address: **Lawrence Livermore National Laboratory**  
Page: **1** of **1**

Job Number: **A20047.08**  
Job Name: **LLNL Prioritization**  
By: **LKF**  
Checked:

## BUILDING DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year Built</td>
<td>1965 (per LLNL records; not evident on dwgs)</td>
</tr>
<tr>
<td>Remodeled</td>
<td>None known</td>
</tr>
<tr>
<td>UBC Zone</td>
<td>4 – Type B Near Field</td>
</tr>
<tr>
<td>Area (sf)</td>
<td>3200</td>
</tr>
<tr>
<td>Length (ft)</td>
<td>87’</td>
</tr>
<tr>
<td>Width (ft)</td>
<td>28’</td>
</tr>
<tr>
<td>No. Stories/Story Height</td>
<td>1 story with mezzanine, 22’-9”</td>
</tr>
<tr>
<td>Total Height</td>
<td>26’-3” including parapet</td>
</tr>
</tbody>
</table>

## CONSTRUCTION DATA

Gravity Load Structural System: Concrete slabs and beams spanning to concrete retaining walls and bearing walls with strip footings

- Exterior Transverse Walls: Reinforced concrete, typically 12” thick
- Exterior Longitudinal Walls: Reinforced concrete, typically 12” thick
- Roof Framing: 12” concrete slab with #4@12 e.w. top, and #6@6 e.w. bot.
- Intermediate Floor Framing: @ mezzanine: 8” concrete slab with #4@12 each way, or 1¼“ steel grating over steel WF beams
- Ground Floor: 6” concrete slab-on-grade with #4@18 e.w.
- Columns: 42” x 24” piers at perimeter
- Foundation: Strip footings/retaining walls

## LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>System Classification</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm</td>
<td>C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm</td>
</tr>
<tr>
<td>Vertical Elements</td>
<td>Reinforced concrete shear walls</td>
<td>Reinforced concrete shear walls</td>
</tr>
<tr>
<td>Diaphragms</td>
<td>Reinforced concrete slab</td>
<td>Reinforced concrete slab</td>
</tr>
</tbody>
</table>

**SEISMIC EVALUATION PERFORMED?** Yes  
**EVALUATION:** Rapid Evaluation  
**YEAR:** 2003

**SEISMIC EVALUATION CRITERIA:**  
**Life Safety/ ASCE 31-02**

**VULNERABILITY RATING:**  
4  
(1=low to 10=high)

**PRIORITIZATION CLASSIFICATION:** CLASS C

**POTENTIAL LIFE SAFETY DEFICIENCIES:**  
This building was evaluated for the 10% in 50 yr. earthquake.

**MEZZANINES / FALLING HAZARD**  
The small intermediate slab at the interior "mezzanine" level at the center of the building is connected to the main structural system; the reinforcement is continuous with the wall reinforcement. The supporting steel beams at the equipment area are well connected to the concrete walls, but the grating over the beams is not well connected to the beams. Only clips are present, so the grating may slip off the beam supports and the equipment supported on the mezzanine level may become falling hazards.

**PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:**  
**MEZZANINES / FALLING HAZARD**  
Further evaluation may show that the building deformations will be small enough such that the mezzanine grating will not move off the beam supports. Alternatively, strengthening of the connections of the grating to the structure would eliminate this deficiency.
### BUILDING SYSTEM

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>4.3.1.1</th>
<th>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.</th>
</tr>
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<tbody>
<tr>
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<td>4.3.1.3</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Comments**

The small intermediate slab at the interior "mezzanine" level at the center of the building is connected to the main structural system; the reinforcement is continuous with the wall reinforcement. The supporting steel beams at the equipment area are well connected to the concrete walls, but the grating over the beams is not well connected to the beams. Only clips are present, so the grating may slip off the beam supports and the equipment supported on the mezzanine level may become falling hazards.

One story building.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>4.3.2.1</th>
<th>WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.</th>
</tr>
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<tr>
<td></td>
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</table>

**Comments**

One story building.

<table>
<thead>
<tr>
<th></th>
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<th>4.3.2.2</th>
<th>SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</th>
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**Comments**

One story building.

<table>
<thead>
<tr>
<th></th>
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<th>4.3.2.3</th>
<th>GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</th>
</tr>
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</table>

**Comments**

One story building.

<table>
<thead>
<tr>
<th></th>
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<th>4.3.2.4</th>
<th>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</th>
</tr>
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<tbody>
<tr>
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</table>

**Comments**

One story building.

<table>
<thead>
<tr>
<th></th>
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<th>4.3.2.5</th>
<th>MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</th>
</tr>
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<tbody>
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</table>

**Comments**

No post-tensioning anchors.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th>4.3.2.6</th>
<th>TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</th>
</tr>
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<tbody>
<tr>
<td></td>
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</table>

**Comments**

No post-tensioning anchors.

<table>
<thead>
<tr>
<th></th>
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<th>4.3.3.4</th>
<th>DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

**Comments**

No post-tensioning anchors.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>4.3.3.5</th>
<th>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.</th>
</tr>
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<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

**Comments**

No post-tensioning anchors.
### BUILDING SYSTEM

- **4.3.3.9** CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

### LATERAL-FORCE-RESISTING SYSTEM

- **4.4.1.6.1** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.
  - System consists only of a thick slab spanning to thick concrete walls.

- **4.4.2.1.1** 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.
  - There are two primary shear walls in each direction.

- **4.4.2.2.1** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f'c}$ for Life Safety and Immediate Occupancy.
  - For transverse direction: $V_{f'c} = 52 \text{ psi max} < 100 \text{ psi (} f'c \text{ unknown)}$

- **4.4.2.2.2** REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall not be 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" for Life Safety and Immediate Occupancy.

### CONNECTIONS

- **4.6.2.1** 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 diaphragms for Immediate Occupancy.
  - The concrete diaphragm is attached for shear transfer with continuous reinforcement.

- **4.6.3.5** 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.
  - Walls are doweled into strip footings.

---

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
LATERAL-FORCE-RESISTING SYSTEM

☐☐☒ 4.4.1.6.2 DEFORMATION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

☐☐☒ 4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

☐☐☒ 4.4.2.2.3 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.

☐☐☒ 4.4.2.2.4 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.

☐☐☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.

☐☐☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐☐☒ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☐ ☐ ☒ 4.5.1.7 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.
DIAPHRAGMS

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

Statement applies to Immediate Occupancy Performance Level only.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

There are no pile caps.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
STEEL GRATING - "LEWING" K-BAR PRESS
LOCKED RECTANGULAR DESIGN TYPE AA
1 1/4" x 1/2" BEARING BARS & 1/3" x 4" ORGS
(OR EQUAL) - FIELD BOLTED.

MAKE THIS SECTION OF PANEL REMOVABLE IN ONE PIECE.

3 5/8" x 1 1/4"
20 GA ANGLE

PLAN OF MEZZANINE
BLDG. 827C & 827E ONLY

ALL DETAILED
BLDG. 3:
Building 833

Building 833 is a one-story reinforced concrete bearing wall building. The structure consists of a 12" thick concrete flat slab supported by concrete shear walls. There has been two additions at Building 833. The East Addition is similar to the main structure. The West Addition consists of an asbestos cement slab supported on interior WF beams and columns and exterior asbestos cement panels. The potential structural deficiencies noted for Building 833 are 1) The asbestos roof cannot adequately deliver seismic load to the lateral-force-resisting elements at the West Addition; and 2) Out of plane wall anchorage could not be identified on the West Addition. For the building to meet life-safety requirements, we recommend that the roof be replaced or strengthened with horizontal rod bracing or metal deck at the West Addition. In addition, we recommend that the out of plane wall anchorage at the West Addition be further investigated or strengthened.
Building Name: Building 833

Building Address: Lawrence Livermore National Laboratory

Job Number: A20047.08  Job Name: LLNL Prioritization

Date: August 21, 2003

Page: 1 of 1

By: JYF  Checked: JEH

BUILDING DATA

Year Built: 1959  Year(s) Remodeled: No Available Info

Area (sf): 2,050  Length (ft): 51

No. Stories: 1  Story Height: 11'

UBC Zone: 4 – Type B Near Field

Width (ft): 38

Total Height: 11'

CONSTRUCTION DATA

Gravity Load Structural System:
12" thick flat slab supported on interior and exterior 8" to 1'-0" thick reinforced concrete shear walls. At
the West Addition: Asbestos cement slab supported on interior WF beams and columns and exterior
asbestos cement panels.

Exterior Transverse Walls:
8" to 1'-0" thick reinforced concrete shear walls or
asbestos cement panels

Exterior Longitudinal Walls:
8" to 1'-0" thick reinforced concrete shear walls or
asbestos cement panels

Openings?: Door and window openings

Roof Framing: 12" thick flat slab, at the West Addition: asbestos cement slab

Intermediate Floor Framing: None

Ground Floor: 4" thick concrete slab on grade w/ 4x4x6/6 WWF

Columns: None

Foundation: Concrete strip footing

LATERAL-FORCE-RESISTING SYSTEM

System Classification:
Longitudinal
Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)

Vertical Elements:
Concrete flat slab, concrete shear walls
Asbestos cement slab, asbestos cement walls
12" thick concrete flat slab, Asbestos cement slab

Diaphragms:
Concrete flat slab, concrete shear walls
Asbestos cement slab, asbestos cement walls
12" thick concrete flat slab, Asbestos cement slab

Transverse
Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)

SEISMIC EVALUATION PERFORMED? Yes

EVALUATION: Rapid Evaluation  YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING:
\[
\frac{5}{1=\text{low to } 10=\text{high}}
\]

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

OTHER DIAPHRAGMS
The roof at the addition on the West Side of the building consists of asbestos cement panels.

WALL ANCHORAGE
Out of plane anchorage could not be verified on the site visit for the West Side addition. No drawings are available for review.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Further investigation of the West Side addition is recommended. Add out of plane anchorage at the West Side Addition as required.
Strengthen the diaphragm at the West Side Addition with rod bracing or metal deck.
BUILDING SYSTEM

- 4.3.1.1 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.

- 4.3.1.3 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.

- 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. One story building.

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

- 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. One story building.

- 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. The shear walls are dowelled into the foundation system. Verification of the connection of the asbestos panels to the foundation could not be made. The shear capacities of the asbestos panels were not taken into account. One story building.

- 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. Concrete shear walls around the perimeter of the building.

- 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

- 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. Site visit made on 8/19/03. No signs of deterioration were observed.
### BUILDING SYSTEM

- **4.3.3.5** POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coll anchors shall not have been used.

- **4.3.3.9** CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. Site visit made on 8/19/03. There are no cracks >1/8".

### LATERAL-FORCE-RESISTING SYSTEM

- **4.4.1.6.1** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

- **4.4.2.1.1** 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. There are at least 2 lines of resistance in each direction of loading.

- **4.4.2.2.1** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f_c}$ for Life Safety and Immediate Occupancy. The maximum shear stress is 41 psi < 100 psi. Note: $2\sqrt{f_c} = 110$ psi for $f_c = 3,000$ psi.

- **4.4.2.2.2** 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" for Life Safety and Immediate Occupancy. Typ. reinforcement in reinforced concrete walls:

  - 8" thick wall:
    - vertical: $#5@12"$ o.c.; $\rho = 0.0032 > 0.0015$
    - horizontal: $#4@10"$ o.c.; $\rho = 0.0025 > 0.0025$

  - 12" thick wall:
    - $#4@12"$ o.c. E.W.; $\rho = 0.0028 > 0.0025$

  The spacing $\leq 18"$.

### CONNECTIONS

- **4.6.2.1** 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 diaphragms for Immediate Occupancy. Rebar from slab dowels into concrete shear walls.

- **4.6.3.5** 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. Rebar dowels into foundation match vertical rebar in shear walls.
ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

CONNECTIONS

FOR WEST SIDE ADDITION W/ FLEXIBLE DIAPHRAGM

☐ ☐ ☐ 4.6.1.1 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.

Out of plane wall anchorage could not be verified for the West Side Addition at the site visit on August 19, 2003. Drawings are not available for the West Side Addition.

* = Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# ASCE 31* SUPPLEMENTAL CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

## LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4.1.6.2</td>
<td>☑️</td>
<td>DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.</td>
<td>No secondary elements in the original building or the addition on the East side of the building. At the West side of the building, there are WF steel columns.</td>
</tr>
<tr>
<td>4.4.1.6.3</td>
<td>☑️</td>
<td>FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
<td></td>
</tr>
<tr>
<td>4.4.2.2.3</td>
<td>☑️</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>4.4.2.2.4</td>
<td>☑️</td>
<td>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.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td>4.4.2.2.5</td>
<td>☑️</td>
<td>CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td>4.4.2.2.6</td>
<td>☑️</td>
<td>REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td>4.4.2.2.7</td>
<td>☑️</td>
<td>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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
</tbody>
</table>

## DIAPHRAGMS

<table>
<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5.1.1</td>
<td>☑️</td>
<td>DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
<td></td>
</tr>
<tr>
<td>4.5.1.4</td>
<td>☑️</td>
<td>OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td>4.5.1.7</td>
<td>☑️</td>
<td>PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td></td>
</tr>
</tbody>
</table>
### DIAPHRAGMS

4.5.1.8  **DIAPHRAGM REINFORCEMENT AT OPENINGS:** There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

**Life Safety Performance Level.**

### CONNECTIONS

4.6.3.10  **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.

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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.2.3 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.

☐ ☐ ☒ 4.4.2.2.4 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.

☐ ☐ ☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than \(8d_c\). This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☒ ☐ ☒ 4.5.1.7 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.

☒ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☐ ☒ 4.5.2.1 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.
ASCE 31* SUPPLEMENTAL CHECKLIST C2A: CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

DIAPHRAGMS

☐ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☐ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☐ ☐ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☒ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing. The roof consists of asbestos cement panels at the West side addition.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

* Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 836B

Building 836B is a one-story building. At the East Elevation, there is a reinforced concrete block wall. In the EW direction, there are 2 bays of rod bracing. In the NS direction, there are steel moment resisting frames. The roof consists of blow out panels with rod bracing supported by steel web joists at 4 feet o.c. The out of plane anchorage at the concrete block wall consists of ledger angles supporting the deck or joists and bolted to the wall w/ 3/4" diameter bolts at 32 inches o. c. A structural evaluation of Building 836B was not completed because no structural drawings for the roof level were available for review. A detailed on-site evaluation is required to conclusively determine the structural deficiencies in the building. However, based on our site visit observations, experience and judgement, we cannot deem Building 836B to be life-safe. We identified the following as potential deficiencies for the building: 1) The diaphragm may not adequately transfer seismic loads to the lateral-force-resisting elements; 2) The out-of-plane anchorage connections may not adequate.

For the building to meet life-safety requirements, we recommend a detailed on-site evaluation to conclusively identify the deficiencies in the building and strengthened elements of the structure as required.
Building 836D

Building 836D is approximately 2,500-sq. ft. and is a one-story reinforced concrete bearing wall building. There are concrete shear walls on three sides of the building. At the front, there are no concrete shear walls and only blow out panels. The roof consists of also blow out panels. A structural evaluation of Building 836D was not completed because no structural drawings were available for review. A detailed on-site evaluation is required to conclusively determine the structural deficiencies in the building. However, based on our site visit observations, experience and judgement, we identified the following deficiencies for the building: 1) The diaphragm cannot adequately transfer seismic loads to the shear walls; 2) There is no redundancy in the lateral-force-resisting system in one direction of loading; and 3) The out-of-plane anchorage connections are not adequate.

For the building to meet life-safety requirements, we recommend adding a brace frame or moment frame at the front of the building.
Building 870

Building 870 is a one-story wood frame building. The structure consists of 2x6 tongue and groove supported by wood purlins and steel girders, which are supported by wood posts or steel pipes. The lateral-force-resisting system consists of 3/8" plywood shear walls. Potential structural deficiencies noted for Building 870 are 1) The shear walls are not adequate for resisting the seismic demands; and 2) The diaphragm span is greater than 24' allowable for straight sheathing. We recommend that new plywood shear walls are added and that the roof be strengthened with plywood sheathing.
Building Name: Building 870  Date:  July 15, 2003
Building Address: Lawrence Livermore National Laboratory  Page:  1 of  1
Job Number: A20047.08  Job Name: LLNL Prioritization  By: JYF  Checked: JEH

BUILDING DATA
Year Built: 1958  Year(s) Remodeled: 1983  UBC Zone: 4 – Type B Near Fiel
Area (sf): 3,890  Length (ft): 97  Width (ft): 41
No. Stories: 1  Story Height: 9  Total Height: 9

CONSTRUCTION DATA
Gravity Load Structural System: 2x6 T&G, Wood purlins on steel/wood girders supported by perimeter posts and steel pipes at the interior
Exterior Transverse Walls: 3/8" plywood shear walls (1" diagonal sheathing at interior)
Exterior Longitudinal Walls: 3/8" plywood shear walls
Roof Framing: 2x6 T&G supported on 4x12 D.F. beams and 12B16.5/12WF27 girders
Intermediate Floor Framing: None
Ground Floor: 6" concrete slab on grade w/ 4x4-6/6 WWF
Columns: 4x8 posts (exterior) and 3" diameter steel pipes (interior)
Foundation: Spread footing under columns, strip footing under walls and at perimeter

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Classification:</td>
<td>Type 1 Wood light frame</td>
</tr>
<tr>
<td>Vertical Elements:</td>
<td>Wood purlins, steel/wood girders, wood posts &amp; steel columns</td>
</tr>
<tr>
<td>Diaphragms:</td>
<td>2x6 T&amp;G</td>
</tr>
<tr>
<td></td>
<td>2x6 T&amp;G</td>
</tr>
</tbody>
</table>


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING:
6
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS B

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

STRESS CHECK
Shear stresses in the shear walls exceed the allowable values. Maximum D/C = 1.16.

DIAPHRAGM SPAN
Max span = 40'>24'. Diaphragm is 2x6 T&G, not wood structural panels or diagonal sheathing.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Add plywood sheathing at the roof.
Add plywood shear walls.
ASCE 31* BASIC CHECKLIST W1: WOOD LIGHT FRAMES

C NC N/A Comments

BUILDING SYSTEM

☐ ☐ ☐ 4.3.1.1 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 of the foundation.

☐ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☐ ☐ ☐ 4.3.3.1 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.

☐ ☐ ☜ 4.3.3.2 WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15% 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.

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.1.1 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.

☐ ☐ ☞ 4.4.2.7.1 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:

<table>
<thead>
<tr>
<th>Type of Sheathing</th>
<th>Stress (lf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural panel</td>
<td>1000</td>
</tr>
<tr>
<td>Diagonal</td>
<td>700</td>
</tr>
<tr>
<td>Straight</td>
<td>100</td>
</tr>
<tr>
<td>All other conditions</td>
<td>100</td>
</tr>
</tbody>
</table>

There are 3 interior diagonal sheathed shear walls in the transverse direction. At the perimeter of the building, there are 3/8" plywood shear walls.

Shear walls are continuous to the foundation (Detail 4/ S9).

Site visit made on 8/19/03. No signs of deterioration were observed. We noticed that the 2x6 T&G straight sheathing at the roof has shrunk. There are noticeable gaps between the 2x6 pieces.

Life Safety Performance Level.

☐ ☐ ☞ 4.4.2.7.2 STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system.

One story building.

☐ ☐ ☞ 4.4.2.7.3 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 multistory building.

One story building.

☐ ☐ ☞ 4.4.2.7.4 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.

The narrowest shear wall is at Line A. The maximum height = 10'-7 1/2" and the width = 6'-0". The aspect ratio < 2 to 1.
**LATERAL-FORCE-RESISTING SYSTEM**

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ ☑ ☑ 4.4.2.7.5</td>
<td>WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor.</td>
<td>One story building.</td>
</tr>
<tr>
<td>☑ ☑ ☑ 4.4.2.7.6</td>
<td>HILLSIDE SITE: For structures that are taller on at least one side by more than half of a 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.</td>
<td>Building is on level lot.</td>
</tr>
<tr>
<td>☑ ☑ ☑ 4.4.2.7.7</td>
<td>CRIPPLE WALLS: Cripple walls below first floor level shear walls shall be braced to the foundation with wood structural panels.</td>
<td>There are no cripple walls.</td>
</tr>
<tr>
<td>☑ ☑ ☑ 4.4.2.7.8</td>
<td>OPENINGS: Walls with openings greater than 80% 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 tie capable of transferring the lateral forces.</td>
<td>There are no shear walls with large openings.</td>
</tr>
</tbody>
</table>

**CONNECTIONS**

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ ☑ ☑ 4.6.3.3</td>
<td>WOOD POSTS: There shall be a positive connection of wood posts to the foundation.</td>
<td>Wood posts are connected to 1/4&quot;x3&quot; steel U-shaped plates by (2) 1/2&quot; diameter bolts. The U-shaped plates are 6&quot; embedded into the concrete footing. (Detail 3/S9)</td>
</tr>
<tr>
<td>☑ ☑ ☑ 4.6.3.4</td>
<td>WOOD SILLS: All wood sills shall be bolted to the foundation.</td>
<td>2x4 sill plates are anchored into the foundation by 5/8&quot; diameter bolts at 4'0&quot; or center. (Detail 4/S9)</td>
</tr>
<tr>
<td>☑ ☑ ☑ 4.6.4.1</td>
<td>GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.</td>
<td>Girders are bolted to plates which are welded to the steel columns. (Details 1 and 3/ S10). Girders are bolted to wood posts (Detail 4/S10).</td>
</tr>
</tbody>
</table>

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.7.9 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.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☐ 4.5.1.3 ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation.

☒ ☐ ☒ 4.5.1.7 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.

☒ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☒ ☐ ☐ 4.5.2.1 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.

☒ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

☒ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☒ ☐ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☒ ☐ ☐ 4.6.3.9 WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft or less for Life Safety and 4 ft or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete.

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* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 166A & D

Building 166A & D are similar one-story steel light framed structures. The roof systems consist of bare metal deck with insulation and roofing. The lateral system in the transverse direction consists of steel moment frames. In the longitudinal direction, the lateral system consists of 4 bays of ½" diameter rods. The total square footage for 166A is 3,200 square feet and building 166D is 4,000 square feet.

Structural drawings were not available. The only potential deficiency is the ability of the moment connections to develop the strength of the adjoining connections. A detailed evaluation will likely show that moment frame connection meets the life-safety performance level. These buildings are rated Class D – Low Priority pending detailed evaluation.
Building Name: Building 166A
Building Address: Lawrence Livermore National Laboratory
Job Number: A20047.08 Job Name: LLNL Prioritization
Date: September 19, 2003

BUILDING DATA
- Year Built: -
- Year(s) Remodeled: -
- Area (sf): 3,200 sf
- Length (ft): 80'
- No. Stories: 1
- Story Height: Sloped Roof
- Width (ft): 40'
- Total Height: -
- UBC Zone: 4 – Type B Near Field

CONSTRUCTION DATA
- Exterior Transverse Walls: metal wall panels
- Exterior Longitudinal Walls: metal wall panels
- Roof Framing: Bare metal deck supported on steel roof beams
- Intermediate Floor Framing: -
- Openings?: Roll up doors
- Ground Floor: Concrete slab on grade
- Columns: Wide flange columns located on the perimeter.
- Foundation: No structural drawings available.

LATERAL-FORCE-RESISTING SYSTEM
- Longitudinal (W-E)
  - System Classification: S3 – Steel Light Frames
  - Vertical Elements: Steel wide flange columns
  - Diaphragms: Bare metal deck with roofing
- Transverse (N-S)
  - S3 – Steel Light Frames
  - Steel wide flange columns
  - Bare metal deck with roofing

SEISMIC EVALUATION PERFORMED?: Yes EVALUATION: Rapid Evaluation YEAR: 2003
SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02
VULNERABILITY RATING: 3
(1 = low to 10 = high)

PRIORITIZATION CLASSIFICATION: CLASS D
*Pending detailed evaluations of moment connection
POTENTIAL LIFE SAFETY DEFICIENCIES (STRUCTURAL):
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

   All moment connections shall be able to develop strength of adjoining members.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Detailed evaluation of steel moment connection to confirm compliance
with life safety performance level.
**ASCE 31+ BASIC CHECKLIST S3: STEEL LIGHT FRAMES**

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>BUILDING SYSTEM</strong></td>
</tr>
<tr>
<td>☑</td>
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<td>☑</td>
<td>4.3.1.1 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.</td>
</tr>
<tr>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>4.3.1.3 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.</td>
</tr>
<tr>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
</tr>
<tr>
<td>☑</td>
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<td>☑</td>
<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>4.3.3.3 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.</td>
</tr>
</tbody>
</table>

| ☑ | ☑ | ☑ | **LATERAL-FORCE-RESISTING SYSTEM** |
| ☑ | ☑ | ☑ | 4.4.3.1.2 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, for Life Safety and for Immediate Occupancy. | For 36 ksi steel, DCR = 1.03. OK |

| ☑ | ☑ | ☑ | **CONNECTIONS** |
| ☑ | ☑ | ☑ | 4.6.2.2 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. | Metal deck welded to roof beams. |
| ☑ | ☑ | ☑ | 4.6.3.1 STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. | No structural drawings. From site visit, columns were observed to have anchor bolts into the slab on grade. |
| ☑ | ☑ | ☑ | 4.6.3.8 WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy. | |
| ☑ | ☑ | ☑ | 4.6.5.1 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. | Roof consists of bare metal deck on steel roof beams. |
ASCE 31* BASIC CHECKLIST S3: STEEL LIGHT FRAMES

CONNECTIONS

☐ ☐ ☐ 4.6.5.2 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.

* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.1.3.3 MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones.

☐ ☐ ☐ 4.4.1.3.7 COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).

☐ ☐ ☐ 4.4.1.3.8 BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☐ 4.4.1.3.10 OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☐ 4.4.1.3.11 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.

DIAPHRAGMS

☐ ☐ ☐ 4.5.1.7 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.

☐ ☐ ☐ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☐ ☐ ☐ 4.6.3.10 UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and plies 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.

☐ ☐ ☐ 4.6.5.3 ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12" for Life Safety and 8" for Immediate Occupancy.

No structural drawings available. But pile foundations not typical at site.

No structural drawings available.

*—Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
BUILDING DATA

Year Built: - Year(s) Remodeled: - UBC Zone: 4 – Type B Near Field
Area (sf): 4,000 sf Length (ft): 100’ Width (ft): 40’
No. Stories: 1 Story Height: Sloped Roof Total Height: 26’

CONSTRUCTION DATA


Exterior Transverse Walls: metal wall panels
Exterior Longitudinal Walls: metal wall panels

Roof Framing: Bare metal deck supported on steel roof beams
Intermediate Floor Framing: -

Openings?: None
Openings?: None

Ground Floor: Concrete slab on grade

Columns: Wide flange columns located on the perimeter.

Foundation: No structural drawings available.

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal (W-E) Transverse (N-S)
System Classification: S3 – Steel Light Frames S3 – Steel Light Frames
Vertical Elements: Steel wide flange columns Steel wide flange columns
Diaphragms: Bare metal deck with roofing Bare metal deck with roofing


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: \[
\frac{3}{1=low \ to \ 10=high}
\]

PRIORITIZATION CLASSIFICATION: CLASS D

*Pending detailed evaluations of moment connections
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

All moment connections shall be able to develop strength of adjoining members.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Detailed evaluation of moment connection.
## BUILDING SYSTEM

4.3.1.1 **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.

4.3.1.3 **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.

4.3.2.4 **VERTICAL DISCONTINUITIES:** All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

4.3.2.6 **TORSION:** The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

4.3.3.3 **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.

There are steel moment frames in the transverse direction and rod braced frames in the longitudinal direction.

## LATERAL-FORCE-RESISTING SYSTEM

4.4.3.1.2 **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 0.50\(F_y\) for Life Safety and for Immediate Occupancy.

Calculated axial stress in rods is approximately 36.5 ksi. For 36 ksi steel, DCR = 1.01, OK

## CONNECTIONS

4.6.2.2 **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.

Metal deck welded to roof beams.

4.6.3.1 **STEEL COLUMNS:** The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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.

No structural drawings. From site visit, columns were observed to have anchor bolts into the slab on grade.

4.6.3.8 **WALL PANELS:** Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy.

4.6.5.1 **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.

Roof consists of bare metal deck on steel roof beams.

4.6.5.2 **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.
ASCE 31* BASIC CHECKLIST S3: STEEL LIGHT FRAMES

CONNECTIONS

☐  ☐  ☐  4.6.5.2 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.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
<table>
<thead>
<tr>
<th>LATERAL-FORCE-RESISTING SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4.1.3.3  <strong>MOMENT-RESISTING CONNECTIONS:</strong> All moment connections shall be able to develop the strength of the adjoining members or panel zones.</td>
</tr>
<tr>
<td>☐ ☒ ☐</td>
</tr>
<tr>
<td>4.4.1.3.7 <strong>COMPACT MEMBERS:</strong> All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).</td>
</tr>
<tr>
<td>☐ ☒ ☒</td>
</tr>
<tr>
<td>4.4.1.3.8 <strong>BEAM PENETRATIONS:</strong> All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
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<tr>
<td>4.4.1.3.10 <strong>OUT-OF-PLANE BRACING:</strong> Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐ ☒ ☒</td>
</tr>
<tr>
<td>4.4.1.3.11 <strong>BOTTOM FLANGE BRACING:</strong> The bottom flanges of beams shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>☐ ☒ ☒</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>DIAPHRAGMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5.1.7 <strong>PLAN IRREGULARITIES:</strong> 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.</td>
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<tr>
<td>☐ ☒ ☐</td>
</tr>
<tr>
<td>4.5.1.8 <strong>DIAPHRAGM REINFORCEMENT AT OPENINGS:</strong> There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>☐ ☒ ☒</td>
</tr>
<tr>
<td>4.5.7.1 <strong>OTHER DIAPHRAGMS:</strong> The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
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</tbody>
</table>

<table>
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<td>4.6.3.10 <strong>UPLIFT AT PILE CAPS:</strong> Pile caps shall have top reinforcement and piers 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.</td>
</tr>
<tr>
<td>☐ ☒ ☐</td>
</tr>
<tr>
<td>4.6.5.3 <strong>ROOF PANEL CONNECTIONS:</strong> Roof panel connections shall be spaced at or less than 12&quot; for Life Safety and 8&quot; for Immediate Occupancy.</td>
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<td>☐ ☒ ☐</td>
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</tbody>
</table>

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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING DATA

Year Built: 1959  Year(s) Remodeled: None  UBC Zone: 4 – Type B Near Field
Area (sf): 4,800  Length (ft): 80  Width (ft): 60
No. Stories: 1  Story Height: 14.5 ft  Total Height: 14.5 ft

CONSTRUCTION DATA

Gravity Load Structural System: Bare metal deck supported by WF beams and tapered steel beams, which are supported by perimeter reinforced concrete block walls

Exterior Transverse Walls: 8" concrete block walls
Exterior Longitudinal Walls: 8" concrete block walls
Roof Framing: 1 1/2" Bare metal deck supported by 10B11.5 beams tapered steel girders
Intermediate Floor Framing: None

Ground Floor: 5" concrete slab on grade w/ 6x6-6/6 WWM

Columns: None  Foundation: Strip footing @ concrete block walls

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Classification: Type 13 (Reinforced concrete block walls w/ flexible diaphragm)</td>
<td></td>
</tr>
<tr>
<td>Vertical Elements: Steel beams and girders, reinforced concrete block walls @ perimeter</td>
<td></td>
</tr>
<tr>
<td>Diaphragms: Bare metal deck</td>
<td></td>
</tr>
<tr>
<td>Type 13(Reinforced concrete block walls w/ flexible diaphragm)</td>
<td></td>
</tr>
<tr>
<td>Steel beams and girders, reinforced concrete block walls @ perimeter</td>
<td></td>
</tr>
<tr>
<td>Bare metal deck</td>
<td></td>
</tr>
</tbody>
</table>


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 1
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None recommended.
## Building System

<table>
<thead>
<tr>
<th></th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>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. The bare metal deck delivers load to the W beams and tapered steel girders, which transfer load to the perimeter reinforced concrete block walls. The concrete block walls are doweled into the concrete strip foundation system.</td>
</tr>
<tr>
<td>☒</td>
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<td>☐</td>
<td>Adjacent Buildings: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>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. There are no mezzanines.</td>
</tr>
<tr>
<td>☒</td>
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<td>☒</td>
<td>Weak Story: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. One story building</td>
</tr>
<tr>
<td>☒</td>
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<td>☒</td>
<td>Soft Story: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. One story building</td>
</tr>
<tr>
<td>☒</td>
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<td>Geometry: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. One story building</td>
</tr>
<tr>
<td>☒</td>
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<td>☒</td>
<td>Vertical Discontinuities: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. The concrete block walls are doweled into the concrete strip foundation system. One story building</td>
</tr>
<tr>
<td>☒</td>
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<td>☒</td>
<td>Mass: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. Site visit made on 7/30/03. No signs of deterioration were observed.</td>
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<tr>
<td>☒</td>
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<td>☒</td>
<td>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. Site visit made on 7/30/03. No signs of deterioration were observed.</td>
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<tr>
<td>☒</td>
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<td>☒</td>
<td>Masonry Units: There shall be no visible deterioration of masonry units. Site visit made on 7/30/03. No eroded mortar was observed.</td>
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<tr>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>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. Site visit made on 7/30/03. No eroded mortar was observed.</td>
</tr>
</tbody>
</table>
ASCE 31\textsuperscript{st} BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

BUILDING SYSTEM

☒ ☐ ☐ 4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

Site visit made on 7/30/03. There are no cracks >1/8".

LATERAL-FORCE-RESISTING SYSTEM

☒ ☐ ☐ 4.4.2.1.1 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.

There are two lines of shear walls in both the longitudinal and transverse directions.

☒ ☐ ☐ 4.4.2.4.1 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.

The maximum shear stress in the concrete block wall is 10 psi < 70 psi at Line 5.

☒ ☐ ☐ 4.4.2.4.2 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.

Typ. reinforcement in reinforced concrete block walls:
- Vertical Reinforcing = \#5@32" o.c.: reinforcing ratio = 0.0012 > 0.0007
- Horizontal Reinforcing = \#5@24" o.c.: horizontal: reinforcing ratio = 0.0016 > 0.0007.

Total reinforcing steel ratio = \((0.31*32/24+0.31)/2/(32^{"}8^\circ)\) = 0.0028 = 0.002

CONNECTIONS

☒ ☐ ☐ 4.6.1.1 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.

Out of plane anchorage: EW walls: (2) 3/4" diameter bolts at 20 ft o.c. and 1/2" diameter bolts @ 2 ft o.c. NS walls: (2) 5/8" diameter bolts at 10 ft o.c. and 1/2" diameter bolts @ 2 ft o.c.

D/C = 0.96.
There are no wood ledgers.

☒ ☐ ☐ 4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.

Details shows the metal deck to be welded to 3"x1/4" embed plates w/ \#4 anchors embedded into concrete block wall @ 2' o.c.

☒ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

#5x 3'-6" dowels @ 32" o.c. into foundation to match vertical reinforcing in the concrete block walls.

☒ ☐ ☐ 4.6.3.5 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.
### ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

<table>
<thead>
<tr>
<th>Code</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>4.6.4.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>GIRDER/COLUMN CONNECTION:</strong> There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td><strong>There are no columns.</strong></td>
</tr>
</tbody>
</table>

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Performance Level.

☐ ☐ ☒ 4.4.2.4.4 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.

Life Safety Performance Level.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.

Steel beams serve as the cross ties.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

There are no diaphragm openings adjacent to shear walls.

☒ ☐ ☐ 4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.

There are no diaphragm openings adjacent to shear walls.

☒ ☐ ☒ 4.5.1.7 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.

Life Safety Performance Level.

☒ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Performance Level.

☒ ☐ ☒ 4.5.2.1 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.

Bare metal deck.

☒ ☐ ☒ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.

Bare metal deck.

☒ ☐ ☒ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

Bare metal deck.

☒ ☐ ☒ 4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Performance Level.
## DIAPHRAGMS

|   |   | 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing. |

## CONNECTIONS

|   |   | 4.6.1.4 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 no greater than 1/8". |

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
ROOF PLAN

Scale: 1' = 1'-0"
BUILDING PLAN

- 5" deterioration in slab @ 12" o.c., extend 18" into sides.
- 6'-0"
- 30'-0"
- 10'-0"
- 6'-0"
- 6'-0"
- 10'-0"
- 24'-0"
- Canopy: open.
- Concrete deck.
- Foundation:
- 6" concrete slab with 6'-0" x 6'-0" W.W.W.
- Flashed floor elevation: 603.30
- For floor finishing details, see deck shop.

FOUNDATION PLAN
Scale: 1/8"=1'-0"
Building Name: Building 281, Increment 2
Date: July 23, 2003

Building Address: Lawrence Livermore National Laboratory

Job Number: A20047.08 Job Name: LLNL Prioritization

By: JYF Checked: JEH

BUILDING DATA

Year Built: 1958 Year(s) Remodeled: 1969 UBC Zone: 4 – Type B Near Field
Area (sf): 9,700 Length (ft): 162.6 Width (ft): 68.7
No. Stories: 1 Story Height: 12.5 ft Total Height: 12.5 ft

CONSTRUCTION DATA

Gravity Load Structural System:
Bare metal deck supported by WF beams, which are supported by WF columns and perimeter and interior reinforced concrete block walls

Exterior Transverse Walls: 8" concrete block walls
Exterior Longitudinal Walls: 8" concrete block walls

Roof Framing: Bare metal deck supported by 10B11.5 beams and 18WF50 girders
Intermediate Floor Framing: None

Ground Floor: 6" concrete slab on grade w/ 6x6-6/6 WWM

Columns: 6WF15.5 columns
Foundation: Strip footing @ concrete block walls

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Classification:</td>
<td>Type 13 (Reinforced concrete block walls w/ flexible diaphragm)</td>
</tr>
<tr>
<td>Vertical Elements:</td>
<td>Steel beams and girders, reinforced concrete block walls @ perimeter and interior, WF columns</td>
</tr>
<tr>
<td>Diaphragms:</td>
<td>Bare metal deck</td>
</tr>
<tr>
<td></td>
<td>Type 13 (Reinforced concrete block walls w/ flexible diaphragm)</td>
</tr>
<tr>
<td></td>
<td>Steel beams and girders, reinforced concrete block walls @ perimeter and interior, WF columns</td>
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<td></td>
<td>Bare metal deck</td>
</tr>
</tbody>
</table>


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 1
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None recommended.
## BUILDING SYSTEM

### 4.3.1.1 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.

The bare metal deck delivers load to the WF beams and girders, which transfer load to the interior and perimeter reinforced concrete block walls. The concrete block walls are doweled into the concrete strip foundation system.

Building 281 (South, Building 281 Addition), constructed in 1991 is adjacent to Building 281 (North, Increment 2). The seismic joint is ~4" measured on site visit on 7/22/03. The original Bldg 281, constructed in the early 1950's is seismically separated by a 3' seismic joint. All buildings are at the same elevation.

There are no mezzanines.

One story building

### 4.3.1.2 ADJACENT BUILDINGS:
The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.

### 4.3.1.3 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.

There are no mezzanines.

### 4.3.2.1 WEAK STORY:
The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

One story building

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

One story building

### 4.3.2.3 GEOMETRY:
There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

The concrete block walls are doweled into the concrete strip foundation system.

### 4.3.2.4 VERTICAL DISCONTINUITIES:
All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

One story building

### 4.3.2.5 MASS:
There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

One story building

### 4.3.3.1 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.

Site visit made on 7/22/03. No signs of deterioration were observed.

### 4.3.3.7 MASONRY UNITS:
There shall be no visible deterioration of masonry units.
ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

BUILDING SYSTEM

☐ ☐ ☐ 4.3.3.8 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.
Site visit made on 7/22/03. No eroded mortar was observed.

☐ ☐ ☐ 4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.
Site visit made on 7/22/03. There are no cracks >1/8".

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.1.1 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.
There are at least two lines of shear walls in both the longitudinal and transverse directions.

☐ ☐ ☐ 4.4.2.4.1 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.
The maximum shear stress in the concrete block wall is 64 psi < 70 psi at the Line E.

☐ ☐ ☐ 4.4.2.4.2 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 0.007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls.
Typ. reinforcement in reinforced concrete block walls:
Vertical Reinforcing = #5@32" o.c.: reinforcing ratio = 0.0012 > 0.0007
Horizontal Reinforcing = #5@32" o.c. horizontal: reinforcing ratio =0.0012 > 0.0007.
Total reinforcing steel ratio =
\( (0.31+0.31)/\text{n}^2/(32^2\times8^2) = 0.0024 = 0.002 \)

CONNECTIONS

☐ ☐ ☐ 4.6.1.1 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.
Out of plane anchorage: Critical case-Girder to wall connection: (2) 3/4" diameter x 12" bolts. Maximum spacing of anchorage @ 18'. Metal deck to wall connection: #4 L-anchors @ 2' o.c.
D/C = 0.79.

☐ ☐ ☐ 4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.
There are no wood ledgers.

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.
Details shows the metal dock to be screwed to 3x1/4 plate which are connected to the concrete block walls by #4 L anchors @ 24" o.c.
### CONNECTIONS

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* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# ASCE 31* SUPPLEMENTAL CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

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## LATERAL-FORCE-RESISTING SYSTEM

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<td><strong>4.4.2.4.3</strong> REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>Life Safety Performance Level.</td>
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<td><strong>4.4.2.4.4</strong> 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.</td>
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<td>Life Safety Performance Level.</td>
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## DIAPHRAGMS

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<td><strong>4.5.1.2</strong> CROSS TIES: There shall be continuous cross ties between diaphragm chords.</td>
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<td>Steel beams serve as the cross ties.</td>
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<td><strong>4.5.1.4</strong> OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
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<tr>
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<td>Diaphragm openings adjacent to shear walls are less than 25% of the wall length. Max opening size = 40” x 40”.</td>
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<td>Openings adjacent to shear walls =27” for mechanical units.</td>
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<td><strong>4.5.1.6</strong> OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.</td>
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<td><strong>4.5.1.7</strong> 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.</td>
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<td>Life Safety Performance Level.</td>
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<td><strong>4.5.1.8</strong> DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>Life Safety Performance Level.</td>
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<td><strong>4.5.2.1</strong> 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.</td>
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<td></td>
<td>Bare metal deck.</td>
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<td><strong>4.5.2.2</strong> SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.</td>
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<td>Bare metal deck.</td>
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<td><strong>4.5.2.3</strong> UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.</td>
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<td></td>
<td>Bare metal deck.</td>
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<td><strong>4.5.3.1</strong> NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td></td>
<td>Life Safety Performance Level.</td>
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</tbody>
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**DIAPHRAGMS**

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<tbody>
<tr>
<td>☒</td>
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<td>☐</td>
<td>4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
</tr>
</tbody>
</table>

**CONNECTIONS**

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<tbody>
<tr>
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<td>4.6.1.4 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 no greater than 1/8&quot;.</td>
</tr>
</tbody>
</table>

* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31
BUILDING DATA

Year Built: 1991
Area (sf): 4,300
No. Stories: 1

Concertation Data

Gravity Load Structural System: 1/2" plywood supported by 3x12 wood joists spaced at ~ 2'-0" o.c. and 5 1/8 glulams. TS4x4 columns, and perimeter concrete block walls

Exterior Transverse Walls: 8" concrete block walls
Exterior Longitudinal Walls: 8" concrete block walls
Roof Framing: 1/2" plywood supported by wood joists and glulams
Intermediate Floor Framing: None

Ground Floor: 6" concrete slab on grade w/ #5@12" o.c. E.W.
Columns: TS 4x4 columns
Foundation: Strip footing @ concrete block walls, spread footings at columns

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal

System Classification: Type 13 (Reinforced concrete block walls w/ wood diaphragm)
Vertical Elements: Wood joists and glulams, TS columns, concrete block walls at perimeter
Diaphragms: 1/2" plywood sheathing

Transverse

System Classification: Type 13 (Reinforced concrete block walls w/ wood diaphragm)
Vertical Elements: Wood joists and glulams, TS columns, concrete block walls at perimeter
Diaphragms: 1/2" plywood sheathing


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 1
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None recommended.
## Building System

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>☑</td>
<td><strong>4.3.1.1</strong> 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.</td>
<td>The ½&quot; plywood diaphragm delivers load to the wood beams and girders, which transfer load to the interior and perimeter reinforced concrete block walls. The concrete block walls are doweled into the concrete strip foundation system. Building 281 (South, Building 281 Addition constructed in 1991 is adjacent to Building 281 (North, Increment 2). The seismic joint is ~4&quot; measured on site visit on 7/22/03. All buildings are at the same elevation. There are no mezzanines.</td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.1.2</strong> ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
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<tr>
<td>☑</td>
<td><strong>4.3.1.3</strong> 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.</td>
<td></td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.2.1</strong> WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.</td>
<td>One story building</td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.2.2</strong> SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
<td>One story building</td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.2.3</strong> GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
<td>One story building</td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.2.4</strong> VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
<td>The concrete block walls are doweled into the concrete strip foundation system.</td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.2.5</strong> MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
<td>One story building</td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.3.1</strong> 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.</td>
<td>Site visit made on 7/22/03. No signs of deterioration were observed.</td>
</tr>
<tr>
<td>☑</td>
<td><strong>4.3.3.7</strong> MASONRY UNITS: There shall be no visible deterioration of masonry units.</td>
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<td><strong>4.3.3.8</strong> 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.</td>
<td>Site visit made on 7/22/03. No eroded mortar was observed.</td>
</tr>
</tbody>
</table>
ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

BUILDING SYSTEM

☐ ☐ ☐ 4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. Site visit made on 7/22/03. There are no cracks >1/8".

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.2.1.1 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. There are at least two lines of shear walls in both the longitudinal and transverse directions.

☐ ☐ ☐ 4.4.2.4.1 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. The maximum shear stress in the concrete block wall is 31 psi < 70 psi at the Line E.

☐ ☐ ☐ 4.4.2.4.2 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" for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. Typ. reinforcement in reinforced concrete block walls:

Vertical Reinforcing = #5@16" o.c.:
reinforcing ratio = 0.0024 > 0.0007

Horizontal Reinforcing = #5@24" o.c.:
horizontal: reinforcing ratio =0.0016 > 0.0007.

Total reinforcing steel ratio =
(0.31*24/16+0.31)ln^2/(24"*8") = 0.004 = 0.002

CONNECTIONS

☐ ☐ ☐ 4.6.1.1 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. Out of plane anchorage: Simpson PATM25 w/ 13-16d.

D/C = 0.90.

☐ ☐ ☐ 4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy. 1/2" plywood is connected to joists and ledger w/ Simpson PATM25's. Ledgers are bolted to concrete block walls w/ (2)-5/8" diameter x9" A307 bolts @ 24" o.c.

☐ ☐ ☐ 4.6.3.5 FOUNDATION DOWELS: Wall reinforcement shall be dowelled 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. #5 L-dowels @ 16" o.c. into concrete foundation to match vertical reinforcing in the concrete block walls.
**ASCE 31* BASIC CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS**

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<td>Glulams are connected to TS columns w/ Simpson CCOS 1/4.</td>
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</table>

4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

* = Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
## LATERAL-FORCE-RESISTING SYSTEM

<table>
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</thead>
<tbody>
<tr>
<td>☐</td>
<td>4.4.2.4.3 REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td>☐</td>
<td>4.4.2.4.4 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.</td>
<td>Life Safety Performance Level.</td>
</tr>
</tbody>
</table>

## DIAPHRAGMS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords.</td>
<td>Glulams act as cross ties in the NS direction. Wood joists act as cross ties in the EW direction.</td>
</tr>
<tr>
<td>☒</td>
<td>4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
<td></td>
</tr>
<tr>
<td>☒</td>
<td>4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.</td>
<td></td>
</tr>
<tr>
<td>☐</td>
<td>4.5.1.7 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.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td>☒</td>
<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
<tr>
<td>☒</td>
<td>4.5.2.1 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.</td>
<td>1/2&quot; plywood sheathing.</td>
</tr>
<tr>
<td>☒</td>
<td>4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing.</td>
<td>1/2&quot; plywood sheathing.</td>
</tr>
<tr>
<td>☒</td>
<td>4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.</td>
<td>Blocked diaphragm.</td>
</tr>
<tr>
<td>☒</td>
<td>4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>Life Safety Performance Level.</td>
</tr>
</tbody>
</table>
**ASCE 31** SUPPLEMENTAL CHECKLIST RM1: REINFORCED MASONRY BEARING WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
</table>

**DIAPHRAGMS**

- [x] 4.5.7.1 **OTHER DIAPHRAGMS:** The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

**CONNECTIONS**

- [ ] 4.6.1.4 **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 no greater than 1/8".

*— Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31*
BUILDING PLAN

FOUNDRATION AND SLAB ON GRADE PLAN

SCALE: 1" = 1'-0"
Building 292

Building 292 is a one-story building. It consists of two types of construction: 1) 1/2" plywood sheathing supported by joists and glulams, which are supported by wood shear walls; 2) 4' to 7' thick concrete flat slab supported by interior and exterior concrete shear walls. The only deficiency noted for Building 292 is the lateral-force-resisting system of the mezzanine. The structural drawing showing the mezzanine details was not available for review. During our site visit, we did not have access to this part of the building. Madhu Kamath (Structural Engineer at LLNL) has verified that the mezzanine has a separate lateral force resisting system than the main structure. The mezzanine consists of hollow steel tube sections with angle knee braces.

Therefore this building is placed in Class D – Low Priority.
BUILDING DATA

Year Built: 1979  Year(s) Remodeled: 1997, 1999  UBC Zone: 4 – Type B Near Field
Area (sf): 19,200  Length (ft): 142  Width (ft): 187
No. Stories: 1  Story Height: 18' to 26'  Total Height: 26' max

CONSTRUCTION DATA

Two types of construction: For the machine and target rooms, the structure consists of 4' to 7' thick concrete slabs supported by interior and exterior shear walls. The shear walls are dowelled into the foundation below. The rest of the structure consists of 1/2" plywood sheathing supported by joists and glulams, which are supported by exterior plywood shear walls and interior stud walls. The shear walls are anchored to the concrete foundation below.

Gravity Load Structural System:

Exterior Transverse Walls: 3/8" plywood shear walls or reinforced concrete walls
Exterior Longitudinal Walls: 3/8" plywood shear walls or reinforced concrete walls

Openings?: Door and window openings

Roof Framing: None

Intermediate Floor Framing: None

Ground Floor: 4" to 12" concrete slab on grade. 4" slab: #3@ 18" o.c., E.W. 6" slab: #4@ 18" o.c., E.W. 8" slab: #4@ 12" o.c., E.W. 12" slab: #8@ 12" o.c., E.W., E.F.

Columns: 4" diameter standard pipe columns
Foundation: Concrete strip footing and spread footings

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal

Type 9 (Concrete shear wall building w/ stiff diaphragm) and Type 2 (Wood frames, commercial and industrial)

Vertical Elements:

Wood joists, glulams, steel pipe columns, wood stud and shear walls, concrete shear walls

Diaphragms:

1/2" plywood or 4' to 7' concrete slab

Transverse

Type 9 (Concrete shear wall building w/ stiff diaphragm) and Type 2 (Wood frames, commercial and industrial)

Vertical Elements:

Wood joists, glulams, steel pipe columns, wood stud and shear walls, concrete shear walls

Diaphragms:

1/2" plywood or 4' to 7' concrete slab


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 1
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None recommended.
### BUILDING SYSTEM

#### General

4.3.1.1 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.

4.3.1.2 ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.

4.3.1.3 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. Architectural drawings show a platform. The structural drawings do not show any anchorage of the mezzanine. On our site visit on 8/6/03, we could not enter this portion of the building. Madhu Kamath (LLNL personnel) has verified that the mezzanine has a separate lateral force resisting system than the main structure. The mezzanine consists of hollow steel tube sections with angle knee braces.

#### Configuration

4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.
BUILDING SYSTEM

☐ ☐ ☒ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

☒ ☐ ☐ 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

One story building.

The rigid diaphragm is only at the machine and target rooms, which have thick concrete walls at the perimeter and interior.

Condition of Materials

☒ ☐ ☒ 4.3.3.1 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.

Site visit made on 8/6/03. No signs of deterioration were observed.

Life Safety Performance Level.

☐ ☐ ☒ 4.3.3.2 WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15% 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.

☐ ☐ ☒ 4.3.3.3 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.

Site visit made on 8/6/03. No signs of deterioration were observed.

Site visit made on 8/6/03. No signs of deterioration were observed.

☐ ☐ ☒ 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

☐ ☐ ☒ 4.3.3.5 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.

☐ ☐ ☒ 4.3.3.6 PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections.

☐ ☐ ☒ 4.3.3.7 MASONRY UNITS: There shall be no visible deterioration of masonry units.

☐ ☐ ☒ 4.3.3.8 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.

Site visit made on 8/6/03. There are no cracks >1/8".

☒ ☐ ☒ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

☒ ☐ ☒ 4.3.3.10 REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.
### BUILDING SYSTEM

- **4.3.3.11** UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in the wall elements greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy, and shall not form an X pattern.

- **4.3.3.12** CRACKS IN INFILL WALLS: There shall be no existing diagonal cracks in the infilled walls that extend throughout a panel, greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8" for Life Safety and 1/16" for Immediate Occupancy.

- **4.3.3.13** CRACKS IN BOUNDARY COLUMNS: There shall be no existing diagonal cracks wider than 1/8" for Life Safety and 1/16" for Immediate Occupancy in concrete columns that encase masonry infills.

### LATERAL-FORCE-RESISTING SYSTEM

#### Shear Walls – General

- **4.4.2.1.1** 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.

#### Concrete Shear Walls

- **4.4.2.2.1** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2 \sqrt{f_c}$ for Life Safety and Immediate Occupancy.

- **4.4.2.2.2** 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" for Life Safety and Immediate Occupancy.

- **4.4.2.2.9** 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.

There are at least two lines of shear walls in each direction of loading.

The maximum shear stress is 22 psi < 100 psi at Line 2. See Building Plan. Note:

\[ 2 \sqrt{f_c} = 110 \text{ psi for } f_c = 3,000 \text{ psi}. \]

Typ. reinforcement in reinforced concrete walls:

- 4'-8" thick wall: #6 @9" o.c.; $\rho = 0.44/(9\times9) = 0.0054 > 0.0025$
- 7" thick wall: #7 @9" o.c.; $\rho = 0.6/(9\times9) = 0.0074 > 0.0025$
- 8" thick wall: #8 @9" o.c.; $\rho = 0.75/(9\times9) = 0.0098 > 0.0025$

The spacing = 12" < 18". 

Life Safety Performance Level.
### Walls in Wood-Frame Buildings

<table>
<thead>
<tr>
<th></th>
<th>4.4.2.7.1 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:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Structural panel sheathing: 1000 pff</td>
</tr>
<tr>
<td></td>
<td>Diagonal sheathing: 700 pff</td>
</tr>
<tr>
<td></td>
<td>Straight sheathing: 100 pff</td>
</tr>
<tr>
<td></td>
<td>All other conditions: 100 pff</td>
</tr>
</tbody>
</table>

EW direction of loading: Max shear stress = 908 pff < 1,000 pff for 3/8" plywood sheathing.

NS direction of loading: Max stress = 324 pff < 1,000 pff for 3/8" plywood sheathing.

|   | 4.4.2.7.2 STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. |

One story building.

|   | 4.4.2.7.3 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 multistory building. |

The narrowest shear wall is in Area A. The height = 16' and the width = 12'. The aspect ratio < 2 to 1.

|   | 4.4.2.7.4 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 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. |

One story building.

|   | 4.4.2.7.5 WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. |

One story building.

|   | 4.4.2.7.6 HILLSIDE SITE: For structures that are taller on at least one side by more than half of a 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. |

One story building.

|   | 4.4.2.7.7 CRIPPLE WALLS: Cripple walls below first floor level shear walls shall be braced to the foundation with wood structural panels. |

One story building.

|   | 4.4.2.7.8 OPENINGS: Walls with openings greater than 80% 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. |

One story building.

### DIAPHRAGMS

### Precast Concrete Diaphragms

|   | 4.5.5.1 TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. |
## Connections for Normal Forces

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>4.6.1.1 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.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min. wall anchorage for out of plane @ 4' thick slab: #8 @ 18&quot; o.c. top and #6 @ 9&quot; o.c. bottom dowel into the walls from the concrete slab, E.W.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D/C = 0.5.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>There are no wood ledgers in the concrete portion of the building.</td>
</tr>
</tbody>
</table>

### Shear Transfer

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>4.6.2.1 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 diaphragms for Immediate Occupancy.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>@ Concrete shear wall: Rebar from the slab is doweled into the concrete wall. Min. wall anchorage for shear transfer @ 4' thick slab: #8 @ 18&quot; o.c. top and #6 @ 9&quot; o.c. bottom dowel into the walls from the concrete slab E.W.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>@ Wood shear wall: the plywood sheathing is panel nailed to joists and blocking, which are nailed to the plywood shear walls.</td>
</tr>
</tbody>
</table>

|   |   |   | 4.6.2.2 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. |

|   |   |   | 4.6.2.3 TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be dowelled 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. |

## Vertical Components

|   |   |   | 4.6.3.1 STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety and the anchorage shall be able to develop the 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. |

<p>|   |   |   | 4.6.3.2 CONCRETE COLUMNS: All concrete columns shall be dowelled into the foundation for Life Safety and the dowels shall be able to develop the tensile capacity of reinforcement in columns of lateral-force-resisting system for Immediate Occupancy. |</p>
<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>4.6.3.3 WOOD POSTS: There shall be a positive connection of wood posts to the foundation.</td>
</tr>
<tr>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>4.6.3.4 WOOD SILLS: All wood sills shall be bolted to the foundation. 3x sills are bolted to the foundation w/ 5/8&quot; diameter bolts @ 4'-0&quot; o.c.</td>
</tr>
<tr>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>4.6.3.5 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. Dowels into the foundation match vertical rebar in the walls.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.6.3.6 SHEAR-WALL-BOUNDARY COLUMNS: The shear wall boundary columns shall be anchored to the building for Life Safety and the anchorage shall be able to develop the tensile capacity of the column for Immediate Occupancy.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.6.3.7 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.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.6.3.8 WALL PANELS: Metal, fiberglass or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. Gluams are connected to the steel pipes with welded plate column caps.</td>
</tr>
</tbody>
</table>

### Interconnection of Elements

| ☑ | ☐ | ☐ | 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. |

### Panel Connections

| ☑ | ☐ | ☒ | 4.6.5.1 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. |
| ☑ | ☐ | ☒ | 4.6.5.2 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. |

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
## LATERAL-FORCE-RESISTING SYSTEM

### Concrete Shear Walls

<table>
<thead>
<tr>
<th>#</th>
<th>4.4.2.2.3</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>4.4.2.2.4</td>
<td>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.</td>
</tr>
<tr>
<td>#</td>
<td>4.4.2.2.5</td>
<td>CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>#</td>
<td>4.4.2.2.6</td>
<td>REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>#</td>
<td>4.4.2.2.7</td>
<td>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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>#</td>
<td>4.4.2.2.8</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Walls in Wood-Frame Buildings

| # | 4.4.2.7.9 | 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. |

### DIAPHRAGMS

#### General

| # | 4.5.1.1 | DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. |
| # | 4.5.1.2 | CROSS TIES: There shall be continuous cross ties between diaphragm chords. |

---

*Life Safety Performance Level.*

*There are no steel beams.*

*There are no split level roofs or expansion joints.*

Gulams and joists serve as the cross ties. In Area 3, there are no gulams in the EW direction. However, the area is small and a full height stud wall is located in the middle of the building. This statement is considered mitigated.
LATERAL-FORCE-RESISTING SYSTEM

☐  ☐  ☐  4.5.1.3 ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation.

☐  ☐  ☐  4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☐  ☐  ☒  4.5.1.5 OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25% of the frame length for Life Safety and 15% of the frame length for Immediate Occupancy.

☐  ☐  ☒  4.5.1.6 OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 ft long for Life Safety and 4 ft long for Immediate Occupancy.

☐  ☐  ☒  4.5.1.7 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. Life Safety Performance Level.

☐  ☐  ☒  4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.

Wood Diaphragms

☐  ☐  ☒  4.5.2.1 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. 1/2" plywood sheathing.

☒  ☐  ☐  4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. 1/2" plywood sheathing.

☒  ☐  ☒  4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

Metal Deck Diaphragms

☒  ☐  ☒  4.5.3.1 NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 ft and shall have aspect ratios less than 4 to 1. This statement shall apply to the Immediate Occupancy Performance Level only.

Other Diaphragms
### LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Code</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ ☐ ☒</td>
<td>OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal, deck, concrete or horizontal bracing.</td>
</tr>
</tbody>
</table>

### CONNECTIONS

#### Anchorage for Normal Forces

<table>
<thead>
<tr>
<th>Code</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ ☐ ☒</td>
<td>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.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>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 no greater than 1/8&quot;.</td>
</tr>
</tbody>
</table>

#### Vertical Components

<table>
<thead>
<tr>
<th>Code</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒ ☑ ☑</td>
<td>WOOD SILL BOLTS: Sill bolts shall be spaced at 6 ft or less for Life Safety and 4 ft or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>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.</td>
</tr>
</tbody>
</table>

#### Interconnection of Elements

<table>
<thead>
<tr>
<th>Code</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ ☐ ☒</td>
<td>GIRDERs: Girders supported by walls or pilasters shall have at least two ties securing the anchor bolts for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than 3&quot; for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements.</td>
</tr>
<tr>
<td>☐ ☐ ☒</td>
<td>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.</td>
</tr>
</tbody>
</table>

#### Panel Connections

<table>
<thead>
<tr>
<th>Code</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ ☐ ☒</td>
<td>ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12&quot; for Life Safety and 8&quot; for Immediate Occupancy.</td>
</tr>
</tbody>
</table>

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
BUILDING DATA

Year Built: 1980  
Year(s) Remodeled: 2003 (seismic upgrade)  
UBC Zone: 4 – Type B Near Field  
Area (sf): 47,200 SF  
Length (ft): 160  
Width (ft): 220  
No. Stories: 1  
Story Height: 21'  
Total Height: 21'

CONSTRUCTION DATA

Gravity Load Structural System: 5/8" or 3/8" plywood sheathing supported by 2x6 wood joists @ 24" o.c. in the EW direction and 48" deep trusses in the NS direction. The joists are supported by interior TS 6x6 columns and perimeter precast concrete shear walls.

Exterior Transverse Walls: 6.25" precast concrete shear walls  
Exterior Longitudinal Walls: 6.25" precast concrete shear walls  
Roof Framing: 5/8" or 3/8" plywood sheathing supported by 2x6 wood joists @ 24" o.c. in the EW direction and 48" deep trusses in the NS direction.

Intermediate Floor Framing: None  
Ground Floor: 6" slab on grade w/ 6x6 W1.4/W1.4 WWF on 6" aggregate base  
Columns: TS6x6  
Foundation: Concrete strip footing and spread footings

LATERAL-FORCE-RESISTING SYSTEM

System Classification: Longitudinal  
Type 11 (Precast concrete shear wall building w/ flexible diaphragm)

Vertical Elements: Wood joists and trusses, TS columns, perimeter precast concrete shear walls

Diaphragms: 5/8" or 3/8" plywood sheathing

System Classification: Transverse  
Type 11 (Precast concrete shear wall building w/ flexible diaphragm)

Vertical Elements: Wood joists and trusses, TS columns, perimeter precast concrete shear walls

Diaphragms: 5/8" or 3/8" plywood sheathing

SEISMIC EVALUATION PERFORMED? Yes  
EVALUATION: Rapid Evaluation  
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 1  
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:  
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:  
None recommended.
NOTE: This evaluation has been completed based on the drawings by Peoples Associates Structural Engineers, "Building 298 Roof Replacement", 2003, A1 To A5, S1 To S7. According to LLNL, the construction of the retrofit project has just been started. The results in this evaluation assume that the construction will be completed per the 2003 retrofit drawings.
### BUILDING SYSTEM

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>☒</td>
<td>LOAD PATH</td>
<td>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. Load is transferred from the 3/8&quot; or 5/8&quot; plywood sheathing to the wood joists and wood trusses, which are then transferred to the perimeter precast concrete panels. The panels are doweled in the concrete slab on grade. The S.O.G. is doweled in to the concrete strip footing below the precast walls.</td>
</tr>
<tr>
<td>☐</td>
<td>ADJACENT BUILDINGS</td>
<td>The clear distance between the building being evaluated and any adjacent building shall be greater than 4% of the height of the shorter building for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>☒</td>
<td>MEZZANINES</td>
<td>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. The 3/4&quot; plywood diaphragm and joists in the mezzanine frames into the interior partition walls of the main building. From mezzanine level down, there are 1/2&quot; plywood sheathing on both sides of the partition walls.</td>
</tr>
<tr>
<td>☐</td>
<td>WEAK STORY</td>
<td>The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy. One story building.</td>
</tr>
<tr>
<td>☒</td>
<td>SOFT STORY</td>
<td>The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. One story building.</td>
</tr>
<tr>
<td>☐</td>
<td>GEOMETRY</td>
<td>There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. One story building.</td>
</tr>
<tr>
<td>☒</td>
<td>VERTICAL DISCONTINUITIES</td>
<td>All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. The panels are doweled in the concrete slab on grade. The S.O.G. is doweled in to the concrete strip footing below the precast walls. One story building.</td>
</tr>
<tr>
<td>☐</td>
<td>MASS</td>
<td>There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. One story building.</td>
</tr>
<tr>
<td>☒</td>
<td>DETERIORATION OF WOOD</td>
<td>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. No site visit will be performed. Retrofit project under construction.</td>
</tr>
</tbody>
</table>

P:\Project\A02\000.099A\20047.06\Calcs\Active\Workshts\Calculations and Summary Sheets per Building\Bldg 298 Basic PC1.doc
ASCE 31* BASIC CHECKLIST PC1: PRECAST/TILT-UP CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

BUILDING SYSTEM

☐ ☑ ☑ 4.3.3.6 PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections.

LATERAL-FORCE-RESISTING SYSTEM

☒ ☐ ☐ 4.4.2.1.1 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.

☒ ☐ ☐ 4.4.2.3.1 SHEAR STRESS CHECK: The shear stress in the precast panels, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or graves for Life Safety and Immediate Occupancy.

☒ ☐ ☐ 4.4.2.3.2 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 $18''$ for Life Safety and Immediate Occupancy.

CONNECTIONS

☒ ☐ ☐ 4.6.1.1 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.

☒ ☐ ☐ 4.6.1.2 WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers.

☒ ☐ ☐ 4.6.2.1 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 strengths of the walls or diaphragms for Immediate Occupancy.

Comments

No site visit will be performed. Retrofit project under construction.

There are at least two lines of shear walls in each direction of loading.

The max. shear stress is 30 psi at the east and west elevations < 100 psi. Note: $2\sqrt{f'c} = 110$ psi for $f'c = 3,000$ psi.

Typ. reinforcement in reinforced concrete walls: At min. cross section of thickness = 6.25".

Vertical Reinforcing = #4@12" o.c.: reinforcing ratio = 0.0027 > 0.0007

Horizontal Reinforcing = #4@12" o.c. horizontal: reinforcing ratio = 0.0027 > 0.0007.

Spacing = 12" o.c. < 18" o.c.

In 2003, the roof seismic upgrade added HSS 4x3 members, bolted to the precast panels w/ (2) 5/8" M.B. Spacing of the HSS members is ~ 8" o.c.

Typical diaphragm to precast wall anchorage: Simpson HD2 @ 8'-0" o.c.

Typical diaphragm to precast wall anchorage for shear transfer: Wood trusses are nailed to 4x10 ledgers, which are connected to C9 channels @ 8" o.c. The C9's are bolted to the precast walls w/ (3) 1" diameter anchors.
ASCE 31* BASIC CHECKLIST PC1: PRECAST/TILT-UP CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

CONNECTIONS

☑ ☐ ☐ 4.6.3.7 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.

☑ ☐ ☐ 4.6.4.1 GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support.

The panels are doweled in the concrete slab on grade w/ #4 @ 12" o.c. The S.O.G. is doweled in to the concrete spread footing below the precast walls w/ 1/4 dowels, each footing.

Glulams are connected to the TS columns w/ column caps w/ (2) 3/4" diameter bolts.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.2.2.3 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.

☒ ☐ ☐ 4.4.2.3.3 WALL OPENINGS: The total width of openings along any perimeter wall line shall constitute less than 75% of the length of any perimeter wall for Life Safety and 50% for Immediate Occupancy with the wall piers having aspect ratios of less than 2 to 1 for Life Safety and Immediate Occupancy. Openings are < 75% of the length of any perimeter wall.

☐ ☐ ☒ 4.4.2.3.4 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.

☐ ☐ ☒ 4.4.2.3.5 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. Life Safety Performance Level.

☐ ☐ ☒ 4.4.2.3.6 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.2 CROSS TIES: There shall be continuous cross ties between diaphragm chords. Truss joists serve as the cross ties in the NS direction. 2x6 joists serve as the cross ties in the EW direction. Life Safety Performance Level.

☐ ☐ ☒ 4.5.1.7 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. Life Safety Performance Level.

☒ ☐ ☐ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Performance Level.

☐ ☐ ☒ 4.5.2.1 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. Diaphragm consists of plywood sheathing.

☒ ☐ ☐ 4.5.2.2 SPANS: All wood diaphragms with spans greater than 24 ft for Life Safety and 12 ft for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Spans = 8' < 24'. Diaphragm consists of plywood sheathing.
ASCE 31* BASIC CHECKLIST PC1: PRECAST/TILT-UP CONCRETE SHEAR WALL BUILDINGS WITH FLEXIBLE DIAPHRAGMS

DIAPHRAGMS

☐ ☐ ☐ 4.5.2.3 UNBLOCKED DIAPHRAGMS: All diagonally sheathed and unblocked wood structural panel diaphragms shall have horizontal spans less than 40 ft for Life Safety and 30 ft for Immediate Occupancy and shall have aspect ratios less than or equal to 4 to 1 for Life Safety and 3 to 1 for Immediate Occupancy.

☐ ☐ ☐ 4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.

CONNECTIONS

☒ ☐ ☐ 4.6.1.3 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.

☐ ☐ ☐ 4.6.3.10 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.

☒ ☐ ☐ 4.6.4.2 GIRDER: Girder supported by walls or pilasters shall have at least two ties securing the anchor bolts for Life Safety and Immediate Occupancy.

Typical diaphragm to precast wall anchorage for out of plane: Simpson HD2 @ 8'-0" o.c. Typical diaphragm to precast wall anchorage for shear transfer: Wood trusses are nailed to 4x10 ledgers, which are connected to C9 channels @ 8' o.c.. The C9's are bolted to the precast walls w/ (3) 1" diameter anchors.

3#5 continuous at bolts.

* = Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
DEGENKOLB ENGINEERS

Building Name: **Building 519B**  
Building Address: **Lawrence Livermore National Laboratory**  
Job Number: **A20047.08**  
Job Name: **LLNL Prioritization**  
Date: **August 8, 2003**  
Page: **1** of **2**  
By: **AK**  
Checked:

**PRIORITIZATION BUILDING DATA SHEET**

**BUILDING DATA**
- Year Built: -
- Year(s) Remodeled: -
- Area (sf): 3,200 sf
- Length (ft): 80'
- Width (ft): 40'
- No. Stories: 1
- Story Height: Sloped Roof
- Total Height: -
- UBC Zone: 4 – Type B Near Field

**CONSTRUCTION DATA**
- Exterior Transverse Walls: metal wall panels  
  Openings?: Roll up doors
- Exterior Longitudinal Walls: metal wall panels  
  Openings?: Roll up doors
- Roof Framing: Bare metal deck supported on steel roof beams
- Intermediate Floor Framing: -
- Ground Floor: Concrete slab on grade
- Columns: Wide flange columns located on the perimeter.
- Foundation: No structural drawings available.

**LATERAL-FORCE-RESISTING SYSTEM**

<table>
<thead>
<tr>
<th>Longitudinal (W-E)</th>
<th>Transverse (N-S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Classification: S3 – Steel Light Frames</td>
<td>S3 – Steel Light Frames</td>
</tr>
<tr>
<td>Vertical Elements: Steel wide flange columns</td>
<td>Steel wide flange columns</td>
</tr>
<tr>
<td>Diaphragms: Bare metal deck with roofing</td>
<td>Bare metal deck with roofing</td>
</tr>
</tbody>
</table>

SEISMIC EVALUATION PERFORMED? **Yes**  
EVALUATION: Rapid Evaluation  
YEAR: **2003**

SEISMIC EVALUATION CRITERIA: **Life Safety/ ASCE 31-02**

VULNERABILITY RATING: 3  
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: **CLASS D**
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

MEZZANINE
Mezzanine is attached to the structure on 3 sides only.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Provide angle braces at mezzanine.
# LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th></th>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>4.4.1.3.3 MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. No structural drawings available.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>4.4.1.3.7 COMPACT MEMBERS: All frame elements shall meet section requirements set forth by Table I-9-1 of Seismic Provisions for Structural Steel Buildings (AISC, 1997).</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☒</td>
<td>4.4.1.3.8 BEAM PENETRATIONS: All openings in frame-beam webs shall be less than 1/4 of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Evaluation.</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☒</td>
<td>4.4.1.3.10 OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. Life Safety Evaluation.</td>
</tr>
<tr>
<td>☐</td>
<td>☒</td>
<td>☒</td>
<td>4.4.1.3.11 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. Life Safety Evaluation.</td>
</tr>
</tbody>
</table>

## DIAPHRAGMS

<table>
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<tr>
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<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.5.7.1 OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete or horizontal bracing.</td>
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## CONNECTIONS

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<td>☒</td>
<td>4.6.3.10 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. No structural drawings. But pile foundations not typical at site.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>4.6.5.3 ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12&quot; for Life Safety and 8&quot; for Immediate Occupancy. No structural drawings available.</td>
</tr>
</tbody>
</table>

* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING DATA
Year Built: 1958  Year(s) Remodeled: None  UBC Zone: 4 – Type B Near Fiekl
Area (sf): 2,300  Length (ft): 51'-6"  Width (ft): 40
No. Stories: 1  Story Height: 12'  Total Height: 12'

CONSTRUCTION DATA
Gravity Load Structural System: 12" thick LWC flat slab supported by 8" to 1'-10" thick reinforced concrete shear walls.
Exterior Transverse Walls: 8" to 1'-10" thick reinforced concrete shear walls
Exterior Longitudinal Walls: 8" to 1'-10" thick reinforced concrete shear walls
Openings?: Door and window openings
Openings?: Door and window openings
Roof Framing: 12" thick LWC flat slab
Intermediate Floor Framing: None
Ground Floor: 8" concrete slab on grade w/ #4 @ 9" o.c.
Columns: None
Foundation: Concrete strip footing or thickened slab

LATERAL-FORCE-RESISTING SYSTEM
System Classification: Longitudinal  Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)  Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)
Vertical Elements: Concrete flat slab, concrete shear walls
Diaphragms: 12" thick concrete flat slab
Concrete flat slab, concrete shear walls
12" thick concrete flat slab

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02
VULNERABILITY RATING: 1
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None recommended.
ASCE 31ª BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

BUILDING SYSTEM

4.3.1.1 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.

4.3.1.3 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.

4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

4.3.3.5 POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coll anchors shall not have been used.

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

12" thick concrete slab transfers load to the perimeter and interior concrete shear walls. The shear walls are doweled into the foundation system.

The mezzanine level is bolted to concrete shear walls on all sides.

One story building.

One story building.

One story building.

The shear walls are doweled into the foundation system.

Concrete shear walls around the perimeter of the building.

Site visit made on 8/18/03. No signs of deterioration were observed except minor corrosion at one corner of a shear wall on the west side of the building.

Site visit made on 8/18/03. There are no cracks >1/8".
## LATERAL-FORCE-RESISTING SYSTEM

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<tr>
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<th>Comments</th>
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<tbody>
<tr>
<td>☒</td>
<td>☐</td>
<td>☒</td>
<td>4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.</td>
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<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.4.2.1.1 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.</td>
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<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or (2\sqrt{f_c}) for Life Safety and Immediate Occupancy.</td>
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<tr>
<td>☒</td>
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<td>☐</td>
<td>4.4.2.2.2 REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0025 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&quot; for Life Safety and Immediate Occupancy.</td>
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<tr>
<td>☒</td>
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<td>☐</td>
<td>There are at least 2 lines of resistance in each direction of loading.</td>
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<td>☐</td>
<td>The maximum shear stress is 39 psi &lt; 100 psi. Note: (2\sqrt{f_c} = 100) psi for (f_c = 2,500) psi.</td>
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<tr>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>Typ. reinforcement in reinforced concrete walls: 8&quot; thick wall: min. #4 @18&quot; o.c. E.F.; (\rho = 0.0028 &gt; 0.0025) 12&quot; thick wall: #4 @15&quot; o.c. E.F.; (\rho = 0.0022 &gt; 0.0015) horiz. #4 @ 9&quot; o.c. inside face, #6 @ 9&quot; o.c. outside face; (\rho = 0.0059 &gt; 0.0025) 24&quot; thick wall: vertical: #5@12&quot; o.c. E.F.; (\rho = 0.0022 &gt; 0.0015) horiz.: #6 @ 6&quot; o.c. E.F.; (\rho = 0.0061 &gt; 0.002)</td>
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<tr>
<td>☒</td>
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<td>☐</td>
<td>The spacing &lt; = 18&quot;.</td>
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</table>

## CONNECTIONS

| ☒ | ☐ | ☐ | 4.6.2.1 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 diaphragms for Immediate Occupancy. |
| ☒ | ☐ | ☐ | Rebar from slab dowels into concrete shear walls. |
| ☒ | ☐ | ☐ | 4.6.3.5 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. |
| ☒ | ☐ | ☐ | #4 dowels from wall to foundation |

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
ASCE 31* SUPPLEMENTAL CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

☐ ☐ ☒ 4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

☐ ☐ ☒ 4.4.2.2.3 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.

☐ ☐ ☒ 4.4.2.2.4 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.

☐ ☐ ☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d_p. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☒ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☐ ☐ ☒ 4.5.1.7 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.
**ASCE 31* SUPPLEMENTAL CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS**

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<td>4.5.1.8</td>
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</tbody>
</table>

**DIAPHRAGMS**

- **4.5.1.8** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

**CONNECTIONS**

- **4.6.3.10** 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.

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building Name: Building 810B
Building Address: Lawrence Livermore National Laboratory
Job Number: A20047.08
Job Name: LLNL Prioritization
Date: August 6, 2003

PRIORITIZATION BUILDING DATA SHEET

BUILDING DATA
Year Built: 1982
Area (sf): 900
No. Stories: 1

Year(s) Remodeled: None known
Length (ft): 32'-7"
Story Height: 27'-2"

CONSTRUCTION DATA
Gravity Load Structural System: 8" thick concrete roof slab over concrete beams spanning to concrete columns adjacent to concrete bearing walls
Exterior Transverse Walls: Reinforced concrete
Exterior Longitudinal Walls: Reinforced concrete
Roof Framing: Reinforced concrete beams and slab
Intermediate Floor Framing: N/A
Ground Floor: Reinforced concrete slab on grade, with lower pit area in center.
Columns: 16" sq. reinforced concrete
Foundation: Strip footings under walls, spread footings or concrete caissons under columns, retaining walls at pit.

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
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</thead>
<tbody>
<tr>
<td>System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm</td>
<td>C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm</td>
</tr>
<tr>
<td>Vertical Elements: Reinforced concrete shear walls</td>
<td>Reinforced concrete shear walls</td>
</tr>
<tr>
<td>Diaphragms: Reinforced concrete roof slab</td>
<td>Reinforced concrete roof slab</td>
</tr>
</tbody>
</table>


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 3
(I=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

UPLIFT AT PILE CAPS
There is no top reinforcement in the caissons, so that they may not be capable of resisting tension due to overturning.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
UPLIFT AT PILE CAPS
Further evaluation may show that tension demands are low enough that the caisson cap is adequate.
BUILDING SYSTEM

☐ ☐ ☐ 4.3.1.1 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.

☐ ☐ ☐ 4.3.1.3 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.

☐ ☐ ☐ 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.

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

☐ ☐ ☐ 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

☐ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☐ ☐ ☐ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

☐ ☐ ☐ 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

☐ ☐ ☐ 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

☐ ☐ ☐ 4.3.3.5 POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coll anchors shall not have been used.

☒ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

Comments: No post-tensioning anchors
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

Concrete beams span to columns embedded in walls.

☐ ☐ ☐ 4.4.2.1.1 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.

☐ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f_c}$ for Life Safety and Immediate Occupancy.

$V_{f}^{*\times \mu} = 35 \text{ psi} < 100 \text{ psi} \quad \text{OK}$

Spacing is not more than 18" o.c.

☐ ☐ ☐ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

Typical wall is 10", with #4@8" e.w.e.f. → 0.0049 OK

CONNECTIONS

☐ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

☐ ☐ ☐ 4.6.3.5 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.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐  ☐  ☒  4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

☐  ☐  ☒  4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

☐  ☐  ☒  4.4.2.2.3 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.

☐  ☐  ☒  4.4.2.2.4 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.

☐  ☐  ☒  4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8dₚ. This statement shall apply to the Immediate Occupancy Performance Level only.

☐  ☐  ☒  4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐  ☐  ☒  4.4.2.2.7 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”. This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒  ☐  ☐  4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒  ☐  ☐  4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☐  ☐  ☒  4.5.1.7 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.
## Diaphragms

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<tr>
<td></td>
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<td>✗</td>
<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
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</table>

## Connections

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<td></td>
<td>✗</td>
<td></td>
<td>4.6.3.10 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.</td>
</tr>
</tbody>
</table>

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING DATA

Year Built: 1961       Year(s) Remodeled: None known
Area (sf): 1200       Length (ft): 43'
No. Stories: 1       Story Height: 15'-5" with gun pit below grade

CONSTRUCTION DATA

Gravity Load Structural System: 8" reinforced concrete roof slab with concrete beams spanning to concrete bearing walls, with strip and spread footings.

Exterior Transverse Walls: Reinforced concrete
Exterior Longitudinal Walls: Reinforced concrete
Roof Framing: Concrete slab over concrete beams
Intermediate Floor Framing: N/A
Ground Floor: Typically 6" or 14" slab-on-grade, 8" slab above gun pit, gun pit filled in with 8" conc. slab
Columns: Concrete columns adjacent to walls
Foundation: Strip footings/tie beams; deeper, thick footings at gun pit

LATERAL-FORCE-RESISTING SYSTEM

System Classification: Longitudinal
                      C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Vertical Elements:  Reinforced concrete shear walls
Diaphragms:        Reinforced concrete slab

Transverse
C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Reinforced concrete shear walls
Reinforced concrete slab


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 1
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POSSIBLE LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None recommended
### BUILDING SYSTEM

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No post-tensioning anchors
## LATERAL-FORCE-RESISTING SYSTEM

- **COMPLETE FRAMES:** Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

- **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.

- **SHEAR STRESS CHECK:** The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{c}$ for Life Safety and Immediate Occupancy.

- **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" for Life Safety and Immediate Occupancy.

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<tr>
<td></td>
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<td></td>
<td>$V_{leq} = 71$ psi $&lt; 100$ psi OK</td>
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<td>Max spacing is 18&quot;.</td>
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<td>Typical wall is 8&quot;, with a minimum of #4@12&quot; e.w.e.f. $\rightarrow 0.0041$. OK</td>
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## CONNECTIONS

- **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 diaphragms for Immediate Occupancy.

- **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.

* -- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# LATERAL-FORCE-RESISTING SYSTEM

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<td>4.4.1.6.2</td>
<td>DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.</td>
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<td>4.4.1.6.3</td>
<td>FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
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<td>4.4.2.2.3</td>
<td>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.</td>
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<td>☒</td>
<td>4.4.2.2.4</td>
<td>OVERTURNING: All shear walls shall have aspect ratios less than 4 to 1. Wall pliers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.4.2.2.5</td>
<td>CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<tr>
<td>☐</td>
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<td>☒</td>
<td>4.4.2.2.6</td>
<td>REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>☐</td>
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<td>4.4.2.2.7</td>
<td>WALL THICKNESS: Thickness of bearing walls shall not be less than 1/2b the unsupported height or length, whichever is shorter, nor less than 4”. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
</tbody>
</table>

# DIAPHRAGMS

<p>| ☒ | ☐ | ☐ | 4.5.1.1 | DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. |
| ☒ | ☐ | ☐ | 4.5.1.4 | OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. |
| ☐ | ☐ | ☒ | 4.5.1.7 | 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. |</p>
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<td><strong>DIAPHRAGMS</strong></td>
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<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
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</table>

|   |    |    | **CONNECTIONS** |
|   |    |    | 4.6.3.10 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. |

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building Name: Building 817A
Building Address: Lawrence Livermore National Laboratory
Job Number: A20047.08
Job Name: LLNL Prioritization
Date: August 7, 2003
Page: 1 of 1
By: LKF
Checked: 

BUILDING DATA
Year Built: 1959
Area (sf): 400
No. Stories: 1

Year(s) Remodeled: None known
Length (ft): 26'
Story Height: 10'

UBC Zone: 4 – Type B Near Field
Width (ft): 16'
Total Height: 10'

CONSTRUCTION DATA
Gravity Load Structural System: 12" reinforced concrete roof slab to concrete bearing walls, with strip footings.

Exterior Transverse Walls: Reinforced concrete
Exterior Longitudinal Walls: Reinforced concrete
Roof Framing: 12" reinforced concrete roof slab
Intermediate Floor Framing: N/A
Ground Floor: Concrete slab-on-grade
Columns: N/A

Foundation: Strip footings, thickened footings, retaining walls around back and sides

Openings?: No; soil
Openings?: Doors on east; soil on west

LATERAL-FORCE-RESISTING SYSTEM
Longitudinal
System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Vertical Elements: Reinforced concrete shear walls
Diaphragms: Reinforced concrete slab

Transverse
C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Reinforced concrete shear walls
Reinforced concrete slab


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING:
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

COUPLING BEAMS:
3’ deep portion of wall above doors on east face is not detailed as a coupling beam (no 135° hooks).

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
THIS IS A LOW OCCUPANCY STRUCTURE WITH LOW SEISMIC DEMANDS. THEREFORE JUDGED TO MEET INTENT OF
LIFE SAFETY REQUIREMENTS
No further analysis required.
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<th>N/A</th>
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#### BUILDING SYSTEM

- **4.3.1.1 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.

- **4.3.1.3 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.

- **4.3.2.1 WEAK STORY:** The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

- **4.3.2.3 GEOMETRY:** There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

- **4.3.2.4 VERTICAL DISCONTINUITIES:** All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

- **4.3.2.5 MASS:** There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

- **4.3.2.6 TORSION:** The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

- **4.3.3.4 DETERIORATION OF CONCRETE:** There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

- **4.3.3.5 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.

- **4.3.3.9 CONCRETE WALL CRACKS:** All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

**Comments:**

- No post-tensioning anchors.
ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

☒ ☐ ☐ 4.4.2.1.1 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.

☒ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or \( \frac{f_{c}}{2} \) for Life Safety and Immediate Occupancy.

☒ ☐ ☐ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

There are no beams or columns. The concrete slab is well connected to the walls.

\( \frac{f_{c}}{2} = 13 \text{ psi} < 100 \text{ psi} \quad \text{OK} \)

Max spacing is 18". Typical wall is 12", with a minimum of #4@12" e.w.e.f. \( \rightarrow 0.0027 \). \quad \text{OK}

CONNECTIONS

☒ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

☒ ☐ ☐ 4.6.3.5 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.

Comments

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
**LATERAL-FORCE-RESISTING SYSTEM**

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<th>DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.</th>
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<td>No such secondary components.</td>
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<th>FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</th>
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<td>No such flat slabs.</td>
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<th>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.</th>
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<td>3' deep portion of wall above doors on east face is not detailed as a coupling beam (no 135° hooks). Further evaluation might show that this is not a life-safety issue. This is a low-priority potential deficiency because the shear stress in the walls is very low. Statement applies to Immediate Occupancy Performance Level only.</td>
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### CONNECTIONS

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</tr>
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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING DATA
Year Built: 1959  Year(s) Remodeled: 1971
Area (sf): 300  Length (ft): 36'
No. Stories: 1  Story Height: 10'

CONSTRUCTION DATA
Gravity Load Structural System: Reinforced concrete roof slab, spanning to concrete bearing/retaining walls, with strip footings.

Exterior Transverse Walls: 12" Reinforced concrete
Exterior Longitudinal Walls: 12" Reinforced concrete
Roof Framing: 12" concrete slab
Intermediate Floor Framing: N/A
Ground Floor: 6" Concrete slab-on-grade
Columns: N/A
Foundation: Strip footings, retaining walls around back and sides

Openings?: No; soil

Openings?: Door on west; soil on east

LATERAL-FORCE-RESISTING SYSTEM
Longitudinal
System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Vertical Elements: Reinforced concrete shear walls
Diaphragms: Concrete slab

Transverse
System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Vertical Elements: Reinforced concrete shear walls
Diaphragms: Concrete slab

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02
VULNERABILITY RATING: 2
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

COUPLING BEAMS:
Portion of wall above front doors is not detailed as a coupling beam (no 135° hooks).

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
THIS IS A LOW OCCUPANCY STRUCTURE WITH LOW SEISMIC DEMANDS. THEREFORE JUDGED TO MEET INTENT OF LIFE SAFETY REQUIREMENTS:
No further analysis required.
**ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS**

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**BUILDING SYSTEM**

- **☐ ☐ ☐ 4.3.1.1** 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.

- **☐ ☐ ☒ 4.3.1.3** 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.

- **☐ ☐ ☒ 4.3.2.1** WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

- **☐ ☐ ☒ 4.3.2.3** GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

- **☐ ☐ ☐ 4.3.2.4** VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

- **☐ ☐ ☒ 4.3.2.5** MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

- **☒ ☐ ☐ 4.3.2.6** TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

- **☒ ☐ ☐ 4.3.3.4** DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

- **☒ ☐ ☒ 4.3.3.5** 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.

- **☒ ☐ ☐ 4.3.3.9** CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

☒ ☐ ☐ 4.4.2.1.1 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.

☒ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2√f’c for Life Safety and Immediate Occupancy.

☒ ☐ ☐ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

There are no beams or columns. The concrete slab is well connected to the walls.

VJ* = 25 psi < 100 psi OK

Max spacing is 18".
Typical wall is 12", with a minimum of #4@12" o.w.e.f. → 0.0027. OK

CONNECTIONS

☒ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

☒ ☐ ☐ 4.6.3.5 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.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Status</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>4.4.1.6.2</td>
<td>DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.</td>
<td>☑</td>
<td>No such secondary components.</td>
</tr>
<tr>
<td>4.4.1.6.3</td>
<td>FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
<td>☑</td>
<td>No such flat slabs.</td>
</tr>
<tr>
<td>4.4.2.2.3</td>
<td>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.</td>
<td>☑</td>
<td>Portion of wall above doors at front face is not detailed as a coupling beam (no 135° hooks). Further evaluation might show that this is not a life-safety issue. This is a low-priority potential deficiency because the shear stress in the walls is low.</td>
</tr>
<tr>
<td>4.4.2.2.4</td>
<td>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.</td>
<td>☑</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>4.4.2.2.5</td>
<td>CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d_e. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>☑</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>4.4.2.2.6</td>
<td>REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>☑</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td>4.4.2.2.7</td>
<td>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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
<td>☑</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
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## DIAPHRAGMS

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<tbody>
<tr>
<td>4.5.1.1</td>
<td>DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>4.5.1.4</td>
<td>OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>4.5.1.7</td>
<td>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.</td>
<td>☑</td>
<td>Statement applies to Immediate Occupancy Performance Level only.</td>
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</table>
**ASCE 31* SUPPLEMENTAL CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS**

**DIAPHRAGMS**

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</table>

- 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

**CONNECTIONS**

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- 4.6.3.10 UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and plies 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.

*— Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING PLANS, ELEVATIONS, AND SECTIONS

PLAN AND ELEVATION FROM RETROFIT (1971) DRAWINGS
BUILDING DATA
Year Built: 1959
Area (sf): 300
No. Stories: 1

CONSTRUCTION DATA
Gravity Load Structural System: Concrete slab spanning to concrete bearing/retaining walls, with strip footings.
Exterior Transverse Walls: Reinforced concrete
Exterior Longitudinal Walls: Reinforced concrete
Roof Framing: 12" reinforced concrete slab
Intermediate Floor Framing: N/A
Ground Floor: 6" Concrete slab-on-grade
Columns: N/A
Foundation: Strip footings, retaining walls around back and sides

LATERAL-FORCE-RESISTING SYSTEM
Longitudinal
System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Vertical Elements: Reinforced concrete shear walls
Diaphragms: Reinforced concrete slab

Transverse
System Classification: C2: Concrete Shear Wall Building with Rigid or Stiff Diaphragm
Vertical Elements: Reinforced concrete shear walls
Diaphragms: Reinforced concrete slab

SEISMIC EVALUATION PERFORMED? Yes
EVALUATION: Rapid Evaluation
YEAR: 2003
SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02
2
VULNERABILITY RATING:
(1=low to 10=high)
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.
COUPLING BEAMS:
Portion of wall above front doors is not detailed as a coupling beam (no 135° hooks).
PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
THIS IS A LOW OCCUPANCY STRUCTURE WITH LOW SEISMIC DEMANDS. THEREFORE JUDGED TO MEET INTENT OF LIFE SAFETY REQUIREMENTS:
No further analysis required.
ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

BUILDING SYSTEM

☐ ☐ ☐ 4.3.1.1 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.

☐ ☐ ☐ 4.3.1.3 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.

☐ ☐ ☐ 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life Safety and Immediate Occupancy.

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

☐ ☐ ☐ 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

☐ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☐ ☐ ☐ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

☐ ☐ ☐ 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

☐ ☐ ☐ 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

☐ ☐ ☐ 4.3.3.5 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.

☐ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

Comments
## LATERAL-FORCE-RESISTING SYSTEM

- **4.4.1.6.1** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.
  - There are no beams or columns. The concrete slab is well connected to the walls.

- **4.4.2.1.1** 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.

- **4.4.2.2.1** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{fc}$ for Life Safety and Immediate Occupancy.
  - $\psi_{cg} = 25$ psi < 100 psi OK

- **4.4.2.2.2** 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" for Life Safety and Immediate Occupancy.
  - Max spacing is 18".
  - Typical wall is 12", with a minimum of #4@12" e.w.e.f. → 0.0027. OK

## CONNECTIONS

- **4.6.2.1** 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 diaphragms for Immediate Occupancy.

- **4.6.3.5** 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.

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LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☑ 4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

☐ ☐ ☑ 4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

☐ ☐ ☑ 4.4.2.2.3 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.

☐ ☐ ☑ 4.4.2.2.4 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.

☐ ☐ ☑ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☑ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☐ ☑ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☐ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☐ ☐ ☑ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☐ ☐ ☑ 4.5.1.7 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.
### DIAPHRAGMS

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<td>☑</td>
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<td>☑</td>
<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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### CONNECTIONS

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<td>4.6.3.10 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.</td>
</tr>
</tbody>
</table>

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*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING DATA

Year Built: 1959
Area (sf): 1,300
No. Stories: 1

Year(s) Remodeled: None
Length (ft): 51
Story Height: 11'

UBC Zone: 4 - Type B Near Fissle
Width (ft): 38
Total Height: 11'

CONSTRUCTION DATA

Gravity Load Structural System: 12" thick flat slab supported on interior and exterior 8" to 1'-0" thick reinforced concrete shear walls.

Exterior Transverse Walls: 8" to 1'-0" thick reinforced concrete shear walls
Exterior Longitudinal Walls: 8" to 1'-0" thick reinforced concrete shear walls

Roof Framing: 12" thick flat slab
Intermediate Floor Framing: None
Ground Floor: 4" thick concrete slab on grade w/ 4x4x6/6 WWF
Columns: None
Foundation: Concrete strip footing

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>System Classification:</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)</td>
<td>Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)</td>
</tr>
<tr>
<td>Vertical Elements:</td>
<td>Concrete flat slab, concrete shear walls</td>
<td>Concrete flat slab, concrete shear walls</td>
</tr>
<tr>
<td>Diaphragms:</td>
<td>12&quot; thick concrete flat slab</td>
<td>12&quot; thick concrete flat slab</td>
</tr>
</tbody>
</table>

SEISMIC EVALUATION PERFORMED?: Yes
EVALUATION: Rapid Evaluation
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 1
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

There are no potential life safety deficiencies identified.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None recommended.
## BUILDING SYSTEM

<table>
<thead>
<tr>
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<th>Comments</th>
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<tr>
<td></td>
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<td>4.3.1.1 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.</td>
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<tr>
<td></td>
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<td></td>
<td>12” thick LWC flat slab supported by 8” to 1’-0” thick reinforced concrete shear walls. The shear walls are dowelled into the foundation system.</td>
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<td>4.3.1.3 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.</td>
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<td>One story building.</td>
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<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
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<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting-system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
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<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
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<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<td>The shear walls are dowelled into the foundation system.</td>
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<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
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<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
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<td></td>
<td>Concrete shear walls around the perimeter of the building.</td>
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<td>4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
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<tr>
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<td></td>
<td>Site visit made on 8/18/03. No signs of deterioration were observed.</td>
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<td>4.3.3.5 POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coll anchors shall not have been used.</td>
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</tbody>
</table>
|   |   |   |   |   |   |   | Site visit made on 8/18/03. There are no cracks >1/8".
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☒ 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

☒ ☐ ☐ 4.4.2.1.1 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.

☒ ☐ ☐ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or \(2\sqrt{f_c}\) for Life Safety and Immediate Occupancy.

☒ ☐ ☐ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

There are at least 2 lines of resistance in each direction of loading.

The maximum shear stress is 18 psi < 100 psi. Note: \(2\sqrt{f_c} = 110\) psi for \(f_c = 3,000\) psi.

Typ. reinforcement in reinforced concrete walls:
8" thick wall:
vertical: \#5 @12" o.c.; \(\rho = 0.0032 > 0.0015\)
horizontal: \#4 @10" o.c.; \(\rho = 0.0025 = 0.002\)
12" thick wall: 2\#4 @12" o.c. E.W.; \(\rho = 0.0028 > 0.0025\)

The spacing \(< 18\)".

CONNECTIONS

☒ ☐ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

Rebar from slab dowels into concrete shear walls.

☒ ☐ ☐ 4.6.3.5 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.

Rebar dowels into foundation match vertical rebar in shear walls.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
# Lateral-Force-Resisting System

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<tr>
<td>4.4.1.6.2</td>
<td>DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.</td>
<td>No secondary elements.</td>
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<tr>
<td>4.4.1.6.3</td>
<td>FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
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<td>4.4.2.2.3</td>
<td>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.</td>
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<tr>
<td>4.4.2.2.4</td>
<td>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.</td>
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<tr>
<td>4.4.2.2.5</td>
<td>CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<tr>
<td>4.4.2.2.6</td>
<td>REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<tr>
<td>4.4.2.2.7</td>
<td>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“. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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## Diaphragms

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<tbody>
<tr>
<td>4.5.1.1</td>
<td>DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
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<tr>
<td>4.5.1.4</td>
<td>OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
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<tr>
<td>4.5.1.7</td>
<td>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.</td>
<td>Life Safety Performance Level.</td>
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## DIAPHRAGMS

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<tr>
<td>☐</td>
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<td>☒</td>
<td>4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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## CONNECTIONS

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<tr>
<td>☐</td>
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<td>4.6.3.10 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.</td>
</tr>
</tbody>
</table>

* – Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Building 818A

Building 818A is a one-story reinforced concrete bearing wall building. The structure consists of 2" asbestos panels. The deck is supported by steel beams. The steel beams span to interior and exterior concrete shear walls. Potential structural deficiencies noted for Building 818A are 1) The asbestos roof cannot adequately serve as a diaphragm; 2) Out of plane wall anchorage was found to be inadequate; and 3) There are no cross ties. For the building to meet life-safety requirements, we recommend that the roof be replaced or strengthened with horizontal rod bracing or metal deck. In addition, we recommend that the out of plane wall anchorage is strengthened and cross ties are added.
Building 826

Building 826 is a one-story reinforced concrete bearing building. The structure consists of a 6" thick concrete flat slab supported by concrete beams and columns or concrete shear walls. The primary structural deficiency noted for Building 826 is the canopy’s attachment to the main structure which induces cross grain bending on the wood ledger supporting the canopy. For the building to meet life-safety requirements, we recommend that the connection at the canopy be strengthened with steel straps.
Building Name: Building 826
Building Address: Lawrence Livermore National Laboratory
Job Number: A20047.08
Job Name: LLNL Prioritization

Date: July 31, 2003
Page: 1 of 1
By: JYF
Checked: JEH

PRIORITIZATION BUILDING DATA SHEET

BUILDING DATA
Year Built: 1961
Year(s) Remodeled: None
Area (sf): 2,200
Length (ft): 50
Width (ft): 43'-6"
No. Stories: 1
Story Height: 10'-10"
Total Height: 10'-10"
UBC Zone: 4 - Type B Near Field

CONSTRUCTION DATA
Gravity Load Structural System: 6" thick flat slab supported by concrete beams and columns or 8" to 1'-2" thick reinforced concrete shear walls.
Exterior Transverse Walls: 8" to 1'-2" thick reinforced concrete shear walls
Exterior Longitudinal Walls: 8" to 1'-2" thick reinforced concrete shear walls
Roof Framing: 6" thick flat slab supported by concrete beams
Intermediate Floor Framing: None
Ground Floor: 4" concrete slab on grade w/#4 @ 16" o.c. E.W.
Columns: 10" x 12" concrete columns
Foundation: Concrete strip footing or thickened slab
Openings?: Door and window openings

LATERAL-FORCE-RESISTING SYSTEM
System Classification: Longitudinal
Type 9 (Concrete Shear Wall Building w/Stiff Diaphragm)
Vertical Elements: Concrete flat slab, concrete beams and columns, concrete shear walls
Diaphragms: 6" thick flat slab

Transverse
Type 9 (Concrete Shear Wall Building w/Stiff Diaphragm)
Concrete flat slab, concrete beams and columns, concrete shear walls

6" thick flat slab

SEISMIC EVALUATION PERFORMED? Yes
EVALUATION: Rapid Evaluation
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 5
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS C
POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

CANOPY SUPPORT
The canopy is attached to the main building but induces cross grain bending on the wood ledger supporting the canopy.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
Demand on the building is low. There are two columns in the building. The potential deficiency identified for deflection compatibility can be mitigated through detailed analysis.
Retrofit canopy to main building connection. Replace connection at wood ledger to eliminate cross grain bending.
## ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

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<tr>
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<tbody>
<tr>
<td><strong>BUILDING SYSTEM</strong></td>
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<td>☑</td>
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<td>☑</td>
<td>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.</td>
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<td>☐</td>
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<td>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.</td>
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<tr>
<td>☐</td>
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<td>☑</td>
<td>WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
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<td>☐</td>
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<td>SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
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<td>☐</td>
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<td>GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
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<td>VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
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<td>MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
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<td>☑</td>
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<td>TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
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<td>☑</td>
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<td>☑</td>
<td>DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
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<td>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.</td>
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<td>CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
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### ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

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<td><strong>LATERAL-FORCE-RESISTING SYSTEM</strong></td>
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<td>❋</td>
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<td>4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.</td>
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<td>4.4.2.1.1 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.</td>
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<td>4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2\sqrt{f'_c}$ for Life Safety and Immediate Occupancy.</td>
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<td>4.4.2.2.2 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&quot; for Life Safety and Immediate Occupancy.</td>
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<td>There are at least 2 lines of resistance in each direction of loading.</td>
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<td>The maximum shear stress in the concrete block wall is 30 psi &lt; 100 psi. Note: $2\sqrt{f'_c}$ =100 psi for $f'_c = 2,500$ psi.</td>
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<td>Typ. reinforcement in reinforced concrete walls: 8&quot; thick wall: vertical: #4 @12&quot; o.c.; $\rho = 0.0021 &gt; 0.0015$ horizontal: #4 @9&quot; o.c.; $\rho = 0.0028 &gt; 0.0025$ 12&quot; thick wall: 2#4 @12&quot; o.c. E.W.; $\rho = 0.0028 &gt; 0.0025$ 24&quot; thick wall: 2#5@6&quot; o.c. vertical and 2#5 @ 12&quot; o.c. horizontal; $\rho = 0.00215 = 0.0025$</td>
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<td>The spacing &lt; = 18&quot;.</td>
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<td>Judged okay with respect to Life Safety for these large wall with Low Seismic demands.</td>
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</table>

### CONNECTIONS
| ☐ | ☐  | ☐  | 4.6.2.1 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 diaphragms for Immediate Occupancy. |
| ☐ | ☐  | ☐  | 4.6.3.5 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. |
|    |    |     | Rebar from slab dowels into concrete shear walls. |
|    |    |     | Rebar dowels into foundation match vertical rebar in shear walls. |

*-- Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
### LATERAL-FORCE-RESISTING SYSTEM

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<tr>
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<th>4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.</th>
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<tbody>
<tr>
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<td>0'-10&quot; x 1'-0&quot; columns have (8)#5 vertical rebar and 2#2 ties @ 10&quot; o.c. The shear capacity is not adequate to develop the flexural strength of the column.</td>
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<td>Deformations expected to be low in this small concrete shear wall building. Judged okay for Life-Safety.</td>
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<td>4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
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<td>4.4.2.2.3 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.</td>
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<td>4.4.2.2.4 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.</td>
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<td>4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<td>4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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<tr>
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<td></td>
<td>4.4.2.2.7 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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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### DIAPHRAGMS

|   |   |   |   | 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. |
|   |   | 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy. |
|   |   | 4.5.1.7 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. |

Life Safety Performance Level.
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<th>N/A</th>
<th>Comments</th>
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</table>

### DIAPHRAGMS

- **4.5.1.8** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

### CONNECTIONS

- **4.6.3.10** 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.

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
BUILDING DATA
Year Built: 1957
Area (sf): 1,300
No. Stories: 1

CONSTRUCTION DATA
Gravity Load Structural System: 12" thick flat slab supported by concrete columns or interior and exterior 8" to 1'-0" thick reinforced concrete shear walls.
Exterior Transverse Walls: 8" to 1'-0" thick reinforced concrete shear walls
Exterior Longitudinal Walls: 8" to 1'-0" thick reinforced concrete shear walls
Roof Framing: 12" thick flat slab
Intermediate Floor Framing: None
Ground Floor: 4" thick concrete slab on grade w/ 4x4x6/6 WWF
Columns: 1'-3" x 1'-3" concrete columns
Foundation: Concrete strip footing

LATERAL-FORCE-RESISTING SYSTEM
System Classification: Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)
Vertical Elements: Concrete flat slab, concrete columns and concrete shear walls
Diaphragms: 12" thick concrete flat slab

SEISMIC EVALUATION PERFORMED?: Yes  EVALUATION: Rapid Evaluation  YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 3
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:
THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.
None

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:
None.
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<tr>
<td><strong>LOAD PATH:</strong> 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.</td>
<td>8&quot; concrete flat slab supported concrete beams, which span to concrete columns or perimeter 12&quot; thick reinforced concrete shear walls. The shear walls are dowelled into the foundation system.</td>
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<tr>
<td><strong>MEZZANINES:</strong> 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.</td>
<td>One story building.</td>
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<tr>
<td><strong>WEAK STORY:</strong> The strength of the lateral-force-resisting system in any story shall not be less than 60% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.</td>
<td>One story building.</td>
<td></td>
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<tr>
<td><strong>SOFT STORY:</strong> The stiffness of the lateral-force-resisting system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy.</td>
<td>One story building.</td>
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<tr>
<td><strong>GEOMETRY:</strong> There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.</td>
<td>One story building.</td>
<td></td>
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</tr>
<tr>
<td><strong>VERTICAL DISCONTINUITIES:</strong> All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.</td>
<td>The shear walls are dowelled into the foundation system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MASS:</strong> There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.</td>
<td>One story building.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TORSION:</strong> The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
<td>Concrete shear walls around the perimeter of the building.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DETERIORATION OF CONCRETE:</strong> There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
<td>Site visit made on 8/18/03. No signs of deterioration were observed.</td>
<td></td>
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</tr>
<tr>
<td><strong>POST-TENSIONING ANCHORS:</strong> 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.</td>
<td>Site visit made on 8/18/03. There are no cracks &gt;1/8&quot;.</td>
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</tr>
<tr>
<td><strong>CONCRETE WALL CRACKS:</strong> All existing diagonal cracks in wall elements shall be less than 1/8&quot; for Life Safety and 1/16&quot; for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.</td>
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</tbody>
</table>
LATERAL-FORCE-RESISTING SYSTEM

☐  ☐  ☐  4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

☐  ☐  ☐  4.4.2.1.1 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.

☐  ☐  ☐  4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt{f_c}$ for Life Safety and Immediate Occupancy. There are at least 2 lines of resistance in each direction of loading.

☐  ☐  ☐  4.4.2.2.2 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” for Life Safety and Immediate Occupancy. The maximum shear stress is 31 psi < 100 psi. Note: $2 \sqrt{f_c} = 110$ psi for $f_c = 3,000$ psi.

☐  ☐  ☐  4.4.2.2.2 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” for Life Safety and Immediate Occupancy. Typ. reinforcement in reinforced concrete walls:

12” thick wall: 2#4 @16” o.c. E.W.; $p = 0.0021 < 0.0025$

The spacing $\leq 18$”.

CONNECTIONS

☐  ☐  ☐  4.6.2.1 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 diaphragms for Immediate Occupancy. Rebar from slab dowels into concrete shear walls.

☐  ☐  ☐  4.6.3.5 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. Rebar dowels into foundation match vertical rebar in shear walls.

*– Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

LATERAL-FORCE-RESISTING SYSTEM

☐ ☑ ☐ 4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

☐ ☑ ☐ 4.4.2.1.1 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.

☐ ☑ ☑ 4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or 2 $\sqrt{f'c}$ for Life Safety and Immediate Occupancy.

☐ ☑ ☑ 4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

There are at least 2 lines of resistance in each direction of loading.

The maximum shear stress is 31 psi < 100 psi. Note: $2 \sqrt{f'c} = 110$ psi for $f'c = 3,000$ psi.

Typ. reinforcement in reinforced concrete walls:
12" thick wall: 2#4 @16" o.c. E.W.; $\rho = 0.0021 < 0.0025$

The spacing $< = 18"$.

Building has low seismic demands. Judge okay for Life-Safety.

CONNECTIONS

☐ ☑ ☐ 4.6.2.1 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 diaphragms for Immediate Occupancy.

Rebar from slab dowels into concrete shear walls.

☐ ☑ ☐ 4.6.3.5 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.

Rebar dowels into foundation match vertical rebar in shear walls.

* - Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
**LATERAL-FORCE-RESISTING SYSTEM**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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. 1'-3&quot; x 1'-3&quot; columns have (4)#7 vertical rebar and 2#2 ties @ 12&quot; o.c. The shear capacity is not adequate to develop the flexural strength of the column. Building has low seismic demands. Judges okay for Life Safety.</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.4.2.2.3 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.</td>
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<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.4.2.2.4 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.</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.4.2.2.7 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&quot;. This statement shall apply to the Immediate Occupancy Performance Level only.</td>
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</tbody>
</table>

**DIAPHRAGMS**

<table>
<thead>
<tr>
<th></th>
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<th>Life Safety Performance Level.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.</td>
</tr>
<tr>
<td></td>
<td>✗</td>
<td></td>
<td>4.5.1.7 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.</td>
</tr>
</tbody>
</table>
BUILDING DATA

Year Built: 1960  
Area (sf): 6,200  
No. Stories: 1

Year(s) Remodeled: None  
Length (ft): 90  
Story Height: 15'

UBC Zone: 4 – Type B Near Field  
Width (ft): 61  
Total Height: 15'

CONSTRUCTION DATA

Gravity Load Structural System: 12” thick LWC flat slab supported on concrete beams. The concrete beams span to concrete columns in the interior or are supported by 8” to 2’-0” thick reinforced concrete shear walls.

Exterior Transverse Walls: 8” to 2’-0” thick reinforced concrete shear walls
Exterior Longitudinal Walls: 8” to 2’-0” thick reinforced concrete shear walls

Openings?: Door and window openings

Roof Framing: 12” thick LWC flat slab

Intermediate Floor Framing: None

Ground Floor: 8” to 10” concrete slab on grade w/ #4 @ 10” o.c. min. E.W.

Columns: 1-6” x 1-6” concrete columns
Foundation: Concrete strip footing or thickened slab

LATERAL-FORCE-RESISTING SYSTEM

Longitudinal
System Classification: Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)
Vertical Elements: Concrete flat slab, concrete beams and columns, concrete shear walls
Diaphragms: 12” thick concrete flat slab

Transverse
System Classification: Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)
Vertical Elements: Concrete flat slab, concrete beams and columns, concrete shear walls
Diaphragms: 12” thick concrete flat slab


SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 3

1=low to 10=high

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:

THIS BUILDING WAS EVALUATED FOR THE 10% IN 50 YR. EARTHQUAKE.

None.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

None.
ASCE 31* BASIC CHECKLIST C2: CONCRETE SHEAR WALL BUILDINGS WITH RIGID OR STIFF DIAPHRAGMS

BUILDING SYSTEM

☐ ☐ ☐ 4.3.1.1 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.

☐ ☐ ☐ 4.3.1.3 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.

☐ ☐ ☐ 4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy.

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

☐ ☐ ☐ 4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines.

☒ ☐ ☐ 4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation.

☒ ☐ ☐ 4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered.

☒ ☐ ☐ 4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.

☒ ☐ ☐ 4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.

☐ ☐ ☐ 4.3.3.5 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.

☒ ☐ ☐ 4.3.3.9 CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.

12" thick LWC flat slab supported on concrete beams. The concrete beams span to concrete columns in the interior or are supported by 8" to 2'-0" thick reinforced concrete shear walls. The shear walls are doweled into the foundation system.

The mezzanine level is bolted to concrete shear walls on all sides.

One story building.

One story building.

One story building.

The shear walls are doweled into the foundation system.

One story building.

Concrete shear walls around the perimeter of the building.

Site visit made on 8/19/03. No signs of deterioration were observed.

Site visit made on 8/19/03. There are no cracks >1/8".
## LATERAL-FORCE-RESISTING SYSTEM

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</tbody>
</table>

- **4.4.1.6.1** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

- **4.4.2.1.1** 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.

- **4.4.2.2.1** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2 \sqrt{f'c}$ for Life Safety and Immediate Occupancy.

- **4.4.2.2.2** 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" for Life Safety and Immediate Occupancy.

*There are at least 2 lines of resistance in each direction of loading.*

*The maximum shear stress is 65 psi < 100 psi. Note: $2 \sqrt{f'c} = 100$ psi for $f'c = 2,500$ psi.*

*Typ. reinforcement in reinforced concrete walls: 8" thick wall:*
  - vertical: #4 @12" o.c.; $\rho = 0.0021 > 0.0015$
  - horizontal: #4 @ 8" o.c.; $\rho = 0.0028 > 0.0025$

*12" thick wall:*
  - #4 @12" o.c. E.W.; $\rho = 0.0020 > 0.0025$

*24" thick wall:*
  - 2#5 @ 6" o.c. vertical and 2#5 @ 12" o.c. horizontal; $\rho = 0.00215 < 0.0025$

*The spacing < = 18".*

Seismic demands are low. Judged okay for Life-Safety.

## CONNECTIONS

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</table>

- **4.6.2.1** 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 diaphragms for Immediate Occupancy.

*Rebar from slab dowels into concrete shear walls.*

- **4.6.3.5** FOUNDATION DOWELS: Wall reinforcement shall be dowelled 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.

*Rebar dowels into foundation match vertical rebar in shear walls.*

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
LATERAL-FORCE-RESISTING SYSTEM

4.4.1.6.1 COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.

4.4.2.1.1 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.

4.4.2.2.1 SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2 \sqrt{f'c}$ for Life Safety and Immediate Occupancy.

4.4.2.2.2 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" for Life Safety and Immediate Occupancy.

There are at least 2 lines of resistance in each direction of loading.

The maximum shear stress is 65 psi < 100 psi. Note: $2 \sqrt{f'c} = 100$ psi for $f'c = 2,500$ psi.

Typical reinforcement in reinforced concrete walls:
- 8" thick wall:
  - Vertical: #4 @ 12" o.c.; $\rho = 0.0021 > 0.0015$
  - Horizontal: #4 @ 9" o.c.; $\rho = 0.0028 > 0.0025$
- 12" thick wall: #4 @ 12" o.c. E.W.; $\rho = 0.0028 > 0.0025$
- 24" thick wall: #5@6" o.c. vertical and #5 @ 12" o.c. horizontal; $\rho = 0.00215 > 0.0025$

The spacing $\leq 18"$.

CONNECTIONS

4.6.2.1 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 diaphragms for Immediate Occupancy.

Rebar from slab dowels into concrete shear walls.

4.6.3.5 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.

Rebar dowels into foundation match vertical rebar in shear walls.

* — Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
LATERAL-FORCE-RESISTING SYSTEM

☐ ☒ ☐ 4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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.

1"-6" x 1"-6" columns have (8)#7 vertical rebar and 2#2 ties @ 12" o.c. The shear capacity is not adequate to develop the flexural strength of the column.

Seismic demands are low. Judged okay for Life-Safety.

☐ ☒ ☒ 4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety.

☐ ☒ ☒ 4.4.2.2.3 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.

☐ ☒ ☒ 4.4.2.2.4 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.

Life Safety Performance Level.

☐ ☒ ☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Performance Level.

☐ ☒ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Performance Level.

☐ ☒ ☒ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

Life Safety Performance Level.

DIAPHRAGMS

☒ ☒ ☒ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☒ ☒ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

Life Safety Performance Level.

☒ ☒ ☒ 4.5.1.7 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.
DIAPHRAGMS

☐ ☐ ☒ 4.5.1.8 DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the immediate Occupancy Performance Level only.

Life Safety Performance Level.

CONNECTIONS

☐ ☐ ☒ 4.6.3.10 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.

*– Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.
Small shower enclosure added per site. Visit office concrete slab walls.
Building Name: Building 851  
Date: August 20, 2003  

Building Address: Lawrence Livermore National Laboratory  
Page: 1 of 1

Job Number: A20047.08  
Job Name: LLNL Prioritization  
By: JYF  
Checked: JEH

PRIORITIZATION BUILDING DATA SHEET

BUILDING DATA

Year Built: 1960  
Year(s) Remodeled: None  
UBC Zone: 4 – Type B Near Field

Area (sf): 10,800  
Length (ft): 87  
Width (ft): 124

No. Stories: 2  
Story Height: ~13’  
Total Height: 27’

CONSTRUCTION DATA

Gravity Load Structural System: 9” to 12” concrete flat slab supported by concrete beams, which span to interior concrete columns or interior and exterior 12” to 3’-0” concrete shear walls

Exterior Transverse Walls: 12” to 3’-0” thick reinforced concrete shear walls

Exterior Longitudinal Walls: 12” to 3’-0” thick reinforced concrete shear walls

Openings?: Door and window openings

Roof Framing: 9” thick flat slab supported by concrete beams typical, 12” thick flat slab at high roof

Intermediate Floor Framing: @ mezzanines: 1/4” checked plate supported by WF beams. The WF beams are embedded and bolted to the concrete shear walls on 4 side.

Ground Floor: 8” concrete slab on grade w/ #4 @ 10” o.c. E.W. typical

Columns: 14” x 16” concrete columns

Foundation: Concrete strip footing or thickened slab

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Transverse</th>
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<tbody>
<tr>
<td>System Classification: Type 9 (Concrete Shear Wall Building w/ Stiff Diaphragm)</td>
<td></td>
</tr>
<tr>
<td>Vertical Elements: Concrete flat slab, concrete beams and columns, concrete shear walls</td>
<td></td>
</tr>
<tr>
<td>Diaphragms: 9” to 12” thick flat slab</td>
<td></td>
</tr>
<tr>
<td>Concrete flat slab, concrete beams and columns, concrete shear walls</td>
<td></td>
</tr>
<tr>
<td>9” to 12” thick flat slab</td>
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</table>

SEISMIC EVALUATION PERFORMED? Yes  
EVALUATION: Rapid Evaluation  
YEAR: 2003

SEISMIC EVALUATION CRITERIA: Life Safety/ ASCE 31-02

VULNERABILITY RATING: 3  
(1=low to 10=high)

PRIORITIZATION CLASSIFICATION: CLASS D

POTENTIAL LIFE SAFETY DEFICIENCIES:

This building was evaluated for the 10% in 50 yr. earthquake.

None.

PRELIMINARY STRENGTHENING SCHEMES OR MITIGATION MEASURES:

None.
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<tr>
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<td><strong>BUILDING SYSTEM</strong></td>
</tr>
<tr>
<td>✓</td>
<td>☐</td>
<td>☐</td>
<td>4.3.1.1 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. 9&quot; or 12&quot; thick flat slab supported on concrete beams. The concrete beams spa to concrete columns in the interior or are supported by 12&quot; to 3'-0&quot; thick reinforced concrete shear walls. The shear walls are dowelled into the foundation system.</td>
</tr>
<tr>
<td>✓</td>
<td>☐</td>
<td>☐</td>
<td>4.3.1.3 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. The two mezzanines are supported by steel beams, which are embedded into the main buildings concrete shear walls. Note: At mechanical equipment room 4, the mezzanine floor consists of metal gratings. The gratings are connected to the WF beams below with clips only.</td>
</tr>
<tr>
<td>✓</td>
<td>☐</td>
<td>☐</td>
<td>4.3.2.1 WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80% of the strength in an adjacent story above or below for Life-Safety and Immediate Occupancy. Shear walls continue to the foundation.</td>
</tr>
<tr>
<td>✓</td>
<td>☐</td>
<td>☐</td>
<td>4.3.2.2 SOFT STORY: The stiffness of the lateral-force-resisting-system in any story shall not be less than 70% of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80% of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. Shear walls continue to the foundation.</td>
</tr>
<tr>
<td>✓</td>
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<td>4.3.2.3 GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30% in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. The shear walls are dowelled into the foundation system.</td>
</tr>
<tr>
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<td>4.3.2.4 VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. Shear walls all along perimeter of building.</td>
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<tr>
<td>✓</td>
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<td>☐</td>
<td>4.3.2.5 MASS: There shall be no change in effective mass of more than 50% from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses and mezzanines need not be considered. Site visit made on 8/20/03. No signs of deterioration were observed.</td>
</tr>
<tr>
<td>✓</td>
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<td>☐</td>
<td>4.3.2.6 TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20% of the building width in either plan dimension for Life Safety and Immediate Occupancy.</td>
</tr>
<tr>
<td>✓</td>
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<td>☐</td>
<td>4.3.3.4 DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements.</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>4.3.3.5 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.</td>
</tr>
</tbody>
</table>
### Building System

- **4.3.3.9** CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8" for Life Safety and 1/16" forImmediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern.  
  Site visit made on 8/20/03. There are no cracks >1/8".

### Lateral-Force-Resisting System

- **4.4.1.6.1** COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical load carrying system.
  There are at least 2 lines of resistance in each direction of loading.

- **4.4.2.1.1** 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.
  The maximum shear stress in the concrete block wall is 59 psi < 100 psi. Note: $2 \sqrt{f'_c} = 110$ psi for f'_c = 3.00 psi.

- **4.4.2.2.1** SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 100 psi or $2 \sqrt{f'_c}$ for Life Safety and Immediate Occupancy.
  Typ. reinforcement in reinforced concrete walls:
  - 12" thick wall: min. #4 @12" E,F. o.c.; $p = 0.0026 > 0.0025$
  - 2" thick wall: min. #5 @10" o.c. E,F.; $p = 0.0026 > 0.0025$
  - 3" thick wall: min. #5@6" o.c. E,F.; $p = 0.0029 > 0.0025$
  The spacing < 18".

### Connections

- **4.6.2.1** 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 diaphragms for Immediate Occupancy.
  Rebar from slab dowels into concrete shear walls.

- **4.6.3.5** 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.
  Rebar dowels into foundation. #4 @ 8" typ.

*— Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
LATERAL-FORCE-RESISTING SYSTEM

☐ ☐ ☐ 4.4.1.6.2 DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of 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. 1'-2" x 1'-4" columns have (6)#8 vertical rebar and 2#3 ties @ 14" o.c. The shear capacity is not adequate to develop the flexural strength of the column.

☐ ☐ ☒ 4.4.1.6.3 FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety. Seismic demands are low. Judged okay for Life-Safety.

☐ ☒ ☒ 4.4.2.2.3 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.

☐ ☒ ☒ 4.4.2.2.4 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.

☐ ☒ ☒ 4.4.2.2.5 CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2 to 1, the boundary elements shall be confined with spirals or ties with spacing less than 8d. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☒ ☒ 4.4.2.2.6 REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only.

☐ ☒ ☒ 4.4.2.2.7 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". This statement shall apply to the Immediate Occupancy Performance Level only.

DIAPHRAGMS

☒ ☐ ☐ 4.5.1.1 DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints.

☒ ☐ ☐ 4.5.1.4 OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25% of the wall length for Life Safety and 15% of the wall length for Immediate Occupancy.

☐ ☒ ☒ 4.5.1.7 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.
**DIAPHRAGMS**

- **4.5.1.8** DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only.

**CONNECTIONS**

- **4.6.3.10** 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.

*Checklist statements are based on the second public ballot version of ASCE 31. This checklist will be updated as revisions are made to ASCE 31.*
Appendix D  Cost Projections
## Seismic Strengthening Cost Projection for 41 Tier I Evaluated Buildings (80 Building Sectors)

### Basis for Cost Projection: FEMA 156 & 157

Cost Projections for 57 Non-Exempt Building Sectors (33 Building Sectors are Exempt with no Strengthening Required)

### Subject: Cost Projection

#### Job Number: A02X04.08

**Date:** 09/30/2003

**By:** JDN

**Section:** Appendix D

---

### Table: Cost Projections for 57 Non-Exempt Building Sectors

<table>
<thead>
<tr>
<th>Building Number</th>
<th>Year of Erection</th>
<th>Use of Structural System</th>
<th>Total Cost of Seismic Strengthening</th>
<th>Bid Construction Cost</th>
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</table>

### Group Subtotals:

- **Total Cost:** $15,909,000
- **Bid Construction Cost:** $11,800,000
- **Contributed:** 70.0%
Appendix E
Proposal and Statement of Work
June 30, 2003

Ms. Eileen Nasto
Contract Administrator Specialist
University of California
Lawrence Livermore National Laboratory
P.O. Box 5012
Livermore, California 94551

Reference: Request for Proposal
FEMA 310 Seismic Evaluation of 41 Buildings
Blanket Agreement No. H615700
[Degenkolb Job Number – A20047.08]

Dear Eileen:

We are pleased to respond to the request for proposal dated June 20, 2003, regarding the FEMA 310 Tier I evaluations of 41 buildings at Lawrence Livermore National Laboratory.

We have in-depth knowledge of buildings at Lawrence Livermore National Laboratory. We assisted LLNL with seismic screening of the building inventory to meet the requirements of Executive Order 12941. We performed detailed seismic evaluations and prepared recommendations for seismic strengthening for many buildings, including B131, B151, B231, B239, B241, B391 and B511.

Most recently, we assisted LLNL in establishing a prioritization system for seismic mitigation of buildings that do not meet the minimum requirements of Executive Order 12941; these buildings are identified as “non-exempt” buildings. At this time, there are 85 non-exempt buildings at LLNL. Forty-four of those buildings have been evaluated in the past and based on the type and extent of seismic deficiencies have been prioritized into one of the following categories: “Highest Priority”, “High Priority”, “Medium Priority”, and “Lowest Priority”. See Attachment A. Forty-one of those buildings have not been evaluated in the past, and therefore have not been prioritized.

The purpose of this project is to perform seismic evaluations of the 41 non-evaluated buildings in accordance with the Tier I screening evaluation procedure using FEMA 310 “Handbook for the Seismic Evaluation of Buildings – A Prestandard”. The buildings will then be prioritized based on the type and extent of seismic deficiencies, consistent with criteria and methodology used in previous evaluations. Cost projections for seismic mitigation will be prepared based on FEMA 156 and 157, and a summary report of findings will be prepared.
In addition to our past work at LLNL, we have assisted other building owners in performing seismic evaluations and developing prioritization programs for seismic strengthening, including the Veterans Administration, Kaiser Permanente, Hewlett-Packard, and the University of California at Berkeley. This experience combined with our in depth knowledge of the buildings at LLNL makes us well qualified to assist LLNL with this important project.

Scope of Work

We will perform our work in accordance with the Statement of Work contained in the RFP for the following buildings:

LLNL Main Site:


LLNL Site 300:


See Attachment B for available information on the size and building system for each of the 41 buildings included in this project.

We propose to perform the following tasks:

1. Attend project kick-off meeting with LLNL project team.

2. Coordinate with LLNL personnel to obtain drawings for each of the 41 buildings identified in the Statement of Work. The drawings will be the basis for the seismic evaluations.

3. Review drawings and collect general building information using the Prioritization Building Data Sheet. This involves gathering general building data (size, number of stories, year of construction etc.), and construction data (gravity system, lateral system, wall system, and foundation system description). This Data Sheet will also be used to prioritize potential seismic deficiencies.
4. Perform a Tier I screening evaluation in accordance with FEMA 310 procedures. The purpose of this evaluation is to identify potential seismic deficiencies in the building without performing a detailed seismic evaluation. An understanding of the potential seismic deficiencies within each building will be the basis for prioritizing each building as part of the LLNL seismic mitigation program.

5. Perform a walkthrough of each of the 41 buildings. We understand that there may be limited access to certain buildings or areas within the buildings. The intent of the walkthrough is to confirm that the available drawings properly identify the extent of the building, and to observe whether significant building modifications have occurred.

6. Prioritize each of the 41 buildings into one of the following categories:
   - **“Highest Priority Buildings”:** Buildings that are “Exceptionally High Risk” and require evaluation and mitigation of seismic deficiencies in accordance with RP6. In accordance with EO 12941, exceptionally high risk buildings are defined on the basis that a) they have a structural system known to be especially vulnerable to earthquake induced damage, or b) they have a combination of high occupancy and high seismic risk in accordance with Approach A in the DOE Management Plan. **We expect none of the 41 buildings will be placed in this classification.**
   - **“High Priority Buildings”:** Buildings that do not meet Life Safety and have the potential to sustain heavy damage and possibly local collapse in a major earthquake, but some margin against total collapse based on observed behavior of similar buildings in past earthquakes. **We expect a small number of the 41 buildings will be placed in this classification.**
   - **“Medium Priority Buildings”:** Buildings that do not meet Life Safety and may incur life threatening level of damage, with collapse not likely. **We expect approximately 50% of the 41 buildings will be placed in this classification.**
   - **“Lowest Priority Buildings”:** Buildings that do not have structural Life Safety deficiencies, but have potential nonstructural deficiencies. **We expect approximately 50% of the 41 buildings will be placed in this classification.**
7. Prepare cost projections for the seismic mitigation of the 41 buildings using FEMA 156 and 157 methodology. Cost projections are based on an accumulation of data regarding actual costs of strengthening buildings collected by FEMA. The FEMA 156/157 methodology presents costs on a dollar per square foot basis depending on level of ground shaking, desired performance level, building size and lateral system type. The cost projections are adjusted based on the level of certainty desired. We will present the average cost of strengthening and the cost of strengthening to obtain a 90% confidence level.


9. Meet with LLNL to review draft report.

10. Obtain LLNL comments and prepare final report.

The prioritization of the 41 buildings into the four categories will be consistent with the methodology used for prioritization of the 44 buildings that we have previously evaluated. The prioritization goes beyond the FEMA 310 Tier I evaluations and is based on the expected damage state of each building following a major earthquake.

We assume that each of the 41 buildings contains one building sector to be evaluated. We have not included time to evaluate multiple independent building sectors within each of the 41 buildings. Nonstructural evaluations are not included.

Personnel

Jorn E. Halle will be the Principal and project manager and will be assisted by Darrick Hom, who will be the lead engineer. Joyce Feng, Gina Sandoval and Allen Kwan will be design engineers. Chris D. Poland will serve as project mentor, providing in-house consultation and review. Resumes for each team member is attached.

All employees of Degenkolb Engineers that will be working on this project are United States citizens.

Ms. Feng, Ms. Sandoval, and Mr. Kwan are California licensed Professional Engineers and have considerable experience in the evaluation of existing buildings.
June 30, 2003
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Mr. Halle, Mr. Hom and Mr. Poland are California licensed Structural Engineers and have extensive experience in the seismic evaluation and mitigation of existing buildings. Mr. Poland, with the assistance of Mr. Hom, led the project to develop FEMA 310 and then to turn it into an American Society of Civil Engineer Standard ASCE 31.

Compensation

We propose to perform our work on a fixed fee basis for $112,000 in accordance with our Blanket Agreement Number H615700 with LLNL. We estimate that our reimbursable expenses will be in the range of $500 for creating copies of the report, mail, and mileage to LLNL. Attached is a fee worksheet showing a breakdown of our effort.

We intend to use five labor categories titled Senior Principal, Principal, Project Engineer, Design Engineer, and Engineering Administrator. Hourly billing rates are in accordance with our Blanket Agreement.

We will not submit or deliver to the University any proprietary technical data.

We will complete a draft Report delivered to LLNL by the end of September. We expect that LLNL will take two weeks to review the report so that we can submit the Final Report by October 30, 2003. We assume that work will start on Monday July 7, 2003.
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We appreciate the opportunity to be of continued service to LLNL. Please contact us immediately if you need additional information or clarification.

Very truly yours,
DEGENKOLB ENGINEERS

Jorn E. Halle
Principal, S. E. 3966

Chris D. Poland
Senior Principal, S. E. 2336

ACCEPTED: Lawrence Livermore National Laboratory

BY: 

DATE:

PURCHASE ORDER OR REFERENCE NUMBER:
The following Degenkolb Engineers' personnel are licensed by the California Board for Professional Engineers and Land Surveyors (Effective February 3, 2003)

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Ayrosa, Anna Marie V.
Barnard, Matthew P.
Bartoletti, Stacy J.
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This information is provided pursuant to section 138 of the Business and Professions Code and Title 16, Chapter 5 California Code of Regulations section 463.5.
Appendix F  Degenkolb Engineers Letter Dated June 6, 2003
June 6, 2003

Mr. Dave Coats  
University of California  
Lawrence Livermore National Laboratory  
P.O. Box 5502  
Livermore, California 94551

Reference: Seismic Mitigation and Prioritization Study  
Release KXM0001 under Blanket Agreement H615700  
Lawrence Livermore National Laboratory  
[Degenkolb Job Number A20047.02]

Dear Dave:

We enjoyed meeting with you and Mr. Frank Tokarz to discuss the seismic mitigation program for existing buildings at Lawrence Livermore National Laboratory. The purpose of this letter is to summarize our discussion on key issues regarding the seismic mitigation program, including:

- Basis for “Exempt” status of buildings in the 1998 Executive Order 12941 Report,
- Regulatory requirements to mitigate structural deficiencies in “Non-Exempt” buildings,
- Description of expected performance and damage state of buildings that are “Non-exempt” and,
- Recommendations for evaluations to better define cost of seismic strengthening for high priority “Non-Exempt” buildings.

Background

The seismic mitigation program at LLNL was initiated in 1996 to meet the requirements of Executive Order 12941 (EO 12941) dated December 1, 1994. EO 12941, titled Seismic Safety of Federally Owned or Leased Buildings, required each federal agency to develop an inventory of its buildings and to estimate costs of mitigating unacceptable seismic risks in those buildings. In September 1998, LLNL submitted to the Department of Energy an electronic database with building inventory information and a report titled “Supporting Documentation on the Implementation of EO 12941”. A summary report titled “Seismic Evaluation for Compliance with Executive Order 12941”, was prepared by Degenkolb in October 1998.
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EO 12941 also required the development of standards for the seismic rehabilitation of Federal Buildings. RP4, titled Standards of Seismic Safety for Existing Federally Owned or Leased Buildings was developed by the Interagency Committee on Seismic Safety in Construction (ICSSC) as the minimum technical standard for evaluation and mitigation of seismic risks. This Standard was recently updated to incorporate new knowledge in earthquake engineering gained from research and from observed performance of structures in recent earthquakes. RP6, Standards of Seismic Safety for Federally Owned and Leased Buildings, dated January 18, 2002 is the revision to RP4.

RP6 is the current Federal regulatory Standard that provides common minimum requirements for the seismic safety of existing Federal buildings. The primary objective of the Standards is to reduce the life-safety risk to occupants and to the public. Therefore, Life-Safety is defined as the minimum performance level appropriate for Federal Buildings. Life-Safety building performance is described as “building performance that includes significant damage to both structural and nonstructural components during the design earthquake, though at least some margin against either partial or total structural collapse remains. Injuries may occur, but the level of risk for life threatening injury and entrapment is low. People will likely be unable to reoccupy the building for continuous use until structural repairs are completed.”

RP6 Standards include:
- Criteria for defining buildings as “exempt” from the Standards,
- Definition of situations that trigger the need for seismic evaluation and mitigation of existing Federal buildings,
- Minimum standards for the seismic evaluation of existing buildings,
- Minimum standards for the seismic mitigation of existing buildings, and
- Requirement that each Agency develop standards for performance levels higher than life-safety

The work to comply with the EO12941 requirements and prepare the 1998 report had four components, including the building inventory, building evaluation, cost estimation, and reporting.

1. The inventory phase included collecting building data for all buildings at LLNL. Buildings meeting the requirements of RP4 and the DOE Management Plan were identified as “exempt” from seismic evaluation and mitigation. The remaining buildings were identified as “non-exempt”. This exempt status means that they are judged to be adequate from a seismic safety perspective and need no further consideration.
The evaluation phase included the evaluation of a sample of non-exempt building representative of the building stock at LLNL, along with several buildings having the potential of being classified as Exceptionally High Risk. Most of the buildings evaluated were required to meet the Life-Safety performance level (PC1), and a few were evaluated for higher performance levels (PC2/PC3). The majority of PC1 buildings had a rapid Tier 1 or a detailed Tier 2 evaluation performed. The majority of PC2/PC3 buildings were not evaluated, although we expect that many will likely meet Life-Safety requirements if evaluations are performed.

The cost estimation phase included development of cost projections for the seismic mitigation of all non-exempt buildings using the methodology of FEMA 156 and 157, *Typical Costs for Seismic Rehabilitation of Existing Buildings*.


Subsequent to your 1998 report, the seismic mitigation program at LLNL has evolved as building functions have changed and seismic evaluation and mitigation work has continued. This has resulted in changes in the status of a number of exempt and non-exempt buildings. At the time of the 1998 E012941 report, there were a total of 534 buildings included in the facility database. Of those buildings, 449 are currently identified as exempt and 85 are non-exempt.

**Exempt Buildings**

The criteria used at LLNL to define buildings as “exempt” from seismic evaluation and mitigation were taken directly from the Federal Standard RP4 and the DOE Management Plan. These exemptions are valid and represent that these buildings meet Life-Safety performance in the judgement of the ICSSC. These exemptions are based on earthquake engineering research and observation of building performance in past earthquakes. Buildings that are “exempt” do not require further evaluation or mitigation to comply with the minimum Federal Standard for seismic safety of existing Federal buildings. RP6 uses similar exemptions.
The 449 exempt buildings at LLNL have been classified based on the following nine categories:

Exemption E1: There are 21 buildings classified as intended for incidental human occupancy, or occupied by persons for a total of less than two hours a day. The low potential that any one building will collapse, combined with the low occupancy within these structures results in a very low life safety risk.

Exemption E2: There are zero buildings classified as detached family dwellings in an area of low seismicity.

Exemption E3: There are 81 small one story buildings of steel light frame or wood construction with an area less than 3000 square feet. Performance of these types of buildings is very similar to modern residential construction found in the United States. Observed performance of these structures in past earthquakes is very good with respect to the life safety performance level.

Exemption E4: There are 14 buildings that have been previously strengthened to meet RP4 requirements for life safety protection or better and are therefore acceptable.

Exemption E5: There are 306 buildings designed and constructed in accordance with seismic provisions that are considered by Federal Standard RP4 to provide life-safety protection. RP4 defines “benchmark” years for each building code that are considered to result in a building that meets a Life Safety performance level. The benchmark year is dependent on the code and the type of construction. This definition is largely based on observed behavior of buildings in past earthquakes and a knowledge of when modern detailing practices were introduced into codes.

Exemption E6: There are 16 buildings that have been evaluated and meet “life-safety” protection standards. Seven buildings were evaluated by Degenkolb and nine buildings were evaluated by Engle & Engle prior to 1994. We recommend a re-evaluation of the buildings to confirm the Engle & Engle findings, because the evaluations were based on University of California Evaluation criteria, which is different from the E012941 criteria.

Exemption E8: There are 8 buildings as of year 2001 scheduled for abandonment or demolition within the next five years. This timeframe for removal of the deficiency is consistent with the timeframe to seismically strengthen an existing building and is therefore judged to be acceptable.
See attachment A for identification of specific buildings classified by exemption category.

Non-Exempt Buildings

There are currently eighty-five “non-exempt” buildings on the LLNL campus. These buildings require seismic evaluation to confirm their level of deficiency, and some will require seismic mitigation, in order to meet the Federal Standards seismic safety of existing buildings. These buildings define the extent of the seismic mitigation program at LLNL. See attachment B for a summary of the recommended LLNL seismic mitigation program.

Regulatory Requirements For Seismic Mitigation of Non-Exempt Buildings:

RP6 currently mandates seismic rehabilitation only if a building is considered to be an “exceptionally high risk” or if certain trigger events occur. Such events include changes in facility use, major building alterations, or when the building experiences earthquake related damage. The extent of mandated seismic mitigation work is therefore low (4 out of 85 buildings) relative to the overall extent of work in the LLNL seismic mitigation program.

RP6 states that as a minimum, a building shall be evaluated and unacceptable risks mitigated when any of the following occur:

1. a change in function results in a significant increase in the building’s level of use, importance, or occupancy,
2. a project is planned which significantly extends the building’s useful life through alterations or repairs which total more than 30% of the replacement value of the building,
3. the building or part of the building has been damaged by fire, wind, earthquake, or other cause to the extent that significant structural degradation of the vertical or lateral capacity has occurred.
4. the building is deemed to be exceptionally high risk to occupants or the public at large, or
5. the building is added to the Federal inventory through purchase or donation after.
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The majority of the seismic mitigation work at LLNL is left to the discretion LLNL and the DOE (81 out of 85 buildings). The duration of the program will likely depend on the availability of funding, resources, schedule to perform the rehabilitation work, and opportunity planning to coincide with other work. To be most effective, the program should be based on a prioritization system. Based on our past conversations, we understand that at LLNL prioritization will be based on seismic performance and building occupancy level.

Seismic Mitigation Recommendations for Non-Exempt Buildings:

In our recent meetings, we identified five classes of buildings at LLNL that require seismic evaluation and mitigation. The 85 non-exempt buildings are placed in one of the five building classes (Class A-E) depending on the severity of the seismic vulnerability and whether the buildings have been evaluated in the past.

Class A – Highest Priority Buildings (4 Buildings):

Buildings 377, 231, 241, and 511 are currently rated as “Exceptionally High Risk” in the 1998 E012941 report and require evaluation and mitigation of seismic deficiencies in accordance with RP6. Exceptionally high risk buildings were defined in the 1998 evaluation on the basis that a) they have a structural system known to be especially vulnerable to earthquake induced damage, or b) they have a combination of high occupancy and high seismic risk in accordance with Approach A in the DOE Management Plan. Exceptionally high risk buildings have the potential for collapse. We recommend the following:

- Building 377: This building is one story measuring 5,000 square feet with masonry walls and a heavy precast plank roof system with minimal interconnections. This type of structural system may exhibit poor performance in a seismic event. We recommend developing a seismic strengthening schemes to upgrade life safety protection.

- Building 511: This building is a large wood framed building constructed in 1942 and previously used as an airplane hanger. The building measures 60,000 square feet and contains a high bay center portion and low bay wings. Our seismic evaluations have identified high demand capacity ratios combined with a high occupancy, therefore placing the building in the exceptionally high risk category. We recommend strengthening building 511 according to recommendations in August 2002 report by Degenkolb. Further evaluation is not required.
Building 231: This building, initially constructed in 1969, has 8 seismically independent sectors constructed primarily of steel with perimeter concrete non-bearing walls, measuring a total of 137,000 square feet. Our past seismic evaluations have identified high demand capacity ratios combined with a high occupancy, therefore placing the building in the exceptionally high risk category. This building has had a past detailed evaluation that focused on development of strengthening recommendations to PC2 in the past. A computer analysis was not performed. We recommend that a detailed evaluation be performed and strengthening concepts and cost estimates developed to upgrade the building to life safety.

Building 241: This building was constructed in 1960 and measures 54,000 square feet. The building is steel framed and has a perimeter precast nonbearing walls. This building has had a past detailed evaluation that focused on development of strengthening recommendations to PC2. A computer analysis was not performed. We recommend that a detailed evaluation be performed and strengthening concepts and cost estimates developed to upgrade the building to life safety.

Class B – High Priority Buildings (5 Buildings):

Buildings 391, 321,381, 131 and 194 do not meet Life Safety and are classified as having a High Priority. Heavy damage and possibly local collapse conditions are expected in a major earthquake, but some margin against total collapse is expected based on observed behavior of similar buildings in past earthquakes.

We recommend these buildings be evaluated and strengthened to life-safety as an “active” part of the LLNL seismic mitigation program. Determine cost to strengthen, obtain funding and strengthen as funding becomes available. Note that RP6 does not currently trigger action. Past seismic evaluations are available and have focused on development of strengthening schemes to the PC2 level.

Building 391 has been evaluated in the past and construction documents for strengthening to the life-safety performance level are available.
Class C – Medium Priority Buildings (13 Buildings):

Thirteen buildings do not meet Life Safety and are classified as having medium priority.

- Buildings 141, 151, 251, 255, and 343 have the potential for “life threatening damage”, affecting people in the local vicinity of where the damage will occur, but collapse is not likely.

- Buildings 216, 217, 218, 219, 314, 315, 316, and 319 are two story wood framed barracks buildings. The primary deficiency is the lack of a cripple wall between the foundation and the raised first floor. There is a potential that the buildings will suffer a local collapse condition between the foundation and first floor. The consequence of this collapse is not likely to threaten life safety.

We recommend strengthening of these buildings as they are remodeled or modernized, or as seismic mitigation funding becomes available.

Class D - Evaluated Buildings with Non-Structural Deficiencies Only (22 Buildings):

Twenty-two of the 85 non-exempt buildings have been evaluated and do not have structural deficiencies that require mitigation to meet Life Safety performance. However, these buildings are not exempt because they may have non-structural deficiencies. Nonstructural bracing deficiencies may result in life threatening damage due to falling hazards. However, mitigating these deficiencies is a Low Priority relative to mitigating structural deficiencies. We recommend that nonstructural bracing deficiencies be identified and mitigated as part of an ongoing facility maintenance program for all non-exempt buildings. See attachment B for identification of buildings in this category.
Class E - Non-Evaluated Buildings (41 Buildings):

Forty-one of the 85 non-exempt buildings have not been seismically evaluated. Most of the non-evaluated buildings are classified by LLNL as having a target PC2 or PC3 performance objective. Since the focus of the initial evaluations was on PC1 buildings, the PC2 and PC3 buildings were not evaluated.

We recommend that a Tier I evaluation for Life Safety be performed on the non-evaluated buildings so that buildings can be prioritized with the other non-exempt buildings. Although this evaluation will be inconclusive with regards to the buildings meeting PC2 and PC3 criteria, we expect that approximately 1/3 of the buildings will meet Life Safety and be placed in Class D, thus reducing the overall scope of the seismic mitigation program. We expect the majority of the buildings that do not meet Life Safety will be placed in Class C, Medium Priority with some potentially in Class B, High Priority.

Recommendations

As the next step in the seismic mitigation program at LLNL we recommend performing the following evaluations:

**Tier I Evaluations for previously non-evaluated buildings:**
Perform Tier I evaluations of the 42 buildings that have not previously been evaluated. We expect that up to 33% of these buildings will meet the "life safety" performance criteria. The intent of these evaluations is to eliminate some buildings from the seismic mitigation program by showing they meet life safety criteria by evaluation. The buildings that do not meet life safety can then be prioritized with the previously evaluated buildings.

**Tier II Evaluations for High Priority Buildings:**
Perform detailed Tier II evaluations and develop concept level strengthening schemes to the life safety performance level for the buildings currently identified as High Priority and above. These include buildings 377, 231, 241, 381, 131, 194. Buildings 511, 321, and 391 have completed life safety strengthening concepts and require no additional evaluation work. The intent of these evaluations is to prepare conceptual strengthening schemes for costing purposes, and to reclassify building priority if appropriate. Past building evaluations will be used where possible.
We appreciate the opportunity to be of continued service to LLNL. Please contact us if you would like to schedule a meeting or discuss the information contained in this letter. We will be happy to prepare a more detailed scope of work identifying extent of evaluation work necessary per building as the need arises.

Very truly yours,

DEGENKOLB ENGINEERS

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