Kensington Public Safety Building: Risk Assessment Report

The Kensington Public Safety Building is undergoing a retrofit in accordance with the 2019 California Existing Building Code in order to address potentially life-threatening seismic deficiencies. While this retrofit will conform to code due to the extensive nature of the planned upgrades to the building, the Board of Directors desires to better quantify the increase in performance the structure experiences due to the retrofit. ZFA has performed an Advanced SP3 Risk Analysis following the FEMA P-58 methodology, a national standard for performing seismic risk assessments. The methodology focuses on three key metrics – Financial Losses, Loss of Life, and Recovery Time – in the wake of a seismic event.

Summary of Risk Assessment Approach

To properly capture the performance of the building, ZFA produced (4) analytical building models in the SP3 software – (2) existing and (2) retrofitted – and then averaged the results of the models based on the proportion of building area included in each. The models included structural and non-structural components which are assigned acceleration and drift capacities. In an earthquake, the whole building and its contents move. SP3 provides values for standard building components and evaluates the probability of damage across 2500 iterations at each prescribed intensity. For the Kensington Public Safety Building, ZFA evaluated the following **Return Periods**: 50% in 50 year, 10% in 50 year, Code Design Earthquake, 5% in 50 year, Code Maximum Considered Earthquake, and the 2% in 50 Year. These **Return Periods** coincide with a particular **Seismic Event Intensity**, as defined below, of shaking and peak ground acceleration. The ground acceleration values are based on the United States Geological Survey (USGS) database. The damage consequences are defined as cost, risk to human life, and time to repair or regain function.

In this report, ZFA has focused on the 10% in 50 year event as the return period is independent of the site. Typically, the 10% in 50 year event is equivalent in intensity to the Code Design Earthquake. However, the Code Design Earthquake return period and intensity varies by site which leads to difficulty in comparing and understanding risk assessment results. Thus, to provide a clear statement of performance for the Public Safety Building, we highlight the 10% in 50 year seismic event.

In addition to this brief report, ZFA has prepared a set of summary sheets featuring graphics and figures related to the analyses performed at each intensity.

Risk Assessment Background – Definitions

- **Scenario Expected Loss (SEL):** The average losses for a given scenario
- **Scenario Upper Loss (SUL):** Losses which have a 90% probability of not being exceeded for a given scenario
- **Seismic Event Intensity:** The probability of exceedance of ground shaking in a given time period; e.g. “10% in 50 years” corresponds to the level of shaking that has a 10% probability of being exceeded over a 50-year period.
- **Casualty:** Injury or Death due to earthquake shaking and falling hazards.
- **Functional Recovery:** Time to complete repairs such that the damaged building can support its pre-earthquake function.

- **Red Tag:** Unsafe placard posting from a post-earthquake building evaluation. Red-tagged buildings
- **Code Design Earthquake*:** The earthquake effects that are two-thirds of the corresponding risk-targeted maximum considered earthquake (MCE_R) effects.
- **Code Maximum Considered Earthquake (MCE_R)*:** The most severe earthquake effects considered by ASCE 7 determined for the orientation that results in the largest maximum response to horizontal ground motions and with adjustment for targeted risk.

*Definitions taken directly from ASCE 7-16, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

Results Summary – 10% in 50-year Event

Financial Losses: In the existing building, the expected (mean) losses were 42% of the total building replacement value. In the retrofitted structure, the losses were reduced to 14%, for a net gain of 28%. This 28% gain is equivalent to approximately $3 million saved in post-earthquake construction costs for the design-level event – the relative intensity of shaking which the retrofit is deemed to meet.

Casualties: For the existing building, the anticipated number of persons injured in a design level event is ~0.40 and the probability that any one person will be injured anywhere in the building is 11%. For the retrofitted condition, the number of persons drops to ~0.05 and the probability of a single injury is 1.62%. The relative improvement in safety based on probability of injury is a near 10x reduction due to the retrofit.

Recovery: In its current condition, the structure is expected to require 4.4 months to meet the Functional Recovery requirements of ATC-138, the latest draft standard in functional recovery. After the retrofit, the expected functional recovery time is approximately 3.0 months.

Red Tag Probability: It is anticipated that in the 10% in 50 year event, the existing building would have a 27% probability of receiving a red tag. The retrofitted building would not likely receive a red tag for the design event, as the theoretical probability is 0%.

Limitations

The seismic performance assessment summarized in the above was completed using industry standards of practice and care. The findings are in accordance with our best prediction of the building performance during a seismic event and consider the variation in results for a range of seismic intensities.

It is important to note that it is unrealistic to precisely predict any of the probabilistic assessment information or data. Each factor affecting the seismic performance of a building has a degree of uncertainty that affects our ability to predict exact frequency values. For example, the fault that will produce the next earthquake and the magnitude of shaking that will occur are not known with any certainty. Nor is there a perfect understanding of the structural seismic behavior, including factors such as damping, stiffness and strength degradation, soil-structure interaction effects, and elements designed to resist only gravity loads. The smaller city of Christchurch, New Zealand (population <400,000 people) is still, over a decade later, struggling to rebuild the central business district following a M6.2 earthquake in 2011. Therefore, the recovery times provided in this study are limited to a stand-alone building because the impeding factors remain largely unknown at this time.

Regards,

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ZFA STRUCTURAL ENGINEERS
Designer

Steve Patton, SE
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Associate Principal

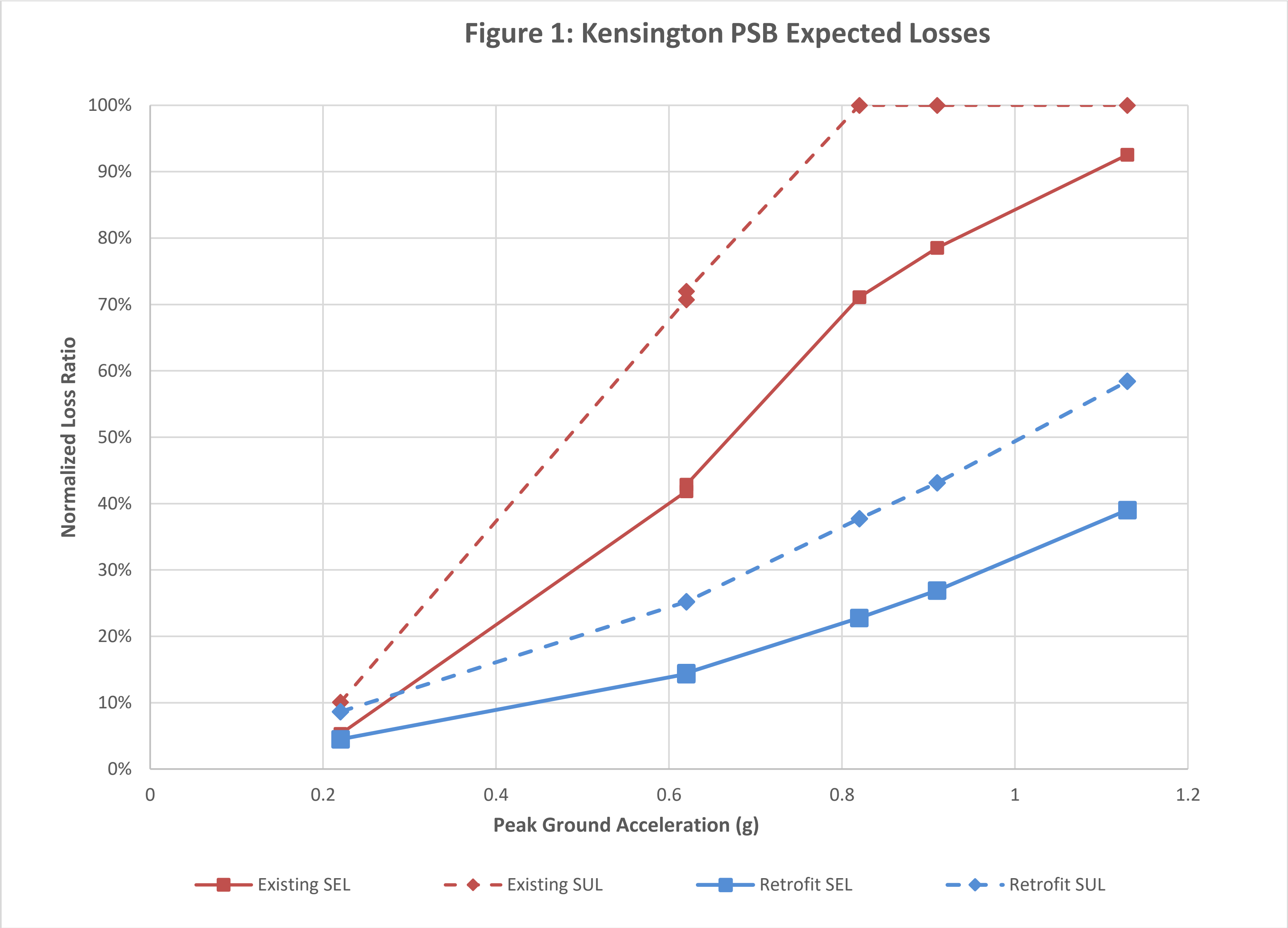
Kensington Public Safety Building

217 Arlington Avenue
Kensington, CA 94707

Site Coordinates	Lat 37.75868; Long -121.95975
Retrofit Building Code	2019 California Existing Building Code
Year Constructed	1969
# of Stories	Two Stories
Occupancy / Use	Fire Station
Structural Seismic Systems (ASCE 41-17 Building Type)	Wood Light Frame w/ Concrete shear wall and steel moment frame in longitudinal direction at ground floor (W2, C2, S1a)
Total Area	6133 SF
Building Aspect Ratio	1.95
Replacement Cost per SF	$1794 / SF
Story Heights	13'-6" at First Floor 9'-0" at Second Floor
Building Irregularities	None
Risk Category	IV
Soil Site Class	C – Stiff Soil
Type of Construction	Wood frame structure with gypsum board on wood partitions.
Existing Foundation System	Grade Beams and Piers on three sides, and at interior. Concrete retaining wall along East face of building.

1. Financial Losses:

Based on an expected building replacement value of approximately $11 million, for the 10% in 50-year event (PGA = 0.62), the retrofit provides a mean cost savings of $3 M.



2. Casualties:

Table 1: Existing Building

Total Casualties	50%/50 year	10%/50 year	DE	5%/50 year	MCER	2%/50 year
Injury (number people)	0.0780	0.3880	0.3913	0.5904	0.6616	0.8230
% single person is injured anywhere	(2.370)	(11.055)	(11.098)	(16.249)	(18.094)	(22.398)
Death (number of people)	0.0007	0.0037	0.0037	0.0058	0.0065	0.0082
% single person is killed anywhere	(0.021)	(0.099)	(0.100)	(0.153)	(0.174)	(0.220)

Table 2: Retrofit Building

Total Casualties	50%/50 year	10%/50 year	DE	5%/50 year	MCER	2%/50 year
Injury (number people)	0.0006	0.0512	0.0579	0.0834	0.1043	0.1450
% single person is injured anywhere	(0.033)	(1.615)	(1.776)	(2.755)	(3.444)	(4.902)
Death (number of people)	0.0000	0.0000	0.0000	0.0001	0.0002	0.0006
% single person is killed anywhere	0.000	(0.001)	(0.001)	(0.005)	(0.010)	(0.024)

3. Recovery:

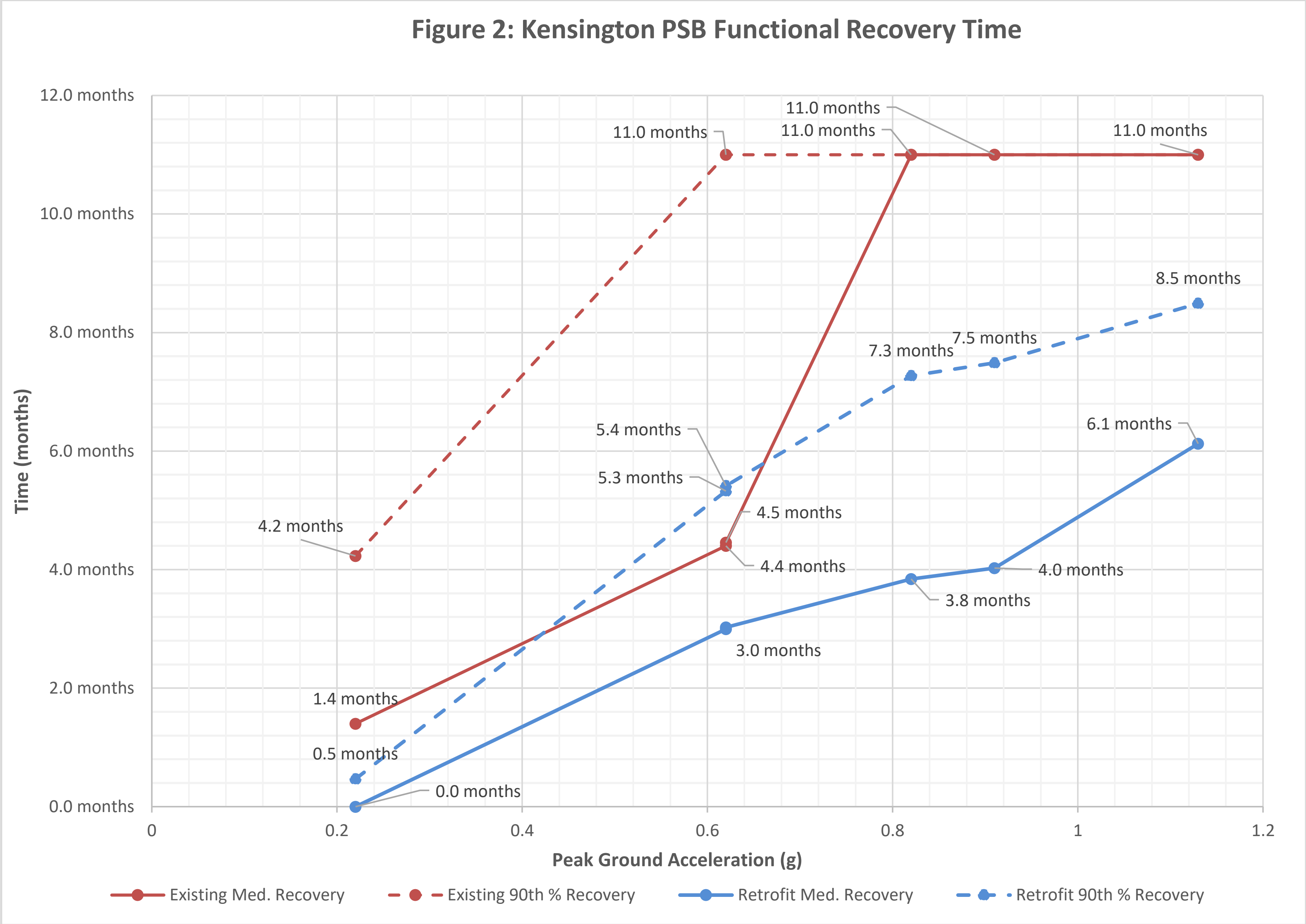
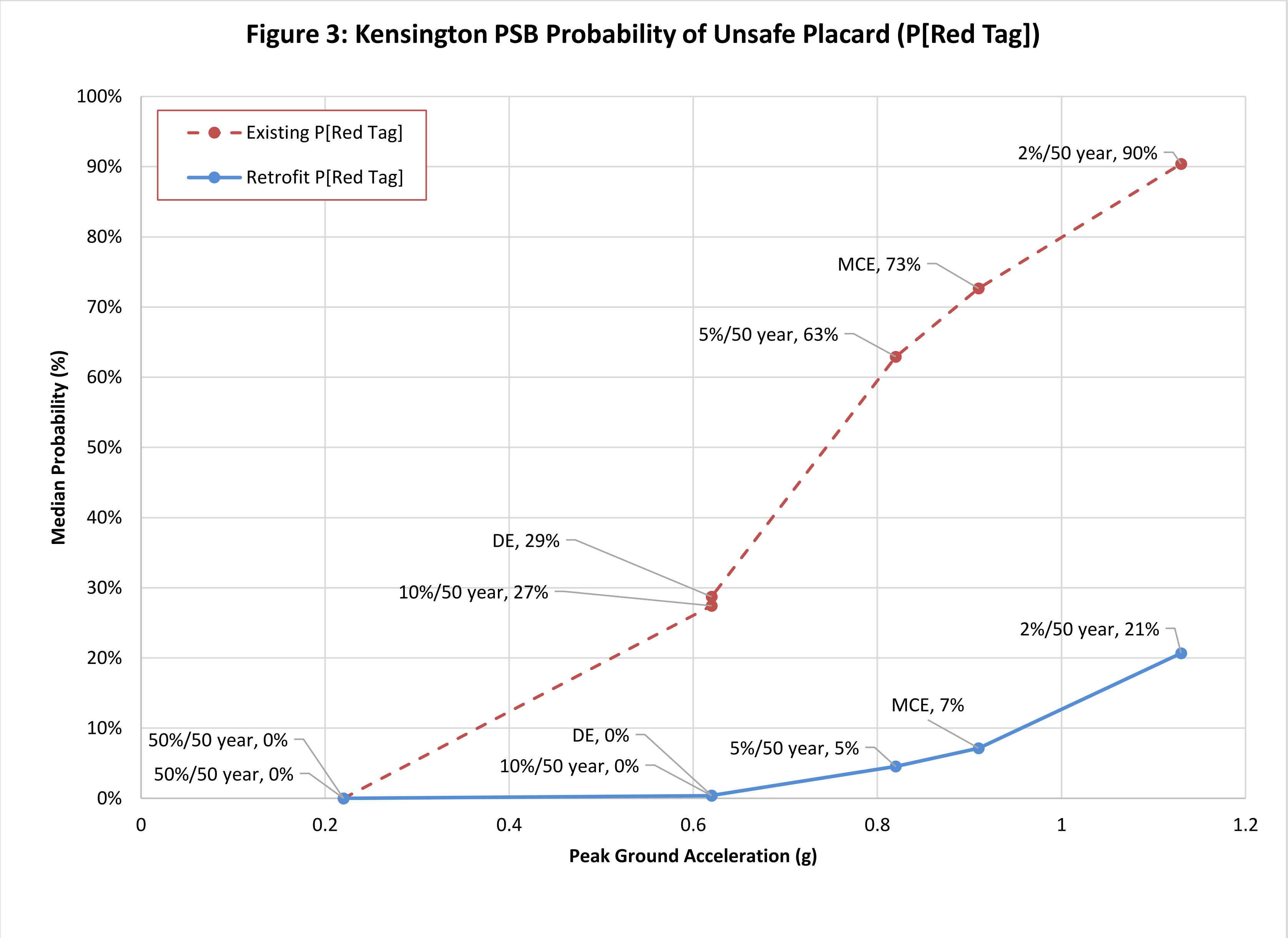


Figure 2: Kensington PSB Functional Recovery Time
Time (months)
12.0 months
10.0 months
8.0 months
6.0 months
4.0 months
2.0 months
0.0 months
0
0.2
0.4
0.6
0.8
1
1.2
Peak Ground Acceleration (g)
11.0 months
11.0 months
11.0 months
11.0 months
8.5 months
7.5 months
7.3 months
6.1 months
5.4 months
5.3 months
4.5 months
4.2 months
4.4 months
4.0 months
3.8 months
3.0 months
1.4 months
0.5 months
0.0 months
Existing Med. Recovery
Existing 90th % Recovery
Retrofit Med. Recovery
Retrofit 90th % Recovery

4. Red Tag Probability:



SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Full Detailed Report

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program
by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	Existing WLF w/ Frame
Building Type:	WLF: General
Design Code Year:	1967
Number of Stories:	2
Occupancy:	Commercial Office
Address:	217 Arlington Avenue Kensington, CA, 94707
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	4,395
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	Moderate
Plan Irregularity:	Extreme
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–
Dir. 2 Story 1	–
Dir. 2 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Ordinary, Ordinary
Drift Limit (Dir. 1, 2):	1.5%, 1.5%
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	0.419	0.283
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	0.45	0.6

Component Information

Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options

Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*

Interior Finishes

- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *No*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *No*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *No*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	4.6	8.1
10% in 50 years	475 Years	39	67
DE	481 Years	40	68
5% in 50 years	975 Years	64	100
MCE_R	1277 Years	72	100
2% in 50 years	2475 Years	90	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	14 days	2.1 weeks	0 days	1.9 months	2.3 months
10% in 50 years	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
DE	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 BASIS OF ANALYSIS

This analysis is based on the SP3-RiskModel of the Seismic Performance Prediction Program (SP3) software platform. The underlying analysis methods are based on the FEMA P-58 analytical method, which is a transparent and well documented method developed through a 15 year project (Applied Technology Council, 2018). This project leveraged the previous decades of academic research, funded by a $16 million investment by the Federal Emergency Management Agency (FEMA). In contrast to many risk assessment methods based on judgment and past earthquake experience, the FEMA P-58 and SP3 analysis are based on engineering-oriented risk evaluation methods.

3 DOCUMENTATION OF SITE AND BUILDING INPUT DATA

Project Name: Kensington Fire Station
Model Name: Existing WLF w/ Frame

3.1 Site Information

Address: 217 Arlington Avenue, Kensington, CA, 94707
Latitude: 37.90622°
Longitude: -122.27875°

3.2 Building Information

Material Type:	WLF
Number of Stories:	2
Total Building Square Footage:	4,395
Occupancy Type:	Commercial Office
Total Expected Building Replacement Value:	$1,328,911

4 SITE HAZARD INFORMATION

This section presents the site's seismic hazard information. The V_{S30} value is the shear wave velocity in the soil at a depth of 30 meters. This value and the associated site class are presented in Table 4.1.

Table 4.1. Site soil information

V_{S30} (m/s):	537.0
Site Class:	C
Closest V_{S30} for USGS Hazard Lookup (m/s):	530

Table 4.2 and Figure 4.1 present the spectral acceleration information for this site. The spectral acceleration is a measure of how much force the building will attract in an earthquake. This amount of force is dependent on the intensity of the ground shaking (e.g. 10% in 50 years), as well as a dynamic property of the building known as the "fundamental period". Shorter buildings tend to have smaller fundamental periods and taller buildings tend to have larger fundamental periods. As indicated by Figure 4.1, smaller fundamental periods (with the exception of very short fundamental periods) will attract more force in an earthquake.

The Design Earthquake (DE) and Maximum Considered Earthquake (MCE) are based on the modern code maximum direction spectra and are converted to geometric mean for comparison.

Table 4.2. Geometric mean spectral acceleration values (in g)

Intensity	Return Period (yrs)	PGA	$S_a(0.2s)$	$S_a(1.0s)$	$S_a(0.45s)$	$S_a(0.6s)$	$S_a(T_1)/v_{ult}$ † Dir 1	Dir 2
50% in 50 years	72	0.22	0.52	0.17	0.36	0.29	0.86	1.02
10% in 50 years	475	0.62	1.50	0.56	1.11	0.92	2.66	3.23
DE	481	0.62	1.50	0.57	1.12	0.92	2.67	3.25
5% in 50 years	975	0.82	2.03	0.80	1.55	1.29	3.70	4.55
MCE_R	1277	0.91	2.26	0.91	1.73	1.44	4.12	5.07
2% in 50 years	2475	1.13	2.84	1.19	2.22	1.86	5.29	6.58

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.419$ and $T_1 = 0.450$s and in direction 2 $v_{ult} = 0.283$ and $T_1 = 0.600$s (see Table 5.3 for more detailed structural properties)

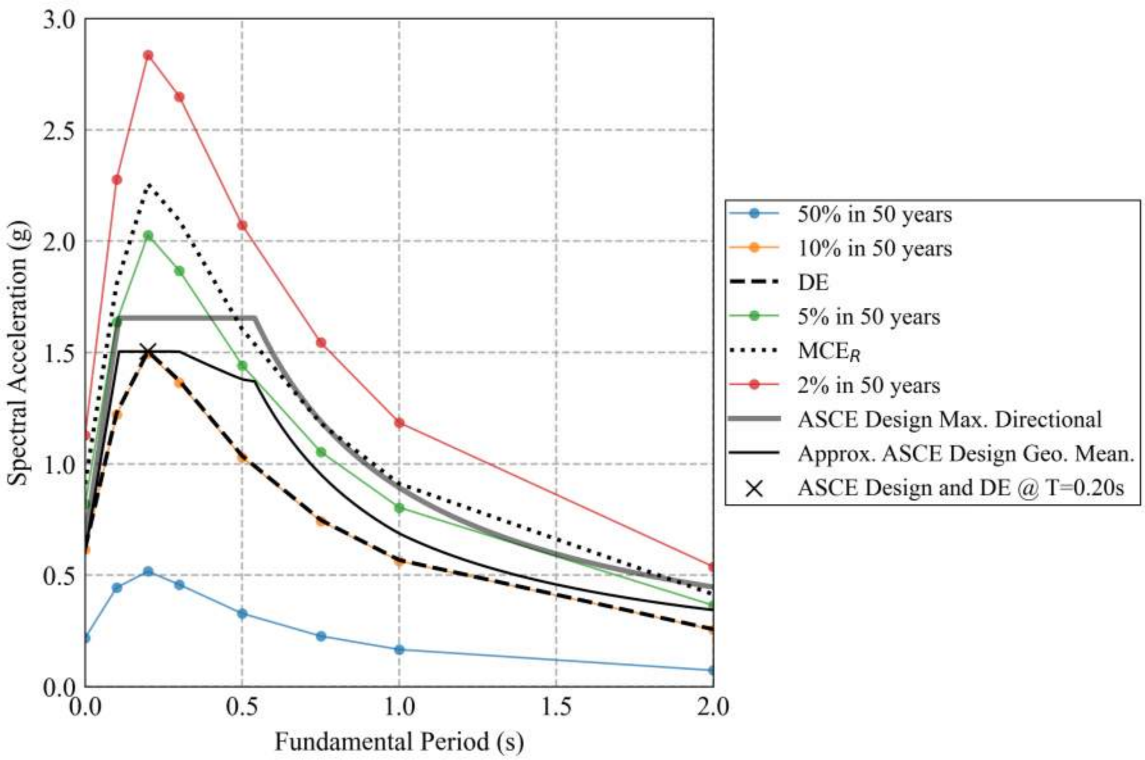


Figure 4.1. Hazard curves for this site. All curves are geometric mean unless otherwise stated.

5 BUILDING DESIGN SUMMARY FROM THE *SP3 BUILDING CODE DESIGN DATABASE*

5.1 Building Code Design Parameters

The seismic design parameters used to compute the seismic base shear coefficients for this building are presented in Table 5.1. These parameters are specific to the 1967 edition of the Uniform Building Code (International Conference of Building Officials, 1967).

Table 5.1. Code design parameters

(a) UBC 1967 structural system parameters

Parameter	Dir. 1	Dir. 2
C_d	1	1
k	1	1

(b) UBC 1967 site specific parameters

Parameter	Value
Z	1
Seismic Zone	3

5.2 Modern Building Code Design Parameters (for comparison purposes)

For comparison to modern code, the modern code parameters are presented in Table 5.2.

Table 5.2. Modern code design parameters

(a) ASCE/SEI 7-2010 structural system parameters

Parameter	Dir. 1	Dir. 2
C_t	0.02	0.02
C_d	4	4
x	0.75	0.75
R	6.5	6.5
Ω_0	3	3

(b) ASCE/SEI 7-2010 site specific parameters

Parameter	Value
S_s	2.482
S_1	1.031
S_{ds}	1.655
S_{d1}	0.893
SDC	E
C_u	1.4

(c) ASCE/SEI 7-2010 site specific parameters based on the period of the building

Parameter	Value
$\text{MCE}_{R,max}(g)$	2.482
$\text{MCE}_{R,geomean}(g)$	2.06
$\text{DE}_{max}(g)$	1.655
$\text{DE}_{geomean}(g)$	1.373

5.3 Structural Properties

This section summarizes the main structural properties of the building in each direction. These structural properties are used as inputs to the SP3 Structural Response Prediction Engine.

Table 5.3. Structural properties table

Parameter	Direction 1	Direction 2
General		
Structural System	WLF: General	WLF: General
Building Edge Length (ft)	33	65
Detailing Level	Ordinary	Ordinary
Seismic Strength		
Seismic Design Base Shear Ratio, C_s †	0.100	0.100
Wind Strength		
Wind Design Base Shear Ratio, v_{wind} †	0.157	0.072
Total Strength		
Ultimate Base Shear Ratio, v_{ult}	0.419‡	0.283‡
Stiffness		
$T_{1,design}$ (s)	0.27	0.19
T_1 Final (s)	0.45‡	0.60‡

† Design base shear values reported as LRFD

‡ User defined, not SP3 default

5.4 Mode Shapes

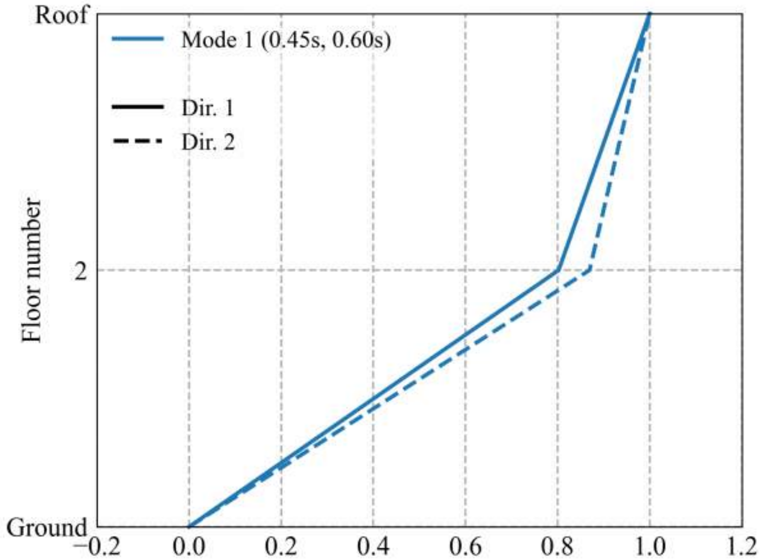


Figure 5.1. Mode shapes

Table 5.4. Mode shape values

	Dir. 1 Mode 1	Dir. 2 Mode 1
Roof	1.00	1.00
2	0.802	0.869
Ground	0.00	0.00

6 SP3 PERFORMANCE FACTORS

Table 6.1 compares the seismic design base shear, C_s, to the 475-year shaking (reduced by the modern response modification coefficient, R). Generally speaking, the modern building code design requirements are based on the 475-year event with the exception of extremely high seismic (near-fault) areas that are designed for a lesser deterministic ground motion or the transition region between deterministic and probabilistic portions of the ground motion maps.

The shaking intensity is then reduced by the response modification coefficient, R, based on the ductility level of the system (in anticipation of controlled damage of specially designed elements).

When the ratio of design base shear to the reduced spectra ($C_s/\left[S_a(T_1)_{475}/R\right]$) is 1.0, then the building was designed consistent with 10% in 50 year hazard. When the ratio is above 1.0, it was designed higher, so expect better performance (all other things equal), and for ratios below 1.0, expect worse performance.

Table 6.1. Design base shear vs. 475-year shaking intensity

	Dir. 1	Dir. 2
Seismic Design Base Shear, C_s	0.100	0.100
475-year Shaking Intensity, $S_a(T_1)_{475}$ †	1.11g	0.915g
Reduced Spectral Acceleration, $S_a(T_1)_{475}/R$ ‡	0.171g	0.141g
Ratio of Design Base Shear to 475-year Shaking Demand, $C_s/\left[S_a(T_1)_{475}/R\right]$ §	**0.58**	**0.71**

† T_1 includes all sources of overstiffness ($T_{1,dir1} = 0.450$s and $T_{1,dir2} = 0.600$s, see Table 5.3).
‡ Response Modification Coefficient, R, is from the modern code ($R_{dir1} = 6.5$ and $R_{dir2} = 6.5$).

Table 6.2 shows a comparison of the properties of the building to the properties of the building if it were constructed using the modern code guidelines. This table only compares the difference in building strength and period, and does not present differences in component damageability. The full SP3-RiskModel analysis does include effects of component damageability differences, so while the metrics in this table are informative, they are not all-encompassing of differences between new and old code design.

Table 6.2. Comparison of structural properties from UBC 1967 and ASCE/SEI 7-2010

	Dir. 1	Dir. 2
Seismic Design Base Shear, C_s		
UBC 1967	0.100	0.100
ASCE/SEI 7-2010†	0.382	0.382
Ratio $\frac{C_{s,UBC1967}}{C_{s,ASCE/SEI7-2010}}$	**0.262**	**0.262**
Ultimate Base Shear (C_s with Overstrength), v_{ult}		
UBC 1967	0.419	0.283
ASCE/SEI 7-2010	0.433	0.605
Ratio $\frac{v_{ult,UBC1967}}{v_{ult,ASCE/SEI7-2010}}$	**0.967**	**0.468**
Period Considering All Sources of Stiffness, T_1 (s)		
UBC 1967	0.450	0.600
ASCE/SEI 7-2010	0.833	0.455

† $R_{dir1} = 6.5$ and $R_{dir2} = 6.5$

7 BUILDING STABILITY

The FEMA P-154 collapse capacity score was calculated as follows using the "very high" seismicity level. The terminology used in this section is consistent with the FEMA P-154 methodology (Applied Technology Council, 2015a):

- P$[COL|MCE_R]_{P-154}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking, times the collapse factor
- P$[COL|MCE_R]_{P-58}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking
- Collapse Factor: expected ratio of collapsed area to total area given that the building is in the HAZUS Complete structural damage state

For a more in-depth explanation of "collapse," refer to Section 4.4.1.5 of FEMA P-155 Third Edition available here (Applied Technology Council, 2015b).

Table 7.1. Breakdown of FEMA P-154 score assignment

FEMA ID:	W2
Basic Score	1.8
Soil	0
Year	0
Plan Irregularity	-0.6
Vertical Irregularity	-0.5
Risk Category† (Cat IV)	0
Sum:	0.7
Minimum Allowed:	0.7
Score:	**0.7**
Dispersion (β):	0.58

† Non-standard property implemented by SP3

The FEMA P-154 probability of collapse at the MCE_R level event is then calculated as:

$$\begin{aligned} \mathrm{P}[COL|MCE_R]_{P-154} &= 10^{-\text{score}} \\ &= 10^{-0.7} \\ &= 20.0\% \end{aligned} \qquad \text{(FEMA P-155 eqn. 4-1)}$$

Taking into account the fraction of floor area collapsed (0.33 in this case), the probability of collapse is:

$$\begin{aligned} \mathrm{P}[COL|MCE_R]_{P-58} &= \mathrm{P}[COL|MCE_R]_{P-154} \;/\; \text{Collapse Factor} \\ &= 20.0\% \;/\; 0.33 \\ &= 60.5\% \end{aligned}$$

The median collapse capacity (before any direct modifications to the median) is calculated as:

$$\begin{aligned} S_{a,\ collapse\ median,\ P-58} &= \exp\left(\ln(S_{a,MCE_R}) - \text{norminv}\left(P[COL|MCE_R]_{P-58}\right) \cdot \beta\right) \\ &= \exp\left(\ln(1.58g) - \text{norminv}\left(60.5\%\right) \cdot 0.58\right) \\ &= 1.36g \end{aligned}$$

where `norminv` is the inverse of the standard normal cumulative distribution function (CDF).

To further refine the collapse capacity, the factors from Table 7.2 were applied to the median collapse S_a.

Table 7.2. Scale factor applied to the median collapse S_a value.

Reason	Factor
Wood Light Frame	1.05

The WLF modification reflects a weighted average of the FEMA P-154 median and the median collapse capacity observed in extensive non-linear dynamic modeling.
The final median for the collapse curve is therefore:

$$\begin{aligned} S_{a,\ collapse\ median,\ P-58\ (adjusted)} &= S_{a,\ collapse\ median,\ P-58} \cdot \text{Factors} \\ &= 1.36g \cdot 1.05 \qquad \text{(Using additional SP3 factors)} \\ &= 1.43g \end{aligned}$$

Which corresponds to a probability of collapse at MCE of:

$$\text{P}[COL|MCE_R]_{P-58\ (adjusted)} = 56.9\% \qquad \text{(Using additional SP3 factors)}$$

Figure 7.1 shows the collapse capacity cumulative distribution function used in the analysis.

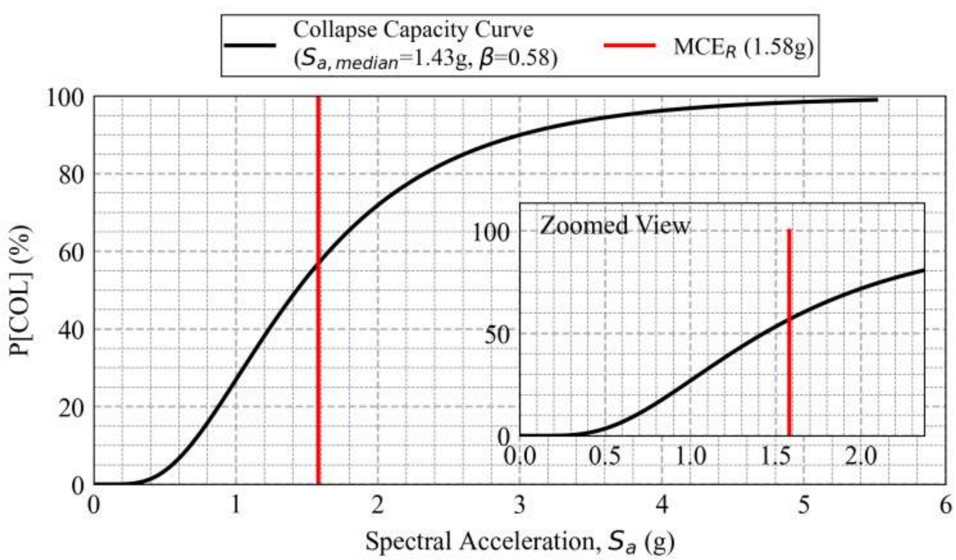


Figure 7.1. Cumulative distribution function for collapse capacity

8 STRUCTURAL RESPONSE PREDICTIONS FROM THE SP3 STRUCTURAL RESPONSE PREDICTION ENGINE

The SP3 Response Prediction Engine predicts the structural responses (typically providing 100 ground motions per intensity level); this is done by using a combination of three-mode elastic modal analysis, coupled with both elastic and inelastic response modifiers mined from the large SP3 Structural Responses Database (with over 4,000,000 response simulations, and growing). These response predictions track all of the important statistical information in the responses (mean, variability, and correlations); this enables a statistically robust vulnerability curve at the end of the risk assessment process.

8.1 Peak Interstory Drift

Peak interstory drift ratio is an important metric for both structural and non-structural components in the building. It measures how much the ceiling of a given story moves relative to the floor, normalized to the height of the story. The greater the interstory drift ratio, the greater the damage to the components on that level. Typical components that are damaged from interstory drift ratio are structural components (beams and columns), gypsum partition walls, and exterior cladding and glazing.

Table 8.1. Median Peak Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.03	0.13	0.13	0.17	0.20	0.31
1	0.31	1.87	1.88	2.85	3.29	4.68
$\frac{S_a(T_1)}{v_{ult}} =$	0.86	2.66	2.67	3.70	4.12	5.29

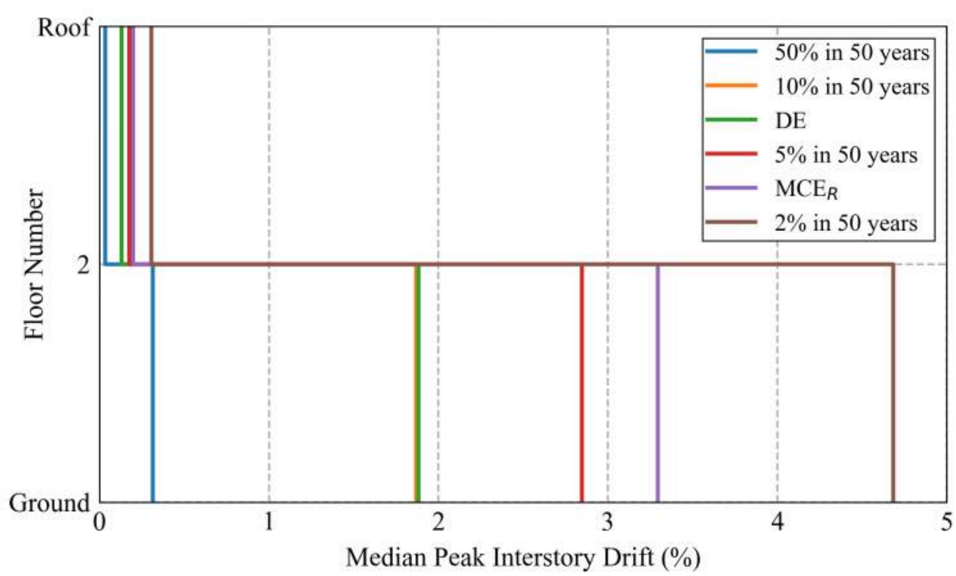


Figure 8.1. Median Peak Interstory Drift demands in direction 1

Table 8.2. Median Peak Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE$_R$	2% in 50 years
2	0.04	0.12	0.12	0.17	0.20	0.31
1	0.71	3.19	3.21	4.80	5.50	7.78
$\frac{S_a(T_1)}{v_{ult}} =$	1.02	3.23	3.25	4.55	5.07	6.58

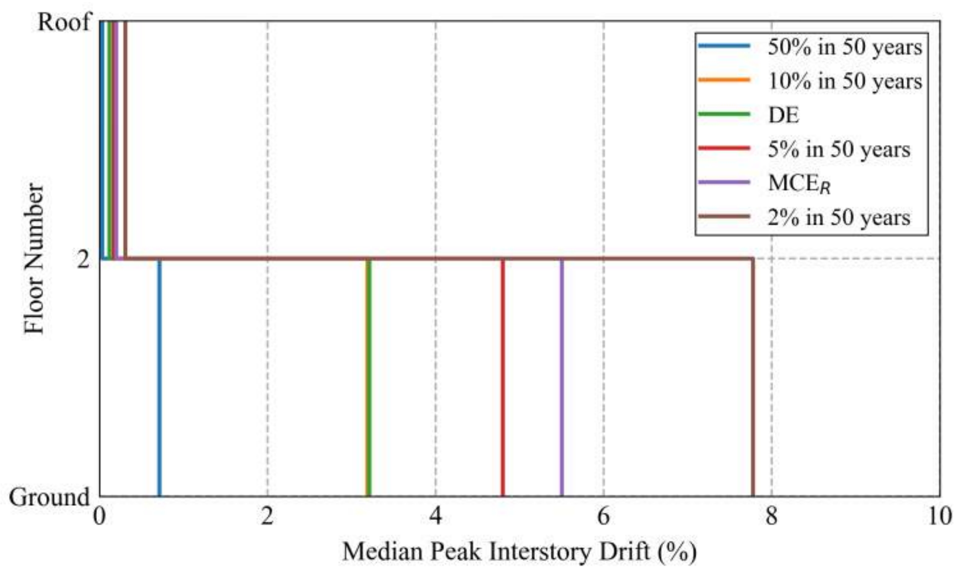


Figure 8.2. Median Peak Interstory Drift demands in direction 2

8.2 Residual Interstory Drift

Residual drift is a metric that informs the need for structural repairs or building demolition (where excessive drifts are present). Residual drift ratio is a measure of how much the building is "leaning over" after the seismic event has ceased. A residual drift of 2% would indicate that the story is laterally displaced 2% of it's height, which equates to about 3.6 inches for a 15 foot tall story.

Table 8.3. Median Residual Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.20	0.21	0.42	0.52	0.84
$\frac{S_a(T_1)}{v_{ult}} =$	0.86	2.66	2.67	3.70	4.12	5.29

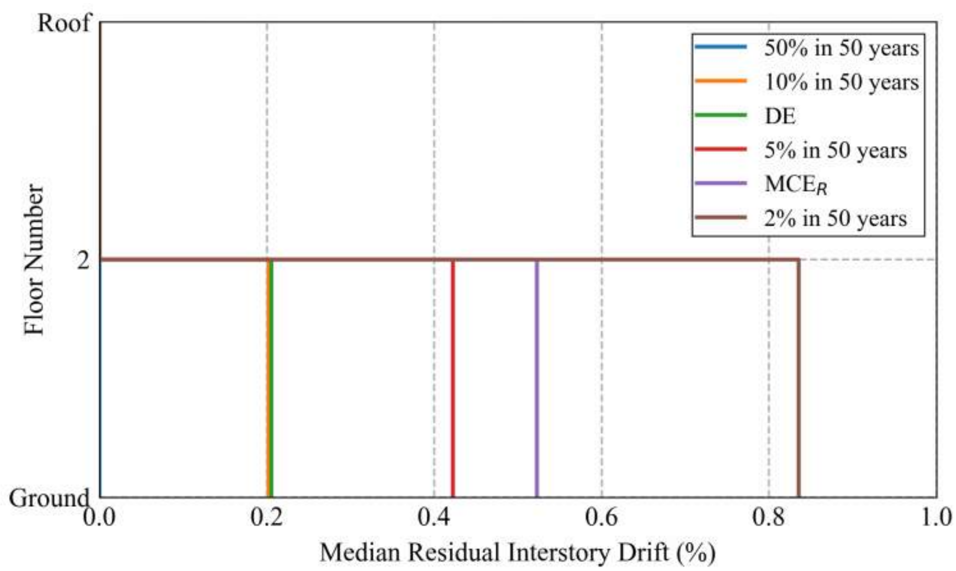


Figure 8.3. Median Residual Interstory Drift demands in direction 1

Table 8.4. Median Residual Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.34	0.34	0.65	0.78	1.54
$\frac{S_a(T_1)}{v_{ult}} =$	1.02	3.23	3.25	4.55	5.07	6.58

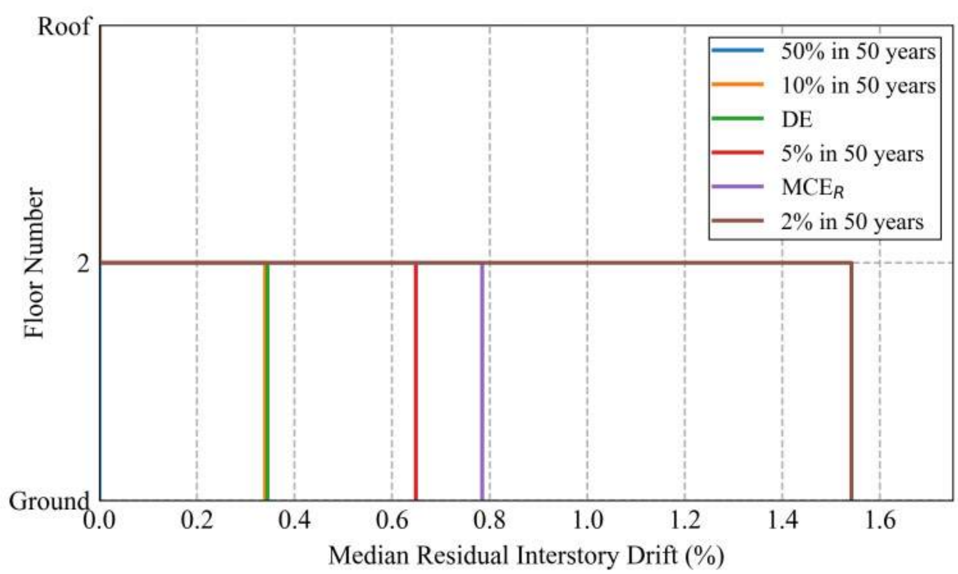


Figure 8.4. Median Residual Interstory Drift demands in direction 2

8.3 Peak Floor Acceleration

Peak floor acceleration is an an important metric for non-structural components in the building. Components such as piping, HVAC, and electrical switchgear are sensitive to the floor accelerations. High accelerations will typically damage a component itself or cause the component's anchorage to fail, both of which may require repair or replacement of the component.

Table 8.5. Median Peak Floor Acceleration demands in direction 1

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE$_R$	2% in 50 years
Roof	0.35	0.69	0.69	0.82	0.91	1.13
2	0.34	0.67	0.67	0.82	0.91	1.13
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}} =$	0.86	2.66	2.67	3.70	4.12	5.29

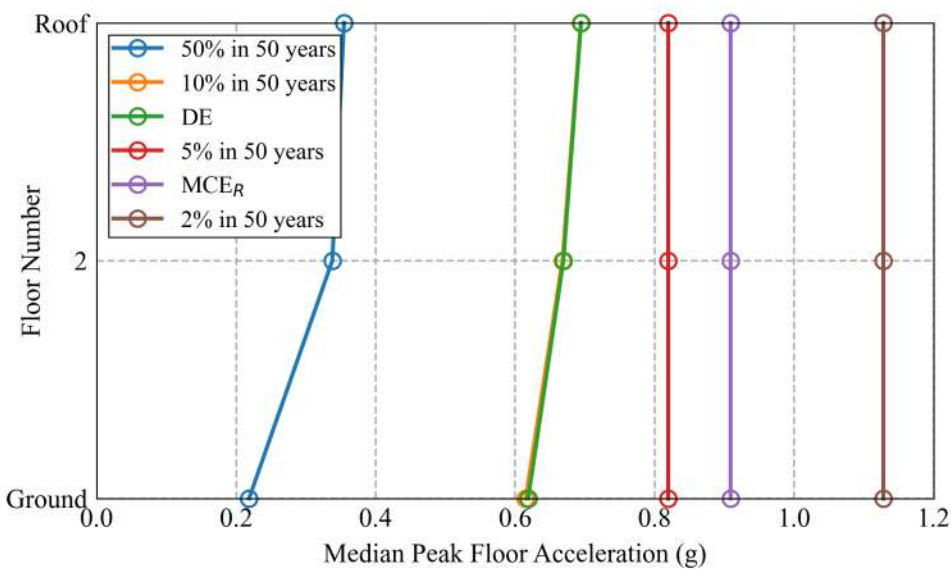


Figure 8.5. Median Peak Floor Acceleration demands in direction 1

Table 8.6. Median Peak Floor Acceleration demands in direction 2

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Roof	0.36	0.62	0.62	0.82	0.91	1.13
2	0.37	0.62	0.62	0.82	0.91	1.13
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}} =$	1.02	3.23	3.25	4.55	5.07	6.58

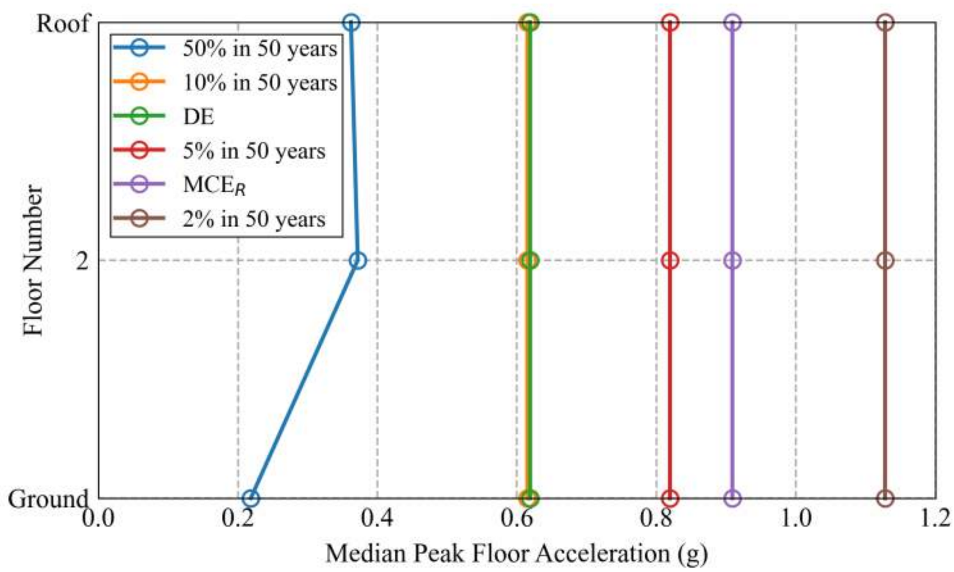


Figure 8.6. Median Peak Floor Acceleration demands in direction 2

8.4 Max. Residual Interstory Drift

Table 8.7. Median Max. Residual Interstory Drift demands in direction 1

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.20	0.21	0.42	0.52	0.84
$\frac{S_a(T_1)}{v_{ult}} =$	0.86	2.66	2.67	3.70	4.12	5.29

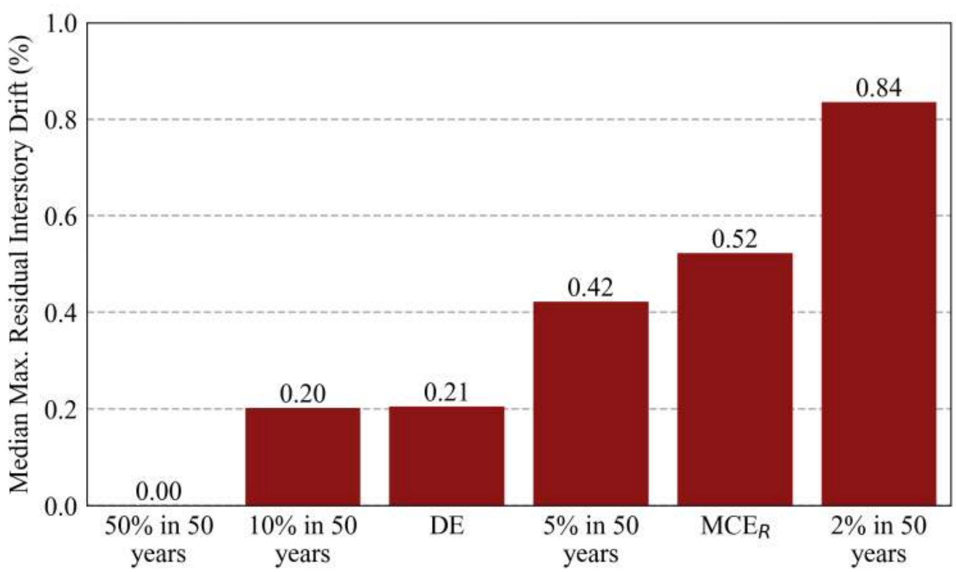


Figure 8.7. Median Max. Residual Interstory Drift demands in direction 1

Table 8.8. Median Max. Residual Interstory Drift demands in direction 2

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.34	0.34	0.65	0.78	1.54
$\frac{S_a(T_1)}{v_{ult}} =$	1.02	3.23	3.25	4.55	5.07	6.58

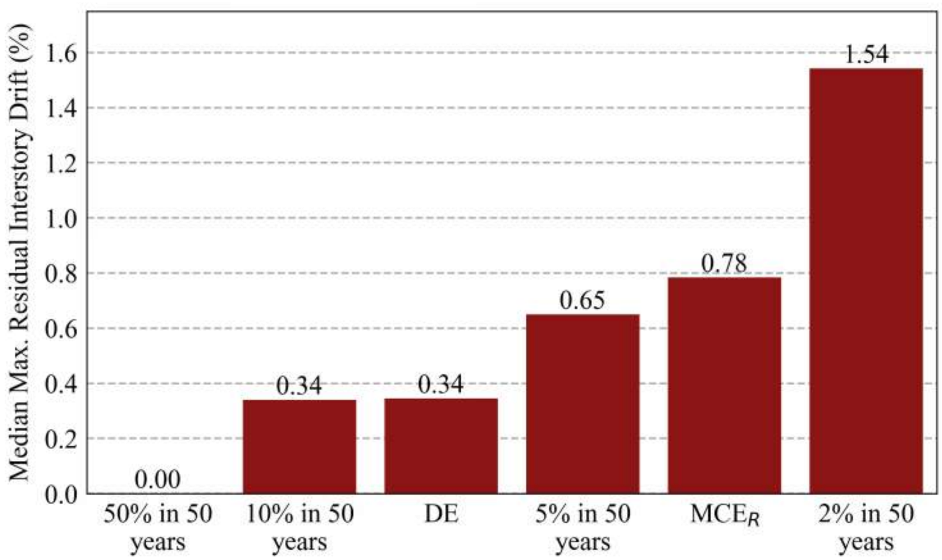


Figure 8.8. Median Max. Residual Interstory Drift demands in direction 2

9 REPAIR COSTS - BY LEVEL OF GROUND MOTION

9.1 Mean and 90th Percentile Repair Costs (SEL and SUL)

The different metrics for repair cost are as follows:

- **Mean (SEL)**: ("Scenario Expected Loss") the average repair cost of the building repair/replacement.
- **Median**: there is a 50% probability that the repair cost will not exceed this value.
- **Fitted SUL**: Fitted value of "Scenario Upper Loss".
- **Counted 90th Percentile**: there is a 90% probability that the repair cost will not exceed this value.

Table 9.1. Loss metrics normalized by building cost

Intensity	PGA (g)	Mean (SEL) (%)	Fitted SUL (%)	Median (%)	Counted 90th Percentile (%)	$S_a(T_1)/v_{ult}$ † Dir 1	Dir 2
50% in 50 years	0.22	4.6	8.1	4.1	8.1	0.86	1.02
10% in 50 years	0.62	39	67	17	100	2.66	3.23
DE	0.62	40	68	18	100	2.67	3.25
5% in 50 years	0.82	64	100	100	100	3.70	4.55
MCE$_R$	0.91	72	100	100	100	4.12	5.07
2% in 50 years	1.13	90	100	100	100	5.29	6.58

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.419$ and $T_1 = 0.450$s and in direction 2 $v_{ult} = 0.283$ and $T_1 = 0.600$s (see Table 5.3 for more detailed structural properties)

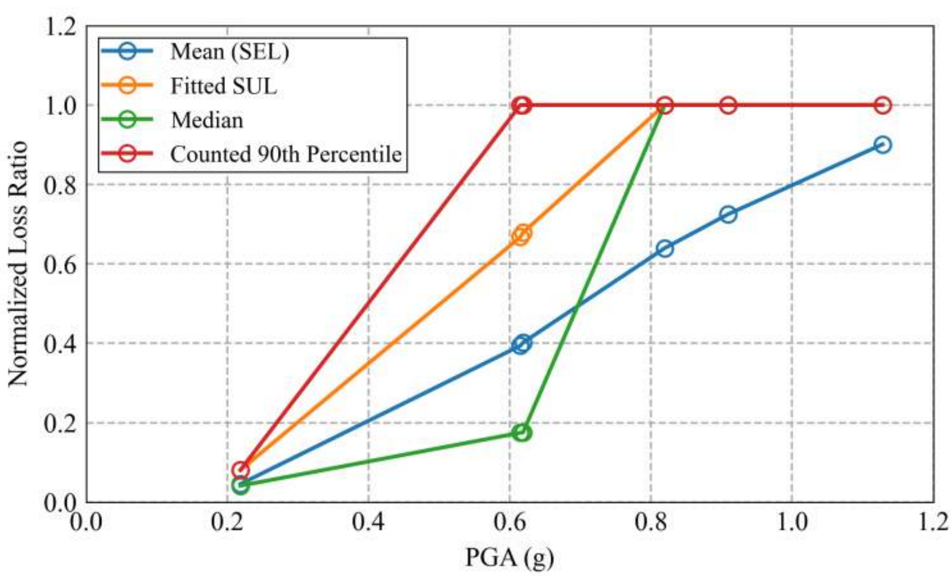


Figure 9.1. Loss metrics across all intensity levels analyzed

10 REPAIR COST BREAKDOWN BY BUILDING COMPONENTS

10.1 Categories for Repair Cost Breakdowns

Repair costs are binned into eight categories as follows:

- **Collapse**: building demolition and replacement following a collapse.
- **Residual**: building demolition and replacement following unacceptable residual drifts.
- **Structural**: components of the lateral force resisting system or gravity system (e.g. beam column connections, link beams, shear wall, shear tabs, etc.).
- **Partitions**: partition wall components (e.g. wood or metal stud gypsum full height partitions).
- **Exterior**: components placed on the exterior of the building (e.g. cladding, glazing, etc.).
- **Interior**: non-structural components on the interior of the building (e.g. raised access floors, ceilings, lighting).
- **HVAC**: HVAC and plumbing components (e.g. water piping and bracing, sanitary piping, ducting, boilers etc.).
- **Other**: components not included in the categories above (e.g. elevators, user defined components, fire protection components).

10.2 Repair Cost Breakdown for Various Ground Motion Levels

Table 10.1. Expected mean loss per component group (in percent)

Intensity	Total	Collapse	Residual	Structural	Partitions	Other	Exterior	HVAC	Interior
50% in 50 years	4.6	0.0	0.0	0.2	2.1	1.2	0.1	0.6	0.3
10% in 50 years	39	27	1.1	2.9	4.7	2.0	0.8	0.7	0.3
DE	40	27	1.6	2.9	4.6	2.0	0.8	0.7	0.3
5% in 50 years	64	49	6.2	3.0	3.1	1.4	0.6	0.5	0.2
MCE_R	72	56	8.9	2.5	2.5	1.1	0.5	0.4	0.1
2% in 50 years	90	73	14	1.2	0.9	0.4	0.2	0.2	0.0

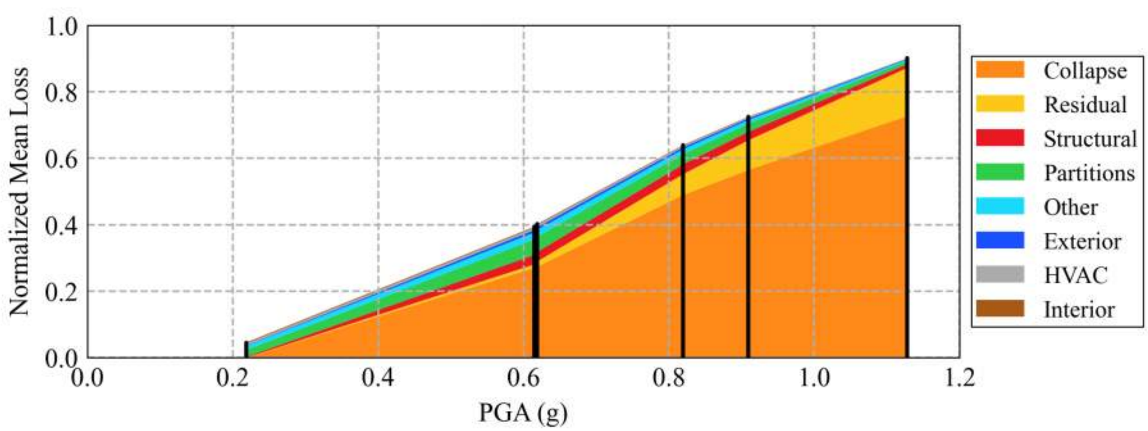


Figure 10.1. Contribution of building components to mean loss ratio

10.3 Repair Cost Breakdown for Expected Annual Loss

The expected annual loss for this building is $5,411.

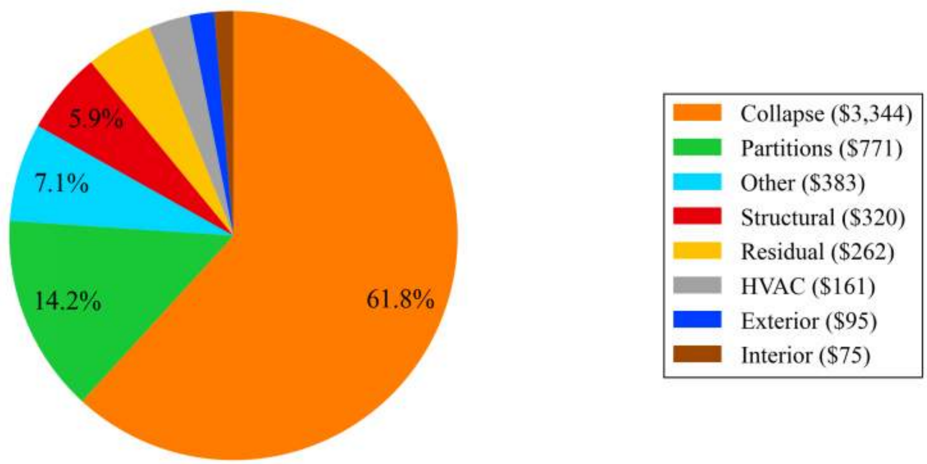


Figure 10.2. Annualized loss breakdown

11 REPAIR TIME AND BUILDING CLOSURE TIME

These downtimes were calculated using the ATC-138 Functional Recovery (Beta) Methodology. This includes all sources of impedance specified by the user; possible sources of impedance considered are listed below.

- Post-earthquake Inspection
- Engineering Mobilization and Review/Re-design
- Financing
- Contractor Mobilization and Bid Process
- Permitting

These capture the time required to start the repairs, since beginning repairs immediately after an earthquake may not be realistic.

Table 11.1. Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	14 days	2.1 weeks	0 days	1.9 months	2.3 months
10% in 50 years	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
DE	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

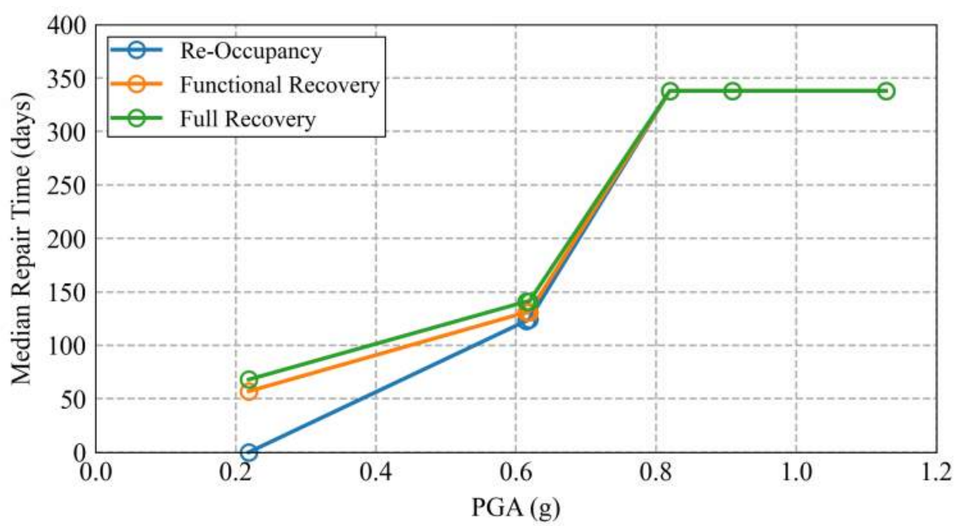


Figure 11.1. Median repair time from the ATC-138 Functional Recovery (Beta) Methodology, includes specified impeding factors

12 DISCLAIMER

REFERENCES

Applied Technology Council. 2015a. *FEMA P-154: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*.

Applied Technology Council. 2015b. *FEMA P-155: Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation*.

Applied Technology Council. 2018. *FEMA P-58: Seismic Perfromance Assessment of Buildings*.

International Conference of Building Officials. 1967. *Uniform Building Code 1967 Edition*. International Conference of Building Officials.

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Functional Recovery Time Report

using the

ATC-138 Functional Recovery (Beta) Methodology

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	Existing WLF w/ Frame
Building Type:	WLF: General
Design Code Year:	1967
Number of Stories:	2
Occupancy:	Commercial Office
Address:	217 Arlington Avenue Kensington, CA, 94707
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	4,395
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	Moderate
Plan Irregularity:	Extreme
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–
Dir. 2 Story 1	–
Dir. 2 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Ordinary, Ordinary
Drift Limit (Dir. 1, 2):	1.5%, 1.5%
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	0.419	0.283
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	0.45	0.6

Component Information

Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options	
Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*

Interior Finishes

- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *No*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *No*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *No*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	4.6	8.1
10% in 50 years	475 Years	39	67
DE	481 Years	40	68
5% in 50 years	975 Years	64	100
MCE_R	1277 Years	72	100
2% in 50 years	2475 Years	90	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	14 days	2.1 weeks	0 days	1.9 months	2.3 months
10% in 50 years	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
DE	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 FUNCTIONAL RECOVERY OVERVIEW

Table 2.1. Recovery Times from the ATC-138 Functional Recovery (Beta) Methodology

Intensity	Return Period	PGA (g)	Sa(T_1)*	Median			90^{th} Percentile		
				Re-Occ.	Func.	Full	Re-Occ.	Func.	Full
50% in 50 years	72 years	0.22	0.32	0d	1.9m	2.3m	3.5m	4.4m	4.7m
10% in 50 years	475 years	0.62	1.01	4.1m	4.4m	4.7m	11m	11m	11m
DE	481 years	0.62	1.02	4.1m	4.4m	4.7m	11m	11m	11m
5% in 50 years	975 years	0.82	1.42	11m	11m	11m	11m	11m	11m
MCE_R	1277 years	0.91	1.58	11m	11m	11m	11m	11m	11m
2% in 50 years	2475 years	1.13	2.04	11m	11m	11m	11m	11m	11m

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

Table 2.2. Global Consequences

Intensity	Return Period	PGA (g)	Sa(T_1)*	P[red tag]	P[collapse]	P[excessive residual]
50% in 50 years	72 years	0.22	0.32	0.0%	0.0%	0.0%
10% in 50 years	475 years	0.62	1.01	28%	27%	1.1%
DE	481 years	0.62	1.02	29%	27%	1.6%
5% in 50 years	975 years	0.82	1.42	55%	49%	6.2%
MCE_R	1277 years	0.91	1.58	65%	56%	8.9%
2% in 50 years	2475 years	1.13	2.04	87%	73%	14%

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

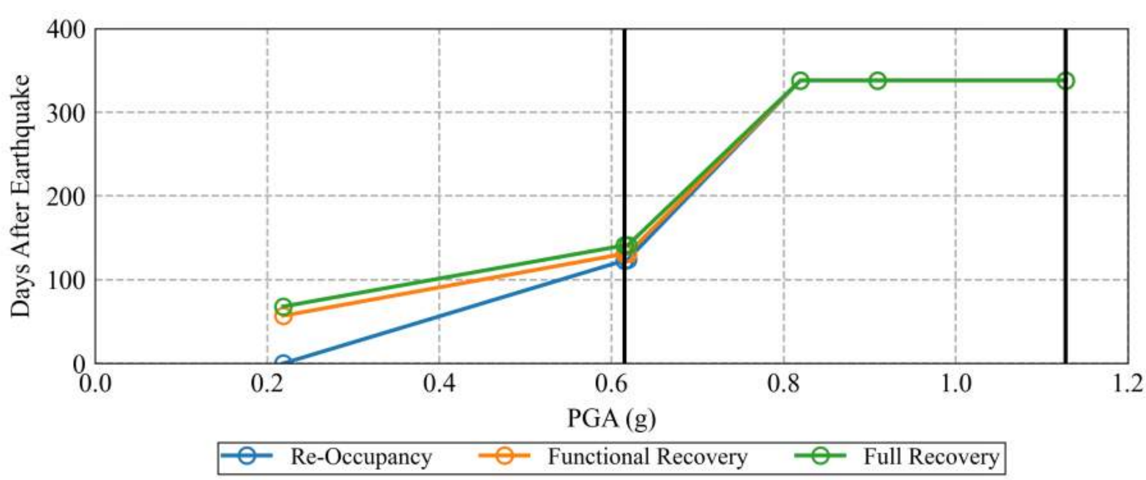


Figure 2.1. ATC-138 Functional Recovery (Beta) Methodology median recovery times

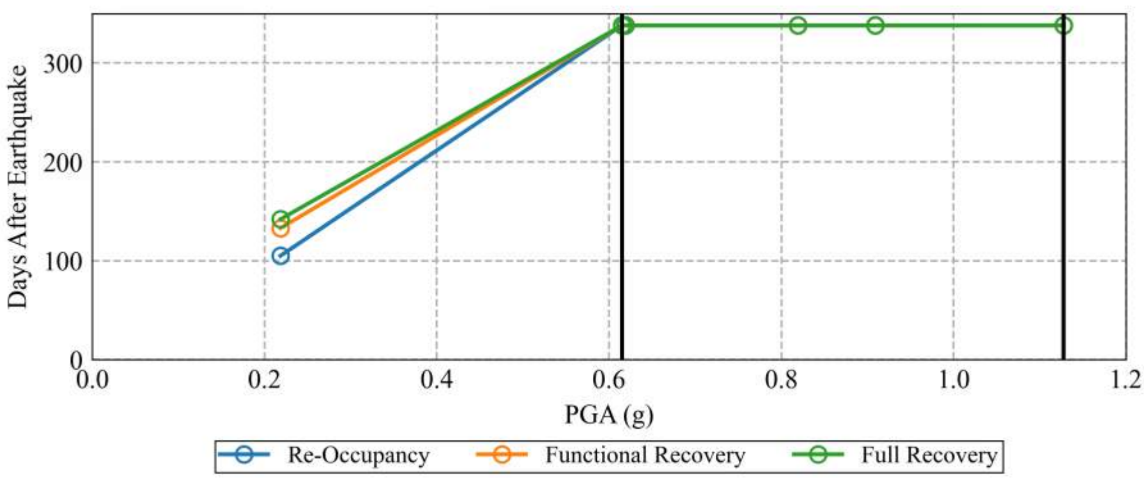


Figure 2.2. ATC-138 Functional Recovery (Beta) Methodology 90^{th} percentile recovery times

3 COMPONENT DAMAGE OVERVIEW

3.1 Most Damaged Components

This section outlines the most damaged component at each intensity. "Most damaged" is determined by cost and does not necessarily mean that it's the main component impeding building function.

Table 3.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1071.302	1	$1,507
10% in 50 years	B1031.011a	1	$16,523
DE	B1031.011a	1	$16,821
5% in 50 years	B1031.011a	1	$21,343
MCE_R	B1031.011a	1	$18,853
2% in 50 years	B1031.011a	1	$8,919

Table 3.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	D1014.022	1	$14,645
10% in 50 years	C1011.211a	3	$31,390
DE	C1011.211a	3	$31,104
5% in 50 years	C1011.211a	3	$21,129
MCE_R	C1011.211a	3	$16,921
2% in 50 years	C1011.211a	3	$6,506

Details of the most damaged components and their damage states:

- **B1031.011a**: Steel Column Base Plates, Column W < 150 plf
  - DS1a: Initiation of crack at the fusion line between the column flange and the base plate weld. Damage in field is either obscured or deemed to not warrant repair. No repair conducted.
  - DS1b: Initiation of crack at the fusion line between the column flange and the base plate weld.
- **B1071.302**: Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs
  - DS1: Cracking of paint over fasteners or joints.
- **C1011.211a**: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above
  - DS3: Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.
- **D1014.022**: Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.
  - DS1a: Damaged controls.
  - DS1b: Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.

DS1c: Damaged entrance and car door, and or flooring damage.
DS1d: Oil leak in hydraulic line, and or hydraulic tank failure.

3.2 Worker Days Summary

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.3. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.8	0.9	0.8	0.7	0.2
DS2	0.0	6.1	6.7	7.7	5.7	2.9
DS3	0.0	4.3	3.7	6.2	6.9	3.2
Total	**0.0**	**11**	**11**	**15**	**13**	**6.3**
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.0	0.0	0.0	0.0	0.0
DS2a	0.0	0.0	0.0	0.0	0.0	0.0
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.0	0.0	0.0	0.0	0.0
DS2a	0.0	0.0	0.0	0.0	0.0	0.0
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	0.7	2.8	2.8	1.4	0.9	0.2
DS2	0.1	2.0	1.9	1.4	1.1	0.4
DS3	0.0	5.6	5.5	6.2	5.3	2.8
Total	**0.8**	**10**	**10**	**8.9**	**7.3**	**3.4**
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.5	0.2	0.2	0.1	0.1	0.0
DS2	0.2	0.2	0.2	0.1	0.0	0.0
DS3	0.2	1.5	1.5	0.7	0.5	0.1
DS4	0.0	1.2	1.1	0.9	0.7	0.3
DS5	0.0	1.5	1.4	2.0	1.7	1.0
Total	**0.8**	**4.5**	**4.4**	**3.8**	**3.1**	**1.4**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	1.9	1.8	1.8	0.7	0.5	0.1
DS2	0.6	2.2	2.2	1.1	0.8	0.2
DS3	0.7	13	13	11	9.0	3.8
Total	**3.2**	**17**	**17**	**13**	**10**	**4.2**

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Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.9	1.2	1.2	1.0	0.9	0.4
DS2	1.7	0.8	0.7	0.3	0.2	0.1
DS3	3.9	16	16	11	8.6	3.1
Total	**7.6**	**18**	**18**	**12**	**10**	**3.6**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.7	0.6	0.6	0.5	0.5	0.2
DS2	1.7	0.7	0.6	0.2	0.2	0.1
DS3	4.6	16	16	11	8.5	3.1
Total	**8.1**	**17**	**17**	**11**	**9.1**	**3.4**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.3	0.1	0.1	0.1	0.0	0.0
DS2	0.4	0.9	0.9	0.4	0.3	0.1
DS3	0.4	4.5	4.6	3.9	3.2	1.3
Total	**1.1**	**5.6**	**5.6**	**4.4**	**3.6**	**1.4**
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**3.0**	**2.8**	**2.8**	**1.7**	**1.2**	**0.4**
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	0.3	0.3	0.3	0.2	0.2	0.1
DS1b	4.3	5.5	5.6	3.6	2.8	1.1
DS1c	5.3	7.2	7.3	4.7	3.5	1.2
DS1d	0.8	1.2	1.1	0.8	0.6	0.2
Total	**11**	**14**	**14**	**9.3**	**7.1**	**2.6**
D2021.012a #1 (D2021.012a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.012b #1 (D2021.012b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.022a #1 (D2021.022a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.0	0.1	0.1	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.1	0.1	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	0.6	0.6	0.6	0.4	0.3	0.1
DS1b	0.3	0.4	0.4	0.2	0.2	0.1
Total	**1.0**	**1.0**	**1.0**	**0.6**	**0.5**	**0.2**

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Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
D3032.011a #2 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	0.8	0.7	0.6	0.4	0.3	0.1
DS1b	0.5	0.4	0.4	0.2	0.2	0.1
Total	**1.3**	**1.0**	**1.0**	**0.6**	**0.5**	**0.2**
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**	**0.0**
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.2**	**1.1**	**1.1**	**1.1**	**1.0**	**0.5**

3.3 Component Name Reference

This list is provided for reference where only the fragility ID is available.

- **B1031.011a**: Steel Column Base Plates, Column W < 150 plf
- **B1035.041**: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27
- **B1035.051**: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27
- **B1071.002**: Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs
- **B1071.302**: Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs
- **B2011.401**: Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs
- **C1011.211a**: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above
- **C1011.311a**: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above
- **C2011.041b**: Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.
- **C3034.001**: Independent Pendant Lighting - non seismic
- **D1014.022**: Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.
- **D2021.012a**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, PIPING FRAGILITY
- **D2021.012b**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, BRACING FRAGILITY
- **D2021.022a**: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING FRAGILITY
- **D2031.022a**: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY
- **D2031.022b**: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY
- **D3032.011a**: Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only
- **D3041.011c**: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F
- **D3041.032c**: HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F

4 DETAILED REOCCUPANCY AND FUNCTIONALITY RESULTS BY GROUND MOTION INTENSITY

4.1 50% in 50 years Intensity

4.1.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

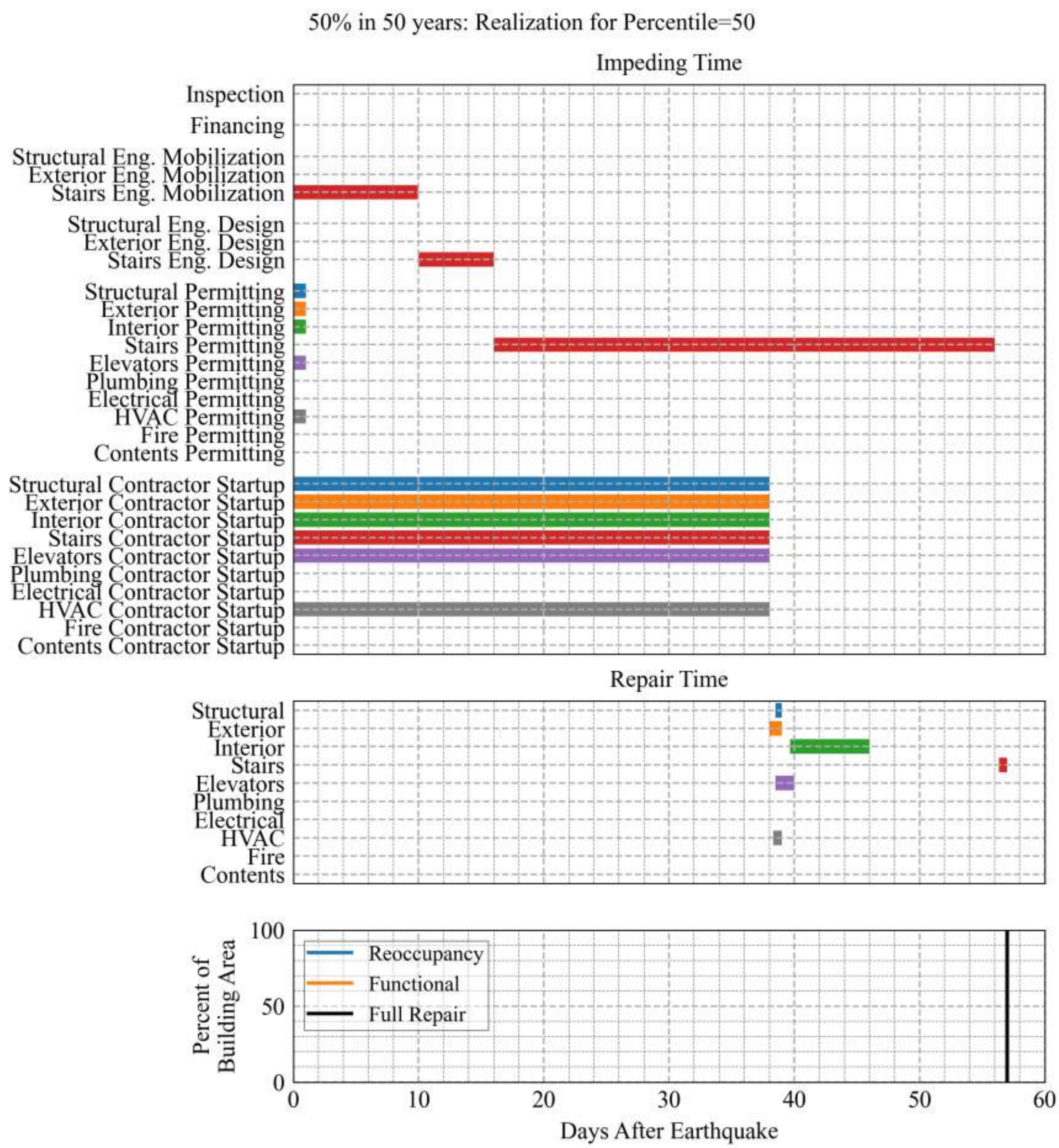

Figure 4.1. 50% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

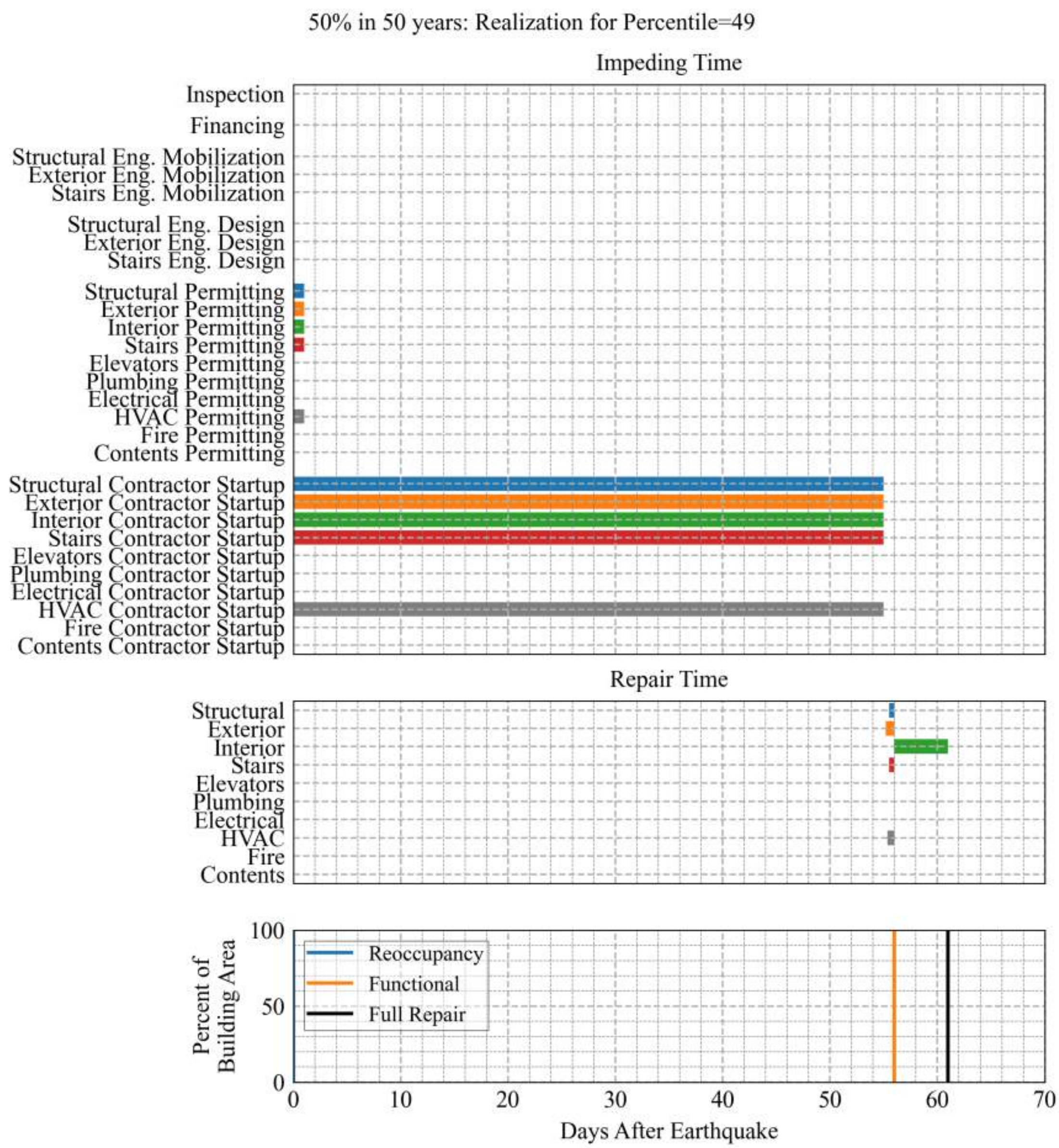

Figure 4.2. 50% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

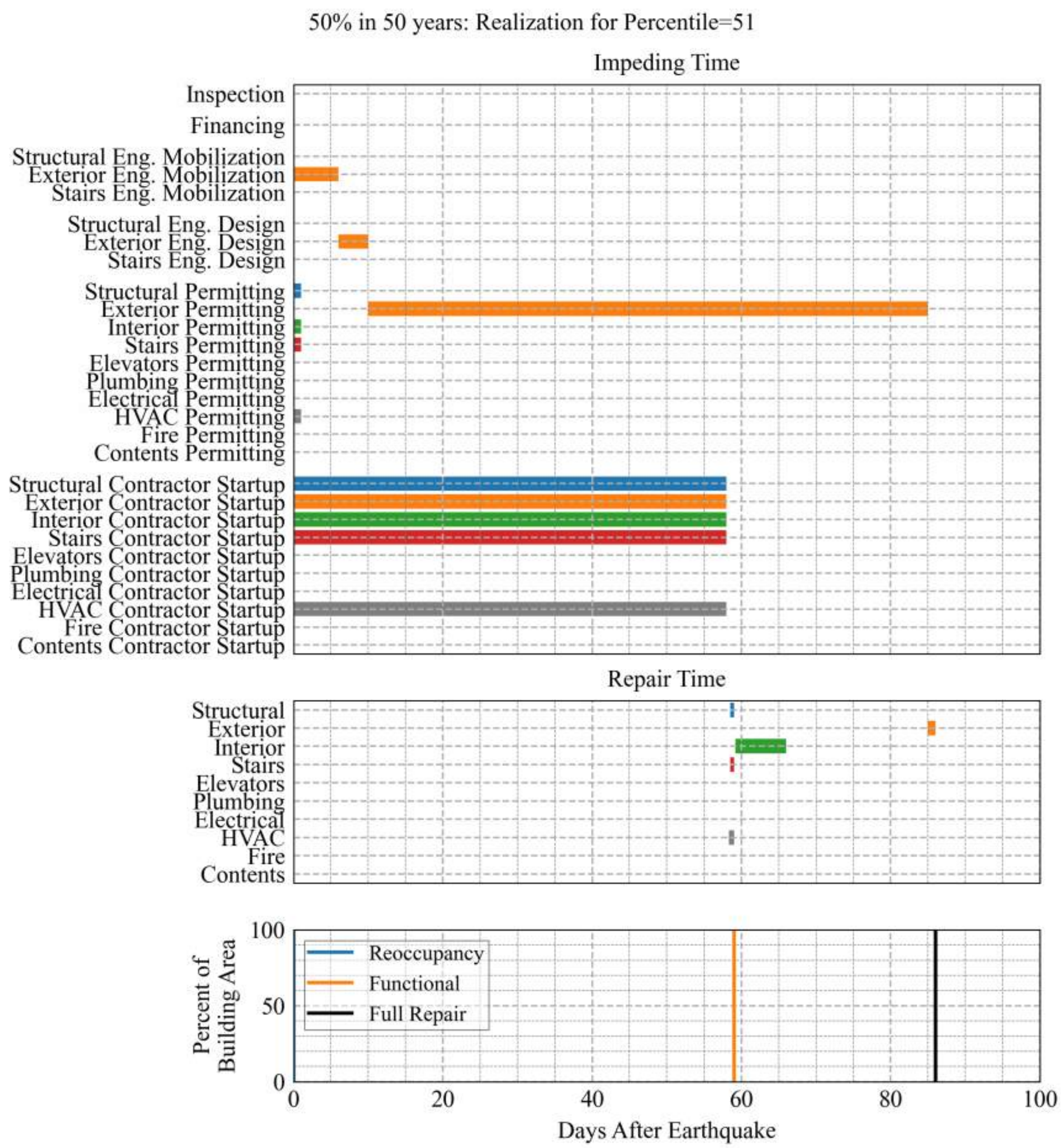

Figure 4.3. 50% in 50 years Percentile = 51

4.1.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

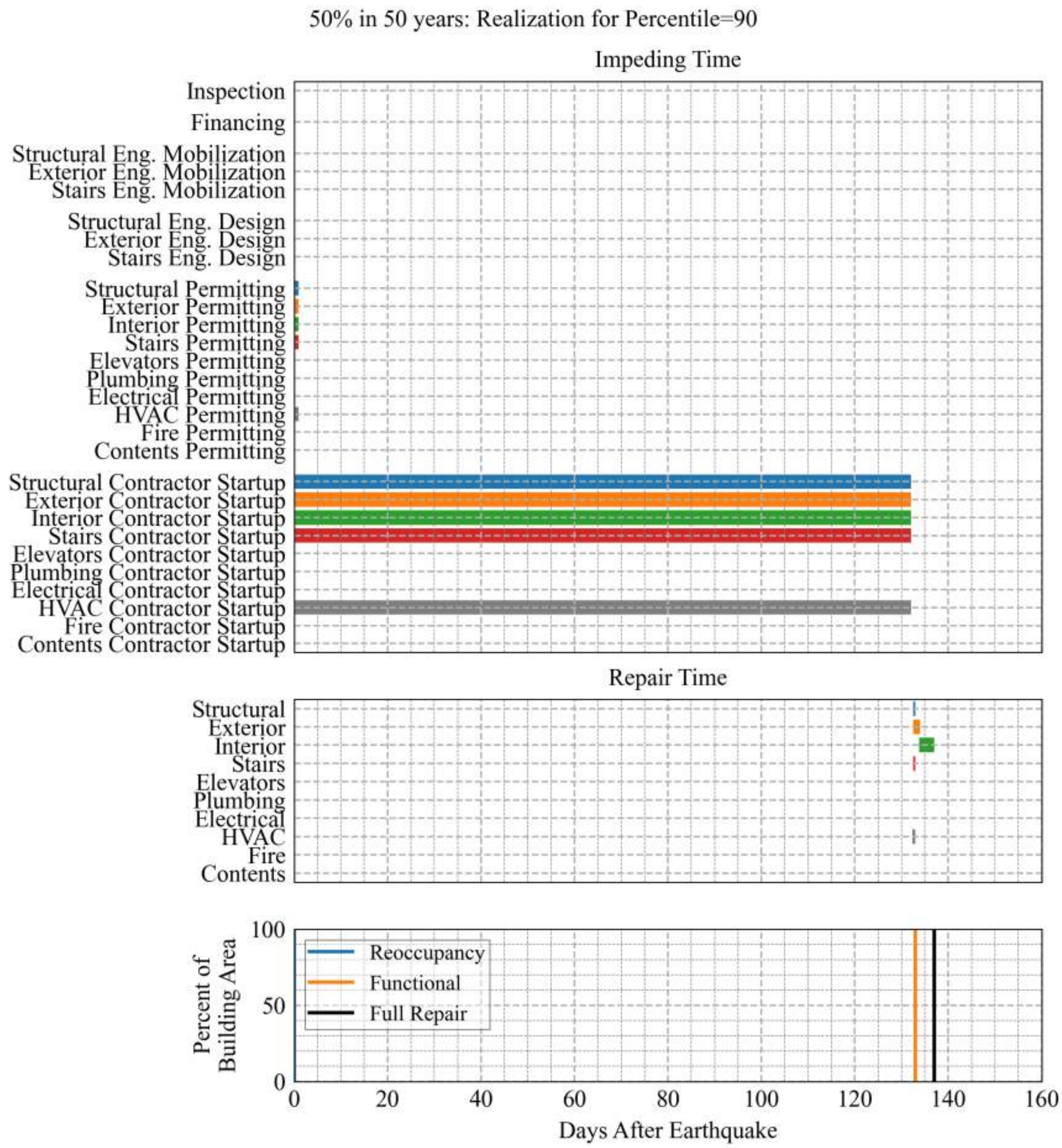

Figure 4.4. 50% in 50 years Percentile = 90

4.1.3 Damage to Building Systems

Table 4.1 shows the percentage of realizations that the named system prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.1. Percent of realizations affecting building reoccupancy/function per system - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	25	25	25	25	25	1.0	0.0
Stairway Doors	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	5.1	4.9	2.2	0.4	0.0	0.0	0.0
Interior	0.6	0.6	0.5	0.4	0.3	0.0	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	24	23	12	2.7	0.0	0.0	0.0
Water	18	18	18	17	12	0.2	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	98	98	98	94	70	1.5	0.0

4.1.4 Damage to Individual Components

Table 4.2 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.2. Percent of realizations affecting building reoccupancy/functionality per component - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.002	0.5 / 0.4	0.4 / 0.4	0.1 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.302	0.0 / 1.5	0.0 / 1.1	0.0 / 0.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	5.1 / 9.6	4.9 / 8.5	2.2 / 1.9	0.4 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 13	0.0 / 11	0.0 / 2.8	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 24	0.0 / 22	0.0 / 12	0.0 / 2.6	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	25 / 0.0	25 / 0.0	25 / 0.0	25 / 0.0	25 / 0.0	1.0 / 0.0	0.0 / 0.0
C3034.001	0.6 / 19	0.6 / 17	0.3 / 4.6	0.0 / 0.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.012a	0.3 / 0.3	0.3 / 0.3	0.2 / 0.3	0.2 / 0.3	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0
D2021.012b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.022a	0.3 / 0.3	0.3 / 0.3	0.3 / 0.3	0.2 / 0.2	0.1 / 0.1	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 17	0.0 / 17	0.0 / 17	0.0 / 16	0.0 / 11	0.0 / 0.2	0.0 / 0.0
D2031.022b	0.0 / 1.8	0.0 / 1.8	0.0 / 1.8	0.0 / 1.8	0.0 / 1.0	0.0 / 0.0	0.0 / 0.0
D3032.011a	0.0 / 98	0.0 / 98	0.0 / 98	0.0 / 94	0.0 / 69	0.0 / 1.4	0.0 / 0.0
D3041.011c	0.1 / 0.8	0.1 / 0.8	0.0 / 0.8	0.0 / 0.8	0.0 / 0.7	0.0 / 0.1	0.0 / 0.0
D3041.032c	0.3 / 5.6	0.3 / 5.6	0.2 / 5.6	0.2 / 5.6	0.1 / 4.6	0.0 / 0.0	0.0 / 0.0

4.2 10% in 50 years Intensity

4.2.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

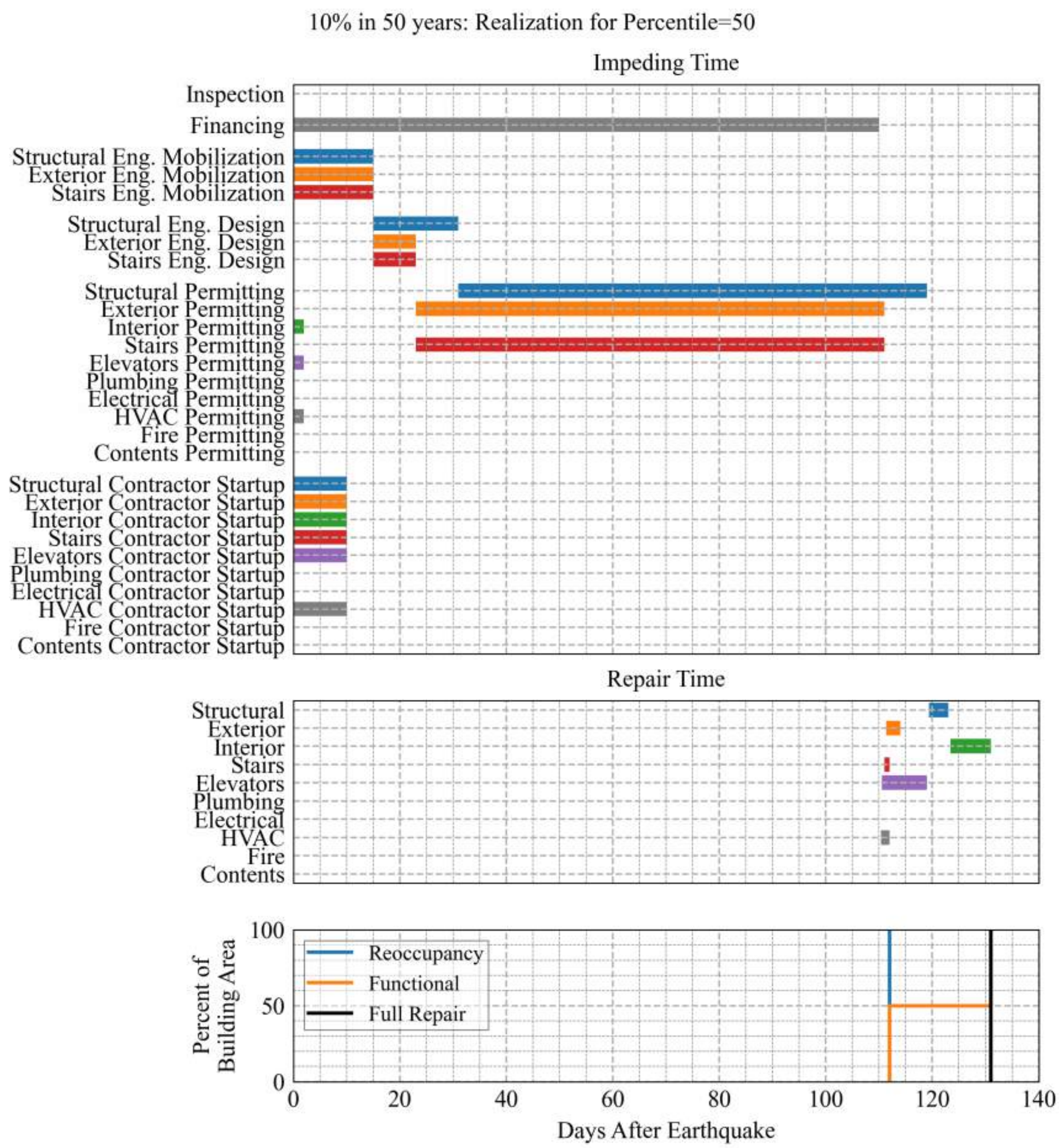

Figure 4.5. 10% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

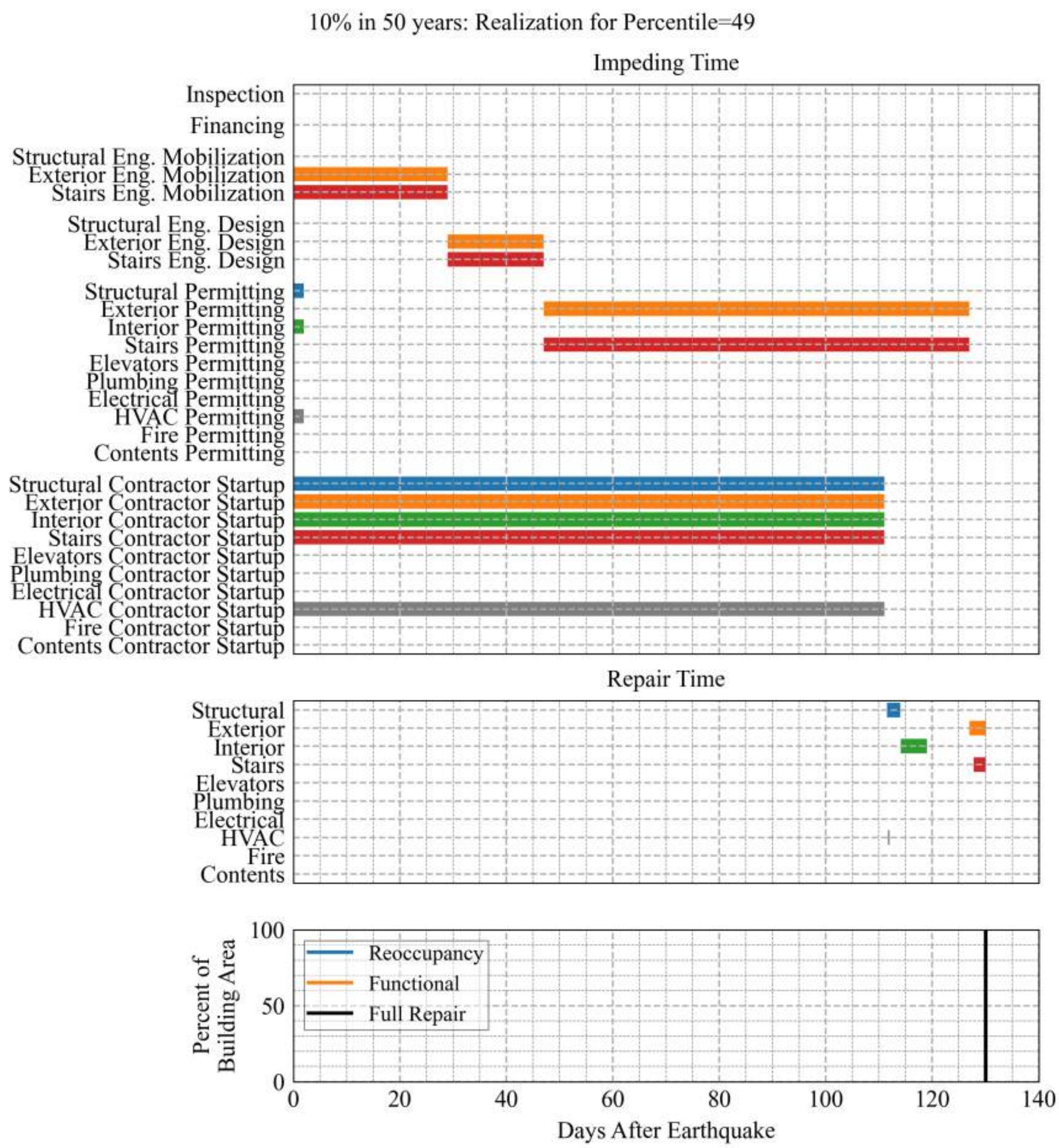

Figure 4.6. 10% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

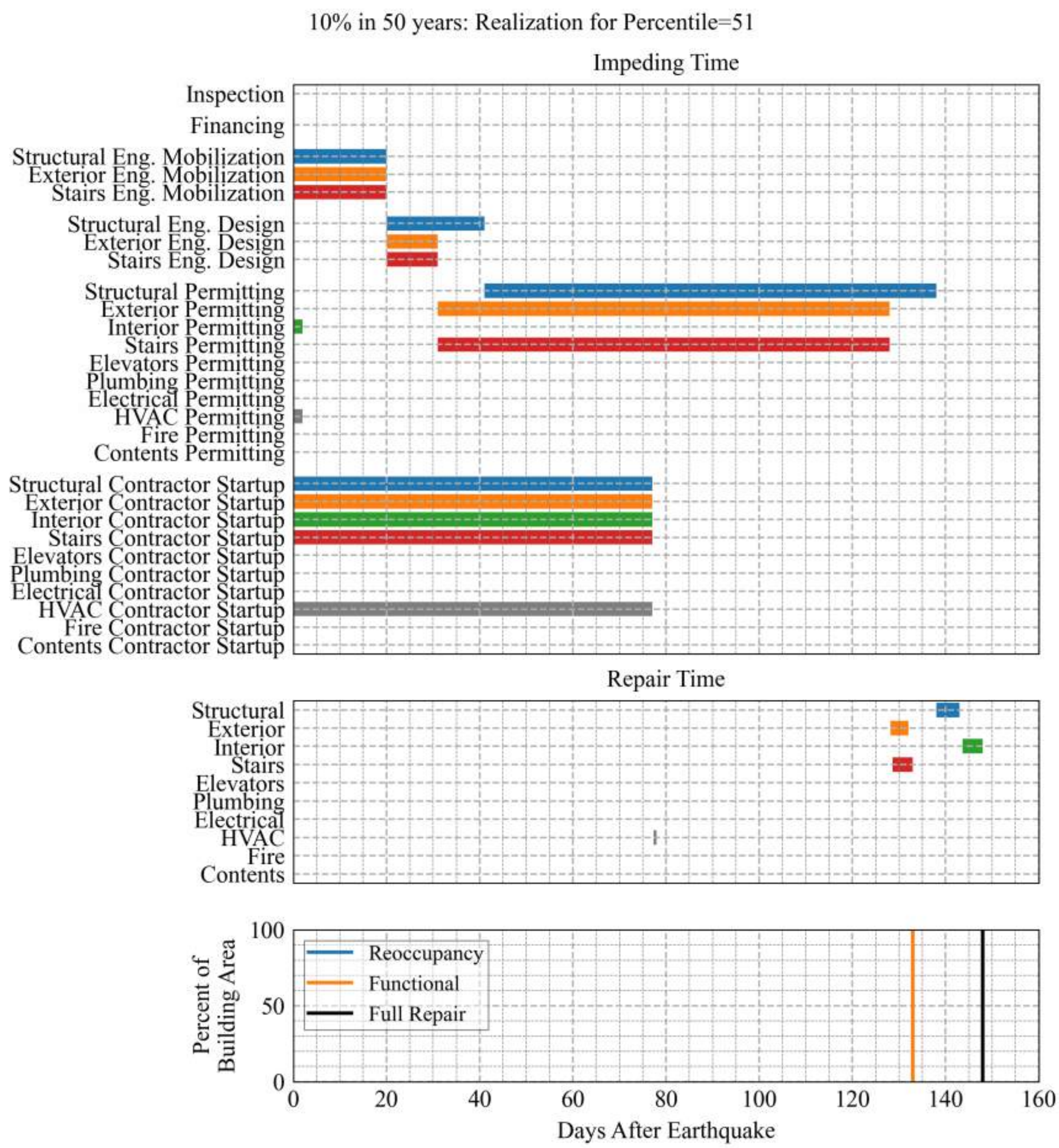

Figure 4.7. 10% in 50 years Percentile = 51

4.2.2 Selected Realizations for 90th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (10% in 50 years Percentile = 90) resulted in global failure, no scheduling was computed.

4.2.3 Damage to Building Systems

Table 4.3 shows the percentage of realizations that the named system prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.3. Percent of realizations affecting building reoccupancy/function per system - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	28	28	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	82	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	82	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	70	70	70	70	70	3.4	0.0
Stairway Doors	65	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	67	64	41	15	4.0	0.0	0.0
Interior	9.1	8.7	8.0	7.2	6.7	0.2	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	36	36	36	36	36	2.2	0.0
Interior	70	69	50	21	6.6	0.0	0.0
Water	42	42	42	42	40	0.9	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	72	72	72	72	69	3.5	0.0

4.2.4 Damage to Individual Components

Table 4.4 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.4. Percent of realizations affecting building reoccupancy/functionality per component - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.002	44 / 44	40 / 41	20 / 22	9.4 / 8.3	3.3 / 3.5	0.0 / 0.0	0.0 / 0.0
B1071.302	0.0 / 65	0.0 / 63	0.0 / 46	0.0 / 38	0.0 / 37	0.0 / 2.2	0.0 / 0.0
B2011.401	67 / 69	63 / 66	38 / 48	14 / 39	4.0 / 37	0.0 / 2.2	0.0 / 0.0
C1011.211a	0.0 / 69	0.0 / 65	0.0 / 33	0.0 / 12	0.0 / 3.4	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 70	0.0 / 67	0.0 / 38	0.0 / 14	0.0 / 4.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	70 / 0.0	70 / 0.0	70 / 0.0	70 / 0.0	70 / 0.0	3.4 / 0.0	0.0 / 0.0
C3034.001	9.1 / 68	8.5 / 64	5.3 / 28	2.2 / 8.8	0.6 / 3.2	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.012a	4.6 / 4.8	4.5 / 4.8	4.0 / 4.8	3.2 / 4.8	2.8 / 4.6	0.2 / 0.2	0.0 / 0.0
D2021.012b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.022a	5.2 / 5.2	5.2 / 5.2	5.2 / 5.2	5.2 / 5.2	5.1 / 5.1	0.1 / 0.1	0.0 / 0.0
D2031.022a	0.0 / 39	0.0 / 39	0.0 / 39	0.0 / 39	0.0 / 37	0.0 / 0.8	0.0 / 0.0
D2031.022b	0.0 / 9.0	0.0 / 9.0	0.0 / 9.0	0.0 / 9.0	0.0 / 8.7	0.0 / 0.2	0.0 / 0.0
D3032.011a	0.0 / 72	0.0 / 72	0.0 / 72	0.0 / 72	0.0 / 68	0.0 / 1.6	0.0 / 0.0
D3041.011c	3.0 / 7.5	1.7 / 7.5	0.7 / 7.5	0.6 / 7.5	0.2 / 7.5	0.0 / 0.7	0.0 / 0.0
D3041.032c	5.5 / 24	5.2 / 24	4.6 / 24	4.1 / 24	3.8 / 24	0.1 / 2.5	0.0 / 0.0

4.3 DE Intensity

4.3.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

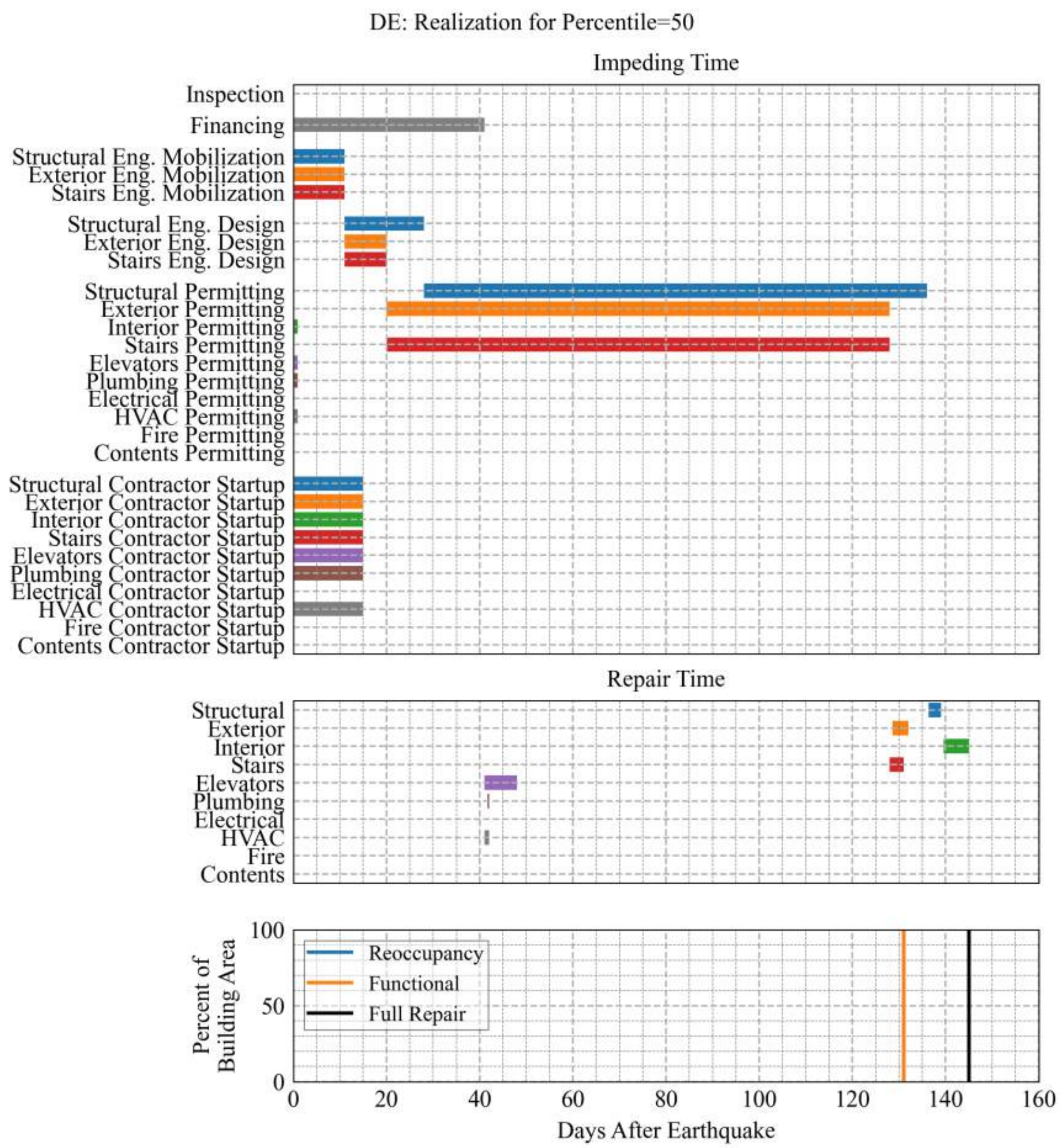

Figure 4.8. DE Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

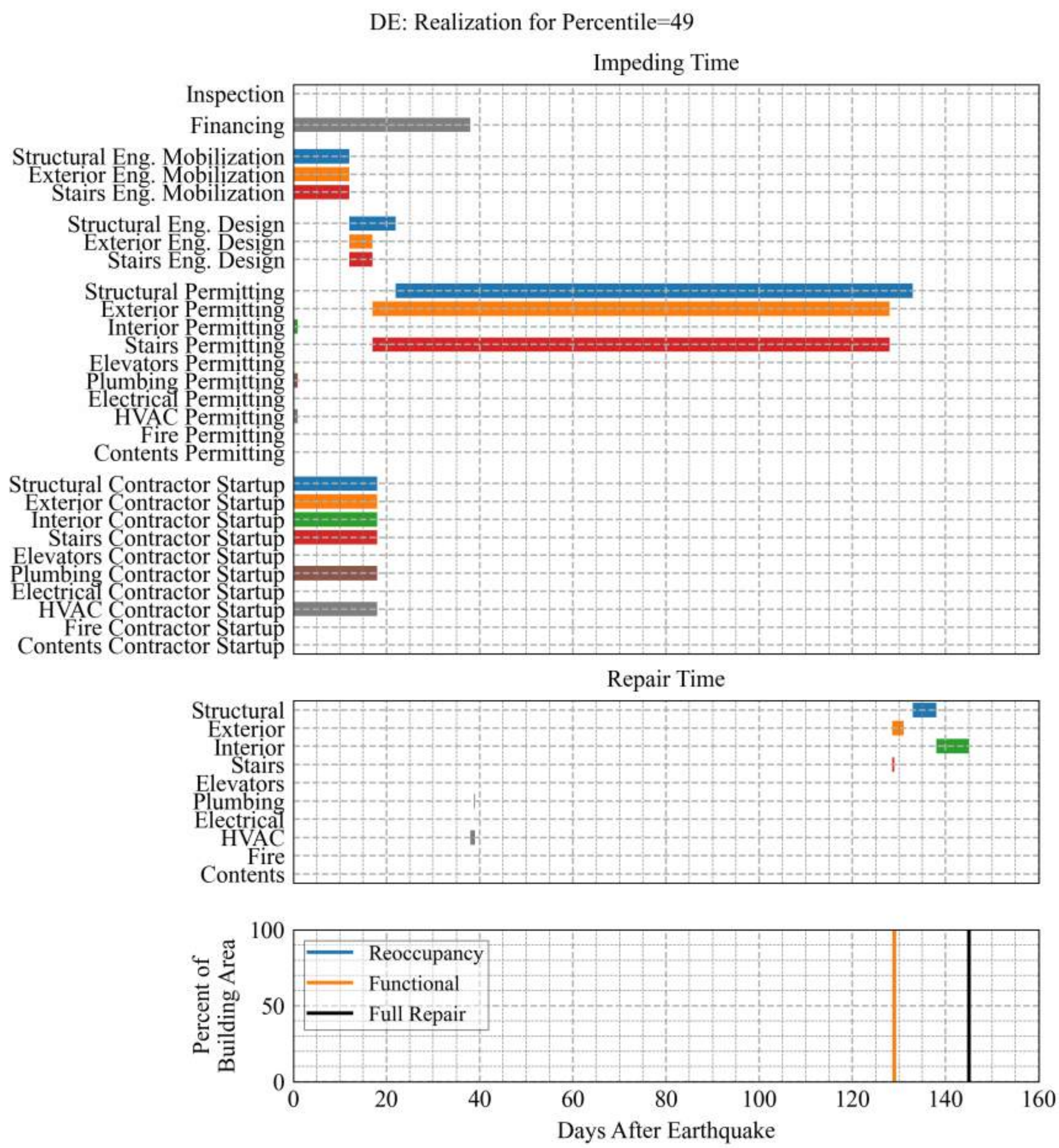

Figure 4.9. DE Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

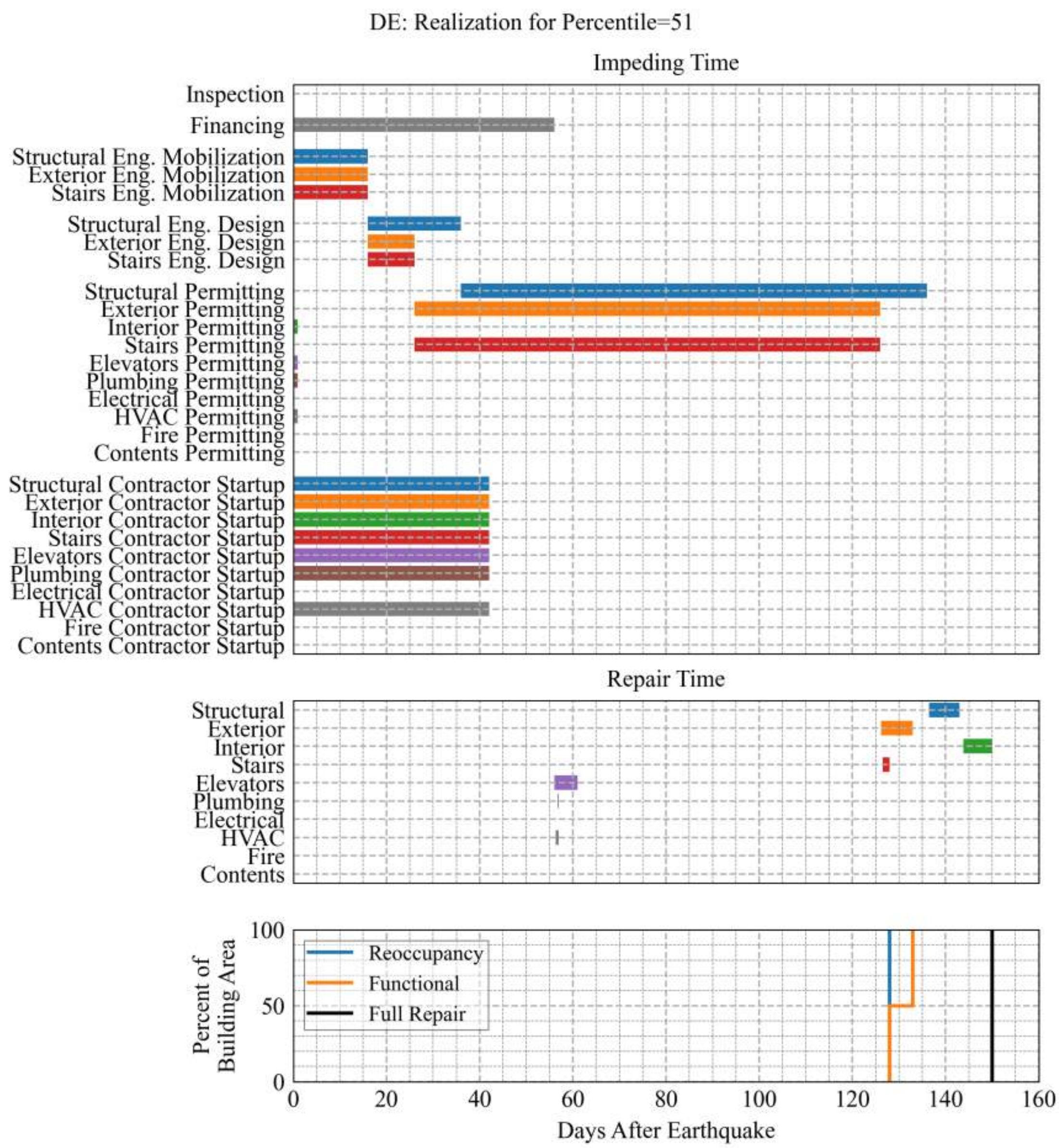

Figure 4.10. DE Percentile = 51

4.3.2 Selected Realizations for 90^{th} percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (DE Percentile = 90) resulted in global failure, no scheduling was computed.

4.3.3 Damage to Building Systems

Table 4.5 shows the percentage of realizations that the named system prevents reoccupancy/function for the DE intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.5. Percent of realizations affecting building reoccupancy/function per system - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	29	29	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	85	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	85	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	69	69	69	69	69	2.9	0.0
Stairway Doors	64	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	67	63	40	14	4.1	0.0	0.0
Interior	9.6	8.9	7.7	6.9	6.2	0.1	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	34	34	34	34	34	1.5	0.0
Interior	70	68	50	20	6.6	0.0	0.0
Water	41	41	41	41	39	0.8	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	71	71	71	71	68	3.0	0.0

4.3.4 Damage to Individual Components

Table 4.6 shows the percentage of realizations that a specific component prevents reoccupancy/function for the DE intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.6. Percent of realizations affecting building reoccupancy/functionality per component - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.002	44 / 44	40 / 40	19 / 21	8.9 / 8.2	3.7 / 3.6	0.0 / 0.0	0.0 / 0.0
B1071.302	0.0 / 63	0.0 / 61	0.0 / 45	0.0 / 36	0.0 / 35	0.0 / 1.5	0.0 / 0.0
B2011.401	67 / 69	63 / 65	37 / 46	14 / 37	4.0 / 36	0.0 / 1.5	0.0 / 0.0
C1011.211a	0.0 / 69	0.0 / 64	0.0 / 34	0.0 / 12	0.0 / 3.8	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 69	0.0 / 65	0.0 / 37	0.0 / 14	0.0 / 4.2	0.0 / 0.0	0.0 / 0.0
C2011.041b	69 / 0.0	69 / 0.0	69 / 0.0	69 / 0.0	69 / 0.0	2.9 / 0.0	0.0 / 0.0
C3034.001	9.6 / 67	8.7 / 62	5.0 / 30	2.3 / 9.2	0.6 / 3.7	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.012a	5.6 / 5.6	5.4 / 5.6	4.6 / 5.6	3.8 / 5.6	3.2 / 5.2	0.1 / 0.1	0.0 / 0.0
D2021.012b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.022a	4.5 / 4.5	4.5 / 4.5	4.5 / 4.5	4.5 / 4.5	4.3 / 4.3	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 38	0.0 / 38	0.0 / 38	0.0 / 38	0.0 / 36	0.0 / 0.8	0.0 / 0.0
D2031.022b	0.0 / 8.7	0.0 / 8.7	0.0 / 8.7	0.0 / 8.6	0.0 / 8.4	0.0 / 0.2	0.0 / 0.0
D3032.011a	0.0 / 71	0.0 / 71	0.0 / 71	0.0 / 71	0.0 / 67	0.0 / 1.2	0.0 / 0.0
D3041.011c	3.6 / 7.8	1.9 / 7.8	0.6 / 7.8	0.4 / 7.8	0.1 / 7.8	0.0 / 0.7	0.0 / 0.0
D3041.032c	6.4 / 23	5.7 / 23	4.8 / 23	4.3 / 23	3.9 / 23	0.0 / 2.0	0.0 / 0.0

4.4 MCE$_R$ Intensity

4.4.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE$_R$ Percentile = 50) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE_R Percentile = 49) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE_R Percentile = 51) resulted in global failure, no scheduling was computed.

4.4.2 Selected Realizations for 90th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE$_R$ Percentile = 90) resulted in global failure, no scheduling was computed.

4.4.3 Damage to Building Systems

Table 4.7 shows the percentage of realizations that the named system prevents reoccupancy/function for the MCE$_R$ intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.7. Percent of realizations affecting building reoccupancy/function per system - MCE$_R$

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	65	65	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	97	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	97	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	34	34	34	34	34	1.8	0.0
Stairway Doors	34	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	34	34	25	13	5.4	0.0	0.0
Interior	11	10	9.4	9.0	8.1	0.4	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	30	30	30	30	30	1.6	0.0
Interior	35	34	30	17	8.4	0.2	0.0
Water	28	28	28	28	27	0.9	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	35	35	35	35	34	2.7	0.0

4.4.4 Damage to Individual Components

Table 4.8 shows the percentage of realizations that a specific component prevents reoccupancy/function for the MCE_R intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.8. Percent of realizations affecting building reoccupancy/functionality per component - MCE_R

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.002	31 / 31	29 / 30	18 / 19	10 / 10	4.5 / 4.5	0.0 / 0.0	0.0 / 0.0
B1071.302	0.0 / 34	0.0 / 34	0.0 / 32	0.0 / 30	0.0 / 30	0.0 / 1.6	0.0 / 0.0
B2011.401	34 / 35	33 / 34	22 / 32	12 / 31	5.0 / 30	0.0 / 1.6	0.0 / 0.0
C1011.211a	0.0 / 35	0.0 / 33	0.0 / 21	0.0 / 12	0.0 / 4.7	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 35	0.0 / 33	0.0 / 22	0.0 / 12	0.0 / 4.8	0.0 / 0.0	0.0 / 0.0
C2011.041b	34 / 0.0	34 / 0.0	34 / 0.0	34 / 0.0	34 / 0.0	1.8 / 0.0	0.0 / 0.0
C3034.001	11 / 34	10 / 33	6.3 / 20	3.7 / 10	1.3 / 4.4	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.012a	6.6 / 6.6	6.5 / 6.6	5.9 / 6.6	5.5 / 6.6	4.9 / 6.4	0.2 / 0.2	0.0 / 0.0
D2021.012b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.022a	6.4 / 6.4	6.4 / 6.4	6.4 / 6.4	6.4 / 6.4	5.9 / 5.9	0.4 / 0.4	0.0 / 0.0
D2031.022a	0.0 / 26	0.0 / 26	0.0 / 26	0.0 / 26	0.0 / 25	0.0 / 0.9	0.0 / 0.0
D2031.022b	0.0 / 10	0.0 / 10	0.0 / 10	0.0 / 10	0.0 / 10	0.0 / 0.4	0.0 / 0.0
D3032.011a	0.0 / 35	0.0 / 35	0.0 / 35	0.0 / 35	0.0 / 33	0.0 / 1.2	0.0 / 0.0
D3041.011c	5.6 / 8.8	3.8 / 8.8	2.1 / 8.8	1.7 / 8.8	0.5 / 8.8	0.0 / 0.9	0.0 / 0.0
D3041.032c	8.4 / 19	8.0 / 19	7.5 / 19	7.1 / 19	6.4 / 19	0.4 / 2.0	0.0 / 0.0

4.5 2% in 50 years Intensity

4.5.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 50) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 49) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 51) resulted in global failure, no scheduling was computed.

4.5.2 Selected Realizations for 90^{th} percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 90) resulted in global failure, no scheduling was computed.

4.5.3 Damage to Building Systems

Table 4.9 shows the percentage of realizations that the named system prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.9. Percent of realizations affecting building reoccupancy/function per system - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	87	87	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	99	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	99	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	13	13	13	13	13	0.8	0.0
Stairway Doors	13	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	13	13	10	6.1	2.5	0.0	0.0
Interior	5.6	5.2	4.8	4.8	4.6	0.1	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	12	12	12	12	12	0.8	0.0
Interior	13	13	12	8.5	4.8	0.0	0.0
Water	11	11	11	11	11	0.3	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	13	13	13	13	13	1.0	0.0

4.5.4 Damage to Individual Components

Table 4.10 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.10. Percent of realizations affecting building reoccupancy/functionality per component - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.002	12 / 12	12 / 12	8.1 / 8.3	5.2 / 5.0	2.0 / 2.0	0.0 / 0.0	0.0 / 0.0
B1071.302	0.0 / 13	0.0 / 13	0.0 / 12	0.0 / 12	0.0 / 12	0.0 / 0.8	0.0 / 0.0
B2011.401	13 / 13	13 / 13	8.8 / 12	5.6 / 12	2.3 / 12	0.0 / 0.8	0.0 / 0.0
C1011.211a	0.0 / 13	0.0 / 12	0.0 / 8.9	0.0 / 5.6	0.0 / 2.3	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 13	0.0 / 12	0.0 / 8.7	0.0 / 6.1	0.0 / 2.2	0.0 / 0.0	0.0 / 0.0
C2011.041b	13 / 0.0	13 / 0.0	13 / 0.0	13 / 0.0	13 / 0.0	0.8 / 0.0	0.0 / 0.0
C3034.001	5.6 / 13	5.1 / 12	4.0 / 8.4	2.7 / 5.4	1.3 / 2.3	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.012a	3.4 / 3.4	3.2 / 3.4	3.0 / 3.4	2.8 / 3.4	2.7 / 3.3	0.1 / 0.1	0.0 / 0.0
D2021.012b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.022a	3.5 / 3.5	3.5 / 3.5	3.5 / 3.5	3.5 / 3.5	3.5 / 3.5	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 11	0.0 / 11	0.0 / 11	0.0 / 11	0.0 / 11	0.0 / 0.3	0.0 / 0.0
D2031.022b	0.0 / 5.4	0.0 / 5.4	0.0 / 5.4	0.0 / 5.4	0.0 / 5.3	0.0 / 0.1	0.0 / 0.0
D3032.011a	0.0 / 13	0.0 / 13	0.0 / 13	0.0 / 13	0.0 / 13	0.0 / 0.3	0.0 / 0.0
D3041.011c	3.5 / 5.1	2.3 / 5.1	1.4 / 5.1	1.2 / 5.1	0.6 / 5.1	0.0 / 0.4	0.0 / 0.0
D3041.032c	4.5 / 8.9	4.2 / 8.9	3.9 / 8.9	3.8 / 8.9	3.6 / 8.9	0.1 / 1.0	0.0 / 0.0

SEISMIC RISK ASSESSMENT REPORT
Created with the SP3-RiskModel

Detailed Component Report

Report Generated for:
217 Arlington Avenue, Kensington, CA, 94707
Latitude: 37.90622°
Longitude: -122.27875°

Report Generated by:
The SP3-RiskModel Software v1.2.0 of the
Seismic Performance Prediction Program (SP3)

March 16, 2022

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	Existing WLF w/ Frame
Building Type:	WLF: General
Design Code Year:	1967
Number of Stories:	2
Occupancy:	Commercial Office
Address:	
217 Arlington Avenue Kensington, CA, 94707	
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	4,395
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	Moderate
Plan Irregularity:	Extreme
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–
Dir. 2 Story 1	–
Dir. 2 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Ordinary, Ordinary
Drift Limit (Dir. 1, 2):	1.5%, 1.5%
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	0.419	0.283
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	0.45	0.6

Component Information

Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options

Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*

Interior Finishes

- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *No*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *No*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *No*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	4.6	8.1
10% in 50 years	475 Years	39	67
DE	481 Years	40	68
5% in 50 years	975 Years	64	100
MCE_R	1277 Years	72	100
2% in 50 years	2475 Years	90	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	14 days	2.1 weeks	0 days	1.9 months	2.3 months
10% in 50 years	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
DE	2.4 months	2.5 months	4.1 months	4.4 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 MOST DAMAGED COMPONENTS

Table 2.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1071.302	1	$1,507
10% in 50 years	B1031.011a	1	$16,523
DE	B1031.011a	1	$16,821
5% in 50 years	B1031.011a	1	$21,343
MCE_R	B1031.011a	1	$18,853
2% in 50 years	B1031.011a	1	$8,919

Table 2.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	D1014.022	1	$14,645
10% in 50 years	C1011.211a	3	$31,390
DE	C1011.211a	3	$31,104
5% in 50 years	C1011.211a	3	$21,129
MCE_R	C1011.211a	3	$16,921
2% in 50 years	C1011.211a	3	$6,506

Details of the most damaged components and their damage states:

- **B1031.011a**: Steel Column Base Plates, Column W < 150 plf
  - DS1a: Initiation of crack at the fusion line between the column flange and the base plate weld. Damage in field is either obscured or deemed to not warrant repair. No repair conducted.
  - DS1b: Initiation of crack at the fusion line between the column flange and the base plate weld.
- **B1071.302**: Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs
  - DS1: Cracking of paint over fasteners or joints.
- **C1011.211a**: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above
  - DS3: Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.
- **D1014.022**: Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.
  - DS1a: Damaged controls.
  - DS1b: Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.
  - DS1c: Damaged entrance and car door, and or flooring damage.
  - DS1d: Oil leak in hydraulic line, and or hydraulic tank failure.

3 DETAILED COMPONENT DAMAGE BREAKDOWNS

3.1 Repair Cost

This table shows the expected contribution to repair cost on a per-damage state basis. The header shows the total loss, the loss contribution from collapse, and the loss contribution from residual drift for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.1.1. Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**60.5k**	**524k**	**534k**	**850k**	**963k**	**1.2M**
Collapse	0	358k	363k	650k	750k	966k
Residual	0	14.4k	20.7k	82.9k	119k	192k
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0	0	0	0	0	0
DS1b	34.2	1.24k	1.2k	1.11k	983	416
DS2	16.8	8.84k	9.37k	11.2k	8.25k	4.2k
DS3	0	6.45k	6.26k	9.05k	9.62k	4.31k
Total	**51**	**16.5k**	**16.8k**	**21.3k**	**18.9k**	**8.92k**
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0	0	0	0	0	0
DS1b	0	0	0	0	0	0
DS2a	0	0	0	0	0	0
DS2b	0	0	0	0	0	0
DS3	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0	0	0	0	0	0
DS1b	0	0	0	0	0	0
DS2a	0	0	0	0	0	0
DS2b	0	0	0	0	0	0
DS3	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	990	3.95k	3.97k	1.95k	1.35k	361
DS2	70.8	2.79k	2.77k	1.97k	1.61k	537
DS3	49.6	8.07k	8k	8.87k	7.56k	3.83k
Total	**1.11k**	**14.8k**	**14.7k**	**12.8k**	**10.5k**	**4.73k**
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	840	285	283	177	142	65.8
DS2	329	351	373	131	93.8	26.3
DS3	338	2.63k	2.61k	1.32k	941	227
DS4	0	1.58k	1.46k	1.13k	1.02k	302
DS5	0	2.03k	1.9k	2.61k	2.26k	1.19k
Total	**1.51k**	**6.87k**	**6.63k**	**5.37k**	**4.46k**	**1.81k**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	793	599	580	233	153	40.1
DS2	342	1.07k	1.07k	555	411	114
DS3	462	8.87k	8.82k	7.57k	6.2k	2.65k
Total	**1.6k**	**10.5k**	**10.5k**	**8.36k**	**6.76k**	**2.81k**

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Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**60.5k**	**524k**	**534k**	**850k**	**963k**	**1.2M**
Collapse	0	358k	363k	650k	750k	966k
Residual	0	14.4k	20.7k	82.9k	119k	192k
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	3.56k	2.05k	2.06k	1.79k	1.55k	783
DS2	3k	1.4k	1.31k	552	327	168
DS3	6.8k	27.9k	27.7k	18.8k	15k	5.55k
Total	**13.4k**	**31.4k**	**31.1k**	**21.1k**	**16.9k**	**6.51k**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	3.07k	1.12k	1.1k	934	802	370
DS2	3.24k	1.18k	1.1k	357	247	144
DS3	8.24k	28.4k	28.4k	19.2k	14.7k	5.41k
Total	**14.6k**	**30.7k**	**30.6k**	**20.5k**	**15.8k**	**5.92k**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	419	184	187	65.7	44.2	8.9
DS2	543	1.19k	1.13k	599	408	103
DS3	458	5.74k	5.82k	4.92k	4.11k	1.72k
Total	**1.42k**	**7.12k**	**7.14k**	**5.58k**	**4.57k**	**1.84k**
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**4.09k**	**3.75k**	**3.85k**	**2.41k**	**1.76k**	**582**
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	381	459	487	263	243	78.4
DS1b	5.93k	7.59k	7.73k	4.96k	3.98k	1.59k
DS1c	7.15k	10.4k	10.1k	6.53k	4.76k	1.83k
DS1d	1.19k	1.67k	1.45k	1.1k	854	259
Total	**14.6k**	**20.1k**	**19.8k**	**12.9k**	**9.84k**	**3.75k**
D2021.012a #1 (D2021.012a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	1.32	4.26	4.62	4.32	3.26	1.67
DS2	0.49	9.18	11.1	12.9	12.5	7.67
Total	**1.81**	**13.4**	**15.7**	**17.2**	**15.7**	**9.34**
D2021.012b #1 (D2021.012b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	1.23	5.8	5.64	5.32	4.79	2.15
DS2	1.23	13.2	11.5	19.4	20.8	11.1
Total	**2.46**	**19**	**17.2**	**24.7**	**25.6**	**13.3**
D2021.022a #1 (D2021.022a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING...)						
DS1	6.24	30.4	31.4	28.6	23.3	12.4
DS2	2.96	70.4	57.8	91.2	98.6	49.4
Total	**9.21**	**101**	**89.2**	**120**	**122**	**61.8**
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**106**	**292**	**274**	**236**	**210**	**93.8**
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	10.9	26.4	27.5	20.6	16.8	7.53
DS2	12.9	69.2	69.4	92.4	86.4	47
Total	**23.8**	**95.6**	**96.8**	**113**	**103**	**54.5**
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	711	752	763	485	390	151
DS1b	2.53k	2.83k	2.73k	1.79k	1.34k	470
Total	**3.24k**	**3.59k**	**3.49k**	**2.28k**	**1.73k**	**621**

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Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**60.5k**	**524k**	**534k**	**850k**	**963k**	**1.2M**
Collapse	0	358k	363k	650k	750k	966k
Residual	0	14.4k	20.7k	82.9k	119k	192k
D3032.011a #2 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	972	770	771	469	377	136
DS1b	3.49k	2.8k	2.76k	1.8k	1.36k	520
Total	**4.46k**	**3.57k**	**3.53k**	**2.27k**	**1.74k**	**656**
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	6.23	21.8	22.9	22.2	18.9	7.61
DS2	9.16	97.5	105	141	128	77.3
Total	**15.4**	**119**	**128**	**164**	**147**	**84.9**
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**270**	**1.32k**	**1.29k**	**1.3k**	**1.12k**	**572**

3.2 Repair time

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.2.1. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.8	0.9	0.8	0.7	0.2
DS2	0.0	6.1	6.7	7.7	5.7	2.9
DS3	0.0	4.3	3.7	6.2	6.9	3.2
Total	**0.0**	**11**	**11**	**15**	**13**	**6.3**
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.0	0.0	0.0	0.0	0.0
DS2a	0.0	0.0	0.0	0.0	0.0	0.0
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.0	0.0	0.0	0.0	0.0
DS2a	0.0	0.0	0.0	0.0	0.0	0.0
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	0.7	2.8	2.8	1.4	0.9	0.2
DS2	0.1	2.0	1.9	1.4	1.1	0.4
DS3	0.0	5.6	5.5	6.2	5.3	2.8
Total	**0.8**	**10**	**10**	**8.9**	**7.3**	**3.4**
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.5	0.2	0.2	0.1	0.1	0.0
DS2	0.2	0.2	0.2	0.1	0.0	0.0
DS3	0.2	1.5	1.5	0.7	0.5	0.1
DS4	0.0	1.2	1.1	0.9	0.7	0.3
DS5	0.0	1.5	1.4	2.0	1.7	1.0
Total	**0.8**	**4.5**	**4.4**	**3.8**	**3.1**	**1.4**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	1.9	1.8	1.8	0.7	0.5	0.1
DS2	0.6	2.2	2.2	1.1	0.8	0.2
DS3	0.7	13	13	11	9.0	3.8
Total	**3.2**	**17**	**17**	**13**	**10**	**4.2**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.9	1.2	1.2	1.0	0.9	0.4
DS2	1.7	0.8	0.7	0.3	0.2	0.1
DS3	3.9	16	16	11	8.6	3.1
Total	**7.6**	**18**	**18**	**12**	**10**	**3.6**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.7	0.6	0.6	0.5	0.5	0.2
DS2	1.7	0.7	0.6	0.2	0.2	0.1
DS3	4.6	16	16	11	8.5	3.1
Total	**8.1**	**17**	**17**	**11**	**9.1**	**3.4**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.3	0.1	0.1	0.1	0.0	0.0
DS2	0.4	0.9	0.9	0.4	0.3	0.1
DS3	0.4	4.5	4.6	3.9	3.2	1.3
Total	**1.1**	**5.6**	**5.6**	**4.4**	**3.6**	**1.4**
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**3.0**	**2.8**	**2.8**	**1.7**	**1.2**	**0.4**
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	0.3	0.3	0.3	0.2	0.2	0.1
DS1b	4.3	5.5	5.6	3.6	2.8	1.1
DS1c	5.3	7.2	7.3	4.7	3.5	1.2
DS1d	0.8	1.2	1.1	0.8	0.6	0.2
Total	**11**	**14**	**14**	**9.3**	**7.1**	**2.6**
D2021.012a #1 (D2021.012a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.012b #1 (D2021.012b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.022a #1 (D2021.022a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.0	0.1	0.1	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.1	0.1	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	0.6	0.6	0.6	0.4	0.3	0.1
DS1b	0.3	0.4	0.4	0.2	0.2	0.1
Total	**1.0**	**1.0**	**1.0**	**0.6**	**0.5**	**0.2**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
D3032.011a #2 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	0.8	0.7	0.6	0.4	0.3	0.1
DS1b	0.5	0.4	0.4	0.2	0.2	0.1
Total	**1.3**	**1.0**	**1.0**	**0.6**	**0.5**	**0.2**
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**	**0.0**
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.2**	**1.1**	**1.1**	**1.1**	**1.0**	**0.5**

3.3 Casualties

Table 3.3.1 shows the total expected casualty results broken into collapse and non-collapse sources. The non-parenthetical values are casualties in terms of number of people and the parenthetical values show the probability of casualty for an individual person placed randomly in the building.

Table 3.3.2 shows the casualty breakdown on a per component basis. The values in this table are in terms of number of people, not probabilities.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.3.1. Total expected casualties (Number of People (%))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Total Non-Collapse Casualties						
Injury	0.0872 (2.03)	0.124 (2.90)	0.125 (2.91)	0.0990 (2.30)	0.0872 (2.03)	0.0582 (1.36)
Death	0.000847 (0.020)	0.00127 (0.030)	0.00126 (0.029)	0.00105 (0.024)	0.000882 (0.021)	0.000572 (0.013)
Total Collapse Casualties						
Injury	0.00 (0.00)	0.372 (8.66)	0.377 (8.77)	0.675 (15.7)	0.779 (18.1)	1.00 (23.3)
Death	0.00 (0.00)	0.00376 (0.087)	0.00381 (0.089)	0.00682 (0.159)	0.00787 (0.183)	0.0101 (0.236)
Total Collapse and Non-Collapse Casualties						
Injury	0.0872 (2.03)	0.463 (10.8)	0.468 (10.9)	0.726 (16.9)	0.817 (19.0)	1.02 (23.7)
Death	0.000847 (0.020)	0.00468 (0.109)	0.00472 (0.110)	0.00735 (0.171)	0.00825 (0.192)	0.0103 (0.239)

Table 3.3.2. Expected casualties per component (Number of People)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
Injury	0.0872	0.124	0.125	0.0988	0.0870	0.0581
Death	0.000847	0.00127	0.00126	0.00105	0.000882	0.000572
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
Injury	0.000001	0.000008	0.000009	0.000015	0.000017	0.000016
Death	0.00	0.00	0.00	0.00	0.00	0.00
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
Injury	0.000026	0.000147	0.000141	0.000154	0.000158	0.000133
Death	0.00	0.00	0.00	0.00	0.00	0.00

3.4 Quantity Damaged

This table shows the expected percentage of the components that are in a given damage state (normalized to the total quantity of that component in the entire building). The small parenthetical value is the probability that any component throughout the building is in that damage state (the percentage of realizations that have a component in that damage state).

All of these values are conditioned on no global failure. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.4.1. Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0.6 (1.8)	23 (53)	23 (54)	30 (68)	32 (70)	35 (76)
DS1b	0.0 (0.1)	1.2 (4.6)	1.3 (4.8)	1.8 (7.0)	2.1 (8.3)	1.9 (7.8)
DS2	0.0 (0.0)	6.9 (21)	7.6 (22)	14 (40)	14 (40)	19 (50)
DS3	0.0 (0.0)	4.4 (11)	4.0 (11)	10 (25)	13 (29)	17 (39)
Total	**0.6** (1.8)	**36** (60)	**36** (60)	**57** (81)	**61** (84)	**74** (93)
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS1b	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS2a	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS2b	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS3	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Total	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS1b	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS2a	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS2b	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
DS3	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Total	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)	**0.0** (0.0)
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	1.9 (25)	13 (80)	14 (81)	11 (68)	10 (65)	7.3 (47)
DS2	0.1 (1.6)	7.9 (59)	7.8 (59)	9.3 (64)	9.8 (68)	8.9 (65)
DS3	0.0 (0.5)	8.8 (61)	8.9 (61)	16 (84)	18 (89)	25 (97)
Total	**2.0** (26)	**30** (99)	**30** (99)	**37** (100)	**38** (100)	**42** (100)
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	27 (89)	17 (71)	18 (71)	20 (77)	21 (81)	29 (92)
DS2	5.3 (28)	8.9 (46)	9.2 (47)	5.9 (32)	5.1 (29)	5.3 (34)
DS3	1.8 (9.6)	21 (72)	22 (72)	18 (60)	17 (56)	12 (42)
DS4	0.0 (0.0)	8.2 (34)	7.8 (33)	10 (44)	11 (50)	11 (47)
DS5	0.0 (0.0)	6.7 (22)	6.4 (21)	14 (41)	16 (47)	25 (65)
Total	**34** (92)	**63** (100)	**63** (100)	**69** (100)	**71** (100)	**82** (100)

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	6.7 (81)	11 (91)	11 (92)	6.9 (74)	5.9 (72)	4.2 (61)
DS2	1.8 (35)	9.3 (92)	9.3 (93)	7.8 (90)	7.3 (88)	5.6 (81)
DS3	0.9 (16)	25 (97)	25 (98)	34 (100)	36 (100)	42 (100)
Total	**9.4 (82)**	**45 (100)**	**45 (100)**	**49 (100)**	**49 (100)**	**51 (100)**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	18 (72)	17 (49)	17 (49)	24 (63)	26 (66)	36 (84)
DS2	7.1 (36)	4.8 (24)	4.7 (24)	3.3 (16)	2.5 (11)	4.1 (15)
DS3	5.0 (26)	30 (98)	30 (98)	33 (99)	35 (100)	36 (100)
Total	**30 (99)**	**51 (100)**	**52 (100)**	**61 (100)**	**63 (100)**	**76 (100)**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	24 (74)	14 (50)	14 (51)	20 (64)	22 (67)	29 (81)
DS2	10 (34)	5.7 (24)	5.4 (24)	2.8 (13)	2.9 (13)	4.2 (18)
DS3	8.1 (26)	42 (97)	42 (98)	47 (100)	47 (100)	49 (100)
Total	**43 (99)**	**62 (100)**	**62 (100)**	**70 (100)**	**72 (100)**	**82 (100)**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	30 (54)	19 (36)	19 (35)	11 (21)	8.6 (17)	4.5 (9.0)
DS2	9.7 (19)	29 (51)	29 (49)	24 (42)	20 (38)	16 (30)
DS3	2.8 (5.5)	48 (76)	49 (77)	65 (90)	70 (94)	80 (98)
Total	**43 (75)**	**97 (100)**	**96 (100)**	**99 (100)**	**99 (100)**	**100 (100)**
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**38 (88)**	**77 (99)**	**77 (99)**	**87 (100)**	**90 (100)**	**95 (100)**
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	16 (16)	28 (28)	30 (30)	28 (28)	30 (30)	30 (30)
DS1b	26 (26)	47 (47)	48 (48)	48 (48)	50 (50)	53 (53)
DS1c	22 (22)	43 (43)	43 (43)	43 (43)	42 (42)	43 (43)
DS1d	18 (18)	36 (36)	32 (32)	38 (38)	39 (39)	32 (32)
Total	**82 (45)**	**150 (85)** *	**150 (84)** *	**160 (87)** *	**160 (86)** *	**160 (89)** *

*Percent of total quantity above 100 is caused by simultaneous damage states

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
D2021.012a #1 (D2021.012a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	2.8 (5.3)	16 (29)	16 (28)	25 (41)	26 (45)	35 (56)
DS2	0.2 (0.3)	3.6 (6.6)	4.2 (7.8)	8.0 (14)	10 (19)	15 (26)
Total	**2.9 (5.5)**	**19 (33)**	**20 (33)**	**33 (50)**	**36 (56)**	**51 (69)**
D2021.012b #1 (D2021.012b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	2.5 (4.8)	16 (28)	16 (27)	24 (39)	27 (46)	33 (55)
DS2	0.2 (0.5)	3.6 (6.8)	3.1 (6.1)	8.4 (15)	12 (20)	17 (29)
Total	**2.7 (5.2)**	**19 (33)**	**19 (31)**	**32 (48)**	**39 (57)**	**50 (70)**
D2021.022a #1 (D2021.022a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING...)						
DS1	2.5 (4.6)	16 (28)	16 (29)	25 (41)	26 (43)	33 (54)
DS2	0.1 (0.3)	3.8 (7.2)	3.3 (6.3)	8.0 (14)	11 (18)	16 (27)
Total	**2.6 (4.8)**	**20 (32)**	**19 (33)**	**33 (50)**	**37 (54)**	**49 (68)**
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**9.2 (17)**	**35 (54)**	**34 (53)**	**47 (68)**	**54 (75)**	**64 (84)**
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	7.9 (15)	27 (45)	28 (46)	33 (56)	37 (60)	41 (60)
DS2	0.9 (1.8)	6.6 (12)	6.7 (12)	14 (24)	17 (30)	26 (42)
Total	**8.9 (16)**	**34 (52)**	**35 (54)**	**47 (68)**	**54 (74)**	**67 (82)**

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	27	27	49	56	73
P[Res](%)	0.0	1.1	1.6	6.2	8.9	14
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	32 (52)	48 (72)	49 (74)	49 (75)	52 (76)	53 (78)
DS1b	32 (52)	50 (74)	49 (74)	50 (76)	48 (72)	47 (72)
Total	**64** (80)	**98** (100)	**98** (100)	**100** (100)	**100** (100)	**100** (100)
D3032.011a #2 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	44 (68)	49 (74)	49 (75)	48 (73)	50 (76)	48 (74)
DS1b	44 (67)	49 (75)	49 (75)	51 (76)	49 (75)	52 (77)
Total	**88** (96)	**98** (100)	**98** (100)	**99** (100)	**100** (100)	**100** (100) *

*Percent of total quantity above 100 is caused by simultaneous damage states

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	2.7 (5.2)	12 (22)	13 (24)	20 (34)	23 (40)	25 (43)
DS2	0.4 (0.8)	5.7 (10)	6.2 (11)	13 (22)	16 (26)	25 (40)
Total	**3.1** (6.0)	**18** (30)	**20** (33)	**33** (50)	**39** (59)	**50** (68)
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**2.9** (5.6)	**20** (34)	**20** (32)	**33** (50)	**36** (55)	**50** (69)

4 COMPONENT DAMAGEABILITY AND COST OVERVIEW

This section provides an overview of key component parameters for loss assessment. The components are broken into groups such that the specified component modifiers are applied to all components in the given table.

Some notes on the columns are as follows:

- **DS: Median (Unit Repair Cost Range)**: This presents median EDP for each damage state as well as the associated repair cost range to repair one unit of the component (varies based on quantity).
- **Max Repair Potential**: This is the cost to completely replace this component throughout the building assuming the most expensive damage state for all components (includes volume discounting). The number in parenthesis is the value as a percentage of building replacement value. Note that this does not need to add up to the total building replacement value, but rather gives a sense of how much potential the component has to contribute to the mean loss when it is damaged.

Table 4.1. "Structural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B1031.011a	Steel Column Base Plates, Column W < 150 plf	EDP Peak Interstory Drift DS1a: 0.04 ($0 - $0) DS1b: 0.04 ($21,710 - $35,279) DS2: 0.07 ($31,001 - $43,765) DS3: 0.1 ($36,203 - $51,110)	$204,439 (15.4%)
B1035.041	Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27	EDP Peak Interstory Drift DS1a: 0.017 ($13,420 - $20,130) DS1b: 0.017 ($15,089 - $22,634) DS2a: 0.025 ($16,202 - $24,303) DS2b: 0.025 ($19,585 - $29,377) DS3: 0.03 ($16,202 - $24,303)	$58,754 (4.42%)
B1035.051	Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27	EDP Peak Interstory Drift DS1a: 0.017 ($19,563 - $29,344) DS1b: 0.017 ($21,232 - $31,848) DS2a: 0.025 ($21,009 - $31,514) DS2b: 0.025 ($26,840 - $40,260) DS3: 0.03 ($21,009 - $31,514)	$80,520 (6.06%)
B1071.002	Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs	EDP Peak Interstory Drift DS1: 0.015 ($1,827 - $2,969) DS2: 0.0262 ($2,532 - $3,575) DS3: 0.0369 ($6,355 - $8,972)	$115,343 (8.68%)
B1071.302	Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs	EDP Peak Interstory Drift DS1: 0.0021 ($175 - $412) DS2: 0.0071 ($374 - $879) DS3: 0.012 ($1,156 - $2,721) DS4: 0.0262 ($2,306 - $4,256) DS5: 0.0369 ($4,079 - $6,760)	$32,640 (2.46%)
		Total:	$491,696 (37.0%)

Table 4.2. "Exterior Finishes" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B2011.401	Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs	EDP Peak Interstory Drift DS1: 0.01 ($175 - $412) DS2: 0.0175 ($374 - $879) DS3: 0.025 ($1,156 - $2,721)	$49,831 (3.75%)
		Total:	$49,831 (3.75%)

Table 4.3. "Partition Walls" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C1011.211a	Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($1,598 - $5,328) DS2: 0.0071 ($3,428 - $11,425) DS3: 0.012 ($11,297 - $37,656)	$110,821 (8.34%)
C1011.311a	Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($904 - $3,015) DS2: 0.0071 ($2,223 - $7,411) DS3: 0.012 ($7,151 - $23,838)	$78,951 (5.94%)
		Total:	$189,772 (14.3%)

Table 4.4. "Other Nonstructural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C2011.041b	Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.	EDP Peak Interstory Drift DS1: 0.011 ($487 - $695) DS2: 0.026 ($1,043 - $2,782) DS3: 0.05 ($3,130 - $8,346)	$16,692 (1.26%)
		Total:	$16,692 (1.26%)

Table 4.5. "Lighting" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C3034.001	Independent Pendant Lighting - non seismic	EDP Peak Floor Acceleration DS1: 0.6 ($413 - $1,377)	$4,131 (0.31%)
		Total:	$4,131 (0.31%)

Table 4.6. "Elevators" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D1014.022	Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.	EDP Peak Floor Acceleration DS1a: 0.3 ($668 - $2,226) DS1b: 0.3 ($6,844 - $22,812) DS1c: 0.3 ($10,015 - $33,383) DS1d: 0.3 ($1,920 - $6,398)	$33,383 (2.51%)
		Total:	$33,383 (2.51%)

Table 4.7. "Piping" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D2021.012a	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($363 - $444) DS2: 2.6 ($3,317 - $4,055)	$358 (0.03%)
D2021.012b	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($476 - $581) DS2: 2.6 ($4,757 - $5,814)	$513 (0.04%)
D2021.022a	Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($292 - $974) DS2: 2.6 ($2,796 - $9,319)	$2,572 (0.19%)
D2031.022a	Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.2 ($2,796 - $9,319)	$1,132 (0.09%)
D2031.022b	Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.2 ($334 - $1,113) DS2: 2.4 ($3,630 - $12,101)	$1,470 (0.11%)
		Total:	$6,045 (0.45%)

Table 4.8. "HVAC" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D3032.011a	Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only	EDP Peak Floor Acceleration DS1a: 0.25 ($939 - $1,148) DS1b: 0.25 ($3,380 - $4,131)	$7,887 (0.59%)
D3032.011a	Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only	EDP Peak Floor Acceleration DS1a: 0.25 ($939 - $1,148) DS1b: 0.25 ($3,380 - $4,131)	$7,887 (0.59%)

Continued on next page

Table 4.8 (*Continued*). "HVAC" component list.

Component	Description	DS: Median (Repair Cost Range)	Max Repair Potential
D3041.011c	HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F	EDP Peak Floor Acceleration DS1: 1.5 ($814 - $995) DS2: 2.25 ($7,949 - $9,716)	$2,384 (0.18%)
D3041.032c	HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F	EDP Peak Floor Acceleration DS1: 1.5 ($3,756 - $4,590)	$8,763 (0.66%)
		Total:	$26,920 (2.03%)

Table 4.9. Summary of component value breakdown (building replacement value = $1,328,911).

Component Category	Max Repair Potential	% of Building Replacement Value
Structural	$491,696	37.0%
Exterior Finishes	$49,831	3.75%
Partition Walls	$189,772	14.3%
Other Nonstructural	$16,692	1.26%
Lighting	$4,131	0.31%
Elevators	$33,383	2.51%
Piping	$6,045	0.45%
HVAC	$26,920	2.03%
Total	$818,470	61.6%

5 COMPONENT QUANTITIES AND MODIFICATION FACTORS

Table 5.1. Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
B1031.011a (B1031.011a #1): Steel Column Base Plates, Column W < 150 plf						
1	0	4	–	1	1	1
B1035.041 (B1035.041 #1): Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27						
2	0	2	–	1	1	1
B1035.051 (B1035.051 #1): Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27						
2	0	2	–	1	1	1
B1071.002 (B1071.002 #1): Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs						
1	5.8	2.16	–	1	1	1
2	7.4	2.79	–	1	1	1
B1071.302 (B1071.302 #1): Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs						
1	4.45	0	–	1	1	1
2	3.51	0	–	1	1	1
B2011.401 (B2011.401 #1): Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs						
1	10.935	10.65	–	1	1	1
2	7.29	14.22	–	1	1	1
C1011.211a (C1011.211a #1): Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above						
1	0.67	0.7	–	1	1	1
2	1.1	1.27	–	1	1	1
C1011.311a (C1011.311a #1): Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above						
1-2	0.8	1.5	–	1	1	1
C2011.041b (C2011.041b #1): Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.						
1	1	1	–	1	0.5	1
C3034.001 (C3034.001 #1): Independent Pendant Lighting - non seismic						
2-R	–	–	5	1	1	1
D1014.022 (D1014.022 #1): Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.						
G	–	–	1	1	1	1
D2021.012a (D2021.012a #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, PIPING FRAGILITY						
2-R	–	–	0.0441576	1	1	1
D2021.012b (D2021.012b #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, BRACING FRAGILITY						
2-R	–	–	0.0441576	1	1	1
D2021.022a (D2021.022a #1): Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING FRAGILITY						
2-R	–	–	0.1379925	1	1	1

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Table 5.1 (*Continued*). Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
D2031.022a (D2031.022a #1): Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY						
2-R	–	–	0.0607167	1	1	1
D2031.022b (D2031.022b #1): Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY						
2-R	–	–	0.0607167	1	1	1
D3032.011a (D3032.011a #1): Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only						
G	–	–	2	1	1	1
D3032.011a (D3032.011a #2): Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only						
R	–	–	2	1	1	1
D3041.011c (D3041.011c #1): HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F						
2-R	–	–	0.12266	1	1	1
D3041.032c (D3041.032c #1): HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F						
2-R	–	–	1	1	1	1

6 FRAGILITY INFORMATION

6.1 B1031.011a #1: (B1031.011a) Steel Column Base Plates, Column W < 150 plf

NISTIR Classification	B1031.011a
Author	Greg Deierlein
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.1.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.1.2. Damage state progression.

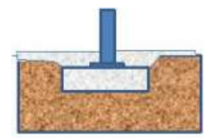
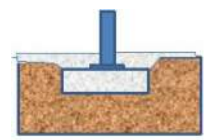
Damage State	Description	Repair Description	Image
DS1a	Initiation of crack at the fusion line between the column flange and the base plate weld. Damage in field is either obscured or deemed to not warrant repair. No repair conducted.	The repair will involve removal of a portion of grade slab, gouging out material surrounding the fracture initiating and re-welding, then repair of slab. Field condition is deemed to not warrant repair by field observation. This Damage State is Mutually Exclusive with DS2. See fragility DS1 and DS2 probabilities.	
DS1b	Initiation of crack at the fusion line between the column flange and the base plate weld.	The repair will involve removal of a portion of grade slab, gouging out material surrounding the fracture initiating and re-welding, then repair of slab.	
DS2	Propagation of brittle crack into column and/or base plate.	Depending on the crack trajectory, the repair will range from replacement of a portion of the column or base plate to full replacement of the column base. Replacement will require shoring of column, torch cutting to remove damaged material, and fabrication and field welding to install replacement material.	Not Available
DS3	Complete fracture of the column (or column weld) and dislocation of column relative to the base.	Repair would likely involve replacing the entire base plate assembly and most of the column in the story above the base plate.	Not Available

Table 6.1.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	**DS1b**	**DS2**	**DS3**
Type	Mut. Excl.	Mut. Excl.	Sequential	Sequential
Probability	0.95	0.05	–	–
Median	0.04	0.04	0.07	0.1
β	0.4	0.4	0.4	0.4

Table 6.1.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	**DS1b**	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	20.0	20.0	20.0	20.0
Highest Cost Median	$0	$35,279	$43,765	$51,110
Lowest Cost Median	$0	$21,710	$31,001	$36,203
β (COV)	0.25	0.41	0.37	0.34

Table 6.1.5. Parameters for the repair time distributions.

	DS1a	**DS1b**	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	20.0	20.0	20.0	20.0
Highest Median Repair Time (Days)	0	24.62	30.54	35.66
Lowest Median Repair Time (Days)	0	15.15	21.63	25.26
β (COV)	0.35	0.48	0.44	0.42

Table 6.1.6. Life safety information.

	DS1a	**DS1b**	**DS2**	**DS3**
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	Yes	Yes
Unsafe Placard Median	–	–	0.25	0.1
Unsafe Placard β	–	–	0.5	0.5

6.2 B1035.041 #1: (B1035.041) Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27

NISTIR Classification	B1035.041
Author	Greg Deierlein
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.2.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.2.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Fracture of lower beam flange weld and failure of web bolts (shear tab connection), with fractures confined to the weld region.	Repair will typically require gouging out and re-welding of the beam flange weld, repair of shear tab, and replacing shear bolts. Repair and replace partitions at connection.	
DS1b	Similar to DS1, except that fracture propagates into column flanges.	In addition to column measures for DS1, repairs to column will be necessary. Cover plate, patch, or replace damaged column flange at connection.	
DS2a	Fracture of upper beam flange weld, without DS1 type damage. Fracture is confined to beam flange region.	Repairs will be similar to those required for DS1, except that access to weld will likely require removal and replacement of a portion of the floor slab above the weld.	Not Available
DS2b	Similar to DS3, except that fracture propagates into column flanges.	In addition to column measures for DS3, repairs to column will be necessary that will involve replacing a portion of the column flange.	Not Available
DS3	Fracture initiating at weld access hole and propagating through beam flange, possibly accompanied by local buckling deformations of web and flange.	Repair is similar to that for DS1 except that a portion of the beam web and flange may need to be heat straightened or replaced.	Not Available

Table 6.2.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.	Mut. Excl.	Sequential
Probability	0.75	0.25	0.75	0.25	–
Median	0.017	0.017	0.025	0.025	0.03
β	0.4	0.4	0.4	0.4	0.4

Table 6.2.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Cost Median	$20,130	$22,634	$24,303	$29,377	$24,303
Lowest Cost Median	$13,420	$15,089	$16,202	$19,585	$16,202
β (COV)	0.35	0.35	0.32	0.37	0.34

Table 6.2.5. Parameters for the repair time distributions.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Median Repair Time (Days)	8.51	9.57	11.75	12.42	10.28
Lowest Median Repair Time (Days)	5.68	6.38	8.32	8.28	6.85
β (COV)	0.43	0.43	0.41	0.45	0.42

Table 6.2.6. Life safety information.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Non-collapse casualties	No	No	No	No	No
Affected Area	– –	– –	– –	– –	– –
Serious Injury Median	–	–	–	–	–
Serious Injury β	–	–	–	–	–
Loss of Life Median	–	–	–	–	–
Loss of Life β	–	–	–	–	–
Can Cause Red Tag	Yes	Yes	Yes	Yes	Yes
Unsafe Placard Median	0.5	0.5	0.5	0.5	0.5
Unsafe Placard β	0.5	0.5	0.5	0.5	0.5

6.3 B1035.051 #1: (B1035.051) Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27

NISTIR Classification	B1035.051
Author	Greg Deierlein
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.3.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.3.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Fracture of lower beam flange weld and failure of web bolts (shear tab connection), with fractures confined to the weld region.	Repair will typically require gouging out and re-welding of the beam flange weld, repair of shear tab, and replacing shear bolts. Repair and replace partitions at connection.	
DS1b	Similar to DS1, except that fracture propagates into column flanges.	In addition to column measures for DS1, repairs to column will be necessary. Cover plate, patch, or replace damaged column flange at connection.	
DS2a	Fracture of upper beam flange weld, without DS1 type damage. Fracture is confined to beam flange region.	Repairs will be similar to those required for DS1, except that access to weld will likely require removal and replacement of a portion of the floor slab above the weld.	Not Available
DS2b	Similar to DS3, except that fracture propagates into column flanges.	In addition to column measures for DS3, repairs to column will be necessary that will involve replacing a portion of the column flange.	Not Available
DS3	Fracture initiating at weld access hole and propagating through beam flange, possibly accompanied by local buckling deformations of web and flange.	Repair is similar to that for DS1 except that a portion of the beam web and flange may need to be heat straightened or replaced.	Not Available

Table 6.3.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS2a	DS2b	DS3
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.	Mut. Excl.	Sequential
Probability	0.75	0.25	0.75	0.25	–
Median	0.017	0.017	0.025	0.025	0.03
β	0.4	0.4	0.4	0.4	0.4

Table 6.3.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS2a	DS2b	DS3
Distribution Type	Normal	Normal	Normal	Normal	Normal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Cost Median	$29,344	$31,848	$31,514	$40,260	$31,514
Lowest Cost Median	$19,563	$21,232	$21,009	$26,840	$21,009
β (COV)	0.36	0.36	0.3	0.32	0.33

Table 6.3.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS2a	DS2b	DS3
Distribution Type	Normal	Normal	Normal	Normal	Normal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Median Repair Time (Days)	12.41	13.47	16.68	17.03	13.33
Lowest Median Repair Time (Days)	8.27	8.98	12.24	11.35	8.88
β (COV)	0.44	0.44	0.39	0.4	0.41

Table 6.3.6. Life safety information.

	DS1a	DS1b	DS2a	DS2b	DS3
Non-collapse casualties	No	No	No	No	No
Affected Area	– –	– –	– –	– –	– –
Serious Injury Median	–	–	–	–	–
Serious Injury β	–	–	–	–	–
Loss of Life Median	–	–	–	–	–
Loss of Life β	–	–	–	–	–
Can Cause Red Tag	Yes	Yes	Yes	Yes	Yes
Unsafe Placard Median	0.5	0.5	0.5	0.5	0.5
Unsafe Placard β	0.5	0.5	0.5	0.5	0.5

6.4 B1071.002 #1: (B1071.002) Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs

NISTIR Classification	B1071.002
Author	Andre Filiatrault
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.4.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.4.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.4.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.015	0.0262	0.0369
β	0.4	0.19	0.2

Table 6.4.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$2,969	$3,575	$8,972
Lowest Cost Median	$1,827	$2,532	$6,355
β (COV)	0.19	0.22	0.08

Table 6.4.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	2.07	2.5	6.26
Lowest Median Repair Time (Days)	1.27	1.77	4.44
β (COV)	0.31	0.33	0.26

Table 6.4.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.5 B1071.302 #1: (B1071.302) Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs

NISTIR Classification	B1071.302
Author	HBRG (exterior only)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	5
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.5.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.5.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS4	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove interior finish, remove wood sheathing, install new sheathing, reinstall and finish interior material.	
DS5	Fracture of studs, major sill plate cracking.	Remove and replace interior finish, sheathing, studs and plates. Provide shoring as required.	

Table 6.5.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3	DS4	DS5
Type	Sequential	Sequential	Sequential	Sequential	Sequential
Probability	–	–	–	–	–
Median	0.0021	0.0071	0.012	0.0262	0.0369
β	0.6	0.45	0.45	0.19	0.2

Table 6.5.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3	DS4	DS5
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0	8.0	8.0
Highest Cost Median	$412	$879	$2,721	$4,256	$6,760
Lowest Cost Median	$175	$374	$1,156	$2,306	$4,079
β (COV)	0.42	0.49	0.1	0.22	0.08

Table 6.5.5. Parameters for the repair time distributions.

	DS1	DS2	DS3	DS4	DS5
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0	8.0	8.0
Highest Median Repair Time (Days)	0.23	0.49	1.52	2.63	4.37
Lowest Median Repair Time (Days)	0.1	0.21	0.65	2.27	3.57
β (COV)	0.52	0.55	0.34	0.33	0.26

Table 6.5.6. Life safety information.

	DS1	DS2	DS3	DS4	DS5
Non-collapse casualties	No	No	No	No	No
Affected Area	– –	– –	– –	– –	– –
Serious Injury Median	–	–	–	–	–
Serious Injury β	–	–	–	–	–
Loss of Life Median	–	–	–	–	–
Loss of Life β	–	–	–	–	–
Can Cause Red Tag	No	No	No	Yes	Yes
Unsafe Placard Median	–	–	–	0.5	0.25
Unsafe Placard β	–	–	–	0.5	0.5

6.6 B2011.401 #1: (B2011.401) Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs

NISTIR Classification	B2011.401
Author	HBRG (exterior only modifications)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Exterior Finishes
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.6.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.6.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.6.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.01	0.0175	0.025
β	0.4	0.4	0.4

Table 6.6.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$412	$879	$2,721
Lowest Cost Median	$175	$374	$1,156
β (COV)	0.19	0.22	0.08

Table 6.6.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	0.86	1.08	2.4
Lowest Median Repair Time (Days)	0.53	0.77	1.7
β (COV)	0.31	0.33	0.26

Table 6.6.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.7 C1011.211a #1: (C1011.211a) Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.211a
Author	DaveWelch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.7.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.7.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.7.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.7.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$5,328	$11,425	$37,656
Lowest Cost Median	$1,598	$3,428	$11,297
β (COV)	0.42	0.49	0.1

Table 6.7.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	2.99	6.4	21.1
Lowest Median Repair Time (Days)	0.9	1.92	6.33
β (COV)	0.52	0.55	0.34

Table 6.7.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.8 C1011.311a #1: (C1011.311a) Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.311a
Author	Dave Welch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.8.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.8.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.8.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.8.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$3,015	$7,411	$23,838
Lowest Cost Median	$904	$2,223	$7,151
β (COV)	0.42	0.49	0.1

Table 6.8.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.69	4.15	13.36
Lowest Median Repair Time (Days)	0.51	1.25	4.01
β (COV)	0.52	0.55	0.34

Table 6.8.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.9 C2011.041b #1: (C2011.041b) Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.

NISTIR Classification	C2011.041b
Author	HBRG
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Other Nonstructural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.9.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	0.5

Table 6.9.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cosmetic Damage.	Repair cosmetic damage.	Not Available
DS2	Structural damage but live load capacity remains intact.	Repair damage.	Not Available
DS3	Loss of live load capacity.	Replace stair.	Not Available

Table 6.9.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.011	0.026	0.05
β	0.5	0.5	0.5

Table 6.9.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	\$695	\$2,782	\$8,346
Lowest Cost Median	\$487	\$1,043	\$3,130
β (COV)	0.8	0.6	0.4

Table 6.9.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.55	2.21	6.62
Lowest Median Repair Time (Days)	0.39	0.83	2.48
β (COV)	1.0	0.7	0.5

Table 6.9.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.25	0.1
Unsafe Placard β	–	0.1	0.5

6.10 C3034.001 #1: (C3034.001) Independent Pendant Lighting - non seismic

NISTIR Classification	C3034.001
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Lighting
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.10.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.10.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Disassembly of rod system at connections with horizontal light fixture, low cycle fatigue failure of the threaded rod, pullout of rods from ceiling assembly.	Replace damaged lighting components.	Not Available

Table 6.10.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	0.6
β	0.4

Table 6.10.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$1,377
Lowest Cost Median	$413
β (COV)	0.64

Table 6.10.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.99
Lowest Median Repair Time (Days)	0.3
β (COV)	0.68

Table 6.10.6. Life safety information.

	DS1
Non-collapse casualties	Yes
Affected Area	100.0 SF
Serious Injury Median	0.2
Serious Injury β	0.5
Loss of Life Median	0.002
Loss of Life β	0.5
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.11 D1014.022 #1: (D1014.022) Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.

NISTIR Classification	D1014.022
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Elevators
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.11.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.11.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Damaged controls.	Multiple repairs possible (% change of each): Repair damaged controls (100%)	Not Available
DS1b	Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.	Multiple repairs possible (% change of each): Repair damaged vane and hoist-way switches (41%), and or repair bent cab stabilizers (41%), and or repair damaged car guide shoes (41%).	Not Available
DS1c	Damaged entrance and car door, and or flooring damage.	Multiple repairs possible (% change of each): Repair damage to cab door (68%), and or repair cab flooring (46%)	Not Available
DS1d	Oil leak in hydraulic line, and or hydraulic tank failure.	Multiple repairs possible (% change of each): Repair oil leak in hydraulic line (27%), and or hydraulic tank failure (81%)	Not Available

Table 6.11.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS1c	DS1d
Type	Simultaneous	Simultaneous	Simultaneous	Simultaneous
Probability	0.3	0.49	0.44	0.37
Median	0.3	0.3	0.3	0.3
β	0.3	0.3	0.3	0.3

Table 6.11.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS1c	DS1d
Distribution Type	LogNormal	Normal	Normal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0	10.0
Highest Cost Median	$2,226	$22,812	$33,383	$6,398
Lowest Cost Median	$668	$6,844	$10,015	$1,920
β (COV)	0.82	0.32	0.44	0.25

Table 6.11.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS1c	DS1d
Distribution Type	LogNormal	Normal	Normal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.6	16.4	24	4.6
Lowest Median Repair Time (Days)	0.48	4.92	7.2	1.38
β (COV)	0.86	0.41	0.51	0.36

Table 6.11.6. Life safety information.

	DS1a	DS1b	DS1c	DS1d
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	No	No
Unsafe Placard Median	–	–	–	–
Unsafe Placard β	–	–	–	–

6.12 D2021.012a #1: (D2021.012a) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, PIPING FRAGILITY

NISTIR Classification	D2021.012a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.12.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.12.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.12.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.6
β	0.4	0.4

Table 6.12.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	4.0	4.0
Highest Cost Median	$444	$4,055
Lowest Cost Median	$363	$3,317
β (COV)	0.76	0.41

Table 6.12.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	4.0	4.0
Highest Median Repair Time (Days)	0.34	0.56
Lowest Median Repair Time (Days)	0.28	0.14
β (COV)	0.8	0.48

Table 6.12.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.13 D2021.012b #1: (D2021.012b) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC C, BRACING FRAGILITY

NISTIR Classification	D2021.012b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.13.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.13.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Lateral Brace Failure - 1 failure per 1000 feet of pipe.	Replace failed lateral braces. One repair per 1000 LF.	Not Available
DS2	Vertical Brace Failure - 1 failure per 1000 feet of pipe	Replace failed vertical braces. One repair per 1000 LF.	Not Available

Table 6.13.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.6
β	0.4	0.4

Table 6.13.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	4.0	4.0
Highest Cost Median	$581	$5,814
Lowest Cost Median	$476	$4,757
β (COV)	0.6	0.07

Table 6.13.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	4.0	4.0
Highest Median Repair Time (Days)	0.44	0.8
Lowest Median Repair Time (Days)	0.36	0.2
β (COV)	0.65	0.26

Table 6.13.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.14 D2021.022a #1: (D2021.022a) Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC C, PIPING FRAGILITY

NISTIR Classification	D2021.022a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.14.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.14.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.14.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.6
β	0.4	0.4

Table 6.14.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$974	$9,319
Lowest Cost Median	$292	$2,796
β (COV)	0.65	0.4

Table 6.14.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.74	7.09
Lowest Median Repair Time (Days)	0.22	2.13
β (COV)	0.7	0.47

Table 6.14.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.15 D2031.022a #1: (D2031.022a) Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY

NISTIR Classification	D2031.022a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.15.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.15.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Joints break - 1 break per 1000 feet of pipe.	Replace failed 20 ft pipe sections including supports - one per 1000 LF.	Not Available

Table 6.15.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.2
β	0.5

Table 6.15.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	Normal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$9,319
Lowest Cost Median	$2,796
β (COV)	0.31

Table 6.15.5. Parameters for the repair time distributions.

	DS1
Distribution Type	Normal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	7.09
Lowest Median Repair Time (Days)	2.13
β (COV)	0.4

Table 6.15.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.16 D2031.022b #1: (D2031.022b) Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY

NISTIR Classification	D2031.022b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.16.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.16.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Isolated support failure w/o leakage - 0.5 support failures per 1000 feet of pipe (assuming supports every 20 feet).	Replace failed supports - 0.5 per 1000 LF.	Not Available
DS2	Multiple supports failure and 60 feet of pipe fail per 1000 feet of pipe (assuming supports every 20 feet).	Replace failed supports and 60 ft pipe per 1000 LF.	Not Available

Table 6.16.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	1.2	2.4
β	0.5	0.5

Table 6.16.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	Normal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$1,113	$12,101
Lowest Cost Median	$334	$3,630
β (COV)	0.71	0.28

Table 6.16.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	Normal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.85	9.21
Lowest Median Repair Time (Days)	0.25	2.76
β (COV)	0.75	0.38

Table 6.16.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.17 D3032.011a #1: (D3032.011a) Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only

NISTIR Classification	D3032.011a
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.17.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.17.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Equipment does not function. Motor is damaged.	Repair motor.	
DS1b	Equipment does not function. Equipment damaged beyond repair.	Replace equipment.	Not Available

Table 6.17.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b
Type	Mut. Excl.	Mut. Excl.
Probability	0.5	0.5
Median	0.25	0.25
β	0.45	0.45

Table 6.17.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$1,148	$4,131
Lowest Cost Median	$939	$3,380
β (COV)	0.17	0.21

Table 6.17.5. Parameters for the repair time distributions.

	DS1a	DS1b
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	0.97	0.64
Lowest Median Repair Time (Days)	0.79	0.16
β (COV)	0.3	0.32

Table 6.17.6. Life safety information.

	DS1a	DS1b
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.18 D3032.011a #2: (D3032.011a) Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only

NISTIR Classification	D3032.011a
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.18.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.18.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Equipment does not function. Motor is damaged.	Repair motor.	
DS1b	Equipment does not function. Equipment damaged beyond repair.	Replace equipment.	Not Available

Table 6.18.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b
Type	Mut. Excl.	Mut. Excl.
Probability	0.5	0.5
Median	0.25	0.25
β	0.45	0.45

Table 6.18.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$1,148	$4,131
Lowest Cost Median	$939	$3,380
β (COV)	0.17	0.21

Table 6.18.5. Parameters for the repair time distributions.

	DS1a	DS1b
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	0.97	0.64
Lowest Median Repair Time (Days)	0.79	0.16
β (COV)	0.3	0.32

Table 6.18.6. Life safety information.

	DS1a	DS1b
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.19 D3041.011c #1: (D3041.011c) HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F

NISTIR Classification	D3041.011c
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.19.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.19.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Individual supports fail and duct sags - 1 failed support per 1000 feet of ducting.	Replace failed supports and repair ducting in vicinity of failed supports.	Not Available
DS2	Several adjacent supports fail and sections of ducting fall - 60 feet of ducting fail and fall per 1000 foot of ducting.	Replace sections of failed ducting and supports.	Not Available

Table 6.19.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.19.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$995	$9,716
Lowest Cost Median	$814	$7,949
β (COV)	0.37	0.1

Table 6.19.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	0.84	2.99
Lowest Median Repair Time (Days)	0.69	1.49
β (COV)	0.44	0.27

Table 6.19.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	Yes
Affected Area	– –	15.0 SF
Serious Injury Median	–	0.05
Serious Injury β	–	0.5
Loss of Life Median	–	0.0
Loss of Life β	–	0.0
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.20 D3041.032c #1: (D3041.032c) HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F

NISTIR Classification	D3041.032c
Author	Not Given
Normalized Unit	10.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.20.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.20.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	HVAC drops or diffusers dislodges and falls.	Replace diffuser/drop and sections of ceiling and ducting in vicinity to which diffuser/drop is connected.	Not Available

Table 6.20.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.20.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Cost Median	$4,590
Lowest Cost Median	$3,756
β (COV)	0.21

Table 6.20.5. Parameters for the repair time distributions.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Median Repair Time (Days)	3.88
Lowest Median Repair Time (Days)	3.18
β (COV)	0.32

Table 6.20.6. Life safety information.

	DS1
Non-collapse casualties	Yes
Affected Area	4.0 SF
Serious Injury Median	0.1
Serious Injury β	0.5
Loss of Life Median	0.0
Loss of Life β	0.0
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

7 DISCLAIMER

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Full Detailed Report

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	Existing WLF on RC Wall
Building Types:	
Dir. 1: WLF: General	
Dir. 2: RC: Cantilever Shear Wall	
Design Code Year:	1967
Number of Stories:	2
Occupancy:	Commercial Office
Address:	
217 Arlington Avenue Kensington, CA, 94707	
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	1,738
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	Extreme
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Ordinary, Ordinary
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	–
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	–
2^{nd} Mode Period (T_2) (s):	–	–

Component Information

Percent of Building Glazed:	–
Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options	
Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Interior Finishes

- What kind of partition walls does the building have?
  > *Wood Studs*
- Does the building have raised access floors
  > *No*
- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *No*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *No*

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*
- Are there elevators in the building?
  > *Yes*
  - What type of elevators are in the building?
    > *Hydraulic*
    - From which era are the building's elevators?
      > *Pre-1976 California (or pre-1976 California equivalent)*

Fire Supression

- Does the building contain a fire sprinkler system?
  > *Yes*
  - Does the fire sprinkler system have braced horizontal piping?
    > *No*
  - Are the fire sprinkler drops OSHPD certified (or equivalent)?

Continued on next page

Component Checklist (*Continued*))

    > *No*
    - What type of ceiling do the fire drops enter into?
      > *Hard*

Piping
- Is the building's water piping OSHPD certified or equivalent?
  > *No*
- Is the building's sanitary piping OSHPD certified or equivalent?
  > *No*
  - What type of couplings do the pipes have?
    > *Bell and spigot*

HVAC
- Is the HVAC cooling/heating equipment seismically anchored?
  > *No*
  - How is the cooling/heating system configured?
    > *Roof Top Units*
    - Are the RTUs used for medical purposes (or equivalent)?
      > *No*
      - Are the RTUs small or large?
        > *Small*
    - Does the building have a control panel?
      > *Yes*
- Is there an HVAC exhaust system in the building?
  > *Yes*
  - Is the HVAC exhaust system seismically anchored?
    > *No*
- Does the HVAC distribution system meet OSHPD standards (or similar)?
  > *No*
  - Is there any large diameter ducting (6 SqFt+) in the HVAC system?
    > *Yes*

Electrical
- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Concrete
- Are the building's shear walls low rise or slender?
  > *Low Rise (typically <= 40ft building height)*
  - What are the boundary conditions of the walls?
    > *No return flanges or boundary columns*
    - What is the typical wall thickness?
      > *8" to 16"*
      - What is the typical wall height?
        > *Less than 15'*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	7.4	15
10% in 50 years	475 Years	49	80
DE	481 Years	50	82
5% in 50 years	975 Years	89	100
MCE_R	1277 Years	95	100
2% in 50 years	2475 Years	99	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	2.6 weeks	3.7 weeks	0 days	4 days	2.2 months
10% in 50 years	4 months	5.3 months	3.9 months	4.4 months	4.5 months
DE	4.1 months	5.4 months	4.1 months	4.6 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 BASIS OF ANALYSIS

This analysis is based on the SP3-RiskModel of the Seismic Performance Prediction Program (SP3) software platform. The underlying analysis methods are based on the FEMA P-58 analytical method, which is a transparent and well documented method developed through a 15 year project (Applied Technology Council, 2018). This project leveraged the previous decades of academic research, funded by a $16 million investment by the Federal Emergency Management Agency (FEMA). In contrast to many risk assessment methods based on judgment and past earthquake experience, the FEMA P-58 and SP3 analysis are based on engineering-oriented risk evaluation methods.

3 DOCUMENTATION OF SITE AND BUILDING INPUT DATA

Project Name:	Kensington Fire Station
Model Name:	Existing WLF on RC Wall

3.1 Site Information

Address:	217 Arlington Avenue, Kensington, CA, 94707
Latitude:	37.90622°
Longitude:	-122.27875°

3.2 Building Information

Material Type (Direction 1):	WLF
Material Type (Direction 2):	Cast-in-Place Concrete
Number of Stories:	2
Total Building Square Footage:	1,738
Occupancy Type:	Commercial Office
Total Expected Building Replacement Value:	$610,816

4 SITE HAZARD INFORMATION

This section presents the site's seismic hazard information. The V_{S30} value is the shear wave velocity in the soil at a depth of 30 meters. This value and the associated site class are presented in Table 4.1.

Table 4.1. Site soil information

V_{S30} (m/s):	537.0
Site Class:	C
Closest V_{S30} for USGS Hazard Lookup (m/s):	530

Table 4.2 and Figure 4.1 present the spectral acceleration information for this site. The spectral acceleration is a measure of how much force the building will attract in an earthquake. This amount of force is dependent on the intensity of the ground shaking (e.g. 10% in 50 years), as well as a dynamic property of the building known as the "fundamental period". Shorter buildings tend to have smaller fundamental periods and taller buildings tend to have larger fundamental periods. As indicated by Figure 4.1, smaller fundamental periods (with the exception of very short fundamental periods) will attract more force in an earthquake.

The Design Earthquake (DE) and Maximum Considered Earthquake (MCE) are based on the modern code maximum direction spectra and are converted to geometric mean for comparison.

Table 4.2. Geometric mean spectral acceleration values (in g)

Intensity	Return Period (yrs)	PGA	$S_a(0.2s)$	$S_a(1.0s)$	$S_a(0.29s)$	$S_a(T_1)/v_{ult}$ † Dir 1	Dir 2
50% in 50 years	72	0.22	0.52	0.17	0.46	0.52	0.35
10% in 50 years	475	0.62	1.50	0.56	1.38	1.76	1.05
DE	481	0.62	1.50	0.57	1.39	1.77	1.05
5% in 50 years	975	0.82	2.03	0.80	1.89	2.50	1.43
MCE_R	1277	0.91	2.26	0.91	2.11	2.83	1.60
2% in 50 years	2475	1.13	2.84	1.19	2.67	3.69	2.03

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.320$ and $T_1 = 1.01$s and in direction 2 $v_{ult} = 1.32$ and $T_1 = 0.288$s (see Table 5.3 for more detailed structural properties)

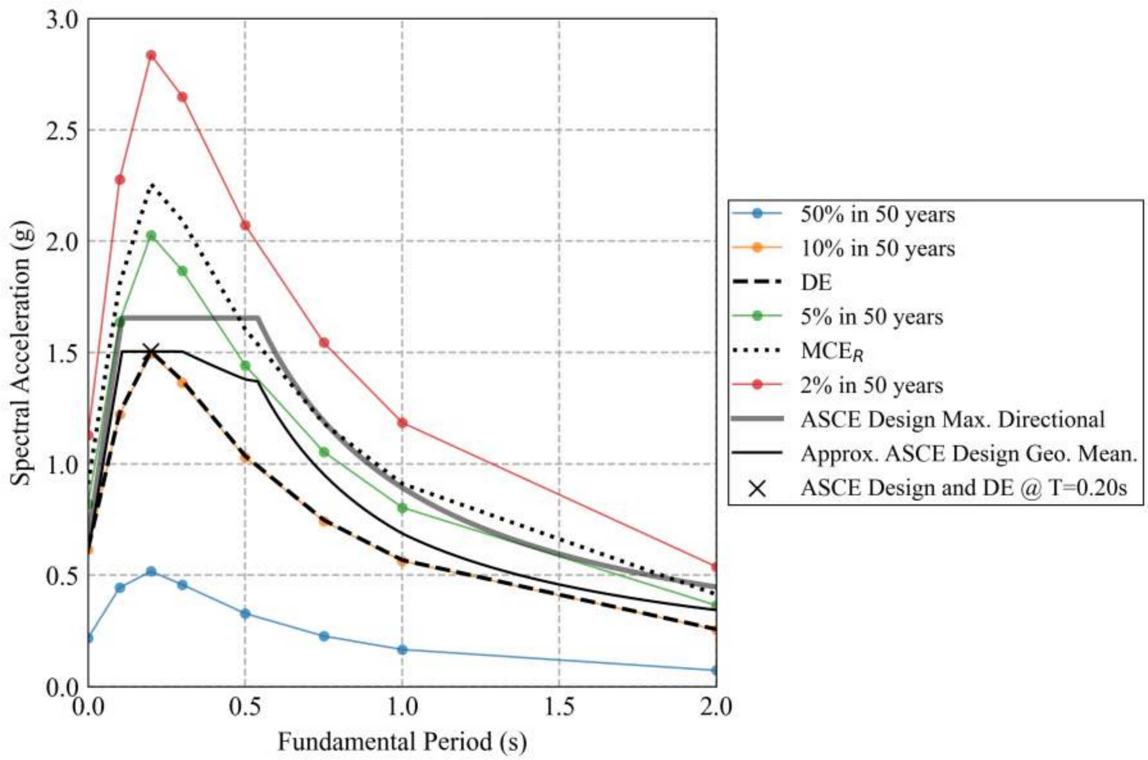


Figure 4.1. Hazard curves for this site. All curves are geometric mean unless otherwise stated.

5 BUILDING DESIGN SUMMARY FROM THE *SP3 BUILDING CODE DESIGN DATABASE*

5.1 Building Code Design Parameters

The seismic design parameters used to compute the seismic base shear coefficients for this building are presented in Table 5.1. These parameters are specific to the 1967 edition of the Uniform Building Code (International Conference of Building Officials, 1967).

Table 5.1. Code design parameters

(a) UBC 1967 structural system parameters

Parameter	Dir. 1	Dir. 2
C_d	1	1
k	1	1.33

(b) UBC 1967 site specific parameters

Parameter	Value
Z	1
Seismic Zone	3

5.2 Modern Building Code Design Parameters (for comparison purposes)

For comparison to modern code, the modern code parameters are presented in Table 5.2.

Table 5.2. Modern code design parameters

(a) ASCE/SEI 7-2010 structural system parameters

Parameter	Dir. 1	Dir. 2
C_t	0.02	0.02
C_d	4	5
x	0.75	0.75
R	6.5	6
Ω_0	3	2.5

(b) ASCE/SEI 7-2010 site specific parameters

Parameter	Value
S_s	2.482
S_1	1.031
S_{ds}	1.655
S_{d1}	0.893
SDC	E
C_u	1.4

(c) ASCE/SEI 7-2010 site specific parameters based on the period of the building

Parameter	Value
$\text{MCE}_{R,max}(g)$	2.066
$\text{MCE}_{R,geomean}(g)$	1.68
$\text{DE}_{max}(g)$	1.377
$\text{DE}_{geomean}(g)$	1.12

5.3 Structural Properties

This section summarizes the main structural properties of the building in each direction. These structural properties are used as inputs to the SP3 Structural Response Prediction Engine.

Table 5.3. Structural properties table

Parameter	Direction 1	Direction 2
General		
Structural System	WLF: General	RC: Cantilever Shear Wall
Building Edge Length (ft)	21	41
Detailing Level	Ordinary	Ordinary
Seismic Strength		
Seismic Design Base Shear Ratio, C_s †	0.100	0.186
C_s with Structural Overstrength	–	0.484
Wind Strength		
Wind Design Base Shear Ratio, v_{wind} †	0.114	0.052
v_{wind} with Structural Overstrength	–	0.126
Total Strength		
Strength Governed by	–	seismic
Governing Seismic/Wind with Structural Overstrength	–	0.484
With Gravity System Strength	–	0.564
With Non-structural Strength	–	1.32
Ultimate Base Shear Ratio, v_{ult}	0.320	1.32
Stiffness		
$T_{1,design}$ (s)	0.34	0.46
T_1 with structural overstiffness (s)	–	0.35
T_1 with gravity system (s)	–	0.34
T_1 with non-structural components (s)	1.01	0.32
T_1 empirical lower bound (s)	–	0.11
T_1 empirical upper bound (s)	–	0.29
T_1 Final (s)	1.01	0.29

† Design base shear values reported as LRFD

5.4 Mode Shapes

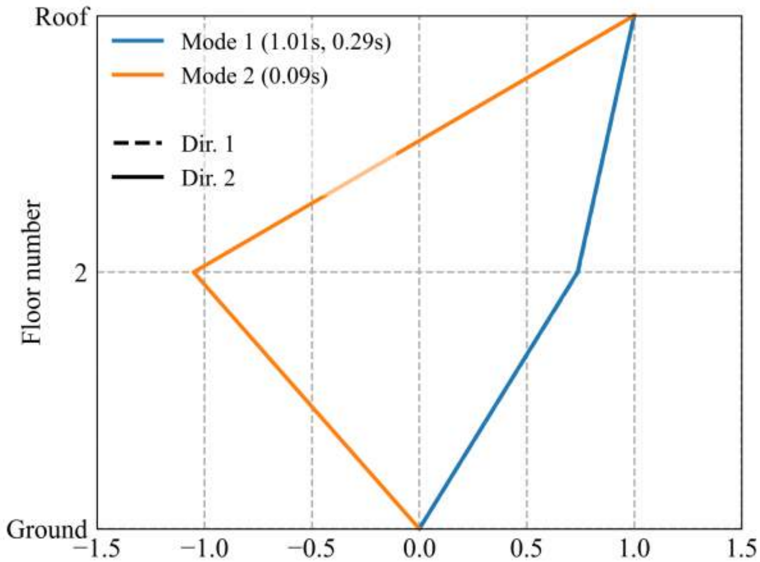


Figure 5.1. Mode shapes

Table 5.4. Mode shape values

	Dir. 1	Dir. 2	
	Mode 1	Mode 1	Mode 2
Roof	1.00	1.00	1.00
2	0.738	0.736	-1.05
Ground	0.00	0.00	0.00

6 SP3 PERFORMANCE FACTORS

Table 6.1 compares the seismic design base shear, C_s, to the 475-year shaking (reduced by the modern response modification coefficient, R). Generally speaking, the modern building code design requirements are based on the 475-year event with the exception of extremely high seismic (near-fault) areas that are designed for a lesser deterministic ground motion or the transition region between deterministic and probabilistic portions of the ground motion maps.

The shaking intensity is then reduced by the response modification coefficient, R, based on the ductility level of the system (in anticipation of controlled damage of specially designed elements).

When the ratio of design base shear to the reduced spectra ($C_s/\left[S_a(T_1)_{475}/R\right]$) is 1.0, then the building was designed consistent with 10% in 50 year hazard. When the ratio is above 1.0, it was designed higher, so expect better performance (all other things equal), and for ratios below 1.0, expect worse performance.

Table 6.1. Design base shear vs. 475-year shaking intensity

	Dir. 1	Dir. 2
Seismic Design Base Shear, C_s	0.100	0.186
475-year Shaking Intensity, $S_a(T_1)_{475}$ †	0.561g	1.38g
Reduced Spectral Acceleration, $S_a(T_1)_{475}/R$ ‡	0.086g	0.230g
Ratio of Design Base Shear to 475-year Shaking Demand, $C_s/\left[S_a(T_1)_{475}/R\right]$ §	**1.16**	**0.81**

† T_1 includes all sources of overstiffness ($T_{1,dir1} = 1.01$s and $T_{1,dir2} = 0.288$s, see Table 5.3).

‡ Response Modification Coefficient, R, is from the modern code ($R_{dir1} = 6.5$ and $R_{dir2} = 6$).

Table 6.2 shows a comparison of the properties of the building to the properties of the building if it were constructed using the modern code guidelines. This table only compares the difference in building strength and period, and does not present differences in component damageability. The full SP3-RiskModel analysis does include effects of component damageability differences, so while the metrics in this table are informative, they are not all-encompassing of differences between new and old code design.

Table 6.2. Comparison of structural properties from UBC 1967 and ASCE/SEI 7-2010

	Dir. 1	Dir. 2
Seismic Design Base Shear, C_s		
UBC 1967	0.100	0.186
ASCE/SEI 7-2010†	0.382	0.414
Ratio $\frac{C_{s,UBC1967}}{C_{s,ASCE/SEI7-2010}}$	**0.262**	**0.450**
Ultimate Base Shear (C_s with Overstrength), v_{ult}		
UBC 1967	0.320	1.32
ASCE/SEI 7-2010	0.713	1.83
Ratio $\frac{v_{ult,UBC1967}}{v_{ult,ASCE/SEI7-2010}}$	**0.448**	**0.721**
Period Considering All Sources of Stiffness, T_1 (s)		
UBC 1967	1.01	0.288
ASCE/SEI 7-2010	0.760	0.165

† $R_{dir1} = 6.5$ and $R_{dir2} = 6$

7 BUILDING STABILITY

The FEMA P-154 collapse capacity score was calculated as follows using the "very high" seismicity level. The terminology used in this section is consistent with the FEMA P-154 methodology (Applied Technology Council, 2015a):

- $\text{P}[COL|MCE_R]_{P-154}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking, times the collapse factor
- $\text{P}[COL|MCE_R]_{P-58}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking
- Collapse Factor: expected ratio of collapsed area to total area given that the building is in the HAZUS Complete structural damage state

For a more in-depth explanation of "collapse," refer to Section 4.4.1.5 of FEMA P-155 Third Edition available here (Applied Technology Council, 2015b).

Since the FEMA P-154 building types associated with the two structural systems specified differ, collapse is based on the more vulnerable structural system which in this case was determined to be the direction 1 system, "WLF: General".

Table 7.1. Breakdown of FEMA P-154 score assignment

FEMA ID:	W2
Basic Score	1.8
Soil	0
Year	0
Plan Irregularity	-0.6
Vertical Irregularity	0
Risk Category† (Cat IV)	0
Sum:	1.2
Minimum Allowed:	0.7
Score:	**1.2**
Dispersion (β):	0.58

† Non-standard property implemented by SP3

The FEMA P-154 probability of collapse at the MCE_R level event is then calculated as:

$$\begin{aligned}\text{P}[COL|MCE_R]_{P-154} &= 10^{-\text{score}} \\ &= 10^{-1.2} \\ &= 6.31\%\end{aligned} \qquad \text{(FEMA P-155 eqn. 4-1)}$$

Taking into account the fraction of floor area collapsed (0.33 in this case), the probability of collapse is:

$$\begin{aligned}\text{P}[COL|MCE_R]_{P-58} &= \text{P}[COL|MCE_R]_{P-154} \text{ / Collapse Factor} \\ &= 6.31\% \text{ / } 0.33 \\ &= 19.1\%\end{aligned}$$

The median collapse capacity (before any direct modifications to the median) is calculated as:

$$\begin{aligned}S_{a,\ collapse\ median,\ P-58} &= \exp\left(\ln(S_{a,MCE_R}) - \text{norminv}\left(P[COL|MCE_R]_{P-58}\right) \cdot \beta\right) \\ &= \exp\left(\ln(1.51g) - \text{norminv}\left(19.1\%\right) \cdot 0.58\right) \\ &= 2.50g\end{aligned}$$

where `norminv` is the inverse of the standard normal cumulative distribution function (CDF).

To further refine the collapse capacity, the factors from Table 7.2 were applied to the median collapse S_a.

Table 7.2. Scale factor applied to the median collapse S_a value.

Reason	Factor
Wood Light Frame	0.791

The WLF modification reflects a weighted average of the FEMA P-154 median and the median collapse capacity observed in extensive non-linear dynamic modeling.

The final median for the collapse curve is therefore:

$$
\begin{aligned}
S_{a,\ collapse\ median,\ P-58\ (adjusted)} &= S_{a,\ collapse\ median,\ P-58} \cdot \text{Factors} \\
&= 2.50g \cdot 0.791 && \text{(Using additional SP3 factors)} \\
&= 1.98g
\end{aligned}
$$

Which corresponds to a probability of collapse at MCE of:

$$\text{P}[COL|MCE_R]_{P-58\ (adjusted)} = 32.0\% \qquad \text{(Using additional SP3 factors)}$$

Figure 7.1 shows the collapse capacity cumulative distribution function used in the analysis.

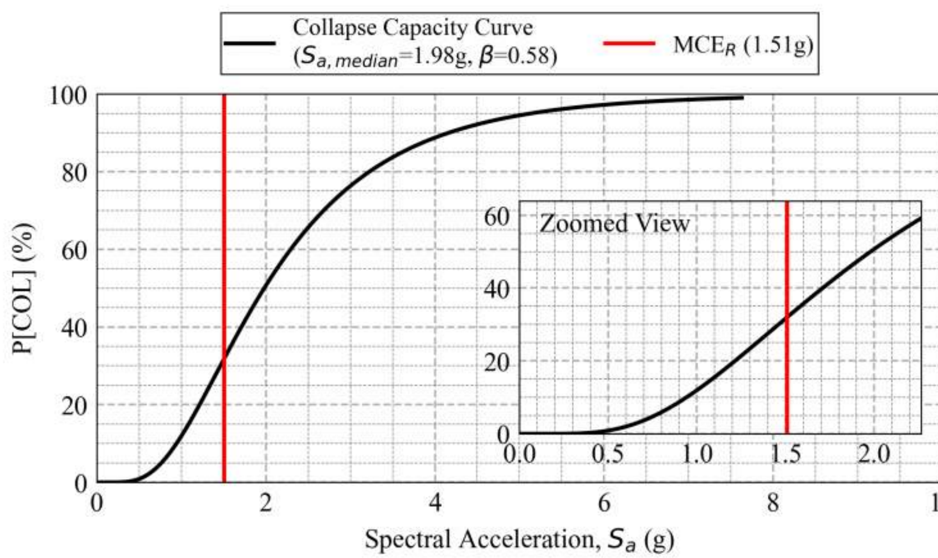


Figure 7.1. Cumulative distribution function for collapse capacity

8 STRUCTURAL RESPONSE PREDICTIONS FROM THE SP3 STRUCTURAL RESPONSE PREDICTION ENGINE

The SP3 Response Prediction Engine predicts the structural responses (typically providing 100 ground motions per intensity level); this is done by using a combination of three-mode elastic modal analysis, coupled with both elastic and inelastic response modifiers mined from the large SP3 Structural Responses Database (with over 4,000,000 response simulations, and growing). These response predictions track all of the important statistical information in the responses (mean, variability, and correlations); this enables a statistically robust vulnerability curve at the end of the risk assessment process.

8.1 Peak Interstory Drift

Peak interstory drift ratio is an important metric for both structural and non-structural components in the building. It measures how much the ceiling of a given story moves relative to the floor, normalized to the height of the story. The greater the interstory drift ratio, the greater the damage to the components on that level. Typical components that are damaged from interstory drift ratio are structural components (beams and columns), gypsum partition walls, and exterior cladding and glazing.

Table 8.1. Median Peak Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.11	0.78	0.78	0.98	0.99	1.21
1	0.59	3.57	3.61	5.86	6.76	8.88
$\frac{S_a(T_1)}{v_{ult}}$ =	0.52	1.76	1.77	2.50	2.83	3.69

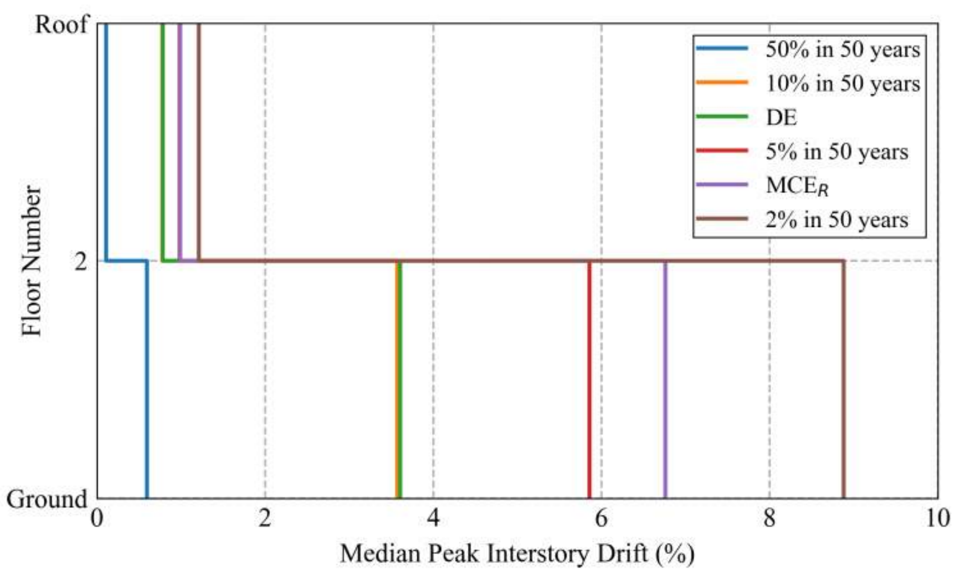


Figure 8.1. Median Peak Interstory Drift demands in direction 1

Table 8.2. Median Peak Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.09	0.31	0.32	0.54	0.66	1.03
1	0.17	0.56	0.57	0.75	0.83	1.03
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

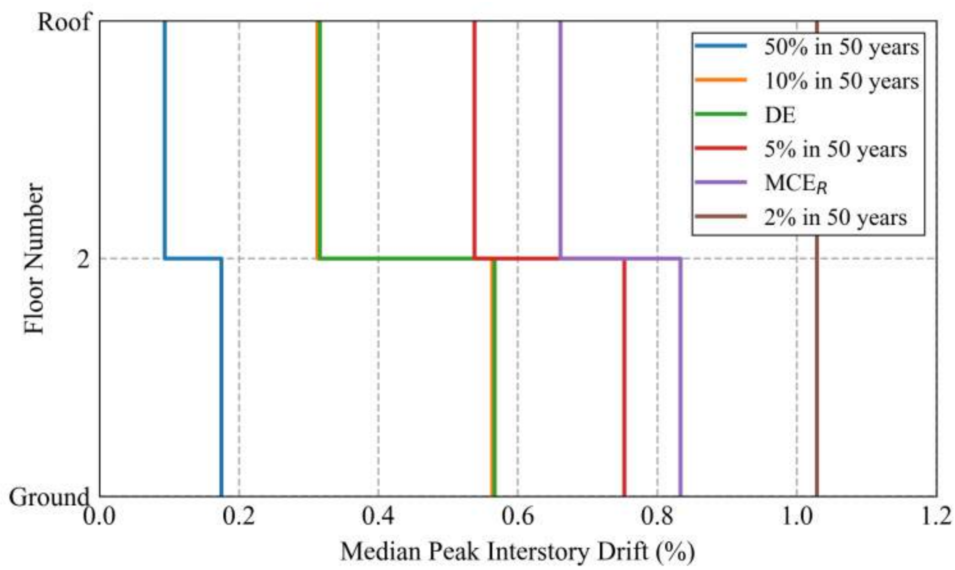


Figure 8.2. Median Peak Interstory Drift demands in direction 2

8.2 Residual Interstory Drift

Residual drift is a metric that informs the need for structural repairs or building demolition (where excessive drifts are present). Residual drift ratio is a measure of how much the building is "leaning over" after the seismic event has ceased. A residual drift of 2% would indicate that the story is laterally displaced 2% of it's height, which equates to about 3.6 inches for a 15 foot tall story.

Table 8.3. Median Residual Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.00	0.00	0.00	0.00	0.00	0.05
1	0.00	0.58	0.59	1.60	2.30	3.96
$\frac{S_a(T_1)}{v_{ult}} =$	0.52	1.76	1.77	2.50	2.83	3.69

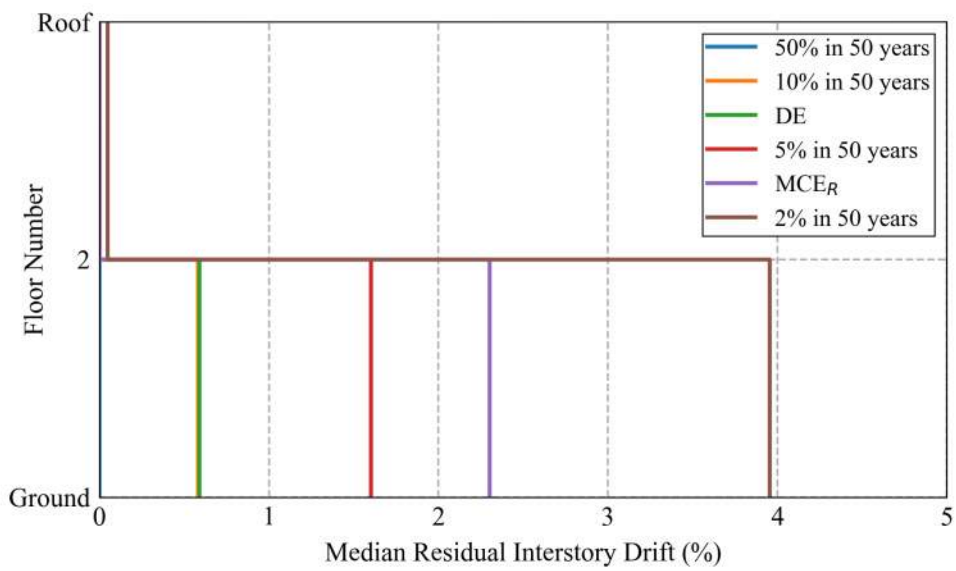


Figure 8.3. Median Residual Interstory Drift demands in direction 1

Table 8.4. Median Residual Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE$_R$	2% in 50 years
2	0.00	0.01	0.01	0.04	0.05	0.10
1	0.00	0.04	0.04	0.07	0.08	0.10
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

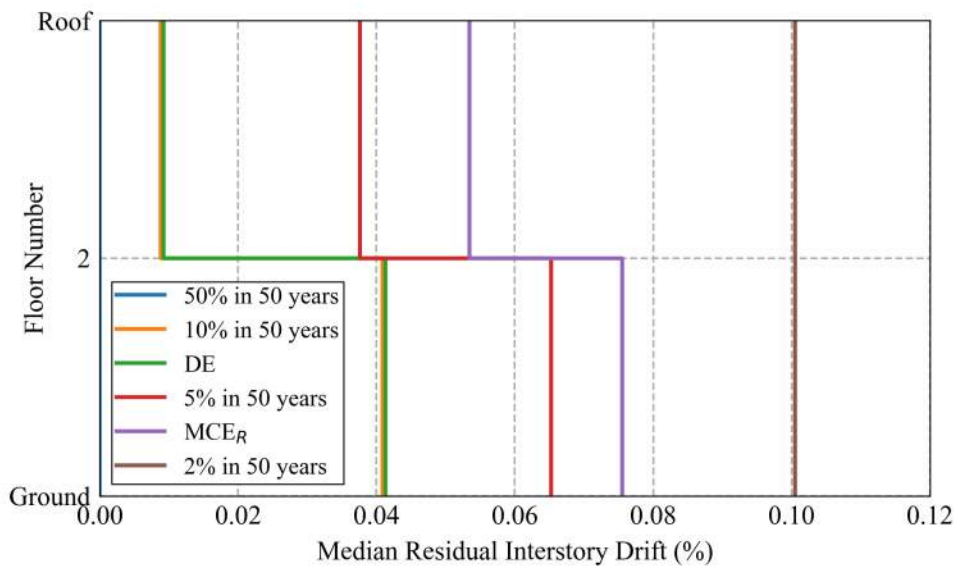


Figure 8.4. Median Residual Interstory Drift demands in direction 2

8.3 Peak Floor Acceleration

Peak floor acceleration is an an important metric for non-structural components in the building. Components such as piping, HVAC, and electrical switchgear are sensitive to the floor accelerations. High accelerations will typically damage a component itself or cause the component's anchorage to fail, both of which may require repair or replacement of the component.

Table 8.5. Median Peak Floor Acceleration demands in direction 1

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Roof	0.33	0.90	0.90	0.97	0.97	1.13
2	0.26	0.85	0.85	0.92	0.95	1.13
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}} =$	0.52	1.76	1.77	2.50	2.83	3.69

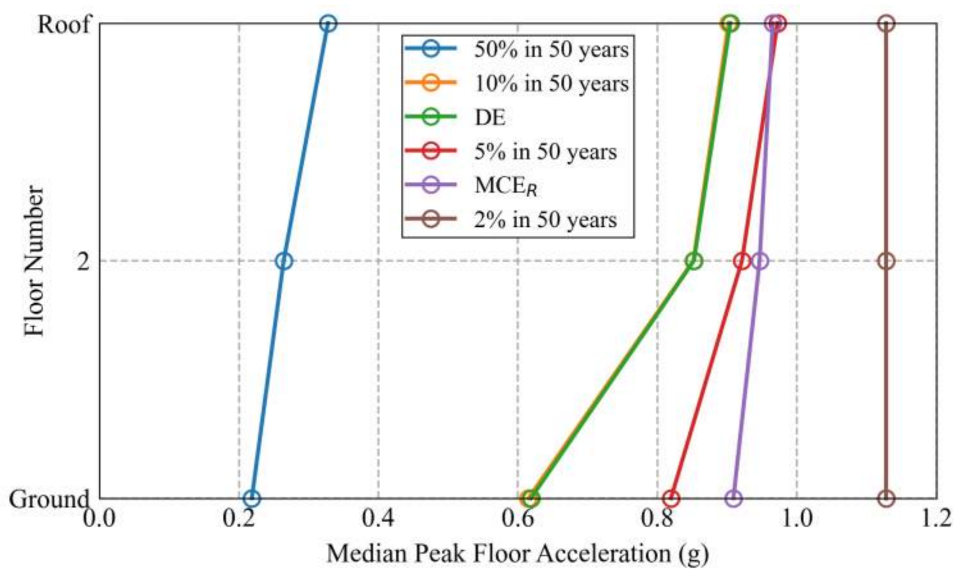


Figure 8.5. Median Peak Floor Acceleration demands in direction 1

Table 8.6. Median Peak Floor Acceleration demands in direction 2

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Roof	0.60	1.54	1.55	1.80	1.86	2.01
2	0.41	1.08	1.09	1.32	1.40	1.57
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}}=$	0.35	1.05	1.05	1.43	1.60	2.03

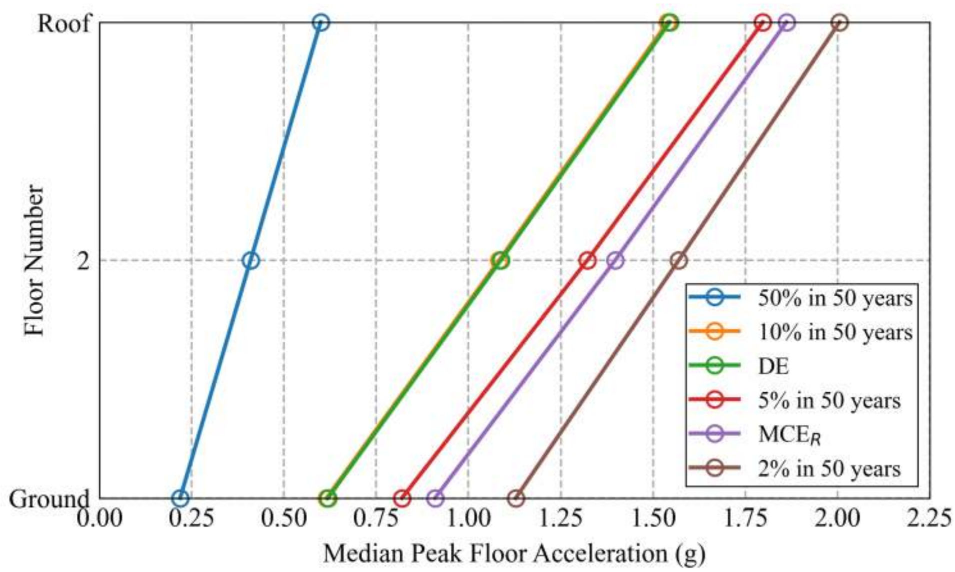


Figure 8.6. Median Peak Floor Acceleration demands in direction 2

8.4 Peak Chord Rotation

Chord rotation informs how slender shear walls damage. Chord rotation is the difference in drift between two adjacent levels of a building.

Table 8.7. Median Peak Chord Rotation demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.08	0.25	0.25	0.22	0.17	0.00
1	0.17	0.56	0.57	0.75	0.83	1.03
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

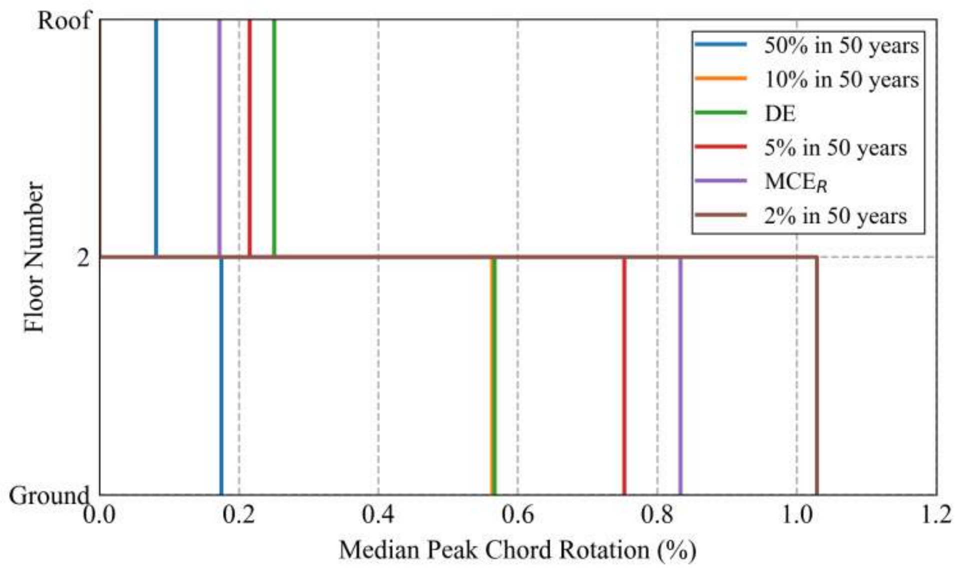


Figure 8.7. Median Peak Chord Rotation demands in direction 2

8.5 Max. Residual Interstory Drift

Table 8.8. Median Max. Residual Interstory Drift demands in direction 1

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.58	0.59	1.60	2.30	3.96
$\frac{S_a(T_1)}{v_{ult}} =$	0.52	1.76	1.77	2.50	2.83	3.69

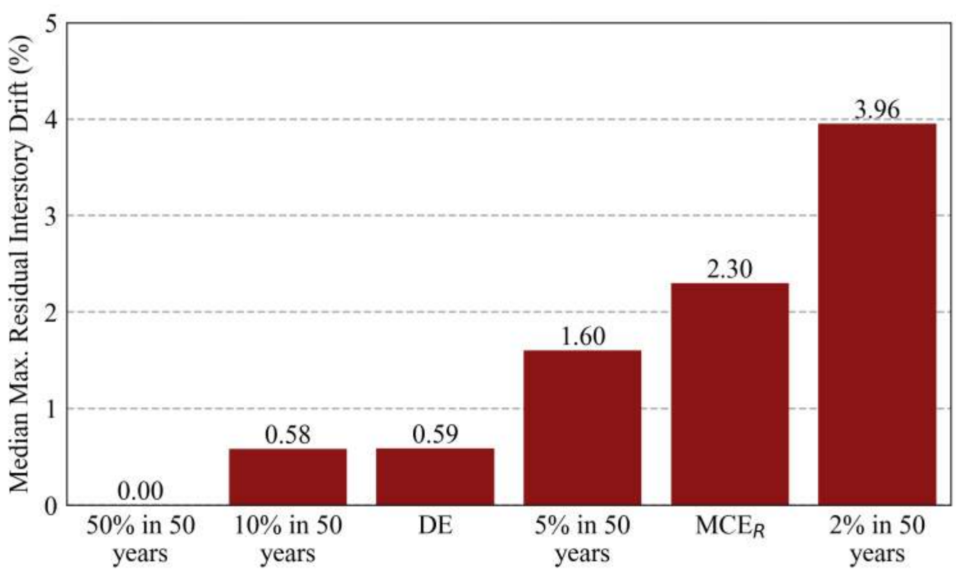


Figure 8.8. Median Max. Residual Interstory Drift demands in direction 1

Table 8.9. Median Max. Residual Interstory Drift demands in direction 2

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.04	0.04	0.07	0.08	0.10
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

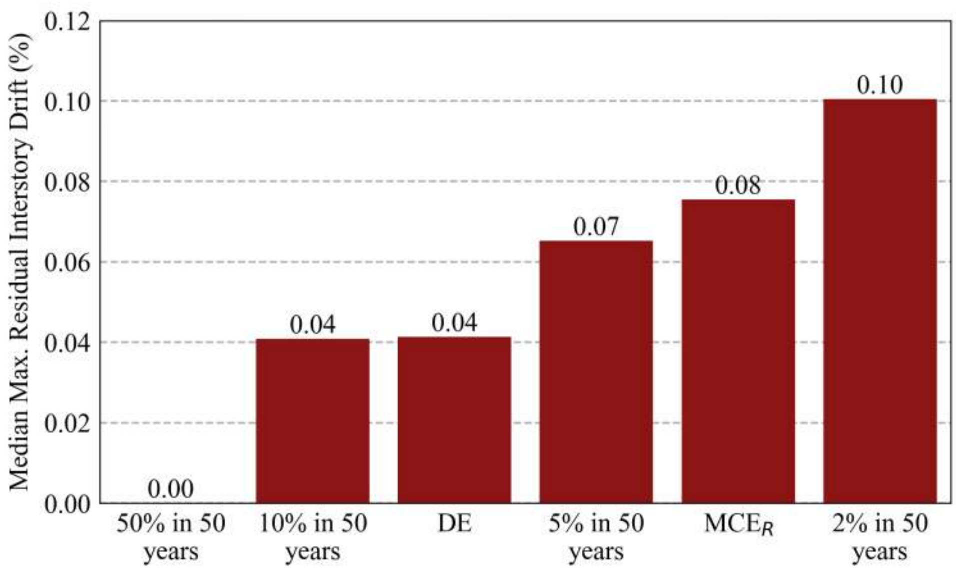


Figure 8.9. Median Max. Residual Interstory Drift demands in direction 2

9 REPAIR COSTS - BY LEVEL OF GROUND MOTION

9.1 Mean and 90th Percentile Repair Costs (SEL and SUL)

The different metrics for repair cost are as follows:

- **Mean (SEL)**: ("Scenario Expected Loss") the average repair cost of the building repair/replacement.
- **Median**: there is a 50% probability that the repair cost will not exceed this value.
- **Fitted SUL**: Fitted value of "Scenario Upper Loss".
- **Counted 90th Percentile**: there is a 90% probability that the repair cost will not exceed this value.

Table 9.1. Loss metrics normalized by building cost

Intensity	PGA (g)	Mean (SEL) (%)	Fitted SUL (%)	Median (%)	Counted 90th Percentile (%)	$S_a(T_1)/v_{ult}$ † Dir 1	$S_a(T_1)/v_{ult}$ † Dir 2
50% in 50 years	0.22	7.4	15	5.7	15	0.52	0.35
10% in 50 years	0.62	49	80	34	100	1.76	1.05
DE	0.62	50	82	35	100	1.77	1.05
5% in 50 years	0.82	89	100	100	100	2.50	1.43
MCE$_R$	0.91	95	100	100	100	2.83	1.60
2% in 50 years	1.13	99	100	100	100	3.69	2.03

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.320$ and $T_1 = 1.01$s and in direction 2 $v_{ult} = 1.32$ and $T_1 = 0.288$s (see Table 5.3 for more detailed structural properties)

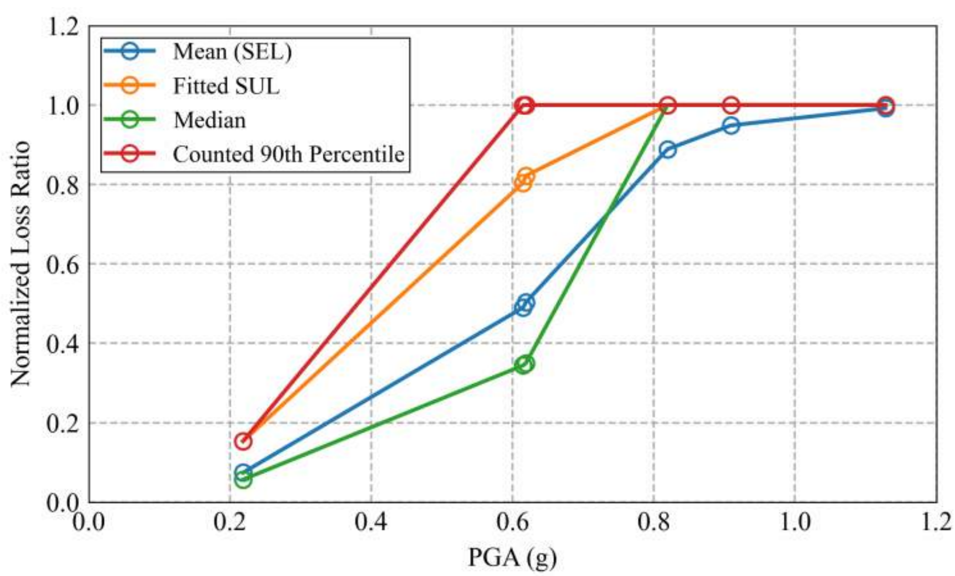


Figure 9.1. Loss metrics across all intensity levels analyzed

10 REPAIR COST BREAKDOWN BY BUILDING COMPONENTS

10.1 Categories for Repair Cost Breakdowns

Repair costs are binned into eight categories as follows:

- **Collapse**: building demolition and replacement following a collapse.
- **Residual**: building demolition and replacement following unacceptable residual drifts.
- **Structural**: components of the lateral force resisting system or gravity system (e.g. beam column connections, link beams, shear wall, shear tabs, etc.).
- **Partitions**: partition wall components (e.g. wood or metal stud gypsum full height partitions).
- **Exterior**: components placed on the exterior of the building (e.g. cladding, glazing, etc.).
- **Interior**: non-structural components on the interior of the building (e.g. raised access floors, ceilings, lighting).
- **HVAC**: HVAC and plumbing components (e.g. water piping and bracing, sanitary piping, ducting, boilers etc.).
- **Other**: components not included in the categories above (e.g. elevators, user defined components, fire protection components).

10.2 Repair Cost Breakdown for Various Ground Motion Levels

Table 10.1. Expected mean loss per component group (in percent)

Intensity	Total	Residual	Collapse	Structural	Interior	Partitions	Other	HVAC	Exterior
50% in 50 years	7.4	0.0	0.0	0.7	1.4	1.3	2.6	1.4	0.1
10% in 50 years	49	16	10	7.4	4.9	4.1	4.2	2.0	0.7
DE	50	17	10	7.2	4.8	3.9	4.2	2.0	0.7
5% in 50 years	89	59	24	1.8	1.2	1.0	1.0	0.5	0.2
MCE_R	95	61	31	0.8	0.5	0.5	0.4	0.2	0.1
2% in 50 years	99	51	48	0.1	0.1	0.1	0.1	0.0	0.0

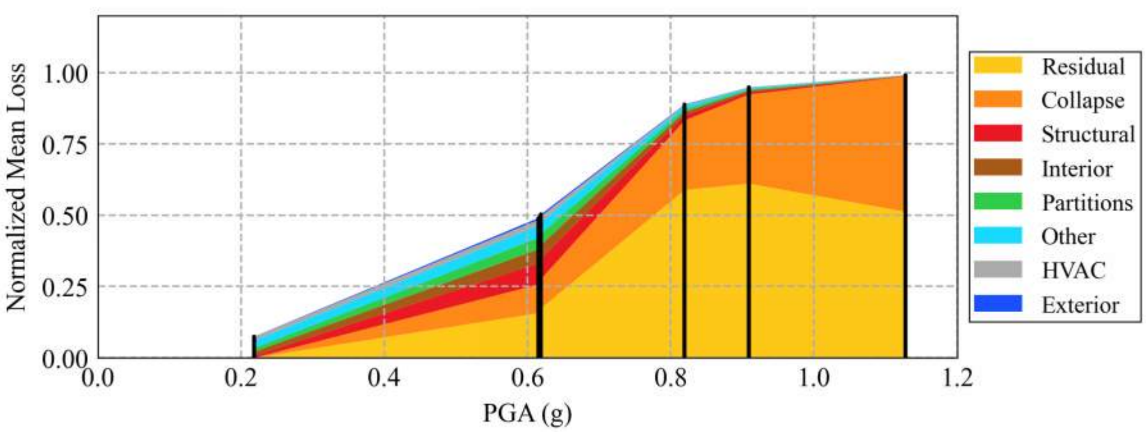


Figure 10.1. Contribution of building components to mean loss ratio

10.3 Repair Cost Breakdown for Expected Annual Loss

The expected annual loss for this building is $3,237.

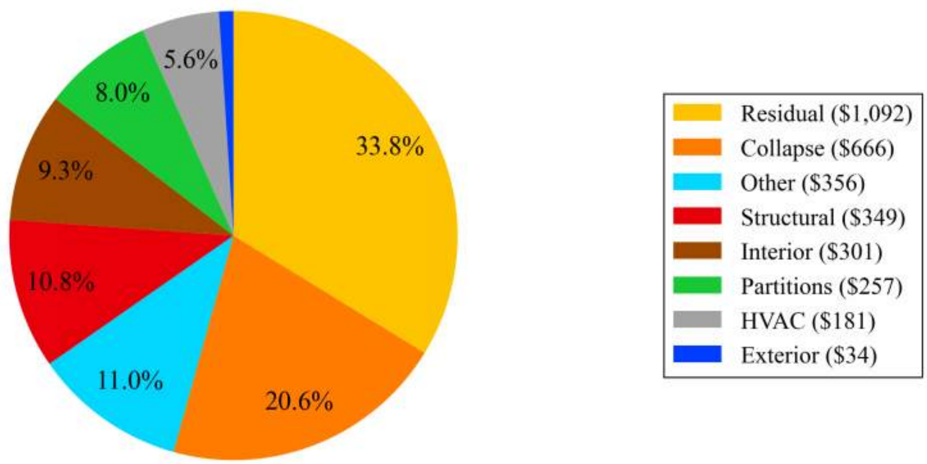


Figure 10.2. Annualized loss breakdown

11 REPAIR TIME AND BUILDING CLOSURE TIME

These downtimes were calculated using the ATC-138 Functional Recovery (Beta) Methodology. This includes all sources of impedance specified by the user; possible sources of impedance considered are listed below.

- Post-earthquake Inspection
- Engineering Mobilization and Review/Re-design
- Financing
- Contractor Mobilization and Bid Process
- Permitting

These capture the time required to start the repairs, since beginning repairs immediately after an earthquake may not be realistic.

Table 11.1. Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	2.6 weeks	3.7 weeks	0 days	4 days	2.2 months
10% in 50 years	4 months	5.3 months	3.9 months	4.4 months	4.5 months
DE	4.1 months	5.4 months	4.1 months	4.6 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

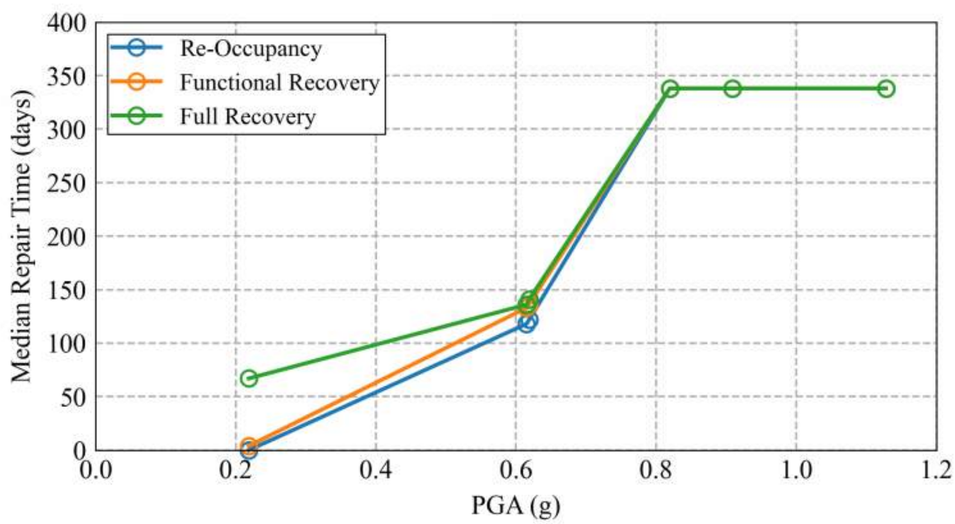


Figure 11.1. Median repair time from the ATC-138 Functional Recovery (Beta) Methodology, includes specified impeding factors

12 DISCLAIMER

REFERENCES

Applied Technology Council. 2015a. *FEMA P-154: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*.

Applied Technology Council. 2015b. *FEMA P-155: Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation*.

Applied Technology Council. 2018. *FEMA P-58: Seismic Perfromance Assessment of Buildings*.

International Conference of Building Officials. 1967. *Uniform Building Code 1967 Edition*. International Conference of Building Officials.

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Functional Recovery Time Report

using the

ATC-138 Functional Recovery (Beta) Methodology

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program
by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	Existing WLF on RC Wall
Building Types:	
Dir. 1: WLF: General	
Dir. 2: RC: Cantilever Shear Wall	
Design Code Year:	1967
Number of Stories:	2
Occupancy:	Commercial Office
Address:	
217 Arlington Avenue	
Kensington, CA, 94707	
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	1,738
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	Extreme
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Ordinary, Ordinary
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	–
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	–
2^{nd} Mode Period (T_2) (s):	–	–

Component Information

Percent of Building Glazed:	–
Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options	
Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Interior Finishes

- What kind of partition walls does the building have?
  > *Wood Studs*
- Does the building have raised access floors
  > *No*
- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *No*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *No*

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*
- Are there elevators in the building?
  > *Yes*
  - What type of elevators are in the building?
    > *Hydraulic*
    - From which era are the building's elevators?
      > *Pre-1976 California (or pre-1976 California equivalent)*

Fire Supression

- Does the building contain a fire sprinkler system?
  > *Yes*
  - Does the fire sprinkler system have braced horizontal piping?
    > *No*
  - Are the fire sprinkler drops OSHPD certified (or equivalent)?

Continued on next page

Component Checklist (*Continued*))

    > *No*
  - What type of ceiling do the fire drops enter into?
      > *Hard*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *No*
- Is the building's sanitary piping OSHPD certified or equivalent?
  > *No*
  - What type of couplings do the pipes have?
    > *Bell and spigot*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *No*
  - How is the cooling/heating system configured?
    > *Roof Top Units*
    - Are the RTUs used for medical purposes (or equivalent)?
      > *No*
      - Are the RTUs small or large?
        > *Small*
    - Does the building have a control panel?
      > *Yes*
- Is there an HVAC exhaust system in the building?
  > *Yes*
  - Is the HVAC exhaust system seismically anchored?
    > *No*
- Does the HVAC distribution system meet OSHPD standards (or similar)?
  > *No*
  - Is there any large diameter ducting (6 SqFt+) in the HVAC system?
    > *Yes*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Concrete

- Are the building's shear walls low rise or slender?
  > *Low Rise (typically <= 40ft building height)*
  - What are the boundary conditions of the walls?
    > *No return flanges or boundary columns*
    - What is the typical wall thickness?
      > *8" to 16"*
      - What is the typical wall height?
        > *Less than 15'*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	7.4	15
10% in 50 years	475 Years	49	80
DE	481 Years	50	82
5% in 50 years	975 Years	89	100
MCE_R	1277 Years	95	100
2% in 50 years	2475 Years	99	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	2.6 weeks	3.7 weeks	0 days	4 days	2.2 months
10% in 50 years	4 months	5.3 months	3.9 months	4.4 months	4.5 months
DE	4.1 months	5.4 months	4.1 months	4.6 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 FUNCTIONAL RECOVERY OVERVIEW

Table 2.1. Recovery Times from the ATC-138 Functional Recovery (Beta) Methodology

Intensity	Return Period	PGA (g)	Sa(T_1)*	Median			90^{th} Percentile		
				Re-Occ.	Func.	Full	Re-Occ.	Func.	Full
50% in 50 years	72 years	0.22	0.32	0d	4d	2.2m	3.2m	3.8m	4.7m
10% in 50 years	475 years	0.62	0.97	3.9m	4.4m	4.5m	11m	11m	11m
DE	481 years	0.62	0.98	4.1m	4.6m	4.7m	11m	11m	11m
5% in 50 years	975 years	0.82	1.34	11m	11m	11m	11m	11m	11m
MCE$_R$	1277 years	0.91	1.51	11m	11m	11m	11m	11m	11m
2% in 50 years	2475 years	1.13	1.93	11m	11m	11m	11m	11m	11m

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

Table 2.2. Global Consequences

Intensity	Return Period	PGA (g)	Sa(T_1)*	P[red tag]	P[collapse]	P[excessive residual]
50% in 50 years	72 years	0.22	0.32	0.0%	0.0%	0.0%
10% in 50 years	475 years	0.62	0.97	26%	10%	16%
DE	481 years	0.62	0.98	28%	10%	17%
5% in 50 years	975 years	0.82	1.34	83%	24%	59%
MCE$_R$	1277 years	0.91	1.51	92%	31%	61%
2% in 50 years	2475 years	1.13	1.93	99%	48%	51%

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

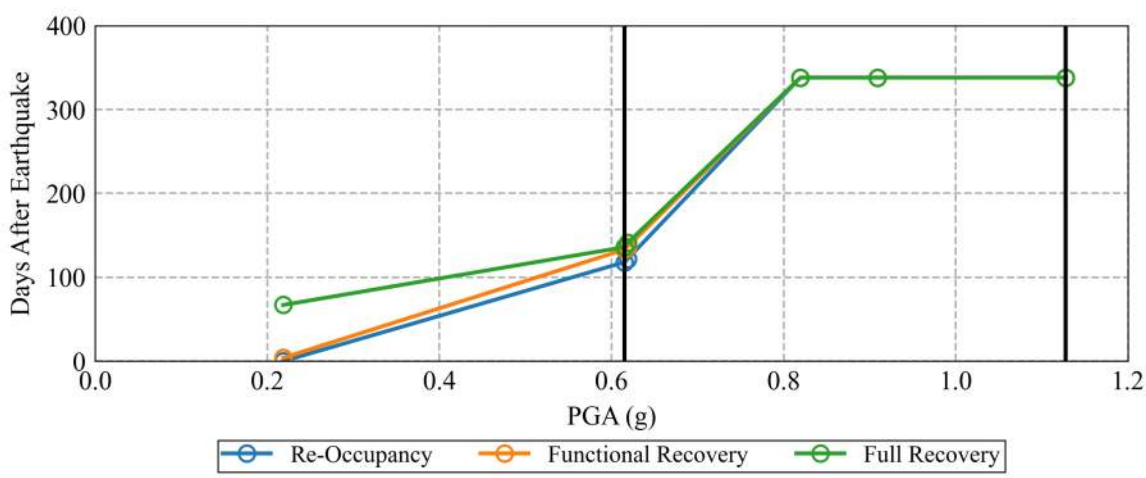


Figure 2.1. ATC-138 Functional Recovery (Beta) Methodology median recovery times

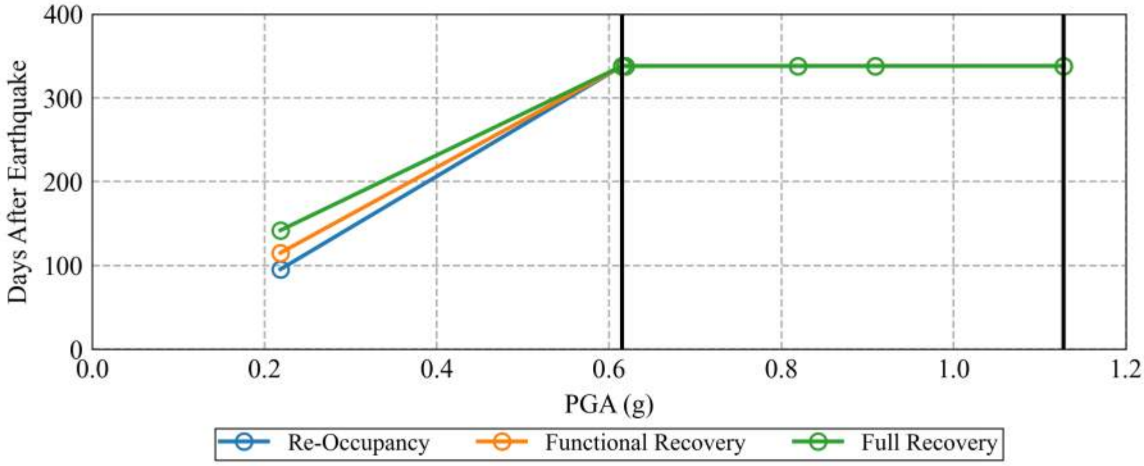


Figure 2.2. ATC-138 Functional Recovery (Beta) Methodology 90^{th} percentile recovery times

3 COMPONENT DAMAGE OVERVIEW

3.1 Most Damaged Components

This section outlines the most damaged component at each intensity. "Most damaged" is determined by cost and does not necessarily mean that it's the main component impeding building function.

Table 3.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1044.011	1	$3,323
10% in 50 years	B1044.011	1	$33,175
DE	B1044.011	1	$32,640
5% in 50 years	B1044.011	1	$7,722
MCE_R	B1044.011	1	$3,514
2% in 50 years	B1044.011	1	$685

Table 3.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	D1014.022	1	$14,674
10% in 50 years	D1014.022	1	$20,630
DE	D1014.022	1	$20,309
5% in 50 years	D1014.022	1	$5,065
MCE_R	D1014.022	1	$2,087
2% in 50 years	D1014.022	1	$308

Details of the most damaged components and their damage states:

- **B1044.011**: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with heights of up to 15'
  - DS1: Cracks with maximum widths greater than 0.04 in but less than 0.12 in.
- **D1014.022**: Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.
  - DS1a: Damaged controls.
  - DS1b: Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.
  - DS1c: Damaged entrance and car door, and or flooring damage.
  - DS1d: Oil leak in hydraulic line, and or hydraulic tank failure.

3.2 Worker Days Summary

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.3. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	1.5	9.0	8.8	2.1	0.9	0.2
DS2	0.1	1.8	1.9	0.5	0.2	0.1
DS3	0.2	7.6	7.6	1.6	0.8	0.1
Total	**1.8**	**18**	**18**	**4.3**	**1.9**	**0.3**
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	0.6	1.5	1.4	0.3	0.1	0.0
DS2	0.0	1.2	1.2	0.3	0.1	0.0
DS3	0.0	5.6	5.4	1.6	0.7	0.1
Total	**0.6**	**8.3**	**8.1**	**2.2**	**1.0**	**0.1**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	0.4	0.6	0.6	0.1	0.1	0.0
DS2	0.1	0.5	0.4	0.1	0.0	0.0
DS3	0.2	3.3	3.2	0.8	0.4	0.1
Total	**0.7**	**4.4**	**4.3**	**1.1**	**0.5**	**0.1**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.2	1.4	1.3	0.3	0.1	0.0
DS2	0.4	1.1	1.1	0.3	0.1	0.0
DS3	1.0	5.9	5.7	1.5	0.8	0.1
Total	**2.6**	**8.4**	**8.2**	**2.1**	**1.0**	**0.1**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.0	1.2	1.1	0.3	0.1	0.0
DS2	0.3	0.9	0.9	0.2	0.1	0.0
DS3	0.5	3.5	3.3	0.9	0.4	0.1
Total	**1.8**	**5.5**	**5.4**	**1.4**	**0.6**	**0.1**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.3	0.2	0.2	0.0	0.0	0.0
DS2	0.3	0.6	0.5	0.1	0.1	0.0
DS3	0.2	3.2	3.1	0.8	0.4	0.1
Total	**0.7**	**3.9**	**3.8**	**0.9**	**0.4**	**0.1**
C3032.001a #1 (C3032.001a: Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only)						
DS1	0.1	0.1	0.1	0.0	0.0	0.0
DS2	0.1	0.4	0.4	0.1	0.0	0.0
DS3	0.3	3.0	3.0	0.8	0.3	0.0
Total	**0.5**	**3.5**	**3.5**	**0.9**	**0.4**	**0.1**

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Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
C3032.001b #1 (C3032.001b: Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only)						
DS1	0.1	0.1	0.1	0.0	0.0	0.0
DS2	0.1	0.3	0.3	0.1	0.0	0.0
DS3	0.4	3.4	3.3	0.8	0.3	0.1
Total	**0.7**	**3.8**	**3.8**	**0.9**	**0.4**	**0.1**
C3032.001c #1 (C3032.001c: Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only)						
DS1	0.2	0.1	0.1	0.0	0.0	0.0
DS2	0.2	0.4	0.4	0.1	0.0	0.0
DS3	0.8	4.0	4.1	1.0	0.4	0.1
Total	**1.1**	**4.5**	**4.6**	**1.1**	**0.5**	**0.1**
C3032.001d #1 (C3032.001d: Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only)						
DS1	0.2	0.1	0.1	0.0	0.0	0.0
DS2	0.3	0.4	0.4	0.1	0.0	0.0
DS3	0.9	4.4	4.2	1.0	0.5	0.1
Total	**1.5**	**4.9**	**4.7**	**1.1**	**0.5**	**0.1**
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**2.0**	**2.8**	**2.7**	**0.6**	**0.3**	**0.0**
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	0.2	0.4	0.3	0.1	0.0	0.0
DS1b	4.2	5.7	5.8	1.4	0.6	0.1
DS1c	5.5	7.4	7.6	1.9	0.7	0.1
DS1d	0.9	1.3	1.2	0.3	0.1	0.0
Total	**11**	**15**	**15**	**3.6**	**1.5**	**0.3**
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**0.1**	**0.3**	**0.3**	**0.1**	**0.0**	**0.0**
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.2	0.2	0.0	0.0	0.0
Total	**0.0**	**0.2**	**0.2**	**0.0**	**0.0**	**0.0**
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	0.5	0.4	0.4	0.1	0.0	0.0
DS1b	0.3	0.2	0.2	0.1	0.0	0.0
Total	**0.8**	**0.6**	**0.6**	**0.1**	**0.1**	**0.0**

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Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
D3041.011b #1 (D3041.011b: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**
D3041.012b #1 (D3041.012b: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D3041.032b #1 (D3041.032b: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.6**	**3.0**	**2.9**	**0.7**	**0.3**	**0.0**
D3041.101a #1 (D3041.101a: HVAC Fan - Capacity: all - Unanchored equipment that is not vibration...)						
DS1	**4.2**	**4.7**	**4.6**	**1.1**	**0.5**	**0.1**
D4011.022a #1 (D4011.022a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**

3.3 Component Name Reference

This list is provided for reference where only the fragility ID is available.

- **B1044.011**: Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’
- **B1071.002**: Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs
- **B2011.401**: Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs
- **C1011.211a**: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above
- **C1011.311a**: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above
- **C2011.041b**: Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.
- **C3032.001a**: Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only
- **C3032.001b**: Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only
- **C3032.001c**: Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only
- **C3032.001d**: Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only
- **C3034.001**: Independent Pendant Lighting - non seismic
- **D1014.022**: Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.
- **D2021.013a**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY
- **D2021.013b**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY
- **D2021.023a**: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY
- **D2021.023b**: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY
- **D2031.022a**: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY
- **D2031.022b**: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY
- **D3032.011a**: Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only
- **D3041.011b**: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC C
- **D3041.012b**: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater, SDC C

- **D3041.032b**: HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC C
- **D3041.101a**: HVAC Fan - Capacity: all - Unanchored equipment that is not vibration isolated - Equipment fragility only
- **D4011.022a**: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - No bracing, SDC C, PIPING FRAGILITY

4 DETAILED REOCCUPANCY AND FUNCTIONALITY RESULTS BY GROUND MOTION INTENSITY

4.1 50% in 50 years Intensity

4.1.1 *Selected Realizations for 50th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

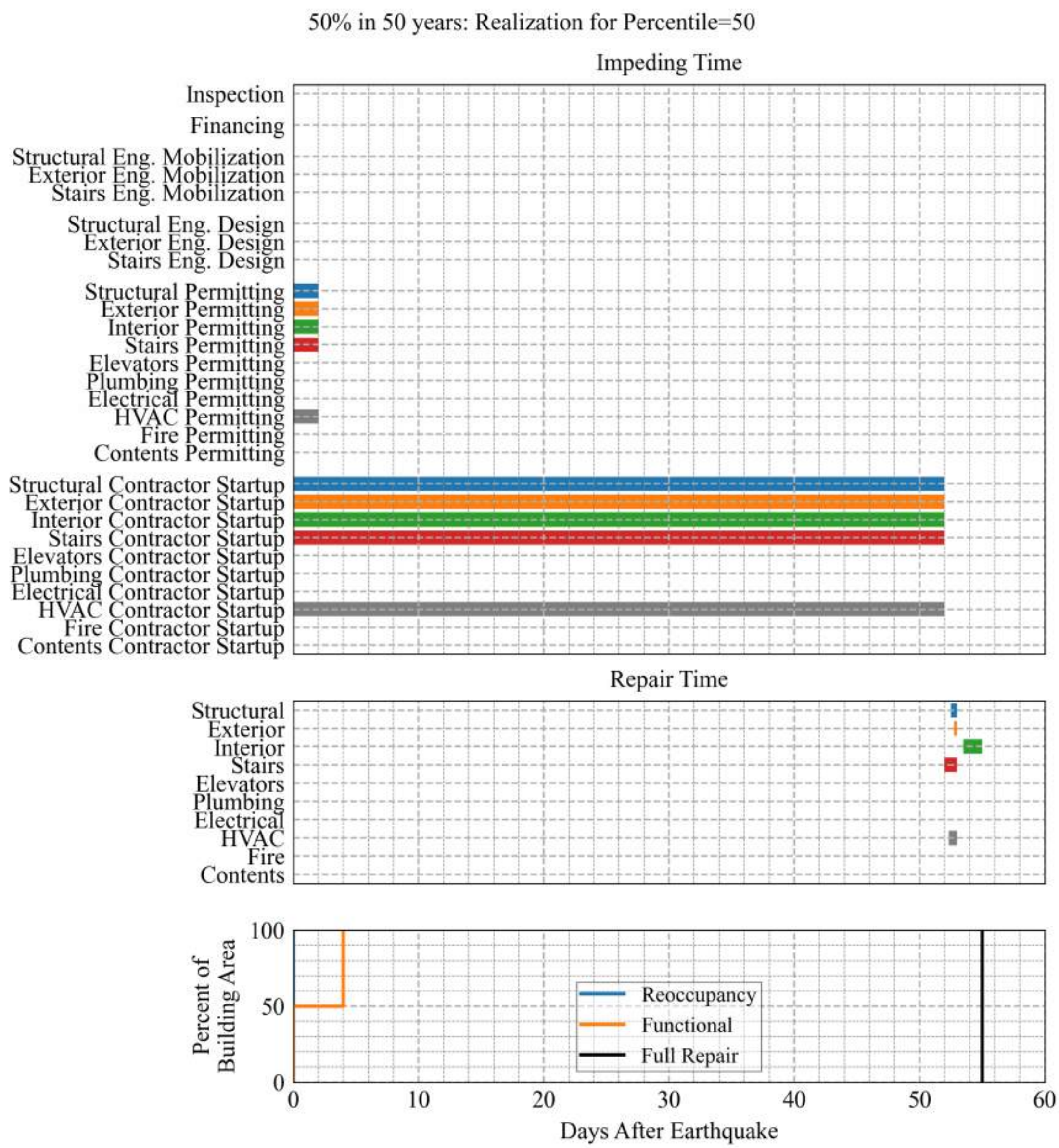

Figure 4.1. 50% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

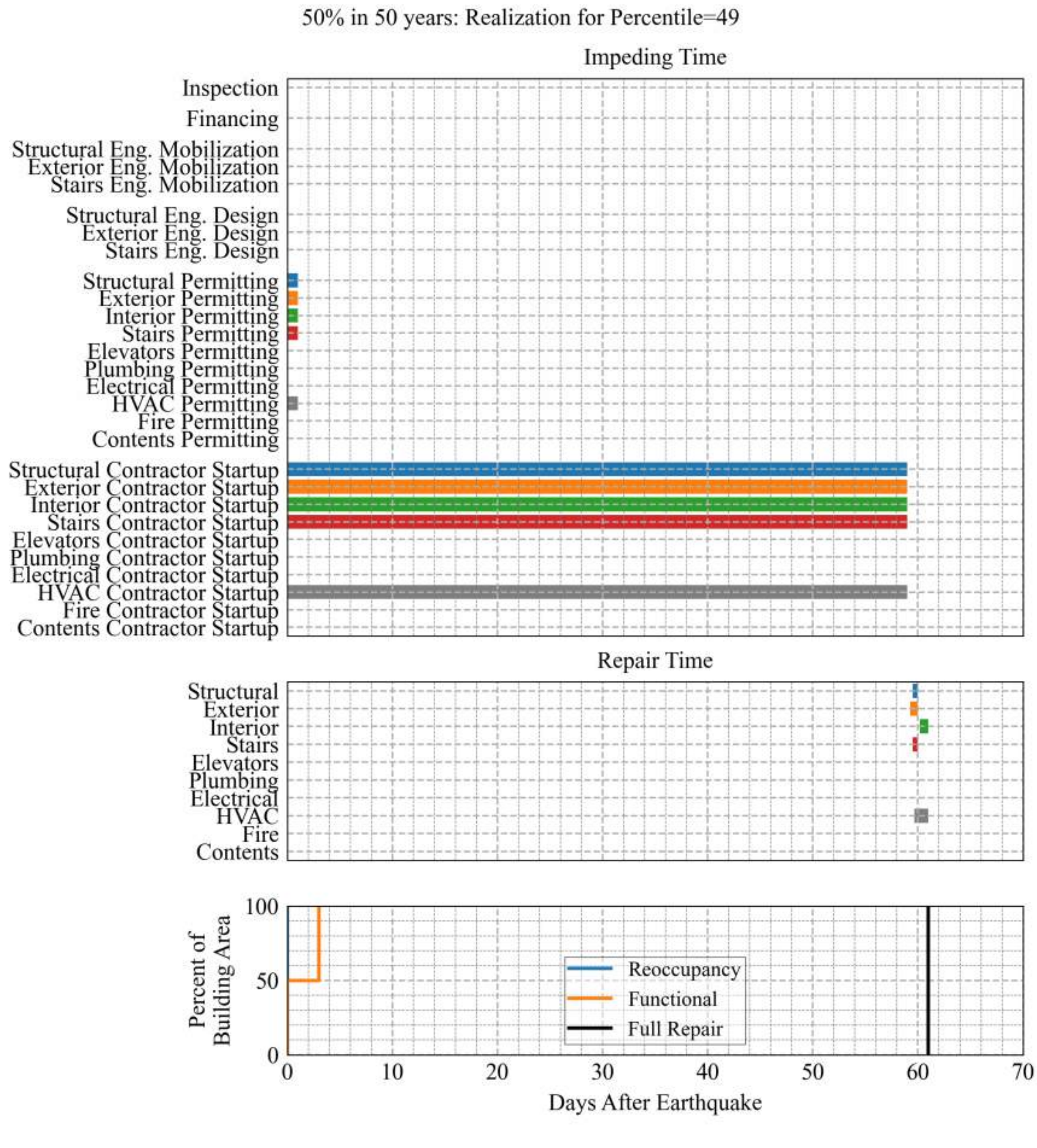

Figure 4.2. 50% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

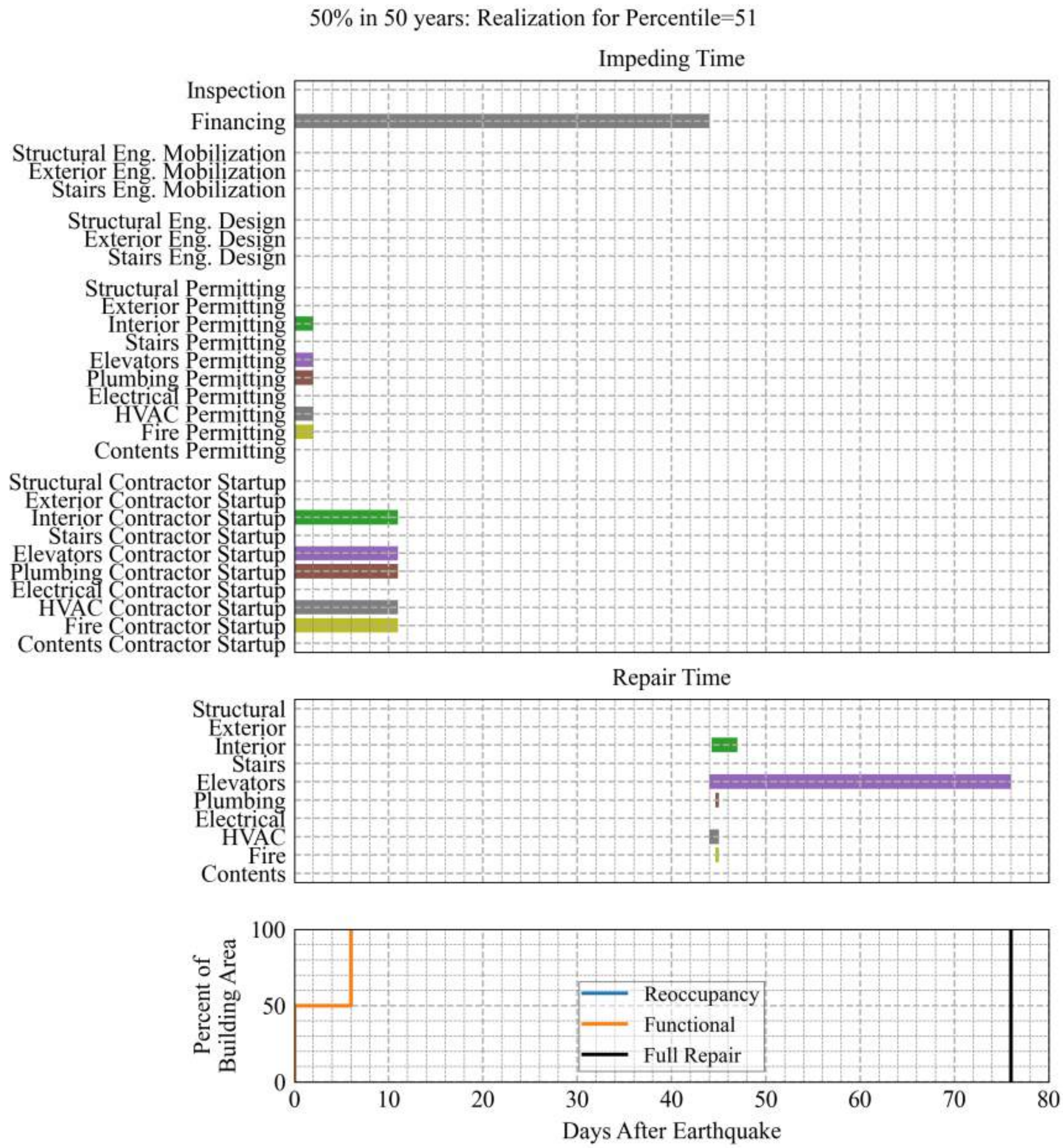

Figure 4.3. 50% in 50 years Percentile = 51

4.1.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

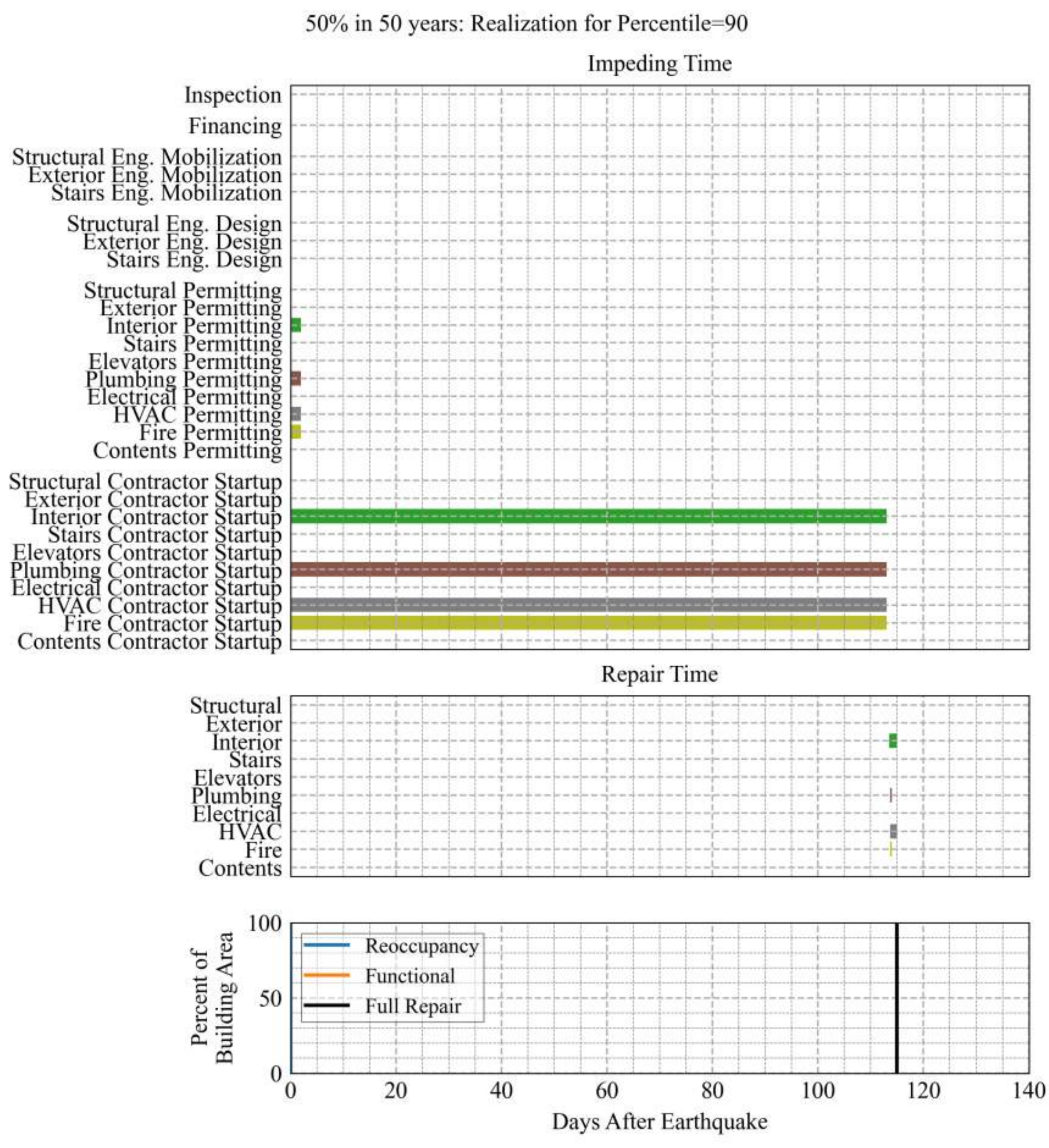

Figure 4.4. 50% in 50 years Percentile = 90

4.1.3 Damage to Building Systems

Table 4.1 shows the percentage of realizations that the named system prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.1. Percent of realizations affecting building reoccupancy/function per system - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	19	19	19	19	19	0.9	0.0
Stairway Doors	5.0	5.0	5.0	5.0	4.6	0.2	0.0
Exterior	1.2	1.1	0.6	0.2	0.0	0.0	0.0
Interior	25	23	14	7.4	5.8	0.2	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	14	13	8.4	6.4	5.7	0.2	0.0
Water	32	32	32	31	27	0.7	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	18	18	18	17	16	0.7	0.0

4.1.4 Damage to Individual Components

Table 4.2 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.2. Percent of realizations affecting building reoccupancy/functionality per component - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 0.2	0.0 / 0.2	0.0 / 0.2	0.0 / 0.2	0.0 / 0.2	0.0 / 0.0	0.0 / 0.0
B1071.002	0.3 / 0.3	0.3 / 0.2	0.1 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	1.2 / 3.1	1.1 / 2.5	0.6 / 0.4	0.2 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 7.5	0.0 / 6.8	0.0 / 1.9	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 7.8	0.0 / 7.0	0.0 / 2.1	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	15 / 0.0	15 / 0.0	15 / 0.0	15 / 0.0	15 / 0.0	0.8 / 0.0	0.0 / 0.0
C3032.001a	9.0 / 3.2	7.2 / 2.8	2.4 / 1.1	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001b	12 / 3.8	8.6 / 3.1	3.5 / 1.6	0.4 / 0.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001c	17 / 5.2	14 / 4.2	4.7 / 2.1	0.5 / 0.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001d	20 / 5.7	16 / 5.1	4.9 / 2.0	0.5 / 0.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.001	25 / 10	23 / 9.4	10 / 3.8	1.7 / 0.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.013a	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.0 / 0.0	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.0 / 0.0	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 31	0.0 / 31	0.0 / 31	0.0 / 30	0.0 / 25	0.0 / 0.7	0.0 / 0.0
D2031.022b	0.0 / 5.2	0.0 / 5.2	0.0 / 5.2	0.0 / 5.1	0.0 / 4.8	0.0 / 0.1	0.0 / 0.0
D3032.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011b	4.6 / 5.1	2.2 / 5.1	0.0 / 5.1	0.0 / 5.0	0.0 / 4.9	0.0 / 0.1	0.0 / 0.0
D3041.012b	4.5 / 5.2	2.1 / 5.2	0.1 / 5.2	0.0 / 5.1	0.0 / 4.8	0.0 / 0.2	0.0 / 0.0
D3041.032b	13 / 15	13 / 15	9.2 / 15	4.4 / 15	3.2 / 13	0.1 / 0.6	0.0 / 0.0
D3041.101a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.022a	6.1 / 6.1	6.1 / 6.1	6.1 / 6.1	6.0 / 6.0	5.4 / 5.4	0.2 / 0.2	0.0 / 0.0

4.2 10% in 50 years Intensity

4.2.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

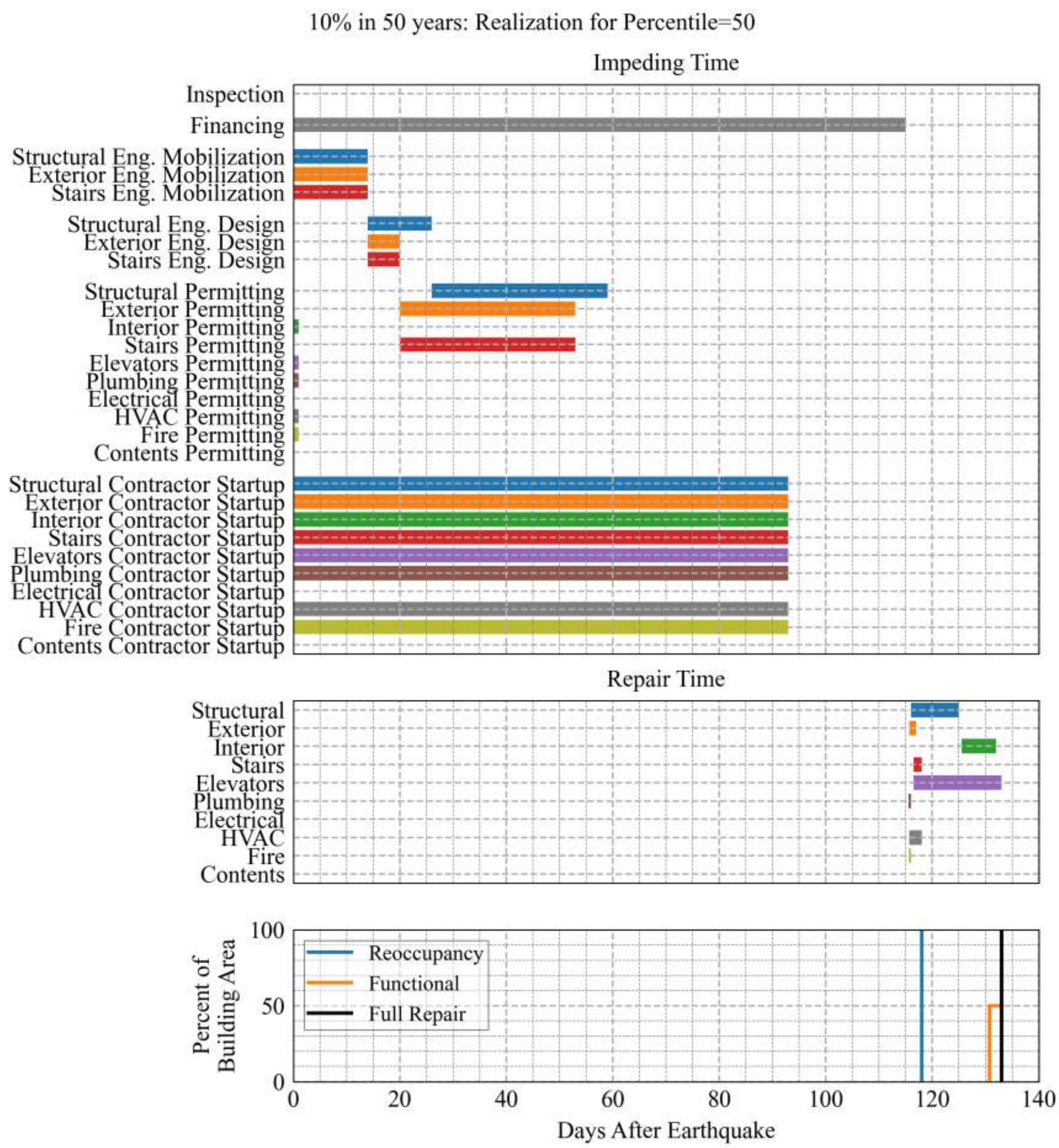

Figure 4.5. 10% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

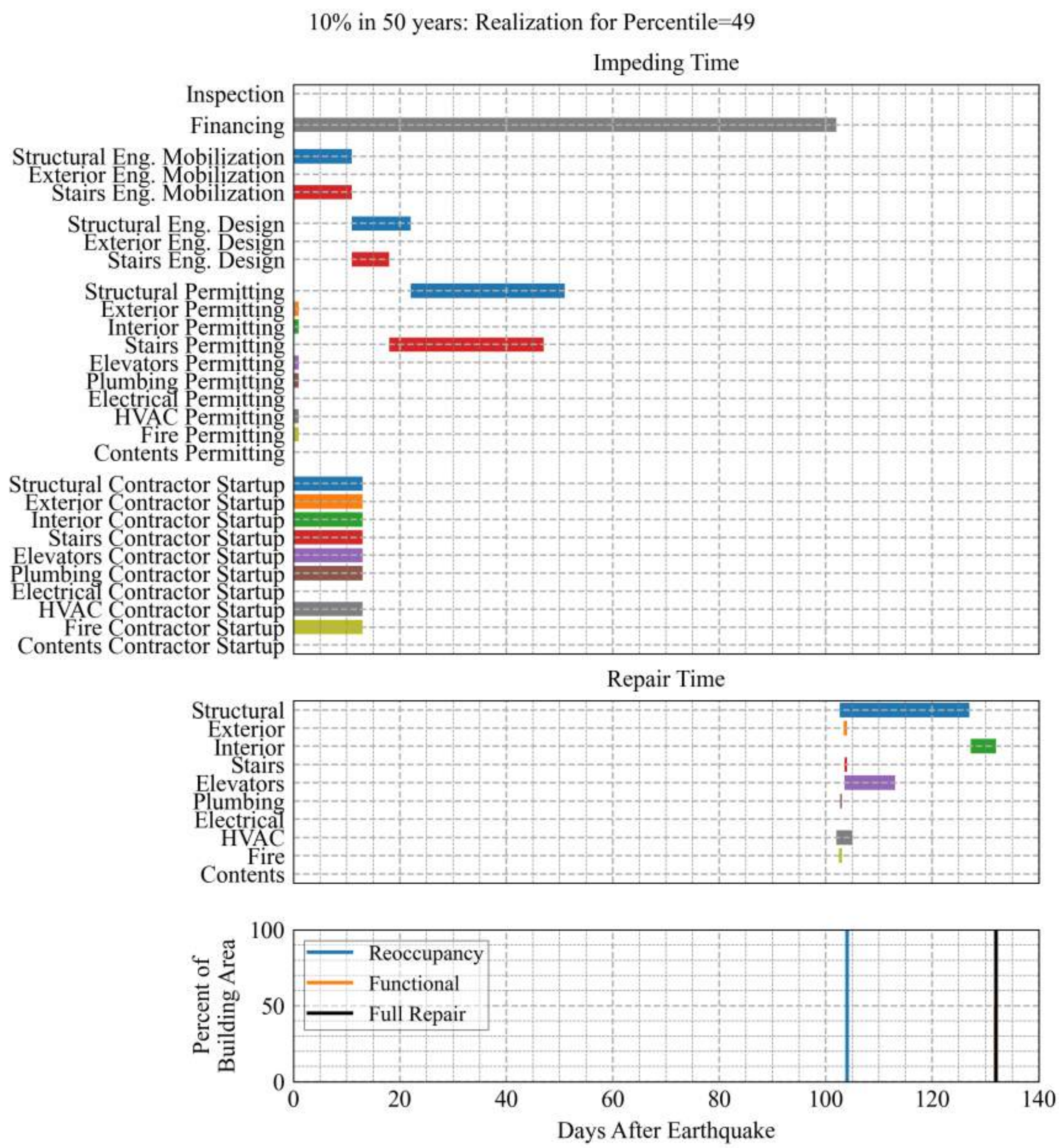

Figure 4.6. 10% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

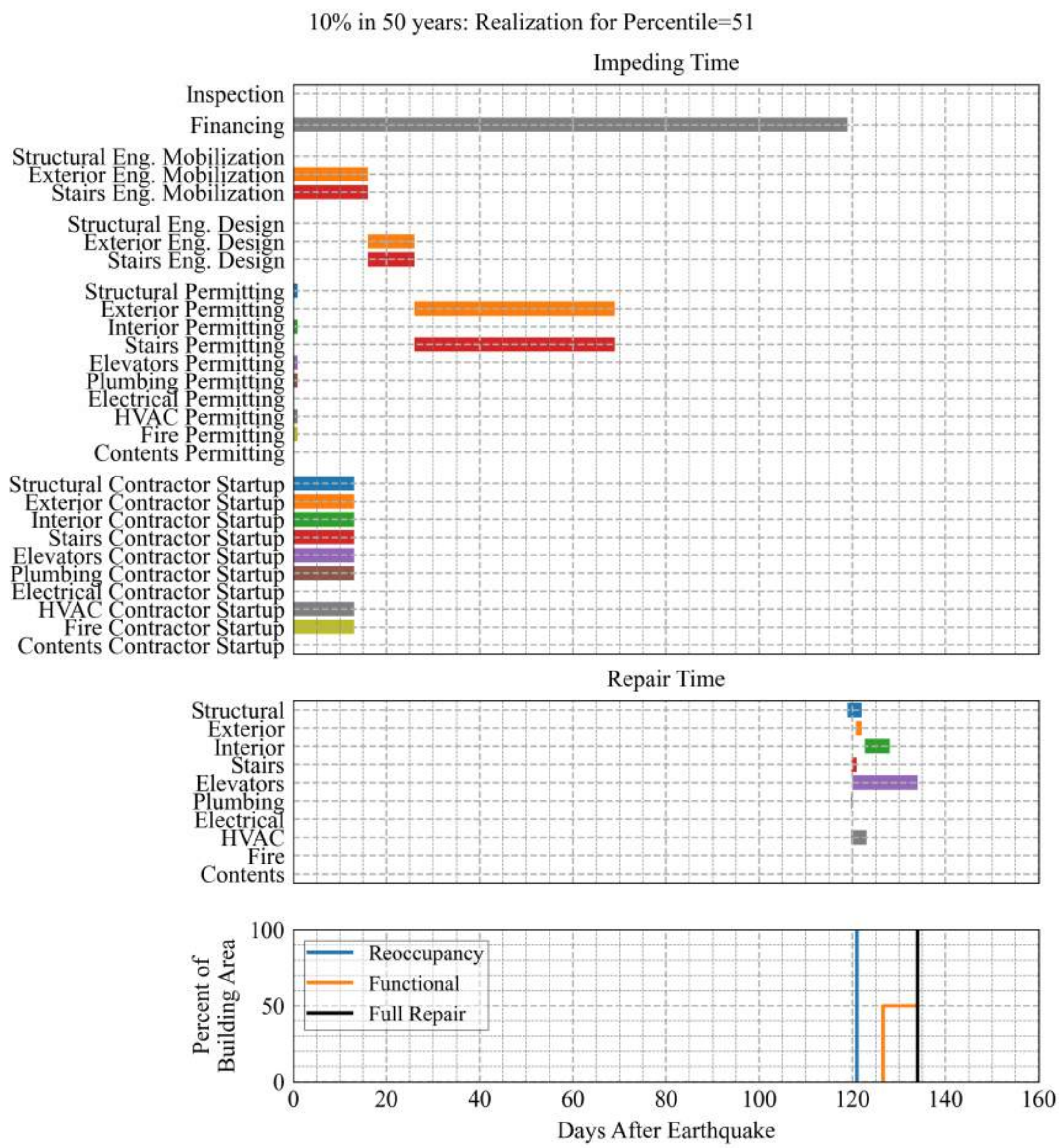

Figure 4.7. 10% in 50 years Percentile = 51

4.2.2 Selected Realizations for 90th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (10% in 50 years Percentile = 90) resulted in global failure, no scheduling was computed.

4.2.3 Damage to Building Systems

Table 4.3 shows the percentage of realizations that the named system prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.3. Percent of realizations affecting building reoccupancy/function per system - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	26	26	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	26	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	83	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	83	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	70	70	70	70	70	2.8	0.0
Stairway Doors	70	25	25	25	24	0.6	0.0
Exterior	51	50	33	8.3	0.0	0.0	0.0
Interior	66	65	53	38	34	0.8	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	71	67	45	35	33	1.0	0.0
Water	64	64	64	64	62	1.3	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	59	59	59	59	59	5.0	0.0

4.2.4 Damage to Individual Components

Table 4.4 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.4. Percent of realizations affecting building reoccupancy/functionality per component - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 16	0.0 / 15	0.0 / 9.6	0.0 / 6.4	0.0 / 5.7	0.0 / 0.4	0.0 / 0.0
B1071.002	39 / 39	36 / 34	17 / 8.7	3.6 / 1.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	51 / 59	47 / 52	25 / 14	5.1 / 1.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 68	0.0 / 62	0.0 / 23	0.0 / 2.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 69	0.0 / 63	0.0 / 24	0.0 / 3.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	68 / 0.0	68 / 0.0	68 / 0.0	68 / 0.0	68 / 0.0	2.8 / 0.0	0.0 / 0.0
C3032.001a	49 / 38	43 / 33	19 / 13	3.4 / 2.9	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001b	52 / 41	46 / 35	21 / 15	3.8 / 3.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001c	60 / 48	54 / 42	24 / 17	3.6 / 3.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001d	63 / 53	57 / 45	27 / 18	4.7 / 3.9	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.001	66 / 69	62 / 62	31 / 21	5.6 / 3.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.013a	9.6 / 9.6	9.6 / 9.6	9.6 / 9.6	9.6 / 9.6	9.4 / 9.4	0.2 / 0.2	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	10 / 10	10 / 10	10 / 10	10 / 10	10.0 / 10.0	0.3 / 0.3	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 62	0.0 / 62	0.0 / 62	0.0 / 62	0.0 / 60	0.0 / 1.2	0.0 / 0.0
D2031.022b	0.0 / 33	0.0 / 33	0.0 / 33	0.0 / 33	0.0 / 32	0.0 / 0.8	0.0 / 0.0
D3032.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011b	33 / 33	16 / 33	1.6 / 33	0.0 / 33	0.0 / 33	0.0 / 3.2	0.0 / 0.0
D3041.012b	33 / 33	16 / 33	1.8 / 33	0.0 / 33	0.0 / 33	0.0 / 0.6	0.0 / 0.0
D3041.032b	53 / 54	52 / 54	46 / 54	32 / 54	28 / 54	0.7 / 4.8	0.0 / 0.0
D3041.101a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.022a	32 / 32	32 / 32	32 / 32	32 / 32	31 / 31	0.7 / 0.7	0.0 / 0.0

4.3 DE Intensity

4.3.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

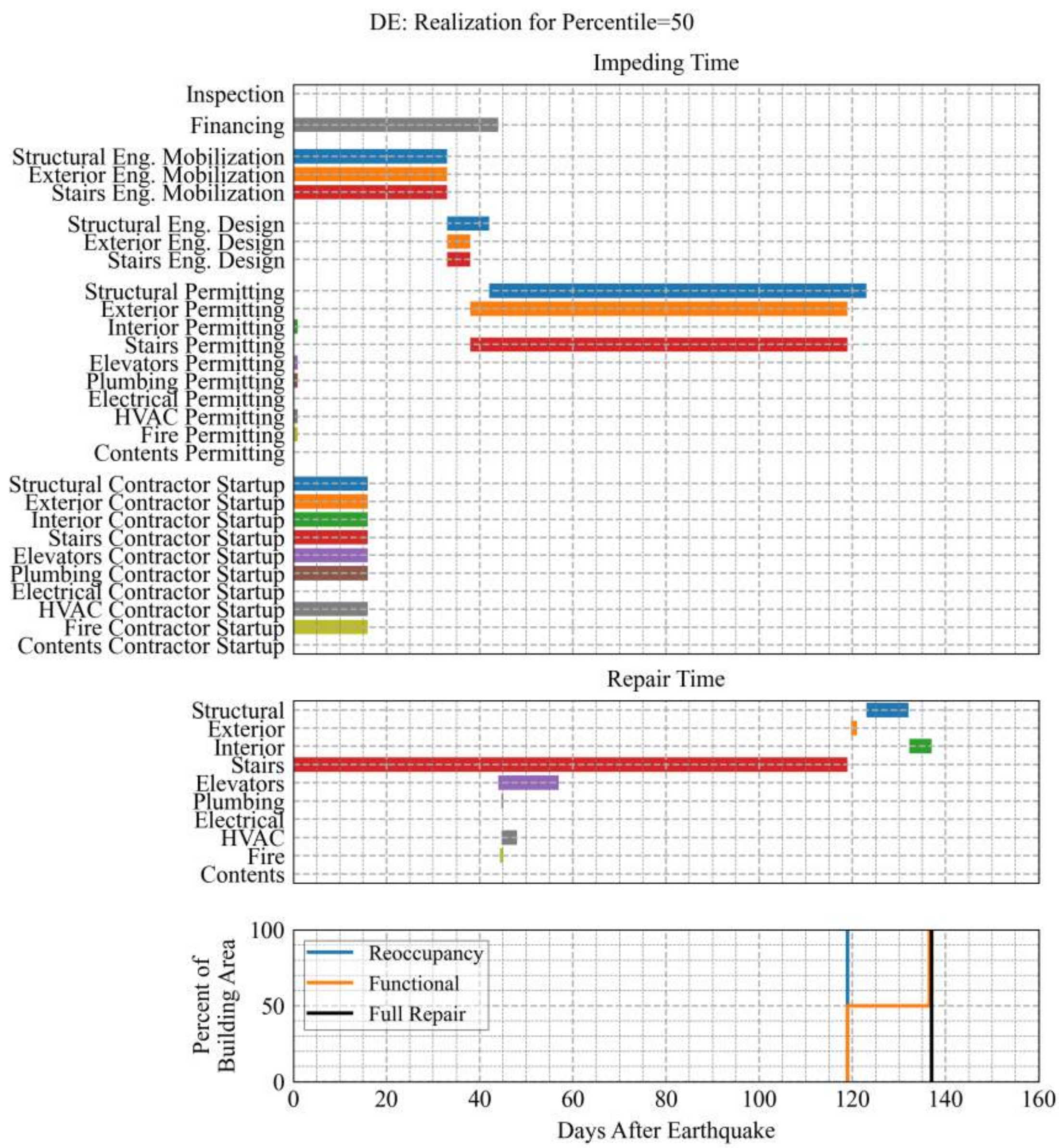

Figure 4.8. DE Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

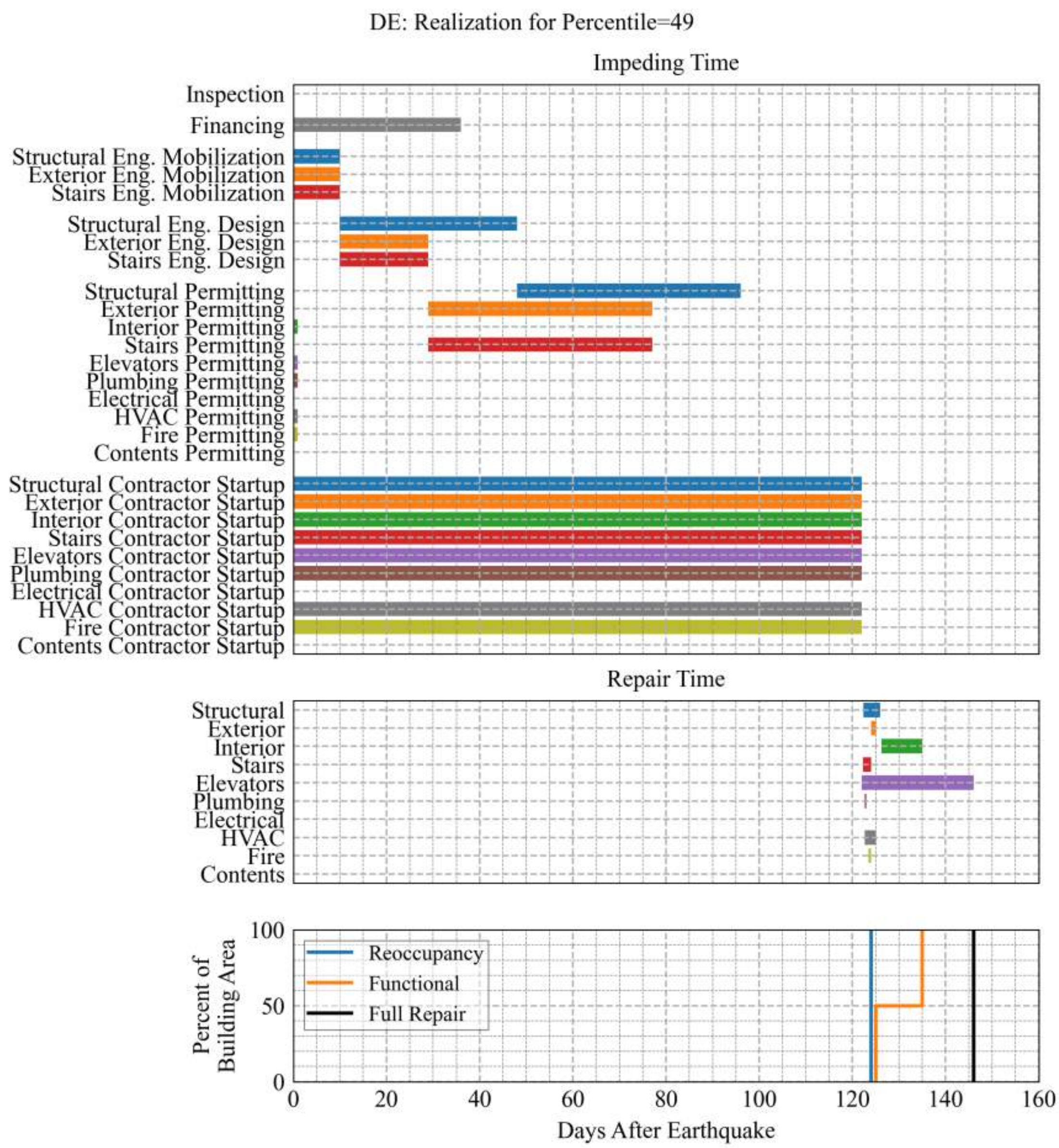

Figure 4.9. DE Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

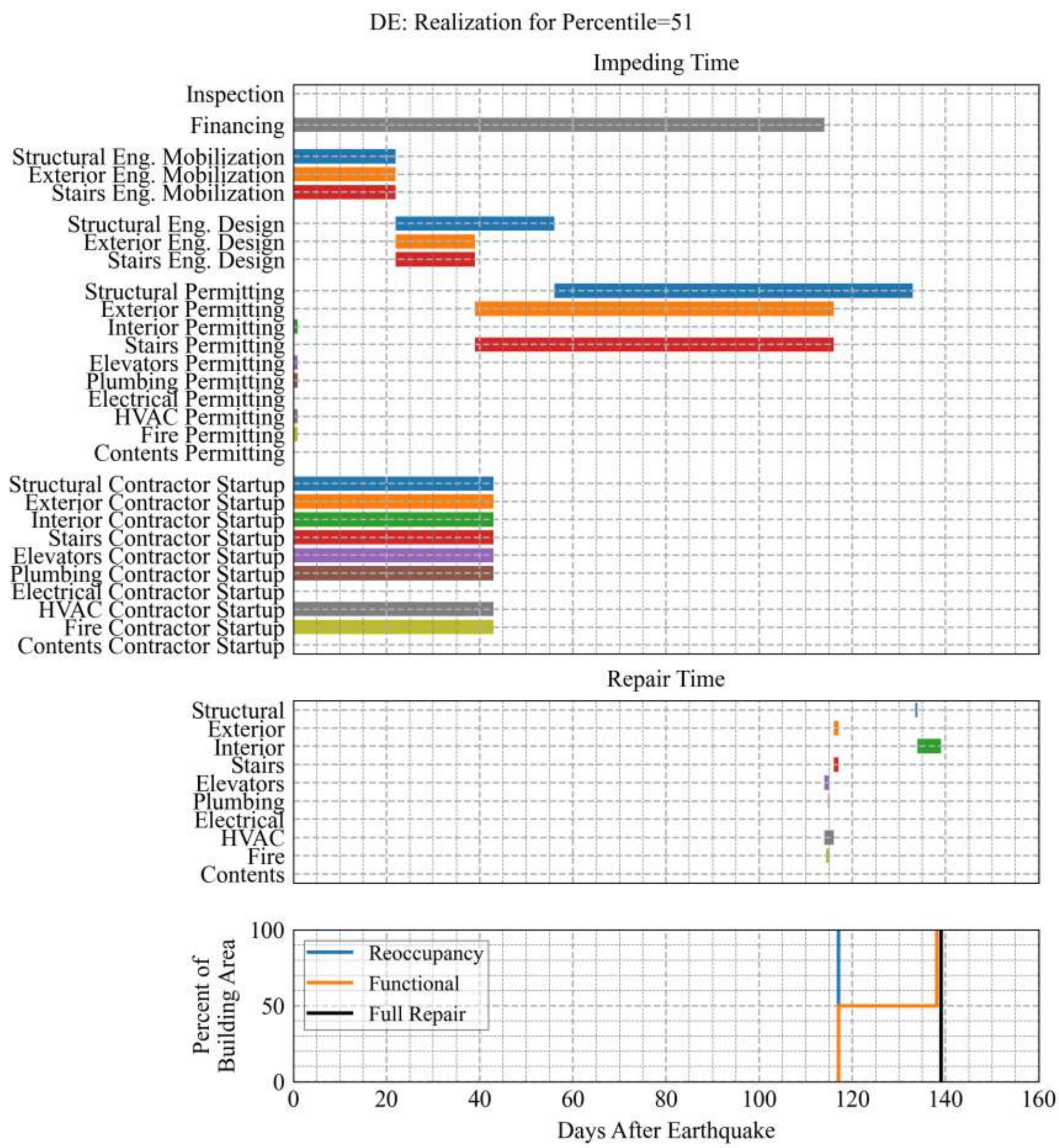

Figure 4.10. DE Percentile = 51

4.3.2 Selected Realizations for 90^{th} percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (DE Percentile = 90) resulted in global failure, no scheduling was computed.

4.3.3 Damage to Building Systems

Table 4.5 shows the percentage of realizations that the named system prevents reoccupancy/function for the DE intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.5. Percent of realizations affecting building reoccupancy/function per system - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	28	28	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	27	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	83	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	83	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	67	67	67	67	67	3.3	0.0
Stairway Doors	68	27	27	27	26	0.8	0.0
Exterior	49	48	32	7.2	0.0	0.0	0.0
Interior	64	63	53	39	35	1.1	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	69	65	46	36	35	1.2	0.0
Water	62	62	62	62	60	1.6	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	57	57	57	57	57	5.0	0.0

4.3.4 Damage to Individual Components

Table 4.6 shows the percentage of realizations that a specific component prevents reoccupancy/function for the DE intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.6. Percent of realizations affecting building reoccupancy/functionality per component - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 15	0.0 / 15	0.0 / 10	0.0 / 6.2	0.0 / 5.5	0.0 / 0.4	0.0 / 0.0
B1071.002	37 / 37	35 / 33	17 / 9.4	3.0 / 1.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	49 / 57	46 / 50	24 / 15	4.8 / 2.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 65	0.0 / 60	0.0 / 24	0.0 / 3.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 66	0.0 / 60	0.0 / 25	0.0 / 3.6	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	64 / 0.0	64 / 0.0	64 / 0.0	64 / 0.0	64 / 0.0	3.2 / 0.0	0.0 / 0.0
C3032.001a	49 / 39	43 / 34	20 / 15	2.9 / 2.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001b	53 / 42	47 / 36	23 / 17	3.9 / 3.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001c	59 / 48	53 / 41	24 / 17	3.8 / 3.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001d	61 / 53	54 / 44	24 / 18	3.4 / 3.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.001	64 / 67	59 / 59	31 / 24	6.8 / 4.6	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.013a	8.7 / 8.7	8.7 / 8.7	8.7 / 8.7	8.7 / 8.7	8.4 / 8.4	0.2 / 0.2	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	9.5 / 9.5	9.5 / 9.5	9.5 / 9.5	9.5 / 9.5	9.2 / 9.2	0.1 / 0.1	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 60	0.0 / 60	0.0 / 60	0.0 / 60	0.0 / 58	0.0 / 1.6	0.0 / 0.0
D2031.022b	0.0 / 32	0.0 / 32	0.0 / 32	0.0 / 32	0.0 / 31	0.0 / 0.8	0.0 / 0.0
D3032.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011b	32 / 33	17 / 33	1.8 / 33	0.0 / 33	0.0 / 33	0.0 / 3.1	0.0 / 0.0
D3041.012b	32 / 32	15 / 32	1.9 / 32	0.0 / 32	0.0 / 32	0.0 / 0.6	0.0 / 0.0
D3041.032b	53 / 54	52 / 54	46 / 54	33 / 54	29 / 54	0.8 / 4.8	0.0 / 0.0
D3041.101a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.022a	34 / 34	34 / 34	34 / 34	34 / 34	33 / 33	1.1 / 1.1	0.0 / 0.0

4.4 MCE$_R$ Intensity

4.4.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE$_R$ Percentile = 50) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE_R Percentile = 49) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE_R Percentile = 51) resulted in global failure, no scheduling was computed.

4.4.2 Selected Realizations for 90th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE_R Percentile = 90) resulted in global failure, no scheduling was computed.

4.4.3 Damage to Building Systems

Table 4.7 shows the percentage of realizations that the named system prevents reoccupancy/function for the MCE_R intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.7. Percent of realizations affecting building reoccupancy/function per system - MCE_R

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	92	92	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	97	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	97	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	7.2	7.2	7.2	7.2	7.2	0.3	0.0
Stairway Doors	7.4	2.7	2.7	2.7	2.6	0.0	0.0
Exterior	6.1	6.0	3.6	1.0	0.0	0.0	0.0
Interior	6.6	6.5	5.4	4.0	3.5	0.0	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	7.4	7.1	4.8	3.6	3.3	0.0	0.0
Water	6.4	6.4	6.4	6.4	6.2	0.1	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	5.9	5.9	5.9	5.9	5.9	0.4	0.0

4.4.4 Damage to Individual Components

Table 4.8 shows the percentage of realizations that a specific component prevents reoccupancy/function for the MCE$_R$ intensity. Note that if a component prevents reoccupancy, it will also prevent functionality. Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.8. Percent of realizations affecting building reoccupancy/functionality per component - MCE$_R$

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 1.6	0.0 / 1.6	0.0 / 1.0	0.0 / 0.7	0.0 / 0.7	0.0 / 0.0	0.0 / 0.0
B1071.002	4.9 / 5.0	4.6 / 4.3	2.2 / 1.2	0.5 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	6.1 / 6.7	5.7 / 5.9	2.6 / 1.4	0.6 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 7.4	0.0 / 6.8	0.0 / 2.3	0.0 / 0.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 7.4	0.0 / 6.7	0.0 / 2.4	0.0 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	7.0 / 0.0	7.0 / 0.0	7.0 / 0.0	7.0 / 0.0	7.0 / 0.0	0.3 / 0.0	0.0 / 0.0
C3032.001a	4.9 / 4.4	4.1 / 3.4	2.1 / 1.4	0.3 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001b	5.4 / 4.7	4.8 / 4.0	2.5 / 2.0	0.5 / 0.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001c	5.9 / 5.3	5.4 / 4.5	2.5 / 1.8	0.4 / 0.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001d	6.3 / 5.8	5.7 / 5.1	2.5 / 1.9	0.5 / 0.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.001	6.6 / 7.2	6.2 / 6.5	3.2 / 2.2	0.5 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.013a	1.1 / 1.1	1.1 / 1.1	1.1 / 1.1	1.1 / 1.1	1.0 / 1.0	0.0 / 0.0	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	1.2 / 1.2	1.2 / 1.2	1.2 / 1.2	1.2 / 1.2	1.2 / 1.2	0.0 / 0.0	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 6.4	0.0 / 6.4	0.0 / 6.4	0.0 / 6.4	0.0 / 6.2	0.0 / 0.1	0.0 / 0.0
D2031.022b	0.0 / 3.2	0.0 / 3.2	0.0 / 3.2	0.0 / 3.2	0.0 / 3.1	0.0 / 0.0	0.0 / 0.0
D3032.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011b	3.4 / 3.4	1.9 / 3.4	0.3 / 3.4	0.0 / 3.4	0.0 / 3.4	0.0 / 0.2	0.0 / 0.0
D3041.012b	3.7 / 3.7	1.7 / 3.7	0.2 / 3.7	0.0 / 3.7	0.0 / 3.6	0.0 / 0.0	0.0 / 0.0
D3041.032b	5.3 / 5.4	5.3 / 5.4	4.6 / 5.4	3.6 / 5.4	3.1 / 5.4	0.0 / 0.4	0.0 / 0.0
D3041.101a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.022a	3.3 / 3.3	3.3 / 3.3	3.3 / 3.3	3.3 / 3.3	3.2 / 3.2	0.0 / 0.0	0.0 / 0.0

4.5 2% in 50 years Intensity

4.5.1 Selected Realizations for 50^{th} percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 50) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 49) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 51) resulted in global failure, no scheduling was computed.

4.5.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 90) resulted in global failure, no scheduling was computed.

4.5.3 Damage to Building Systems

Table 4.9 shows the percentage of realizations that the named system prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.9. Percent of realizations affecting building reoccupancy/function per system - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	99	99	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	99	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	99	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	1.2	1.2	1.2	1.2	1.2	0.0	0.0
Stairway Doors	1.2	0.4	0.4	0.4	0.4	0.0	0.0
Exterior	1.0	0.9	0.6	0.1	0.0	0.0	0.0
Interior	1.1	1.1	0.9	0.6	0.5	0.0	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	1.2	1.1	0.8	0.6	0.5	0.0	0.0
Water	1.0	1.0	1.0	1.0	0.9	0.0	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	0.9	0.9	0.9	0.9	0.9	0.0	0.0

4.5.4 Damage to Individual Components

Table 4.10 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.10. Percent of realizations affecting building reoccupancy/functionality per component - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 0.4	0.0 / 0.4	0.0 / 0.2	0.0 / 0.2	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0
B1071.002	0.6 / 0.6	0.6 / 0.6	0.3 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	1.0 / 1.1	0.8 / 0.9	0.5 / 0.2	0.1 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 1.2	0.0 / 1.0	0.0 / 0.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 1.2	0.0 / 1.0	0.0 / 0.4	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	1.1 / 0.0	1.1 / 0.0	1.1 / 0.0	1.1 / 0.0	1.1 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001a	0.6 / 0.6	0.6 / 0.5	0.3 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001b	0.8 / 0.7	0.6 / 0.5	0.1 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001c	1.0 / 0.8	0.8 / 0.6	0.4 / 0.3	0.1 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.001d	1.0 / 0.9	0.9 / 0.8	0.4 / 0.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.001	1.1 / 1.1	1.0 / 1.0	0.4 / 0.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.022	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.013a	0.2 / 0.2	0.2 / 0.2	0.2 / 0.2	0.2 / 0.2	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	0.1 / 0.1	0.1 / 0.1	0.1 / 0.1	0.1 / 0.1	0.1 / 0.1	0.0 / 0.0	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.022a	0.0 / 1.0	0.0 / 1.0	0.0 / 1.0	0.0 / 1.0	0.0 / 0.9	0.0 / 0.0	0.0 / 0.0
D2031.022b	0.0 / 0.4	0.0 / 0.4	0.0 / 0.4	0.0 / 0.4	0.0 / 0.3	0.0 / 0.0	0.0 / 0.0
D3032.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011b	0.4 / 0.4	0.2 / 0.4	0.0 / 0.4	0.0 / 0.4	0.0 / 0.4	0.0 / 0.0	0.0 / 0.0
D3041.012b	0.4 / 0.4	0.3 / 0.4	0.0 / 0.4	0.0 / 0.4	0.0 / 0.4	0.0 / 0.0	0.0 / 0.0
D3041.032b	0.8 / 0.8	0.8 / 0.8	0.6 / 0.8	0.4 / 0.8	0.4 / 0.8	0.0 / 0.0	0.0 / 0.0
D3041.101a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.022a	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.5 / 0.5	0.4 / 0.4	0.0 / 0.0	0.0 / 0.0

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Detailed Component Report

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	Existing WLF on RC Wall
Building Types:	
Dir. 1: WLF: General	
Dir. 2: RC: Cantilever Shear Wall	
Design Code Year:	1967
Number of Stories:	2
Occupancy:	Commercial Office
Address:	
217 Arlington Avenue	
Kensington, CA, 94707	
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	1,738
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	Extreme
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Ordinary, Ordinary
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	–
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	–
2^{nd} Mode Period (T_2) (s):	–	–

Component Information

Percent of Building Glazed:	–
Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options

Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Interior Finishes

- What kind of partition walls does the building have?
  > *Wood Studs*
- Does the building have raised access floors
  > *No*
- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *No*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *No*

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*
- Are there elevators in the building?
  > *Yes*
  - What type of elevators are in the building?
    > *Hydraulic*
    - From which era are the building's elevators?
      > *Pre-1976 California (or pre-1976 California equivalent)*

Fire Supression

- Does the building contain a fire sprinkler system?
  > *Yes*
  - Does the fire sprinkler system have braced horizontal piping?
    > *No*
  - Are the fire sprinkler drops OSHPD certified (or equivalent)?
    > *No*
    - What type of ceiling do the fire drops enter into?
      > *Hard*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *No*
- Is the building's sanitary piping OSHPD certified or equivalent?
  > *No*
  - What type of couplings do the pipes have?
    > *Bell and spigot*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *No*
  - How is the cooling/heating system configured?
    > *Roof Top Units*
    - Are the RTUs used for medical purposes (or equivalent)?
      > *No*
      - Are the RTUs small or large?
        > *Small*
    - Does the building have a control panel?
      > *Yes*
- Is there an HVAC exhaust system in the building?
  > *Yes*
  - Is the HVAC exhaust system seismically anchored?
    > *No*

Continued on next page

Component Checklist (*Continued*))

- Does the HVAC distribution system meet OSHPD standards (or similar)?
  > *No*
  - Is there any large diameter ducting (6 SqFt+) in the HVAC system?
    > *Yes*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Concrete

- Are the building's shear walls low rise or slender?
  > *Low Rise (typically <= 40ft building height)*
  - What are the boundary conditions of the walls?
    > *No return flanges or boundary columns*
    - What is the typical wall thickness?
      > *8" to 16"*
      - What is the typical wall height?
        > *Less than 15'*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	7.4	15
10% in 50 years	475 Years	49	80
DE	481 Years	50	82
5% in 50 years	975 Years	89	100
MCE_R	1277 Years	95	100
2% in 50 years	2475 Years	99	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	2.6 weeks	3.7 weeks	0 days	4 days	2.2 months
10% in 50 years	4 months	5.3 months	3.9 months	4.4 months	4.5 months
DE	4.1 months	5.4 months	4.1 months	4.6 months	4.7 months
5% in 50 years	11 months	11 months	11 months	11 months	11 months
MCE_R	11 months	11 months	11 months	11 months	11 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 MOST DAMAGED COMPONENTS

Table 2.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1044.011	1	$3,323
10% in 50 years	B1044.011	1	$33,175
DE	B1044.011	1	$32,640
5% in 50 years	B1044.011	1	$7,722
MCE_R	B1044.011	1	$3,514
2% in 50 years	B1044.011	1	$685

Table 2.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	D1014.022	1	$14,674
10% in 50 years	D1014.022	1	$20,630
DE	D1014.022	1	$20,309
5% in 50 years	D1014.022	1	$5,065
MCE_R	D1014.022	1	$2,087
2% in 50 years	D1014.022	1	$308

Details of the most damaged components and their damage states:

- **B1044.011**: Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’
  - DS1: Cracks with maximum widths greater than 0.04 in but less than 0.12 in.
- **D1014.022**: Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.
  - DS1a: Damaged controls.
  - DS1b: Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.
  - DS1c: Damaged entrance and car door, and or flooring damage.
  - DS1d: Oil leak in hydraulic line, and or hydraulic tank failure.

3 DETAILED COMPONENT DAMAGE BREAKDOWNS

3.1 Repair Cost

This table shows the expected contribution to repair cost on a per-damage state basis. The header shows the total loss, the loss contribution from collapse, and the loss contribution from residual drift for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.1.1. Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**45.3k**	**299k**	**307k**	**543k**	**579k**	**606k**
Collapse	0	61.3k	62.6k	149k	191k	290k
Residual	0	95.5k	106k	359k	373k	313k
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	2.75k	16.5k	16k	3.83k	1.75k	267
DS2	136	3.27k	3.32k	823	329	108
DS3	432	13.4k	13.3k	3.07k	1.43k	310
Total	**3.32k**	**33.2k**	**32.6k**	**7.72k**	**3.51k**	**685**
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	810	2.1k	2.01k	438	194	43.9
DS2	60.5	1.79k	1.71k	436	166	30.9
DS3	43.6	8.1k	7.69k	2.19k	1.04k	117
Total	**914**	**12k**	**11.4k**	**3.06k**	**1.4k**	**192**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	202	273	268	63.5	30.6	5.66
DS2	103	397	359	83.8	33.7	5.49
DS3	181	3.52k	3.48k	889	407	59.1
Total	**486**	**4.19k**	**4.11k**	**1.04k**	**471**	**70.2**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	2.14k	2.42k	2.37k	554	244	34
DS2	812	1.95k	2.01k	509	191	48.3
DS3	1.72k	10.7k	10.2k	2.7k	1.33k	170
Total	**4.68k**	**15k**	**14.6k**	**3.76k**	**1.77k**	**252**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.69k	2.05k	2.03k	431	207	34.7
DS2	510	1.72k	1.61k	460	202	47.1
DS3	938	6.12k	5.9k	1.52k	707	95.6
Total	**3.13k**	**9.89k**	**9.53k**	**2.42k**	**1.12k**	**177**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	313	235	262	55	26.5	4.86
DS2	356	708	633	141	54.8	7.02
DS3	224	4.02k	3.87k	1.01k	464	74.9
Total	**893**	**4.96k**	**4.76k**	**1.21k**	**546**	**86.8**
C3032.001a #1 (C3032.001a: Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only)						
DS1	77.1	136	141	29.4	11.6	1.84
DS2	138	501	521	141	64.8	8.95
DS3	518	4.5k	4.34k	1.06k	463	58.6
Total	**733**	**5.14k**	**5k**	**1.23k**	**539**	**69.4**

Continued on next page

Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**45.3k**	**299k**	**307k**	**543k**	**579k**	**606k**
Collapse	0	61.3k	62.6k	149k	191k	290k
Residual	0	95.5k	106k	359k	373k	313k
C3032.001b #1 (C3032.001b: Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only)						
DS1	123	157	150	35.2	15.8	3.15
DS2	214	507	532	122	58.7	10.7
DS3	685	5.18k	5.13k	1.29k	528	70.6
Total	**1.02k**	**5.84k**	**5.81k**	**1.45k**	**603**	**84.5**
C3032.001c #1 (C3032.001c: Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only)						
DS1	275	167	165	33.1	19.6	2.75
DS2	311	640	634	119	56.5	13.3
DS3	1.17k	6.34k	6.32k	1.58k	655	78.2
Total	**1.76k**	**7.14k**	**7.12k**	**1.73k**	**732**	**94.2**
C3032.001d #1 (C3032.001d: Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only)						
DS1	371	151	149	31.6	16.4	1.95
DS2	487	668	635	156	64.5	8.72
DS3	1.49k	7.15k	6.95k	1.66k	758	111
Total	**2.35k**	**7.97k**	**7.74k**	**1.84k**	**839**	**122**
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**2.87k**	**3.81k**	**3.7k**	**938**	**350**	**64.7**
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	323	479	498	101	49	14.8
DS1b	5.7k	8.1k	7.86k	1.9k	837	117
DS1c	7.44k	10.3k	10.3k	2.64k	1.04k	135
DS1d	1.21k	1.75k	1.65k	419	158	41.1
Total	**14.7k**	**20.6k**	**20.3k**	**5.07k**	**2.09k**	**308**
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	2.56	15.8	15.3	3.95	1.65	0.13
DS2	2.45	48.4	42.7	16.8	5.35	1.1
Total	**5.01**	**64.2**	**58**	**20.7**	**7**	**1.23**
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**11.8**	**49**	**51.4**	**12.6**	**5.17**	**0.62**
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	2.17	11.6	12.4	3.26	1.33	0.22
DS2	2.12	41.6	38.9	11.2	5.2	0.46
Total	**4.29**	**53.2**	**51.2**	**14.5**	**6.53**	**0.68**
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	4.82	12.8	11.6	3.3	1.47	0.2
DS2	2.32	16.6	16.6	4	2.02	0.29
Total	**7.14**	**29.4**	**28.2**	**7.31**	**3.49**	**0.49**
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**171**	**449**	**433**	**111**	**45.7**	**7.34**
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	16.8	28.9	29.6	6.39	2.94	0.58
DS2	32.3	256	238	63.4	24.2	2.94
Total	**49.1**	**285**	**268**	**69.8**	**27.2**	**3.52**

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Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**45.3k**	**299k**	**307k**	**543k**	**579k**	**606k**
Collapse	0	61.3k	62.6k	149k	191k	290k
Residual	0	95.5k	106k	359k	373k	313k
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	544	424	431	88.8	48.9	8.4
DS1b	1.91k	1.55k	1.44k	372	138	20.4
Total	**2.46k**	**1.98k**	**1.87k**	**460**	**187**	**28.8**
D3041.011b #1 (D3041.011b: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	8.88	22.2	23.6	5.17	2.05	0.27
DS2	34.3	281	264	73	30.1	3.76
Total	**43.2**	**303**	**288**	**78.1**	**32.2**	**4.03**
D3041.012b #1 (D3041.012b: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	3.26	8.91	8.56	2.09	0.76	0.13
DS2	11.5	91.7	89	22.8	10.2	1.17
Total	**14.8**	**101**	**97.6**	**24.9**	**11**	**1.3**
D3041.032b #1 (D3041.032b: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**761**	**3.5k**	**3.44k**	**869**	**362**	**52.9**
D3041.101a #1 (D3041.101a: HVAC Fan - Capacity: all - Unanchored equipment that is not vibration...)						
DS1	**4.88k**	**5.6k**	**5.42k**	**1.28k**	**571**	**88.5**
D4011.022a #1 (D4011.022a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	29.1	62.2	57	15.1	6.11	1.48
DS2	46.3	288	294	71.6	31.2	4.07
Total	**75.5**	**350**	**351**	**86.8**	**37.3**	**5.55**

3.2 Repair time

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.2.1. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	1.5	9.0	8.8	2.1	0.9	0.2
DS2	0.1	1.8	1.9	0.5	0.2	0.1
DS3	0.2	7.6	7.6	1.6	0.8	0.1
Total	**1.8**	**18**	**18**	**4.3**	**1.9**	**0.3**
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	0.6	1.5	1.4	0.3	0.1	0.0
DS2	0.0	1.2	1.2	0.3	0.1	0.0
DS3	0.0	5.6	5.4	1.6	0.7	0.1
Total	**0.6**	**8.3**	**8.1**	**2.2**	**1.0**	**0.1**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	0.4	0.6	0.6	0.1	0.1	0.0
DS2	0.1	0.5	0.4	0.1	0.0	0.0
DS3	0.2	3.3	3.2	0.8	0.4	0.1
Total	**0.7**	**4.4**	**4.3**	**1.1**	**0.5**	**0.1**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.2	1.4	1.3	0.3	0.1	0.0
DS2	0.4	1.1	1.1	0.3	0.1	0.0
DS3	1.0	5.9	5.7	1.5	0.8	0.1
Total	**2.6**	**8.4**	**8.2**	**2.1**	**1.0**	**0.1**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.0	1.2	1.1	0.3	0.1	0.0
DS2	0.3	0.9	0.9	0.2	0.1	0.0
DS3	0.5	3.5	3.3	0.9	0.4	0.1
Total	**1.8**	**5.5**	**5.4**	**1.4**	**0.6**	**0.1**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.3	0.2	0.2	0.0	0.0	0.0
DS2	0.3	0.6	0.5	0.1	0.1	0.0
DS3	0.2	3.2	3.1	0.8	0.4	0.1
Total	**0.7**	**3.9**	**3.8**	**0.9**	**0.4**	**0.1**
C3032.001a #1 (C3032.001a: Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only)						
DS1	0.1	0.1	0.1	0.0	0.0	0.0
DS2	0.1	0.4	0.4	0.1	0.0	0.0
DS3	0.3	3.0	3.0	0.8	0.3	0.0
Total	**0.5**	**3.5**	**3.5**	**0.9**	**0.4**	**0.1**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
C3032.001b #1 (C3032.001b: Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only)						
DS1	0.1	0.1	0.1	0.0	0.0	0.0
DS2	0.1	0.3	0.3	0.1	0.0	0.0
DS3	0.4	3.4	3.3	0.8	0.3	0.1
Total	**0.7**	**3.8**	**3.8**	**0.9**	**0.4**	**0.1**
C3032.001c #1 (C3032.001c: Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only)						
DS1	0.2	0.1	0.1	0.0	0.0	0.0
DS2	0.2	0.4	0.4	0.1	0.0	0.0
DS3	0.8	4.0	4.1	1.0	0.4	0.1
Total	**1.1**	**4.5**	**4.6**	**1.1**	**0.5**	**0.1**
C3032.001d #1 (C3032.001d: Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only)						
DS1	0.2	0.1	0.1	0.0	0.0	0.0
DS2	0.3	0.4	0.4	0.1	0.0	0.0
DS3	0.9	4.4	4.2	1.0	0.5	0.1
Total	**1.5**	**4.9**	**4.7**	**1.1**	**0.5**	**0.1**
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**2.0**	**2.8**	**2.7**	**0.6**	**0.3**	**0.0**
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	0.2	0.4	0.3	0.1	0.0	0.0
DS1b	4.2	5.7	5.8	1.4	0.6	0.1
DS1c	5.5	7.4	7.6	1.9	0.7	0.1
DS1d	0.9	1.3	1.2	0.3	0.1	0.0
Total	**11**	**15**	**15**	**3.6**	**1.5**	**0.3**
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**0.1**	**0.3**	**0.3**	**0.1**	**0.0**	**0.0**
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.2	0.2	0.0	0.0	0.0
Total	**0.0**	**0.2**	**0.2**	**0.0**	**0.0**	**0.0**
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	0.5	0.4	0.4	0.1	0.0	0.0
DS1b	0.3	0.2	0.2	0.1	0.0	0.0
Total	**0.8**	**0.6**	**0.6**	**0.1**	**0.1**	**0.0**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
D3041.011b #1 (D3041.011b: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**
D3041.012b #1 (D3041.012b: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D3041.032b #1 (D3041.032b: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.6**	**3.0**	**2.9**	**0.7**	**0.3**	**0.0**
D3041.101a #1 (D3041.101a: HVAC Fan - Capacity: all - Unanchored equipment that is not vibration...)						
DS1	**4.2**	**4.7**	**4.6**	**1.1**	**0.5**	**0.1**
D4011.022a #1 (D4011.022a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**

3.3 Casualties

Table 3.3.1 shows the total expected casualty results broken into collapse and non-collapse sources. The non-parenthetical values are casualties in terms of number of people and the parenthetical values show the probability of casualty for an individual person placed randomly in the building.

Table 3.3.2 shows the casualty breakdown on a per component basis. The values in this table are in terms of number of people, not probabilities.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.3.1. Total expected casualties (Number of People (%))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Total Non-Collapse Casualties						
Injury	0.0548 (3.23)	0.158 (9.31)	0.157 (9.24)	0.149 (8.76)	0.139 (8.16)	0.116 (6.85)
Death	0.000431 (0.025)	0.000748 (0.044)	0.000742 (0.044)	0.000642 (0.038)	0.000586 (0.035)	0.000485 (0.029)
Total Collapse Casualties						
Injury	0.00 (0.00)	0.0555 (3.27)	0.0567 (3.34)	0.135 (7.96)	0.173 (10.2)	0.263 (15.5)
Death	0.00 (0.00)	0.000561 (0.033)	0.000573 (0.034)	0.00136 (0.080)	0.00175 (0.103)	0.00266 (0.157)
Total Collapse and Non-Collapse Casualties						
Injury	0.0548 (3.23)	0.198 (11.7)	0.197 (11.6)	0.247 (14.6)	0.268 (15.8)	0.324 (19.1)
Death	0.000431 (0.025)	0.00123 (0.073)	0.00124 (0.073)	0.00185 (0.109)	0.00215 (0.127)	0.00291 (0.171)

Table 3.3.2. Expected casualties per component (Number of People)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
C3032.001a #1 (C3032.001a: Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only)						
Injury	0.00148	0.0168	0.0164	0.0169	0.0167	0.0147
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.001b #1 (C3032.001b: Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only)						
Injury	0.00173	0.0203	0.0204	0.0199	0.0190	0.0190
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.001c #1 (C3032.001c: Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only)						
Injury	0.00284	0.0220	0.0212	0.0215	0.0204	0.0169
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.001d #1 (C3032.001d: Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only)						
Injury	0.00440	0.0242	0.0245	0.0248	0.0226	0.0194
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
Injury	0.0443	0.0742	0.0738	0.0651	0.0594	0.0458
Death	0.000431	0.000748	0.000742	0.000642	0.000586	0.000485

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Table 3.3.2 (*Continued*). Expected casualties per component (Number of People)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
D3041.011b #1 (D3041.011b: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
Injury	0.000003	0.000032	0.000028	0.000032	0.000033	0.000027
Death	0.00	0.00	0.00	0.00	0.00	0.00
D3041.012b #1 (D3041.012b: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
Injury	0.000005	0.000053	0.000053	0.000054	0.000055	0.000051
Death	0.00	0.00	0.00	0.00	0.00	0.00
D3041.032b #1 (D3041.032b: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
Injury	0.000073	0.000445	0.000438	0.000425	0.000397	0.000334
Death	0.00	0.00	0.00	0.00	0.00	0.00

3.4 Quantity Damaged

This table shows the expected percentage of the components that are in a given damage state (normalized to the total quantity of that component in the entire building). The small parenthetical value is the probability that any component throughout the building is in that damage state (the percentage of realizations that have a component in that damage state).

All of these values are conditioned on no global failure. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.4.1. Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	3.9 (13)	36 (76)	36 (76)	38 (78)	36 (77)	35 (86)
DS2	0.1 (0.5)	3.3 (15)	3.4 (16)	3.7 (16)	3.1 (16)	6.1 (26)
DS3	0.2 (0.7)	7.1 (23)	7.3 (23)	7.1 (21)	7.5 (22)	10 (30)
Total	**4.2** (13)	**46** (78)	**47** (78)	**48** (80)	**47** (79)	**52** (89)
B1071.002 #1 (B1071.002: Light framed wood walls with structural panel sheathing, gypsum wallboard...)						
DS1	3.0 (19)	11 (59)	11 (58)	11 (57)	9.9 (54)	15 (69)
DS2	0.2 (1.2)	7.5 (43)	7.5 (42)	8.5 (47)	7.2 (41)	8.4 (46)
DS3	0.1 (0.3)	14 (53)	14 (52)	17 (65)	17 (65)	12 (53)
Total	**3.3** (19)	**32** (96)	**32** (95)	**36** (99)	**35** (98)	**35** (99)
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	5.5 (33)	11 (65)	12 (66)	13 (69)	14 (67)	17 (82)
DS2	1.3 (9.6)	7.5 (50)	6.9 (46)	7.3 (48)	6.6 (43)	7.3 (49)
DS3	0.7 (5.2)	22 (82)	22 (82)	25 (89)	26 (89)	23 (92)
Total	**7.5** (37)	**41** (99)	**40** (99)	**45** (100)	**46** (100)	**47** (99)
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	27 (79)	42 (89)	43 (88)	44 (90)	43 (93)	40 (89)
DS2	4.6 (25)	16 (52)	17 (53)	18 (57)	16 (49)	26 (63)
DS3	3.1 (17)	26 (94)	26 (94)	30 (98)	32 (98)	26 (95)
Total	**35** (97)	**85** (100)	**86** (100)	**92** (100)	**92** (100)	**93** (99)
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	29 (77)	48 (88)	48 (89)	47 (88)	49 (88)	48 (92)
DS2	3.4 (25)	16 (52)	16 (52)	20 (58)	19 (57)	23 (66)
DS3	1.9 (17)	18 (95)	18 (94)	20 (98)	20 (97)	18 (99)
Total	**34** (97)	**82** (100)	**82** (100)	**88** (100)	**88** (100)	**89** (99)
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	22 (43)	23 (42)	25 (44)	25 (47)	25 (47)	25 (49)
DS2	6.2 (12)	17 (32)	16 (29)	16 (29)	13 (26)	9.9 (20)
DS3	1.4 (2.8)	32 (63)	32 (64)	35 (70)	37 (73)	38 (72)
Total	**30** (57)	**73** (100)	**73** (100)	**75** (100)	**75** (100)	**72** (99)
C3032.001a #1 (C3032.001a: Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only)						
DS1	8.1 (15)	19 (34)	20 (36)	19 (33)	17 (30)	15 (30)
DS2	2.1 (4.1)	9.6 (18)	10 (20)	10 (20)	11 (21)	9.9 (20)
DS3	3.3 (5.9)	40 (56)	40 (57)	43 (57)	41 (54)	35 (43)
Total	**14** (22)	**69** (83)	**71** (86)	**73** (88)	**70** (81)	**59** (76)

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
C3032.001b #1 (C3032.001b: Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only)						
DS1	12 (22)	23 (39)	22 (39)	20 (37)	23 (38)	25 (46)
DS2	2.9 (5.4)	9.4 (18)	9.7 (18)	8.5 (16)	9.4 (18)	12 (23)
DS3	4.4 (7.8)	45 (62)	47 (64)	51 (70)	46 (63)	39 (53)
Total	**20** (31)	**78** (90)	**79** (91)	**80** (92)	**79** (88)	**76** (86)
C3032.001c #1 (C3032.001c: Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only)						
DS1	29 (48)	24 (39)	24 (40)	21 (34)	26 (41)	26 (49)
DS2	4.5 (8.6)	12 (22)	12 (22)	11 (21)	11 (21)	20 (36)
DS3	7.6 (13)	56 (74)	58 (75)	61 (77)	57 (72)	44 (59)
Total	**41** (58)	**92** (97)	**93** (99)	**94** (99)	**93** (98)	**90** (99)
C3032.001d #1 (C3032.001d: Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only)						
DS1	40 (61)	22 (36)	22 (36)	20 (34)	22 (34)	21 (36)
DS2	6.7 (13)	12 (21)	12 (22)	13 (22)	11 (19)	15 (26)
DS3	9.9 (16)	63 (80)	63 (79)	65 (81)	64 (77)	58 (72)
Total	**57** (73)	**96** (99)	**97** (99)	**97** (100)	**97** (99)	**94** (99)
C3034.001 #1 (C3034.001: Independent Pendant Lighting - non seismic)						
DS1	**52** (83)	**93** (100)	**94** (100)	**95** (100)	**94** (99)	**92** (99)
D1014.022 #1 (D1014.022: Hydraulic Elevator - Applies to most California Installations prior to...)						
DS1a	15 (15)	30 (30)	29 (29)	27 (27)	29 (29)	39 (39)
DS1b	25 (25)	48 (48)	48 (48)	50 (50)	48 (48)	43 (43)
DS1c	22 (22)	41 (41)	42 (42)	46 (46)	40 (40)	36 (36)
DS1d	19 (19)	36 (36)	36 (36)	39 (39)	31 (31)	53 (53)
Total	**81** (45)	**160** (85) *	**150** (86) *	**160** (87) *	**150** (85) *	**170** (82) *
*Percent of total quantity above 100 is caused by simultaneous damage states						
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	2.5 (4.6)	22 (37)	22 (37)	21 (36)	24 (40)	12 (23)
DS2	0.3 (0.5)	7.3 (13)	6.5 (12)	11 (19)	8.4 (14)	9.9 (16)
Total	**2.7** (5.0)	**29** (45)	**28** (44)	**33** (48)	**32** (48)	**21** (36)
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**9.0** (16)	**52** (71)	**54** (73)	**57** (75)	**53** (70)	**44** (66)
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	2.8 (5.3)	21 (37)	22 (37)	22 (38)	24 (40)	23 (36)
DS2	0.3 (0.5)	7.7 (14)	7.3 (13)	9.4 (17)	9.4 (16)	4.9 (9.9)
Total	**3.1** (5.6)	**29** (45)	**29** (45)	**32** (47)	**33** (48)	**28** (36)
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	6.0 (11)	23 (40)	22 (39)	25 (43)	22 (40)	20 (26)
DS2	2.8 (5.2)	28 (44)	31 (49)	32 (47)	33 (50)	28 (36)
Total	**8.8** (16)	**51** (71)	**53** (73)	**57** (73)	**55** (72)	**48** (63)
D2031.022a #1 (D2031.022a: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	**19** (31)	**65** (83)	**65** (83)	**69** (88)	**66** (84)	**61** (79)
D2031.022b #1 (D2031.022b: Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C,...)						
DS1	15 (26)	36 (58)	37 (60)	39 (62)	38 (61)	43 (66)
DS2	2.8 (5.2)	28 (44)	27 (44)	30 (47)	26 (42)	18 (30)
Total	**18** (29)	**64** (82)	**65** (83)	**69** (86)	**64** (82)	**61** (79)

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	10	10	24	31	48
P[Res](%)	0.0	16	17	59	61	51
D3032.011a #1 (D3032.011a: Compressor - Capacity: Small non medical air supply - Unanchored equipment...)						
DS1a	47 (47)	50 (50)	52 (52)	46 (46)	55 (55)	59 (59)
DS1b	47 (47)	50 (50)	48 (48)	54 (54)	45 (45)	39 (39)
Total	**94** (94)	**100** (100)	**100** (100)	**100** (100) *	**100** (100)	**99** (99)
*Percent of total quantity above 100 is caused by simultaneous damage states						
D3041.011b #1 (D3041.011b: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	6.8 (13)	22 (40)	25 (43)	24 (42)	21 (38)	20 (39)
DS2	2.7 (5.1)	30 (45)	29 (45)	34 (53)	31 (44)	25 (36)
Total	**9.5** (17)	**52** (71)	**54** (72)	**58** (78)	**52** (70)	**44** (66)
D3041.012b #1 (D3041.012b: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	6.3 (11)	24 (41)	23 (41)	24 (42)	20 (36)	21 (39)
DS2	2.7 (5.2)	29 (45)	29 (44)	33 (48)	32 (49)	23 (33)
Total	**9.0** (16)	**53** (72)	**52** (70)	**56** (74)	**52** (70)	**44** (66)
D3041.032b #1 (D3041.032b: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**8.4** (15)	**53** (73)	**53** (74)	**59** (77)	**54** (71)	**44** (66)
D3041.101a #1 (D3041.101a: HVAC Fan - Capacity: all - Unanchored equipment that is not vibration...)						
DS1	**62** (80)	**97** (100)	**97** (100)	**98** (100)	**98** (100)	**95** (99)
D4011.022a #1 (D4011.022a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	15 (27)	42 (66)	42 (66)	46 (71)	44 (66)	43 (66)
DS2	3.3 (6.1)	27 (43)	29 (46)	30 (49)	28 (43)	25 (39)
Total	**19** (31)	**70** (86)	**72** (87)	**76** (91)	**72** (87)	**67** (79)

4 COMPONENT DAMAGEABILITY AND COST OVERVIEW

This section provides an overview of key component parameters for loss assessment. The components are broken into groups such that the specified component modifiers are applied to all components in the given table.

Some notes on the columns are as follows:

- **DS: Median (Unit Repair Cost Range)**: This presents median EDP for each damage state as well as the associated repair cost range to repair one unit of the component (varies based on quantity).
- **Max Repair Potential**: This is the cost to completely replace this component throughout the building assuming the most expensive damage state for all components (includes volume discounting). The number in parenthesis is the value as a percentage of building replacement value. Note that this does not need to add up to the total building replacement value, but rather gives a sense of how much potential the component has to contribute to the mean loss when it is damaged.

Table 4.1. "Structural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B1044.011	Rectangular low aspect ratio concrete walls 8"-16" double curtain; with heights of up to 15'	EDP Peak Interstory Drift DS1: 0.0055 ($7,151 - $10,516) DS2: 0.0109 ($18,456 - $27,141) DS3: 0.013 ($34,471 - $50,692)	$255,291 (41.8%)
B1071.002	Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs	EDP Peak Interstory Drift DS1: 0.015 ($1,827 - $2,969) DS2: 0.0262 ($2,532 - $3,575) DS3: 0.0369 ($6,355 - $8,972)	$57,052 (9.34%)
		Total:	$312,343 (51.1%)

Table 4.2. "Exterior Finishes" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B2011.401	Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs	EDP Peak Interstory Drift DS1: 0.01 ($175 - $412) DS2: 0.0175 ($374 - $879) DS3: 0.025 ($1,156 - $2,721)	$10,381 (1.70%)
		Total:	$10,381 (1.70%)

Table 4.3. "Partition Walls" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C1011.211a	Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($1,598 - $5,328) DS2: 0.0071 ($3,428 - $11,425) DS3: 0.012 ($11,297 - $37,656)	$53,491 (8.76%)

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Table 4.3 (*Continued*). "Partition Walls" component list.

Component	Description	DS: Median (Repair Cost Range)	Max Repair Potential
C1011.311a	Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($904 - $3,015) DS2: 0.0071 ($2,223 - $7,411) DS3: 0.012 ($7,151 - $23,838)	$44,332 (7.26%)
		Total:	$97,823 (16.0%)

Table 4.4. "Other Nonstructural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C2011.041b	Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.	EDP Peak Interstory Drift DS1: 0.011 ($487 - $695) DS2: 0.026 ($1,043 - $2,782) DS3: 0.05 ($3,130 - $8,346)	$16,692 (2.73%)
D4011.022a	Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - No bracing, SDC C, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.1 ($438 - $536) DS2: 2.4 ($3,317 - $4,055)	$1,409 (0.23%)
		Total:	$18,101 (2.96%)

Table 4.5. "Ceilings" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C3032.001a	Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only	EDP Peak Floor Acceleration DS1: 1.17 ($403 - $605) DS2: 1.58 ($3,157 - $4,736) DS3: 1.82 ($6,496 - $9,744)	$14,923 (2.44%)
C3032.001b	Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only	EDP Peak Floor Acceleration DS1: 1.01 ($968 - $1,452) DS2: 1.45 ($7,578 - $11,367) DS3: 1.69 ($15,590 - $23,385)	$15,241 (2.50%)
C3032.001c	Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only	EDP Peak Floor Acceleration DS1: 0.7 ($2,904 - $4,357) DS2: 1.2 ($22,734 - $34,101) DS3: 1.43 ($46,770 - $70,155)	$15,241 (2.50%)
C3032.001d	Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only	EDP Peak Floor Acceleration DS1: 0.56 ($4,034 - $6,051) DS2: 1.08 ($31,575 - $47,362) DS3: 1.31 ($64,958 - $97,437)	$15,241 (2.50%)
		Total:	$60,646 (9.93%)

Table 4.6. "Lighting" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C3034.001	Independent Pendant Lighting - non seismic	EDP Peak Floor Acceleration DS1: 0.6 ($413 - $1,377)	$5,508 (0.90%)
		Total:	$5,508 (0.90%)

Table 4.7. "Elevators" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D1014.022	Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.	EDP Peak Floor Acceleration DS1a: 0.3 ($668 - $2,226) DS1b: 0.3 ($6,844 - $22,812) DS1c: 0.3 ($10,015 - $33,383) DS1d: 0.3 ($1,920 - $6,398)	$33,383 (5.47%)
		Total:	$33,383 (5.47%)

Table 4.8. "Piping" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D2021.013a	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 2.25 ($363 - $444) DS2: 4.1 ($3,317 - $4,055)	$888 (0.15%)
D2021.013b	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($476 - $581)	$127 (0.02%)
D2021.023a	Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 2.25 ($292 - $974) DS2: 4.1 ($2,796 - $9,319)	$729 (0.12%)
D2021.023b	Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($292 - $974) DS2: 2.25 ($292 - $974)	$76 (0.01%)
D2031.022a	Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.2 ($2,796 - $9,319)	$923 (0.15%)
D2031.022b	Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.2 ($334 - $1,113) DS2: 2.4 ($3,630 - $12,101)	$1,199 (0.20%)
		Total:	$3,942 (0.65%)

Table 4.9. "HVAC" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D3032.011a	Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only	EDP Peak Floor Acceleration DS1a: 0.25 ($939 - $1,148) DS1b: 0.25 ($3,380 - $4,131)	$4,131 (0.68%)
D3041.011b	HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC C	EDP Peak Floor Acceleration DS1: 1.5 ($814 - $995) DS2: 2.25 ($7,949 - $9,716)	$1,266 (0.21%)
D3041.012b	HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater, SDC C	EDP Peak Floor Acceleration DS1: 1.5 ($1,189 - $1,454) DS2: 2.25 ($9,952 - $12,164)	$423 (0.07%)
D3041.032b	HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC C	EDP Peak Floor Acceleration DS1: 1.5 ($3,756 - $4,590)	$8,763 (1.43%)
D3041.101a	HVAC Fan - Capacity: all - Unanchored equipment that is not vibration isolated - Equipment fragility only	EDP Peak Floor Acceleration DS1: 0.5 ($3,317 - $4,055)	$7,741 (1.27%)
		Total:	$22,324 (3.65%)

Table 4.10. Summary of component value breakdown (building replacement value = $610,816).

Component Category	Max Repair Potential	% of Building Replacement Value
Structural	$312,343	51.1%
Exterior Finishes	$10,381	1.70%
Partition Walls	$97,823	16.0%
Other Nonstructural	$18,101	2.96%
Ceilings	$60,646	9.93%
Lighting	$5,508	0.90%
Elevators	$33,383	5.47%
Piping	$3,942	0.65%
HVAC	$22,324	3.65%
Total	$564,452	92.4%

5 COMPONENT QUANTITIES AND MODIFICATION FACTORS

Table 5.1. Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
B1044.011 (B1044.011 #1): Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’						
1	0	7.406	–	1	1	1
B1071.002 (B1071.002 #1): Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs						
1	2.97	0	–	1	1	1
2	1.98	4.0275	–	1	1	1
B2011.401 (B2011.401 #1): Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs						
1	2.97	0	–	1	1	1
2	1.98	4.0275	–	1	1	1
C1011.211a (C1011.211a #1): Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above						
1	0.265	0.275	–	1	1	1
2	0.435	0.5	–	1	1	1
C1011.311a (C1011.311a #1): Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above						
1-2	0.22	0.79	–	1	1	1
C2011.041b (C2011.041b #1): Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.						
1	1	1	–	1	0.5	1
C3032.001a (C3032.001a #1): Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only						
2-R	–	–	0.7821	1	1	1
C3032.001b (C3032.001b #1): Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only						
2-R	–	–	0.325875	1	1	1
C3032.001c (C3032.001c #1): Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only						
2-R	–	–	0.108625	1	1	1
C3032.001d (C3032.001d #1): Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only						
2-R	–	–	0.07821	1	1	1
C3034.001 (C3034.001 #1): Independent Pendant Lighting - non seismic						
2-R	–	–	2	1	1	1
D1014.022 (D1014.022 #1): Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.						
G	–	–	1	1	1	1
D2021.013a (D2021.013a #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY						
2-R	–	–	0.109494	1	1	1
D2021.013b (D2021.013b #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY						
2-R	–	–	0.109494	1	1	1
D2021.023a (D2021.023a #1): Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY						
2-R	–	–	0.039105	1	1	1

Continued on next page

Table 5.1 (*Continued*). Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
D2021.023b (D2021.023b #1): Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY						
2-R	–	–	0.039105	1	1	1
D2031.022a (D2031.022a #1): Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY						
2-R	–	–	0.049533	1	1	1
D2031.022b (D2031.022b #1): Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY						
2-R	–	–	0.049533	1	1	1
D3032.011a (D3032.011a #1): Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only						
R	–	–	1	1	1	1
D3041.011b (D3041.011b #1): HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC C						
2-R	–	–	0.065175	1	1	1
D3041.012b (D3041.012b #1): HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater, SDC C						
2-R	–	–	0.01738	1	1	1
D3041.032b (D3041.032b #1): HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC C						
2-R	–	–	1	1	1	1
D3041.101a (D3041.101a #1): HVAC Fan - Capacity: all - Unanchored equipment that is not vibration isolated - Equipment fragility only						
2-R	–	–	1	1	1	1
D4011.022a (D4011.022a #1): Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - No bracing, SDC C, PIPING FRAGILITY						
2-R	–	–	0.1738	1	1	1

6 FRAGILITY INFORMATION

6.1 B1044.011 #1: (B1044.011) Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’

NISTIR Classification	B1044.011
Author	Andrew Whittaker
Normalized Unit	144.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.1.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.1.2. Damage state progression.

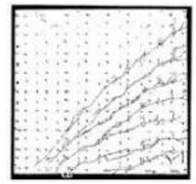
Damage State	Description	Repair Description	Image
DS1	Cracks with maximum widths greater than 0.04 in but less than 0.12 in.	Remove furnishings, ceilings and mechanical, electrical and plumping systems (as necessary) 5 feet either side of damaged area. Replace and repair finishes. Replace furnishings, ceilings and mechanical, electrical and plumping systems (as necessary).	
DS2	Crushed core concrete; localized concrete cracking with widths greater than 0.12 in; buckling of vertical rebar.	(1) Relocate office eqpt & furniture within 6 ft. of wall, both sides. Install protective covers on floor finishes & adjacent curtain wall system. (2) Remove arch. finishes on wall, both sides. (3) Relocate MEP systems within 6 ft. of wall. (4) Prepare & inject grout 330 ft. of crack per 100 ft2 of wall. (5) Remove 15 ft2 per 100 ft2 of wall & 10 1-ft. long sections of #8 buckled vert. rebar. (6) Replace buckled rebar with new rebar, attach to exposed ends of (E) rebar with mech splices; provide 8 #4 seismic ties at 4 in. oc, ea end of wall; rebend 16 horiz. rebar in wall around new rebar. (7) Install formwork & cast 5ksi concrete into pockets cut in step 5. (8) Strip forms, cleanup, reinstall/return office eqpt., finishes, furniture & MEP.	
DS3	Sliding of the wall resulting in large residual displacement; distributed concrete cracking with widths greater than 0.12 in; fracture of rebar.	(1) Relocate eqpt.& furniture within 10 ft. of wall, both sides. Install protection on floor & adjacent walls. (2) Remove wall finishes, both sides. (3) Relocate MEP within 10 ft. of wall. (4) Remove damaged wall in 5-ft.lengths. (5) Install bars: a. 12#9 A706 bars in bz ea. end; mech splices to (E) ; b. #4 A706 dbl sets of seismic ties at 4 in. oc ea bz; c. #4 A706 bar at 6 in. oc, ewef; lap new vert. bars to (E) at top of wall; drill & epoxy bars into wall/fdn at 6 in. oc to match new rebar above. Anchor horiz. Bars in bz with seismic hks or lap 24 in. with (E) horiz. bars. (6) Form wall. Cast 5ksi concrete in 3-ft. lifts; with 1-in. top gap for grout day after casting. (7) Remove forms, clean-up & reinstall/return eqpt, finishes, furniture & MEP.	

Table 6.1.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0055	0.0109	0.013
β	0.36	0.3	0.36

Table 6.1.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	7.0	7.0	7.0
Highest Cost Median	$10,516	$27,141	$50,692
Lowest Cost Median	$7,151	$18,456	$34,471
β (COV)	0.16	0.13	0.11

Table 6.1.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	7.0	7.0	7.0
Highest Median Repair Time (Days)	5.89	15.21	28.4
Lowest Median Repair Time (Days)	4	10.34	19.31
β (COV)	0.29	0.28	0.28

Table 6.1.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.2 B1071.002 #1: (B1071.002) Light framed wood walls with structural panel sheathing, gypsum wallboard and hold-downs

NISTIR Classification	B1071.002
Author	Andre Filiatrault
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.2.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.2.2. Damage state progression.

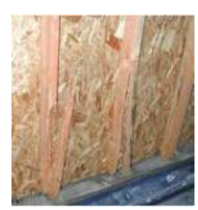
Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.2.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.015	0.0262	0.0369
β	0.4	0.19	0.2

Table 6.2.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$2,969	$3,575	$8,972
Lowest Cost Median	$1,827	$2,532	$6,355
β (COV)	0.19	0.22	0.08

Table 6.2.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	2.07	2.5	6.26
Lowest Median Repair Time (Days)	1.27	1.77	4.44
β (COV)	0.31	0.33	0.26

Table 6.2.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.3 B2011.401 #1: (B2011.401) Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs

NISTIR Classification	B2011.401
Author	HBRG (exterior only modifications)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Exterior Finishes
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.3.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.3.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.3.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.01	0.0175	0.025
β	0.4	0.4	0.4

Table 6.3.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$412	$879	$2,721
Lowest Cost Median	$175	$374	$1,156
β (COV)	0.19	0.22	0.08

Table 6.3.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	0.86	1.08	2.4
Lowest Median Repair Time (Days)	0.53	0.77	1.7
β (COV)	0.31	0.33	0.26

Table 6.3.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.4 C1011.211a #1: (C1011.211a) Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.211a
Author	DaveWelch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.4.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.4.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.4.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.4.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$5,328	$11,425	$37,656
Lowest Cost Median	$1,598	$3,428	$11,297
β (COV)	0.42	0.49	0.1

Table 6.4.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	2.99	6.4	21.1
Lowest Median Repair Time (Days)	0.9	1.92	6.33
β (COV)	0.52	0.55	0.34

Table 6.4.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.5 C1011.311a #1: (C1011.311a) Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.311a
Author	Dave Welch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.5.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.5.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.5.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.5.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$3,015	$7,411	$23,838
Lowest Cost Median	$904	$2,223	$7,151
β (COV)	0.42	0.49	0.1

Table 6.5.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.69	4.15	13.36
Lowest Median Repair Time (Days)	0.51	1.25	4.01
β (COV)	0.52	0.55	0.34

Table 6.5.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.6 C2011.041b #1: (C2011.041b) Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.

NISTIR Classification	C2011.041b
Author	HBRG
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Other Nonstructural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.6.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	0.5

Table 6.6.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cosmetic Damage.	Repair cosmetic damage.	Not Available
DS2	Structural damage but live load capacity remains intact.	Repair damage.	Not Available
DS3	Loss of live load capacity.	Replace stair.	Not Available

Table 6.6.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.011	0.026	0.05
β	0.5	0.5	0.5

Table 6.6.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$695	$2,782	$8,346
Lowest Cost Median	$487	$1,043	$3,130
β (COV)	0.8	0.6	0.4

Table 6.6.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.55	2.21	6.62
Lowest Median Repair Time (Days)	0.39	0.83	2.48
β (COV)	1.0	0.7	0.5

Table 6.6.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.25	0.1
Unsafe Placard β	–	0.1	0.5

6.7 C3032.001a #1: (C3032.001a) Suspended Ceiling, SDC A,B,C, Area (A): A < 250, Vert support only

NISTIR Classification	C3032.001a
Author	Not Given
Normalized Unit	250.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.7.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.7.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.7.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.17	1.58	1.82
β	0.25	0.25	0.25

Table 6.7.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$605	$4,736	$9,744
Lowest Cost Median	$403	$3,157	$6,496
β (COV)	0.55	0.52	0.2

Table 6.7.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.42	3.24	6.69
Lowest Median Repair Time (Days)	0.28	2.16	4.46
β (COV)	0.6	0.58	0.32

Table 6.7.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	250.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.8 C3032.001b #1: (C3032.001b) Suspended Ceiling, SDC A,B,C, Area (A): 250 < A < 1000, Vert support only

NISTIR Classification	C3032.001b
Author	Not Given
Normalized Unit	600.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.8.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.8.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.8.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.01	1.45	1.69
β	0.25	0.25	0.25

Table 6.8.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$1,452	$11,367	$23,385
Lowest Cost Median	$968	$7,578	$15,590
β (COV)	0.55	0.52	0.2

Table 6.8.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.94	7.42	15.33
Lowest Median Repair Time (Days)	0.62	4.94	10.23
β (COV)	0.6	0.58	0.32

Table 6.8.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	650.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.9 C3032.001c #1: (C3032.001c) Suspended Ceiling, SDC A,B,C, Area (A): 1000 < A < 2500, Vert support only

NISTIR Classification	C3032.001c
Author	Not Given
Normalized Unit	1800.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.9.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.9.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.9.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.7	1.2	1.43
β	0.25	0.25	0.25

Table 6.9.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$4,357	$34,101	$70,155
Lowest Cost Median	$2,904	$22,734	$46,770
β (COV)	0.55	0.52	0.2

Table 6.9.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	2.8	21.61	44.5
Lowest Median Repair Time (Days)	1.88	14.39	29.66
β (COV)	0.6	0.58	0.32

Table 6.9.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	1700.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.10 C3032.001d #1: (C3032.001d) Suspended Ceiling, SDC A,B,C, Area (A): A > 2500, Vert support only

NISTIR Classification	C3032.001d
Author	Not Given
Normalized Unit	2500.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.10.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.10.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.10.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.56	1.08	1.31
β	0.25	0.25	0.25

Table 6.10.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$6,051	$47,362	$97,437
Lowest Cost Median	$4,034	$31,575	$64,958
β (COV)	0.55	0.52	0.2

Table 6.10.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	3.62	29.09	59.71
Lowest Median Repair Time (Days)	2.38	19.41	39.79
β (COV)	0.6	0.58	0.32

Table 6.10.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	2500.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.75	0.5
Unsafe Placard β	–	0.5	0.5

6.11 C3034.001 #1: (C3034.001) Independent Pendant Lighting - non seismic

NISTIR Classification	C3034.001
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Lighting
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.11.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.11.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Disassembly of rod system at connections with horizontal light fixture, low cycle fatigue failure of the threaded rod, pullout of rods from ceiling assembly.	Replace damaged lighting components.	Not Available

Table 6.11.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	0.6
β	0.4

Table 6.11.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$1,377
Lowest Cost Median	$413
β (COV)	0.64

Table 6.11.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.99
Lowest Median Repair Time (Days)	0.3
β (COV)	0.68

Table 6.11.6. Life safety information.

	DS1
Non-collapse casualties	Yes
Affected Area	100.0 SF
Serious Injury Median	0.2
Serious Injury β	0.5
Loss of Life Median	0.002
Loss of Life β	0.5
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.12 D1014.022 #1: (D1014.022) Hydraulic Elevator - Applies to most California Installations prior to 1976, most western states installations prior to 1982 and most U.S installations prior to 1998.

NISTIR Classification	D1014.022
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Elevators
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.12.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.12.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Damaged controls.	Multiple repairs possible (% change of each): Repair damaged controls (100%)	Not Available
DS1b	Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.	Multiple repairs possible (% change of each): Repair damaged vane and hoist-way switches (41%), and or repair bent cab stabilizers (41%), and or repair damaged car guide shoes (41%).	Not Available
DS1c	Damaged entrance and car door, and or flooring damage.	Multiple repairs possible (% change of each): Repair damage to cab door (68%), and or repair cab flooring (46%)	Not Available
DS1d	Oil leak in hydraulic line, and or hydraulic tank failure.	Multiple repairs possible (% change of each): Repair oil leak in hydraulic line (27%), and or hydraulic tank failure (81%)	Not Available

Table 6.12.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS1c	DS1d
Type	Simultaneous	Simultaneous	Simultaneous	Simultaneous
Probability	0.3	0.49	0.44	0.37
Median	0.3	0.3	0.3	0.3
β	0.3	0.3	0.3	0.3

Table 6.12.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS1c	DS1d
Distribution Type	LogNormal	Normal	Normal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0	10.0
Highest Cost Median	$2,226	$22,812	$33,383	$6,398
Lowest Cost Median	$668	$6,844	$10,015	$1,920
β (COV)	0.82	0.32	0.44	0.25

Table 6.12.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS1c	DS1d
Distribution Type	LogNormal	Normal	Normal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.6	16.4	24	4.6
Lowest Median Repair Time (Days)	0.48	4.92	7.2	1.38
β (COV)	0.86	0.41	0.51	0.36

Table 6.12.6. Life safety information.

	DS1a	DS1b	DS1c	DS1d
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	No	No
Unsafe Placard Median	–	–	–	–
Unsafe Placard β	–	–	–	–

6.13 D2021.013a #1: (D2021.013a) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY

NISTIR Classification	D2021.013a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.13.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.13.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.13.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	2.25	4.1
β	0.4	0.4

Table 6.13.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Cost Median	$444	$4,055
Lowest Cost Median	$363	$3,317
β (COV)	0.76	0.41

Table 6.13.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.34	3.09
Lowest Median Repair Time (Days)	0.28	2.53
β (COV)	0.8	0.48

Table 6.13.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.14 D2021.013b #1: (D2021.013b) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY

NISTIR Classification	D2021.013b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.14.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.14.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Lateral Brace Failure - 1 failure per 1000 feet of pipe.	Replace failed lateral braces. One repair per 1000 LF.	Not Available

Table 6.14.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.14.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	3.0
Upper Qty.	10.0
Highest Cost Median	$581
Lowest Cost Median	$476
β (COV)	0.6

Table 6.14.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	3.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.44
Lowest Median Repair Time (Days)	0.36
β (COV)	0.65

Table 6.14.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.15 D2021.023a #1: (D2021.023a) Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY

NISTIR Classification	D2021.023a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.15.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.15.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.15.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	2.25	4.1
β	0.4	0.4

Table 6.15.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$974	$9,319
Lowest Cost Median	$292	$2,796
β (COV)	0.65	0.4

Table 6.15.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.74	7.09
Lowest Median Repair Time (Days)	0.22	2.13
β (COV)	0.7	0.47

Table 6.15.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.16 D2021.023b #1: (D2021.023b) Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY

NISTIR Classification	D2021.023b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.16.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.16.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Lateral Brace Failure - 1 failure per 1000 feet of pipe.	Replace failed lateral braces. One repair per 1000 LF.	Not Available
DS2	Vertical Brace Failure - 1 failure per 1000 feet of pipe	Replace failed vertical braces. One repair per 1000 LF.	Not Available

Table 6.16.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.16.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$974	$974
Lowest Cost Median	$292	$292
β (COV)	0.65	0.65

Table 6.16.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.74	0.74
Lowest Median Repair Time (Days)	0.22	0.22
β (COV)	0.7	0.7

Table 6.16.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.17 D2031.022a #1: (D2031.022a) Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, PIPING FRAGILITY

NISTIR Classification	D2031.022a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.17.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.17.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Joints break - 1 break per 1000 feet of pipe.	Replace failed 20 ft pipe sections including supports - one per 1000 LF.	Not Available

Table 6.17.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.2
β	0.5

Table 6.17.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	Normal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$9,319
Lowest Cost Median	$2,796
β (COV)	0.31

Table 6.17.5. Parameters for the repair time distributions.

	DS1
Distribution Type	Normal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	7.09
Lowest Median Repair Time (Days)	2.13
β (COV)	0.4

Table 6.17.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.18 D2031.022b #1: (D2031.022b) Sanitary Waste Piping - Cast Iron w/bell and spigot couplings, SDC C, BRACING FRAGILITY

NISTIR Classification	D2031.022b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.18.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.18.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Isolated support failure w/o leakage - 0.5 support failures per 1000 feet of pipe (assuming supports every 20 feet).	Replace failed supports - 0.5 per 1000 LF.	Not Available
DS2	Multiple supports failure and 60 feet of pipe fail per 1000 feet of pipe (assuming supports every 20 feet).	Replace failed supports and 60 ft pipe per 1000 LF.	Not Available

Table 6.18.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	1.2	2.4
β	0.5	0.5

Table 6.18.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	Normal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$1,113	$12,101
Lowest Cost Median	$334	$3,630
β (COV)	0.71	0.28

Table 6.18.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	Normal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.85	9.21
Lowest Median Repair Time (Days)	0.25	2.76
β (COV)	0.75	0.38

Table 6.18.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.19 D3032.011a #1: (D3032.011a) Compressor - Capacity: Small non medical air supply - Unanchored equipment that is not vibration isolated - Equipment fragility only

NISTIR Classification	D3032.011a
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.19.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.19.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Equipment does not function. Motor is damaged.	Repair motor.	
DS1b	Equipment does not function. Equipment damaged beyond repair.	Replace equipment.	Not Available

Table 6.19.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b
Type	Mut. Excl.	Mut. Excl.
Probability	0.5	0.5
Median	0.25	0.25
β	0.45	0.45

Table 6.19.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$1,148	$4,131
Lowest Cost Median	$939	$3,380
β (COV)	0.17	0.21

Table 6.19.5. Parameters for the repair time distributions.

	DS1a	DS1b
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	0.97	0.64
Lowest Median Repair Time (Days)	0.79	0.16
β (COV)	0.3	0.32

Table 6.19.6. Life safety information.

	DS1a	DS1b
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.20 D3041.011b #1: (D3041.011b) HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC C

NISTIR Classification	D3041.011b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.20.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.20.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Individual supports fail and duct sags - 1 failed support per 1000 feet of ducting.	Replace failed supports and repair ducting in vicinity of failed supports.	Not Available
DS2	Several adjacent supports fail and sections of ducting fall - 60 feet of ducting fail and fall per 1000 foot of ducting.	Replace sections of failed ducting and supports.	Not Available

Table 6.20.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.20.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$995	$9,716
Lowest Cost Median	$814	$7,949
β (COV)	0.37	0.1

Table 6.20.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	0.84	2.99
Lowest Median Repair Time (Days)	0.69	1.49
β (COV)	0.44	0.27

Table 6.20.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	Yes
Affected Area	– –	15.0 SF
Serious Injury Median	–	0.05
Serious Injury β	–	0.5
Loss of Life Median	–	0.0
Loss of Life β	–	0.0
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.21 D3041.012b #1: (D3041.012b) HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater, SDC C

NISTIR Classification	D3041.012b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.21.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.21.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Individual supports fail and duct sags - 1 failed support per 1000 feet of ducting.	Replace failed supports and repair ducting in vicinity of failed supports.	Not Available
DS2	Several adjacent supports fail and sections of ducting fall - 60 feet of ducting fail and fall per 1000 foot of ducting.	Replace sections of failed ducting and supports.	Not Available

Table 6.21.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.21.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$1,454	$12,164
Lowest Cost Median	$1,189	$9,952
β (COV)	0.26	0.08

Table 6.21.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	1.23	3.74
Lowest Median Repair Time (Days)	1.01	1.87
β (COV)	0.36	0.26

Table 6.21.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	Yes
Affected Area	– –	50.0 SF
Serious Injury Median	–	0.1
Serious Injury β	–	0.5
Loss of Life Median	–	0.0
Loss of Life β	–	0.0
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.22 D3041.032b #1: (D3041.032b) HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC C

NISTIR Classification	D3041.032b
Author	Not Given
Normalized Unit	10.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.22.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.22.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	HVAC drops or diffusers dislodges and falls.	Replace diffuser/drop and sections of ceiling and ducting in vicinity to which diffuser/drop is connected.	Not Available

Table 6.22.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.22.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Cost Median	$4,590
Lowest Cost Median	$3,756
β (COV)	0.21

Table 6.22.5. Parameters for the repair time distributions.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Median Repair Time (Days)	3.88
Lowest Median Repair Time (Days)	3.18
β (COV)	0.32

Table 6.22.6. Life safety information.

	DS1
Non-collapse casualties	Yes
Affected Area	4.0 SF
Serious Injury Median	0.1
Serious Injury β	0.5
Loss of Life Median	0.0
Loss of Life β	0.0
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.23 D3041.101a #1: (D3041.101a) HVAC Fan - Capacity: all - Unanchored equipment that is not vibration isolated - Equipment fragility only

NISTIR Classification	D3041.101a
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.23.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.23.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Damaged, inoperative.	Replace equipment.	

Table 6.23.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	0.5
β	0.4

Table 6.23.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Cost Median	$4,055
Lowest Cost Median	$3,317
β (COV)	0.14

Table 6.23.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Median Repair Time (Days)	3.43
Lowest Median Repair Time (Days)	2.81
β (COV)	0.29

Table 6.23.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.24 D4011.022a #1: (D4011.022a) Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - No bracing, SDC C, PIPING FRAGILITY

NISTIR Classification	D4011.022a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Other Nonstructural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.24.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.24.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Spraying & Dripping Leakage at joints - 0.02 leaks per 20 ft section of pipe.	Replace leaking joints and minor water cleanup.	Not Available
DS2	Joints Break - Major Leakage - 0.02 breaks per 20 ft section of pipe.	Replace 20 ft section of pipe, joints and major water cleanup at leaking joints.	Not Available

Table 6.24.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.1	2.4
β	0.4	0.5

Table 6.24.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Cost Median	$536	$4,055
Lowest Cost Median	$438	$3,317
β (COV)	0.65	0.41

Table 6.24.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.45	0.94
Lowest Median Repair Time (Days)	0.37	0.31
β (COV)	0.7	0.48

Table 6.24.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

7 DISCLAIMER

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Full Detailed Report

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	New WLF w/ Frame
Building Type:	WLF: General
Year of Construction:	2022
Number of Stories:	2
Occupancy:	Commercial Office
Address:	217 Arlington Avenue Kensington, CA, 94707
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	4,395
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	None
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–
Dir. 2 Story 1	–
Dir. 2 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	–, –
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	–
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	–

Component Information

Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options	
Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*

Interior Finishes

- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *Yes*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *Yes*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *Yes*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	0.5	0.9
10% in 50 years	475 Years	9.3	17
DE	481 Years	9.5	17
5% in 50 years	975 Years	14	23
MCE_R	1277 Years	17	27
2% in 50 years	2475 Years	26	42

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	1.4 days	1.5 days	0 days	0 days	6.4 weeks
10% in 50 years	3.8 weeks	4.8 weeks	11 days	2.8 months	3.4 months
DE	3.9 weeks	5.1 weeks	12 days	2.8 months	3.5 months
5% in 50 years	5.7 weeks	7.6 weeks	2.8 months	3.7 months	3.9 months
MCE_R	6.8 weeks	2.1 months	3.1 months	3.8 months	4.1 months
2% in 50 years	2.1 months	2.8 months	3.5 months	4.2 months	4.4 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 BASIS OF ANALYSIS

This analysis is based on the SP3-RiskModel of the Seismic Performance Prediction Program (SP3) software platform. The underlying analysis methods are based on the FEMA P-58 analytical method, which is a transparent and well documented method developed through a 15 year project (Applied Technology Council, 2018). This project leveraged the previous decades of academic research, funded by a $16 million investment by the Federal Emergency Management Agency (FEMA). In contrast to many risk assessment methods based on judgment and past earthquake experience, the FEMA P-58 and SP3 analysis are based on engineering-oriented risk evaluation methods.

3 DOCUMENTATION OF SITE AND BUILDING INPUT DATA

Project Name: Kensington Fire Station
Model Name: New WLF w/ Frame

3.1 Site Information

Address: 217 Arlington Avenue, Kensington, CA, 94707
Latitude: 37.90622°
Longitude: -122.27875°

3.2 Building Information

Material Type:	WLF
Number of Stories:	2
Total Building Square Footage:	4,395
Occupancy Type:	Commercial Office
Total Expected Building Replacement Value:	$1,378,558

4 SITE HAZARD INFORMATION

This section presents the site's seismic hazard information. The V_{S30} value is the shear wave velocity in the soil at a depth of 30 meters. This value and the associated site class are presented in Table 4.1.

Table 4.1. Site soil information

V_{S30} (m/s):	537.0
Site Class:	C
Closest V_{S30} for USGS Hazard Lookup (m/s):	530

Table 4.2 and Figure 4.1 present the spectral acceleration information for this site. The spectral acceleration is a measure of how much force the building will attract in an earthquake. This amount of force is dependent on the intensity of the ground shaking (e.g. 10% in 50 years), as well as a dynamic property of the building known as the "fundamental period". Shorter buildings tend to have smaller fundamental periods and taller buildings tend to have larger fundamental periods. As indicated by Figure 4.1, smaller fundamental periods (with the exception of very short fundamental periods) will attract more force in an earthquake.

The Design Earthquake (DE) and Maximum Considered Earthquake (MCE) are based on the modern code maximum direction spectra and are converted to geometric mean for comparison.

Table 4.2. Geometric mean spectral acceleration values (in g)

Intensity	Return Period (yrs)	PGA	$S_a(0.2s)$	$S_a(1.0s)$	$S_a(0.4s)$	$S_a(0.41s)$	$S_a(T_1)/v_{ult}$ † Dir 1	$S_a(T_1)/v_{ult}$ † Dir 2
50% in 50 years	72	0.22	0.52	0.17	0.39	0.39	0.46	0.49
10% in 50 years	475	0.62	1.50	0.56	1.20	1.18	1.41	1.50
DE	481	0.62	1.50	0.57	1.21	1.19	1.42	1.50
5% in 50 years	975	0.82	2.03	0.80	1.66	1.64	1.95	2.07
MCE_R	1277	0.91	2.26	0.91	1.85	1.83	2.17	2.31
2% in 50 years	2475	1.13	2.84	1.19	2.37	2.33	2.77	2.95

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.854$ and $T_1 = 0.397$s and in direction 2 $v_{ult} = 0.790$ and $T_1 = 0.409$s (see Table 5.2 for more detailed structural properties)

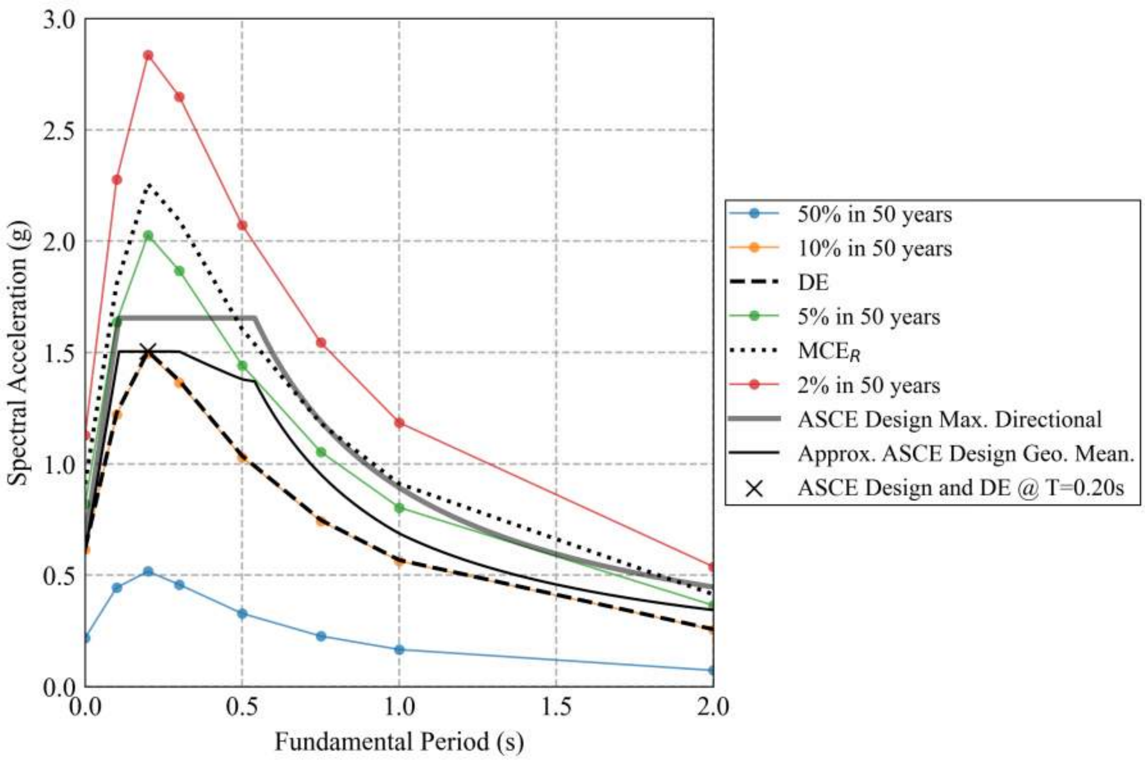


Figure 4.1. Hazard curves for this site. All curves are geometric mean unless otherwise stated.

5 BUILDING DESIGN SUMMARY FROM THE *SP3 BUILDING CODE DESIGN DATABASE*

5.1 Building Code Design Parameters

The seismic design parameters used to compute the seismic base shear coefficients for this building are presented in Table 5.1. These parameters are specific to ASCE/SEI 7-2010 (American Society of Civil Engineers, 2010).

Table 5.1. Code design parameters

(a) ASCE/SEI 7-2010 structural system parameters

Parameter	Dir. 1	Dir. 2
C_t	0.02	0.02
C_d	4	4
x	0.75	0.75
R	6.5	6.5
Ω_0	3	3

(b) ASCE/SEI 7-2010 site specific parameters

Parameter	Value
S_s	2.482
S_1	1.031
S_{ds}	1.655
S_{d1}	0.893
SDC	E
C_u	1.4

(c) ASCE/SEI 7-2010 site specific parameters based on the period of the building

Parameter	Value
$\text{MCE}_{R,max}(g)$	2.482
$\text{MCE}_{R,geomean}(g)$	2.155
$\text{DE}_{max}(g)$	1.655
$\text{DE}_{geomean}(g)$	1.437

5.2 Structural Properties

This section summarizes the main structural properties of the building in each direction. These structural properties are used as inputs to the SP3 Structural Response Prediction Engine.

Table 5.2. Structural properties table

Parameter	Direction 1	Direction 2
General		
Structural System	WLF: General	WLF: General
Building Edge Length (ft)	33	65
Detailing Level	Special	Special
Seismic Strength		
Seismic Design Base Shear Ratio, C_s †	0.382	0.382
Wind Strength		
Wind Design Base Shear Ratio, v_{wind} †	0.180	0.083
Total Strength		
Ultimate Base Shear Ratio, v_{ult}	0.854	0.790
Stiffness		
Design Drift (%)	–	–
$T_{1,design}$ (s)	0.29	0.29
T_1 with non-structural components (s)	0.40	0.41
T_1 Final (s)	0.40	0.41

† Design base shear values reported as LRFD

5.3 Mode Shapes

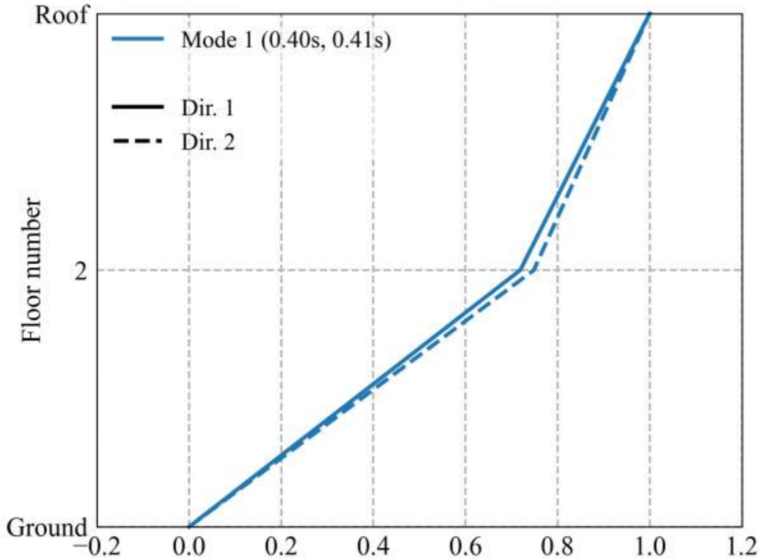


Figure 5.1. Mode shapes

Table 5.3. Mode shape values

	Dir. 1 Mode 1	Dir. 2 Mode 1
Roof	1.00	1.00
2	0.719	0.748
Ground	0.00	0.00

6 SP3 PERFORMANCE FACTORS

Table 6.1 compares the seismic design base shear, C_s, to the 475-year shaking (reduced by the modern response modification coefficient, R). Generally speaking, the modern building code design requirements are based on the 475-year event with the exception of extremely high seismic (near-fault) areas that are designed for a lesser deterministic ground motion or the transition region between deterministic and probabilistic portions of the ground motion maps.

The shaking intensity is then reduced by the response modification coefficient, R, based on the ductility level of the system (in anticipation of controlled damage of specially designed elements).

When the ratio of design base shear to the reduced spectra ($C_s/\left[S_a(T_1)_{475}/R\right]$) is 1.0, then the building was designed consistent with 10% in 50 year hazard. When the ratio is above 1.0, it was designed higher, so expect better performance (all other things equal), and for ratios below 1.0, expect worse performance.

Table 6.1. Design base shear vs. 475-year shaking intensity

	Dir. 1	Dir. 2
Seismic Design Base Shear, C_s	0.382	0.382
475-year Shaking Intensity, $S_a(T_1)_{475}$ †	1.20g	1.18g
Reduced Spectral Acceleration, $S_a(T_1)_{475}/R$ ‡	0.185g	0.182g
Ratio of Design Base Shear to 475-year Shaking Demand, $C_s/\left[S_a(T_1)_{475}/R\right]$ §	**2.07**	**2.10**

† T_1 includes all sources of overstiffness ($T_{1,dir1} = 0.397$s and $T_{1,dir2} = 0.409$s, see Table 5.2).

‡ Response Modification Coefficient, R, is from the modern code ($R_{dir1} = 6.5$ and $R_{dir2} = 6.5$).

7 BUILDING STABILITY

The FEMA P-154 collapse capacity score was calculated as follows using the "very high" seismicity level. The terminology used in this section is consistent with the FEMA P-154 methodology (Applied Technology Council, 2015a):

- P$[COL|MCE_R]_{P-154}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking, times the collapse factor
- P$[COL|MCE_R]_{P-58}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking
- Collapse Factor: expected ratio of collapsed area to total area given that the building is in the HAZUS Complete structural damage state

For a more in-depth explanation of "collapse," refer to Section 4.4.1.5 of FEMA P-155 Third Edition available here (Applied Technology Council, 2015b).

Table 7.1. Breakdown of FEMA P-154 score assignment

FEMA ID:	W2
Basic Score	1.8
Soil	0
Year	2
Plan Irregularity	0
Vertical Irregularity	0
Risk Category† (Cat IV)	0.8
Sum:	4.6
Minimum Allowed:	0.7
Score:	**4.6**
Dispersion (β):	0.58

† Non-standard property implemented by SP3

The FEMA P-154 probability of collapse at the MCE_R level event is then calculated as:

$$\begin{aligned} \text{P}[COL|MCE_R]_{P-154} &= 10^{-\text{score}} \\ &= 10^{-4.6} \\ &= 0.00251\% \end{aligned} \quad \text{(FEMA P-155 eqn. 4-1)}$$

Taking into account the fraction of floor area collapsed (0.33 in this case), the probability of collapse is:

$$\begin{aligned} \text{P}[COL|MCE_R]_{P-58} &= \text{P}[COL|MCE_R]_{P-154} \;/\; \text{Collapse Factor} \\ &= 0.00251\% \;/\; 0.33 \\ &= 0.00761\% \end{aligned}$$

The median collapse capacity (before any direct modifications to the median) is calculated as:

$$\begin{aligned} S_{a,\ collapse\ median,\ P-58} &= \exp\left(\ln(S_{a,MCE_R}) - \text{norminv}\left(P[COL|MCE_R]_{P-58}\right) \cdot \beta\right) \\ &= \exp\left(\ln(1.84g) - \text{norminv}\left(0.00761\%\right) \cdot 0.58\right) \\ &= 16.6g \end{aligned}$$

where `norminv` is the inverse of the standard normal cumulative distribution function (CDF).

To further refine the collapse capacity, the factors from Table 7.2 were applied to the median collapse S_a.

Table 7.2. Scale factor applied to the median collapse S_a value.

Reason	Factor
Wood Light Frame	0.388

The WLF modification reflects a weighted average of the FEMA P-154 median and the median collapse capacity observed in extensive non-linear dynamic modeling.
The final median for the collapse curve is therefore:

$$\begin{aligned} S_{a,\ collapse\ median,\ P-58\ (adjusted)} &= S_{a,\ collapse\ median,\ P-58} \cdot \text{Factors} \\ &= 16.6g \cdot 0.388 & \text{(Using additional SP3 factors)} \\ &= 6.43g \end{aligned}$$

Which corresponds to a probability of collapse at MCE of:

$$\text{P}[COL|MCE_R]_{P-58\ (adjusted)} = 1.55\% \qquad \text{(Using additional SP3 factors)}$$

Figure 7.1 shows the collapse capacity cumulative distribution function used in the analysis.

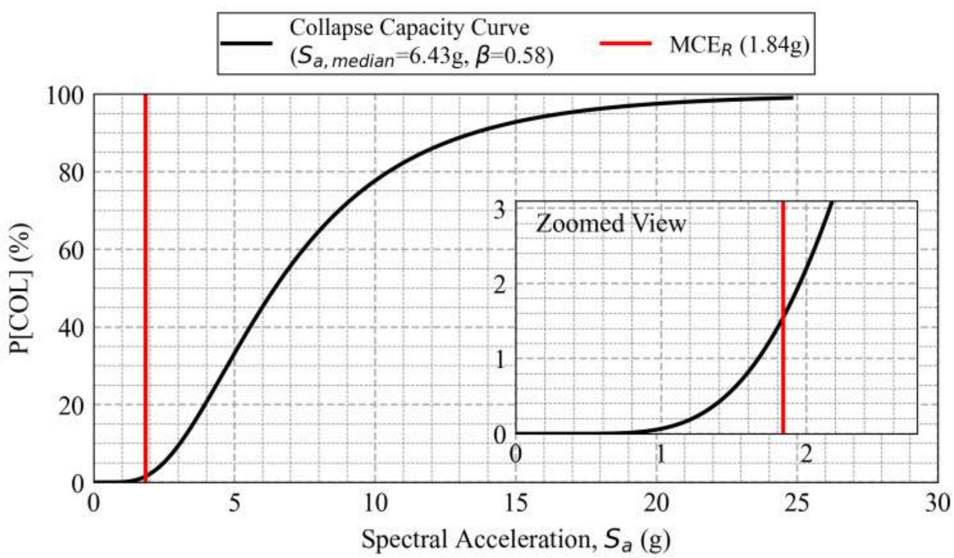


Figure 7.1. Cumulative distribution function for collapse capacity

8 STRUCTURAL RESPONSE PREDICTIONS FROM THE SP3 STRUCTURAL RESPONSE PREDICTION ENGINE

The SP3 Response Prediction Engine predicts the structural responses (typically providing 100 ground motions per intensity level); this is done by using a combination of three-mode elastic modal analysis, coupled with both elastic and inelastic response modifiers mined from the large SP3 Structural Responses Database (with over 4,000,000 response simulations, and growing). These response predictions track all of the important statistical information in the responses (mean, variability, and correlations); this enables a statistically robust vulnerability curve at the end of the risk assessment process.

8.1 Peak Interstory Drift

Peak interstory drift ratio is an important metric for both structural and non-structural components in the building. It measures how much the ceiling of a given story moves relative to the floor, normalized to the height of the story. The greater the interstory drift ratio, the greater the damage to the components on that level. Typical components that are damaged from interstory drift ratio are structural components (beams and columns), gypsum partition walls, and exterior cladding and glazing.

Table 8.1. Median Peak Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.05	0.30	0.30	0.46	0.50	0.58
1	0.18	1.37	1.38	2.16	2.57	3.76
$\frac{S_a(T_1)}{v_{ult}} =$	0.46	1.41	1.42	1.95	2.17	2.77

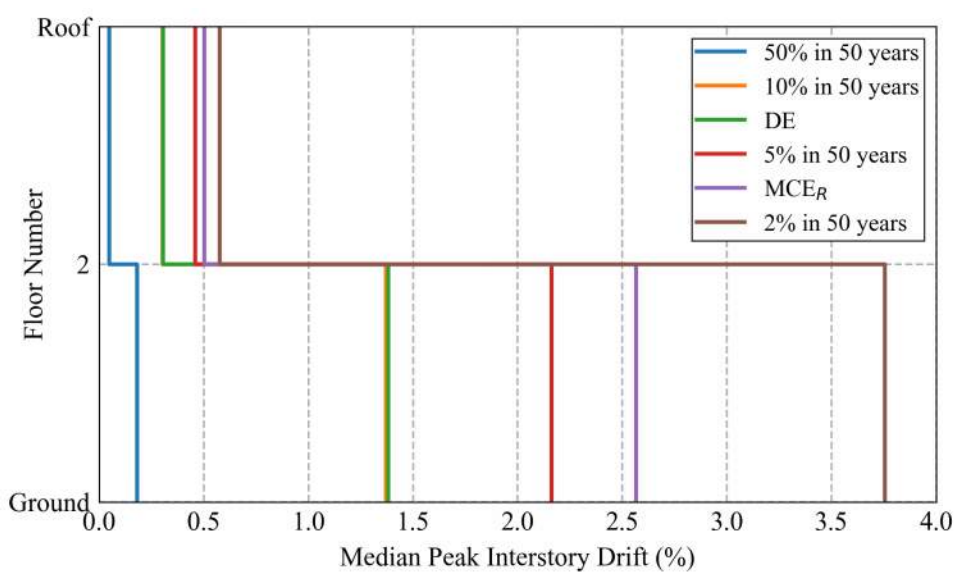


Figure 8.1. Median Peak Interstory Drift demands in direction 1

Table 8.2. Median Peak Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.04	0.28	0.28	0.40	0.43	0.48
1	0.20	1.48	1.49	2.36	2.80	4.03
$\frac{S_a(T_1)}{v_{ult}} =$	0.49	1.50	1.50	2.07	2.31	2.95

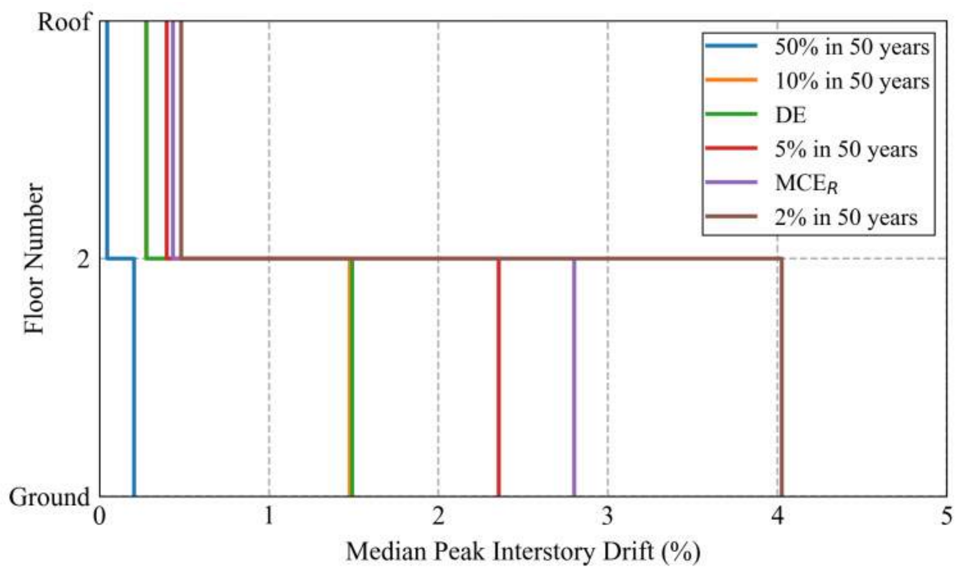


Figure 8.2. Median Peak Interstory Drift demands in direction 2

8.2 Residual Interstory Drift

Residual drift is a metric that informs the need for structural repairs or building demolition (where excessive drifts are present). Residual drift ratio is a measure of how much the building is "leaning over" after the seismic event has ceased. A residual drift of 2% would indicate that the story is laterally displaced 2% of it's height, which equates to about 3.6 inches for a 15 foot tall story.

Table 8.3. Median Residual Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE$_R$	2% in 50 years
2	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.14	0.22	0.44
$\frac{S_a(T_1)}{v_{ult}}$ =	0.46	1.41	1.42	1.95	2.17	2.77

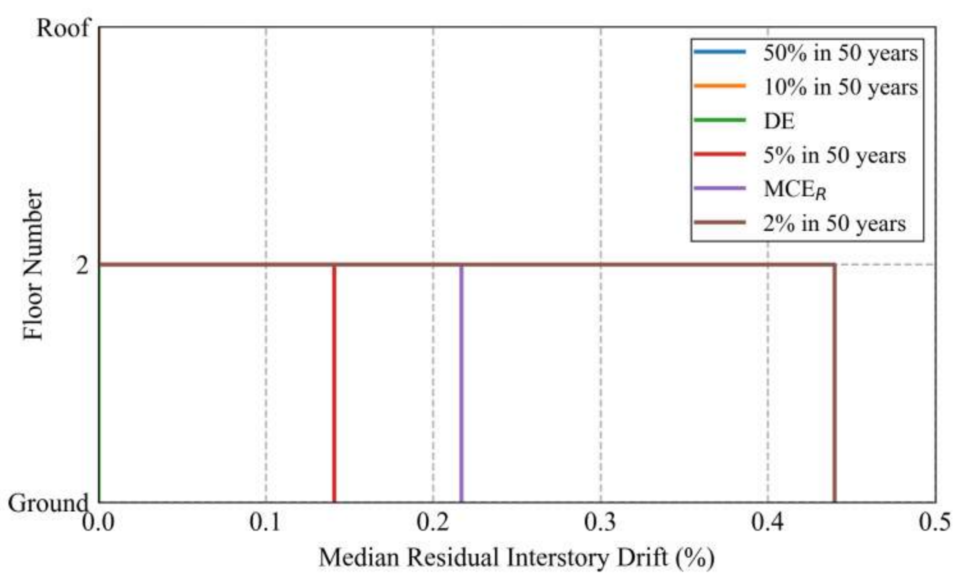


Figure 8.3. Median Residual Interstory Drift demands in direction 1

Table 8.4. Median Residual Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE$_R$	2% in 50 years
2	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.01	0.02	0.18	0.26	0.49
$\frac{S_a(T_1)}{v_{ult}} =$	0.49	1.50	1.50	2.07	2.31	2.95

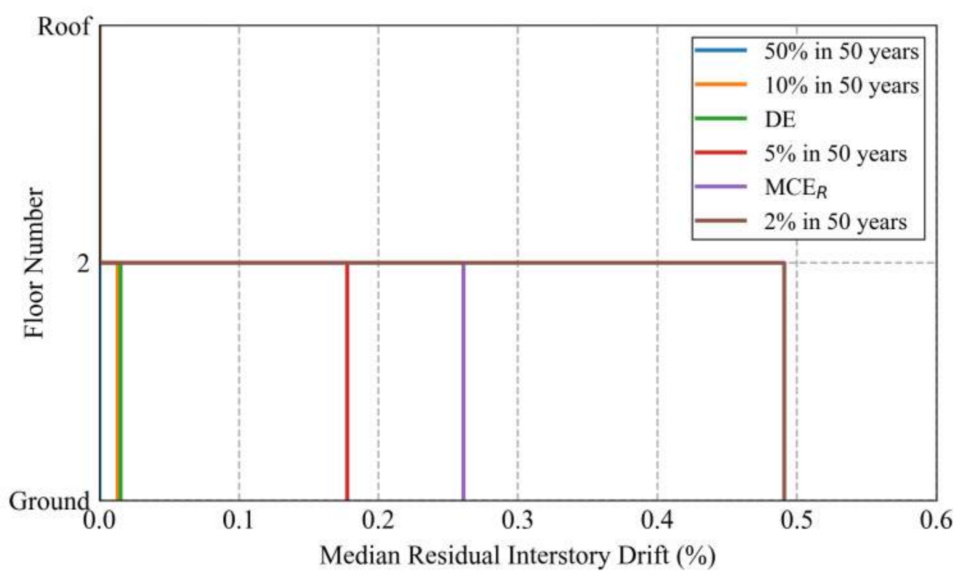


Figure 8.4. Median Residual Interstory Drift demands in direction 2

8.3 Peak Floor Acceleration

Peak floor acceleration is an an important metric for non-structural components in the building. Components such as piping, HVAC, and electrical switchgear are sensitive to the floor accelerations. High accelerations will typically damage a component itself or cause the component's anchorage to fail, both of which may require repair or replacement of the component.

Table 8.5. Median Peak Floor Acceleration demands in direction 1

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Roof	0.32	0.98	0.99	1.14	1.19	1.22
2	0.25	0.97	0.97	1.05	1.10	1.19
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}} =$	0.46	1.41	1.42	1.95	2.17	2.77

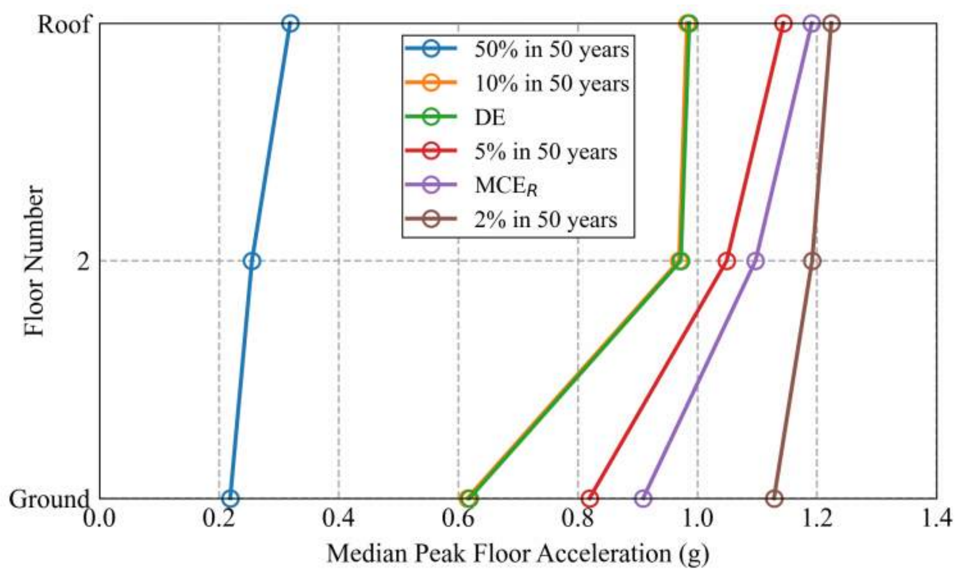


Figure 8.5. Median Peak Floor Acceleration demands in direction 1

Table 8.6. Median Peak Floor Acceleration demands in direction 2

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Roof	0.32	0.96	0.97	1.11	1.14	1.15
2	0.26	0.94	0.94	1.01	1.07	1.14
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}} =$	0.49	1.50	1.50	2.07	2.31	2.95

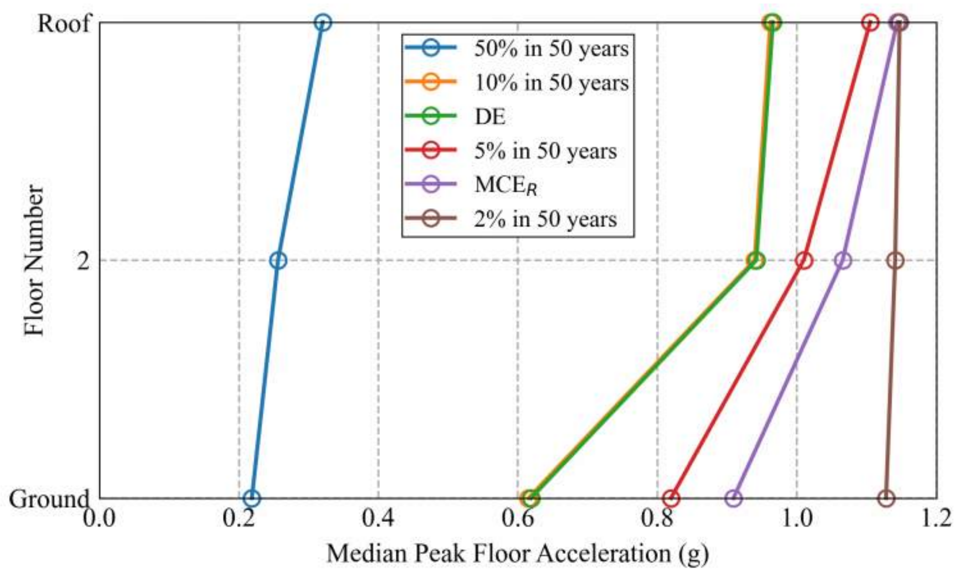


Figure 8.6. Median Peak Floor Acceleration demands in direction 2

8.4 Max. Residual Interstory Drift

Table 8.7. Median Max. Residual Interstory Drift demands in direction 1

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.00	0.00	0.14	0.22	0.44
$\frac{S_a(T_1)}{v_{ult}} =$	0.46	1.41	1.42	1.95	2.17	2.77

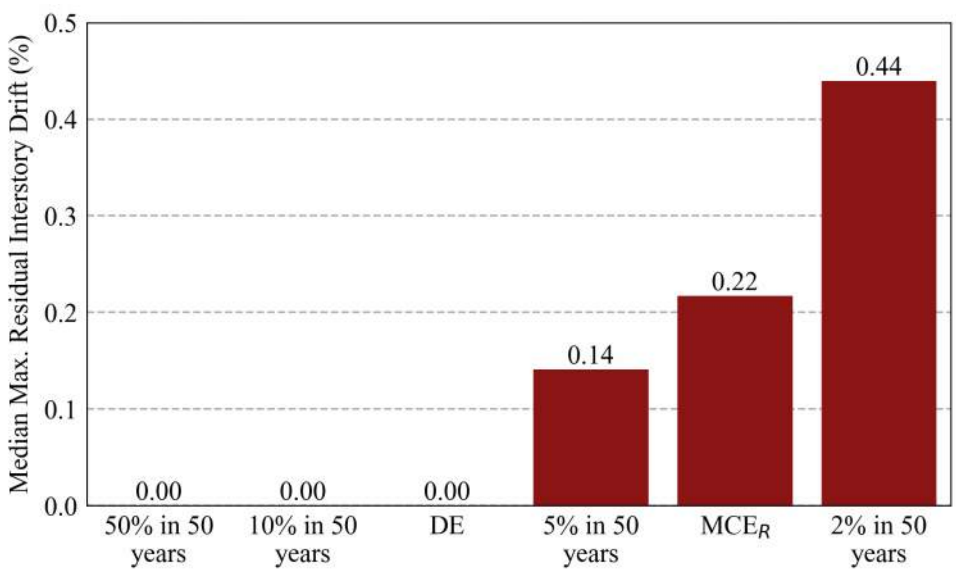


Figure 8.7. Median Max. Residual Interstory Drift demands in direction 1

Table 8.8. Median Max. Residual Interstory Drift demands in direction 2

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.01	0.02	0.18	0.26	0.49
$\frac{S_a(T_1)}{v_{ult}} =$	0.49	1.50	1.50	2.07	2.31	2.95

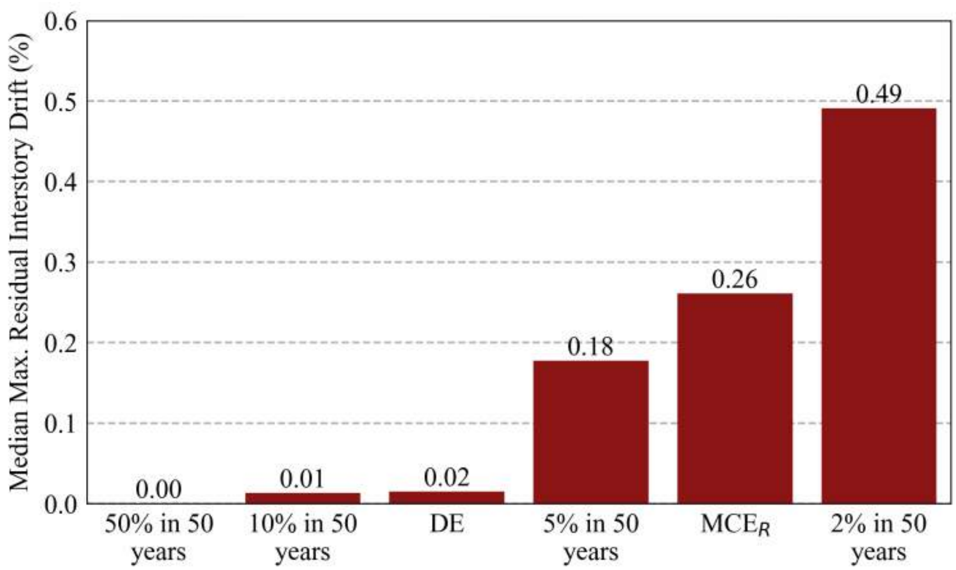


Figure 8.8. Median Max. Residual Interstory Drift demands in direction 2

9 REPAIR COSTS - BY LEVEL OF GROUND MOTION

9.1 Mean and 90th Percentile Repair Costs (SEL and SUL)

The different metrics for repair cost are as follows:

- **Mean (SEL)**: ("Scenario Expected Loss") the average repair cost of the building repair/replacement.
- **Median**: there is a 50% probability that the repair cost will not exceed this value.
- **Fitted SUL**: Fitted value of "Scenario Upper Loss".
- **Counted 90th Percentile**: there is a 90% probability that the repair cost will not exceed this value.

Table 9.1. Loss metrics normalized by building cost

Intensity	PGA (g)	Mean (SEL) (%)	Fitted SUL (%)	Median (%)	Counted 90th Percentile (%)	$S_a(T_1)/v_{ult}$ † Dir 1	Dir 2
50% in 50 years	0.22	0.5	0.9	0.4	0.9	0.46	0.49
10% in 50 years	0.62	9.3	17	7.7	17	1.41	1.50
DE	0.62	9.5	17	8.0	17	1.42	1.50
5% in 50 years	0.82	14	23	12	23	1.95	2.07
MCE$_R$	0.91	17	27	14	27	2.17	2.31
2% in 50 years	1.13	26	42	19	42	2.77	2.95

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.854$ and $T_1 = 0.397$s and in direction 2 $v_{ult} = 0.790$ and $T_1 = 0.409$s (see Table 5.2 for more detailed structural properties)

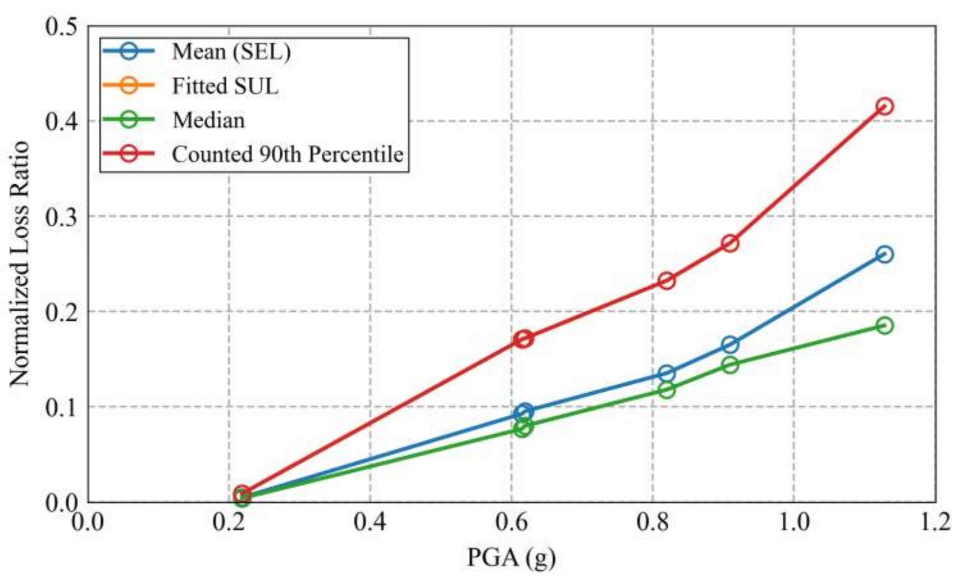


Figure 9.1. Loss metrics across all intensity levels analyzed

10 REPAIR COST BREAKDOWN BY BUILDING COMPONENTS

10.1 Categories for Repair Cost Breakdowns

Repair costs are binned into eight categories as follows:

- **Collapse**: building demolition and replacement following a collapse.
- **Residual**: building demolition and replacement following unacceptable residual drifts.
- **Structural**: components of the lateral force resisting system or gravity system (e.g. beam column connections, link beams, shear wall, shear tabs, etc.).
- **Partitions**: partition wall components (e.g. wood or metal stud gypsum full height partitions).
- **Exterior**: components placed on the exterior of the building (e.g. cladding, glazing, etc.).
- **Interior**: non-structural components on the interior of the building (e.g. raised access floors, ceilings, lighting).
- **HVAC**: HVAC and plumbing components (e.g. water piping and bracing, sanitary piping, ducting, boilers etc.).
- **Other**: components not included in the categories above (e.g. elevators, user defined components, fire protection components).

10.2 Repair Cost Breakdown for Various Ground Motion Levels

Table 10.1. Expected mean loss per component group (in percent)

Intensity	Total	Structural	Residual	Interior	Partitions	Collapse	Exterior	HVAC	Other
50% in 50 years	0.5	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0
10% in 50 years	9.3	1.4	0.0	3.2	3.4	0.0	0.4	0.7	0.2
DE	9.5	1.4	0.0	3.3	3.4	0.0	0.4	0.7	0.2
5% in 50 years	14	3.0	0.0	4.2	4.3	0.0	0.7	0.9	0.3
MCE_R	17	3.9	0.4	4.9	4.5	0.5	0.9	0.9	0.4
2% in 50 years	26	5.7	5.5	4.8	4.5	3.2	1.0	0.9	0.5

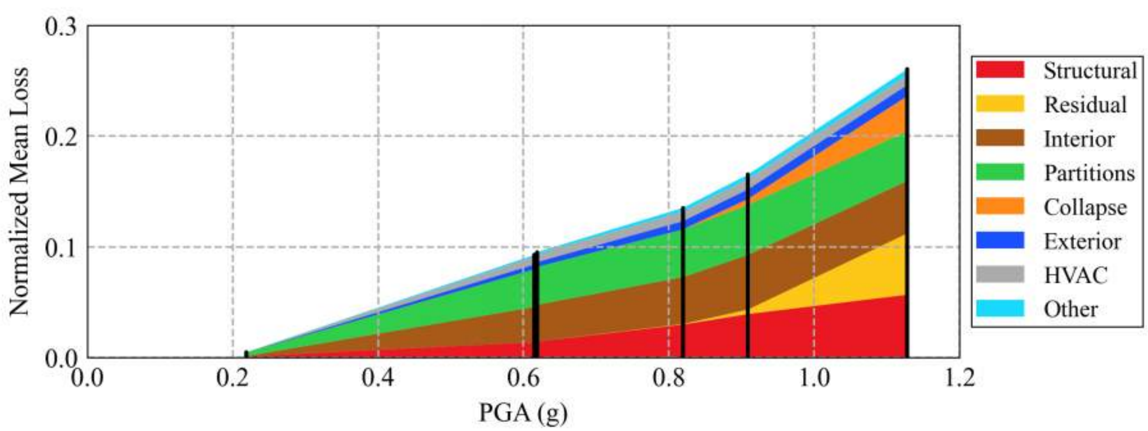


Figure 10.1. Contribution of building components to mean loss ratio

10.3 Repair Cost Breakdown for Expected Annual Loss

The expected annual loss for this building is $1,236.

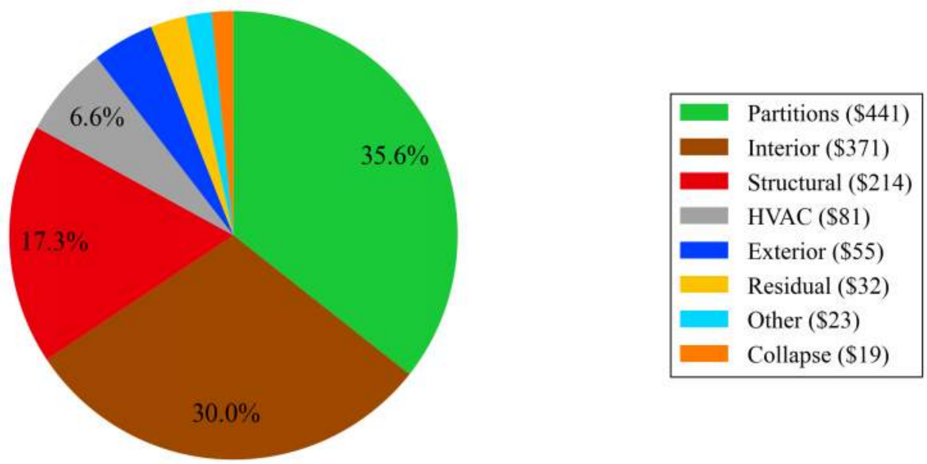


Figure 10.2. Annualized loss breakdown

11 REPAIR TIME AND BUILDING CLOSURE TIME

These downtimes were calculated using the ATC-138 Functional Recovery (Beta) Methodology. This includes all sources of impedance specified by the user; possible sources of impedance considered are listed below.

- Post-earthquake Inspection
- Engineering Mobilization and Review/Re-design
- Financing
- Contractor Mobilization and Bid Process
- Permitting

These capture the time required to start the repairs, since beginning repairs immediately after an earthquake may not be realistic.

Table 11.1. Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	1.4 days	1.5 days	0 days	0 days	6.4 weeks
10% in 50 years	3.8 weeks	4.8 weeks	11 days	2.8 months	3.4 months
DE	3.9 weeks	5.1 weeks	12 days	2.8 months	3.5 months
5% in 50 years	5.7 weeks	7.6 weeks	2.8 months	3.7 months	3.9 months
MCE_R	6.8 weeks	2.1 months	3.1 months	3.8 months	4.1 months
2% in 50 years	2.1 months	2.8 months	3.5 months	4.2 months	4.4 months

† Does ***not*** include impedance factors
‡ Does include impedance factors

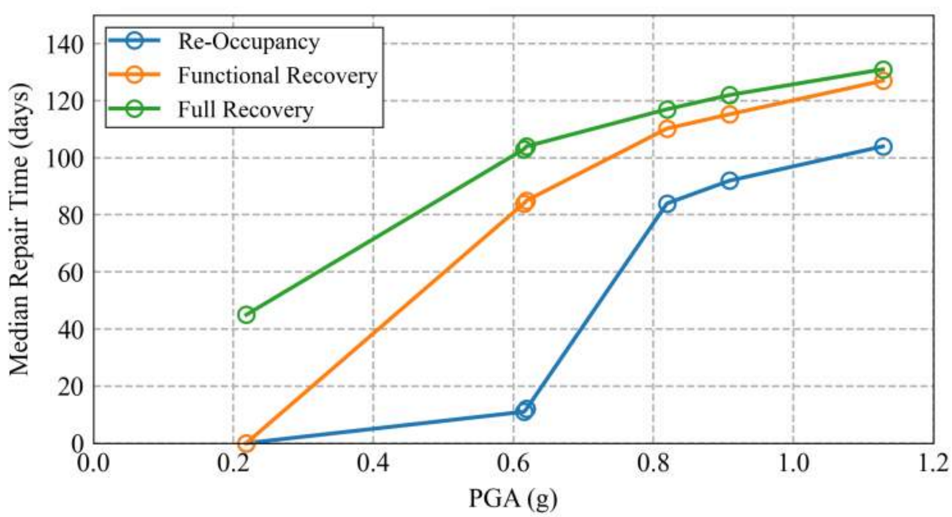


Figure 11.1. Median repair time from the ATC-138 Functional Recovery (Beta) Methodology, includes specified impeding factors

12 DISCLAIMER

REFERENCES

American Society of Civil Engineers. 2010. *ASCE: Minimum Design Loads for Buildings and Other Structures*. American Society of Civil Engineers.

Applied Technology Council. 2015a. *FEMA P-154: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*.

Applied Technology Council. 2015b. *FEMA P-155: Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation*.

Applied Technology Council. 2018. *FEMA P-58: Seismic Perfromance Assessment of Buildings*.

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Functional Recovery Time Report

using the

ATC-138 Functional Recovery (Beta) Methodology

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program
by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	New WLF w/ Frame
Building Type:	WLF: General
Year of Construction:	2022
Number of Stories:	2
Occupancy:	Commercial Office
Address:	217 Arlington Avenue Kensington, CA, 94707
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	4,395
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	None
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–
Dir. 2 Story 1	–
Dir. 2 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	–, –
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	–
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	–

Component Information

Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options	
Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*

Interior Finishes

- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *Yes*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *Yes*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *Yes*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	0.5	0.9
10% in 50 years	475 Years	9.3	17
DE	481 Years	9.5	17
5% in 50 years	975 Years	14	23
MCE_R	1277 Years	17	27
2% in 50 years	2475 Years	26	42

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	1.4 days	1.5 days	0 days	0 days	6.4 weeks
10% in 50 years	3.8 weeks	4.8 weeks	11 days	2.8 months	3.4 months
DE	3.9 weeks	5.1 weeks	12 days	2.8 months	3.5 months
5% in 50 years	5.7 weeks	7.6 weeks	2.8 months	3.7 months	3.9 months
MCE_R	6.8 weeks	2.1 months	3.1 months	3.8 months	4.1 months
2% in 50 years	2.1 months	2.8 months	3.5 months	4.2 months	4.4 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 FUNCTIONAL RECOVERY OVERVIEW

Table 2.1. Recovery Times from the ATC-138 Functional Recovery (Beta) Methodology

Intensity	Return Period	PGA (g)	Sa(T_1)*	Median			90^{th} Percentile		
				Re-Occ.	Func.	Full	Re-Occ.	Func.	Full
50% in 50 years	72 years	0.22	0.39	0d	0d	6.4w	0d	0d	3.7m
10% in 50 years	475 years	0.62	1.19	11d	2.8m	3.4m	4.2m	5.1m	5.5m
DE	481 years	0.62	1.20	12d	2.8m	3.5m	4.4m	5.3m	5.6m
5% in 50 years	975 years	0.82	1.65	2.8m	3.7m	3.9m	5.1m	5.8m	5.9m
MCE$_R$	1277 years	0.91	1.84	3.1m	3.8m	4.1m	5.3m	6.1m	6.3m
2% in 50 years	2475 years	1.13	2.35	3.5m	4.2m	4.4m	6.7m	7.5m	7.6m

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

Table 2.2. Global Consequences

Intensity	Return Period	PGA (g)	Sa(T_1)*	P[red tag]	P[collapse]	P[excessive residual]
50% in 50 years	72 years	0.22	0.39	0.0%	0.0%	0.0%
10% in 50 years	475 years	0.62	1.19	0.0%	0.0%	0.0%
DE	481 years	0.62	1.20	0.0%	0.0%	0.0%
5% in 50 years	975 years	0.82	1.65	0.0%	0.0%	0.0%
MCE$_R$	1277 years	0.91	1.84	0.9%	0.5%	0.4%
2% in 50 years	2475 years	1.13	2.35	8.7%	3.2%	5.5%

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

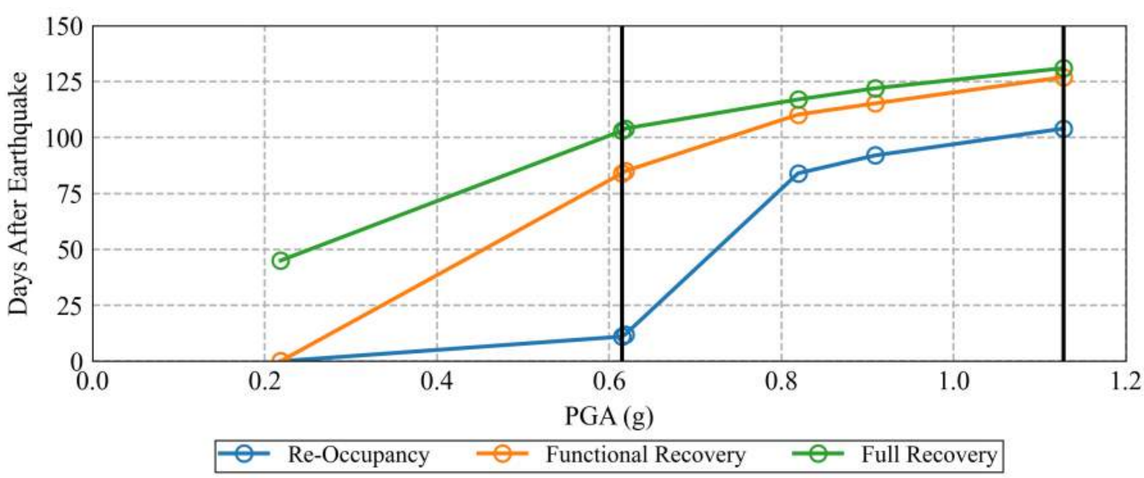


Figure 2.1. ATC-138 Functional Recovery (Beta) Methodology median recovery times

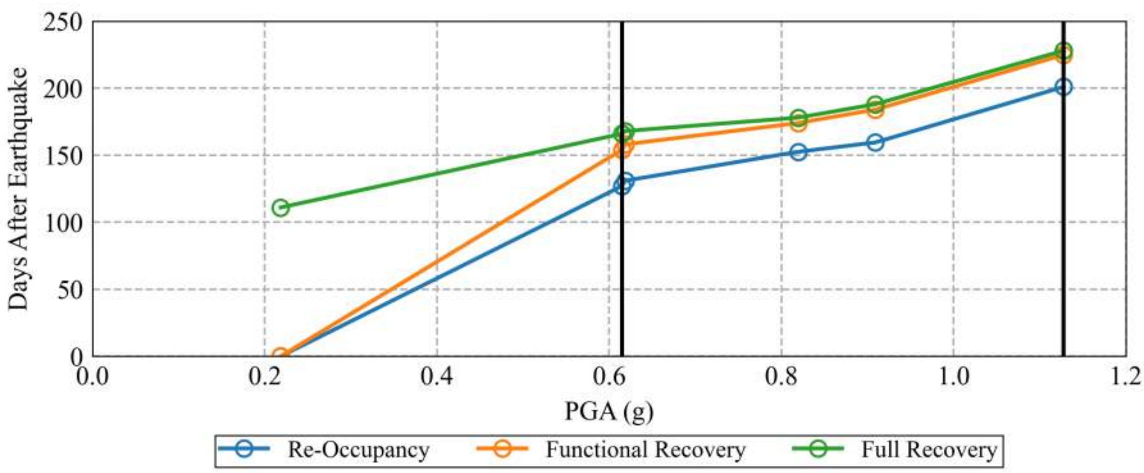


Figure 2.2. ATC-138 Functional Recovery (Beta) Methodology 90^{th} percentile recovery times

3 COMPONENT DAMAGE OVERVIEW

3.1 Most Damaged Components

This section outlines the most damaged component at each intensity. "Most damaged" is determined by cost and does not necessarily mean that it's the main component impeding building function.

Table 3.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1071.302	1	$1,368
10% in 50 years	B1071.302	1	$9,629
DE	B1071.302	1	$9,731
5% in 50 years	B1071.302	1	$16,072
MCE_R	B1031.011a	1	$18,918
2% in 50 years	B1031.011a	1	$34,920

Table 3.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	C1011.311a	1	$3,176
10% in 50 years	C1011.311a	1	$31,144
DE	C1011.311a	1	$31,440
5% in 50 years	C1011.311a	3	$38,842
MCE_R	C1011.311a	3	$40,722
2% in 50 years	C1011.311a	3	$40,630

Details of the most damaged components and their damage states:

- **B1031.011a**: Steel Column Base Plates, Column W < 150 plf
  - DS1a: Initiation of crack at the fusion line between the column flange and the base plate weld. Damage in field is either obscured or deemed to not warrant repair. No repair conducted.
  - DS1b: Initiation of crack at the fusion line between the column flange and the base plate weld.
- **B1071.302**: Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs
  - DS1: Cracking of paint over fasteners or joints.
- **C1011.311a**: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above
  - DS1: Cracking of paint over fasteners or joints.
  - DS3: Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.

3.2 Worker Days Summary

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.3. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.2	0.4	0.7	0.9	1.3
DS2	0.0	1.1	1.3	4.5	7.3	13
DS3	0.0	0.3	0.5	2.5	5.0	10
Total	**0.0**	**1.6**	**2.2**	**7.7**	**13**	**24**
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0.0	0.0	0.0	0.1	0.1	0.2
DS1b	0.0	0.0	0.0	0.0	0.1	0.1
DS2a	0.0	0.0	0.0	0.0	0.0	0.1
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.2**	**0.2**	**0.3**
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0.0	0.0	0.0	0.1	0.3	0.3
DS1b	0.0	0.0	0.0	0.1	0.1	0.1
DS2a	0.0	0.0	0.0	0.0	0.0	0.1
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.2**	**0.4**	**0.5**
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.0	2.7	2.6	2.5	2.3	1.4
DS2	0.0	1.0	1.0	1.9	2.1	2.0
DS3	0.0	1.2	1.2	4.4	6.1	10
Total	**0.0**	**4.9**	**4.9**	**8.9**	**11**	**13**
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.6	0.4	0.4	0.3	0.3	0.3
DS2	0.1	0.4	0.5	0.4	0.4	0.3
DS3	0.1	2.4	2.3	2.2	2.0	1.2
DS4	0.0	1.9	2.0	3.7	4.0	3.6
DS5	0.0	1.7	1.7	6.1	8.9	14
Total	**0.8**	**6.9**	**7.0**	**13**	**16**	**19**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	0.1	2.8	2.8	2.5	2.3	1.6
DS2	0.0	2.2	2.2	2.5	2.4	1.8
DS3	0.0	5.9	5.8	12	15	18
Total	**0.1**	**11**	**11**	**17**	**19**	**22**

Continued on next page

Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	0.7	1.1	1.2	1.0	1.0	0.8
DS2	0.1	1.0	1.0	1.0	1.0	0.8
DS3	0.1	6.7	6.6	9.3	10	10
Total	**0.9**	**8.8**	**8.8**	**11**	**12**	**12**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.4	2.0	2.0	1.7	1.7	1.4
DS2	0.2	2.1	2.0	1.9	1.7	1.5
DS3	0.1	13	13	18	20	20
Total	**1.8**	**17**	**18**	**22**	**23**	**23**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.0	0.5	0.5	0.4	0.4	0.3
DS2	0.0	0.7	0.7	1.2	1.3	1.4
DS3	0.0	0.6	0.7	2.1	2.7	4.3
Total	**0.0**	**1.8**	**1.9**	**3.7**	**4.5**	**6.0**
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	0.0	0.3	0.3	0.3	0.3	0.3
DS2	0.0	0.4	0.4	0.6	0.5	0.5
DS3	0.0	4.0	4.3	6.0	7.1	6.7
Total	**0.0**	**4.7**	**5.0**	**6.9**	**8.0**	**7.6**
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	0.0	0.4	0.4	0.4	0.4	0.4
DS2	0.0	0.7	0.6	0.9	0.9	0.9
DS3	0.0	4.7	5.1	6.9	8.0	8.3
Total	**0.0**	**5.8**	**6.2**	**8.2**	**9.3**	**10**
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	0.0	0.7	0.7	0.7	0.7	0.7
DS2	0.0	0.9	1.0	1.2	1.4	1.3
DS3	0.0	5.5	5.6	7.9	9.4	8.7
Total	**0.0**	**7.0**	**7.3**	**10**	**11**	**11**
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	0.0	0.7	0.8	0.8	0.8	0.8
DS2	0.0	1.2	1.2	1.4	1.7	1.5
DS3	0.0	5.6	5.9	7.4	9.1	9.0
Total	**0.0**	**7.6**	**7.9**	**10**	**12**	**11**
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**0.1**	**3.1**	**3.3**	**3.5**	**3.6**	**3.3**
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.1	0.1	0.1
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.1	0.1	0.1
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**

Continued on next page

Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D2031.013b #1 (D2031.013b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING...)						
DS1	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.0	0.0	0.0	0.0	0.0
DS1c	0.0	0.0	0.0	0.0	0.0	0.0
DS1d	0.0	0.0	0.0	0.1	0.1	0.1
Total	**0.0**	**0.0**	**0.0**	**0.1**	**0.2**	**0.2**
D3032.013c #2 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.0	0.1	0.1	0.1	0.1	0.1
DS1b	0.0	0.1	0.1	0.2	0.2	0.1
DS1c	0.0	0.1	0.1	0.2	0.2	0.1
DS1d	0.0	0.6	0.5	0.7	0.8	0.7
Total	**0.0**	**0.9**	**0.8**	**1.2**	**1.2**	**1.1**
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.1	0.1	0.1	0.1	0.1
DS2	0.0	0.2	0.2	0.2	0.3	0.3
Total	**0.0**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.2**	**6.0**	**6.4**	**7.0**	**7.6**	**7.3**

3.3 Component Name Reference

This list is provided for reference where only the fragility ID is available.

- **B1031.011a**: Steel Column Base Plates, Column W < 150 plf
- **B1035.041**: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27
- **B1035.051**: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27
- **B1071.202**: Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs
- **B1071.302**: Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs
- **B2011.401**: Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs
- **C1011.211a**: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above
- **C1011.311a**: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above
- **C2011.041b**: Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.
- **C3032.004a**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support
- **C3032.004b**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support
- **C3032.004c**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support
- **C3032.004d**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support
- **C3034.002**: Independent Pendant Lighting - seismically rated
- **D2021.013a**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY
- **D2021.013b**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY
- **D2021.023a**: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY
- **D2021.023b**: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY
- **D2031.013b**: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING FRAGILITY
- **D3032.013c**: Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility

- **D3041.011c**: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F
- **D3041.032c**: HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F

4 DETAILED REOCCUPANCY AND FUNCTIONALITY RESULTS BY GROUND MOTION INTENSITY

4.1 50% in 50 years Intensity

4.1.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

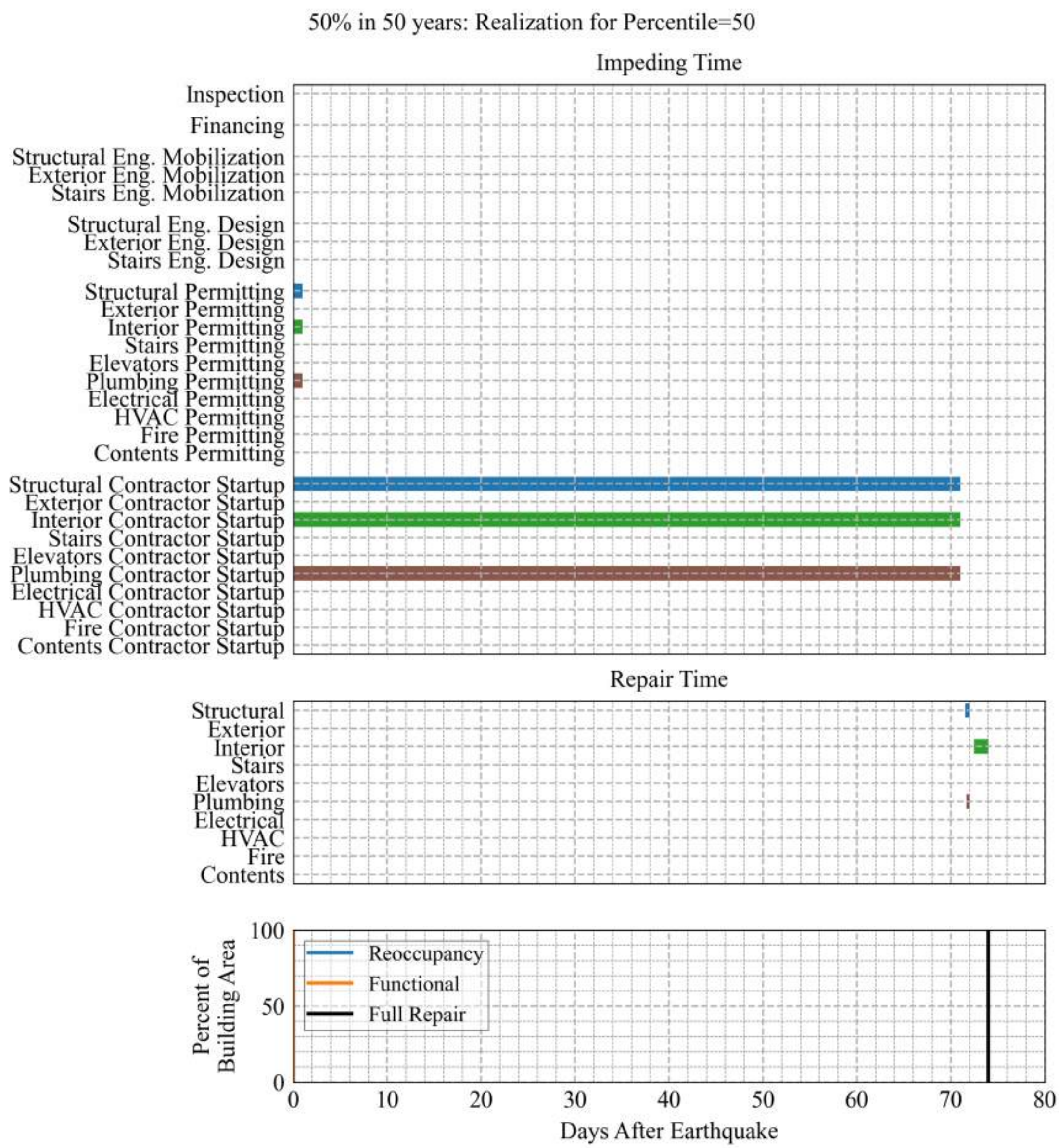


Figure 4.1. 50% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

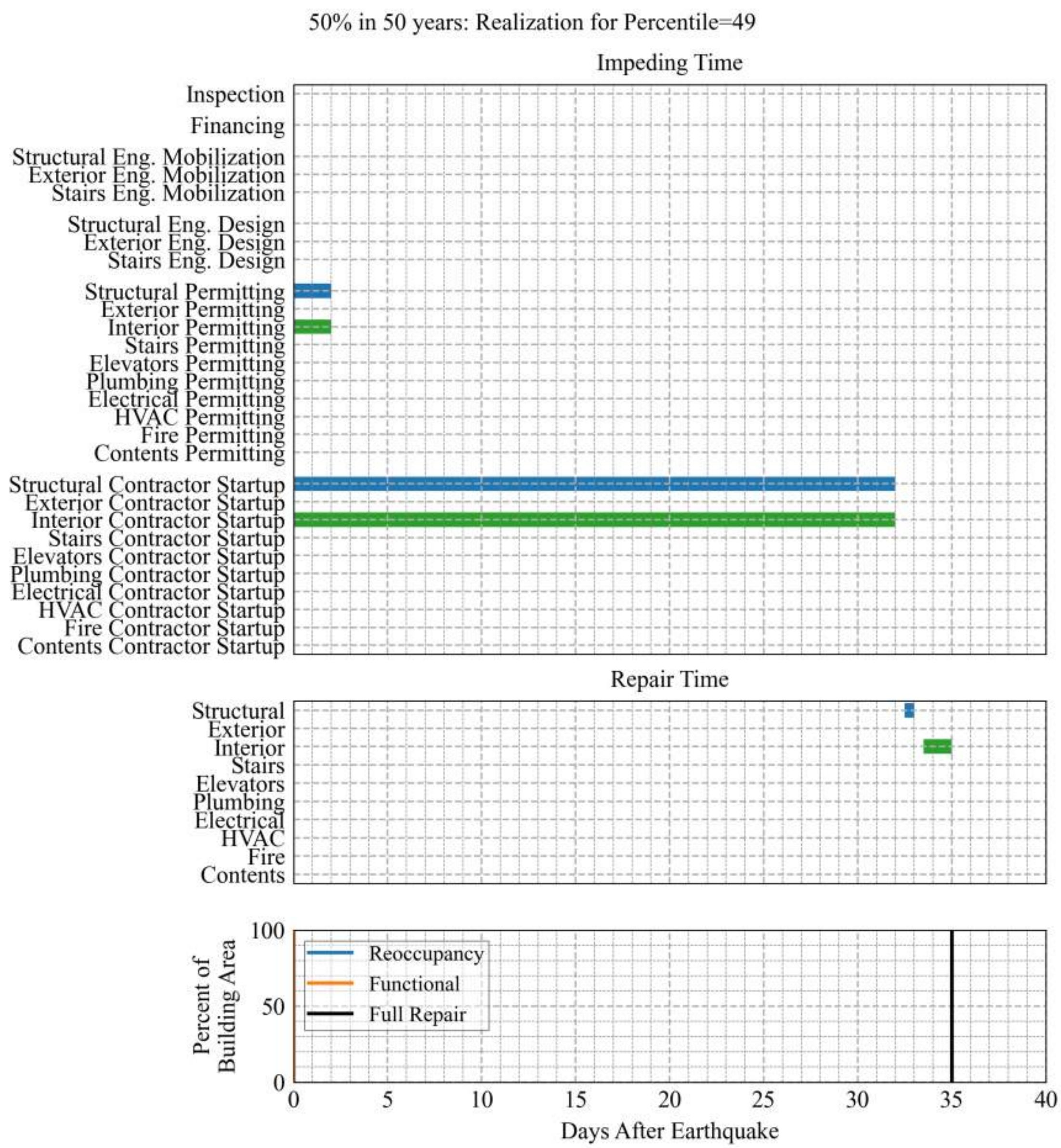


Figure 4.2. 50% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

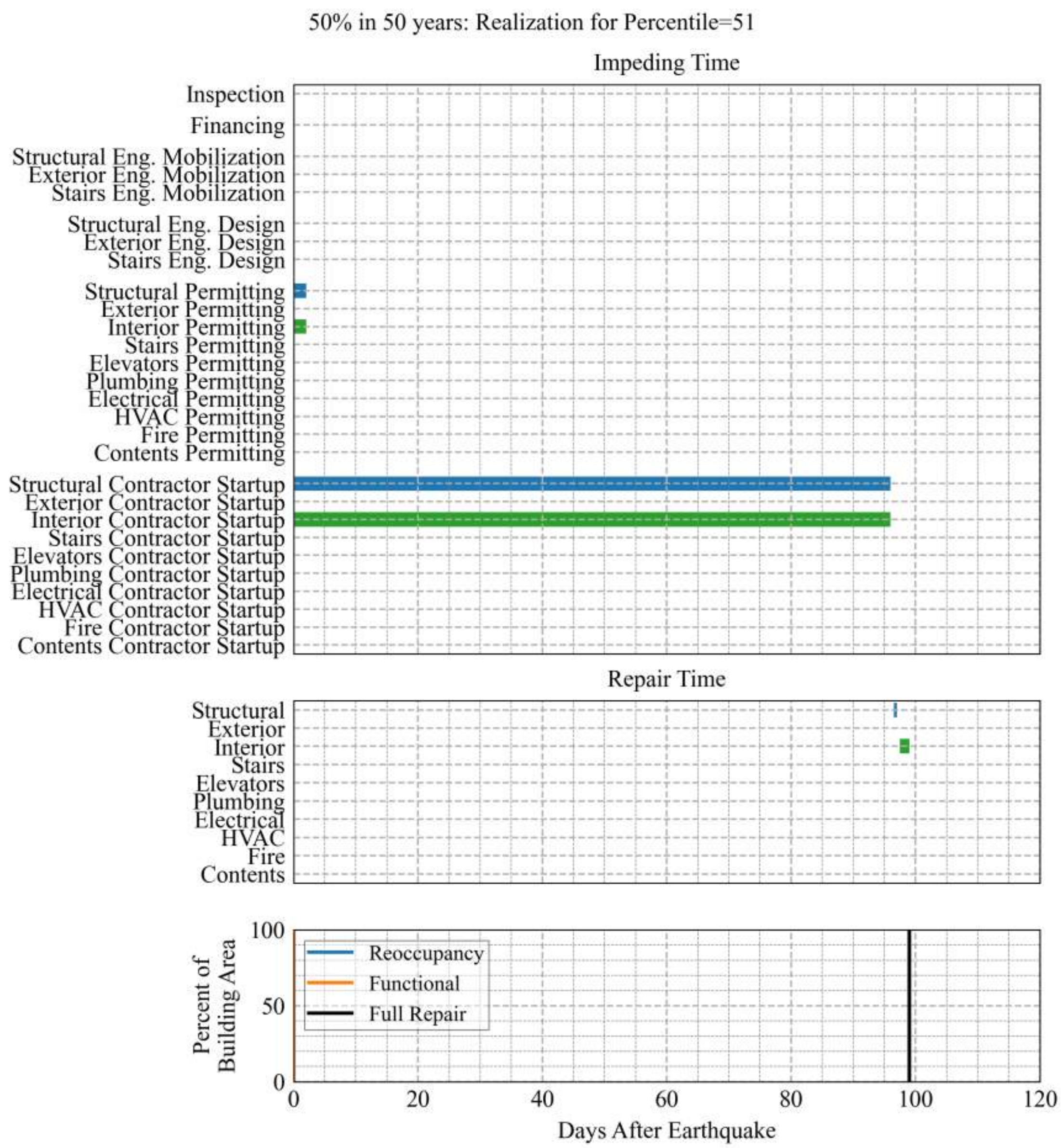


Figure 4.3. 50% in 50 years Percentile = 51

4.1.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

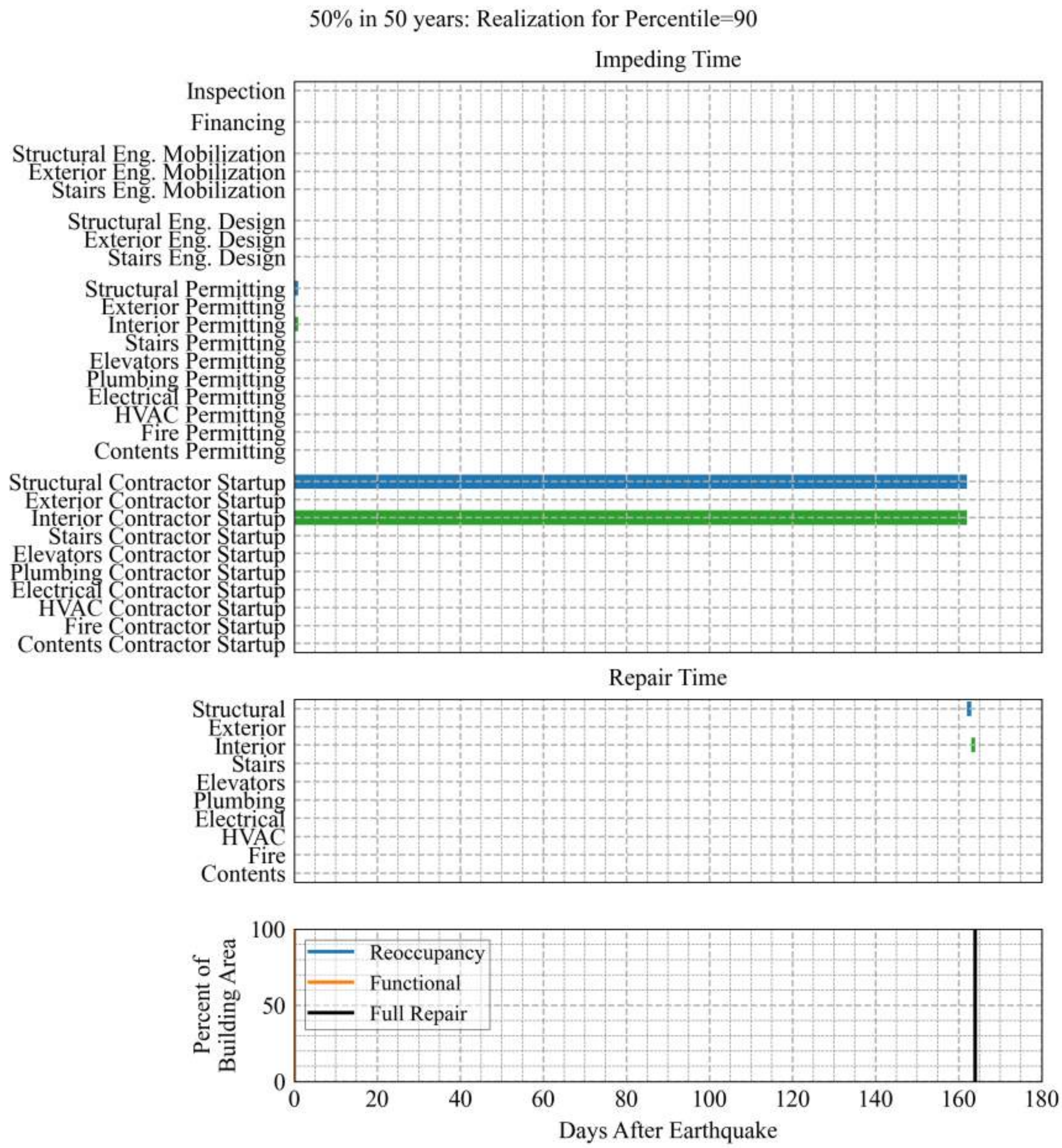


Figure 4.4. 50% in 50 years Percentile = 90

4.1.3 Damage to Building Systems

Table 4.1 shows the percentage of realizations that the named system prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.1. Percent of realizations affecting building reoccupancy/function per system - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Stairway Doors	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	0.5	0.5	0.3	0.0	0.0	0.0	0.0
Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	1.7	1.7	1.7	1.6	1.3	0.0	0.0

4.1.4 Damage to Individual Components

Table 4.2 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.2. Percent of realizations affecting building reoccupancy/functionality per component - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.202	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.302	0.0 / 0.3	0.0 / 0.2	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 0.1	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 0.5	0.0 / 0.5	0.0 / 0.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	0.1 / 0.0	0.1 / 0.0	0.1 / 0.0	0.1 / 0.0	0.1 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004d	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.002	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.013a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 1.1	0.0 / 1.1	0.0 / 1.1	0.0 / 1.1	0.0 / 0.9	0.0 / 0.0	0.0 / 0.0
D3041.011c	0.0 / 0.1	0.0 / 0.1	0.0 / 0.1	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.032c	0.0 / 0.5	0.0 / 0.5	0.0 / 0.5	0.0 / 0.5	0.0 / 0.4	0.0 / 0.0	0.0 / 0.0

4.2 10% in 50 years Intensity

4.2.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

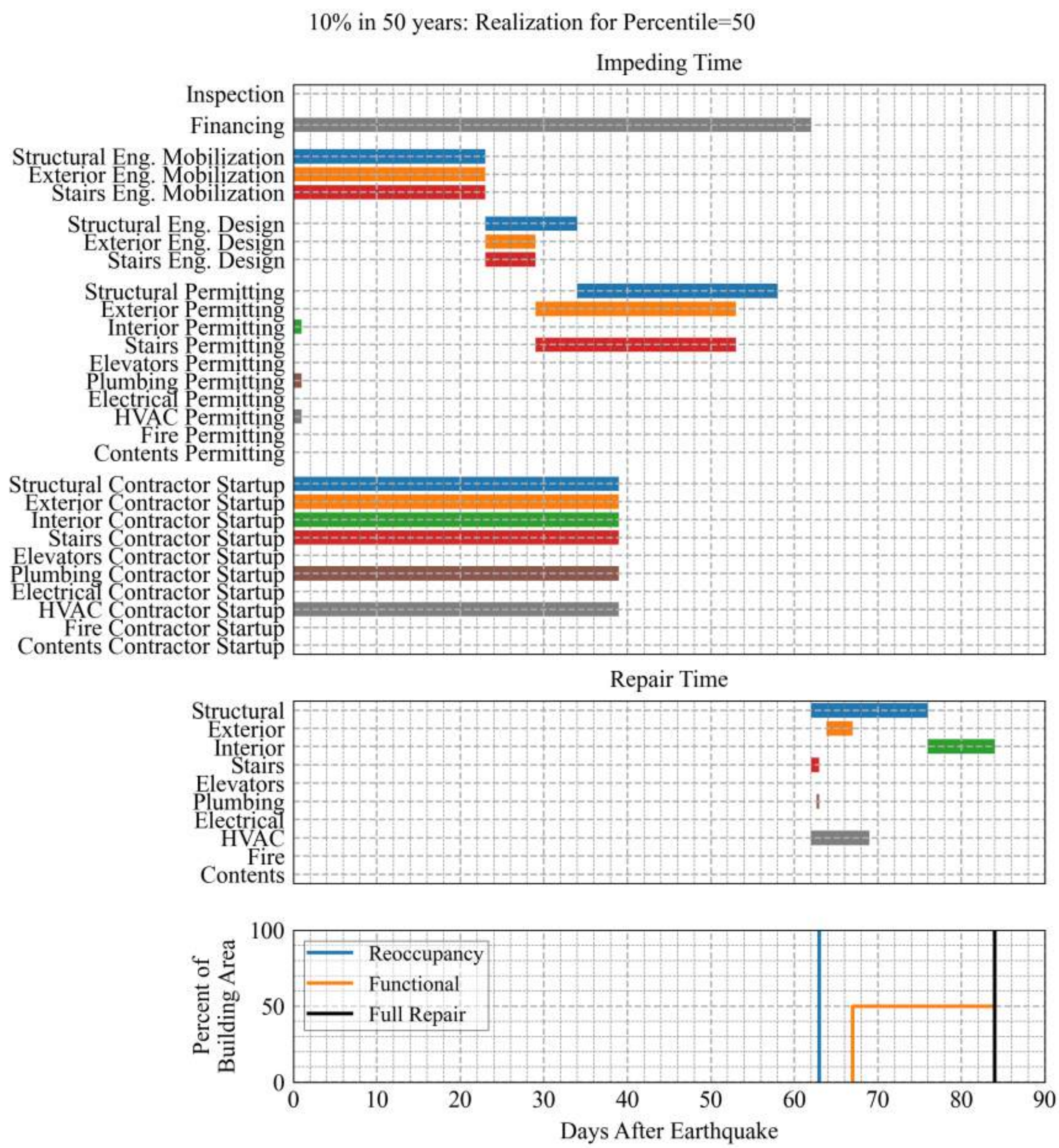


Figure 4.5. 10% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

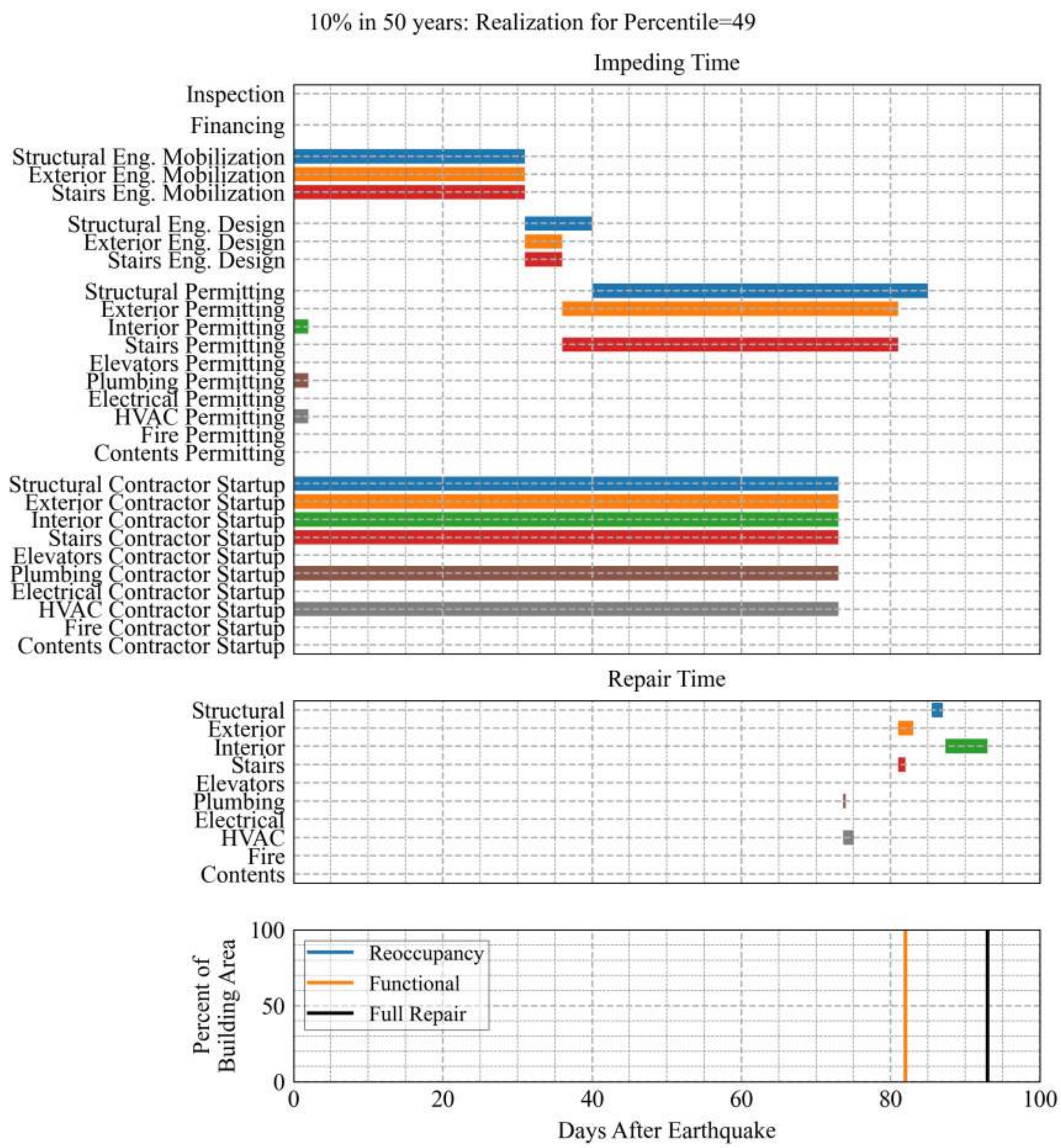


Figure 4.6. 10% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

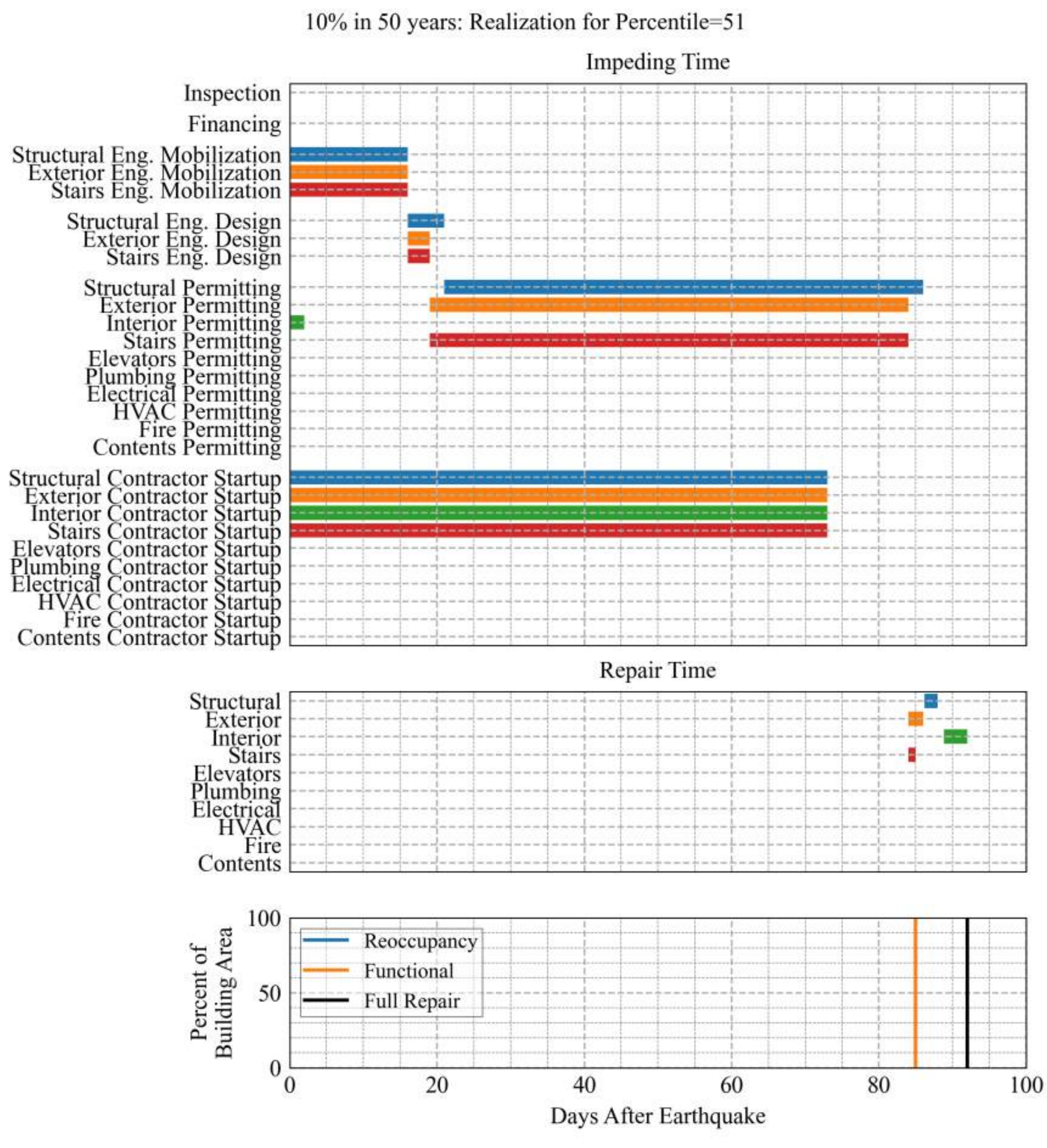


Figure 4.7. 10% in 50 years Percentile = 51

4.2.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

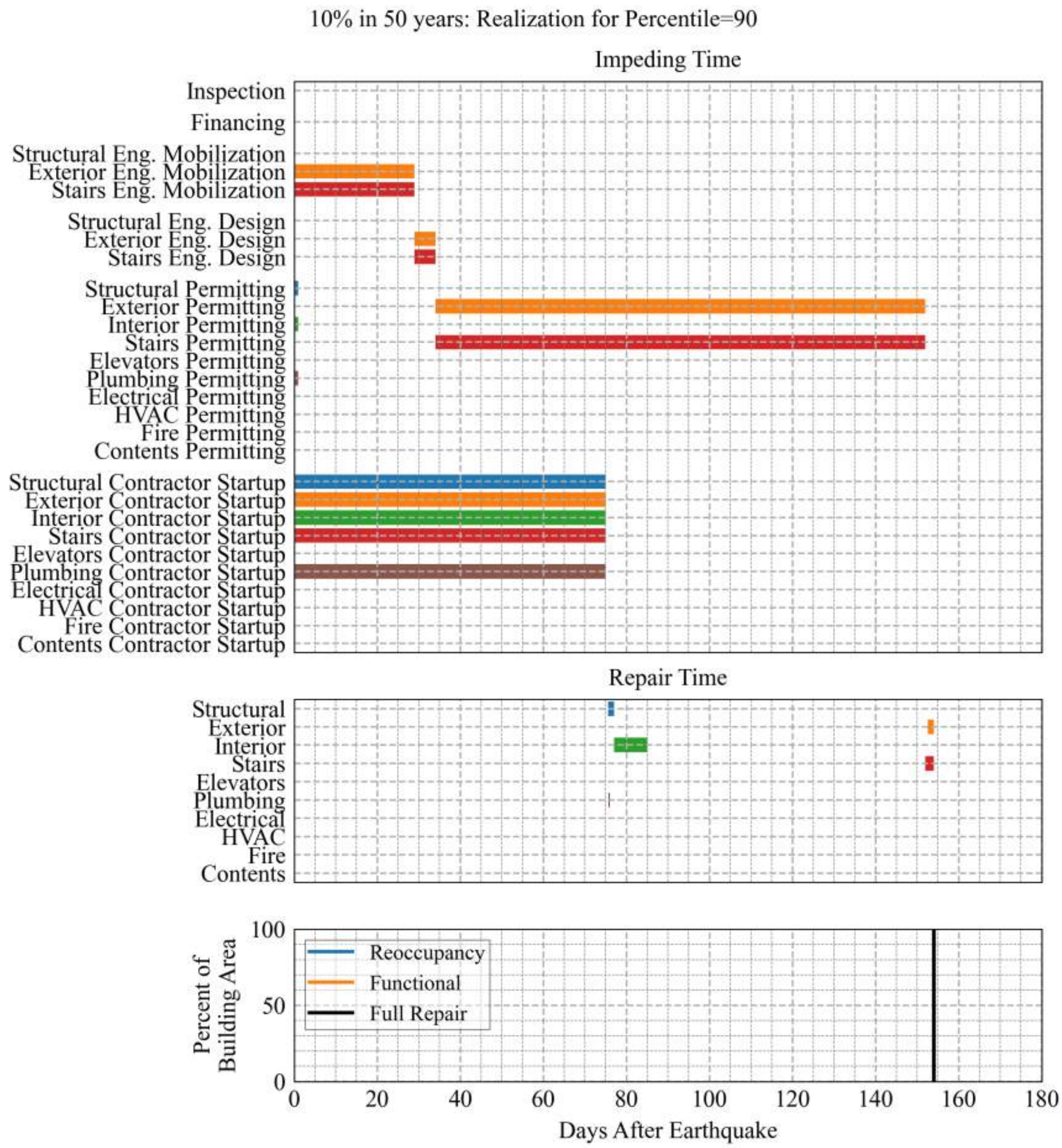


Figure 4.8. 10% in 50 years Percentile = 90

4.2.3 Damage to Building Systems

Table 4.3 shows the percentage of realizations that the named system prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.3. Percent of realizations affecting building reoccupancy/function per system - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	40	40	40	40	40	1.6	0.0
Stairway Doors	2.6	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	56	53	29	6.9	0.4	0.0	0.0
Interior	31	27	14	8.4	7.2	0.2	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	17	17	17	17	17	0.9	0.0
Interior	71	66	35	12	4.7	0.1	0.0
Water	7.8	7.8	7.8	7.6	7.0	0.2	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	60	60	60	59	56	3.6	0.0

4.2.4 Damage to Individual Components

Table 4.4 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.4. Percent of realizations affecting building reoccupancy/functionality per component - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.202	20 / 18	18 / 17	7.6 / 14	1.8 / 13	0.3 / 13	0.0 / 0.7	0.0 / 0.0
B1071.302	0.0 / 71	0.0 / 66	0.0 / 34	0.0 / 18	0.0 / 17	0.0 / 0.9	0.0 / 0.0
B2011.401	56 / 63	53 / 58	27 / 27	5.9 / 17	0.4 / 17	0.0 / 0.9	0.0 / 0.0
C1011.211a	0.0 / 65	0.0 / 58	0.0 / 17	0.0 / 2.0	0.0 / 0.3	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 70	0.0 / 65	0.0 / 32	0.0 / 7.8	0.0 / 0.5	0.0 / 0.0	0.0 / 0.0
C2011.041b	40 / 0.0	40 / 0.0	40 / 0.0	40 / 0.0	40 / 0.0	1.6 / 0.0	0.0 / 0.0
C3032.004a	18 / 12	16 / 10	5.5 / 3.3	1.0 / 0.6	0.2 / 0.1	0.0 / 0.0	0.0 / 0.0
C3032.004b	19 / 14	16 / 12	5.1 / 4.1	0.9 / 0.6	0.1 / 0.1	0.0 / 0.0	0.0 / 0.0
C3032.004c	22 / 16	17 / 13	5.9 / 4.0	1.0 / 0.7	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0
C3032.004d	23 / 18	19 / 14	6.4 / 4.2	1.1 / 0.9	0.2 / 0.1	0.0 / 0.0	0.0 / 0.0
C3034.002	31 / 56	26 / 50	9.8 / 16	1.8 / 1.8	0.2 / 0.4	0.0 / 0.0	0.0 / 0.0
D2021.013a	4.7 / 4.7	4.7 / 4.7	4.7 / 4.7	4.6 / 4.6	4.3 / 4.3	0.1 / 0.1	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	4.4 / 4.4	4.4 / 4.4	4.4 / 4.4	4.3 / 4.3	4.0 / 4.0	0.1 / 0.1	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 31	0.0 / 31	0.0 / 31	0.0 / 30	0.0 / 26	0.0 / 0.7	0.0 / 0.0
D3041.011c	19 / 31	9.6 / 31	1.0 / 31	0.3 / 31	0.1 / 31	0.0 / 2.6	0.0 / 0.0
D3041.032c	30 / 58	26 / 56	13 / 49	8.0 / 43	6.8 / 40	0.2 / 3.1	0.0 / 0.0

4.3 DE Intensity

4.3.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

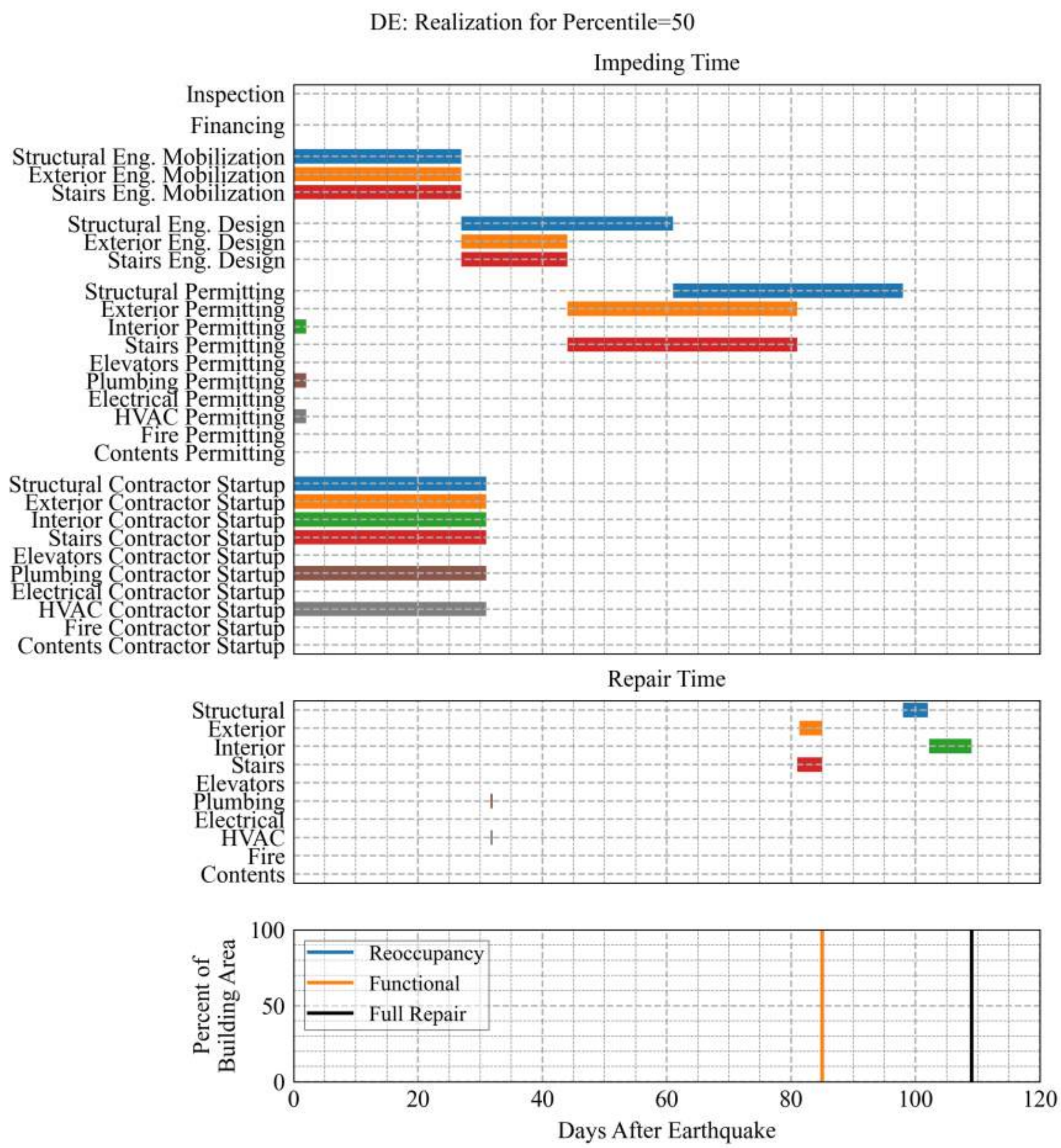


Figure 4.9. DE Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

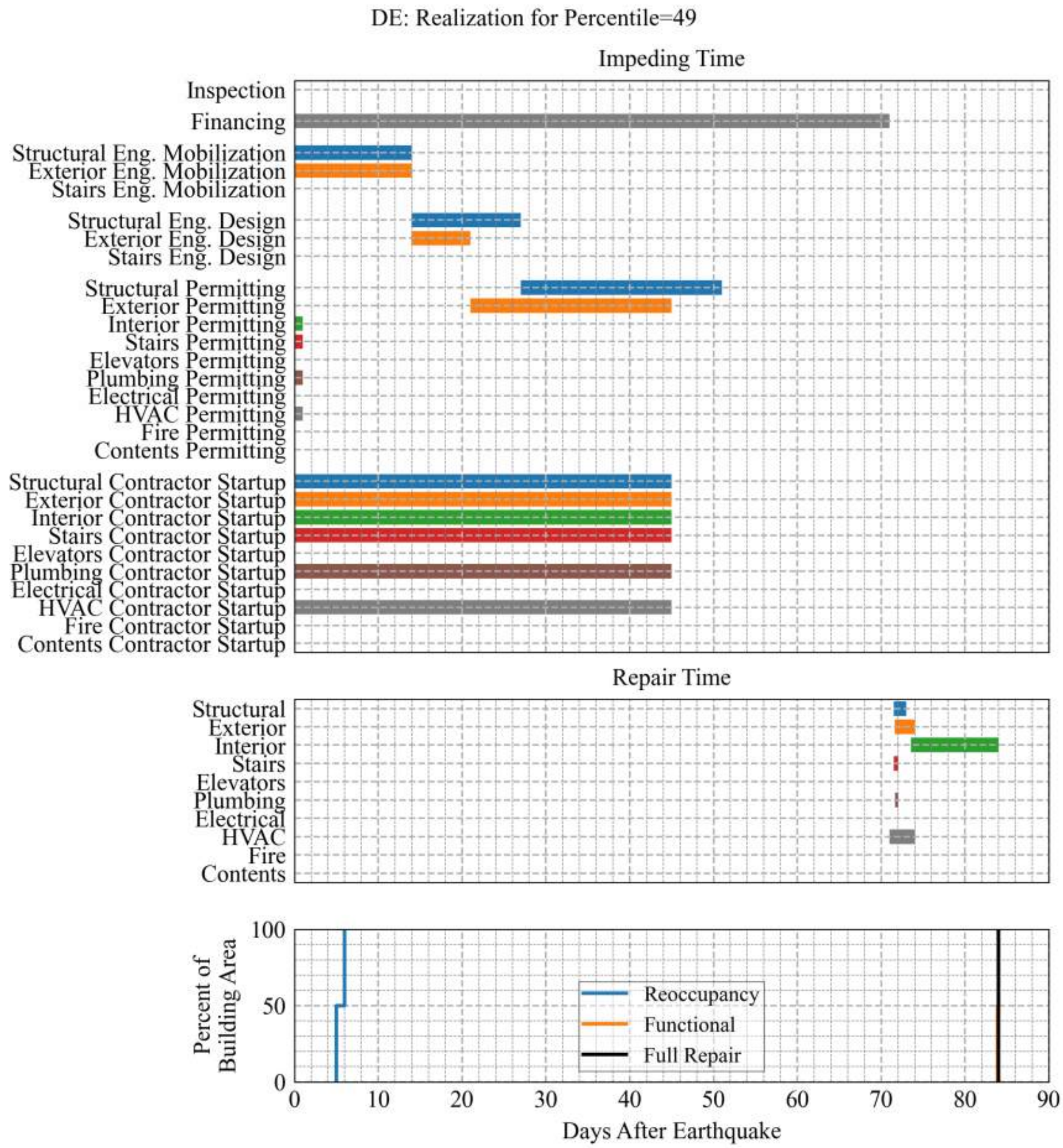


Figure 4.10. DE Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

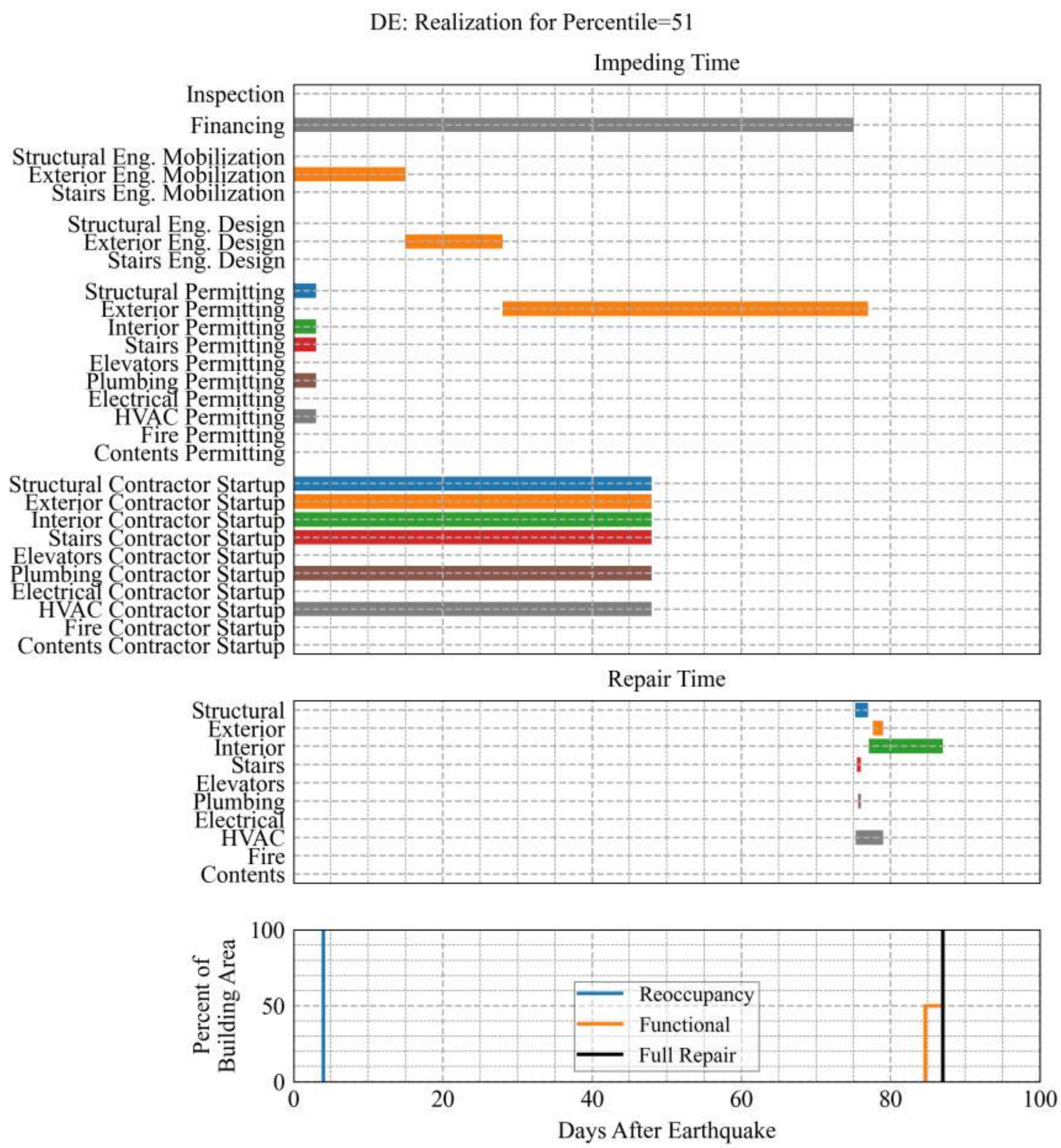


Figure 4.11. DE Percentile = 51

4.3.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

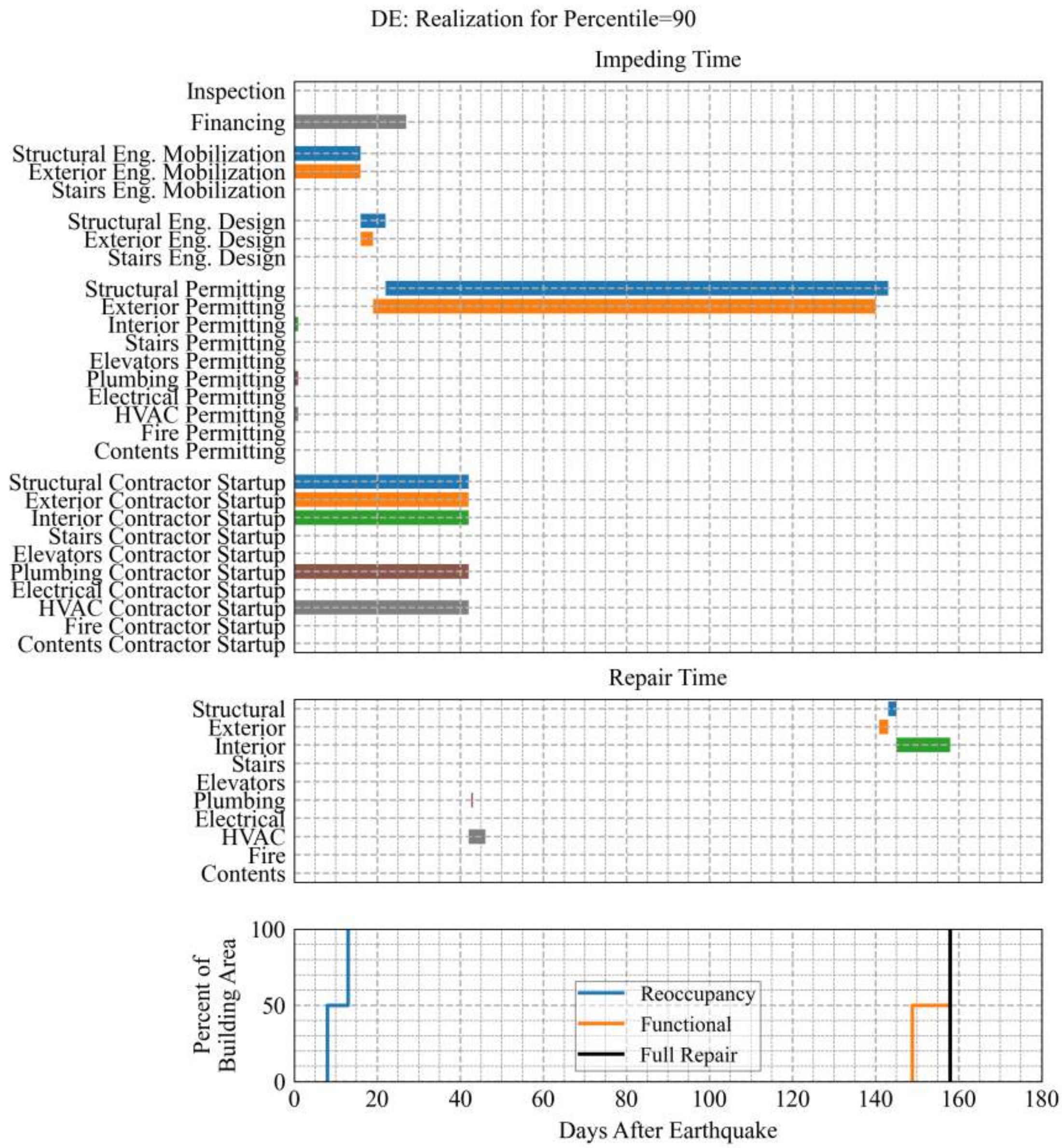


Figure 4.12. DE Percentile = 90

4.3.3 Damage to Building Systems

Table 4.5 shows the percentage of realizations that the named system prevents reoccupancy/function for the DE intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.5. Percent of realizations affecting building reoccupancy/function per system - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	42	42	42	42	42	1.2	0.0
Stairway Doors	3.8	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	56	53	30	7.3	0.5	0.0	0.0
Interior	34	31	17	9.9	8.6	0.0	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	17	17	17	17	17	0.8	0.0
Interior	73	68	38	12	5.4	0.0	0.0
Water	9.2	9.2	9.2	9.2	8.4	0.0	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	61	61	61	61	59	4.0	0.0

4.3.4 Damage to Individual Components

Table 4.6 shows the percentage of realizations that a specific component prevents reoccupancy/function for the DE intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.6. Percent of realizations affecting building reoccupancy/functionality per component - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.202	21 / 18	19 / 17	7.7 / 14	1.9 / 14	0.4 / 14	0.0 / 0.6	0.0 / 0.0
B1071.302	0.0 / 73	0.0 / 68	0.0 / 34	0.0 / 19	0.0 / 17	0.0 / 0.8	0.0 / 0.0
B2011.401	56 / 65	52 / 59	28 / 29	6.7 / 18	0.5 / 17	0.0 / 0.8	0.0 / 0.0
C1011.211a	0.0 / 67	0.0 / 59	0.0 / 18	0.0 / 2.0	0.0 / 0.4	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 73	0.0 / 67	0.0 / 34	0.0 / 7.8	0.0 / 0.5	0.0 / 0.0	0.0 / 0.0
C2011.041b	42 / 0.0	42 / 0.0	42 / 0.0	42 / 0.0	42 / 0.0	1.2 / 0.0	0.0 / 0.0
C3032.004a	19 / 12	16 / 10	5.8 / 3.7	1.1 / 0.8	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0
C3032.004b	21 / 14	18 / 11	5.8 / 3.6	0.7 / 0.3	0.2 / 0.1	0.0 / 0.0	0.0 / 0.0
C3032.004c	23 / 16	19 / 13	5.8 / 3.8	0.8 / 0.7	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0
C3032.004d	24 / 18	20 / 15	6.6 / 4.4	1.6 / 1.0	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0
C3034.002	34 / 59	29 / 52	11 / 16	1.8 / 2.2	0.2 / 0.4	0.0 / 0.0	0.0 / 0.0
D2021.013a	5.3 / 5.3	5.3 / 5.3	5.3 / 5.3	5.3 / 5.3	4.9 / 4.9	0.0 / 0.0	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	5.3 / 5.3	5.3 / 5.3	5.3 / 5.3	5.3 / 5.3	4.8 / 4.8	0.0 / 0.0	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 30	0.0 / 30	0.0 / 30	0.0 / 30	0.0 / 27	0.0 / 0.7	0.0 / 0.0
D3041.011c	21 / 32	10 / 32	1.3 / 32	0.4 / 32	0.1 / 32	0.0 / 2.4	0.0 / 0.0
D3041.032c	32 / 61	30 / 60	16 / 52	9.4 / 47	8.2 / 44	0.0 / 3.3	0.0 / 0.0

4.4 MCE$_R$ Intensity

4.4.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

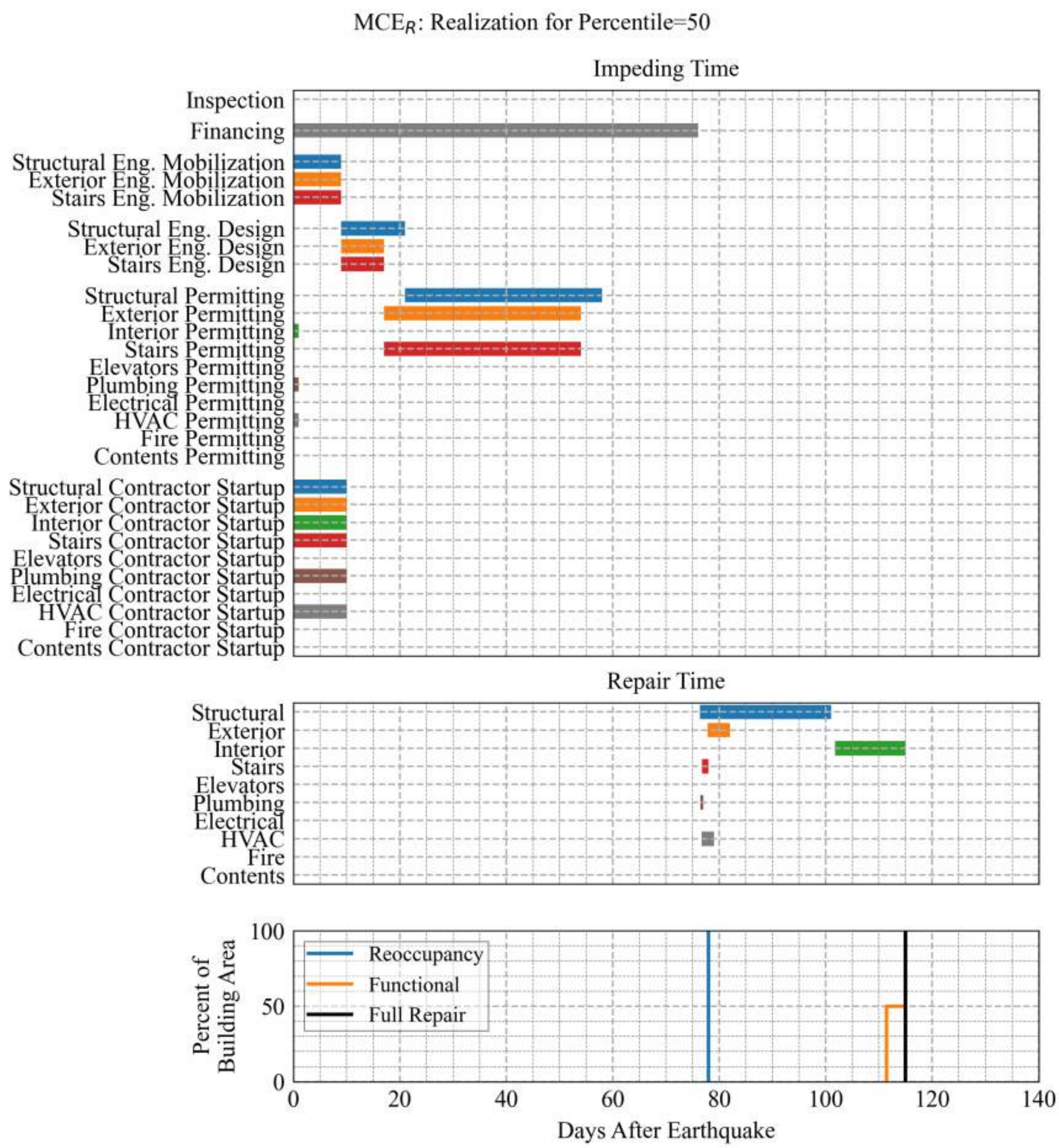


Figure 4.13. MCE$_R$ Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

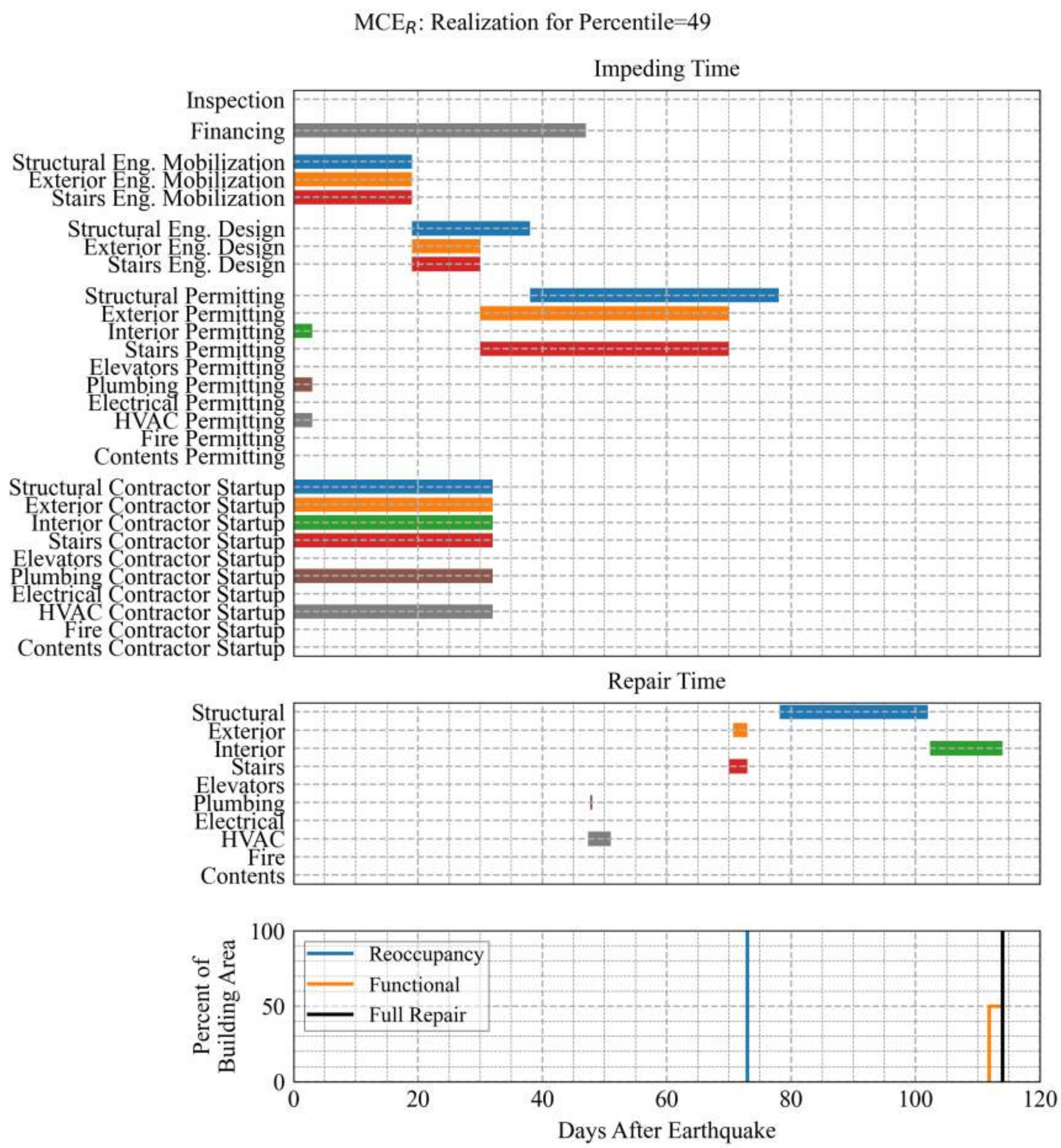


Figure 4.14. MCE$_R$ Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

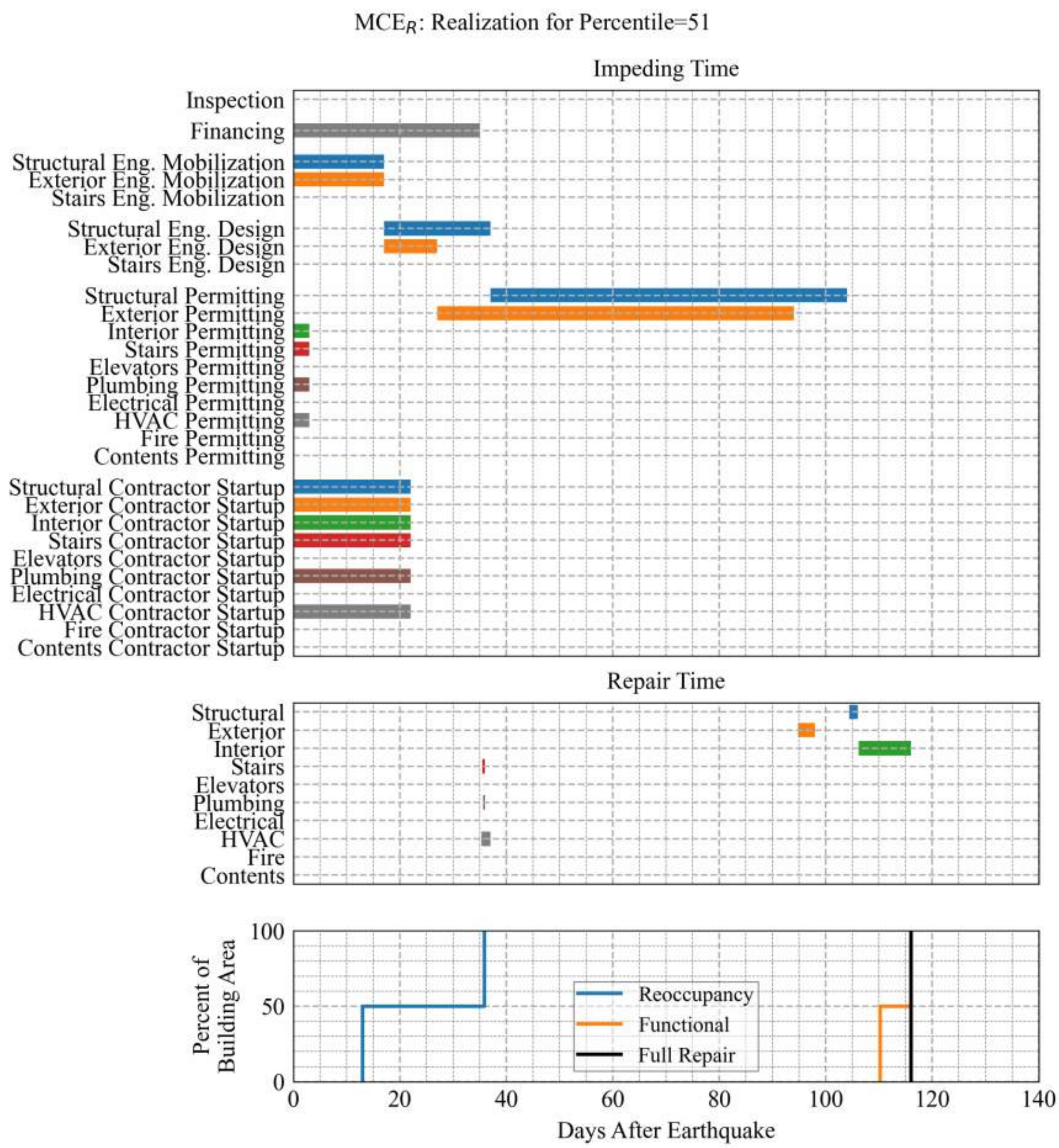


Figure 4.15. MCE$_R$ Percentile = 51

4.4.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

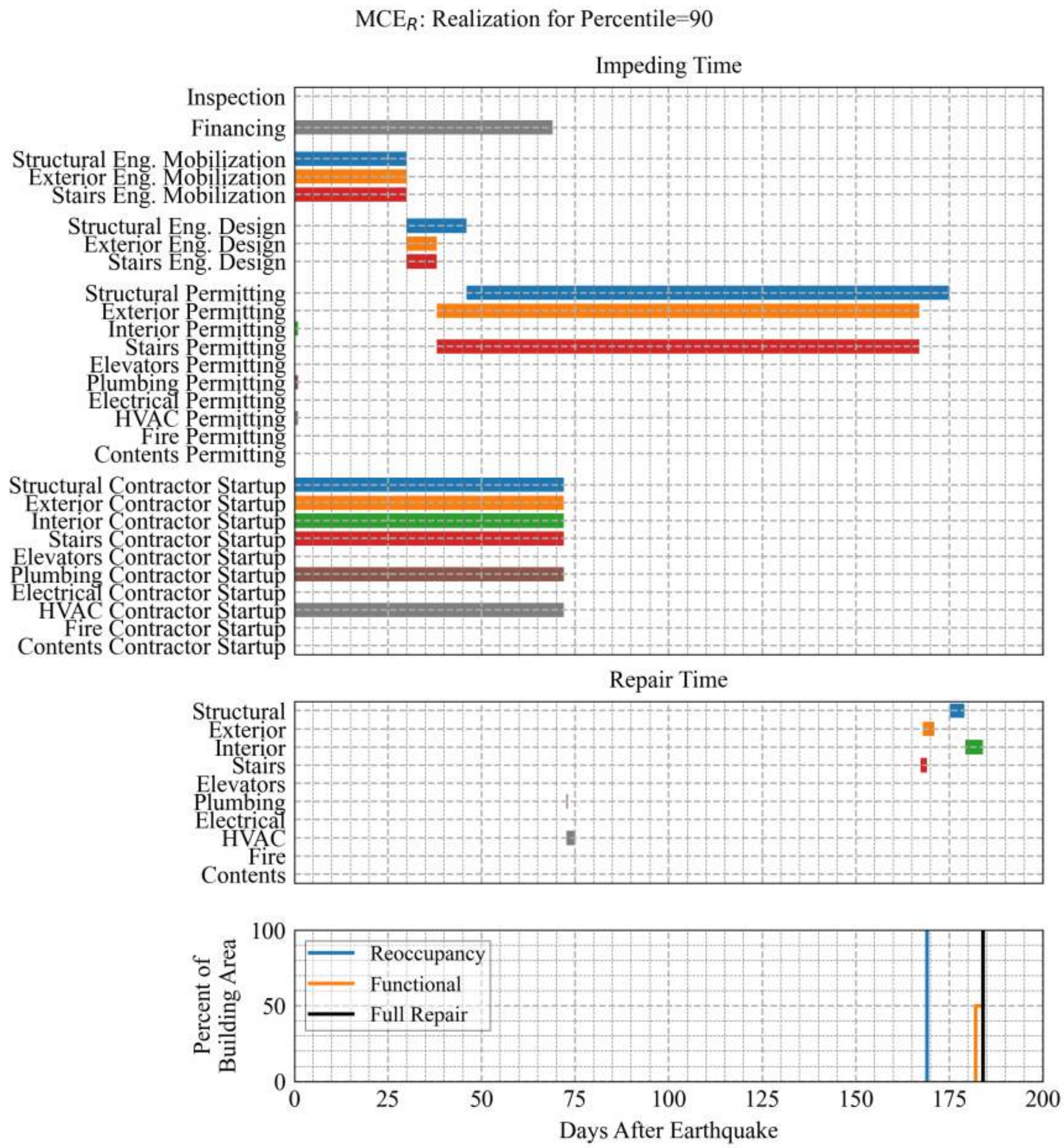


Figure 4.16. MCE$_R$ Percentile = 90

4.4.3 Damage to Building Systems

Table 4.7 shows the percentage of realizations that the named system prevents reoccupancy/function for the MCE$_R$ intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.7. Percent of realizations affecting building reoccupancy/function per system - MCE$_R$

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	0.9	0.9	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	82	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	82	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	79	79	79	79	79	3.7	0.0
Stairway Doors	89	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	94	91	59	21	4.7	0.0	0.0
Interior	49	45	27	19	16	0.2	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	77	77	77	77	77	5.5	0.0
Interior	96	92	57	24	13	0.1	0.0
Water	14	14	14	14	14	0.2	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	74	74	74	74	73	7.7	0.0

4.4.4 Damage to Individual Components

Table 4.8 shows the percentage of realizations that a specific component prevents reoccupancy/function for the MCE_R intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.8. Percent of realizations affecting building reoccupancy/functionality per component - MCE_R

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.202	70 / 70	65 / 69	32 / 68	12 / 67	4.1 / 67	0.0 / 5.0	0.0 / 0.0
B1071.302	0.0 / 96	0.0 / 94	0.0 / 83	0.0 / 78	0.0 / 77	0.0 / 5.5	0.0 / 0.0
B2011.401	94 / 95	90 / 93	51 / 81	18 / 77	4.5 / 77	0.0 / 4.8	0.0 / 0.0
C1011.211a	0.0 / 95	0.0 / 86	0.0 / 33	0.0 / 9.5	0.0 / 3.9	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 96	0.0 / 90	0.0 / 49	0.0 / 17	0.0 / 4.7	0.0 / 0.0	0.0 / 0.0
C2011.041b	79 / 0.0	79 / 0.0	79 / 0.0	79 / 0.0	79 / 0.0	3.7 / 0.0	0.0 / 0.0
C3032.004a	32 / 22	28 / 20	12 / 8.2	4.4 / 3.0	1.8 / 1.4	0.0 / 0.0	0.0 / 0.0
C3032.004b	33 / 24	29 / 20	12 / 9.4	5.2 / 4.0	1.9 / 1.6	0.0 / 0.0	0.0 / 0.0
C3032.004c	37 / 29	31 / 24	13 / 10	5.1 / 4.2	2.0 / 1.7	0.0 / 0.0	0.0 / 0.0
C3032.004d	39 / 31	34 / 26	14 / 11	5.6 / 4.4	2.0 / 1.5	0.0 / 0.0	0.0 / 0.0
C3034.002	49 / 81	43 / 74	20 / 29	7.0 / 8.9	2.5 / 3.8	0.0 / 0.0	0.0 / 0.0
D2021.013a	8.4 / 8.4	8.4 / 8.4	8.4 / 8.4	8.4 / 8.4	8.2 / 8.2	0.1 / 0.1	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	8.5 / 8.5	8.5 / 8.5	8.5 / 8.5	8.5 / 8.5	8.2 / 8.2	0.2 / 0.2	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 41	0.0 / 41	0.0 / 41	0.0 / 41	0.0 / 39	0.0 / 1.0	0.0 / 0.0
D3041.011c	32 / 44	19 / 44	5.5 / 44	3.4 / 44	1.3 / 44	0.0 / 5.4	0.0 / 0.0
D3041.032c	48 / 75	44 / 74	27 / 67	18 / 59	15 / 57	0.2 / 6.3	0.0 / 0.0

4.5 2% in 50 years Intensity

4.5.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

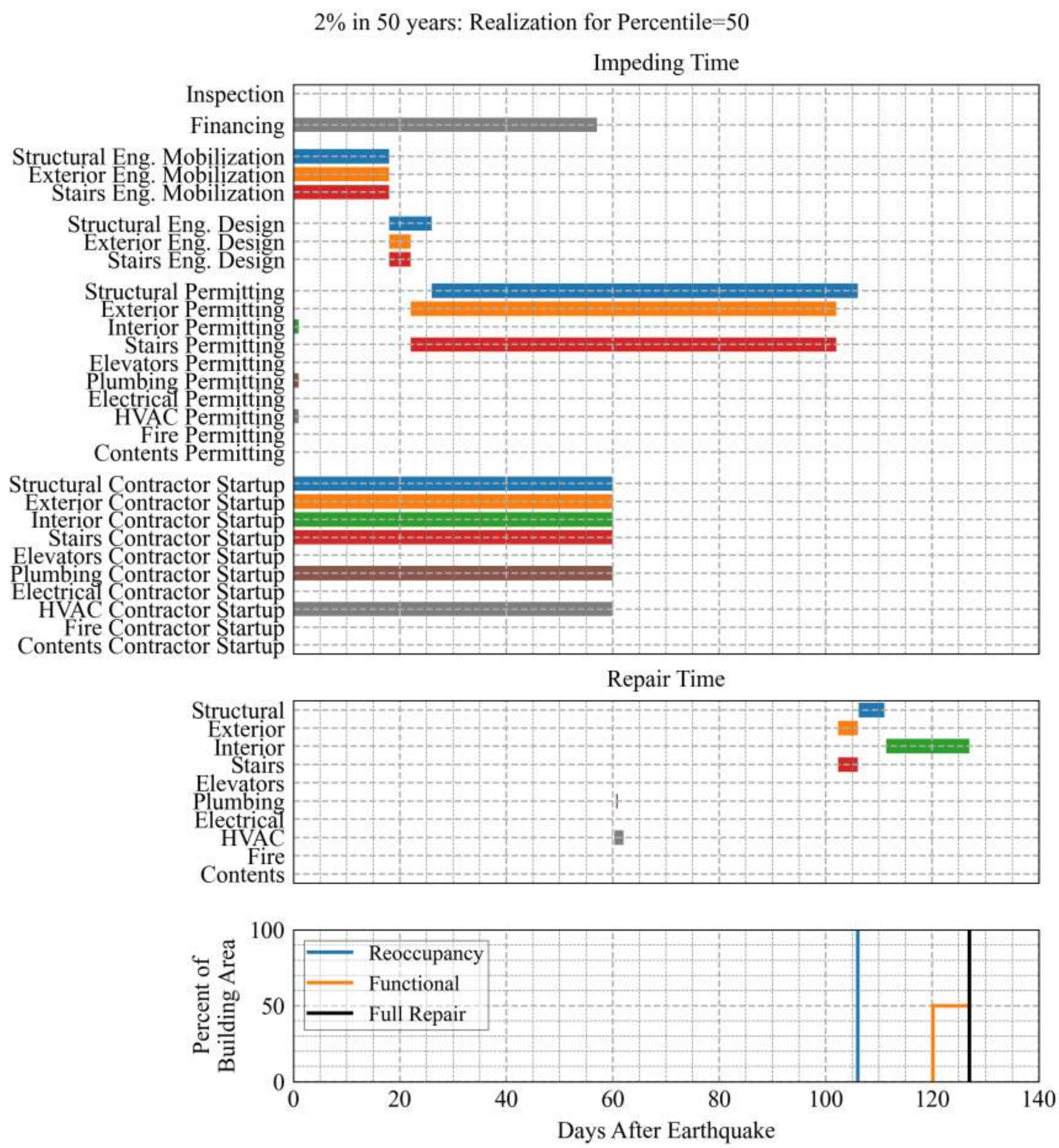


Figure 4.17. 2% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

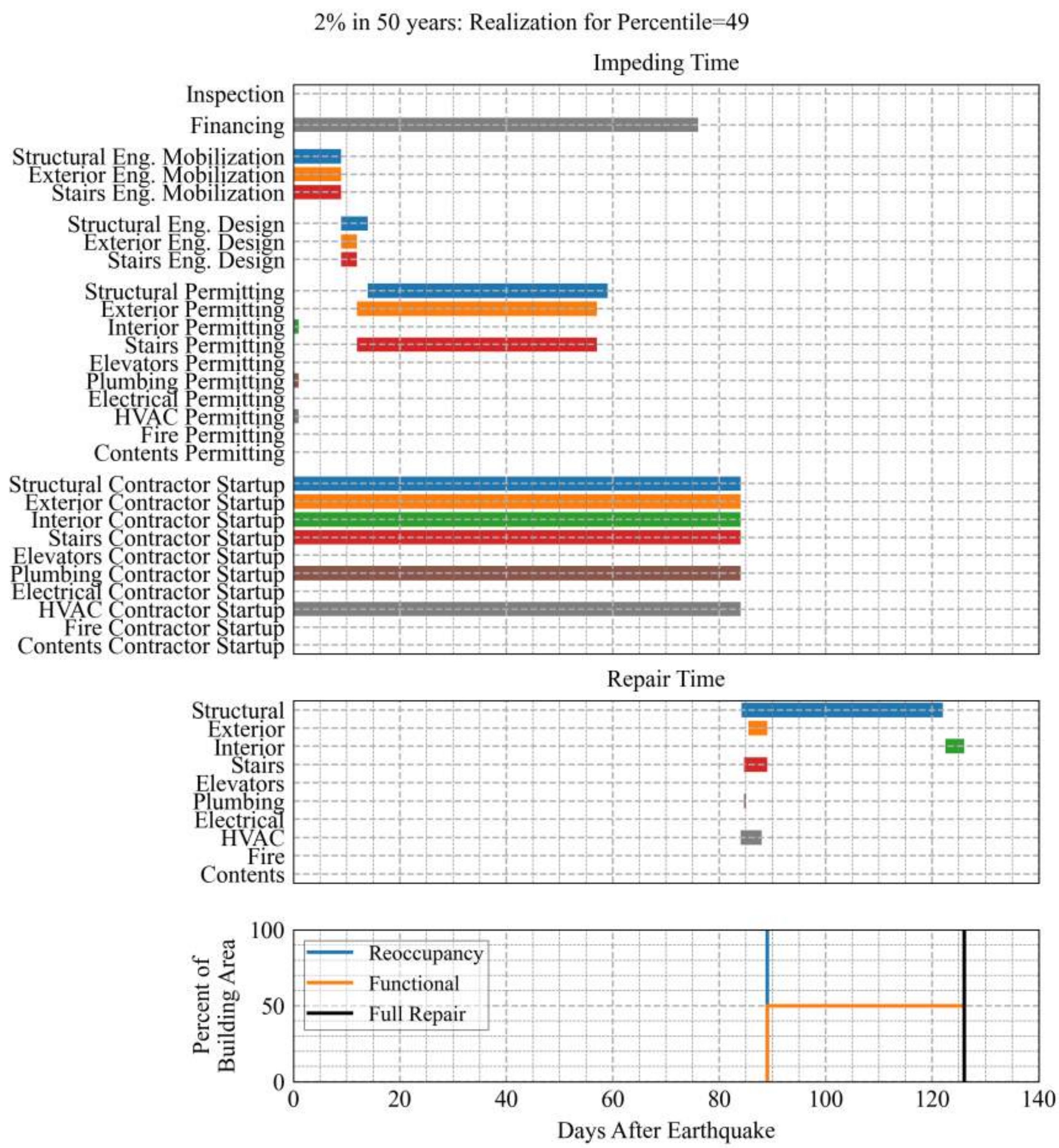


Figure 4.18. 2% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

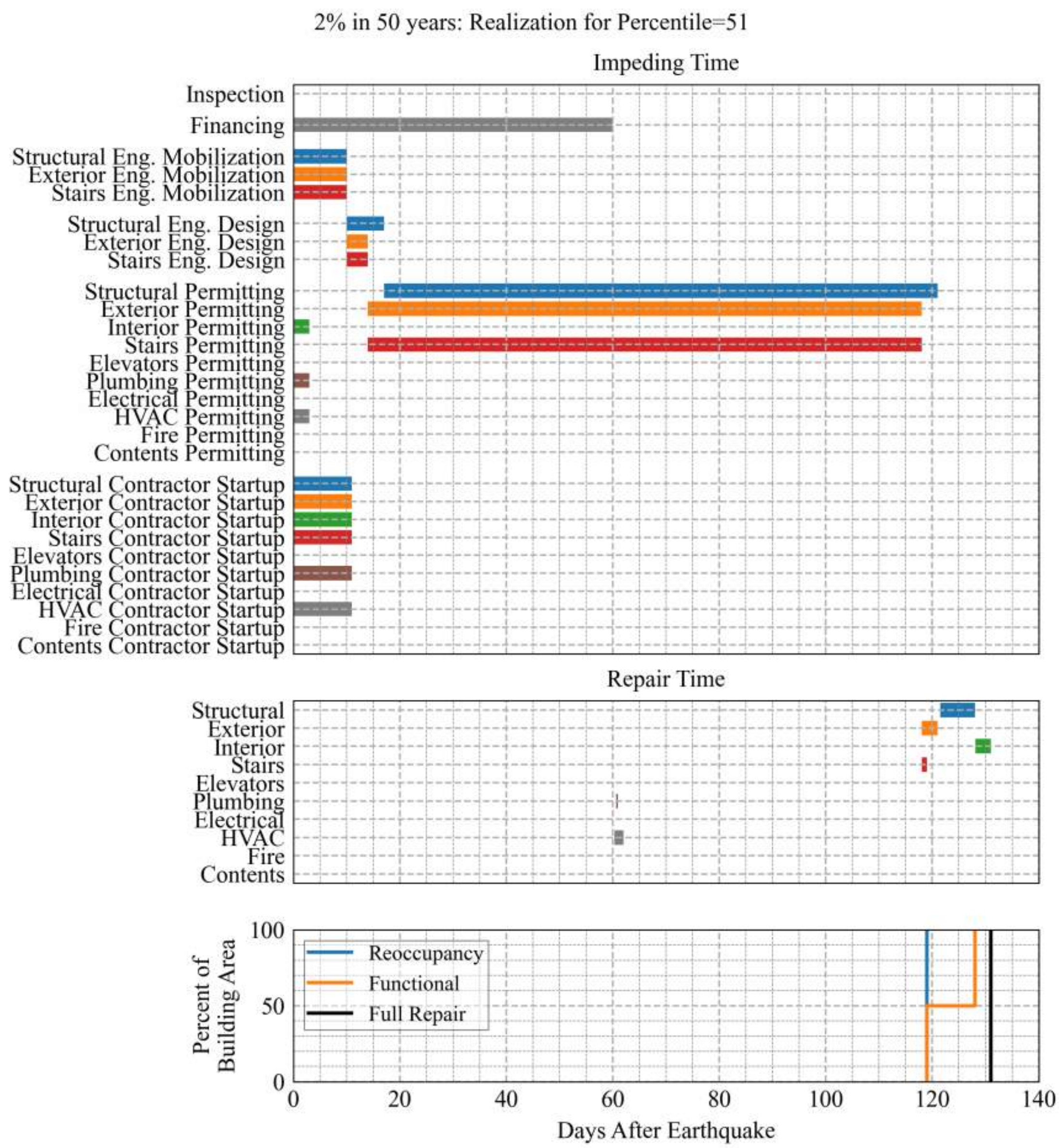


Figure 4.19. 2% in 50 years Percentile = 51

4.5.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

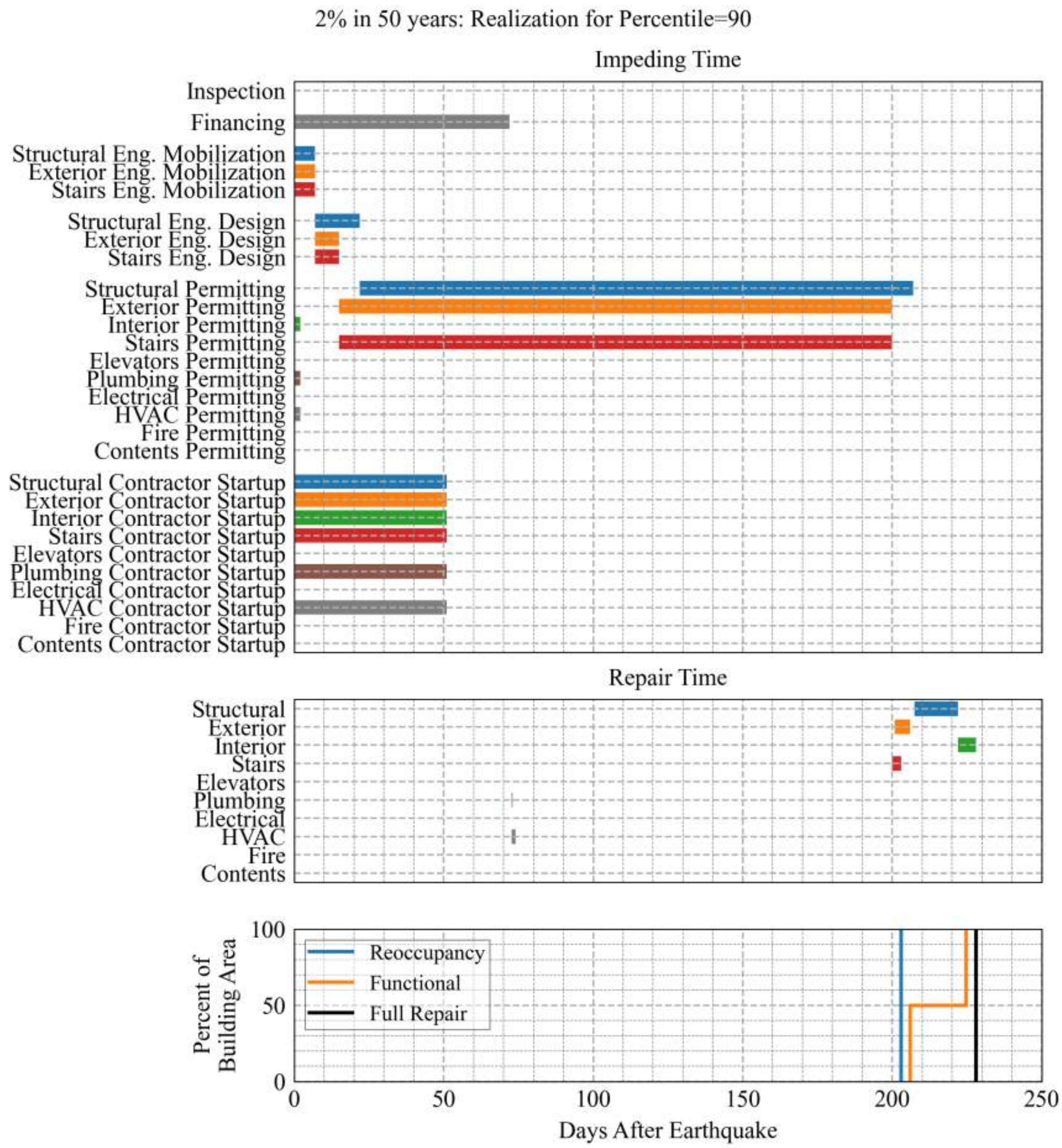


Figure 4.20. 2% in 50 years Percentile = 90

4.5.3 Damage to Building Systems

Table 4.9 shows the percentage of realizations that the named system prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.9. Percent of realizations affecting building reoccupancy/function per system - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	8.7	8.7	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	94	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	94	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	84	84	84	84	84	3.9	0.0
Stairway Doors	88	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	90	89	65	28	9.2	0.0	0.0
Interior	47	43	30	22	18	0.2	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	86	86	86	86	86	5.9	0.0
Interior	91	89	64	32	16	0.2	0.0
Water	15	15	15	15	15	0.2	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	68	68	68	68	67	7.3	0.0

4.5.4 Damage to Individual Components

Table 4.10 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.10. Percent of realizations affecting building reoccupancy/functionality per component - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1031.011a	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.041	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1035.051	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B1071.202	83 / 83	77 / 83	44 / 82	20 / 82	8.1 / 82	0.0 / 5.7	0.0 / 0.0
B1071.302	0.0 / 91	0.0 / 90	0.0 / 88	0.0 / 87	0.0 / 86	0.0 / 5.9	0.0 / 0.0
B2011.401	90 / 91	86 / 90	53 / 88	25 / 86	8.5 / 86	0.0 / 4.3	0.0 / 0.0
C1011.211a	0.0 / 90	0.0 / 85	0.0 / 40	0.0 / 18	0.0 / 7.7	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 91	0.0 / 86	0.0 / 55	0.0 / 25	0.0 / 8.6	0.0 / 0.0	0.0 / 0.0
C2011.041b	84 / 0.0	84 / 0.0	84 / 0.0	84 / 0.0	84 / 0.0	3.9 / 0.0	0.0 / 0.0
C3032.004a	30 / 24	26 / 21	14 / 11	7.3 / 6.0	3.1 / 2.5	0.0 / 0.0	0.0 / 0.0
C3032.004b	32 / 26	28 / 23	15 / 13	7.8 / 6.7	3.2 / 2.9	0.0 / 0.0	0.0 / 0.0
C3032.004c	34 / 29	30 / 25	16 / 13	8.2 / 6.7	3.5 / 3.0	0.0 / 0.0	0.0 / 0.0
C3032.004d	36 / 33	32 / 29	16 / 15	8.7 / 8.5	3.7 / 3.3	0.0 / 0.0	0.0 / 0.0
C3034.002	47 / 79	42 / 75	23 / 36	11 / 16	4.5 / 6.8	0.0 / 0.0	0.0 / 0.0
D2021.013a	8.6 / 8.6	8.6 / 8.6	8.6 / 8.6	8.6 / 8.6	8.3 / 8.3	0.2 / 0.2	0.0 / 0.0
D2021.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.023a	9.6 / 9.6	9.6 / 9.6	9.6 / 9.6	9.6 / 9.6	9.4 / 9.4	0.2 / 0.2	0.0 / 0.0
D2021.023b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.013b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 34	0.0 / 34	0.0 / 34	0.0 / 34	0.0 / 33	0.0 / 0.6	0.0 / 0.0
D3041.011c	32 / 42	19 / 42	8.6 / 42	6.7 / 42	2.7 / 42	0.0 / 4.9	0.0 / 0.0
D3041.032c	46 / 72	42 / 72	29 / 66	21 / 59	17 / 56	0.2 / 6.2	0.0 / 0.0

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Detailed Component Report

Report Generated for:

217 Arlington Avenue, Kensington, CA, 94707

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program

by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	New WLF w/ Frame
Building Type:	WLF: General
Year of Construction:	2022
Number of Stories:	2
Occupancy:	Commercial Office
Address:	217 Arlington Avenue Kensington, CA, 94707
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	No
Total Square Feet:	4,395
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	None
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–
Dir. 2 Story 1	–
Dir. 2 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	–, –
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	–
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	–

Component Information

Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options

Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*

Interior Finishes

- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *Yes*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *Yes*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *Yes*

Electrical

- Does the building have a backup battery/generator system?
  > *No*
- Which best describes the building's electrical system?
  > *No significant electrical equipment (rugged)*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	0.5	0.9
10% in 50 years	475 Years	9.3	17
DE	481 Years	9.5	17
5% in 50 years	975 Years	14	23
MCE_R	1277 Years	17	27
2% in 50 years	2475 Years	26	42

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	1.4 days	1.5 days	0 days	0 days	6.4 weeks
10% in 50 years	3.8 weeks	4.8 weeks	11 days	2.8 months	3.4 months
DE	3.9 weeks	5.1 weeks	12 days	2.8 months	3.5 months
5% in 50 years	5.7 weeks	7.6 weeks	2.8 months	3.7 months	3.9 months
MCE_R	6.8 weeks	2.1 months	3.1 months	3.8 months	4.1 months
2% in 50 years	2.1 months	2.8 months	3.5 months	4.2 months	4.4 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 MOST DAMAGED COMPONENTS

Table 2.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1071.302	1	$1,368
10% in 50 years	B1071.302	1	$9,629
DE	B1071.302	1	$9,731
5% in 50 years	B1071.302	1	$16,072
MCE_R	B1031.011a	1	$18,918
2% in 50 years	B1031.011a	1	$34,920

Table 2.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	C1011.311a	1	$3,176
10% in 50 years	C1011.311a	1	$31,144
DE	C1011.311a	1	$31,440
5% in 50 years	C1011.311a	3	$38,842
MCE_R	C1011.311a	3	$40,722
2% in 50 years	C1011.311a	3	$40,630

Details of the most damaged components and their damage states:

- **B1031.011a**: Steel Column Base Plates, Column W < 150 plf
  - DS1a: Initiation of crack at the fusion line between the column flange and the base plate weld. Damage in field is either obscured or deemed to not warrant repair. No repair conducted.
  - DS1b: Initiation of crack at the fusion line between the column flange and the base plate weld.
- **B1071.302**: Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs
  - DS1: Cracking of paint over fasteners or joints.
- **C1011.311a**: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above
  - DS1: Cracking of paint over fasteners or joints.
  - DS3: Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.

3 DETAILED COMPONENT DAMAGE BREAKDOWNS

3.1 Repair Cost

This table shows the expected contribution to repair cost on a per-damage state basis. The header shows the total loss, the loss contribution from collapse, and the loss contribution from residual drift for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.1.1. Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**6.69k**	**128k**	**131k**	**186k**	**228k**	**359k**
Collapse	0	0	0	0	7.42k	43.5k
Residual	0	0	0	551	5.51k	76.1k
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0	0	0	0	0	0
DS1b	0	331	639	1.22k	1.47k	1.75k
DS2	0	1.53k	1.7k	6.59k	9.91k	18.6k
DS3	0	529	725	3.65k	7.53k	14.6k
Total	**0**	**2.4k**	**3.07k**	**11.5k**	**18.9k**	**34.9k**
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0	14.4	34	255	281	442
DS1b	0	0	0	48	168	93.7
DS2a	0	0	0	28.4	20.8	95.2
DS2b	0	0	0	34.3	15.6	27.1
DS3	0	0	0	3.91	61.4	55.3
Total	**0**	**14.4**	**34**	**370**	**547**	**713**
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0	23.1	67.8	380	609	646
DS1b	0	7.74	17.5	156	137	216
DS2a	0	0	0	16.2	40.3	128
DS2b	0	0	0	0	52.6	0
DS3	0	0	0	7.56	48.7	111
Total	**0**	**30.8**	**85.3**	**559**	**888**	**1.1k**
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	13.2	3.89k	3.77k	3.58k	3.22k	2k
DS2	0	1.39k	1.44k	2.73k	3.04k	2.79k
DS3	0	1.78k	1.75k	6.36k	8.76k	14.1k
Total	**13.2**	**7.06k**	**6.97k**	**12.7k**	**15k**	**18.9k**
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	1.13k	716	734	606	556	471
DS2	143	811	844	698	625	478
DS3	91.7	4.23k	4.13k	3.98k	3.57k	2.16k
DS4	0	1.92k	2.03k	3.71k	4.03k	3.7k
DS5	0	1.96k	1.99k	7.08k	10.1k	15.9k
Total	**1.37k**	**9.63k**	**9.73k**	**16.1k**	**18.9k**	**22.7k**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	50.3	957	942	834	758	537
DS2	7.03	1.07k	1.07k	1.21k	1.19k	864
DS3	2.87	3.98k	3.97k	8.26k	10k	12.4k
Total	**60.2**	**6k**	**5.98k**	**10.3k**	**12k**	**13.8k**

Continued on next page

Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**6.69k**	**128k**	**131k**	**186k**	**228k**	**359k**
Collapse	0	0	0	0	7.42k	43.5k
Residual	0	0	0	551	5.51k	76.1k
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.22k	2.05k	2.05k	1.83k	1.71k	1.45k
DS2	195	1.79k	1.82k	1.78k	1.67k	1.44k
DS3	117	12k	11.9k	16.9k	18.2k	18.6k
Total	**1.53k**	**15.9k**	**15.7k**	**20.5k**	**21.6k**	**21.5k**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	2.58k	3.49k	3.55k	3.01k	2.89k	2.48k
DS2	375	3.69k	3.73k	3.4k	3.18k	2.68k
DS3	219	24k	24.2k	32.4k	34.6k	35.5k
Total	**3.18k**	**31.1k**	**31.4k**	**38.8k**	**40.7k**	**40.6k**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	12.7	581	591	586	482	315
DS2	1.5	905	948	1.5k	1.74k	1.71k
DS3	0	823	878	2.62k	3.4k	5.51k
Total	**14.2**	**2.31k**	**2.42k**	**4.71k**	**5.63k**	**7.53k**
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	1.26	364	374	418	458	448
DS2	0	635	710	857	833	719
DS3	25.7	5.94k	6.24k	8.64k	10.2k	10k
Total	**27**	**6.94k**	**7.32k**	**9.91k**	**11.4k**	**11.2k**
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	4.84	607	581	608	730	663
DS2	16.6	979	962	1.25k	1.39k	1.34k
DS3	11.5	7.24k	7.77k	10.5k	12.2k	12.2k
Total	**33**	**8.83k**	**9.32k**	**12.4k**	**14.3k**	**14.2k**
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	22.5	1.03k	1.03k	1.09k	1.06k	1.07k
DS2	8.08	1.44k	1.62k	1.83k	2.22k	2.01k
DS3	0	8.79k	9.05k	12.6k	15.1k	13.8k
Total	**30.6**	**11.3k**	**11.7k**	**15.5k**	**18.4k**	**16.9k**
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	37.5	1.22k	1.3k	1.34k	1.34k	1.25k
DS2	10.8	1.93k	1.85k	2.36k	2.79k	2.41k
DS3	0	9.08k	9.7k	12.3k	14.8k	14.7k
Total	**48.3**	**12.2k**	**12.9k**	**16k**	**18.9k**	**18.4k**
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**134**	**4.54k**	**4.62k**	**4.77k**	**5.05k**	**4.88k**
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.14	37.3	41.2	47.1	54	53.5
DS2	0	57.8	59.7	86.8	97.2	103
Total	**0.14**	**95.1**	**101**	**134**	**151**	**157**
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**3.55**	**134**	**143**	**158**	**174**	**165**
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	0.06	30.5	31.8	38.3	42.7	38.9
DS2	0	43.3	51.5	79.6	83	90.9
Total	**0.06**	**73.8**	**83.3**	**118**	**126**	**130**

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Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**6.69k**	**128k**	**131k**	**186k**	**228k**	**359k**
Collapse	0	0	0	0	7.42k	43.5k
Residual	0	0	0	551	5.51k	76.1k
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	1.37	48.4	47.5	50.2	52.1	49.4
DS2	0.19	34.7	37.9	45.3	52.2	48.3
Total	**1.57**	**83.1**	**85.5**	**95.5**	**104**	**97.6**
D2031.013b #1 (D2031.013b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING...)						
DS1	**1.25**	**57.5**	**58.8**	**73.7**	**82**	**77.9**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0	5.86	4.97	15.4	23.1	34.6
DS1b	0	20	17.9	53.1	70.6	81.8
DS1c	0	4.6	7.93	19.3	21.9	30.9
DS1d	2.39	36.2	37.2	77.2	110	158
Total	**2.39**	**66.6**	**68**	**165**	**225**	**305**
D3032.013c #2 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	2.1	110	128	157	172	155
DS1b	8.84	393	425	520	536	444
DS1c	7.26	158	161	201	207	176
DS1d	25.3	684	562	874	902	809
Total	**43.5**	**1.34k**	**1.28k**	**1.75k**	**1.82k**	**1.58k**
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	2.34	79.9	82.8	84.3	87.2	83.3
DS2	1.75	584	616	745	874	842
Total	**4.1**	**664**	**699**	**829**	**962**	**925**
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**191**	**7.07k**	**7.52k**	**8.46k**	**9.07k**	**8.66k**

3.2 Repair time

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.2.1. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.2	0.4	0.7	0.9	1.3
DS2	0.0	1.1	1.3	4.5	7.3	13
DS3	0.0	0.3	0.5	2.5	5.0	10
Total	**0.0**	**1.6**	**2.2**	**7.7**	**13**	**24**
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0.0	0.0	0.0	0.1	0.1	0.2
DS1b	0.0	0.0	0.0	0.0	0.1	0.1
DS2a	0.0	0.0	0.0	0.0	0.0	0.1
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.2**	**0.2**	**0.3**
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0.0	0.0	0.0	0.1	0.3	0.3
DS1b	0.0	0.0	0.0	0.1	0.1	0.1
DS2a	0.0	0.0	0.0	0.0	0.0	0.1
DS2b	0.0	0.0	0.0	0.0	0.0	0.0
DS3	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.2**	**0.4**	**0.5**
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.0	2.7	2.6	2.5	2.3	1.4
DS2	0.0	1.0	1.0	1.9	2.1	2.0
DS3	0.0	1.2	1.2	4.4	6.1	10
Total	**0.0**	**4.9**	**4.9**	**8.9**	**11**	**13**
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.6	0.4	0.4	0.3	0.3	0.3
DS2	0.1	0.4	0.5	0.4	0.4	0.3
DS3	0.1	2.4	2.3	2.2	2.0	1.2
DS4	0.0	1.9	2.0	3.7	4.0	3.6
DS5	0.0	1.7	1.7	6.1	8.9	14
Total	**0.8**	**6.9**	**7.0**	**13**	**16**	**19**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	0.1	2.8	2.8	2.5	2.3	1.6
DS2	0.0	2.2	2.2	2.5	2.4	1.8
DS3	0.0	5.9	5.8	12	15	18
Total	**0.1**	**11**	**11**	**17**	**19**	**22**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	0.7	1.1	1.2	1.0	1.0	0.8
DS2	0.1	1.0	1.0	1.0	1.0	0.8
DS3	0.1	6.7	6.6	9.3	10	10
Total	**0.9**	**8.8**	**8.8**	**11**	**12**	**12**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.4	2.0	2.0	1.7	1.7	1.4
DS2	0.2	2.1	2.0	1.9	1.7	1.5
DS3	0.1	13	13	18	20	20
Total	**1.8**	**17**	**18**	**22**	**23**	**23**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.0	0.5	0.5	0.4	0.4	0.3
DS2	0.0	0.7	0.7	1.2	1.3	1.4
DS3	0.0	0.6	0.7	2.1	2.7	4.3
Total	**0.0**	**1.8**	**1.9**	**3.7**	**4.5**	**6.0**
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	0.0	0.3	0.3	0.3	0.3	0.3
DS2	0.0	0.4	0.4	0.6	0.5	0.5
DS3	0.0	4.0	4.3	6.0	7.1	6.7
Total	**0.0**	**4.7**	**5.0**	**6.9**	**8.0**	**7.6**
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	0.0	0.4	0.4	0.4	0.4	0.4
DS2	0.0	0.7	0.6	0.9	0.9	0.9
DS3	0.0	4.7	5.1	6.9	8.0	8.3
Total	**0.0**	**5.8**	**6.2**	**8.2**	**9.3**	**10**
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	0.0	0.7	0.7	0.7	0.7	0.7
DS2	0.0	0.9	1.0	1.2	1.4	1.3
DS3	0.0	5.5	5.6	7.9	9.4	8.7
Total	**0.0**	**7.0**	**7.3**	**10**	**11**	**11**
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	0.0	0.7	0.8	0.8	0.8	0.8
DS2	0.0	1.2	1.2	1.4	1.7	1.5
DS3	0.0	5.6	5.9	7.4	9.1	9.0
Total	**0.0**	**7.6**	**7.9**	**10**	**12**	**11**
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**0.1**	**3.1**	**3.3**	**3.5**	**3.6**	**3.3**
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.1	0.1	0.1
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.1	0.1	0.1
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE$_R$	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D2031.013b #1 (D2031.013b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING...)						
DS1	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.0	0.0	0.0	0.0	0.0
DS1c	0.0	0.0	0.0	0.0	0.0	0.0
DS1d	0.0	0.0	0.0	0.1	0.1	0.1
Total	**0.0**	**0.0**	**0.0**	**0.1**	**0.2**	**0.2**
D3032.013c #2 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.0	0.1	0.1	0.1	0.1	0.1
DS1b	0.0	0.1	0.1	0.2	0.2	0.1
DS1c	0.0	0.1	0.1	0.2	0.2	0.1
DS1d	0.0	0.6	0.5	0.7	0.8	0.7
Total	**0.0**	**0.9**	**0.8**	**1.2**	**1.2**	**1.1**
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.1	0.1	0.1	0.1	0.1
DS2	0.0	0.2	0.2	0.2	0.3	0.3
Total	**0.0**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.2**	**6.0**	**6.4**	**7.0**	**7.6**	**7.3**

3.3 Casualties

Table 3.3.1 shows the total expected casualty results broken into collapse and non-collapse sources. The non-parenthetical values are casualties in terms of number of people and the parenthetical values show the probability of casualty for an individual person placed randomly in the building.

Table 3.3.2 shows the casualty breakdown on a per component basis. The values in this table are in terms of number of people, not probabilities.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.3.1. Total expected casualties (Number of People (%))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Total Non-Collapse Casualties						
Injury	0.000021 (0.000)	0.0547 (1.27)	0.0640 (1.49)	0.0844 (1.96)	0.0990 (2.31)	0.103 (2.40)
Death	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total Collapse Casualties						
Injury	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00743 (0.173)	0.0435 (1.01)
Death	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.000075 (0.002)	0.000439 (0.010)
Total Collapse and Non-Collapse Casualties						
Injury	0.000021 (0.000)	0.0547 (1.27)	0.0640 (1.49)	0.0844 (1.96)	0.106 (2.47)	0.143 (3.34)
Death	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.000075 (0.002)	0.000439 (0.010)

Table 3.3.2. Expected casualties per component (Number of People)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
Injury	0.000002	0.0121	0.0133	0.0192	0.0211	0.0247
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
Injury	0.00	0.0134	0.0169	0.0209	0.0259	0.0253
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
Injury	0.00	0.0141	0.0160	0.0207	0.0252	0.0248
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
Injury	0.00	0.0143	0.0169	0.0226	0.0259	0.0274
Death	0.00	0.00	0.00	0.00	0.00	0.00
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
Injury	0.000001	0.000052	0.000058	0.000071	0.000072	0.000079
Death	0.00	0.00	0.00	0.00	0.00	0.00

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Table 3.3.2 (*Continued*). Expected casualties per component (Number of People)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
Injury	0.000018	0.000698	0.000776	0.000928	0.000962	0.000967
Death	0.00	0.00	0.00	0.00	0.00	0.00

3.4 Quantity Damaged

This table shows the expected percentage of the components that are in a given damage state (normalized to the total quantity of that component in the entire building). The small parenthetical value is the probability that any component throughout the building is in that damage state (the percentage of realizations that have a component in that damage state).

All of these values are conditioned on no global failure. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.4.1. Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
B1031.011a #1 (B1031.011a: Steel Column Base Plates, Column W < 150 plf)						
DS1a	0.0 (0.0)	6.5 (18)	6.6 (18)	15 (38)	20 (48)	28 (65)
DS1b	0.0 (0.0)	0.2 (0.8)	0.5 (1.8)	0.8 (3.1)	0.9 (3.7)	1.3 (5.0)
DS2	0.0 (0.0)	0.9 (2.8)	1.0 (3.5)	3.8 (11)	5.7 (17)	11 (32)
DS3	0.0 (0.0)	0.3 (0.8)	0.3 (1.0)	1.9 (4.9)	3.7 (8.9)	7.6 (18)
Total	**0.0** (0.0)	**7.8** (19)	**8.5** (19)	**22** (41)	**30** (54)	**48** (74)
B1035.041 #1 (B1035.041: Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth...)						
DS1a	0.0 (0.0)	0.0 (0.1)	0.1 (0.2)	0.6 (1.2)	0.8 (1.5)	1.2 (2.3)
DS1b	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.2)	0.4 (0.7)	0.2 (0.4)
DS2a	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.0 (0.1)	0.2 (0.4)
DS2b	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.0 (0.0)	0.0 (0.1)
DS3	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.2)	0.1 (0.3)
Total	**0.0** (0.0)	**0.0** (0.1)	**0.1** (0.2)	**0.9** (1.7)	**1.3** (2.3)	**1.9** (3.2)
B1035.051 #1 (B1035.051: Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam...)						
DS1a	0.0 (0.0)	0.0 (0.1)	0.1 (0.2)	0.6 (1.2)	1.1 (2.1)	1.2 (2.3)
DS1b	0.0 (0.0)	0.0 (0.0)	0.0 (0.1)	0.3 (0.5)	0.2 (0.5)	0.3 (0.7)
DS2a	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.2 (0.4)
DS2b	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.0 (0.0)
DS3	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.2 (0.3)
Total	**0.0** (0.0)	**0.1** (0.1)	**0.2** (0.3)	**0.9** (1.6)	**1.6** (2.8)	**1.9** (3.4)
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.0 (0.8)	16 (85)	16 (86)	17 (87)	16 (84)	11 (71)
DS2	0.0 (0.0)	4.6 (40)	4.9 (41)	9.8 (65)	11 (70)	11 (72)
DS3	0.0 (0.0)	2.7 (20)	2.7 (21)	10 (57)	14 (71)	25 (90)
Total	**0.0** (0.8)	**23** (96)	**23** (96)	**37** (100)	**41** (100)	**47** (100)
B1071.302 #1 (B1071.302: Interior Structural Wall - Light framed wood walls with structural panel...)						
DS1	27 (97)	31 (99)	32 (99)	27 (99)	24 (98)	22 (98)
DS2	1.8 (16)	17 (87)	17 (88)	14 (84)	13 (81)	11 (76)
DS3	0.4 (3.8)	28 (93)	28 (92)	26 (91)	24 (89)	16 (75)
DS4	0.0 (0.0)	6.4 (40)	6.8 (41)	12 (64)	14 (69)	13 (69)
DS5	0.0 (0.0)	3.7 (19)	3.8 (20)	13 (56)	19 (70)	33 (90)
Total	**30** (98)	**86** (100)	**87** (100)	**93** (100)	**94** (100)	**95** (100)

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	0.4 (8.0)	17 (97)	17 (96)	15 (97)	14 (96)	11 (91)
DS2	0.0 (0.7)	9.1 (90)	9.1 (90)	11 (92)	10 (92)	8.1 (86)
DS3	0.0 (0.1)	11 (82)	11 (83)	23 (98)	28 (99)	38 (100)
Total	**0.5** (8.2)	**37** (100)	**37** (100)	**49** (100)	**53** (100)	**57** (100)
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	22 (70)	37 (88)	37 (89)	33 (86)	31 (83)	29 (82)
DS2	1.6 (6.4)	15 (50)	15 (50)	15 (49)	15 (48)	13 (46)
DS3	0.3 (1.2)	31 (89)	30 (88)	43 (98)	47 (99)	52 (100)
Total	**24** (76)	**83** (100)	**83** (100)	**91** (100)	**93** (100)	**94** (100)
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	23 (71)	37 (89)	37 (89)	33 (87)	32 (85)	29 (82)
DS2	1.3 (4.9)	15 (51)	15 (50)	14 (50)	14 (49)	12 (45)
DS3	0.2 (0.9)	31 (88)	31 (90)	43 (98)	47 (99)	52 (100)
Total	**24** (76)	**83** (100)	**83** (100)	**90** (100)	**92** (100)	**94** (100)
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	1.0 (2.0)	43 (66)	41 (66)	41 (65)	36 (61)	26 (46)
DS2	0.0 (0.1)	16 (31)	17 (32)	27 (46)	31 (52)	34 (57)
DS3	0.0 (0.0)	4.9 (9.9)	5.2 (10)	16 (30)	21 (38)	35 (60)
Total	**1.1** (2.1)	**64** (91)	**63** (91)	**83** (98)	**88** (99)	**95** (100)
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	0.0 (0.1)	11 (20)	11 (20)	12 (23)	13 (24)	14 (26)
DS2	0.0 (0.0)	2.4 (4.7)	2.5 (4.8)	3.3 (6.4)	3.3 (6.6)	3.2 (6.4)
DS3	0.0 (0.1)	11 (19)	11 (20)	16 (27)	19 (32)	21 (33)
Total	**0.1** (0.2)	**24** (38)	**25** (40)	**32** (48)	**36** (53)	**38** (55)
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	0.1 (0.2)	15 (28)	15 (27)	16 (29)	18 (33)	18 (33)
DS2	0.1 (0.1)	3.3 (6.6)	3.3 (6.6)	4.1 (7.9)	4.4 (8.7)	4.6 (8.8)
DS3	0.0 (0.0)	12 (20)	12 (22)	17 (28)	20 (32)	22 (35)
Total	**0.2** (0.3)	**30** (46)	**31** (48)	**37** (54)	**42** (61)	**45** (63)
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	0.6 (1.1)	26 (44)	26 (44)	28 (47)	27 (46)	29 (49)
DS2	0.0 (0.0)	4.5 (8.6)	5.1 (10)	6.0 (12)	7.2 (14)	6.9 (14)
DS3	0.0 (0.0)	14 (23)	14 (24)	20 (32)	23 (37)	24 (37)
Total	**0.6** (1.1)	**44** (62)	**45** (64)	**53** (72)	**58** (76)	**59** (78)
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	0.9 (1.7)	31 (51)	33 (55)	33 (55)	33 (55)	34 (58)
DS2	0.0 (0.1)	6.3 (12)	6.2 (12)	7.6 (14)	8.9 (17)	8.3 (16)
DS3	0.0 (0.0)	14 (24)	15 (26)	19 (31)	23 (37)	25 (40)
Total	**0.9** (1.8)	**51** (70)	**54** (73)	**60** (78)	**66** (83)	**68** (85)
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**1.0** (8.0)	**42** (91)	**43** (91)	**50** (94)	**55** (95)	**56** (97)
D2021.013a #1 (D2021.013a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.1 (0.2)	15 (27)	16 (29)	19 (34)	23 (39)	24 (39)
DS2	0.0 (0.0)	2.4 (4.7)	2.7 (5.3)	4.1 (7.7)	4.5 (8.5)	5.1 (9.4)
Total	**0.1** (0.2)	**18** (30)	**19** (32)	**23** (38)	**27** (44)	**29** (45)
D2021.013b #1 (D2021.013b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**1.1** (2.0)	**42** (63)	**44** (64)	**50** (70)	**54** (74)	**56** (75)

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	0.0	0.0	0.0	0.5	3.2
P[Res](%)	0.0	0.0	0.0	0.0	0.4	5.5
D2021.023a #1 (D2021.023a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING...)						
DS1	0.1 (0.1)	16 (27)	17 (29)	19 (33)	23 (38)	23 (39)
DS2	0.0 (0.0)	2.4 (4.4)	2.7 (5.3)	4.2 (7.9)	4.6 (8.6)	5.8 (10)
Total	**0.1 (0.1)**	**18 (30)**	**19 (33)**	**23 (38)**	**27 (43)**	**29 (45)**
D2021.023b #1 (D2021.023b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING...)						
DS1	0.8 (1.5)	24 (41)	25 (43)	26 (45)	28 (48)	28 (48)
DS2	0.1 (0.3)	18 (30)	19 (33)	23 (38)	28 (43)	28 (43)
Total	**0.9 (1.8)**	**42 (61)**	**44 (65)**	**49 (69)**	**55 (75)**	**56 (76)**
D2031.013b #1 (D2031.013b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING...)						
DS1	**0.4 (0.8)**	**21 (35)**	**22 (37)**	**26 (43)**	**29 (47)**	**31 (49)**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.0 (0.0)	0.8 (0.8)	0.8 (0.8)	2.2 (2.2)	3.2 (3.2)	5.5 (5.5)
DS1b	0.0 (0.0)	0.4 (0.4)	0.4 (0.4)	1.1 (1.1)	1.5 (1.5)	2.0 (2.0)
DS1c	0.0 (0.0)	0.4 (0.4)	0.6 (0.6)	1.7 (1.7)	1.9 (1.9)	3.0 (3.0)
DS1d	0.0 (0.0)	0.8 (0.8)	0.8 (0.8)	1.5 (1.5)	2.4 (2.4)	3.6 (3.6)
Total	**0.0 (0.0)**	**2.5 (2.5)**	**2.6 (2.6)**	**6.4 (6.4)**	**8.9 (8.9)**	**14 (14)**
D3032.013c #2 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.2 (0.3)	8.7 (16)	9.5 (17)	12 (22)	13 (24)	12 (23)
DS1b	0.1 (0.2)	4.1 (7.7)	4.4 (8.4)	5.5 (11)	5.9 (11)	5.1 (9.7)
DS1c	0.3 (0.6)	6.9 (13)	7.1 (13)	8.9 (17)	9.2 (17)	8.6 (16)
DS1d	0.2 (0.5)	7.1 (14)	6.0 (11)	9.1 (17)	9.9 (19)	9.2 (17)
Total	**0.8 (1.4)**	**27 (42)**	**27 (41)**	**35 (53)**	**38 (56)**	**35 (52)**
D3041.011c #1 (D3041.011c: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.8 (1.6)	24 (42)	25 (44)	26 (45)	27 (45)	27 (47)
DS2	0.1 (0.1)	18 (31)	19 (32)	23 (38)	28 (44)	29 (46)
Total	**0.8 (1.7)**	**43 (63)**	**45 (66)**	**49 (70)**	**54 (75)**	**56 (76)**
D3041.032c #1 (D3041.032c: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**1.0 (3.5)**	**42 (77)**	**45 (80)**	**50 (85)**	**55 (88)**	**57 (88)**

4 COMPONENT DAMAGEABILITY AND COST OVERVIEW

This section provides an overview of key component parameters for loss assessment. The components are broken into groups such that the specified component modifiers are applied to all components in the given table.

Some notes on the columns are as follows:

- **DS: Median (Unit Repair Cost Range)**: This presents median EDP for each damage state as well as the associated repair cost range to repair one unit of the component (varies based on quantity).
- **Max Repair Potential**: This is the cost to completely replace this component throughout the building assuming the most expensive damage state for all components (includes volume discounting). The number in parenthesis is the value as a percentage of building replacement value. Note that this does not need to add up to the total building replacement value, but rather gives a sense of how much potential the component has to contribute to the mean loss when it is damaged.

Table 4.1. "Structural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B1031.011a	Steel Column Base Plates, Column W < 150 plf	EDP Peak Interstory Drift DS1a: 0.04 ($0 - $0) DS1b: 0.04 ($21,710 - $35,279) DS2: 0.07 ($31,001 - $43,765) DS3: 0.1 ($36,203 - $51,110)	$204,439 (14.8%)
B1035.041	Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27	EDP Peak Interstory Drift DS1a: 0.017 ($13,420 - $20,130) DS1b: 0.017 ($15,089 - $22,634) DS2a: 0.025 ($16,202 - $24,303) DS2b: 0.025 ($19,585 - $29,377) DS3: 0.03 ($16,202 - $24,303)	$58,754 (4.26%)
B1035.051	Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27	EDP Peak Interstory Drift DS1a: 0.017 ($19,563 - $29,344) DS1b: 0.017 ($21,232 - $31,848) DS2a: 0.025 ($21,009 - $31,514) DS2b: 0.025 ($26,840 - $40,260) DS3: 0.03 ($21,009 - $31,514)	$80,520 (5.84%)
B1071.202	Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs	EDP Peak Interstory Drift DS1: 0.015 ($947 - $1,539) DS2: 0.0262 ($1,366 - $1,928) DS3: 0.0369 ($3,033 - $4,281)	$60,423 (4.38%)
B1071.302	Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs	EDP Peak Interstory Drift DS1: 0.0021 ($175 - $412) DS2: 0.0071 ($374 - $879) DS3: 0.012 ($1,156 - $2,721) DS4: 0.0262 ($2,306 - $4,256) DS5: 0.0369 ($4,079 - $6,760)	$54,243 (3.93%)
		Total:	$458,379 (33.3%)

Table 4.2. "Exterior Finishes" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B2011.401	Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs	EDP Peak Interstory Drift DS1: 0.01 ($175 - $412) DS2: 0.0175 ($374 - $879) DS3: 0.025 ($1,156 - $2,721)	$35,785 (2.60%)
		Total:	$35,785 (2.60%)

Table 4.3. "Partition Walls" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C1011.211a	Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($1,598 - $5,328) DS2: 0.0071 ($3,428 - $11,425) DS3: 0.012 ($11,297 - $37,656)	$39,041 (2.83%)
C1011.311a	Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($904 - $3,015) DS2: 0.0071 ($2,223 - $7,411) DS3: 0.012 ($7,151 - $23,838)	$72,686 (5.27%)
		Total:	$111,727 (8.10%)

Table 4.4. "Other Nonstructural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C2011.041b	Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.	EDP Peak Interstory Drift DS1: 0.011 ($487 - $695) DS2: 0.026 ($1,043 - $2,782) DS3: 0.05 ($3,130 - $8,346)	$16,692 (1.21%)
		Total:	$16,692 (1.21%)

Table 4.5. "Ceilings" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C3032.004a	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.92 ($303 - $1,008) DS2: 2.34 ($2,368 - $7,894) DS3: 2.48 ($4,872 - $16,240)	$49,470 (3.59%)

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Table 4.5 (*Continued*). "Ceilings" component list.

Component	Description	DS: Median (Repair Cost Range)	Max Repair Potential
C3032.004b	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.76 ($726 - $2,420) DS2: 2.26 ($5,683 - $18,945) DS3: 2.44 ($11,692 - $38,975)	$60,997 (4.42%)
C3032.004c	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.45 ($2,178 - $7,261) DS2: 2.1 ($17,050 - $56,835) DS3: 2.34 ($35,077 - $116,925)	$64,236 (4.66%)
C3032.004d	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.31 ($3,025 - $10,085) DS2: 2.03 ($23,681 - $78,937) DS3: 2.29 ($48,719 - $162,396)	$64,236 (4.66%)
		Total:	$238,938 (17.3%)

Table 4.6. "Lighting" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C3034.002	Independent Pendant Lighting - seismically rated	EDP Peak Floor Acceleration DS1: 1.5 ($413 - $1,377)	$4,131 (0.30%)
		Total:	$4,131 (0.30%)

Table 4.7. "Piping" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D2021.013a	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 2.25 ($363 - $444) DS2: 4.1 ($3,317 - $4,055)	$2,245 (0.16%)
D2021.013b	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($476 - $581)	$322 (0.02%)
D2021.023a	Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 2.25 ($292 - $974) DS2: 4.1 ($2,796 - $9,319)	$1,843 (0.13%)
D2021.023b	Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($292 - $974) DS2: 2.25 ($292 - $974)	$193 (0.01%)

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Table 4.7 (*Continued*). "Piping" component list.

Component	Description	DS: Median (Repair Cost Range)	Max Repair Potential
D2031.013b	Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 2.25 ($334 - $1,113)	$279 (0.02%)
		Total:	$4,882 (0.35%)

Table 4.8. "HVAC" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D3032.013c	Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility	EDP Peak Floor Acceleration DS1a: 3.2 ($563 - $689) DS1b: 3.2 ($3,943 - $4,820) DS1c: 3.2 ($939 - $1,148) DS1d: 3.2 ($3,943 - $4,820)	$4,820 (0.35%)
D3032.013c	Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility	EDP Peak Floor Acceleration DS1a: 2.05 ($563 - $689) DS1b: 2.05 ($3,943 - $4,820) DS1c: 2.05 ($939 - $1,148) DS1d: 2.05 ($3,943 - $4,820)	$9,201 (0.67%)
D3041.011c	HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F	EDP Peak Floor Acceleration DS1: 1.5 ($814 - $995) DS2: 2.25 ($7,949 - $9,716)	$3,203 (0.23%)
D3041.032c	HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F	EDP Peak Floor Acceleration DS1: 1.5 ($3,756 - $4,590)	$15,857 (1.15%)
		Total:	$33,081 (2.40%)

Table 4.9. Summary of component value breakdown (building replacement value = $1,378,558).

Component Category	Max Repair Potential	% of Building Replacement Value
Structural	$458,379	33.3%
Exterior Finishes	$35,785	2.60%
Partition Walls	$111,727	8.10%
Other Nonstructural	$16,692	1.21%
Ceilings	$238,938	17.3%
Lighting	$4,131	0.30%
Piping	$4,882	0.35%
HVAC	$33,081	2.40%
Total	$903,614	65.5%

5 COMPONENT QUANTITIES AND MODIFICATION FACTORS

Table 5.1. Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
B1031.011a (B1031.011a #1): Steel Column Base Plates, Column W < 150 plf						
1	0	4	–	1	1	1
B1035.041 (B1035.041 #1): Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27						
2	0	2	–	1	1	1
B1035.051 (B1035.051 #1): Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27						
2	0	2	–	1	1	1
B1071.202 (B1071.202 #1): Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs						
1	8.201	2.295	–	1	1	1
2	4.725	4.703	–	1	1	1
B1071.302 (B1071.302 #1): Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs						
1	2.295	5.873	–	1	1	1
2	2.16	2.97	–	1	1	1
B2011.401 (B2011.401 #1): Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs						
1	7.783	7.678	–	1	1	1
2	5.248	10.2384	–	1	1	1
C1011.211a (C1011.211a #1): Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above						
1-2	0.26	0.26	–	1	1	1
C1011.311a (C1011.311a #1): Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above						
1-2	0.666666667	1.314285714	–	1	1	1
C2011.041b (C2011.041b #1): Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.						
1	1	1	–	1	1	1
C3032.004a (C3032.004a #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support						
2-R	–	–	1.97775	1	1	1
C3032.004b (C3032.004b #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support						
2-R	–	–	0.8240625	1	1	1
C3032.004c (C3032.004c #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support						
2-R	–	–	0.2746875	1	1	1
C3032.004d (C3032.004d #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support						
2-R	–	–	0.197775	1	1	1
C3034.002 (C3034.002 #1): Independent Pendant Lighting - seismically rated						
2-R	–	–	5	1	1	1
D2021.013a (D2021.013a #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY						
2-R	–	–	0.276885	1	1	1

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Table 5.1 (*Continued*). Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
D2021.013b (D2021.013b #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY						
2-R	–	–	0.276885	1	1	1
D2021.023a (D2021.023a #1): Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY						
2-R	–	–	0.0988875	1	1	1
D2021.023b (D2021.023b #1): Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY						
2-R	–	–	0.0988875	1	1	1
D2031.013b (D2031.013b #1): Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING FRAGILITY						
2-R	–	–	0.1252575	1	1	1
D3032.013c (D3032.013c #1): Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility						
G	–	–	1	1	1	1
D3032.013c (D3032.013c #2): Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility						
R	–	–	2	1	1	1
D3041.011c (D3041.011c #1): HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F						
2-R	–	–	0.1648125	1	1	1
D3041.032c (D3041.032c #1): HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F						
2-R	–	–	2	1	1	1

6 FRAGILITY INFORMATION

6.1 B1031.011a #1: (B1031.011a) Steel Column Base Plates, Column W < 150 plf

NISTIR Classification	B1031.011a
Author	Greg Deierlein
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.1.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.1.2. Damage state progression.

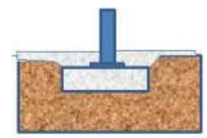
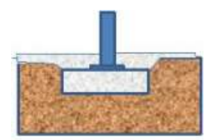
Damage State	Description	Repair Description	Image
DS1a	Initiation of crack at the fusion line between the column flange and the base plate weld. Damage in field is either obscured or deemed to not warrant repair. No repair conducted.	The repair will involve removal of a portion of grade slab, gouging out material surrounding the fracture initiating and re-welding, then repair of slab. Field condition is deemed to not warrant repair by field observation. This Damage State is Mutually Exclusive with DS2. See fragility DS1 and DS2 probabilities.	
DS1b	Initiation of crack at the fusion line between the column flange and the base plate weld.	The repair will involve removal of a portion of grade slab, gouging out material surrounding the fracture initiating and re-welding, then repair of slab.	
DS2	Propagation of brittle crack into column and/or base plate.	Depending on the crack trajectory, the repair will range from replacement of a portion of the column or base plate to full replacement of the column base. Replacement will require shoring of column, torch cutting to remove damaged material, and fabrication and field welding to install replacement material.	Not Available
DS3	Complete fracture of the column (or column weld) and dislocation of column relative to the base.	Repair would likely involve replacing the entire base plate assembly and most of the column in the story above the base plate.	Not Available

Table 6.1.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS2	DS3
Type	Mut. Excl.	Mut. Excl.	Sequential	Sequential
Probability	0.95	0.05	–	–
Median	0.04	0.04	0.07	0.1
β	0.4	0.4	0.4	0.4

Table 6.1.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	20.0	20.0	20.0	20.0
Highest Cost Median	$0	$35,279	$43,765	$51,110
Lowest Cost Median	$0	$21,710	$31,001	$36,203
β (COV)	0.25	0.41	0.37	0.34

Table 6.1.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	20.0	20.0	20.0	20.0
Highest Median Repair Time (Days)	0	24.62	30.54	35.66
Lowest Median Repair Time (Days)	0	15.15	21.63	25.26
β (COV)	0.35	0.48	0.44	0.42

Table 6.1.6. Life safety information.

	DS1a	DS1b	DS2	DS3
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	Yes	Yes
Unsafe Placard Median	–	–	0.25	0.1
Unsafe Placard β	–	–	0.5	0.5

6.2 B1035.041 #1: (B1035.041) Pre-Northridge WUF-B beam-column joint, beam one side of column, beam depth <= W27

NISTIR Classification	B1035.041
Author	Greg Deierlein
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.2.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.2.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Fracture of lower beam flange weld and failure of web bolts (shear tab connection), with fractures confined to the weld region.	Repair will typically require gouging out and re-welding of the beam flange weld, repair of shear tab, and replacing shear bolts. Repair and replace partitions at connection.	
DS1b	Similar to DS1, except that fracture propagates into column flanges.	In addition to column measures for DS1, repairs to column will be necessary. Cover plate, patch, or replace damaged column flange at connection.	
DS2a	Fracture of upper beam flange weld, without DS1 type damage. Fracture is confined to beam flange region.	Repairs will be similar to those required for DS1, except that access to weld will likely require removal and replacement of a portion of the floor slab above the weld.	Not Available
DS2b	Similar to DS3, except that fracture propagates into column flanges.	In addition to column measures for DS3, repairs to column will be necessary that will involve replacing a portion of the column flange.	Not Available
DS3	Fracture initiating at weld access hole and propagating through beam flange, possibly accompanied by local buckling deformations of web and flange.	Repair is similar to that for DS1 except that a portion of the beam web and flange may need to be heat straightened or replaced.	Not Available

Table 6.2.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.	Mut. Excl.	Sequential
Probability	0.75	0.25	0.75	0.25	–
Median	0.017	0.017	0.025	0.025	0.03
β	0.4	0.4	0.4	0.4	0.4

Table 6.2.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Cost Median	$20,130	$22,634	$24,303	$29,377	$24,303
Lowest Cost Median	$13,420	$15,089	$16,202	$19,585	$16,202
β (COV)	0.35	0.35	0.32	0.37	0.34

Table 6.2.5. Parameters for the repair time distributions.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Median Repair Time (Days)	8.51	9.57	11.75	12.42	10.28
Lowest Median Repair Time (Days)	5.68	6.38	8.32	8.28	6.85
β (COV)	0.43	0.43	0.41	0.45	0.42

Table 6.2.6. Life safety information.

	DS1a	**DS1b**	**DS2a**	**DS2b**	**DS3**
Non-collapse casualties	No	No	No	No	No
Affected Area	– –	– –	– –	– –	– –
Serious Injury Median	–	–	–	–	–
Serious Injury β	–	–	–	–	–
Loss of Life Median	–	–	–	–	–
Loss of Life β	–	–	–	–	–
Can Cause Red Tag	Yes	Yes	Yes	Yes	Yes
Unsafe Placard Median	0.5	0.5	0.5	0.5	0.5
Unsafe Placard β	0.5	0.5	0.5	0.5	0.5

6.3 B1035.051 #1: (B1035.051) Pre-Northridge WUF-B beam-column joint, beam both sides of column, beam depth <= W27

NISTIR Classification	B1035.051
Author	Greg Deierlein
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.3.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.3.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Fracture of lower beam flange weld and failure of web bolts (shear tab connection), with fractures confined to the weld region.	Repair will typically require gouging out and re-welding of the beam flange weld, repair of shear tab, and replacing shear bolts. Repair and replace partitions at connection.	
DS1b	Similar to DS1, except that fracture propagates into column flanges.	In addition to column measures for DS1, repairs to column will be necessary. Cover plate, patch, or replace damaged column flange at connection.	
DS2a	Fracture of upper beam flange weld, without DS1 type damage. Fracture is confined to beam flange region.	Repairs will be similar to those required for DS1, except that access to weld will likely require removal and replacement of a portion of the floor slab above the weld.	Not Available
DS2b	Similar to DS3, except that fracture propagates into column flanges.	In addition to column measures for DS3, repairs to column will be necessary that will involve replacing a portion of the column flange.	Not Available
DS3	Fracture initiating at weld access hole and propagating through beam flange, possibly accompanied by local buckling deformations of web and flange.	Repair is similar to that for DS1 except that a portion of the beam web and flange may need to be heat straightened or replaced.	Not Available

Table 6.3.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS2a	DS2b	DS3
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.	Mut. Excl.	Sequential
Probability	0.75	0.25	0.75	0.25	–
Median	0.017	0.017	0.025	0.025	0.03
β	0.4	0.4	0.4	0.4	0.4

Table 6.3.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS2a	DS2b	DS3
Distribution Type	Normal	Normal	Normal	Normal	Normal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Cost Median	$29,344	$31,848	$31,514	$40,260	$31,514
Lowest Cost Median	$19,563	$21,232	$21,009	$26,840	$21,009
β (COV)	0.36	0.36	0.3	0.32	0.33

Table 6.3.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS2a	DS2b	DS3
Distribution Type	Normal	Normal	Normal	Normal	Normal
Lower Qty.	5.0	5.0	5.0	5.0	5.0
Upper Qty.	30.0	30.0	30.0	30.0	30.0
Highest Median Repair Time (Days)	12.41	13.47	16.68	17.03	13.33
Lowest Median Repair Time (Days)	8.27	8.98	12.24	11.35	8.88
β (COV)	0.44	0.44	0.39	0.4	0.41

Table 6.3.6. Life safety information.

	DS1a	DS1b	DS2a	DS2b	DS3
Non-collapse casualties	No	No	No	No	No
Affected Area	– –	– –	– –	– –	– –
Serious Injury Median	–	–	–	–	–
Serious Injury β	–	–	–	–	–
Loss of Life Median	–	–	–	–	–
Loss of Life β	–	–	–	–	–
Can Cause Red Tag	Yes	Yes	Yes	Yes	Yes
Unsafe Placard Median	0.5	0.5	0.5	0.5	0.5
Unsafe Placard β	0.5	0.5	0.5	0.5	0.5

6.4 B1071.202 #1: (B1071.202) Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs

NISTIR Classification	B1071.202
Author	HBRG (exterior only)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.4.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.4.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.4.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.015	0.0262	0.0369
β	0.4	0.19	0.2

Table 6.4.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$1,539	$1,928	$4,281
Lowest Cost Median	$947	$1,366	$3,033
β (COV)	0.19	0.22	0.08

Table 6.4.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	1.07	1.35	2.99
Lowest Median Repair Time (Days)	0.66	0.95	2.12
β (COV)	0.31	0.33	0.26

Table 6.4.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.5 B1071.302 #1: (B1071.302) Interior Structural Wall - Light framed wood walls with structural panel sheathing, gypsum wallboard on both sides, with hold-downs

NISTIR Classification	B1071.302
Author	HBRG (exterior only)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	5
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.5.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.5.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS4	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove interior finish, remove wood sheathing, install new sheathing, reinstall and finish interior material.	
DS5	Fracture of studs, major sill plate cracking.	Remove and replace interior finish, sheathing, studs and plates. Provide shoring as required.	

Table 6.5.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3	DS4	DS5
Type	Sequential	Sequential	Sequential	Sequential	Sequential
Probability	–	–	–	–	–
Median	0.0021	0.0071	0.012	0.0262	0.0369
β	0.6	0.45	0.45	0.19	0.2

Table 6.5.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3	DS4	DS5
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0	8.0	8.0
Highest Cost Median	$412	$879	$2,721	$4,256	$6,760
Lowest Cost Median	$175	$374	$1,156	$2,306	$4,079
β (COV)	0.42	0.49	0.1	0.22	0.08

Table 6.5.5. Parameters for the repair time distributions.

	DS1	DS2	DS3	DS4	DS5
Distribution Type	Normal	Normal	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0	8.0	8.0
Highest Median Repair Time (Days)	0.23	0.49	1.52	2.63	4.37
Lowest Median Repair Time (Days)	0.1	0.21	0.65	2.27	3.57
β (COV)	0.52	0.55	0.34	0.33	0.26

Table 6.5.6. Life safety information.

	DS1	DS2	DS3	DS4	DS5
Non-collapse casualties	No	No	No	No	No
Affected Area	– –	– –	– –	– –	– –
Serious Injury Median	–	–	–	–	–
Serious Injury β	–	–	–	–	–
Loss of Life Median	–	–	–	–	–
Loss of Life β	–	–	–	–	–
Can Cause Red Tag	No	No	No	Yes	Yes
Unsafe Placard Median	–	–	–	0.5	0.25
Unsafe Placard β	–	–	–	0.5	0.5

6.6 B2011.401 #1: (B2011.401) Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs

NISTIR Classification	B2011.401
Author	HBRG (exterior only modifications)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Exterior Finishes
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.6.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.6.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.6.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.01	0.0175	0.025
β	0.4	0.4	0.4

Table 6.6.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$412	$879	$2,721
Lowest Cost Median	$175	$374	$1,156
β (COV)	0.19	0.22	0.08

Table 6.6.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	0.86	1.08	2.4
Lowest Median Repair Time (Days)	0.53	0.77	1.7
β (COV)	0.31	0.33	0.26

Table 6.6.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.7 C1011.211a #1: (C1011.211a) Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.211a
Author	DaveWelch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.7.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.7.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.7.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.7.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$5,328	$11,425	$37,656
Lowest Cost Median	$1,598	$3,428	$11,297
β (COV)	0.42	0.49	0.1

Table 6.7.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	2.99	6.4	21.1
Lowest Median Repair Time (Days)	0.9	1.92	6.33
β (COV)	0.52	0.55	0.34

Table 6.7.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.8 C1011.311a #1: (C1011.311a) Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.311a
Author	Dave Welch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.8.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.8.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.8.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.8.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$3,015	$7,411	$23,838
Lowest Cost Median	$904	$2,223	$7,151
β (COV)	0.42	0.49	0.1

Table 6.8.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.69	4.15	13.36
Lowest Median Repair Time (Days)	0.51	1.25	4.01
β (COV)	0.52	0.55	0.34

Table 6.8.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.9 C2011.041b #1: (C2011.041b) Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.

NISTIR Classification	C2011.041b
Author	HBRG
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Other Nonstructural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.9.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.9.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cosmetic Damage.	Repair cosmetic damage.	Not Available
DS2	Structural damage but live load capacity remains intact.	Repair damage.	Not Available
DS3	Loss of live load capacity.	Replace stair.	Not Available

Table 6.9.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.011	0.026	0.05
β	0.5	0.5	0.5

Table 6.9.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$695	$2,782	$8,346
Lowest Cost Median	$487	$1,043	$3,130
β (COV)	0.8	0.6	0.4

Table 6.9.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.55	2.21	6.62
Lowest Median Repair Time (Days)	0.39	0.83	2.48
β (COV)	1.0	0.7	0.5

Table 6.9.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.25	0.1
Unsafe Placard β	–	0.1	0.5

6.10 C3032.004a #1: (C3032.004a) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support

NISTIR Classification	C3032.004a
Author	Not Given
Normalized Unit	250.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.10.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.10.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.10.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.92	2.34	2.48
β	0.3	0.3	0.3

Table 6.10.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$1,008	$7,894	$16,240
Lowest Cost Median	$303	$2,368	$4,872
β (COV)	0.55	0.52	0.2

Table 6.10.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.7	5.41	11.15
Lowest Median Repair Time (Days)	0.21	1.62	3.34
β (COV)	0.6	0.58	0.32

Table 6.10.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	250.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.11 C3032.004b #1: (C3032.004b) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support

NISTIR Classification	C3032.004b
Author	Not Given
Normalized Unit	600.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.11.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.11.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.11.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.76	2.26	2.44
β	0.3	0.3	0.3

Table 6.11.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$2,420	$18,945	$38,975
Lowest Cost Median	$726	$5,683	$11,692
β (COV)	0.55	0.52	0.2

Table 6.11.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.57	12.39	25.55
Lowest Median Repair Time (Days)	0.46	3.7	7.67
β (COV)	0.6	0.58	0.32

Table 6.11.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	650.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.12 C3032.004c #1: (C3032.004c) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support

NISTIR Classification	C3032.004c
Author	Not Given
Normalized Unit	1800.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.12.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.12.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.12.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.45	2.1	2.34
β	0.3	0.3	0.3

Table 6.12.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$7,261	$56,835	$116,925
Lowest Cost Median	$2,178	$17,050	$35,077
β (COV)	0.55	0.52	0.2

Table 6.12.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	4.64	36.03	74.17
Lowest Median Repair Time (Days)	1.42	10.79	22.25
β (COV)	0.6	0.58	0.32

Table 6.12.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	1700.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.13 C3032.004d #1: (C3032.004d) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support

NISTIR Classification	C3032.004d
Author	Not Given
Normalized Unit	2500.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.13.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.13.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.13.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.31	2.03	2.29
β	0.3	0.3	0.3

Table 6.13.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$10,085	$78,937	$162,396
Lowest Cost Median	$3,025	$23,681	$48,719
β (COV)	0.55	0.52	0.2

Table 6.13.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	6.09	48.45	99.54
Lowest Median Repair Time (Days)	1.76	14.57	29.83
β (COV)	0.6	0.58	0.32

Table 6.13.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	2500.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.75	0.5
Unsafe Placard β	–	0.5	0.5

6.14 C3034.002 #1: (C3034.002) Independent Pendant Lighting - seismically rated

NISTIR Classification	C3034.002
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Lighting
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.14.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.14.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Disassembly of rod system at connections with horizontal light fixture, low cycle fatigue failure of the threaded rod, pullout of rods from ceiling assembly.	Replace damaged lighting components.	Not Available

Table 6.14.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.14.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$1,377
Lowest Cost Median	$413
β (COV)	0.64

Table 6.14.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.99
Lowest Median Repair Time (Days)	0.3
β (COV)	0.68

Table 6.14.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.15 D2021.013a #1: (D2021.013a) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, PIPING FRAGILITY

NISTIR Classification	D2021.013a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.15.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.15.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.15.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	2.25	4.1
β	0.4	0.4

Table 6.15.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Cost Median	$444	$4,055
Lowest Cost Median	$363	$3,317
β (COV)	0.76	0.41

Table 6.15.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.34	3.09
Lowest Median Repair Time (Days)	0.28	2.53
β (COV)	0.8	0.48

Table 6.15.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.16 D2021.013b #1: (D2021.013b) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F, BRACING FRAGILITY

NISTIR Classification	D2021.013b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.16.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.16.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Lateral Brace Failure - 1 failure per 1000 feet of pipe.	Replace failed lateral braces. One repair per 1000 LF.	Not Available

Table 6.16.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.16.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	3.0
Upper Qty.	10.0
Highest Cost Median	$581
Lowest Cost Median	$476
β (COV)	0.6

Table 6.16.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	3.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.44
Lowest Median Repair Time (Days)	0.36
β (COV)	0.65

Table 6.16.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.17 D2021.023a #1: (D2021.023a) Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, PIPING FRAGILITY

NISTIR Classification	D2021.023a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.17.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.17.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.17.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	2.25	4.1
β	0.4	0.4

Table 6.17.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$974	$9,319
Lowest Cost Median	$292	$2,796
β (COV)	0.65	0.4

Table 6.17.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.74	7.09
Lowest Median Repair Time (Days)	0.22	2.13
β (COV)	0.7	0.47

Table 6.17.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.18 D2021.023b #1: (D2021.023b) Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F, BRACING FRAGILITY

NISTIR Classification	D2021.023b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.18.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.18.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Lateral Brace Failure - 1 failure per 1000 feet of pipe.	Replace failed lateral braces. One repair per 1000 LF.	Not Available
DS2	Vertical Brace Failure - 1 failure per 1000 feet of pipe	Replace failed vertical braces. One repair per 1000 LF.	Not Available

Table 6.18.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.18.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$974	$974
Lowest Cost Median	$292	$292
β (COV)	0.65	0.65

Table 6.18.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.74	0.74
Lowest Median Repair Time (Days)	0.22	0.22
β (COV)	0.7	0.7

Table 6.18.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.19 D2031.013b #1: (D2031.013b) Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F, BRACING FRAGILITY

NISTIR Classification	D2031.013b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.19.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.19.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Isolated support failure w/o leakage - 0.5 support failures per 1000 feet of pipe (assuming supports every 20 feet).	Replace failed supports.	Not Available

Table 6.19.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	2.25
β	0.5

Table 6.19.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$1,113
Lowest Cost Median	$334
β (COV)	0.58

Table 6.19.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.85
Lowest Median Repair Time (Days)	0.25
β (COV)	0.63

Table 6.19.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.20 D3032.013c #1: (D3032.013c) Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility

NISTIR Classification	D3032.013c
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.20.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.20.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Anchorage failure.	Repair anchorage and concrete pad and re-mount equipment.	
DS1b	Anchorage failure & Equipment damaged beyond repair.	Replace equipment including attached utilities in addition to repairing anchorage and concrete pad.	Not Available
DS1c	Motor damaged but anchorage is OK.	Repair Motor - Anchorage and Concrete do not require repair.	Not Available
DS1d	Equipment damaged beyond repair but anchorage is OK.	Replace and install equipment including new anchorage if anchorage is post-installed.	Not Available

Table 6.20.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.	Mut. Excl.
Probability	0.35	0.15	0.25	0.25
Median	3.197	3.197	3.197	3.197
β	0.5	0.5	0.5	0.5

Table 6.20.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0	5.0
Highest Cost Median	$689	$4,820	$1,148	$4,820
Lowest Cost Median	$563	$3,943	$939	$3,943
β (COV)	0.55	0.26	0.17	0.26

Table 6.20.5. Parameters for the repair time distributions.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0	5.0
Highest Median Repair Time (Days)	0.58	1.48	0.97	4.08
Lowest Median Repair Time (Days)	0.48	0.74	0.79	3.34
β (COV)	0.6	0.36	0.3	0.36

Table 6.20.6. Life safety information.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	No	No
Unsafe Placard Median	–	–	–	–
Unsafe Placard β	–	–	–	–

6.21 D3032.013c #2: (D3032.013c) Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility

NISTIR Classification	D3032.013c
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.21.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.21.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Anchorage failure.	Repair anchorage and concrete pad and re-mount equipment.	
DS1b	Anchorage failure & Equipment damaged beyond repair.	Replace equipment including attached utilities in addition to repairing anchorage and concrete pad.	Not Available
DS1c	Motor damaged but anchorage is OK.	Repair Motor - Anchorage and Concrete do not require repair.	Not Available
DS1d	Equipment damaged beyond repair but anchorage is OK.	Replace and install equipment including new anchorage if anchorage is post-installed.	Not Available

Table 6.21.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS1c	DS1d
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.	Mut. Excl.
Probability	0.35	0.15	0.25	0.25
Median	2.046	2.046	2.046	2.046
β	0.5	0.5	0.5	0.5

Table 6.21.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS1c	DS1d
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0	5.0
Highest Cost Median	$689	$4,820	$1,148	$4,820
Lowest Cost Median	$563	$3,943	$939	$3,943
β (COV)	0.55	0.26	0.17	0.26

Table 6.21.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS1c	DS1d
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0	5.0
Highest Median Repair Time (Days)	0.58	1.48	0.97	4.08
Lowest Median Repair Time (Days)	0.48	0.74	0.79	3.34
β (COV)	0.6	0.36	0.3	0.36

Table 6.21.6. Life safety information.

	DS1a	DS1b	DS1c	DS1d
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	No	No
Unsafe Placard Median	–	–	–	–
Unsafe Placard β	–	–	–	–

6.22 D3041.011c #1: (D3041.011c) HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F

NISTIR Classification	D3041.011c
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.22.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.22.2. Damage state progression.

Damage State	**Description**	**Repair Description**	**Image**
DS1	Individual supports fail and duct sags - 1 failed support per 1000 feet of ducting.	Replace failed supports and repair ducting in vicinity of failed supports.	Not Available
DS2	Several adjacent supports fail and sections of ducting fall - 60 feet of ducting fail and fall per 1000 foot of ducting.	Replace sections of failed ducting and supports.	Not Available

Table 6.22.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.22.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$995	$9,716
Lowest Cost Median	$814	$7,949
β (COV)	0.37	0.1

Table 6.22.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	0.84	2.99
Lowest Median Repair Time (Days)	0.69	1.49
β (COV)	0.44	0.27

Table 6.22.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	Yes
Affected Area	– –	15.0 SF
Serious Injury Median	–	0.05
Serious Injury β	–	0.5
Loss of Life Median	–	0.0
Loss of Life β	–	0.0
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.23 D3041.032c #1: (D3041.032c) HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F

NISTIR Classification	D3041.032c
Author	Not Given
Normalized Unit	10.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.23.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.23.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	HVAC drops or diffusers dislodges and falls.	Replace diffuser/drop and sections of ceiling and ducting in vicinity to which diffuser/drop is connected.	Not Available

Table 6.23.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.23.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Cost Median	$4,590
Lowest Cost Median	$3,756
β (COV)	0.21

Table 6.23.5. Parameters for the repair time distributions.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Median Repair Time (Days)	3.88
Lowest Median Repair Time (Days)	3.18
β (COV)	0.32

Table 6.23.6. Life safety information.

	DS1
Non-collapse casualties	Yes
Affected Area	4.0 SF
Serious Injury Median	0.1
Serious Injury β	0.5
Loss of Life Median	0.0
Loss of Life β	0.0
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

7 DISCLAIMER

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Full Detailed Report

Report Generated for:

217 Arlington Avenue, Kensington, CA

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program
by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	New WLF on RC Wall
Building Types:	
Dir. 1: WLF: General	
Dir. 2: RC: Cantilever Shear Wall	
Year of Construction:	2022
Number of Stories:	2
Occupancy:	Commercial Office
Address:	
217 Arlington Avenue Kensington, CA	
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	Yes
Total Square Feet:	1,738
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	None
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Special, Ordinary
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	1.317
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	0.29
2^{nd} Mode Period (T_2) (s):	–	0.09

Component Information

Percent of Building Glazed:	–
Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options	
Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Interior Finishes

- What kind of partition walls does the building have?
  > *Wood Studs*
- Does the building have raised access floors
  > *No*
- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
    - What is the Ip factor used to design the ceilings?
      > *1.5*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *Yes*

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*
- Are there elevators in the building?
  > *Yes*
  - What type of elevators are in the building?
    > *Hydraulic*
    - From which era are the building's elevators?
      > *post-1976 California (or post-1976 California equivalent)*

Fire Supression

- Does the building contain a fire sprinkler system?
  > *Yes*
  - Does the fire sprinkler system have braced horizontal piping?

Continued on next page

Component Checklist (*Continued*))

        > *Yes*
        - Are the horizontal mains OSHPD certified (or equivalent)?
            > *Yes*
    - Are the fire sprinkler drops OSHPD certified (or equivalent)?
        > *Yes*
        - What type of ceiling do the fire drops enter into?
            > *Hard*

Piping

- Is the building's water piping OSHPD certified or equivalent?
    > *Yes*
- Is the building's sanitary piping OSHPD certified or equivalent?
    > *Yes*
    - What type of couplings do the pipes have?
        > *Flexible*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
    > *Yes*
    - How is the cooling/heating system configured?
        > *Roof Top Units*
        - Are the RTUs used for medical purposes (or equivalent)?
            > *No*
            - Are the RTUs small or large?
                > *Small*
        - Does the building have a control panel?
            > *No*
- Is there an HVAC exhaust system in the building?
    > *Yes*
    - Is the HVAC exhaust system seismically anchored?
        > *Yes*
- Does the HVAC distribution system meet OSHPD standards (or similar)?
    > *Yes*
    - Is there any large diameter ducting (6 SqFt+) in the HVAC system?
        > *Yes*

Electrical

- Does the building have a backup battery/generator system?
    > *No*

Concrete

- Are the building's shear walls low rise or slender?
    > *Low Rise (typically <= 40ft building height)*
    - What are the boundary conditions of the walls?
        > *No return flanges or boundary columns*
        - What is the typical wall thickness?
            > *8" to 16"*
            - What is the typical wall height?
                > *Less than 15'*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	3.2	7.7
10% in 50 years	475 Years	27	46
DE	481 Years	27	47
5% in 50 years	975 Years	45	75
MCE_R	1277 Years	52	84
2% in 50 years	2475 Years	72	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	4.8 days	6.1 days	0 days	0 days	7 weeks
10% in 50 years	2.8 months	3.6 months	2.2 months	3.5 months	3.8 months
DE	2.7 months	3.5 months	2.3 months	3.6 months	3.8 months
5% in 50 years	4.1 months	5.4 months	3.2 months	4.2 months	4.3 months
MCE_R	4.7 months	6 months	3.6 months	4.6 months	4.7 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 BASIS OF ANALYSIS

This analysis is based on the SP3-RiskModel of the Seismic Performance Prediction Program (SP3) software platform. The underlying analysis methods are based on the FEMA P-58 analytical method, which is a transparent and well documented method developed through a 15 year project (Applied Technology Council, 2018). This project leveraged the previous decades of academic research, funded by a $16 million investment by the Federal Emergency Management Agency (FEMA). In contrast to many risk assessment methods based on judgment and past earthquake experience, the FEMA P-58 and SP3 analysis are based on engineering-oriented risk evaluation methods.

3 DOCUMENTATION OF SITE AND BUILDING INPUT DATA

Project Name:	Kensington Fire Station
Model Name:	New WLF on RC Wall

3.1 Site Information

Address:	217 Arlington Avenue, Kensington, CA
Latitude:	37.90622°
Longitude:	-122.27875°

3.2 Building Information

Material Type (Direction 1):	WLF
Material Type (Direction 2):	Cast-in-Place Concrete
Number of Stories:	2
Total Building Square Footage:	1,738
Occupancy Type:	Commercial Office
Total Expected Building Replacement Value:	$610,816

4 SITE HAZARD INFORMATION

This section presents the site's seismic hazard information. The V_{S30} value is the shear wave velocity in the soil at a depth of 30 meters. This value and the associated site class are presented in Table 4.1.

Table 4.1. Site soil information

V_{S30} (m/s):	537.0
Site Class:	C
Closest V_{S30} for USGS Hazard Lookup (m/s):	530

Table 4.2 and Figure 4.1 present the spectral acceleration information for this site. The spectral acceleration is a measure of how much force the building will attract in an earthquake. This amount of force is dependent on the intensity of the ground shaking (e.g. 10% in 50 years), as well as a dynamic property of the building known as the "fundamental period". Shorter buildings tend to have smaller fundamental periods and taller buildings tend to have larger fundamental periods. As indicated by Figure 4.1, smaller fundamental periods (with the exception of very short fundamental periods) will attract more force in an earthquake.

The Design Earthquake (DE) and Maximum Considered Earthquake (MCE) are based on the modern code maximum direction spectra and are converted to geometric mean for comparison.

Table 4.2. Geometric mean spectral acceleration values (in g)

Intensity	Return Period (yrs)	PGA	$S_a(0.2s)$	$S_a(1.0s)$	$S_a(0.51s)$	$S_a(0.29s)$	$S_a(T_1)/v_{ult}$ † Dir 1	Dir 2
50% in 50 years	72	0.22	0.52	0.17	0.32	0.46	0.67	0.35
10% in 50 years	475	0.62	1.50	0.56	1.02	1.38	2.11	1.05
DE	481	0.62	1.50	0.57	1.03	1.39	2.12	1.05
5% in 50 years	975	0.82	2.03	0.80	1.43	1.88	2.95	1.43
MCE_R	1277	0.91	2.26	0.91	1.59	2.11	3.29	1.60
2% in 50 years	2475	1.13	2.84	1.19	2.05	2.67	4.24	2.03

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.484$ and $T_1 = 0.509$s and in direction 2 $v_{ult} = 1.32$ and $T_1 = 0.290$s (see Table 5.2 for more detailed structural properties)

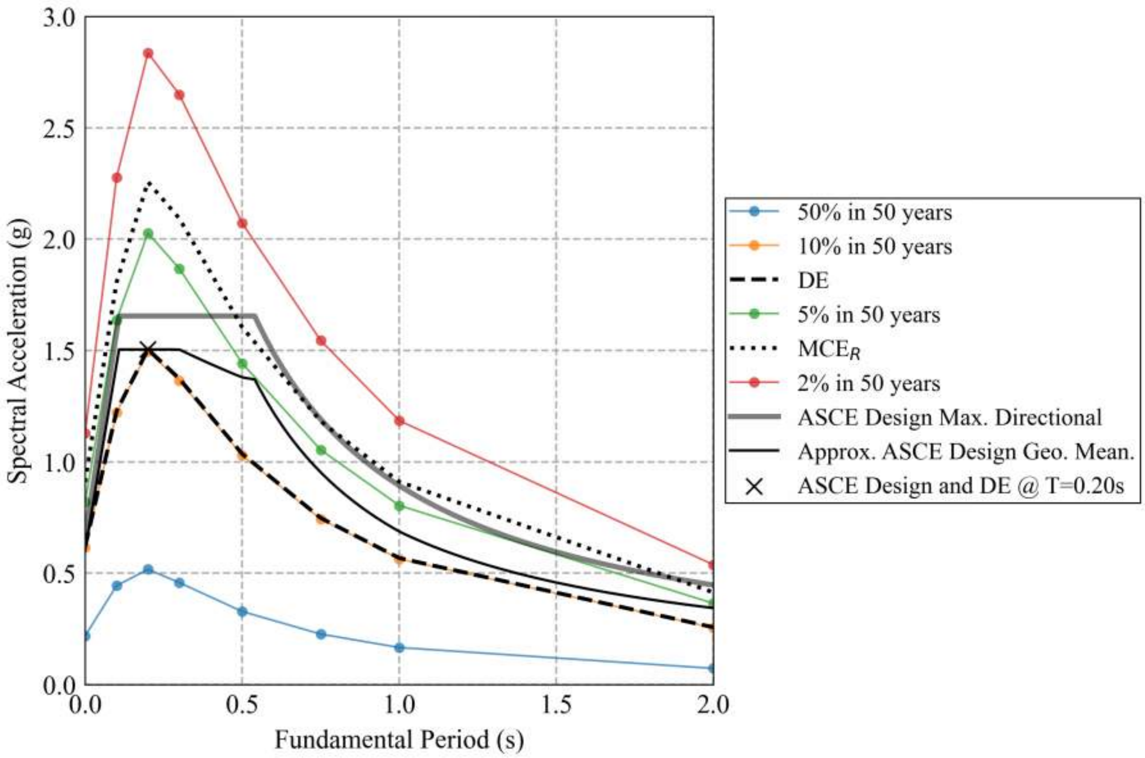


Figure 4.1. Hazard curves for this site. All curves are geometric mean unless otherwise stated.

5 BUILDING DESIGN SUMMARY FROM THE *SP3 BUILDING CODE DESIGN DATABASE*

5.1 Building Code Design Parameters

The seismic design parameters used to compute the seismic base shear coefficients for this building are presented in Table 5.1. These parameters are specific to ASCE/SEI 7-2010 (American Society of Civil Engineers, 2010).

Table 5.1. Code design parameters

(a) ASCE/SEI 7-2010 structural system parameters

Parameter	Dir. 1	Dir. 2
C_t	0.02	0.02
C_d	4	4.5
x	0.75	0.75
R	6.5	5
Ω_0	3	2.5

(b) ASCE/SEI 7-2010 site specific parameters

Parameter	Value
S_s	2.482
S_1	1.031
S_{ds}	1.655
S_{d1}	0.893
SDC	E
C_u	1.4

(c) ASCE/SEI 7-2010 site specific parameters based on the period of the building

Parameter	Value
$\text{MCE}_{R,max}(g)$	2.482
$\text{MCE}_{R,geomean}(g)$	2.159
$\text{DE}_{max}(g)$	1.655
$\text{DE}_{geomean}(g)$	1.439

5.2 Structural Properties

This section summarizes the main structural properties of the building in each direction. These structural properties are used as inputs to the SP3 Structural Response Prediction Engine.

Table 5.2. Structural properties table

Parameter	Direction 1	Direction 2
General		
Structural System	WLF: General	RC: Cantilever Shear Wall
Building Edge Length (ft)	21	41
Detailing Level	Special	Ordinary
Seismic Strength		
Seismic Design Base Shear Ratio, C_s †	0.382	0.496
C_s with Structural Overstrength	–	1.19
Wind Strength		
Wind Design Base Shear Ratio, v_{wind} †	0.131	0.060
v_{wind} with Structural Overstrength	–	0.144
Total Strength		
Strength Governed by	–	seismic
Governing Seismic/Wind with Structural Overstrength	–	1.19
With Gravity System Strength	–	1.27
With Non-structural Strength	–	2.03
Ultimate Base Shear Ratio, v_{ult}	0.484	1.32‡
Stiffness		
Design Drift (%)	–	1.00
$T_{1,design}$ (s)	0.29	0.46‡
T_1 with structural overstiffness (s)	–	0.36
T_1 with gravity system (s)	–	0.35
T_1 with non-structural components (s)	0.51	0.33
T_1 empirical lower bound (s)	–	0.09
T_1 empirical upper bound (s)	–	0.27
T_1 Final (s)	0.51	0.29‡

† Design base shear values reported as LRFD

‡ User defined, not SP3 default

5.3 Mode Shapes

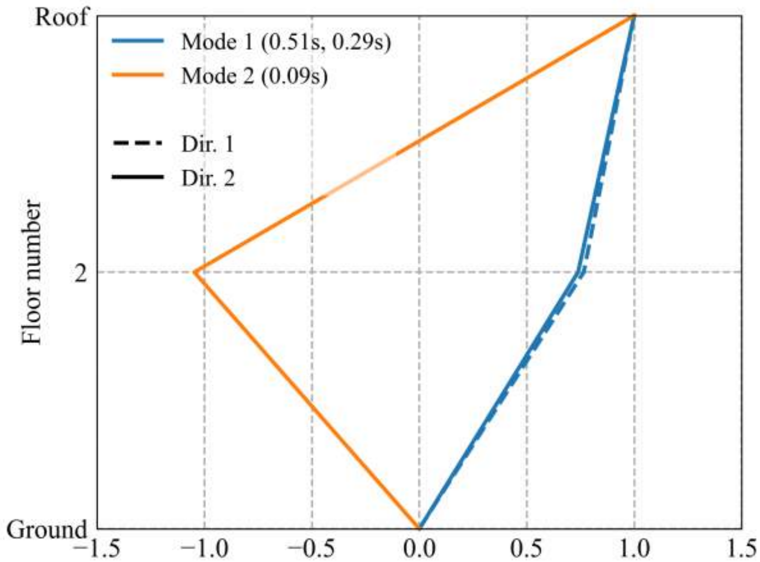


Figure 5.1. Mode shapes

Table 5.3. Mode shape values

	Dir. 1	Dir. 2	
	Mode 1	Mode 1	Mode 2
Roof	1.00	1.00	1.00
2	0.765	0.739	-1.05
Ground	0.00	0.00	0.00

6 SP3 PERFORMANCE FACTORS

Table 6.1 compares the seismic design base shear, C_s, to the 475-year shaking (reduced by the modern response modification coefficient, R). Generally speaking, the modern building code design requirements are based on the 475-year event with the exception of extremely high seismic (near-fault) areas that are designed for a lesser deterministic ground motion or the transition region between deterministic and probabilistic portions of the ground motion maps.

The shaking intensity is then reduced by the response modification coefficient, R, based on the ductility level of the system (in anticipation of controlled damage of specially designed elements).

When the ratio of design base shear to the reduced spectra ($C_s/\left[S_a(T_1)_{475}/R\right]$) is 1.0, then the building was designed consistent with 10% in 50 year hazard. When the ratio is above 1.0, it was designed higher, so expect better performance (all other things equal), and for ratios below 1.0, expect worse performance.

Table 6.1. Design base shear vs. 475-year shaking intensity

	Dir. 1	Dir. 2
Seismic Design Base Shear, C_s	0.382	0.496
475-year Shaking Intensity, $S_a(T_1)_{475}$ †	1.02g	1.38g
Reduced Spectral Acceleration, $S_a(T_1)_{475}/R$ ‡	0.157g	0.230g
Ratio of Design Base Shear to 475-year Shaking Demand, $C_s/\left[S_a(T_1)_{475}/R\right]$ §	**2.44**	**2.16**

† T_1 includes all sources of overstiffness ($T_{1,dir1} = 0.509$s and $T_{1,dir2} = 0.290$s, see Table 5.2).

‡ Response Modification Coefficient, R, is from the modern code ($R_{dir1} = 6.5$ and $R_{dir2} = 6$).

7 BUILDING STABILITY

The FEMA P-154 collapse capacity score was calculated as follows using the "very high" seismicity level. The terminology used in this section is consistent with the FEMA P-154 methodology (Applied Technology Council, 2015a):

- P$[COL|MCE_R]_{P-154}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking, times the collapse factor
- P$[COL|MCE_R]_{P-58}$: the probability that the building will be in the HAZUS complete structural damage state when subjected to MCER shaking
- Collapse Factor: expected ratio of collapsed area to total area given that the building is in the HAZUS Complete structural damage state

For a more in-depth explanation of "collapse," refer to Section 4.4.1.5 of FEMA P-155 Third Edition available here (Applied Technology Council, 2015b).

Since the FEMA P-154 building types associated with the two structural systems specified differ, collapse is based on the more vulnerable structural system which in this case was determined to be the direction 1 system, "WLF: General".

Table 7.1. Breakdown of FEMA P-154 score assignment

FEMA ID:	W2
Basic Score	1.8
Soil	0
Year	2
Plan Irregularity	0
Vertical Irregularity	0
Risk Category† (Cat IV)	0.8
Sum:	4.6
Minimum Allowed:	0.7
Score:	**4.6**
Dispersion (β):	0.58

† Non-standard property implemented by SP3

The FEMA P-154 probability of collapse at the MCE_R level event is then calculated as:

$$\begin{aligned} \text{P}[COL|MCE_R]_{P-154} &= 10^{-\text{score}} \\ &= 10^{-4.6} \\ &= 0.00251\% \end{aligned} \quad \text{(FEMA P-155 eqn. 4-1)}$$

Taking into account the fraction of floor area collapsed (0.33 in this case), the probability of collapse is:

$$\begin{aligned} \text{P}[COL|MCE_R]_{P-58} &= \text{P}[COL|MCE_R]_{P-154} \text{ / Collapse Factor} \\ &= 0.00251\% \text{ / } 0.33 \\ &= 0.00761\% \end{aligned}$$

The median collapse capacity (before any direct modifications to the median) is calculated as:

$$\begin{aligned} S_{a,\ collapse\ median,\ P-58} &= \exp\left(\ln(S_{a,MCE_R}) - \text{norminv}\left(P[COL|MCE_R]_{P-58}\right) \cdot \beta\right) \\ &= \exp\left(\ln(1.85g) - \text{norminv}\left(0.00761\%\right) \cdot 0.58\right) \\ &= 16.6g \end{aligned}$$

where `norminv` is the inverse of the standard normal cumulative distribution function (CDF).

To further refine the collapse capacity, the factors from Table 7.2 were applied to the median collapse S_a.

Table 7.2. Scale factor applied to the median collapse S_a value.

Reason	Factor
Wood Light Frame	0.237

The WLF modification reflects a weighted average of the FEMA P-154 median and the median collapse capacity observed in extensive non-linear dynamic modeling.

The final median for the collapse curve is therefore:

$$\begin{aligned} S_{a,\ collapse\ median,\ P-58\ (adjusted)} &= S_{a,\ collapse\ median,\ P-58} \cdot \text{Factors} \\ &= 16.6g \cdot 0.237 \qquad \text{(Using additional SP3 factors)} \\ &= 3.94g \end{aligned}$$

Which corresponds to a probability of collapse at MCE of:

$$\text{P}[COL|MCE_R]_{P-58\ (adjusted)} = 9.64\% \qquad \text{(Using additional SP3 factors)}$$

Figure 7.1 shows the collapse capacity cumulative distribution function used in the analysis.

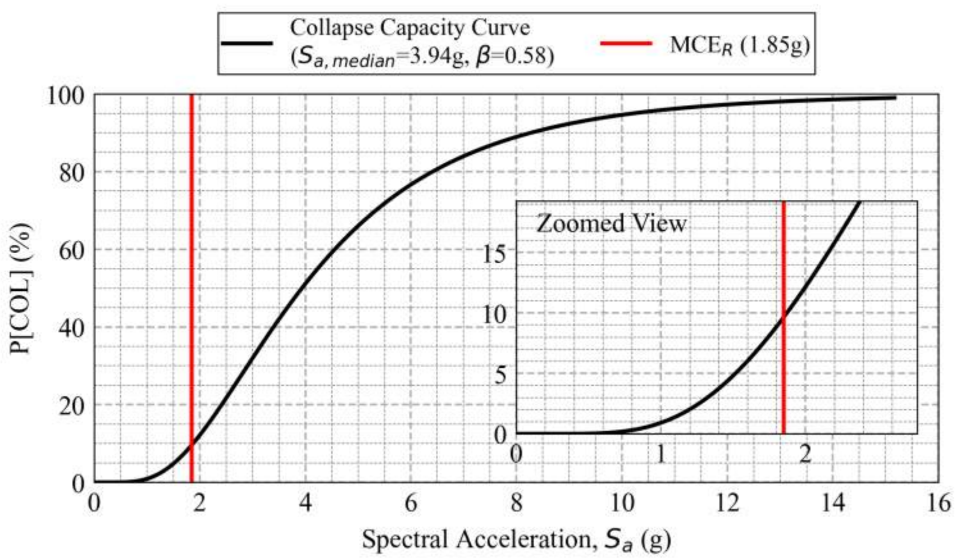


Figure 7.1. Cumulative distribution function for collapse capacity

8 STRUCTURAL RESPONSE PREDICTIONS FROM THE SP3 STRUCTURAL RESPONSE PREDICTION ENGINE

The SP3 Response Prediction Engine predicts the structural responses (typically providing 100 ground motions per intensity level); this is done by using a combination of three-mode elastic modal analysis, coupled with both elastic and inelastic response modifiers mined from the large SP3 Structural Responses Database (with over 4,000,000 response simulations, and growing). These response predictions track all of the important statistical information in the responses (mean, variability, and correlations); this enables a statistically robust vulnerability curve at the end of the risk assessment process.

8.1 Peak Interstory Drift

Peak interstory drift ratio is an important metric for both structural and non-structural components in the building. It measures how much the ceiling of a given story moves relative to the floor, normalized to the height of the story. The greater the interstory drift ratio, the greater the damage to the components on that level. Typical components that are damaged from interstory drift ratio are structural components (beams and columns), gypsum partition walls, and exterior cladding and glazing.

Table 8.1. Median Peak Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.05	0.34	0.34	0.38	0.43	0.62
1	0.36	2.30	2.32	3.64	4.14	5.68
$\frac{S_a(T_1)}{v_{ult}} =$	0.67	2.11	2.12	2.95	3.29	4.24

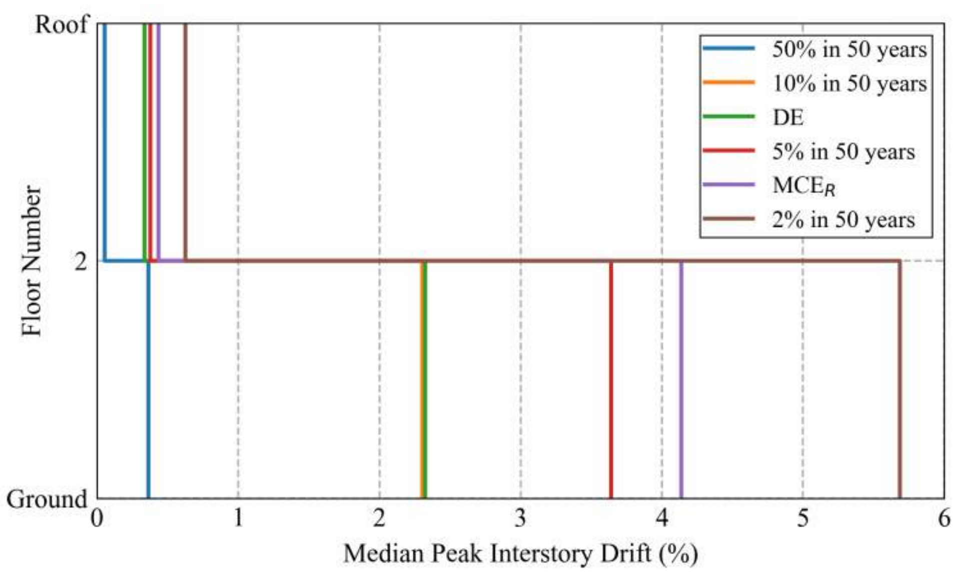


Figure 8.1. Median Peak Interstory Drift demands in direction 1

Table 8.2. Median Peak Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.10	0.32	0.32	0.55	0.68	1.06
1	0.18	0.58	0.58	0.77	0.86	1.06
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

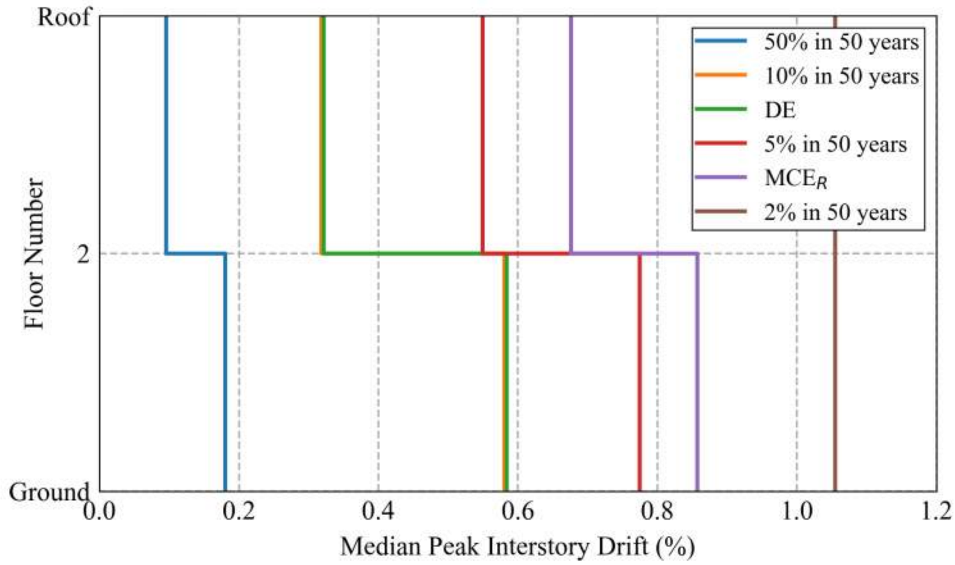


Figure 8.2. Median Peak Interstory Drift demands in direction 2

8.2 Residual Interstory Drift

Residual drift is a metric that informs the need for structural repairs or building demolition (where excessive drifts are present). Residual drift ratio is a measure of how much the building is "leaning over" after the seismic event has ceased. A residual drift of 2% would indicate that the story is laterally displaced 2% of it's height, which equates to about 3.6 inches for a 15 foot tall story.

Table 8.3. Median Residual Interstory Drift demands in direction 1

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.18	0.19	0.43	0.53	0.82
$\frac{S_a(T_1)}{v_{ult}} =$	0.67	2.11	2.12	2.95	3.29	4.24

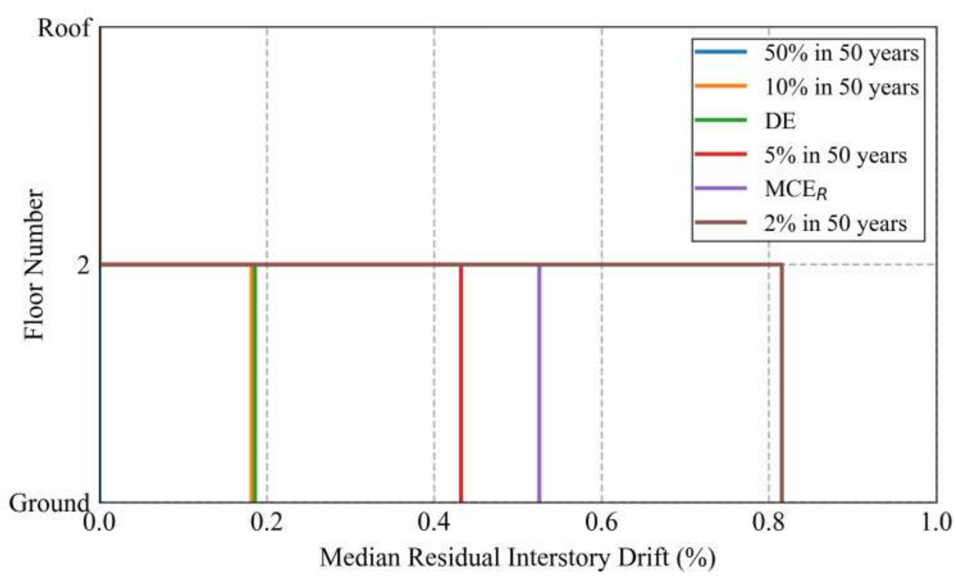


Figure 8.3. Median Residual Interstory Drift demands in direction 1

Table 8.4. Median Residual Interstory Drift demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.00	0.01	0.01	0.04	0.05	0.10
1	0.00	0.04	0.04	0.07	0.08	0.10
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

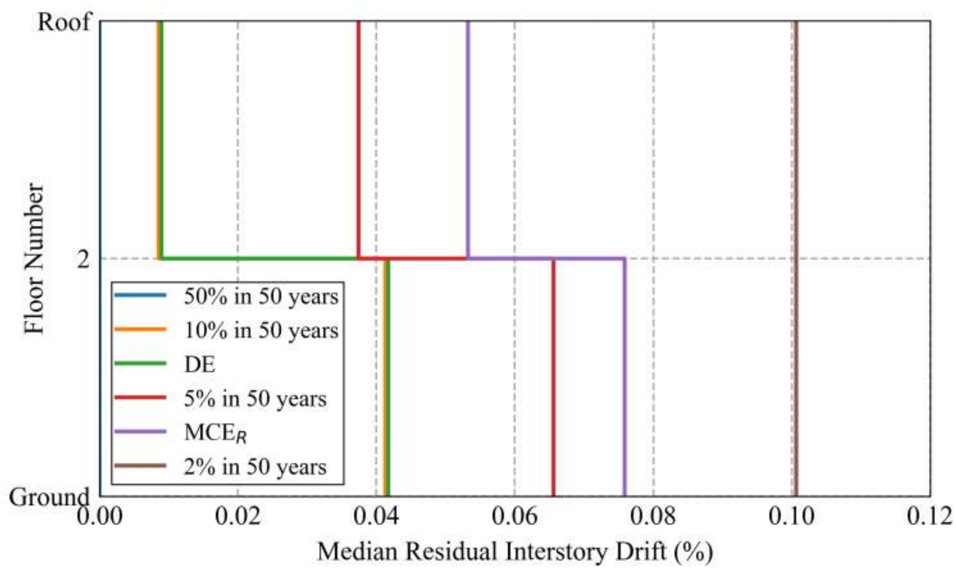


Figure 8.4. Median Residual Interstory Drift demands in direction 2

8.3 Peak Floor Acceleration

Peak floor acceleration is an an important metric for non-structural components in the building. Components such as piping, HVAC, and electrical switchgear are sensitive to the floor accelerations. High accelerations will typically damage a component itself or cause the component's anchorage to fail, both of which may require repair or replacement of the component.

Table 8.5. Median Peak Floor Acceleration demands in direction 1

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Roof	0.34	0.82	0.82	0.83	0.91	1.13
2	0.29	0.75	0.75	0.83	0.91	1.13
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}}=$	0.67	2.11	2.12	2.95	3.29	4.24

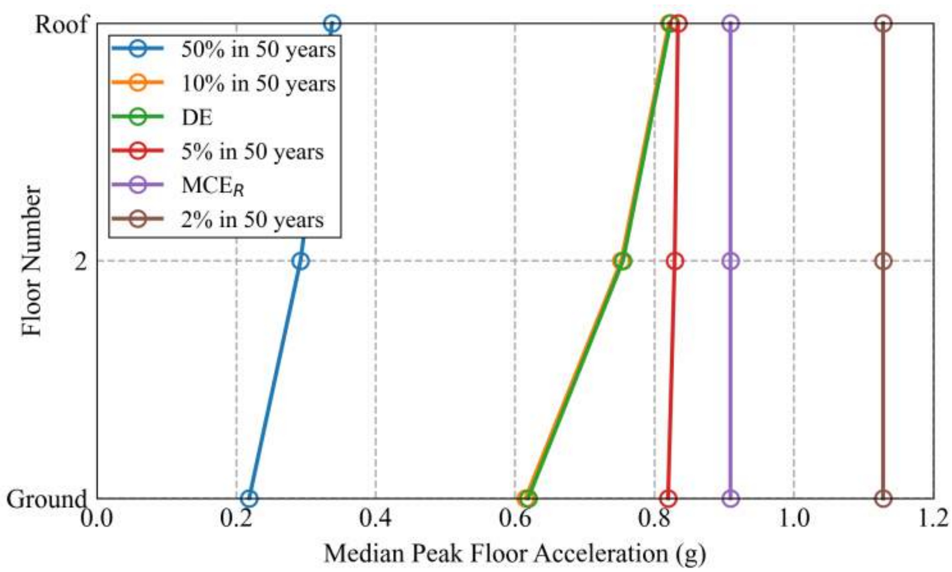


Figure 8.5. Median Peak Floor Acceleration demands in direction 1

Table 8.6. Median Peak Floor Acceleration demands in direction 2

Floor	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Roof	0.55	1.42	1.43	1.70	1.77	1.91
2	0.38	1.03	1.03	1.27	1.35	1.51
Ground	0.22	0.62	0.62	0.82	0.91	1.13
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

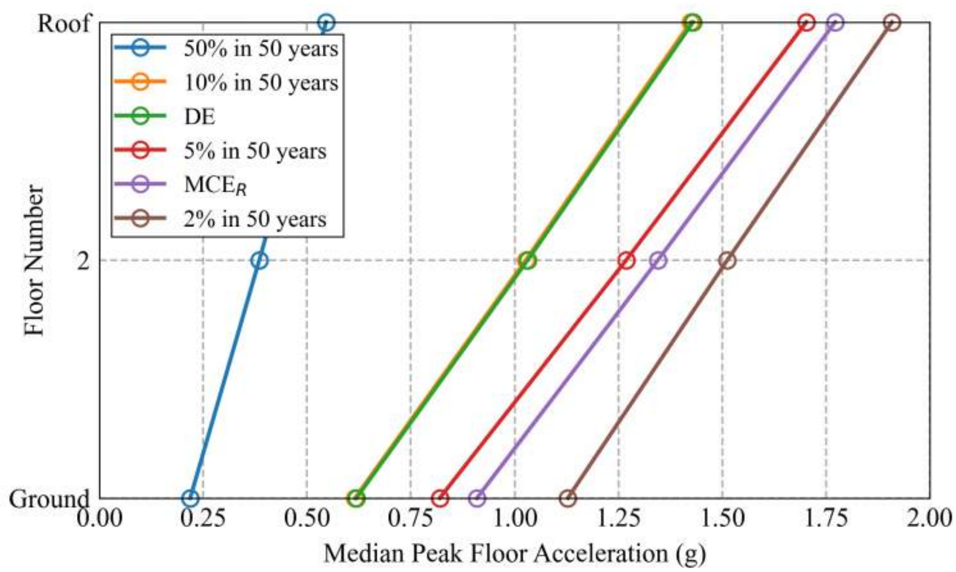


Figure 8.6. Median Peak Floor Acceleration demands in direction 2

8.4 Peak Chord Rotation

Chord rotation informs how slender shear walls damage. Chord rotation is the difference in drift between two adjacent levels of a building.

Table 8.7. Median Peak Chord Rotation demands in direction 2

Story	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
2	0.08	0.26	0.26	0.23	0.18	0.00
1	0.18	0.58	0.58	0.77	0.86	1.06
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

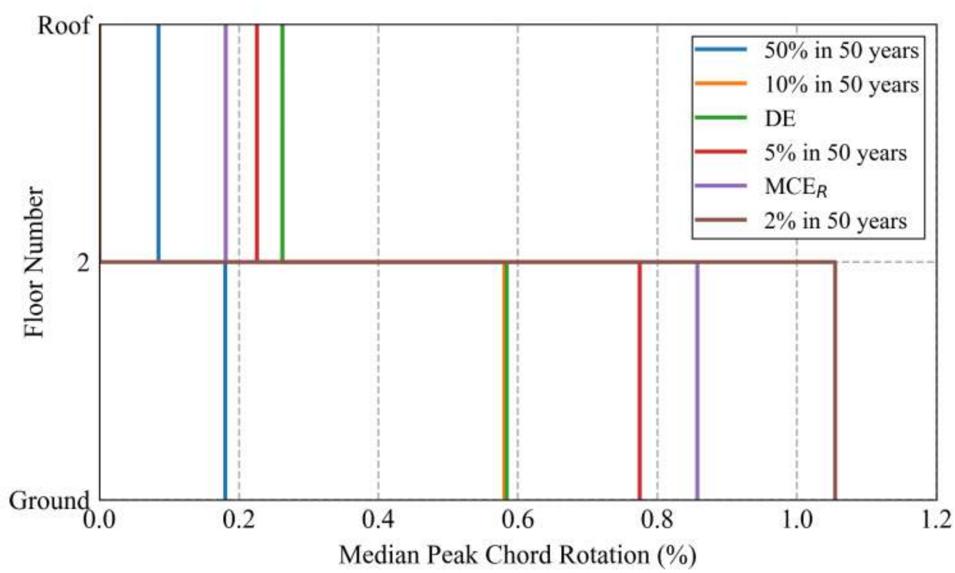


Figure 8.7. Median Peak Chord Rotation demands in direction 2

8.5 Max. Residual Interstory Drift

Table 8.8. Median Max. Residual Interstory Drift demands in direction 1

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.18	0.19	0.43	0.53	0.82
$\frac{S_a(T_1)}{v_{ult}}$ =	0.67	2.11	2.12	2.95	3.29	4.24

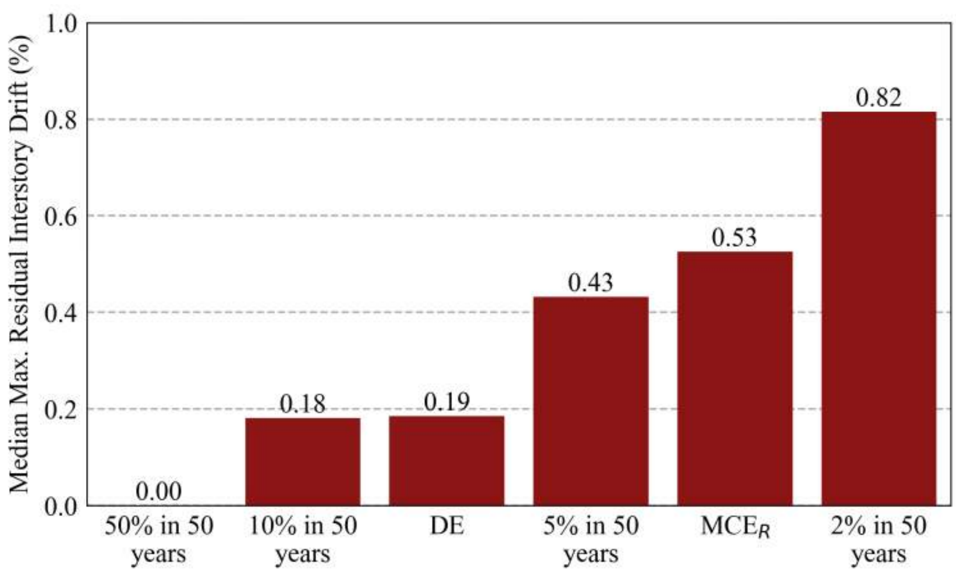


Figure 8.8. Median Max. Residual Interstory Drift demands in direction 1

Table 8.9. Median Max. Residual Interstory Drift demands in direction 2

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
–	0.00	0.04	0.04	0.07	0.08	0.10
$\frac{S_a(T_1)}{v_{ult}} =$	0.35	1.05	1.05	1.43	1.60	2.03

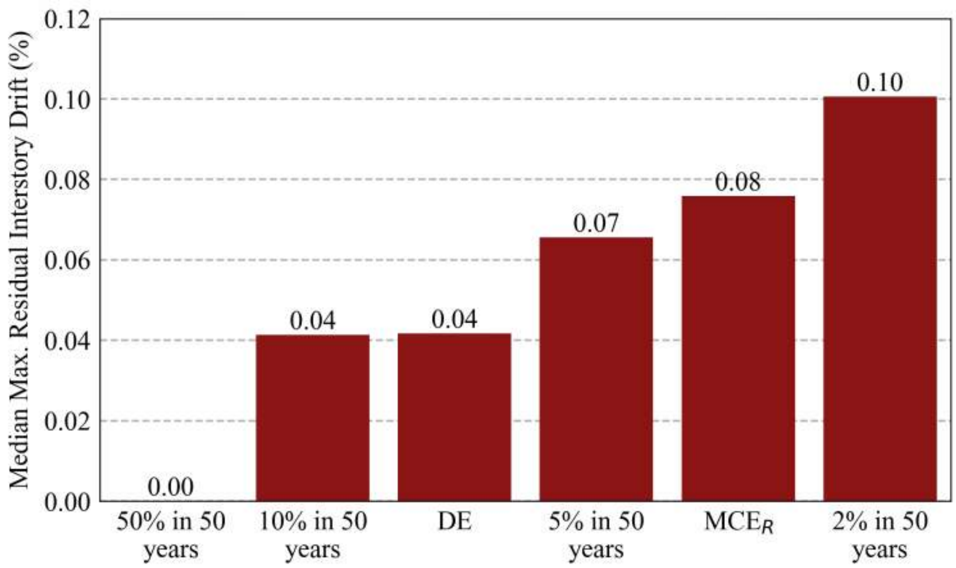


Figure 8.9. Median Max. Residual Interstory Drift demands in direction 2

9 REPAIR COSTS - BY LEVEL OF GROUND MOTION

9.1 Mean and 90th Percentile Repair Costs (SEL and SUL)

The different metrics for repair cost are as follows:

- **Mean (SEL)**: ("Scenario Expected Loss") the average repair cost of the building repair/replacement.
- **Median**: there is a 50% probability that the repair cost will not exceed this value.
- **Fitted SUL**: Fitted value of "Scenario Upper Loss".
- **Counted 90th Percentile**: there is a 90% probability that the repair cost will not exceed this value.

Table 9.1. Loss metrics normalized by building cost

Intensity	PGA (g)	Mean (SEL) (%)	Fitted SUL (%)	Median (%)	Counted 90th Percentile (%)	$S_a(T_1)/v_{ult}$ † Dir 1	Dir 2
50% in 50 years	0.22	3.2	7.7	1.4	8.8	0.67	0.35
10% in 50 years	0.62	27	46	24	46	2.11	1.05
DE	0.62	27	47	24	47	2.12	1.05
5% in 50 years	0.82	45	75	37	100	2.95	1.43
MCE$_R$	0.91	52	84	42	100	3.29	1.60
2% in 50 years	1.13	72	100	100	100	4.24	2.03

† $S_a(T_1)/v_{ult}$ is the ratio of shaking intensity to building strength where in direction 1 $v_{ult} = 0.484$ and $T_1 = 0.509$s and in direction 2 $v_{ult} = 1.32$ and $T_1 = 0.290$s (see Table 5.2 for more detailed structural properties)

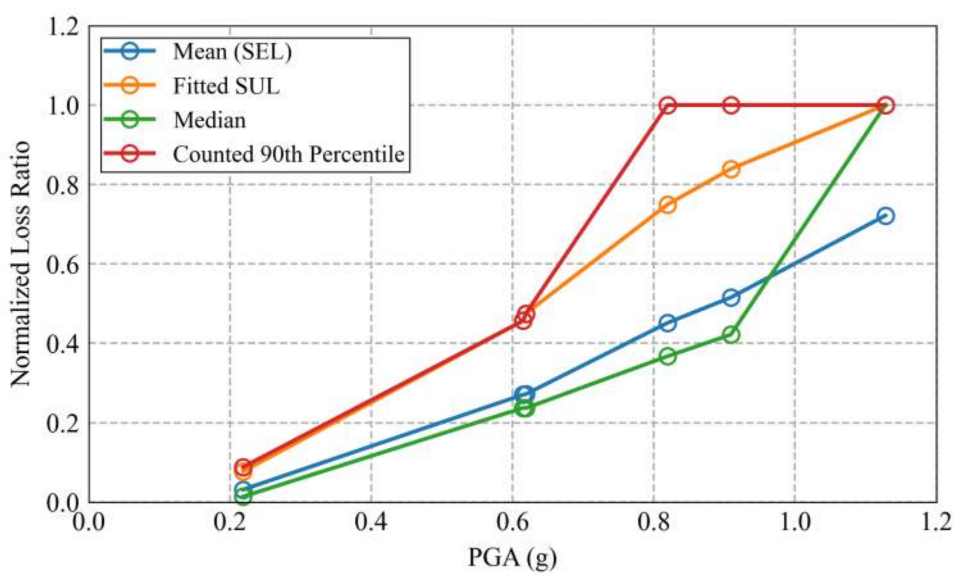


Figure 9.1. Loss metrics across all intensity levels analyzed

10 REPAIR COST BREAKDOWN BY BUILDING COMPONENTS

10.1 Categories for Repair Cost Breakdowns

Repair costs are binned into eight categories as follows:

- **Collapse**: building demolition and replacement following a collapse.
- **Residual**: building demolition and replacement following unacceptable residual drifts.
- **Structural**: components of the lateral force resisting system or gravity system (e.g. beam column connections, link beams, shear wall, shear tabs, etc.).
- **Partitions**: partition wall components (e.g. wood or metal stud gypsum full height partitions).
- **Exterior**: components placed on the exterior of the building (e.g. cladding, glazing, etc.).
- **Interior**: non-structural components on the interior of the building (e.g. raised access floors, ceilings, lighting).
- **HVAC**: HVAC and plumbing components (e.g. water piping and bracing, sanitary piping, ducting, boilers etc.).
- **Other**: components not included in the categories above (e.g. elevators, user defined components, fire protection components).

10.2 Repair Cost Breakdown for Various Ground Motion Levels

Table 10.1. Expected mean loss per component group (in percent)

Intensity	Total	Residual	Collapse	Structural	Partitions	Interior	Other	HVAC	Exterior
50% in 50 years	3.2	0.0	0.0	0.6	0.9	0.3	1.0	0.4	0.0
10% in 50 years	27	0.3	1.0	9.7	4.6	4.4	4.5	1.8	0.7
DE	27	0.3	1.1	9.6	4.6	4.6	4.4	1.8	0.7
5% in 50 years	45	10.0	5.8	12	5.1	5.2	4.3	1.8	0.8
MCE_R	52	14	8.7	12	5.1	5.1	4.2	1.8	0.8
2% in 50 years	72	33	18	9.2	4.0	3.5	2.7	1.2	0.5

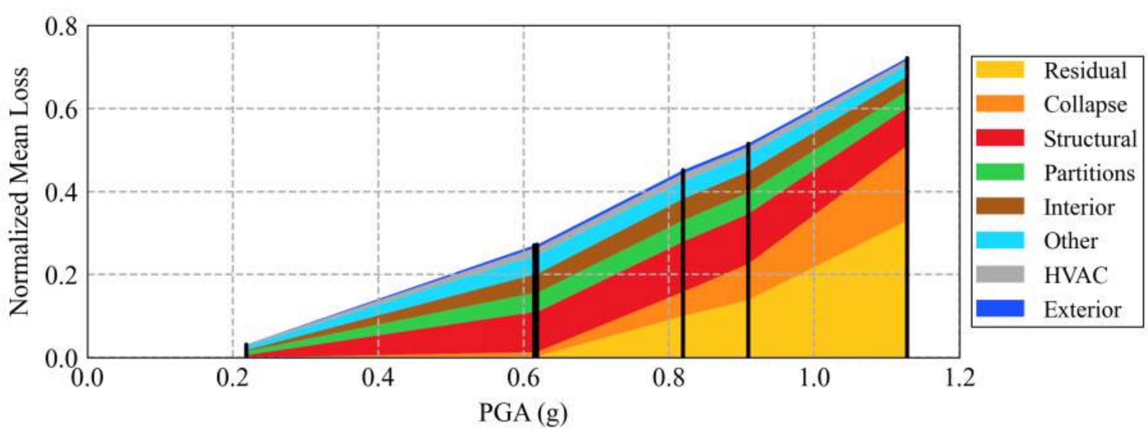


Figure 10.1. Contribution of building components to mean loss ratio

10.3 Repair Cost Breakdown for Expected Annual Loss

The expected annual loss for this building is $1,741.

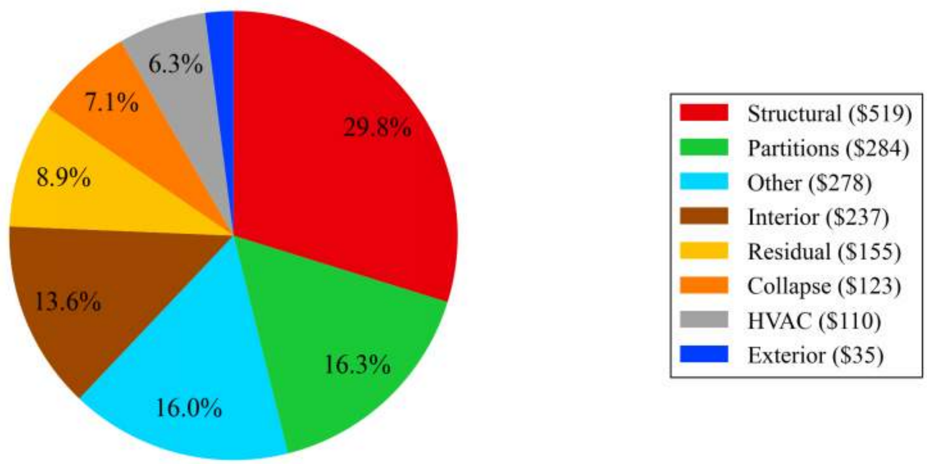


Figure 10.2. Annualized loss breakdown

11 REPAIR TIME AND BUILDING CLOSURE TIME

These downtimes were calculated using the ATC-138 Functional Recovery (Beta) Methodology. This includes all sources of impedance specified by the user; possible sources of impedance considered are listed below.

- Post-earthquake Inspection
- Engineering Mobilization and Review/Re-design
- Financing
- Contractor Mobilization and Bid Process
- Permitting

These capture the time required to start the repairs, since beginning repairs immediately after an earthquake may not be realistic.

Table 11.1. Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	4.8 days	6.1 days	0 days	0 days	7 weeks
10% in 50 years	2.8 months	3.6 months	2.2 months	3.5 months	3.8 months
DE	2.7 months	3.5 months	2.3 months	3.6 months	3.8 months
5% in 50 years	4.1 months	5.4 months	3.2 months	4.2 months	4.3 months
MCE_R	4.7 months	6 months	3.6 months	4.6 months	4.7 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

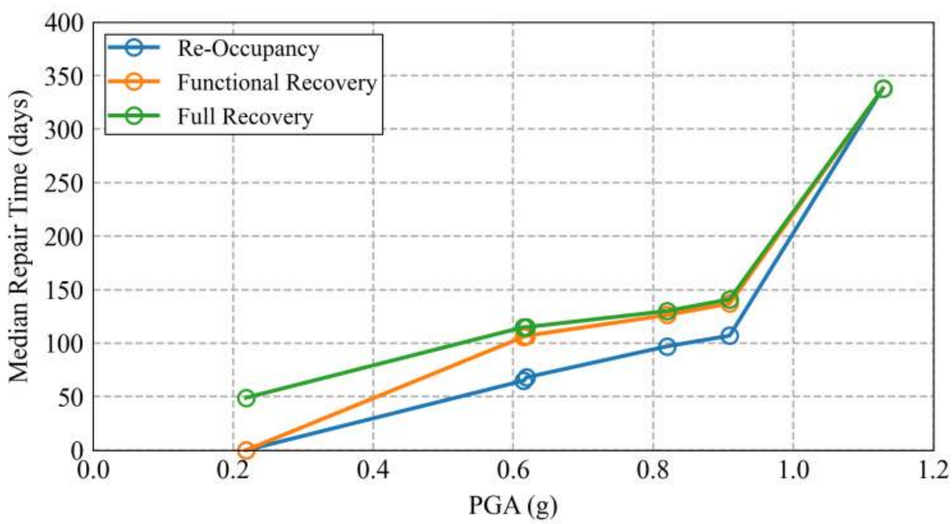


Figure 11.1. Median repair time from the ATC-138 Functional Recovery (Beta) Methodology, includes specified impeding factors

12 DISCLAIMER

REFERENCES

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Applied Technology Council. 2015a. *FEMA P-154: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*.

Applied Technology Council. 2015b. *FEMA P-155: Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation*.

Applied Technology Council. 2018. *FEMA P-58: Seismic Perfromance Assessment of Buildings*.

SEISMIC RISK ASSESSMENT REPORT

Created with the SP3-RiskModel

Functional Recovery Time Report

using the

ATC-138 Functional Recovery (Beta) Methodology

Report Generated for:

217 Arlington Avenue, Kensington, CA

Latitude: 37.90622°

Longitude: -122.27875°

Report Generated by:

The SP3-RiskModel Software v1.2.0 of the

Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program
by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	New WLF on RC Wall
Building Types:	
Dir. 1: WLF: General	
Dir. 2: RC: Cantilever Shear Wall	
Year of Construction:	2022
Number of Stories:	2
Occupancy:	Commercial Office
Address:	
217 Arlington Avenue Kensington, CA	
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	Yes
Total Square Feet:	1,738
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	None
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Special, Ordinary
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	1.317
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	0.29
2^{nd} Mode Period (T_2) (s):	–	0.09

Component Information

Percent of Building Glazed:	–
Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options	
Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Interior Finishes

- What kind of partition walls does the building have?
  > *Wood Studs*
- Does the building have raised access floors
  > *No*
- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
    - What is the Ip factor used to design the ceilings?
      > *1.5*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *Yes*

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*
- Are there elevators in the building?
  > *Yes*
  - What type of elevators are in the building?
    > *Hydraulic*
    - From which era are the building's elevators?
      > *post-1976 California (or post-1976 California equivalent)*

Fire Supression

- Does the building contain a fire sprinkler system?
  > *Yes*
  - Does the fire sprinkler system have braced horizontal piping?

Continued on next page

Component Checklist (*Continued*))

  > *Yes*
  - Are the horizontal mains OSHPD certified (or equivalent)?
    > *Yes*
- Are the fire sprinkler drops OSHPD certified (or equivalent)?
  > *Yes*
  - What type of ceiling do the fire drops enter into?
    > *Hard*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *Yes*
- Is the building's sanitary piping OSHPD certified or equivalent?
  > *Yes*
  - What type of couplings do the pipes have?
    > *Flexible*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *Yes*
  - How is the cooling/heating system configured?
    > *Roof Top Units*
    - Are the RTUs used for medical purposes (or equivalent)?
      > *No*
      - Are the RTUs small or large?
        > *Small*
    - Does the building have a control panel?
      > *No*
- Is there an HVAC exhaust system in the building?
  > *Yes*
  - Is the HVAC exhaust system seismically anchored?
    > *Yes*
- Does the HVAC distribution system meet OSHPD standards (or similar)?
  > *Yes*
  - Is there any large diameter ducting (6 SqFt+) in the HVAC system?
    > *Yes*

Electrical

- Does the building have a backup battery/generator system?
  > *No*

Concrete

- Are the building's shear walls low rise or slender?
  > *Low Rise (typically <= 40ft building height)*
  - What are the boundary conditions of the walls?
    > *No return flanges or boundary columns*
    - What is the typical wall thickness?
      > *8" to 16"*
      - What is the typical wall height?
        > *Less than 15'*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	3.2	7.7
10% in 50 years	475 Years	27	46
DE	481 Years	27	47
5% in 50 years	975 Years	45	75
MCE_R	1277 Years	52	84
2% in 50 years	2475 Years	72	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	4.8 days	6.1 days	0 days	0 days	7 weeks
10% in 50 years	2.8 months	3.6 months	2.2 months	3.5 months	3.8 months
DE	2.7 months	3.5 months	2.3 months	3.6 months	3.8 months
5% in 50 years	4.1 months	5.4 months	3.2 months	4.2 months	4.3 months
MCE_R	4.7 months	6 months	3.6 months	4.6 months	4.7 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 FUNCTIONAL RECOVERY OVERVIEW

Table 2.1. Recovery Times from the ATC-138 Functional Recovery (Beta) Methodology

Intensity	Return Period	PGA (g)	Sa(T_1)*	Median			90^{th} Percentile		
				Re-Occ.	Func.	Full	Re-Occ.	Func.	Full
50% in 50 years	72 years	0.22	0.39	0d	0d	7w	0d	6.6w	4m
10% in 50 years	475 years	0.62	1.20	2.2m	3.5m	3.8m	4.9m	5.9m	6m
DE	481 years	0.62	1.21	2.3m	3.6m	3.8m	4.8m	5.7m	5.9m
5% in 50 years	975 years	0.82	1.66	3.2m	4.2m	4.3m	11m	11m	11m
MCE$_R$	1277 years	0.91	1.85	3.6m	4.6m	4.7m	11m	11m	11m
2% in 50 years	2475 years	1.13	2.36	11m	11m	11m	11m	11m	11m

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

Table 2.2. Global Consequences

Intensity	Return Period	PGA (g)	Sa(T_1)*	P[red tag]	P[collapse]	P[excessive residual]
50% in 50 years	72 years	0.22	0.39	0.0%	0.0%	0.0%
10% in 50 years	475 years	0.62	1.20	1.3%	1.0%	0.3%
DE	481 years	0.62	1.21	1.4%	1.1%	0.3%
5% in 50 years	975 years	0.82	1.66	16%	5.8%	10.0%
MCE$_R$	1277 years	0.91	1.85	23%	8.7%	14%
2% in 50 years	2475 years	1.13	2.36	51%	18%	33%

* Sa(T_1) is the spectral acceleration at T_1 where is the mean of T_1 in both directions

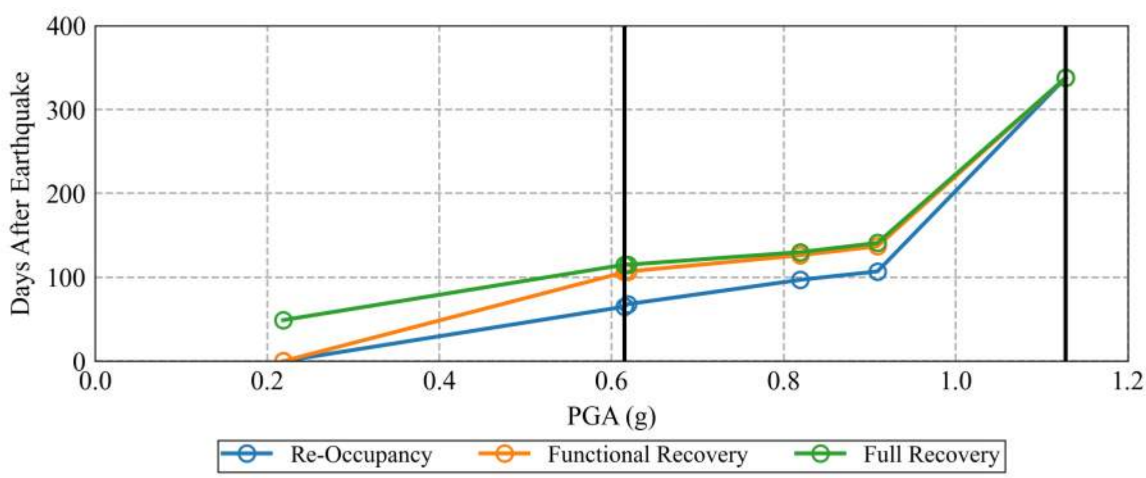

Figure 2.1. ATC-138 Functional Recovery (Beta) Methodology median recovery times

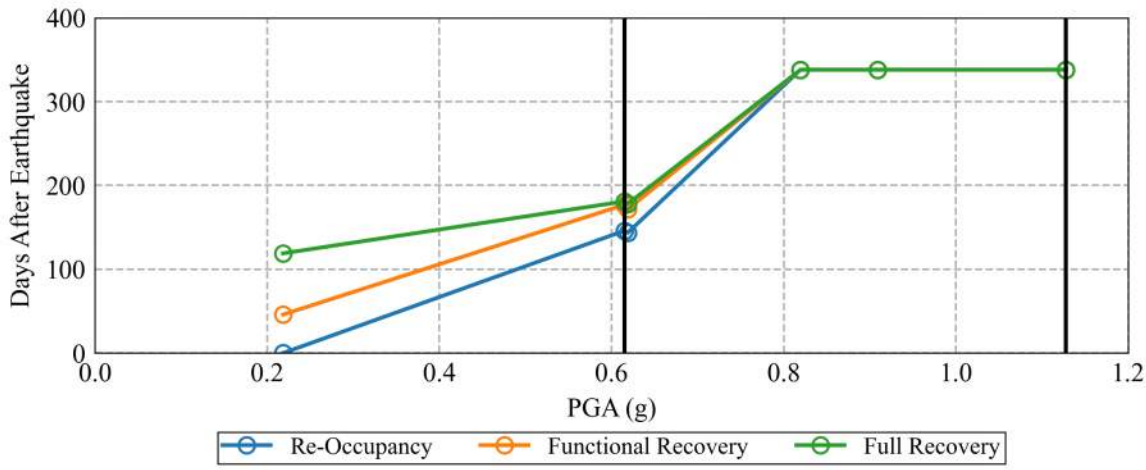

Figure 2.2. ATC-138 Functional Recovery (Beta) Methodology 90^{th} percentile recovery times

3 COMPONENT DAMAGE OVERVIEW

3.1 Most Damaged Components

This section outlines the most damaged component at each intensity. "Most damaged" is determined by cost and does not necessarily mean that it's the main component impeding building function.

Table 3.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1044.011	1	\$3,640
10% in 50 years	B1044.011	1	\$54,073
DE	B1044.011	1	\$53,309
5% in 50 years	B1044.011	1	\$67,194
MCE_R	B1044.011	1	\$66,878
2% in 50 years	B1044.011	1	\$51,183

Table 3.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	D1014.021	1	\$5,819
10% in 50 years	D1014.021	1	\$24,935
DE	D1014.021	1	\$24,302
5% in 50 years	D1014.021	1	\$22,464
MCE_R	D1014.021	1	\$21,878
2% in 50 years	D1014.021	1	\$14,010

Details of the most damaged components and their damage states:

- **B1044.011**: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with heights of up to 15'
  - DS1: Cracks with maximum widths greater than 0.04 in but less than 0.12 in.
- **D1014.021**: Hydraulic Elevator - Applies to most California Installations 1976 or later, most western states installations postdating 1982 and most U.S installations postdating 1998.
  - DS1a: Damaged controls.
  - DS1b: Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.
  - DS1c: Damaged entrance and car door, and or flooring damage.
  - DS1d: Oil leak in hydraulic line, and or hydraulic tank failure.

3.2 Worker Days Summary

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.3. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	1.6	13	13	12	11	6.7
DS2	0.1	3.5	3.5	4.4	4.4	3.8
DS3	0.2	14	14	22	22	18
Total	**2.0**	**30**	**30**	**38**	**37**	**29**
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.1	1.1	1.0	0.7	0.7	0.4
DS2	0.0	0.8	0.8	0.8	0.7	0.4
DS3	0.0	1.8	1.9	3.3	3.3	2.8
Total	**0.1**	**3.6**	**3.8**	**4.8**	**4.7**	**3.6**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	0.2	0.7	0.7	0.6	0.6	0.5
DS2	0.0	0.7	0.7	0.5	0.4	0.3
DS3	0.0	3.1	3.2	3.9	3.9	2.9
Total	**0.2**	**4.5**	**4.6**	**5.0**	**4.9**	**3.6**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.1	2.1	2.1	1.6	1.4	0.7
DS2	0.2	1.2	1.2	1.3	1.4	1.1
DS3	0.3	5.6	5.6	6.8	7.0	5.8
Total	**1.7**	**8.9**	**8.9**	**10**	**10**	**7.5**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.0	1.6	1.5	1.2	1.0	0.5
DS2	0.2	1.2	1.2	1.4	1.5	1.1
DS3	0.2	4.1	4.0	5.2	5.4	4.6
Total	**1.3**	**6.9**	**6.8**	**7.8**	**7.8**	**6.1**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.0	0.3	0.3	0.3	0.2	0.2
DS2	0.0	0.6	0.7	0.7	0.7	0.5
DS3	0.0	1.0	1.0	1.7	1.7	1.4
Total	**0.1**	**2.0**	**2.0**	**2.6**	**2.6**	**2.0**
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	0.0	0.1	0.1	0.1	0.1	0.1
DS2	0.0	0.2	0.2	0.2	0.2	0.1
DS3	0.2	3.2	3.3	4.0	4.0	2.7
Total	**0.2**	**3.5**	**3.7**	**4.3**	**4.3**	**2.9**

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Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	0.0	0.1	0.2	0.1	0.1	0.1
DS2	0.0	0.3	0.3	0.3	0.3	0.2
DS3	0.2	3.2	3.5	4.3	3.9	2.8
Total	**0.2**	**3.7**	**3.9**	**4.7**	**4.3**	**3.1**
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	0.1	0.2	0.2	0.2	0.2	0.1
DS2	0.1	0.4	0.5	0.4	0.4	0.4
DS3	0.1	3.4	3.6	4.3	4.1	2.8
Total	**0.2**	**4.1**	**4.4**	**4.9**	**4.7**	**3.3**
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	0.1	0.3	0.3	0.2	0.2	0.1
DS2	0.1	0.5	0.5	0.4	0.4	0.3
DS3	0.2	3.6	3.7	4.4	4.2	2.9
Total	**0.4**	**4.4**	**4.4**	**5.0**	**4.9**	**3.3**
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**0.3**	**1.9**	**1.9**	**1.9**	**1.9**	**1.2**
D1014.021 #1 (D1014.021: Hydraulic Elevator - Applies to most California Installations 1976 or...)						
DS1a	0.1	0.4	0.4	0.4	0.3	0.2
DS1b	1.7	6.6	6.4	6.1	5.8	3.8
DS1c	2.1	9.3	8.6	7.5	7.6	4.9
DS1d	0.3	1.3	1.3	1.3	1.2	0.7
Total	**4.2**	**18**	**17**	**15**	**15**	**10**
D2021.014a #1 (D2021.014a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.1	0.1	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**
D2021.014b #1 (D2021.014b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.024a #1 (D2021.024a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.0**
D2021.024b #1 (D2021.024b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2031.014b #1 (D2031.014b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or...)						
DS1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.0	0.1	0.1	0.1	0.1	0.1
DS1b	0.0	0.1	0.1	0.1	0.1	0.1
DS1c	0.0	0.1	0.1	0.1	0.1	0.1
DS1d	0.0	0.4	0.4	0.4	0.4	0.3
Total	**0.1**	**0.6**	**0.7**	**0.7**	**0.7**	**0.4**

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Table 3.3 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
D3041.011d #1 (D3041.011d: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.1	0.1	0.1
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D3041.012d #1 (D3041.012d: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D3041.032d #1 (D3041.032d: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.6**	**3.7**	**3.8**	**3.7**	**3.5**	**2.3**
D3041.103c #1 (D3041.103c: HVAC Fan - Capacity: all - Equipment that is either hard anchored or is...)						
DS1a	0.1	0.4	0.4	0.4	0.4	0.2
DS1b	0.0	0.1	0.1	0.1	0.1	0.1
DS1c	0.7	2.3	2.3	2.1	2.0	1.2
Total	**0.9**	**2.8**	**2.8**	**2.6**	**2.5**	**1.5**
D3067.012c #1 (D3067.012c: Control Panel - Capacity: all - Equipment that is either hard anchored or...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.2	0.2	0.3	0.3	0.2
DS1c	0.0	0.5	0.6	0.7	0.7	0.6
Total	**0.0**	**0.7**	**0.8**	**1.0**	**1.0**	**0.8**
D4011.024a #1 (D4011.024a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**

3.3 Component Name Reference

This list is provided for reference where only the fragility ID is available.

- **B1044.011**: Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’
- **B1071.202**: Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs
- **B2011.401**: Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs
- **C1011.211a**: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above
- **C1011.311a**: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above
- **C2011.041b**: Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.
- **C3032.004a**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support
- **C3032.004b**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support
- **C3032.004c**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support
- **C3032.004d**: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support
- **C3034.002**: Independent Pendant Lighting - seismically rated
- **D1014.021**: Hydraulic Elevator - Applies to most California Installations 1976 or later, most western states installations postdating 1982 and most U.S installations postdating 1998.
- **D2021.014a**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY
- **D2021.014b**: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), BRACING FRAGILITY
- **D2021.024a**: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), PIPING FRAGILITY
- **D2021.024b**: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), BRACING FRAGILITY
- **D2031.014b**: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or sim), BRACING FRAGILITY
- **D3032.013c**: Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility
- **D3041.011d**: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F (OSHPD or sim)
- **D3041.012d**: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater,

SDC D, E, or F (OSHPD or sim)

- **D3041.032d**: HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F (OSHPD or sim)
- **D3041.103c**: HVAC Fan - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility
- **D3067.012c**: Control Panel - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility
- **D4011.024a**: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - with designed bracing, SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY

4 DETAILED REOCCUPANCY AND FUNCTIONALITY RESULTS BY GROUND MOTION INTENSITY

4.1 50% in 50 years Intensity

4.1.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

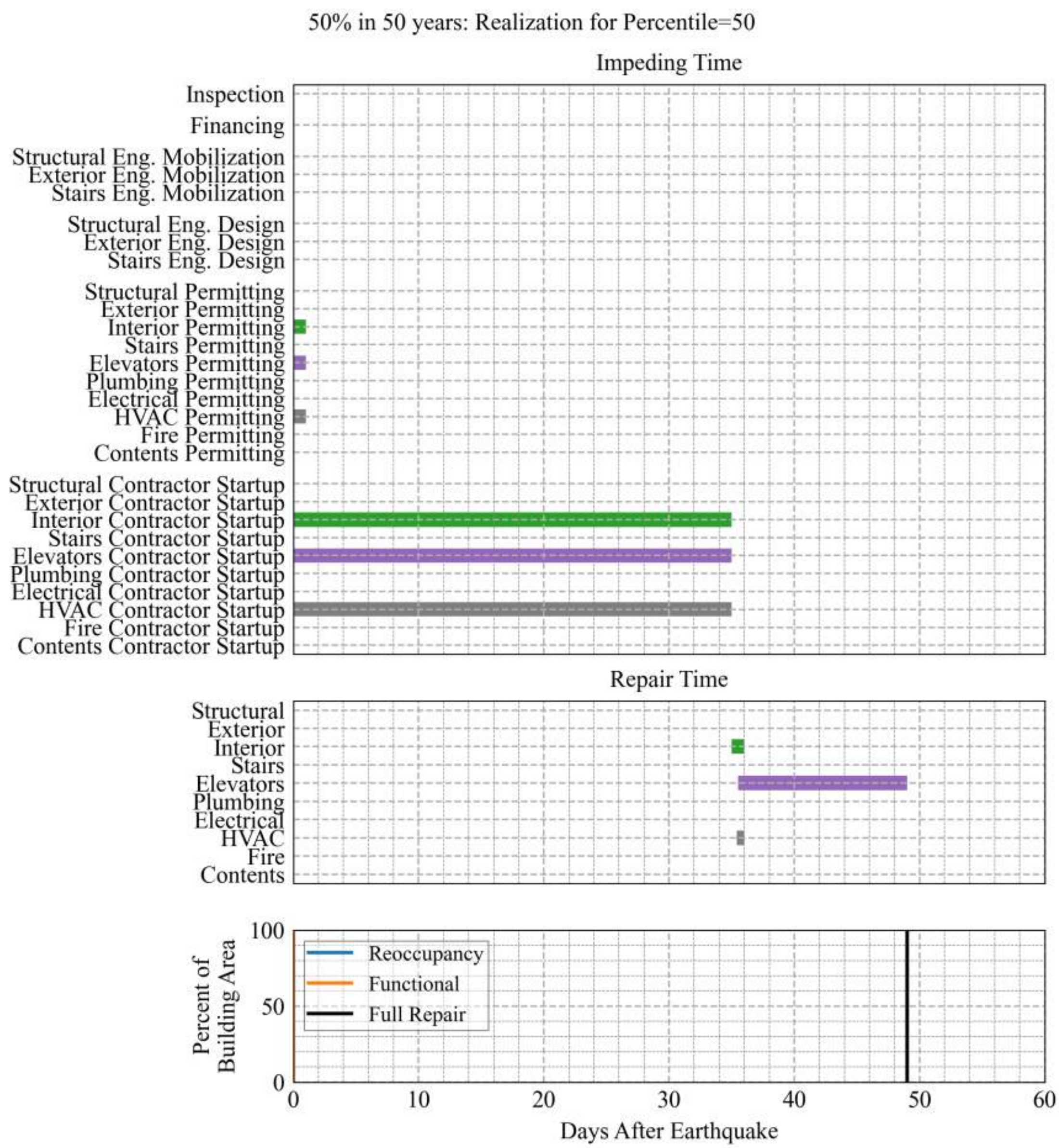

Figure 4.1. 50% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

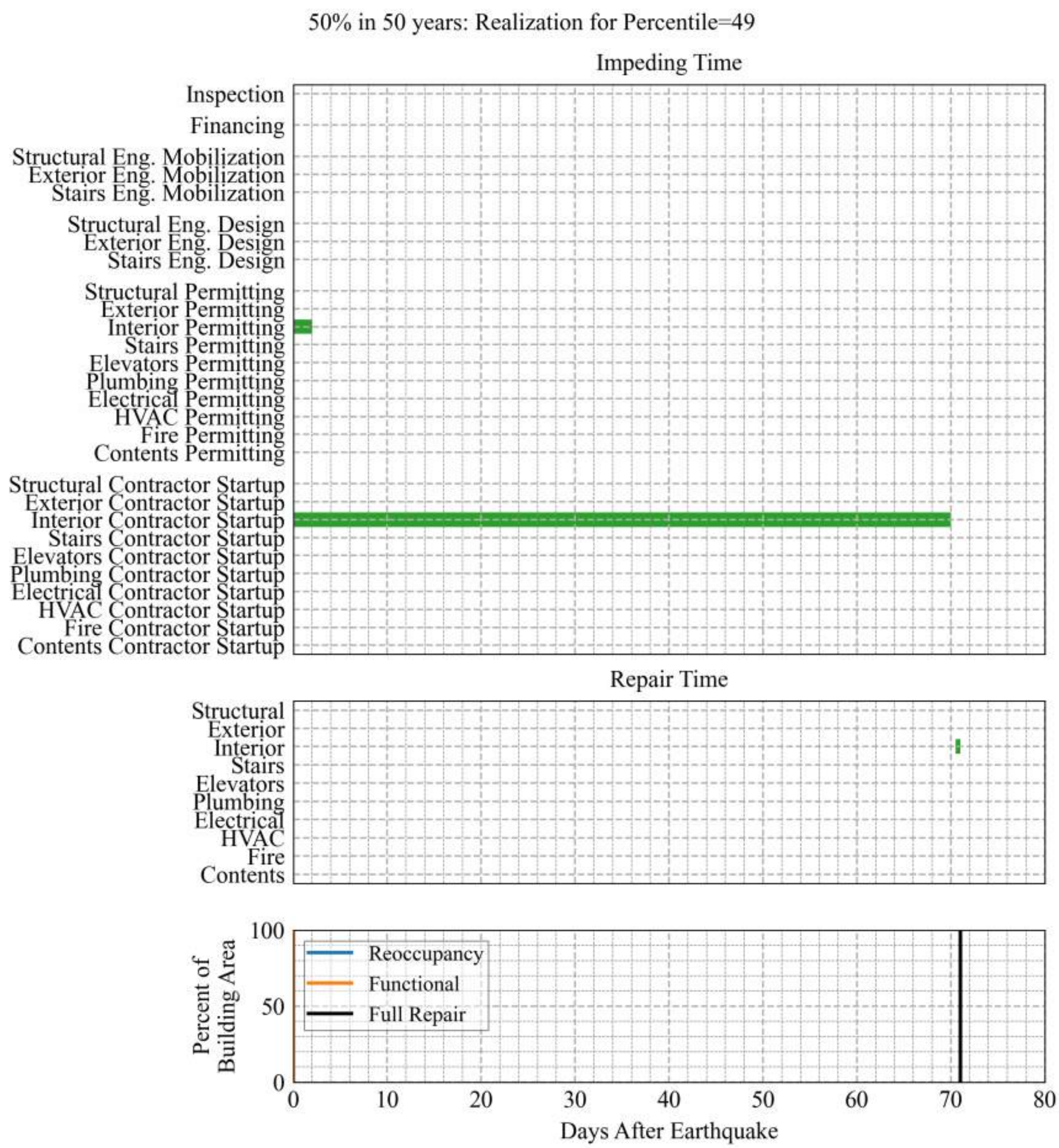

Figure 4.2. 50% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

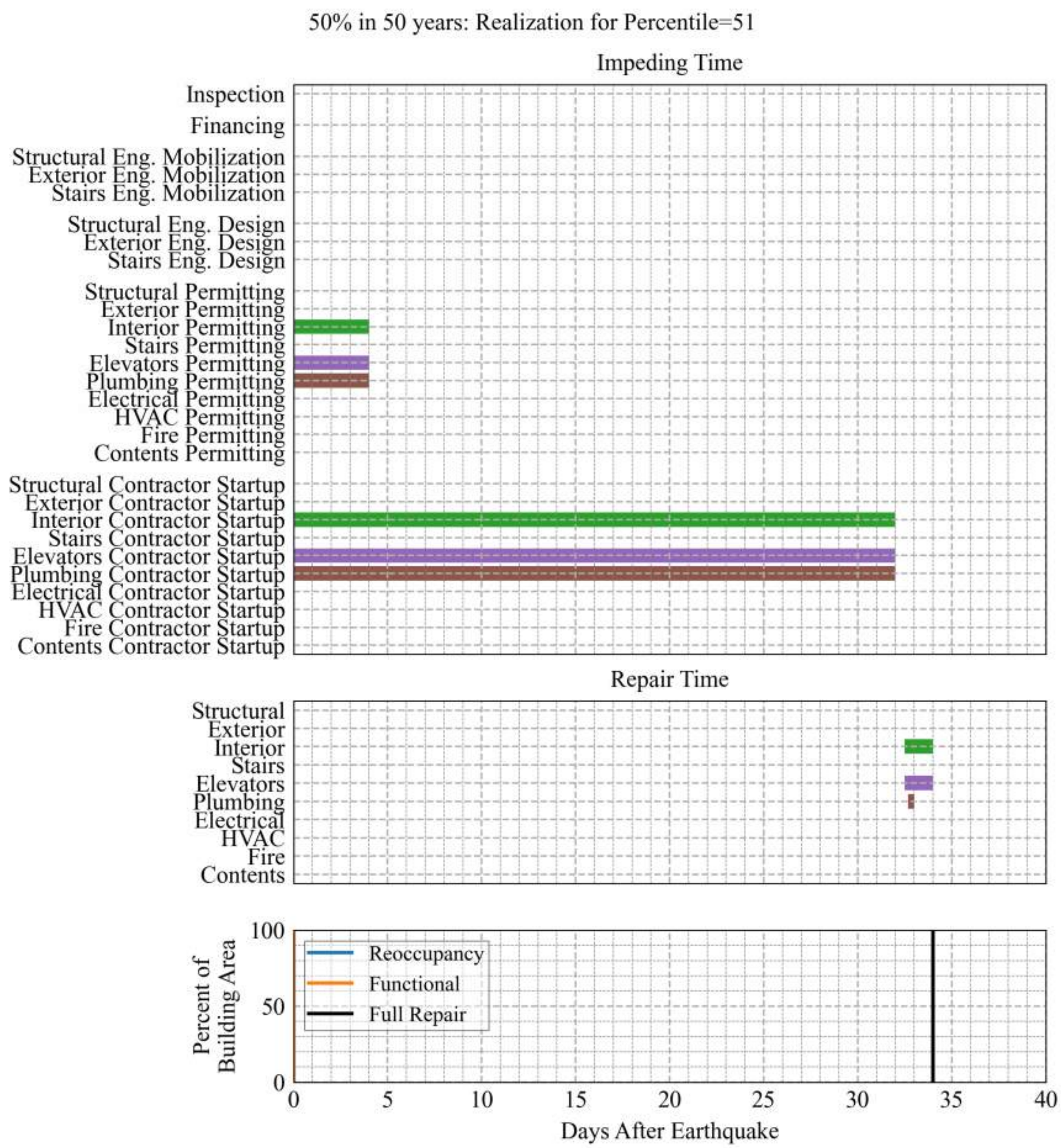

Figure 4.3. 50% in 50 years Percentile = 51

4.1.2 Selected Realizations for 90^{th} percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

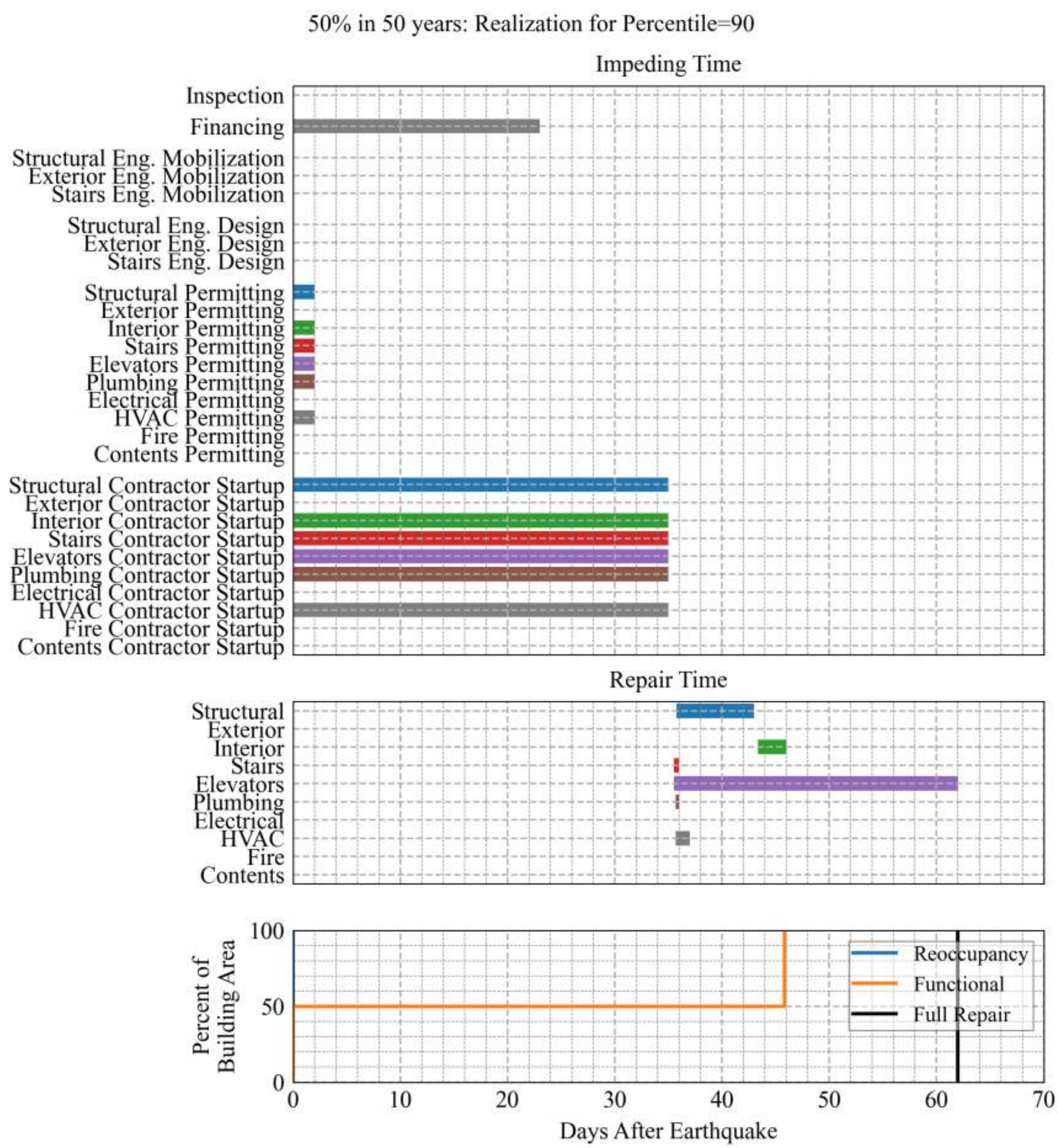

Figure 4.4. 50% in 50 years Percentile = 90

4.1.3 Damage to Building Systems

Table 4.1 shows the percentage of realizations that the named system prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.1. Percent of realizations affecting building reoccupancy/function per system - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	1.4	1.4	1.4	1.4	1.3	0.0	0.0
Stairway Doors	0.8	0.8	0.8	0.8	0.7	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	5.2	4.8	3.1	1.5	1.1	0.0	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	3.2	3.1	1.8	1.1	1.0	0.0	0.0
Water	0.6	0.6	0.6	0.5	0.4	0.0	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	15	15	15	15	12	0.2	0.0

4.1.4 Damage to Individual Components

Table 4.2 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 50% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.2. Percent of realizations affecting building reoccupancy/functionality per component - 50% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 0.1	0.0 / 0.1	0.0 / 0.1	0.0 / 0.1	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0
B1071.202	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	0.0 / 0.3	0.0 / 0.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 1.8	0.0 / 1.8	0.0 / 0.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 2.1	0.0 / 2.0	0.0 / 0.7	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	0.6 / 0.0	0.6 / 0.0	0.6 / 0.0	0.6 / 0.0	0.6 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004a	1.8 / 0.5	1.3 / 0.2	0.4 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004b	1.6 / 0.5	1.3 / 0.4	0.6 / 0.2	0.1 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004c	1.8 / 0.3	1.4 / 0.2	0.5 / 0.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004d	2.4 / 0.6	2.0 / 0.6	0.8 / 0.4	0.1 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.002	5.0 / 1.1	4.3 / 1.0	2.2 / 0.6	0.2 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.021	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.014a	0.2 / 0.2	0.2 / 0.2	0.2 / 0.2	0.2 / 0.2	0.2 / 0.2	0.0 / 0.0	0.0 / 0.0
D2021.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.024a	0.3 / 0.3	0.3 / 0.3	0.3 / 0.3	0.3 / 0.3	0.3 / 0.3	0.0 / 0.0	0.0 / 0.0
D2021.024b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011d	2.0 / 3.8	1.0 / 3.8	0.0 / 3.8	0.0 / 3.7	0.0 / 3.2	0.0 / 0.1	0.0 / 0.0
D3041.012d	0.2 / 0.2	0.2 / 0.2	0.0 / 0.2	0.0 / 0.2	0.0 / 0.2	0.0 / 0.0	0.0 / 0.0
D3041.032d	4.2 / 13	4.0 / 13	2.4 / 13	1.1 / 13	0.8 / 11	0.0 / 0.2	0.0 / 0.0
D3041.103c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3067.012c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.024a	0.9 / 0.9	0.9 / 0.9	0.9 / 0.9	0.9 / 0.9	0.8 / 0.8	0.0 / 0.0	0.0 / 0.0

4.2 10% in 50 years Intensity

4.2.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

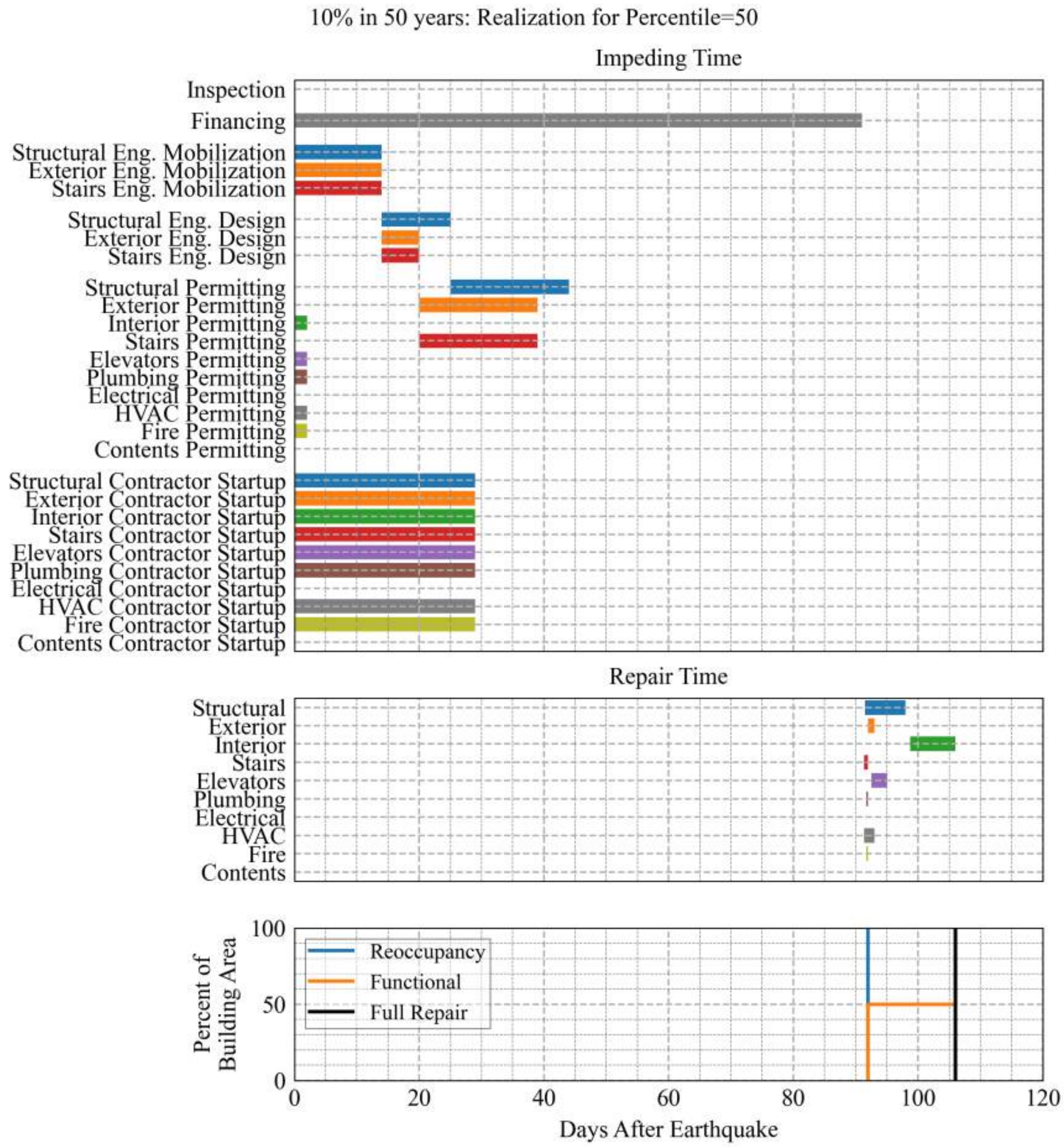

Figure 4.5. 10% in 50 years Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

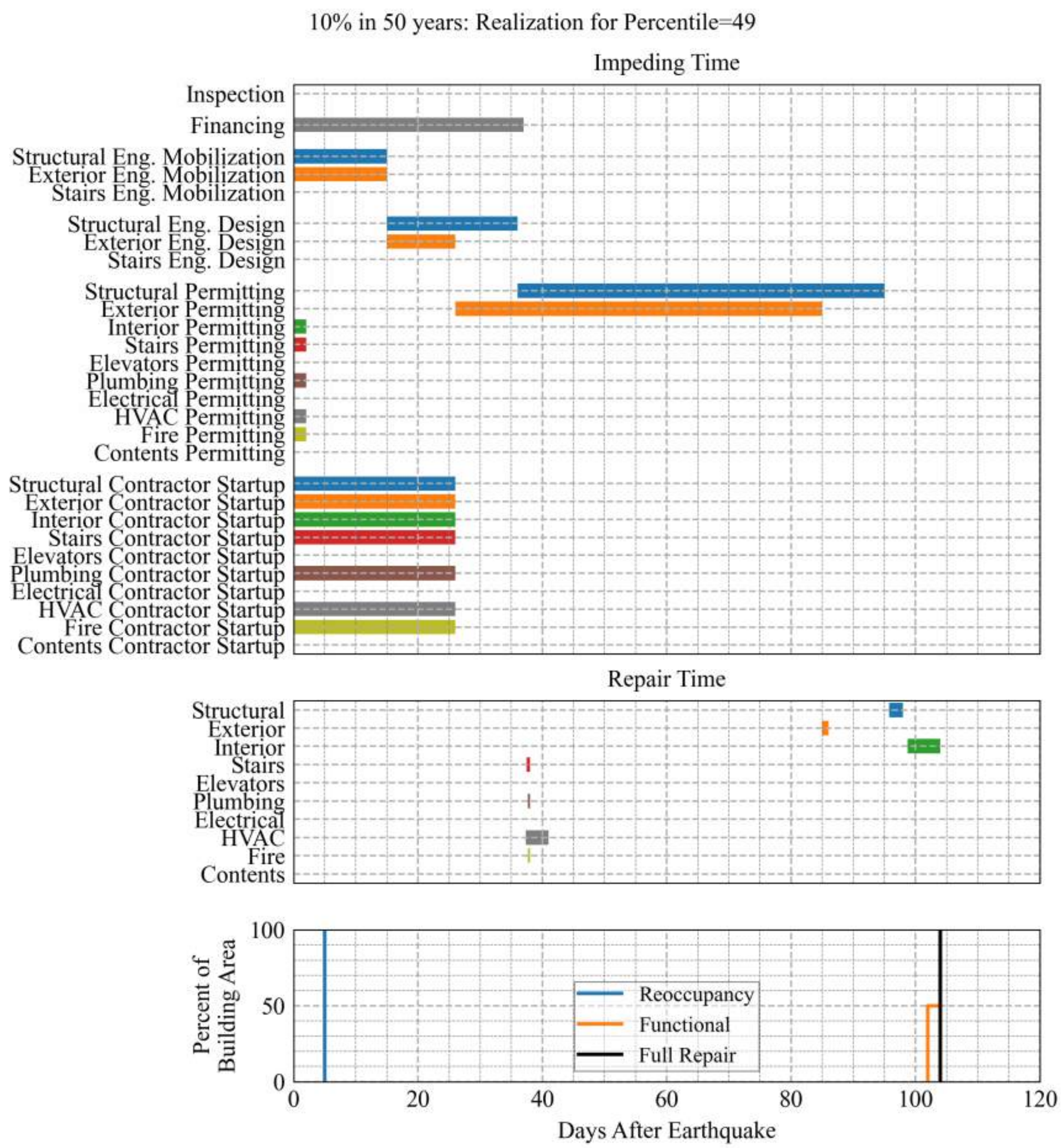

Figure 4.6. 10% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

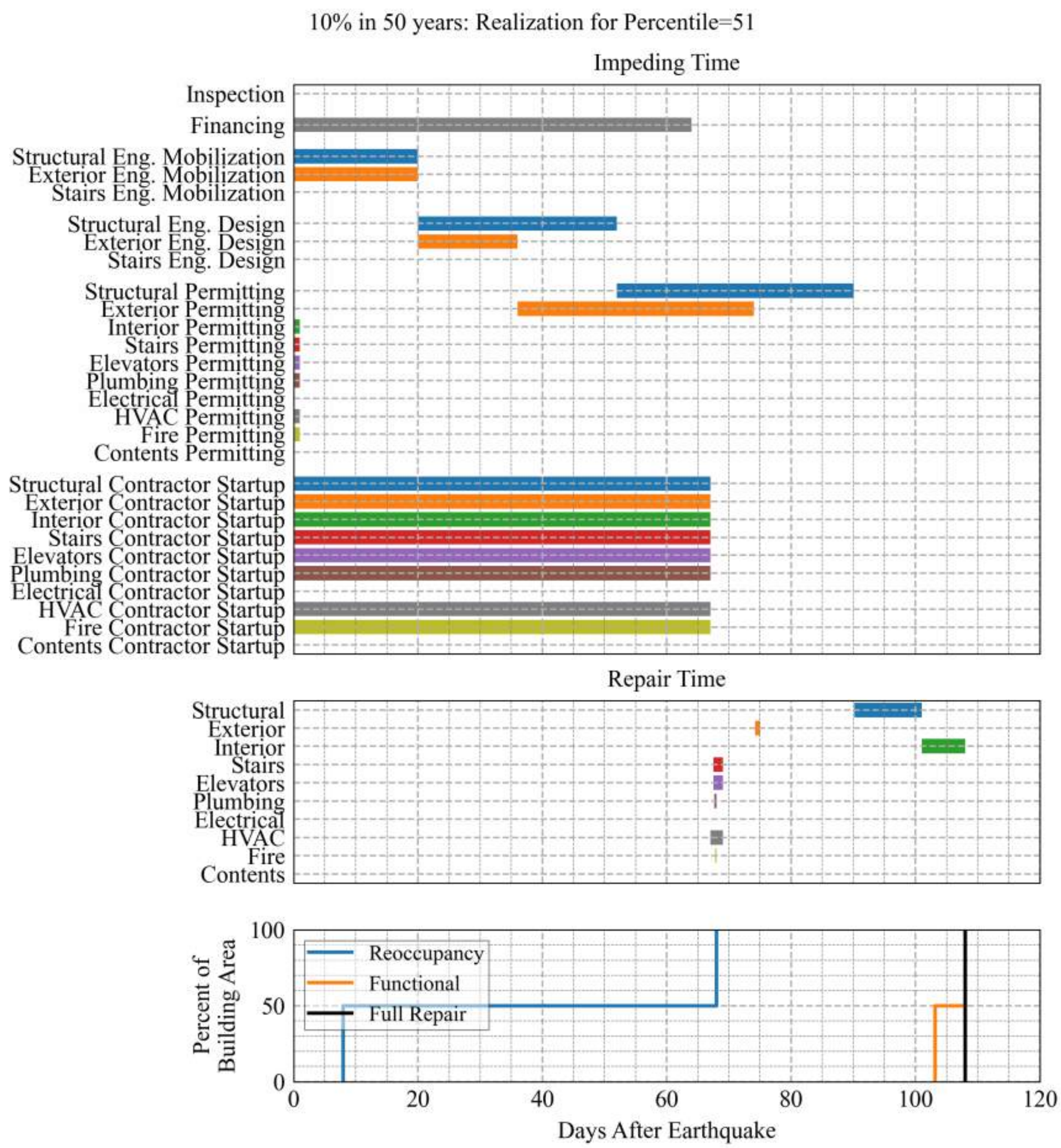

Figure 4.7. 10% in 50 years Percentile = 51

4.2.2 Selected Realizations for 90^{th} percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

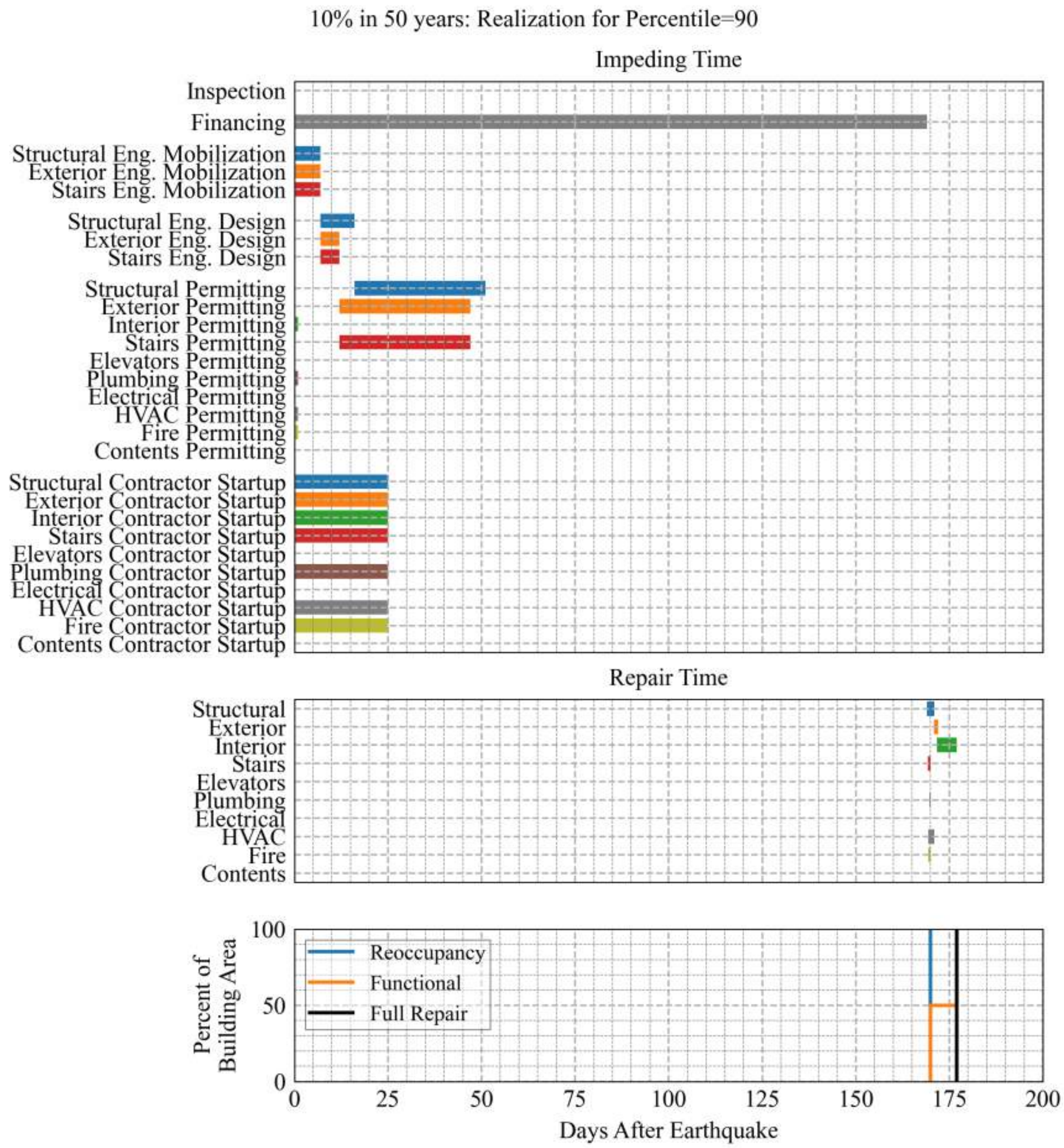

Figure 4.8. 10% in 50 years Percentile = 90

4.2.3 Damage to Building Systems

Table 4.3 shows the percentage of realizations that the named system prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.3. Percent of realizations affecting building reoccupancy/function per system - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	1.3	1.3	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	8.6	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	52	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	52	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	52	52	52	52	51	2.2	0.0
Stairway Doors	72	13	13	13	13	0.4	0.0
Exterior	45	44	27	6.7	0.0	0.0	0.0
Interior	50	49	38	27	24	0.6	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	83	78	43	26	23	1.1	0.0
Water	17	17	17	17	16	0.3	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	72	72	72	72	71	6.7	0.0

4.2.4 Damage to Individual Components

Table 4.4 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 10% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.4. Percent of realizations affecting building reoccupancy/functionality per component - 10% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 24	0.0 / 23	0.0 / 14	0.0 / 7.8	0.0 / 6.5	0.0 / 0.6	0.0 / 0.0
B1071.202	28 / 28	26 / 24	12 / 5.5	2.7 / 0.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	45 / 59	43 / 51	22 / 11	4.5 / 0.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 78	0.0 / 70	0.0 / 24	0.0 / 2.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 80	0.0 / 72	0.0 / 25	0.0 / 2.7	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	43 / 0.0	43 / 0.0	43 / 0.0	43 / 0.0	43 / 0.0	1.8 / 0.0	0.0 / 0.0
C3032.004a	30 / 21	27 / 19	12 / 8.2	1.7 / 1.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004b	31 / 23	27 / 20	13 / 8.7	1.9 / 1.6	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004c	36 / 25	30 / 21	14 / 8.8	1.4 / 1.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004d	37 / 27	32 / 23	15 / 9.9	2.3 / 1.9	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.002	49 / 50	45 / 44	24 / 17	5.6 / 3.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.021	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.014a	11 / 11	11 / 11	11 / 11	11 / 11	10 / 10	0.2 / 0.2	0.0 / 0.0
D2021.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.024a	11 / 11	11 / 11	11 / 11	11 / 11	10 / 10	0.2 / 0.2	0.0 / 0.0
D2021.024b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011d	31 / 38	16 / 38	1.3 / 38	0.0 / 38	0.0 / 38	0.0 / 3.6	0.0 / 0.0
D3041.012d	7.8 / 8.2	3.7 / 8.2	0.6 / 8.2	0.0 / 8.2	0.0 / 7.8	0.0 / 0.2	0.0 / 0.0
D3041.032d	45 / 68	43 / 68	34 / 68	24 / 68	21 / 67	0.6 / 6.2	0.0 / 0.0
D3041.103c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3067.012c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.024a	17 / 17	17 / 17	17 / 17	17 / 17	16 / 16	0.5 / 0.5	0.0 / 0.0

4.3 DE Intensity

4.3.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

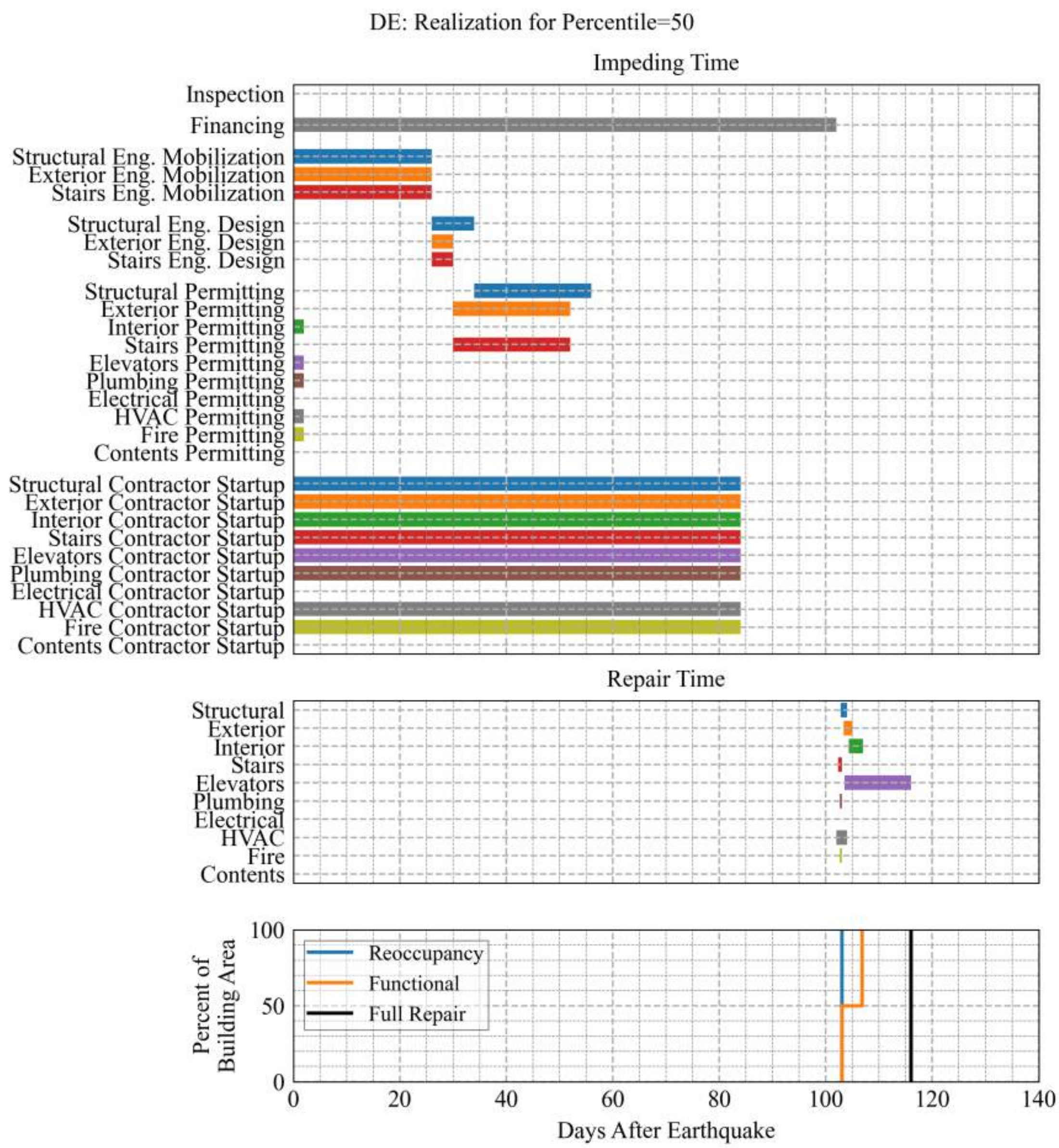

Figure 4.9. DE Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

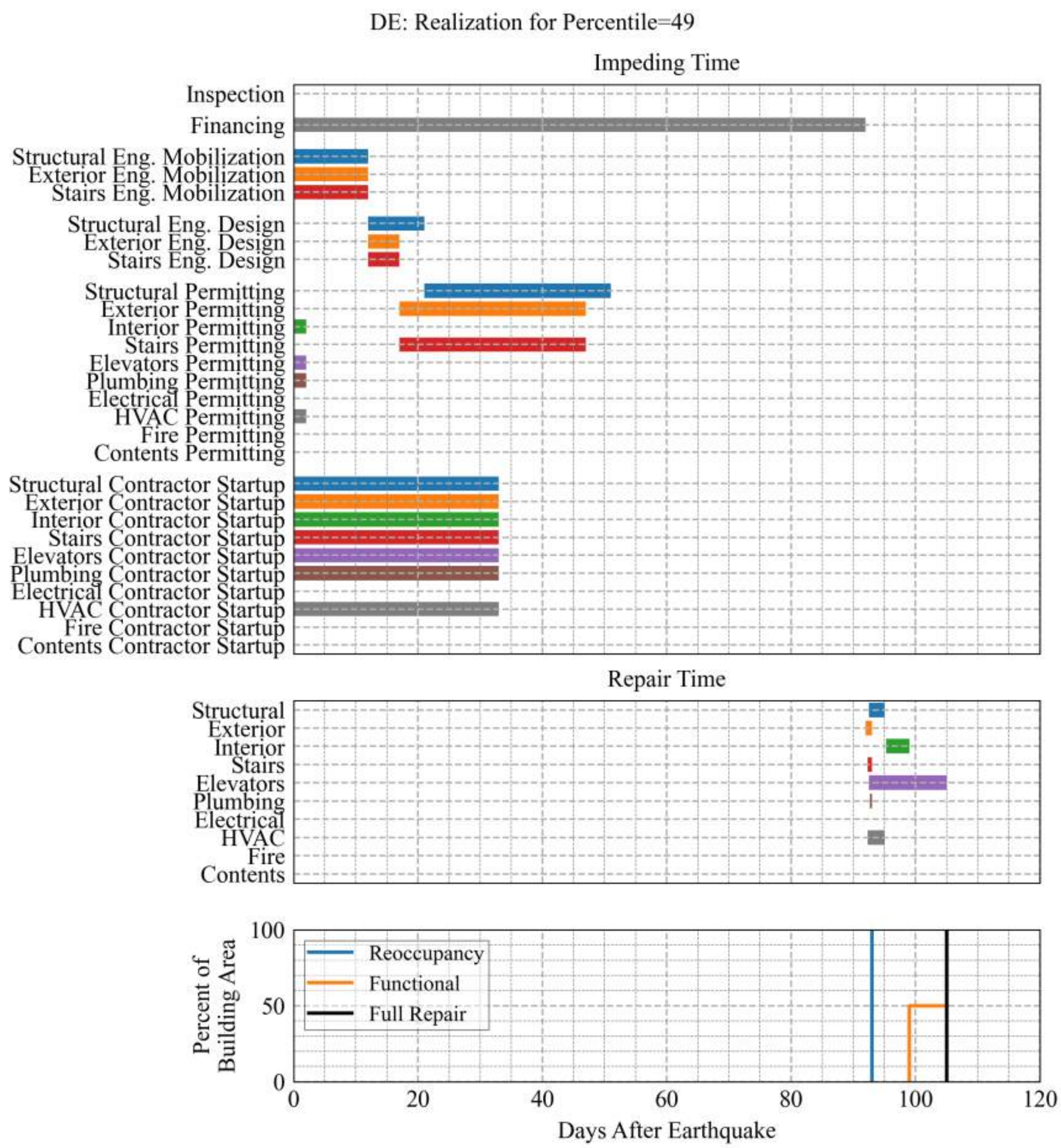

Figure 4.10. DE Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

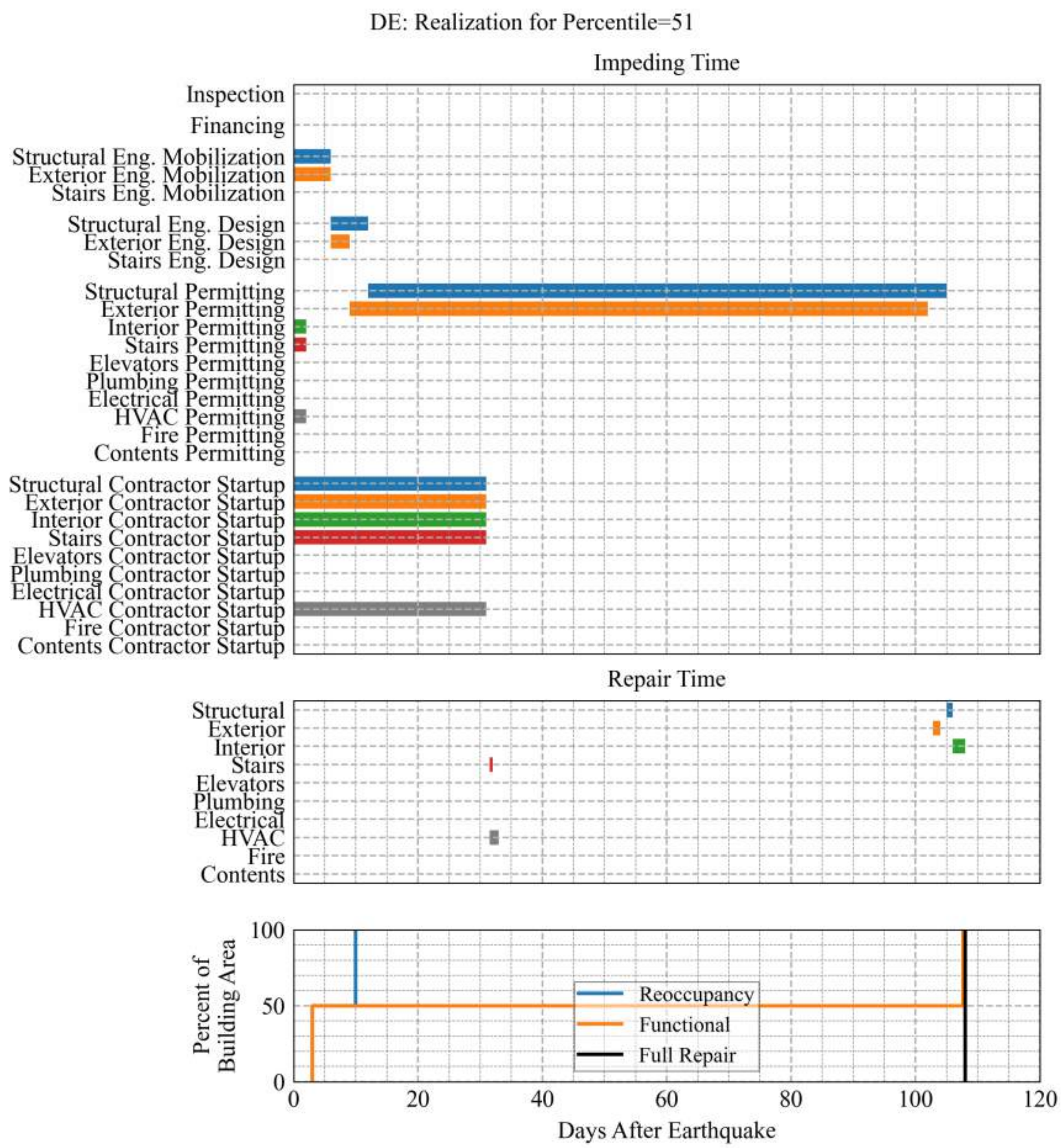

Figure 4.11. DE Percentile = 51

4.3.2 *Selected Realizations for 90^{th} percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

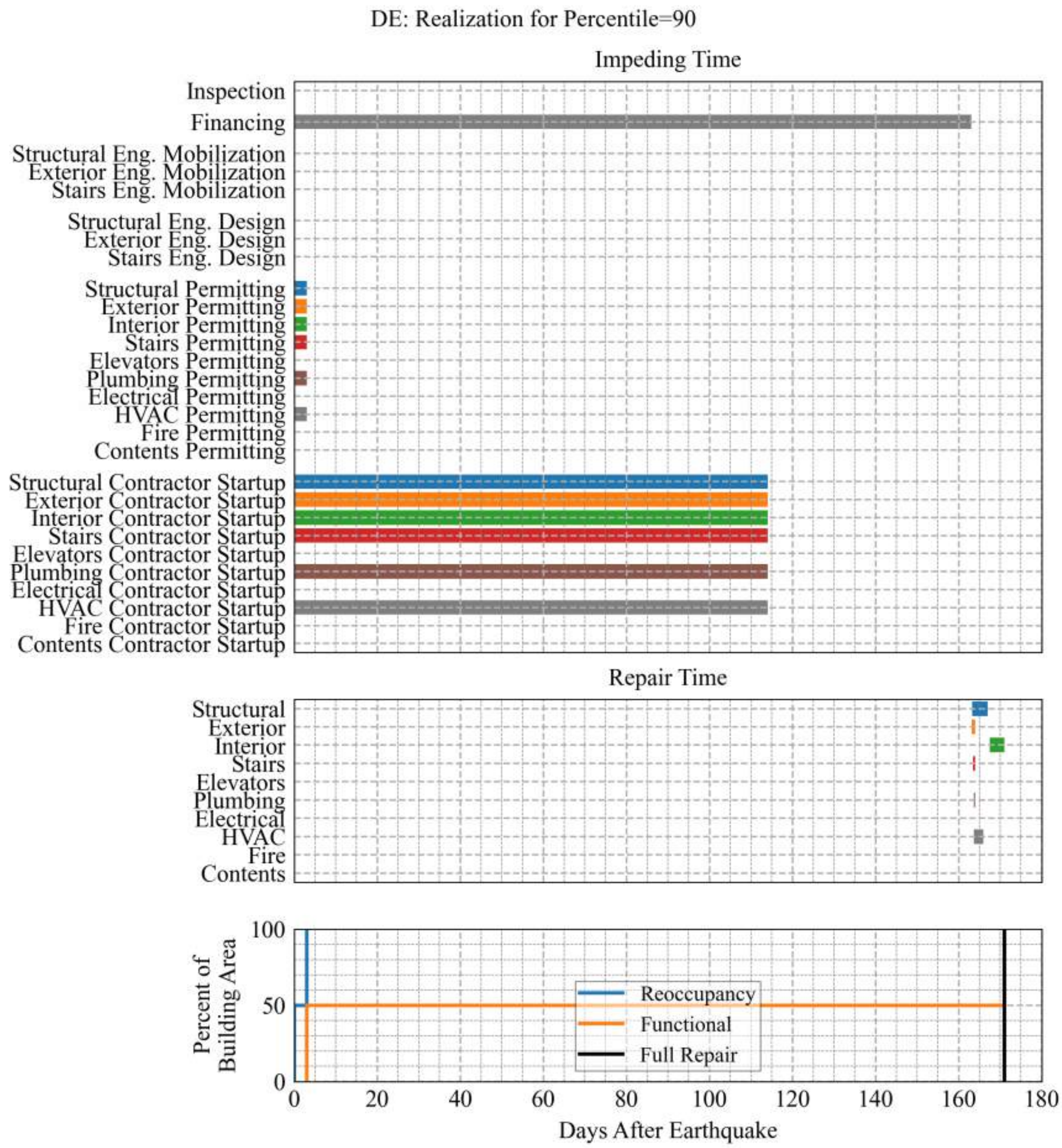

Figure 4.12. DE Percentile = 90

4.3.3 Damage to Building Systems

Table 4.5 shows the percentage of realizations that the named system prevents reoccupancy/function for the DE intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.5. Percent of realizations affecting building reoccupancy/function per system - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	1.4	1.4	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	10	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	54	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	54	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	54	54	54	54	54	1.9	0.0
Stairway Doors	72	14	14	14	14	0.3	0.0
Exterior	47	45	28	6.7	0.0	0.0	0.0
Interior	53	51	40	28	26	0.6	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	84	78	45	28	25	1.0	0.0
Water	17	17	17	17	16	0.3	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	72	72	72	72	72	5.4	0.0

4.3.4 Damage to Individual Components

Table 4.6 shows the percentage of realizations that a specific component prevents reoccupancy/function for the DE intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.6. Percent of realizations affecting building reoccupancy/functionality per component - DE

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 24	0.0 / 23	0.0 / 15	0.0 / 8.8	0.0 / 7.5	0.0 / 0.7	0.0 / 0.0
B1071.202	30 / 30	28 / 26	12 / 5.9	2.4 / 0.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	47 / 61	44 / 52	24 / 12	4.5 / 0.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 79	0.0 / 71	0.0 / 26	0.0 / 2.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 80	0.0 / 72	0.0 / 26	0.0 / 2.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	46 / 0.0	46 / 0.0	46 / 0.0	46 / 0.0	46 / 0.0	1.7 / 0.0	0.0 / 0.0
C3032.004a	32 / 22	29 / 20	13 / 8.8	2.1 / 1.7	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004b	34 / 24	31 / 22	14 / 9.7	2.2 / 1.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004c	37 / 27	32 / 22	13 / 8.8	2.0 / 1.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004d	38 / 27	33 / 23	14 / 9.8	2.1 / 1.8	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.002	52 / 52	48 / 47	24 / 17	4.8 / 2.7	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.021	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.014a	11 / 11	11 / 11	11 / 11	11 / 11	11 / 11	0.2 / 0.2	0.0 / 0.0
D2021.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.024a	11 / 11	11 / 11	11 / 11	11 / 11	10 / 10	0.2 / 0.2	0.0 / 0.0
D2021.024b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011d	33 / 41	16 / 41	2.0 / 41	0.0 / 41	0.0 / 41	0.0 / 3.3	0.0 / 0.0
D3041.012d	7.8 / 8.1	3.6 / 8.1	0.5 / 8.1	0.0 / 8.1	0.0 / 7.8	0.0 / 0.2	0.0 / 0.0
D3041.032d	48 / 69	46 / 69	36 / 69	26 / 69	23 / 68	0.5 / 5.3	0.0 / 0.0
D3041.103c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3067.012c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.024a	18 / 18	18 / 18	18 / 18	18 / 18	18 / 18	0.5 / 0.5	0.0 / 0.0

4.4 MCE$_R$ Intensity

4.4.1 Selected Realizations for 50th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

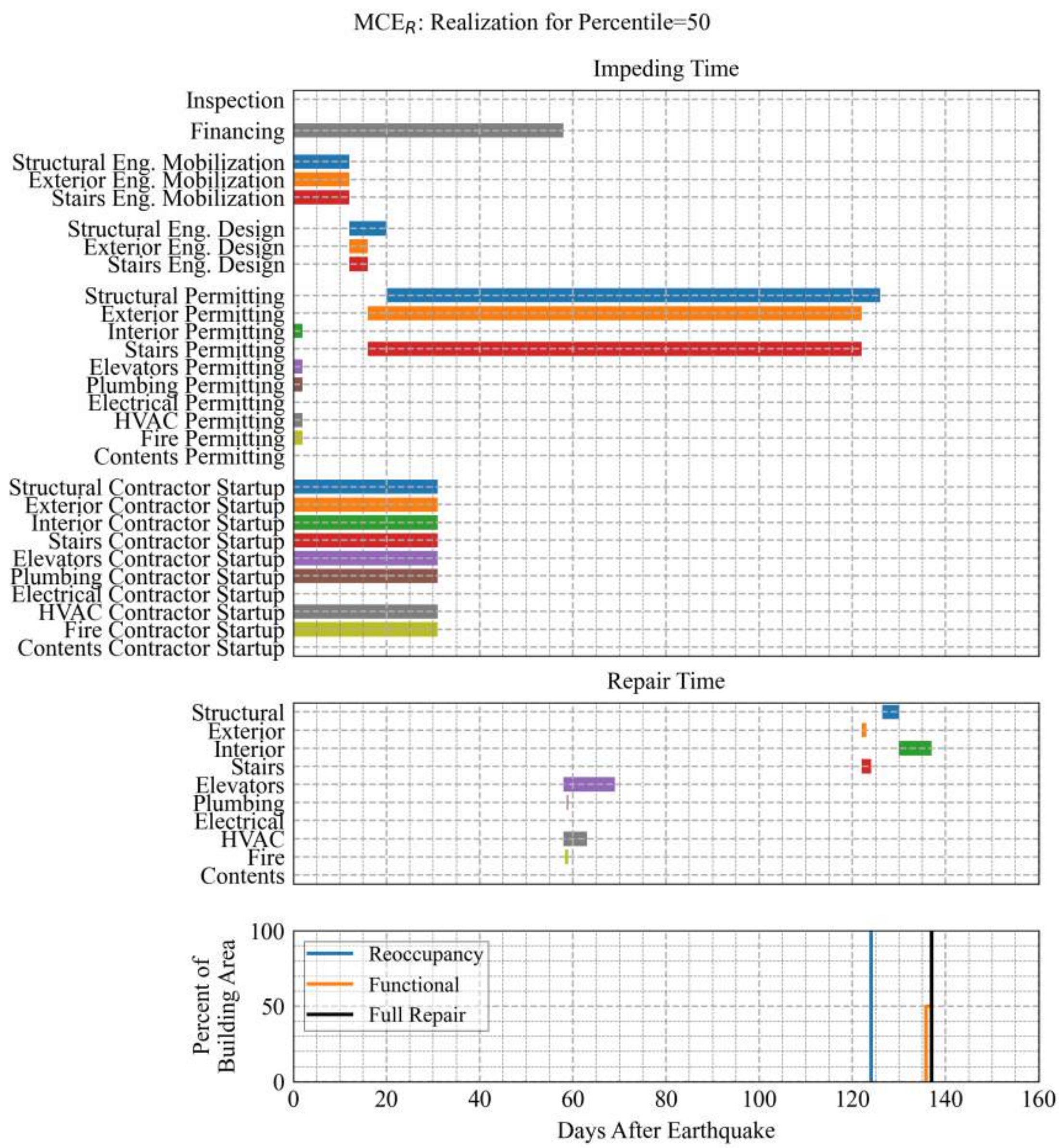

Figure 4.13. MCE$_R$ Percentile = 50

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

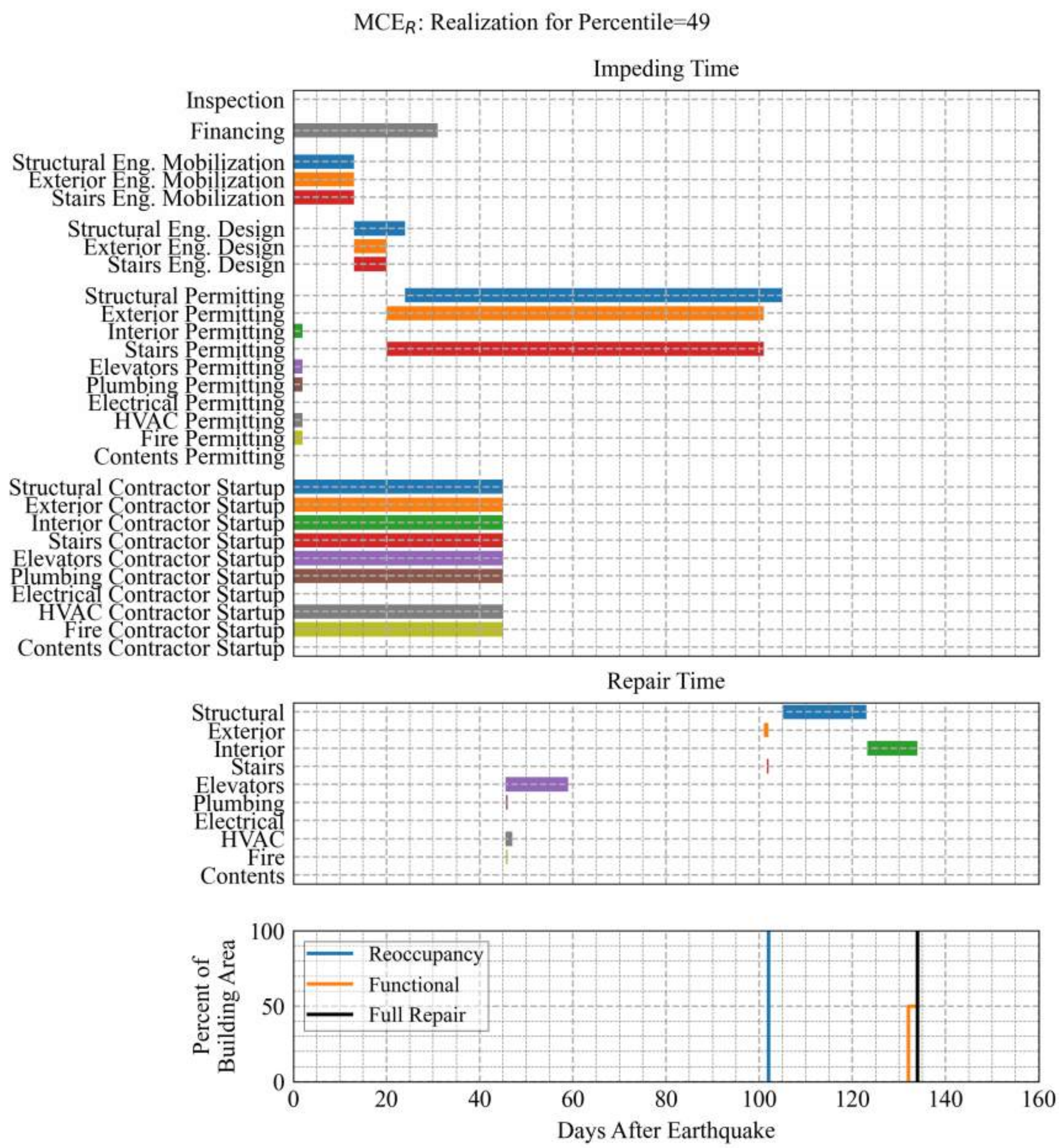

Figure 4.14. MCE$_R$ Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

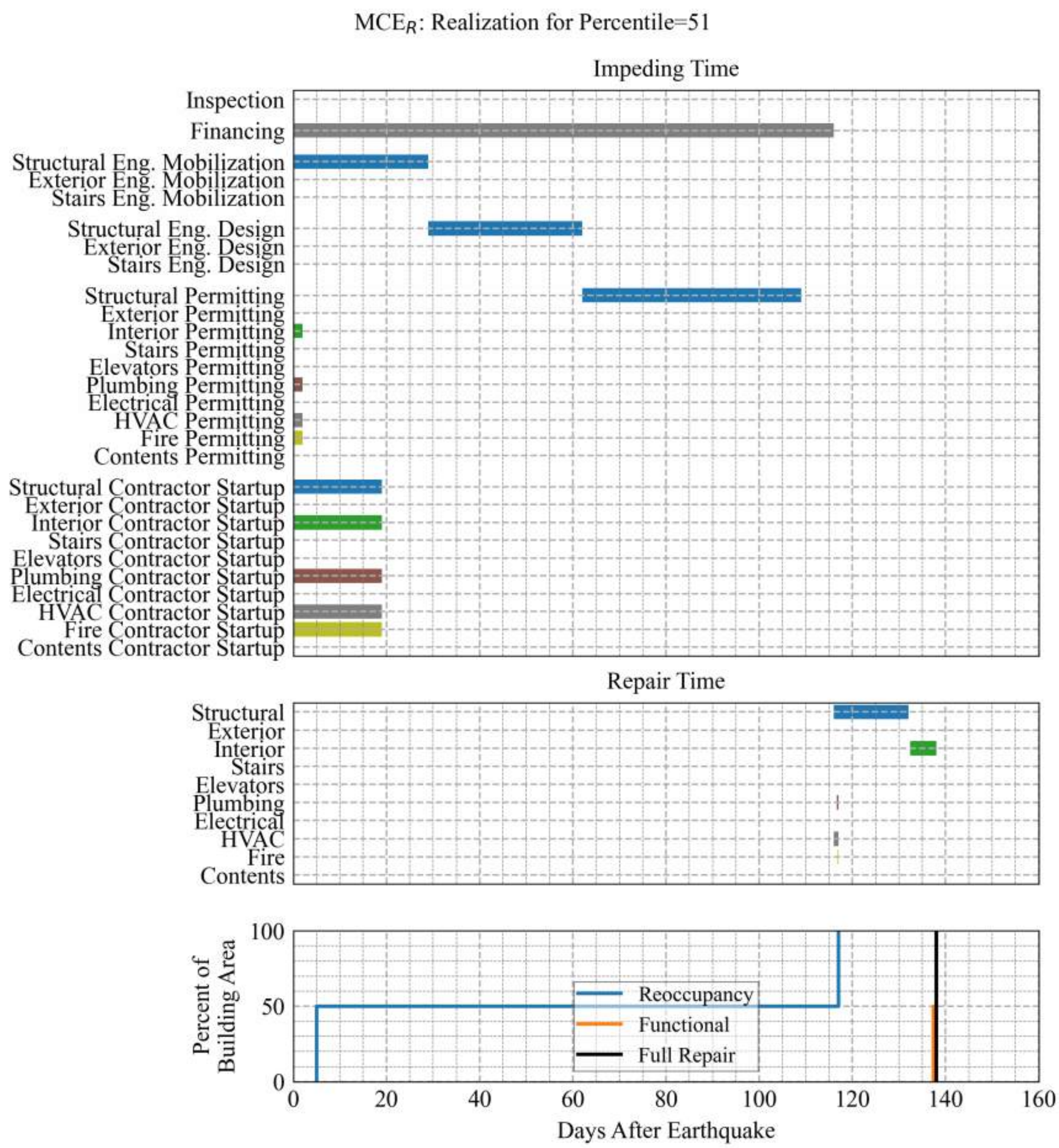

Figure 4.15. MCE$_R$ Percentile = 51

4.4.2 Selected Realizations for 90th percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (MCE_R Percentile = 90) resulted in global failure, no scheduling was computed.

4.4.3 Damage to Building Systems

Table 4.7 shows the percentage of realizations that the named system prevents reoccupancy/function for the MCE$_R$ intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.7. Percent of realizations affecting building reoccupancy/function per system - MCE$_R$

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	23	23	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	17	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	82	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	82	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	60	60	60	60	60	2.6	0.0
Stairway Doors	71	17	17	17	16	0.1	0.0
Exterior	61	59	40	10	0.0	0.0	0.0
Interior	51	50	42	32	28	0.2	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interior	76	72	47	33	30	1.1	0.0
Water	21	21	21	21	21	0.2	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	64	64	64	64	64	6.2	0.0

4.4.4 Damage to Individual Components

Table 4.8 shows the percentage of realizations that a specific component prevents reoccupancy/function for the MCE$_R$ intensity. Note that if a component prevents reoccupancy, it will also prevent functionality. Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.8. Percent of realizations affecting building reoccupancy/functionality per component - MCE$_R$

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 36	0.0 / 36	0.0 / 25	0.0 / 16	0.0 / 13	0.0 / 1.0	0.0 / 0.0
B1071.202	48 / 48	45 / 43	22 / 13	4.0 / 1.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
B2011.401	61 / 68	57 / 60	31 / 18	6.6 / 2.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 75	0.0 / 68	0.0 / 27	0.0 / 5.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 75	0.0 / 68	0.0 / 28	0.0 / 4.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	55 / 0.0	55 / 0.0	55 / 0.0	55 / 0.0	55 / 0.0	2.6 / 0.0	0.0 / 0.0
C3032.004a	34 / 29	31 / 26	16 / 12	2.9 / 2.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004b	36 / 29	32 / 26	15 / 12	2.6 / 2.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004c	38 / 33	34 / 29	16 / 12	2.6 / 2.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004d	40 / 35	36 / 30	16 / 13	2.4 / 2.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.002	51 / 56	47 / 51	25 / 20	5.1 / 3.5	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.021	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.014a	14 / 14	14 / 14	14 / 14	14 / 14	14 / 14	0.1 / 0.1	0.0 / 0.0
D2021.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.024a	15 / 15	15 / 15	15 / 15	15 / 15	14 / 14	0.1 / 0.1	0.0 / 0.0
D2021.024b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011d	36 / 41	19 / 41	1.6 / 41	0.0 / 41	0.0 / 41	0.0 / 4.0	0.0 / 0.0
D3041.012d	11 / 11	5.6 / 11	0.5 / 11	0.0 / 11	0.0 / 11	0.0 / 0.1	0.0 / 0.0
D3041.032d	47 / 61	46 / 61	39 / 61	30 / 61	26 / 61	0.2 / 6.0	0.0 / 0.0
D3041.103c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3067.012c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.024a	21 / 21	21 / 21	21 / 21	21 / 21	21 / 21	0.2 / 0.2	0.0 / 0.0

4.5 2% in 50 years Intensity

4.5.1 Selected Realizations for 50^{th} percentile

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 50) resulted in global failure, no scheduling was computed.

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

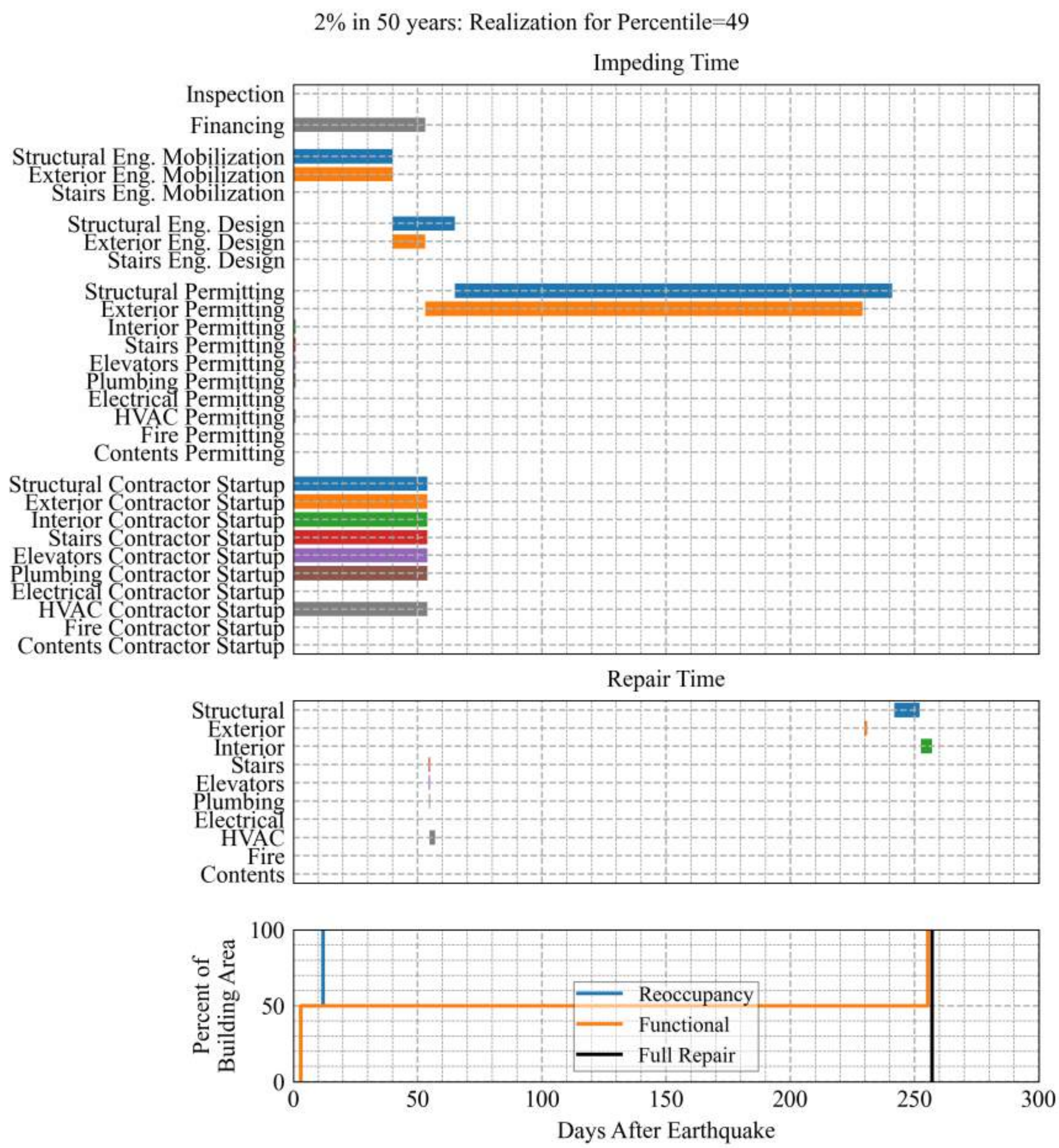

Figure 4.16. 2% in 50 years Percentile = 49

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 51) resulted in global failure, no scheduling was computed.

4.5.2 *Selected Realizations for 90th percentile*

Note that this is a single realization and may not be representative of a general trend. This selected realization is intended to give a sense of what the repair schedule may look like, it is not intended to generalize what the "typical" repair schedule looks like.

This particular realization (2% in 50 years Percentile = 90) resulted in global failure, no scheduling was computed.

4.5.3 Damage to Building Systems

Table 4.9 shows the percentage of realizations that the named system prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a system prevents reoccupancy, it will also prevent functionality. This means that the functionality checks may all be fine, but if the reoccupancy checks indicate the building is not reoccupiable then the building will not be considered functional.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.9. Percent of realizations affecting building reoccupancy/function per system - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
Building Reoccupancy (also affects function)							
Red Tag (Structural)	51	51	0.0	0.0	0.0	0.0	0.0
Hazardous Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fire Egress	12	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Access	91	0.0	0.0	0.0	0.0	0.0	0.0
Falling hazard	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Entry Door Racking	91	0.0	0.0	0.0	0.0	0.0	0.0
Stairs	41	41	41	41	41	2.1	0.0
Stairway Doors	47	10	10	10	10	0.4	0.0
Exterior	44	43	30	8.0	0.0	0.0	0.0
Interior	34	33	28	21	19	0.8	0.0
Building Function (affects function only, not reoccupancy)							
Elevators	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exterior	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Interior	48	47	35	24	21	1.9	0.0
Water	14	14	14	14	14	0.4	0.0
Electrical	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC	41	41	41	41	41	5.3	0.0

4.5.4 *Damage to Individual Components*

Table 4.10 shows the percentage of realizations that a specific component prevents reoccupancy/function for the 2% in 50 years intensity. Note that if a component prevents reoccupancy, it will also prevent functionality.

Each column represents a milestone time after the earthquake and the values in that column indicate the percentage of realizations in which that component is preventing reoccupancy/functionality at that milestone.

Table 4.10. Percent of realizations affecting building reoccupancy/functionality per component - 2% in 50 years

	Immediate	>3 days	>7 days	>14 days	>1 month	>6 months	>12 months
B1044.011	0.0 / 29	0.0 / 28	0.0 / 21	0.0 / 14	0.0 / 12	0.0 / 1.4	0.0 / 0.0
B1071.202	38 / 37	35 / 33	18 / 12	3.2 / 1.6	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0
B2011.401	44 / 47	41 / 42	22 / 14	5.4 / 2.1	0.0 / 0.1	0.0 / 0.0	0.0 / 0.0
C1011.211a	0.0 / 48	0.0 / 44	0.0 / 19	0.0 / 3.1	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C1011.311a	0.0 / 48	0.0 / 44	0.0 / 21	0.0 / 3.2	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C2011.041b	39 / 0.0	39 / 0.0	39 / 0.0	39 / 0.0	39 / 0.0	2.0 / 0.0	0.0 / 0.0
C3032.004a	24 / 21	22 / 19	11 / 8.3	1.7 / 1.6	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004b	25 / 22	22 / 20	10 / 8.7	1.7 / 1.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004c	27 / 25	23 / 21	11 / 8.7	1.8 / 1.4	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3032.004d	27 / 25	25 / 23	11 / 8.6	2.1 / 1.9	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
C3034.002	34 / 40	31 / 36	16 / 15	3.2 / 2.3	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D1014.021	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.014a	9.5 / 9.5	9.5 / 9.5	9.5 / 9.5	9.5 / 9.5	9.3 / 9.3	0.3 / 0.3	0.0 / 0.0
D2021.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2021.024a	8.7 / 8.7	8.7 / 8.7	8.7 / 8.7	8.7 / 8.7	8.5 / 8.5	0.3 / 0.3	0.0 / 0.0
D2021.024b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D2031.014b	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3032.013c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3041.011d	25 / 29	12 / 29	1.0 / 29	0.0 / 29	0.0 / 29	0.0 / 3.7	0.0 / 0.0
D3041.012d	7.0 / 7.1	3.6 / 7.1	0.3 / 7.1	0.0 / 7.1	0.0 / 7.0	0.0 / 0.3	0.0 / 0.0
D3041.032d	32 / 40	31 / 40	26 / 40	20 / 40	18 / 40	0.7 / 4.9	0.0 / 0.0
D3041.103c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D3067.012c	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
D4011.024a	14 / 14	14 / 14	14 / 14	14 / 14	13 / 13	0.6 / 0.6	0.0 / 0.0

SEISMIC RISK ASSESSMENT REPORT
Created with the SP3-RiskModel

Detailed Component Report

Report Generated for:
217 Arlington Avenue, Kensington, CA
Latitude: 37.90622°
Longitude: -122.27875°

Report Generated by:
The SP3-RiskModel Software v1.2.0 of the
Seismic Performance Prediction Program (SP3)

March 16, 2022

Seismic Performance Prediction Program
by Haselton Baker Risk Group

CONTENTS

1 SUMMARY OF INPUTS AND RISK RESULTS

Risk Model Inputs

Primary

Project Name:	Kensington Fire Station
Model Name:	New WLF on RC Wall
Building Types:	
Dir. 1: WLF: General	
Dir. 2: RC: Cantilever Shear Wall	
Year of Construction:	2022
Number of Stories:	2
Occupancy:	Commercial Office
Address:	
217 Arlington Avenue	
Kensington, CA	
Latitude:	37.90622°
Longitude:	-122.27875°

Analysis Options

Include Collapse in Analysis:	Yes
Consider Residual Drift:	Yes
Region Cost Multiplier:	–
Date Cost Multiplier:	–
Occupancy Cost Multiplier:	–

Building Layout Information

Cost per Square Foot:	–
Scale component repair costs with building value?	Yes
Total Square Feet:	1,738
Aspect Ratio:	1.95
First Story Height (ft):	13.5
Upper Story Heights (ft):	9
Vertical Irregularity:	None
Plan Irregularity:	None
Frac. of Full Height Ext. Wood Walls	
Dir. 1 Story 1	–
Dir. 1 Upper Stories	–

Ground Motion and Soil Information

Site Class:	C
Site Hazard:	SP3 Default

Building Design Info

Level of Detailing (Dir. 1, 2):	Special, Ordinary
Drift Limit (Dir. 1, 2):	–, –
Risk Category:	IV
Seismic Importance Factor, I_e:	–
Component Importance Factor, I_p:	–

Structural Properties

Allow Components to Affect Structural Properties?	Yes	
Mode Shapes Specified?	No	
Directional Properties	*Dir. 1*	*Dir. 2*
Base Shear Strength (g):	–	1.317
Yield Drift (%):	–	–
1^{st} Mode Period (T_1) (s):	–	0.29
2^{nd} Mode Period (T_2) (s):	–	0.09

Component Information

Percent of Building Glazed:	–
Selection Method	Custom

Building Stability

Median Collapse Capacity:	–
Beta (Dispersion):	–

Responses

No responses provided

Repair Time Options

Repair Time Method	ATC-138 (Beta)
Factors Delaying Start of Repairs	
Inspection	Yes
Financing	Yes
Permitting	Yes
Engineering Mobilization	Yes
Contractor Mobilization	Yes
Mitigation Factors	
Inspector on Retainer	No
Engineer on Retainer	No
Contractor on Retainer	No
Funding Source	Private Loans
Cash on Hand	–
ATC-138 Functional Recovery (Beta) Options	
Need HVAC for Function	–
Need Elevator for Function	–
Include Surge Demand	–

Component Checklist

Interior Finishes

- What kind of partition walls does the building have?
  > *Wood Studs*
- Does the building have raised access floors
  > *No*
- Does the building have suspended ceilings?
  > *Yes*
  - Are the ceilings laterally supported?
    > *Yes*
    - What is the Ip factor used to design the ceilings?
      > *1.5*
- Does the building contain pendant (non-recessed) lighting?
  > *Yes*
  - Are the pendant lights seismically rated?
    > *Yes*

Stairs and Elevators

- Does the building have stairs?
  > *Yes*
  - What type of stairs are in the building?
    > *Light Frame*
- Are there elevators in the building?
  > *Yes*
  - What type of elevators are in the building?
    > *Hydraulic*
    - From which era are the building's elevators?
      > *post-1976 California (or post-1976 California equivalent)*

Fire Supression

- Does the building contain a fire sprinkler system?
  > *Yes*
  - Does the fire sprinkler system have braced horizontal piping?
    > *Yes*
    - Are the horizontal mains OSHPD certified (or equivalent)?
      > *Yes*
  - Are the fire sprinkler drops OSHPD certified (or equivalent)?
    > *Yes*
    - What type of ceiling do the fire drops enter into?
      > *Hard*

Piping

- Is the building's water piping OSHPD certified or equivalent?
  > *Yes*
- Is the building's sanitary piping OSHPD certified or equivalent?
  > *Yes*
  - What type of couplings do the pipes have?
    > *Flexible*

HVAC

- Is the HVAC cooling/heating equipment seismically anchored?
  > *Yes*
  - How is the cooling/heating system configured?
    > *Roof Top Units*
    - Are the RTUs used for medical purposes (or equivalent)?
      > *No*
      - Are the RTUs small or large?
        > *Small*
    - Does the building have a control panel?
      > *No*

Continued on next page

Component Checklist (*Continued*))

- Is there an HVAC exhaust system in the building?
  > *Yes*
  - Is the HVAC exhaust system seismically anchored?
    > *Yes*
- Does the HVAC distribution system meet OSHPD standards (or similar)?
  > *Yes*
  - Is there any large diameter ducting (6 SqFt+) in the HVAC system?
    > *Yes*

Electrical

- Does the building have a backup battery/generator system?
  > *No*

Concrete

- Are the building's shear walls low rise or slender?
  > *Low Rise (typically <= 40ft building height)*
  - What are the boundary conditions of the walls?
    > *No return flanges or boundary columns*
    - What is the typical wall thickness?
      > *8" to 16"*
      - What is the typical wall height?
        > *Less than 15'*

Expected Loss

Expected loss in percent of total building value

Shaking Intensity	Return Period	SEL (%)	SUL (%)
50% in 50 years	72 Years	3.2	7.7
10% in 50 years	475 Years	27	46
DE	481 Years	27	47
5% in 50 years	975 Years	45	75
MCE_R	1277 Years	52	84
2% in 50 years	2475 Years	72	100

Repair Time

Median repair time summary

	FEMA P-58†		ATC-138 Functional Recovery (Beta)‡		
Intensity	Parallel	Series	Re-Occupancy	Functional	Full
50% in 50 years	4.8 days	6.1 days	0 days	0 days	7 weeks
10% in 50 years	2.8 months	3.6 months	2.2 months	3.5 months	3.8 months
DE	2.7 months	3.5 months	2.3 months	3.6 months	3.8 months
5% in 50 years	4.1 months	5.4 months	3.2 months	4.2 months	4.3 months
MCE_R	4.7 months	6 months	3.6 months	4.6 months	4.7 months
2% in 50 years	11 months	11 months	11 months	11 months	11 months

† Does ***not*** include impedance factors

‡ Does include impedance factors

2 MOST DAMAGED COMPONENTS

Table 2.1. Most damaged Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	B1044.011	1	$3,640
10% in 50 years	B1044.011	1	$54,073
DE	B1044.011	1	$53,309
5% in 50 years	B1044.011	1	$67,194
MCE_R	B1044.011	1	$66,878
2% in 50 years	B1044.011	1	$51,183

Table 2.2. Most damaged Non-Structural components at each intensity level.

Intensity	Component	Damage State	Expected Repair Cost
50% in 50 years	D1014.021	1	$5,819
10% in 50 years	D1014.021	1	$24,935
DE	D1014.021	1	$24,302
5% in 50 years	D1014.021	1	$22,464
MCE_R	D1014.021	1	$21,878
2% in 50 years	D1014.021	1	$14,010

Details of the most damaged components and their damage states:

- **B1044.011**: Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’
  - DS1: Cracks with maximum widths greater than 0.04 in but less than 0.12 in.
- **D1014.021**: Hydraulic Elevator - Applies to most California Installations 1976 or later, most western states installations postdating 1982 and most U.S installations postdating 1998.
  - DS1a: Damaged controls.
  - DS1b: Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.
  - DS1c: Damaged entrance and car door, and or flooring damage.
  - DS1d: Oil leak in hydraulic line, and or hydraulic tank failure.

3 DETAILED COMPONENT DAMAGE BREAKDOWNS

3.1 Repair Cost

This table shows the expected contribution to repair cost on a per-damage state basis. The header shows the total loss, the loss contribution from collapse, and the loss contribution from residual drift for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.1.1. Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**19.3k**	**165k**	**166k**	**276k**	**315k**	**441k**
Collapse	0	6.19k	6.51k	35.6k	53.2k	110k
Residual	0	1.71k	1.71k	60.8k	84.3k	201k
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	2.97k	23.2k	22.6k	20.6k	20k	11.8k
DS2	196	6.18k	6.27k	7.96k	8.07k	6.65k
DS3	475	24.7k	24.4k	38.6k	38.8k	32.8k
Total	**3.64k**	**54.1k**	**53.3k**	**67.2k**	**66.9k**	**51.2k**
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	100	1.49k	1.49k	1.04k	973	668
DS2	1.4	1.15k	1.16k	1.13k	1.06k	568
DS3	0	2.56k	2.77k	4.73k	4.82k	3.95k
Total	**102**	**5.2k**	**5.42k**	**6.9k**	**6.86k**	**5.18k**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	71.8	344	342	261	258	195
DS2	24.5	524	524	397	330	201
DS3	20.1	3.47k	3.62k	4.31k	4.2k	2.84k
Total	**116**	**4.34k**	**4.48k**	**4.97k**	**4.79k**	**3.24k**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.94k	3.66k	3.66k	2.94k	2.49k	1.23k
DS2	455	2.16k	2.07k	2.26k	2.49k	1.89k
DS3	579	10.1k	10.1k	12k	12.4k	10.2k
Total	**2.97k**	**15.9k**	**15.8k**	**17.2k**	**17.4k**	**13.3k**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.76k	2.79k	2.8k	2.16k	1.85k	855
DS2	325	2.16k	2.2k	2.56k	2.57k	1.93k
DS3	301	7.27k	7.12k	9.1k	9.61k	8.17k
Total	**2.38k**	**12.2k**	**12.1k**	**13.8k**	**14k**	**11k**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	53.1	403	403	334	298	186
DS2	20.7	817	887	879	860	554
DS3	0	1.27k	1.23k	2.04k	2.23k	1.82k
Total	**73.8**	**2.49k**	**2.52k**	**3.25k**	**3.39k**	**2.56k**
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	18.8	166	176	170	147	102
DS2	43.9	312	354	382	295	215
DS3	220	4.74k	4.87k	5.81k	5.87k	3.99k
Total	**283**	**5.22k**	**5.4k**	**6.36k**	**6.31k**	**4.31k**

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Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**19.3k**	**165k**	**166k**	**276k**	**315k**	**441k**
Collapse	0	6.19k	6.51k	35.6k	53.2k	110k
Residual	0	1.71k	1.71k	60.8k	84.3k	201k
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	32.6	216	230	208	218	129
DS2	33	485	479	436	443	305
DS3	226	4.9k	5.32k	6.45k	5.89k	4.28k
Total	**292**	**5.6k**	**6.03k**	**7.1k**	**6.55k**	**4.71k**
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	79.2	358	381	323	302	190
DS2	68.2	680	727	660	634	545
DS3	220	5.46k	5.69k	6.83k	6.62k	4.39k
Total	**367**	**6.5k**	**6.8k**	**7.81k**	**7.55k**	**5.13k**
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	109	410	461	394	353	223
DS2	85.9	851	804	696	711	474
DS3	363	5.86k	6.09k	6.93k	6.8k	4.82k
Total	**558**	**7.12k**	**7.36k**	**8.02k**	**7.87k**	**5.52k**
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**426**	**2.63k**	**2.71k**	**2.7k**	**2.64k**	**1.75k**
D1014.021 #1 (D1014.021: Hydraulic Elevator - Applies to most California Installations 1976 or...)						
DS1a	137	562	531	518	532	319
DS1b	2.37k	9.37k	9.4k	9k	8.58k	5.66k
DS1c	2.91k	13.1k	12.4k	11k	11k	6.97k
DS1d	401	1.92k	1.93k	1.91k	1.74k	1.07k
Total	**5.82k**	**24.9k**	**24.3k**	**22.5k**	**21.9k**	**14k**
D2021.014a #1 (D2021.014a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	1.95	18.8	18	21.5	18.1	12.9
DS2	1.03	51.3	57.7	83.2	74.7	46.9
Total	**2.98**	**70.1**	**75.7**	**105**	**92.8**	**59.8**
D2021.014b #1 (D2021.014b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**9.83**	**60.7**	**62.2**	**66.5**	**60.8**	**38.7**
D2021.024a #1 (D2021.024a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	1.24	14.8	16.7	15.8	15.2	10.7
DS2	1.24	45.4	43.8	66.2	66.7	37.1
Total	**2.48**	**60.2**	**60.5**	**82**	**81.9**	**47.8**
D2021.024b #1 (D2021.024b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	4.05	16.3	17	14.2	13.4	9.64
DS2	1.54	19.8	19.6	22.9	22.9	15.6
Total	**5.59**	**36.1**	**36.6**	**37.1**	**36.3**	**25.2**
D2031.014b #1 (D2031.014b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or...)						
DS1	**1.09**	**17**	**18.1**	**20.7**	**21**	**14.5**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	12.9	96.7	91.1	101	89	61
DS1b	44.7	284	281	271	262	210
DS1c	21.6	110	108	116	116	69.3
DS1d	71.6	449	482	478	515	317
Total	**151**	**939**	**963**	**966**	**981**	**658**

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Table 3.1.1 (*Continued*). Expected contribution to repair cost per damage state (Dollars)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Tot. Loss	**19.3k**	**165k**	**166k**	**276k**	**315k**	**441k**
Collapse	0	6.19k	6.51k	35.6k	53.2k	110k
Residual	0	1.71k	1.71k	60.8k	84.3k	201k
D3041.011d #1 (D3041.011d: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	6.65	30.9	29.1	27.3	23.7	15.6
DS2	26.1	314	335	379	369	255
Total	**32.8**	**345**	**364**	**406**	**393**	**271**
D3041.012d #1 (D3041.012d: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	0.06	1.78	1.56	1.95	2.16	1.32
DS2	0.52	19.4	19.9	31.6	27.4	17.6
Total	**0.58**	**21.2**	**21.4**	**33.5**	**29.5**	**19**
D3041.032d #1 (D3041.032d: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**677**	**4.39k**	**4.44k**	**4.36k**	**4.23k**	**2.79k**
D3041.103c #1 (D3041.103c: HVAC Fan - Capacity: all - Equipment that is either hard anchored or is...)						
DS1a	144	475	480	449	438	290
DS1b	313	1.01k	1.03k	994	914	606
DS1c	836	2.7k	2.73k	2.48k	2.33k	1.47k
Total	**1.29k**	**4.18k**	**4.23k**	**3.92k**	**3.68k**	**2.37k**
D3067.012c #1 (D3067.012c: Control Panel - Capacity: all - Equipment that is either hard anchored or...)						
DS1a	2.05	51.3	56.2	72.4	75.6	60.5
DS1b	8.02	211	213	315	350	214
DS1c	28	592	677	844	810	754
Total	**38.1**	**855**	**947**	**1.23k**	**1.24k**	**1.03k**
D4011.024a #1 (D4011.024a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	5.54	45.6	47.9	46.9	42.4	30.5
DS2	7.36	132	149	198	183	117
Total	**12.9**	**178**	**197**	**244**	**226**	**147**

3.2 Repair time

This table shows the expected worker days on a per-damage state basis. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.2.1. Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE$_R$	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	1.6	13	13	12	11	6.7
DS2	0.1	3.5	3.5	4.4	4.4	3.8
DS3	0.2	14	14	22	22	18
Total	**2.0**	**30**	**30**	**38**	**37**	**29**
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.1	1.1	1.0	0.7	0.7	0.4
DS2	0.0	0.8	0.8	0.8	0.7	0.4
DS3	0.0	1.8	1.9	3.3	3.3	2.8
Total	**0.1**	**3.6**	**3.8**	**4.8**	**4.7**	**3.6**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	0.2	0.7	0.7	0.6	0.6	0.5
DS2	0.0	0.7	0.7	0.5	0.4	0.3
DS3	0.0	3.1	3.2	3.9	3.9	2.9
Total	**0.2**	**4.5**	**4.6**	**5.0**	**4.9**	**3.6**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	1.1	2.1	2.1	1.6	1.4	0.7
DS2	0.2	1.2	1.2	1.3	1.4	1.1
DS3	0.3	5.6	5.6	6.8	7.0	5.8
Total	**1.7**	**8.9**	**8.9**	**10**	**10**	**7.5**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	1.0	1.6	1.5	1.2	1.0	0.5
DS2	0.2	1.2	1.2	1.4	1.5	1.1
DS3	0.2	4.1	4.0	5.2	5.4	4.6
Total	**1.3**	**6.9**	**6.8**	**7.8**	**7.8**	**6.1**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	0.0	0.3	0.3	0.3	0.2	0.2
DS2	0.0	0.6	0.7	0.7	0.7	0.5
DS3	0.0	1.0	1.0	1.7	1.7	1.4
Total	**0.1**	**2.0**	**2.0**	**2.6**	**2.6**	**2.0**
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	0.0	0.1	0.1	0.1	0.1	0.1
DS2	0.0	0.2	0.2	0.2	0.2	0.1
DS3	0.2	3.2	3.3	4.0	4.0	2.7
Total	**0.2**	**3.5**	**3.7**	**4.3**	**4.3**	**2.9**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	0.0	0.1	0.2	0.1	0.1	0.1
DS2	0.0	0.3	0.3	0.3	0.3	0.2
DS3	0.2	3.2	3.5	4.3	3.9	2.8
Total	**0.2**	**3.7**	**3.9**	**4.7**	**4.3**	**3.1**
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	0.1	0.2	0.2	0.2	0.2	0.1
DS2	0.1	0.4	0.5	0.4	0.4	0.4
DS3	0.1	3.4	3.6	4.3	4.1	2.8
Total	**0.2**	**4.1**	**4.4**	**4.9**	**4.7**	**3.3**
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	0.1	0.3	0.3	0.2	0.2	0.1
DS2	0.1	0.5	0.5	0.4	0.4	0.3
DS3	0.2	3.6	3.7	4.4	4.2	2.9
Total	**0.4**	**4.4**	**4.4**	**5.0**	**4.9**	**3.3**
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**0.3**	**1.9**	**1.9**	**1.9**	**1.9**	**1.2**
D1014.021 #1 (D1014.021: Hydraulic Elevator - Applies to most California Installations 1976 or...)						
DS1a	0.1	0.4	0.4	0.4	0.3	0.2
DS1b	1.7	6.6	6.4	6.1	5.8	3.8
DS1c	2.1	9.3	8.6	7.5	7.6	4.9
DS1d	0.3	1.3	1.3	1.3	1.2	0.7
Total	**4.2**	**18**	**17**	**15**	**15**	**10**
D2021.014a #1 (D2021.014a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.1	0.1	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**
D2021.014b #1 (D2021.014b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2021.024a #1 (D2021.024a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.0**
D2021.024b #1 (D2021.024b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D2031.014b #1 (D2031.014b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or...)						
DS1	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	0.0	0.1	0.1	0.1	0.1	0.1
DS1b	0.0	0.1	0.1	0.1	0.1	0.1
DS1c	0.0	0.1	0.1	0.1	0.1	0.1
DS1d	0.0	0.4	0.4	0.4	0.4	0.3
Total	**0.1**	**0.6**	**0.7**	**0.7**	**0.7**	**0.4**

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Table 3.2.1 (*Continued*). Expected worker days per damage state (Worker Days)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
D3041.011d #1 (D3041.011d: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.1	0.1	0.1	0.1	0.1
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
D3041.012d #1 (D3041.012d: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
D3041.032d #1 (D3041.032d: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**0.6**	**3.7**	**3.8**	**3.7**	**3.5**	**2.3**
D3041.103c #1 (D3041.103c: HVAC Fan - Capacity: all - Equipment that is either hard anchored or is...)						
DS1a	0.1	0.4	0.4	0.4	0.4	0.2
DS1b	0.0	0.1	0.1	0.1	0.1	0.1
DS1c	0.7	2.3	2.3	2.1	2.0	1.2
Total	**0.9**	**2.8**	**2.8**	**2.6**	**2.5**	**1.5**
D3067.012c #1 (D3067.012c: Control Panel - Capacity: all - Equipment that is either hard anchored or...)						
DS1a	0.0	0.0	0.0	0.0	0.0	0.0
DS1b	0.0	0.2	0.2	0.3	0.3	0.2
DS1c	0.0	0.5	0.6	0.7	0.7	0.6
Total	**0.0**	**0.7**	**0.8**	**1.0**	**1.0**	**0.8**
D4011.024a #1 (D4011.024a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	0.0	0.0	0.0	0.0	0.0	0.0
DS2	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**

3.3 Casualties

Table 3.3.1 shows the total expected casualty results broken into collapse and non-collapse sources. The non-parenthetical values are casualties in terms of number of people and the parenthetical values show the probability of casualty for an individual person placed randomly in the building.

Table 3.3.2 shows the casualty breakdown on a per component basis. The values in this table are in terms of number of people, not probabilities.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A “green” value does not indicate that the value falls in a pre-determined “good” range, just that it performs well compared to other components. Likewise, a “red” value does does not indicate that the value falls in a pre-determined “bad” range, just that it performs worse compared to other components.

Table 3.3.1. Total expected casualties (Number of People (%))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
Total Non-Collapse Casualties						
Injury	0.00200 (0.118)	0.0370 (2.18)	0.0369 (2.17)	0.0517 (3.05)	0.0570 (3.36)	0.0615 (3.63)
Death	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total Collapse Casualties						
Injury	0.00 (0.00)	0.00560 (0.330)	0.00589 (0.347)	0.0322 (1.90)	0.0482 (2.84)	0.0999 (5.89)
Death	0.00 (0.00)	0.000057 (0.003)	0.000060 (0.004)	0.000325 (0.019)	0.000487 (0.029)	0.00101 (0.059)
Total Collapse and Non-Collapse Casualties						
Injury	0.00200 (0.118)	0.0422 (2.49)	0.0424 (2.50)	0.0809 (4.77)	0.100 (5.91)	0.150 (8.86)
Death	0.00 (0.00)	0.000057 (0.003)	0.000060 (0.004)	0.000325 (0.019)	0.000487 (0.029)	0.00101 (0.059)

Table 3.3.2. Expected casualties per component (Number of People)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
Injury	0.000682	0.00868	0.00749	0.0112	0.0137	0.0136
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
Injury	0.000412	0.00902	0.00965	0.0141	0.0145	0.0150
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
Injury	0.000278	0.00879	0.00920	0.0121	0.0131	0.0154
Death	0.00	0.00	0.00	0.00	0.00	0.00
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
Injury	0.000561	0.01000	0.0101	0.0137	0.0152	0.0169
Death	0.00	0.00	0.00	0.00	0.00	0.00
D3041.011d #1 (D3041.011d: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
Injury	0.000002	0.000027	0.000029	0.000036	0.000040	0.000043
Death	0.00	0.00	0.00	0.00	0.00	0.00

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Table 3.3.2 (*Continued*). Expected casualties per component (Number of People)

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
D3041.012d #1 (D3041.012d: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
Injury	0.000000	0.000011	0.000010	0.000018	0.000018	0.000019
Death	0.00	0.00	0.00	0.00	0.00	0.00
D3041.032d #1 (D3041.032d: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
Injury	0.000066	0.000426	0.000441	0.000500	0.000527	0.000512
Death	0.00	0.00	0.00	0.00	0.00	0.00

3.4 Quantity Damaged

This table shows the expected percentage of the components that are in a given damage state (normalized to the total quantity of that component in the entire building). The small parenthetical value is the probability that any component throughout the building is in that damage state (the percentage of realizations that have a component in that damage state).

All of these values are conditioned on no global failure. The header shows the probability of global failures (collapse and residual drift demolition) for reference.

The color scale is meant to indicate **relative** performance of components, not absolute performance. A "green" value does not indicate that the value falls in a pre-determined "good" range, just that it performs well compared to other components. Likewise, a "red" value does does not indicate that the value falls in a pre-determined "bad" range, just that it performs worse compared to other components.

Table 3.4.1. Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
B1044.011 #1 (B1044.011: Rectangular low aspect ratio concrete walls 8"-16" double curtain; with...)						
DS1	4.2 (15)	39 (80)	38 (78)	42 (83)	45 (87)	42 (83)
DS2	0.1 (0.7)	4.6 (22)	4.6 (21)	7.1 (32)	7.8 (35)	10 (43)
DS3	0.2 (0.8)	9.9 (28)	9.9 (28)	19 (45)	20 (48)	27 (60)
Total	**4.5 (15)**	**53 (83)**	**53 (81)**	**68 (91)**	**73 (95)**	**80 (96)**
B1071.202 #1 (B1071.202: Exterior Structural Wall - Light framed wood walls with structural panel...)						
DS1	0.8 (5.0)	12 (57)	12 (57)	10 (45)	11 (46)	12 (53)
DS2	0.0 (0.1)	7.7 (38)	7.7 (38)	8.9 (44)	9.0 (44)	7.9 (38)
DS3	0.0 (0.0)	7.6 (29)	8.2 (31)	17 (56)	18 (62)	24 (77)
Total	**0.8 (5.0)**	**28 (88)**	**28 (90)**	**36 (97)**	**38 (99)**	**45 (99)**
B2011.401 #1 (B2011.401: Exterior Wall - Light framed wood walls with exterior panelized sheathing...)						
DS1	2.2 (14)	11 (56)	11 (55)	11 (54)	12 (58)	17 (73)
DS2	0.4 (2.6)	7.8 (48)	7.7 (46)	7.3 (43)	7.0 (41)	7.9 (44)
DS3	0.1 (0.7)	17 (64)	17 (66)	25 (85)	28 (90)	33 (96)
Total	**2.6 (14)**	**35 (97)**	**36 (97)**	**44 (99)**	**47 (100)**	**58 (100)**
C1011.211a #1 (C1011.211a: Wall Partition - Type: Gypsum with wood studs (both sides), Full Height,...)						
DS1	25 (80)	48 (92)	48 (92)	45 (90)	42 (88)	33 (78)
DS2	2.5 (14)	13 (46)	13 (45)	17 (52)	19 (57)	24 (65)
DS3	1.0 (5.8)	19 (86)	19 (87)	26 (96)	30 (98)	39 (99)
Total	**28 (91)**	**80 (100)**	**80 (100)**	**88 (100)**	**92 (100)**	**96 (100)**
C1011.311a #1 (C1011.311a: Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided...)						
DS1	29 (79)	50 (92)	50 (92)	45 (90)	42 (88)	30 (78)
DS2	2.2 (15)	15 (46)	16 (47)	22 (53)	24 (57)	28 (66)
DS3	0.6 (4.9)	16 (87)	16 (86)	24 (95)	28 (97)	38 (99)
Total	**32 (90)**	**81 (100)**	**81 (100)**	**90 (100)**	**94 (100)**	**96 (100)**
C2011.041b #1 (C2011.041b: Light frame stair fragility. Approximation as a placeholder until there is...)						
DS1	3.7 (7.3)	29 (50)	28 (49)	28 (47)	26 (45)	27 (46)
DS2	0.3 (0.6)	15 (29)	16 (31)	19 (37)	20 (38)	20 (37)
DS3	0.0 (0.0)	7.7 (15)	7.6 (15)	15 (29)	17 (33)	22 (44)
Total	**4.0 (8.0)**	**51 (88)**	**52 (89)**	**61 (96)**	**63 (97)**	**68 (99)**
C3032.004a #1 (C3032.004a: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat...)						
DS1	1.2 (2.3)	11 (20)	11 (21)	13 (24)	12 (22)	13 (24)
DS2	0.3 (0.6)	2.7 (5.3)	2.8 (5.6)	3.4 (6.6)	3.1 (6.1)	3.8 (7.5)
DS3	0.9 (1.7)	19 (30)	20 (32)	28 (42)	31 (44)	33 (47)
Total	**2.4 (4.4)**	**33 (47)**	**34 (50)**	**44 (61)**	**46 (62)**	**50 (67)**

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
C3032.004b #1 (C3032.004b: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat...)						
DS1	2.2 (4.4)	14 (25)	15 (27)	15 (28)	18 (32)	17 (30)
DS2	0.4 (0.7)	3.8 (7.5)	3.8 (7.4)	4.2 (8.3)	4.6 (9.1)	5.0 (9.5)
DS3	0.9 (1.8)	20 (30)	21 (33)	30 (44)	30 (43)	34 (48)
Total	**3.5 (6.5)**	**38 (54)**	**40 (57)**	**50 (67)**	**53 (68)**	**56 (72)**
C3032.004c #1 (C3032.004c: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert &...)						
DS1	5.0 (9.1)	23 (41)	24 (42)	24 (42)	24 (41)	25 (44)
DS2	0.6 (1.2)	5.8 (11)	6.1 (12)	6.6 (13)	6.7 (13)	8.5 (16)
DS3	0.9 (1.8)	22 (34)	23 (36)	32 (46)	33 (47)	35 (51)
Total	**6.5 (11)**	**51 (68)**	**53 (70)**	**63 (78)**	**64 (80)**	**69 (83)**
C3032.004d #1 (C3032.004d: Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat...)						
DS1	6.9 (12)	27 (46)	29 (48)	29 (48)	29 (47)	29 (49)
DS2	0.7 (1.5)	6.8 (13)	6.4 (12)	7.0 (13)	7.4 (14)	7.3 (14)
DS3	1.4 (2.7)	23 (36)	24 (37)	33 (47)	35 (50)	38 (54)
Total	**9.1 (15)**	**57 (74)**	**59 (76)**	**68 (83)**	**71 (85)**	**75 (87)**
C3034.002 #1 (C3034.002: Independent Pendant Lighting - seismically rated)						
DS1	**7.5 (20)**	**49 (80)**	**50 (81)**	**59 (88)**	**62 (89)**	**64 (90)**
D1014.021 #1 (D1014.021: Hydraulic Elevator - Applies to most California Installations 1976 or...)						
DS1a	6.2 (6.2)	26 (26)	25 (25)	28 (28)	30 (30)	31 (31)
DS1b	10 (10)	42 (42)	41 (41)	46 (46)	48 (48)	50 (50)
DS1c	8.8 (8.8)	40 (40)	38 (38)	40 (40)	43 (43)	43 (43)
DS1d	6.3 (6.3)	31 (31)	31 (31)	35 (35)	35 (35)	35 (35)
Total	**32 (17)**	**140 (75)** *	**130 (75)** *	**150 (82)** *	**160 (84)** *	**160 (87)** *
*Percent of total quantity above 100 is caused by simultaneous damage states						
D2021.014a #1 (D2021.014a: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	1.9 (3.6)	19 (33)	20 (34)	25 (43)	25 (42)	27 (45)
DS2	0.1 (0.2)	6.0 (11)	6.4 (11)	11 (18)	11 (19)	11 (19)
Total	**2.0 (3.8)**	**25 (40)**	**26 (41)**	**36 (53)**	**36 (52)**	**38 (56)**
D2021.014b #1 (D2021.014b: Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in...)						
DS1	**7.8 (14)**	**48 (67)**	**49 (67)**	**60 (78)**	**63 (79)**	**63 (80)**
D2021.024a #1 (D2021.024a: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	1.8 (3.4)	20 (35)	21 (36)	25 (43)	27 (44)	29 (47)
DS2	0.2 (0.3)	6.2 (11)	6.1 (11)	11 (18)	11 (19)	11 (18)
Total	**2.0 (3.7)**	**26 (41)**	**27 (42)**	**36 (53)**	**38 (54)**	**40 (57)**
D2021.024b #1 (D2021.024b: Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or...)						
DS1	5.7 (11)	22 (39)	23 (41)	23 (40)	24 (41)	26 (44)
DS2	2.2 (4.0)	26 (41)	26 (40)	36 (53)	38 (55)	41 (57)
Total	**7.8 (14)**	**48 (67)**	**49 (67)**	**59 (77)**	**62 (78)**	**67 (82)**
D2031.014b #1 (D2031.014b: Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or...)						
DS1	**0.9 (1.7)**	**16 (27)**	**17 (29)**	**22 (36)**	**25 (39)**	**27 (43)**
D3032.013c #1 (D3032.013c: Compressor - Capacity: Small non medical air supply - Equipment that is...)						
DS1a	2.1 (2.1)	15 (15)	15 (15)	17 (17)	17 (17)	18 (18)
DS1b	0.9 (0.9)	6.1 (6.1)	6.0 (6.0)	6.5 (6.5)	7.0 (7.0)	8.7 (8.7)
DS1c	1.8 (1.8)	9.7 (9.7)	9.6 (9.6)	12 (12)	13 (13)	12 (12)
DS1d	1.3 (1.3)	9.4 (9.4)	9.9 (9.9)	12 (12)	14 (14)	13 (13)
Total	**6.2 (6.2)**	**40 (40)**	**40 (40)**	**48 (48)**	**51 (51)**	**53 (53)**

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Table 3.4.1 (*Continued*). Expected percentage of damaged components (% of total qty. (% of realizations))

	50% in 50 years	10% in 50 years	DE	5% in 50 years	MCE_R	2% in 50 years
P[Col](%)	0.0	1.0	1.1	5.8	8.7	18
P[Res](%)	0.0	0.3	0.3	10.0	14	33
D3041.011d #1 (D3041.011d: HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional...)						
DS1	5.2 (10)	24 (42)	23 (40)	25 (43)	24 (41)	24 (42)
DS2	2.0 (3.8)	25 (39)	27 (41)	36 (53)	37 (53)	41 (58)
Total	**7.3 (13)**	**49 (67)**	**50 (68)**	**60 (78)**	**61 (76)**	**65 (82)**
D3041.012d #1 (D3041.012d: HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or...)						
DS1	0.1 (0.2)	3.5 (6.6)	3.2 (6.2)	4.7 (8.8)	5.4 (10)	5.2 (10)
DS2	0.1 (0.2)	4.6 (8.3)	4.7 (8.2)	8.9 (16)	8.4 (14)	8.6 (15)
Total	**0.2 (0.5)**	**8.2 (14)**	**7.9 (14)**	**14 (22)**	**14 (23)**	**14 (23)**
D3041.032d #1 (D3041.032d: HVAC Drops / Diffusers without ceilings - supported by ducting only - No...)						
DS1	**7.6 (13)**	**49 (69)**	**51 (69)**	**58 (76)**	**61 (79)**	**64 (81)**
D3041.103c #1 (D3041.103c: HVAC Fan - Capacity: all - Equipment that is either hard anchored or is...)						
DS1a	6.7 (13)	23 (40)	23 (40)	26 (45)	28 (47)	29 (49)
DS1b	3.2 (6.1)	10 (19)	10 (20)	12 (22)	12 (22)	13 (23)
DS1c	10 (19)	35 (56)	35 (56)	38 (59)	38 (62)	38 (61)
Total	**20 (33)**	**68 (87)**	**69 (86)**	**76 (92)**	**78 (92)**	**80 (93)**
D3067.012c #1 (D3067.012c: Control Panel - Capacity: all - Equipment that is either hard anchored or...)						
DS1a	0.2 (0.2)	6.8 (6.8)	7.4 (7.4)	11 (11)	12 (12)	16 (16)
DS1b	0.1 (0.1)	3.0 (3.0)	2.9 (2.9)	5.2 (5.2)	6.3 (6.3)	6.2 (6.2)
DS1c	0.4 (0.4)	9.5 (9.5)	11 (11)	16 (16)	17 (17)	24 (24)
Total	**0.8 (0.8)**	**19 (19)**	**21 (21)**	**32 (32)**	**36 (36)**	**46 (46)**
D4011.024a #1 (D4011.024a: Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style...)						
DS1	3.2 (6.1)	25 (42)	26 (43)	29 (48)	30 (49)	33 (54)
DS2	0.5 (0.9)	9.8 (17)	11 (18)	16 (26)	17 (28)	17 (28)
Total	**3.7 (6.8)**	**35 (51)**	**36 (53)**	**45 (63)**	**47 (65)**	**51 (68)**

4 COMPONENT DAMAGEABILITY AND COST OVERVIEW

This section provides an overview of key component parameters for loss assessment. The components are broken into groups such that the specified component modifiers are applied to all components in the given table.

Some notes on the columns are as follows:

- **DS: Median (Unit Repair Cost Range)**: This presents median EDP for each damage state as well as the associated repair cost range to repair one unit of the component (varies based on quantity).
- **Max Repair Potential**: This is the cost to completely replace this component throughout the building assuming the most expensive damage state for all components (includes volume discounting). The number in parenthesis is the value as a percentage of building replacement value. Note that this does not need to add up to the total building replacement value, but rather gives a sense of how much potential the component has to contribute to the mean loss when it is damaged.

Table 4.1. "Structural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B1044.011	Rectangular low aspect ratio concrete walls 8"-16" double curtain; with heights of up to 15'	EDP Peak Interstory Drift DS1: 0.0055 ($7,151 - $10,516) DS2: 0.0109 ($18,456 - $27,141) DS3: 0.013 ($34,471 - $50,692)	$255,429 (41.8%)
B1071.202	Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs	EDP Peak Interstory Drift DS1: 0.015 ($947 - $1,539) DS2: 0.0262 ($1,366 - $1,928) DS3: 0.0369 ($3,033 - $4,281)	$24,225 (3.97%)
		Total:	$279,654 (45.8%)

Table 4.2. "Exterior Finishes" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
B2011.401	Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs	EDP Peak Interstory Drift DS1: 0.01 ($175 - $412) DS2: 0.0175 ($374 - $879) DS3: 0.025 ($1,156 - $2,721)	$9,297 (1.52%)
		Total:	$9,297 (1.52%)

Table 4.3. "Partition Walls" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C1011.211a	Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($1,598 - $5,328) DS2: 0.0071 ($3,428 - $11,425) DS3: 0.012 ($11,297 - $37,656)	$53,491 (8.76%)

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Table 4.3 (*Continued*). "Partition Walls" component list.

Component	Description	DS: Median (Repair Cost Range)	Max Repair Potential
C1011.311a	Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above	EDP Peak Interstory Drift DS1: 0.0021 ($904 - $3,015) DS2: 0.0071 ($2,223 - $7,411) DS3: 0.012 ($7,151 - $23,838)	$44,332 (7.26%)
		Total:	$97,823 (16.0%)

Table 4.4. "Other Nonstructural" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C2011.041b	Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.	EDP Peak Interstory Drift DS1: 0.011 ($487 - $695) DS2: 0.026 ($1,043 - $2,782) DS3: 0.05 ($3,130 - $8,346)	$16,692 (2.73%)
D4011.024a	Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - with designed bracing, SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.9 ($438 - $536) DS2: 3.4 ($3,317 - $4,055)	$1,409 (0.23%)
		Total:	$18,101 (2.96%)

Table 4.5. "Ceilings" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C3032.004a	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.92 ($303 - $1,008) DS2: 2.34 ($2,368 - $7,894) DS3: 2.48 ($4,872 - $16,240)	$24,287 (3.98%)
C3032.004b	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.76 ($726 - $2,420) DS2: 2.26 ($5,683 - $18,945) DS3: 2.44 ($11,692 - $38,975)	$25,402 (4.16%)
C3032.004c	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.45 ($2,178 - $7,261) DS2: 2.1 ($17,050 - $56,835) DS3: 2.34 ($35,077 - $116,925)	$25,402 (4.16%)

Continued on next page

Table 4.5 (*Continued*). "Ceilings" component list.

Component	Description	DS: Median (Repair Cost Range)	Max Repair Potential
C3032.004d	Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support	EDP Peak Floor Acceleration DS1: 1.31 ($3,025 - $10,085) DS2: 2.03 ($23,681 - $78,937) DS3: 2.29 ($48,719 - $162,396)	$25,402 (4.16%)
		Total:	$100,493 (16.5%)

Table 4.6. "Lighting" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
C3034.002	Independent Pendant Lighting - seismically rated	EDP Peak Floor Acceleration DS1: 1.5 ($413 - $1,377)	$5,508 (0.90%)
		Total:	$5,508 (0.90%)

Table 4.7. "Elevators" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D1014.021	Hydraulic Elevator - Applies to most California Installations 1976 or later, most western states installations postdating 1982 and most U.S installations postdating 1998.	EDP Peak Floor Acceleration DS1a: 0.5 ($668 - $2,226) DS1b: 0.5 ($6,844 - $22,812) DS1c: 0.5 ($10,015 - $33,383) DS1d: 0.5 ($1,920 - $6,398)	$33,383 (5.47%)
		Total:	$33,383 (5.47%)

Table 4.8. "Piping" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D2021.014a	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 2.25 ($363 - $444) DS2: 4.1 ($3,317 - $4,055)	$888 (0.15%)
D2021.014b	Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($476 - $581)	$127 (0.02%)
D2021.024a	Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), PIPING FRAGILITY	EDP Peak Floor Acceleration DS1: 2.25 ($292 - $974) DS2: 4.1 ($2,796 - $9,319)	$729 (0.12%)

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Table 4.8 (*Continued*). "Piping" component list.

Component	Description	DS: Median (Repair Cost Range)	Max Repair Potential
D2021.024b	Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 1.5 ($292 - $974) DS2: 2.25 ($292 - $974)	$76 (0.01%)
D2031.014b	Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or sim), BRACING FRAGILITY	EDP Peak Floor Acceleration DS1: 3 ($334 - $1,113)	$110 (0.02%)
		Total:	$1,931 (0.32%)

Table 4.9. "HVAC" component list.

Component	Description	DS: Median (Unit Repair Cost Range)	Max Repair Potential
D3032.013c	Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility	EDP Peak Floor Acceleration DS1a: 2.05 ($563 - $689) DS1b: 2.05 ($3,943 - $4,820) DS1c: 2.05 ($939 - $1,148) DS1d: 2.05 ($3,943 - $4,820)	$4,820 (0.79%)
D3041.011d	HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F (OSHPD or sim)	EDP Peak Floor Acceleration DS1: 1.5 ($814 - $995) DS2: 2.25 ($7,949 - $9,716)	$1,266 (0.21%)
D3041.012d	HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater, SDC D, E, or F (OSHPD or sim)	EDP Peak Floor Acceleration DS1: 3.75 ($1,189 - $1,454) DS2: 4.5 ($9,952 - $12,164)	$423 (0.07%)
D3041.032d	HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F (OSHPD or sim)	EDP Peak Floor Acceleration DS1: 1.5 ($3,756 - $4,590)	$8,763 (1.43%)
D3041.103c	HVAC Fan - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility	EDP Peak Floor Acceleration DS1a: 1.07 ($876 - $1,071) DS1b: 1.07 ($4,194 - $5,126) DS1c: 1.07 ($3,317 - $4,055)	$9,785 (1.60%)
D3067.012c	Control Panel - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility	EDP Peak Floor Acceleration DS1a: 1.6 ($626 - $765) DS1b: 1.6 ($5,821 - $7,115) DS1c: 1.6 ($5,195 - $6,350)	$7,115 (1.16%)
		Total:	$32,172 (5.27%)

Table 4.10. Summary of component value breakdown (building replacement value = $610,816).

Component Category	Max Repair Potential	% of Building Replacement Value
Structural	$279,654	45.8%
Exterior Finishes	$9,297	1.52%
Partition Walls	$97,823	16.0%
Other Nonstructural	$18,101	2.96%
Ceilings	$100,493	16.5%
Lighting	$5,508	0.90%
Elevators	$33,383	5.47%
Piping	$1,931	0.32%
HVAC	$32,172	5.27%
Total	$578,363	94.7%

5 COMPONENT QUANTITIES AND MODIFICATION FACTORS

Table 5.1. Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
B1044.011 (B1044.011 #1): Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’						
1	0	7.41	–	1	1	1
B1071.202 (B1071.202 #1): Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs						
1	2.97	0	–	1	1	1
2	1.98	3.015	–	1	1	1
B2011.401 (B2011.401 #1): Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs						
1	2.97	0	–	1	1	1
2	1.98	3.015	–	1	1	1
C1011.211a (C1011.211a #1): Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above						
1	0.265	0.275	–	1	1	1
2	0.435	0.5	–	1	1	1
C1011.311a (C1011.311a #1): Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above						
1-2	0.22	0.79	–	1	1	1
C2011.041b (C2011.041b #1): Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.						
1	1	1	–	1	1	1
C3032.004a (C3032.004a #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support						
2-R	–	–	0.7821	1	1	1
C3032.004b (C3032.004b #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support						
2-R	–	–	0.325875	1	1	1
C3032.004c (C3032.004c #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support						
2-R	–	–	0.108625	1	1	1
C3032.004d (C3032.004d #1): Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support						
2-R	–	–	0.07821	1	1	1
C3034.002 (C3034.002 #1): Independent Pendant Lighting - seismically rated						
2-R	–	–	2	1	1	1
D1014.021 (D1014.021 #1): Hydraulic Elevator - Applies to most California Installations 1976 or later, most western states installations postdating 1982 and most U.S installations postdating 1998.						
G	–	–	1	1	1	1
D2021.014a (D2021.014a #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY						
2-R	–	–	0.109494	1	1	1
D2021.014b (D2021.014b #1): Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), BRACING FRAGILITY						
2-R	–	–	0.109494	1	1	1
D2021.024a (D2021.024a #1): Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), PIPING FRAGILITY						
2-R	–	–	0.039105	1	1	1

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Table 5.1 (*Continued*). Component quantity and modification summary.

Location	Qty. Dir 1	Qty. Dir 2	Qty. ND	Cost Scale	Capacity Scale	Time Scale
D2021.024b (D2021.024b #1): Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), BRACING FRAGILITY						
2-R	–	–	0.039105	1	1	1
D2031.014b (D2031.014b #1): Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or sim), BRACING FRAGILITY						
2-R	–	–	0.049533	1	1	1
D3032.013c (D3032.013c #1): Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility						
R	–	–	1	1	1	1
D3041.011d (D3041.011d #1): HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F (OSHPD or sim)						
2-R	–	–	0.065175	1	1	1
D3041.012d (D3041.012d #1): HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater, SDC D, E, or F (OSHPD or sim)						
2-R	–	–	0.01738	1	1	1
D3041.032d (D3041.032d #1): HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F (OSHPD or sim)						
2-R	–	–	1	1	1	1
D3041.103c (D3041.103c #1): HVAC Fan - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility						
2-R	–	–	1	1	1	1
D3067.012c (D3067.012c #1): Control Panel - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility						
G	–	–	1	1	1	1
D4011.024a (D4011.024a #1): Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - with designed bracing, SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY						
2-R	–	–	0.1738	1	1	1

6 FRAGILITY INFORMATION

6.1 B1044.011 #1: (B1044.011) Rectangular low aspect ratio concrete walls 8”-16” double curtain; with heights of up to 15’

NISTIR Classification	B1044.011
Author	Andrew Whittaker
Normalized Unit	144.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.1.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.1.2. Damage state progression.

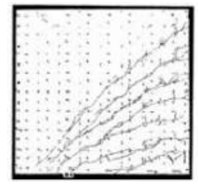
Damage State	Description	Repair Description	Image
DS1	Cracks with maximum widths greater than 0.04 in but less than 0.12 in.	Remove furnishings, ceilings and mechanical, electrical and plumping systems (as necessary) 5 feet either side of damaged area. Replace and repair finishes. Replace furnishings, ceilings and mechanical, electrical and plumping systems (as necessary).	
DS2	Crushed core concrete; localized concrete cracking with widths greater than 0.12 in; buckling of vertical rebar.	(1) Relocate office eqpt & furniture within 6 ft. of wall, both sides. Install protective covers on floor finishes & adjacent curtain wall system. (2) Remove arch. finishes on wall, both sides. (3) Relocate MEP systems within 6 ft. of wall. (4) Prepare & inject grout 330 ft. of crack per 100 ft2 of wall. (5) Remove 15 ft2 per 100 ft2 of wall & 10 1-ft. long sections of #8 buckled vert. rebar. (6) Replace buckled rebar with new rebar, attach to exposed ends of (E) rebar with mech splices; provide 8 #4 seismic ties at 4 in. oc, ea end of wall; rebend 16 horiz. rebar in wall around new rebar. (7) Install formwork & cast 5ksi concrete into pockets cut in step 5. (8) Strip forms, cleanup, reinstall/return office eqpt., finishes, furniture & MEP.	
DS3	Sliding of the wall resulting in large residual displacement; distributed concrete cracking with widths greater than 0.12 in; fracture of rebar.	(1) Relocate eqpt.& furniture within 10 ft. of wall, both sides. Install protection on floor & adjacent walls. (2) Remove wall finishes, both sides. (3) Relocate MEP within 10 ft. of wall. (4) Remove damaged wall in 5-ft.lengths. (5) Install bars: a. 12#9 A706 bars in bz ea. end; mech splices to (E) ; b. #4 A706 dbl sets of seismic ties at 4 in. oc ea bz; c. #4 A706 bar at 6 in. oc, ewef; lap new vert. bars to (E) at top of wall; drill & epoxy bars into wall/fdn at 6 in. oc to match new rebar above. Anchor horiz. Bars in bz with seismic hks or lap 24 in. with (E) horiz. bars. (6) Form wall. Cast 5ksi concrete in 3-ft. lifts; with 1-in. top gap for grout day after casting. (7) Remove forms, clean-up & reinstall/return eqpt, finishes, furniture & MEP.	

Table 6.1.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0055	0.0109	0.013
β	0.36	0.3	0.36

Table 6.1.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	7.0	7.0	7.0
Highest Cost Median	$10,516	$27,141	$50,692
Lowest Cost Median	$7,151	$18,456	$34,471
β (COV)	0.16	0.13	0.11

Table 6.1.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	7.0	7.0	7.0
Highest Median Repair Time (Days)	5.89	15.21	28.4
Lowest Median Repair Time (Days)	4	10.34	19.31
β (COV)	0.29	0.28	0.28

Table 6.1.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.2 B1071.202 #1: (B1071.202) Exterior Structural Wall - Light framed wood walls with structural panel sheathing, with hold-downs

NISTIR Classification	B1071.202
Author	HBRG (exterior only)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Structural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.2.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.2.2. Damage state progression.

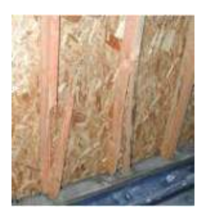
Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.2.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.015	0.0262	0.0369
β	0.4	0.19	0.2

Table 6.2.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$1,539	$1,928	$4,281
Lowest Cost Median	$947	$1,366	$3,033
β (COV)	0.19	0.22	0.08

Table 6.2.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	1.07	1.35	2.99
Lowest Median Repair Time (Days)	0.66	0.95	2.12
β (COV)	0.31	0.33	0.26

Table 6.2.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.3 B2011.401 #1: (B2011.401) Exterior Wall - Light framed wood walls with exterior panelized sheathing (OSB) and horizontal wood siding, no hold-downs

NISTIR Classification	B2011.401
Author	HBRG (exterior only modifications)
Normalized Unit	100.0 sf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Exterior Finishes
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.3.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.3.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Slight separation of sheathing or nails which come loose.	Remove exterior pliable siding, replace loose nails, reinstall siding.	
DS2	Permanent rotation of sheathing, tear out of nails or sheathing.	Remove exterior pliable siding, remove wood sheathing, install new sheathing, reinstall siding.	
DS3	Fracture of studs, major sill plate cracking.	Remove and replace siding, sheathing, studs and plates. Provide shoring as required.	

Table 6.3.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.01	0.0175	0.025
β	0.4	0.4	0.4

Table 6.3.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Cost Median	$412	$879	$2,721
Lowest Cost Median	$175	$374	$1,156
β (COV)	0.19	0.22	0.08

Table 6.3.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	3.0	3.0	3.0
Upper Qty.	8.0	8.0	8.0
Highest Median Repair Time (Days)	0.86	1.08	2.4
Lowest Median Repair Time (Days)	0.53	0.77	1.7
β (COV)	0.31	0.33	0.26

Table 6.3.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.5	0.25
Unsafe Placard β	–	0.5	0.5

6.4 C1011.211a #1: (C1011.211a) Wall Partition - Type: Gypsum with wood studs (both sides), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.211a
Author	DaveWelch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.4.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.4.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.4.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.4.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$5,328	$11,425	$37,656
Lowest Cost Median	$1,598	$3,428	$11,297
β (COV)	0.42	0.49	0.1

Table 6.4.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	2.99	6.4	21.1
Lowest Median Repair Time (Days)	0.9	1.92	6.33
β (COV)	0.52	0.55	0.34

Table 6.4.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.5 C1011.311a #1: (C1011.311a) Interior of Exterior Wall - Type: Gypsum with wood studs (single-sided gypsum), Full Height, Fixed Below, Fixed Above

NISTIR Classification	C1011.311a
Author	Dave Welch (HBRG)
Normalized Unit	100.0 lf
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Partition Walls
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.5.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.5.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cracking of paint over fasteners or joints.	Gypsum wallboard repaired by replacing the tape along the seam of two adjacent panels and local areas with popped fasteners, applying new joint compound, sanding, and repainting.	Not Available
DS2	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard.	Replace 25 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available
DS3	Local and global buckling out-of-plane and crushing of gypsum wallboards. Studs are typically not damaged by failure of the gypsum wallboard, but framing adjustments possible for this damage state.	Replace 100 feet of the affected panel along with the application of new tape, joint compound, followed by sanding and repainting. Studs are not damaged.	Not Available

Table 6.5.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.0021	0.0071	0.012
β	0.6	0.45	0.45

Table 6.5.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$3,015	$7,411	$23,838
Lowest Cost Median	$904	$2,223	$7,151
β (COV)	0.42	0.49	0.1

Table 6.5.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	Normal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.69	4.15	13.36
Lowest Median Repair Time (Days)	0.51	1.25	4.01
β (COV)	0.52	0.55	0.34

Table 6.5.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.6 C2011.041b #1: (C2011.041b) Light frame stair fragility. Approximation as a placeholder until there is more research on the topic. Damage states from P-58 Light frame stair example. Costing approximated from various online sources for stair replacement.

NISTIR Classification	C2011.041b
Author	HBRG
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Interstory Drift
Number of Damage States	3
Is correlated?	No
Is directional?	Yes

Component modifications applied:

Component Group	Other Nonstructural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.6.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
1-2	1	1	1

Table 6.6.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Cosmetic Damage.	Repair cosmetic damage.	Not Available
DS2	Structural damage but live load capacity remains intact.	Repair damage.	Not Available
DS3	Loss of live load capacity.	Replace stair.	Not Available

Table 6.6.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	0.011	0.026	0.05
β	0.5	0.5	0.5

Table 6.6.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	\$695	\$2,782	\$8,346
Lowest Cost Median	\$487	\$1,043	\$3,130
β (COV)	0.8	0.6	0.4

Table 6.6.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	LogNormal	LogNormal	Normal
Lower Qty.	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.55	2.21	6.62
Lowest Median Repair Time (Days)	0.39	0.83	2.48
β (COV)	1.0	0.7	0.5

Table 6.6.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.25	0.1
Unsafe Placard β	–	0.1	0.5

6.7 C3032.004a #1: (C3032.004a) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A < 250, Vert & Lat support

NISTIR Classification	C3032.004a
Author	Not Given
Normalized Unit	250.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.7.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.7.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.7.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**	**DS3**
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.92	2.34	2.48
β	0.3	0.3	0.3

Table 6.7.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$1,008	$7,894	$16,240
Lowest Cost Median	$303	$2,368	$4,872
β (COV)	0.55	0.52	0.2

Table 6.7.5. Parameters for the repair time distributions.

	DS1	**DS2**	**DS3**
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	0.7	5.41	11.15
Lowest Median Repair Time (Days)	0.21	1.62	3.34
β (COV)	0.6	0.58	0.32

Table 6.7.6. Life safety information.

	DS1	**DS2**	**DS3**
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	250.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.8 C3032.004b #1: (C3032.004b) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 250 < A < 1000, Vert & Lat support

NISTIR Classification	C3032.004b
Author	Not Given
Normalized Unit	600.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.8.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.8.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.8.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.76	2.26	2.44
β	0.3	0.3	0.3

Table 6.8.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$2,420	$18,945	$38,975
Lowest Cost Median	$726	$5,683	$11,692
β (COV)	0.55	0.52	0.2

Table 6.8.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.57	12.39	25.55
Lowest Median Repair Time (Days)	0.46	3.7	7.67
β (COV)	0.6	0.58	0.32

Table 6.8.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	650.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.9 C3032.004c #1: (C3032.004c) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): 1000 < A < 2500, Vert & Lat support

NISTIR Classification	C3032.004c
Author	Not Given
Normalized Unit	1800.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.9.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.9.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.9.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.45	2.1	2.34
β	0.3	0.3	0.3

Table 6.9.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$7,261	$56,835	$116,925
Lowest Cost Median	$2,178	$17,050	$35,077
β (COV)	0.55	0.52	0.2

Table 6.9.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	4.64	36.03	74.17
Lowest Median Repair Time (Days)	1.42	10.79	22.25
β (COV)	0.6	0.58	0.32

Table 6.9.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	1700.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.10 C3032.004d #1: (C3032.004d) Suspended Ceiling, SDC D,E,F (Ip=1.5), Area (A): A > 2500, Vert & Lat support

NISTIR Classification	C3032.004d
Author	Not Given
Normalized Unit	2500.0 sf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	3
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Ceilings
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.10.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.10.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	5 % of ceiling grid and tile damage.	Reinstall, repair, or replace 5% of the ceiling area.	Not Available
DS2	30% of ceiling grid and tile damage.	Replace 30% of the ceiling area.	Not Available
DS3	50% of ceiling grid and tile damage.	Replace the entire ceiling	Not Available

Table 6.10.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2	DS3
Type	Sequential	Sequential	Sequential
Probability	–	–	–
Median	1.31	2.03	2.29
β	0.3	0.3	0.3

Table 6.10.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Cost Median	$10,085	$78,937	$162,396
Lowest Cost Median	$3,025	$23,681	$48,719
β (COV)	0.55	0.52	0.2

Table 6.10.5. Parameters for the repair time distributions.

	DS1	DS2	DS3
Distribution Type	Normal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	10.0	10.0	10.0
Highest Median Repair Time (Days)	6.09	48.45	99.54
Lowest Median Repair Time (Days)	1.76	14.57	29.83
β (COV)	0.6	0.58	0.32

Table 6.10.6. Life safety information.

	DS1	DS2	DS3
Non-collapse casualties	No	No	Yes
Affected Area	– –	– –	2500.0 SF
Serious Injury Median	–	–	0.1
Serious Injury β	–	–	0.5
Loss of Life Median	–	–	0.0
Loss of Life β	–	–	0.0
Can Cause Red Tag	No	Yes	Yes
Unsafe Placard Median	–	0.75	0.5
Unsafe Placard β	–	0.5	0.5

6.11 C3034.002 #1: (C3034.002) Independent Pendant Lighting - seismically rated

NISTIR Classification	C3034.002
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Lighting
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.11.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.11.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Disassembly of rod system at connections with horizontal light fixture, low cycle fatigue failure of the threaded rod, pullout of rods from ceiling assembly.	Replace damaged lighting components.	Not Available

Table 6.11.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.11.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$1,377
Lowest Cost Median	$413
β (COV)	0.64

Table 6.11.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.99
Lowest Median Repair Time (Days)	0.3
β (COV)	0.68

Table 6.11.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.12 D1014.021 #1: (D1014.021) Hydraulic Elevator - Applies to most California Installations 1976 or later, most western states installations postdating 1982 and most U.S installations postdating 1998.

NISTIR Classification	D1014.021
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Elevators
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.12.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.12.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Damaged controls.	Multiple repairs possible (% change of each): Repair damaged controls (100%)	Not Available
DS1b	Damaged vane and hoist-way switches, and or bent cab stabilizers, and or damaged car guide shoes.	Multiple repairs possible (% change of each): Repair damaged vane and hoist-way switches (41%), and or repair bent cab stabilizers (41%), and or repair damaged car guide shoes (41%).	Not Available
DS1c	Damaged entrance and car door, and or flooring damage.	Multiple repairs possible (% change of each): Repair damage to doors (68%), and or repair flooring (46%)	Not Available
DS1d	Oil leak in hydraulic line, and or hydraulic tank failure.	Multiple repairs possible (% change of each): Repair oil leak in hydraulic line (27%), and or hydraulic tank failure (81%)	Not Available

Table 6.12.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Type	Simultaneous	Simultaneous	Simultaneous	Simultaneous
Probability	0.3	0.49	0.44	0.37
Median	0.5	0.5	0.5	0.5
β	0.3	0.3	0.3	0.3

Table 6.12.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Distribution Type	LogNormal	Normal	Normal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0	10.0
Highest Cost Median	$2,226	$22,812	$33,383	$6,398
Lowest Cost Median	$668	$6,844	$10,015	$1,920
β (COV)	0.82	0.32	0.44	0.25

Table 6.12.5. Parameters for the repair time distributions.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Distribution Type	LogNormal	Normal	Normal	LogNormal
Lower Qty.	5.0	5.0	5.0	5.0
Upper Qty.	10.0	10.0	10.0	10.0
Highest Median Repair Time (Days)	1.53	15.68	22.94	4.4
Lowest Median Repair Time (Days)	0.46	4.7	6.88	1.32
β (COV)	0.86	0.41	0.51	0.36

Table 6.12.6. Life safety information.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	No	No
Unsafe Placard Median	–	–	–	–
Unsafe Placard β	–	–	–	–

6.13 D2021.014a #1: (D2021.014a) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY

NISTIR Classification	D2021.014a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.13.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.13.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.13.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	2.25	4.1
β	0.4	0.4

Table 6.13.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Cost Median	$444	$4,055
Lowest Cost Median	$363	$3,317
β (COV)	0.76	0.41

Table 6.13.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.34	3.09
Lowest Median Repair Time (Days)	0.28	2.53
β (COV)	0.8	0.48

Table 6.13.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.14 D2021.014b #1: (D2021.014b) Cold or Hot Potable - Small Diameter Threaded Steel - (2.5 inches in diameter or less), SDC D, E, or F (OSHPD or sim), BRACING FRAGILITY

NISTIR Classification	D2021.014b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.14.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.14.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Lateral Brace Failure - 1 failure per 1000 feet of pipe.	Replace failed lateral braces. One repair per 1000 LF.	Not Available

Table 6.14.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.14.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	3.0
Upper Qty.	10.0
Highest Cost Median	$581
Lowest Cost Median	$476
β (COV)	0.6

Table 6.14.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	3.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.44
Lowest Median Repair Time (Days)	0.36
β (COV)	0.65

Table 6.14.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.15 D2021.024a #1: (D2021.024a) Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), PIPING FRAGILITY

NISTIR Classification	D2021.024a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.15.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.15.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Minor leakage at flange connections - 1 leak per 1000 feet of pipe.	Retighten flange bolts at leaking joints. One joint per 1000 LF.	Not Available
DS2	Pipe Break - 1 break per 1000 feet of pipe.	Replace 20 foot sections of pipe where breaks occur. One repair per 1000 LF.	Not Available

Table 6.15.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	2.25	4.1
β	0.4	0.4

Table 6.15.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$974	$9,319
Lowest Cost Median	$292	$2,796
β (COV)	0.65	0.4

Table 6.15.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.74	7.09
Lowest Median Repair Time (Days)	0.22	2.13
β (COV)	0.7	0.47

Table 6.15.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.16 D2021.024b #1: (D2021.024b) Cold or Hot Potable Water Piping (dia > 2.5 inches), SDC D,E,F (OSPHD or sim), BRACING FRAGILITY

NISTIR Classification	D2021.024b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.16.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.16.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Lateral Brace Failure - 1 failure per 1000 feet of pipe.	Replace failed lateral braces. One repair per 1000 LF.	Not Available
DS2	Vertical Brace Failure - 1 failure per 1000 feet of pipe	Replace failed vertical braces. One repair per 1000 LF.	Not Available

Table 6.16.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	**DS2**
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.16.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Cost Median	$974	$974
Lowest Cost Median	$292	$292
β (COV)	0.65	0.65

Table 6.16.5. Parameters for the repair time distributions.

	DS1	**DS2**
Distribution Type	LogNormal	LogNormal
Lower Qty.	5.0	5.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.74	0.74
Lowest Median Repair Time (Days)	0.22	0.22
β (COV)	0.7	0.7

Table 6.16.6. Life safety information.

	DS1	**DS2**
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.17 D2031.014b #1: (D2031.014b) Sanitary Waste Piping - Cast Iron w/flexible couplings, SDC D,E,F (OSHPD or sim), BRACING FRAGILITY

NISTIR Classification	D2031.014b
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Piping
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.17.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.17.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Isolated support failure w/o leakage - 0.5 support failures per 1000 feet of pipe (assuming supports every 20 feet).	Replace failed supports.	Not Available

Table 6.17.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	3
β	0.5

Table 6.17.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Cost Median	$1,113
Lowest Cost Median	$334
β (COV)	0.58

Table 6.17.5. Parameters for the repair time distributions.

	DS1
Distribution Type	LogNormal
Lower Qty.	5.0
Upper Qty.	10.0
Highest Median Repair Time (Days)	0.85
Lowest Median Repair Time (Days)	0.25
β (COV)	0.63

Table 6.17.6. Life safety information.

	DS1
Non-collapse casualties	No
Affected Area	– –
Serious Injury Median	–
Serious Injury β	–
Loss of Life Median	–
Loss of Life β	–
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.18 D3032.013c #1: (D3032.013c) Compressor - Capacity: Small non medical air supply - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility

NISTIR Classification	D3032.013c
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.18.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.18.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Anchorage failure.	Repair anchorage and concrete pad and re-mount equipment.	
DS1b	Anchorage failure & Equipment damaged beyond repair.	Replace equipment including attached utilities in addition to repairing anchorage and concrete pad.	Not Available
DS1c	Motor damaged but anchorage is OK.	Repair Motor - Anchorage and Concrete do not require repair.	Not Available
DS1d	Equipment damaged beyond repair but anchorage is OK.	Replace and install equipment including new anchorage if anchorage is post-installed.	Not Available

Table 6.18.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.	Mut. Excl.
Probability	0.35	0.15	0.25	0.25
Median	2.046	2.046	2.046	2.046
β	0.5	0.5	0.5	0.5

Table 6.18.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0	5.0
Highest Cost Median	$689	$4,820	$1,148	$4,820
Lowest Cost Median	$563	$3,943	$939	$3,943
β (COV)	0.55	0.26	0.17	0.26

Table 6.18.5. Parameters for the repair time distributions.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Distribution Type	LogNormal	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0	5.0
Highest Median Repair Time (Days)	0.58	1.48	0.97	4.08
Lowest Median Repair Time (Days)	0.48	0.74	0.79	3.34
β (COV)	0.6	0.36	0.3	0.36

Table 6.18.6. Life safety information.

	DS1a	**DS1b**	**DS1c**	**DS1d**
Non-collapse casualties	No	No	No	No
Affected Area	– –	– –	– –	– –
Serious Injury Median	–	–	–	–
Serious Injury β	–	–	–	–
Loss of Life Median	–	–	–	–
Loss of Life β	–	–	–	–
Can Cause Red Tag	No	No	No	No
Unsafe Placard Median	–	–	–	–
Unsafe Placard β	–	–	–	–

6.19 D3041.011d #1: (D3041.011d) HVAC Galvanized Sheet Metal Ducting less than 6 sq. ft in cross sectional area, SDC D, E, or F (OSHPD or sim)

NISTIR Classification	D3041.011d
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.19.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.19.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Individual supports fail and duct sags - 1 failed support per 1000 feet of ducting.	Replace failed supports and repair ducting in vicinity of failed supports.	Not Available
DS2	Several adjacent supports fail and sections of ducting fall - 60 feet of ducting fail and fall per 1000 foot of ducting.	Replace sections of failed ducting and supports.	Not Available

Table 6.19.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.5	2.25
β	0.4	0.4

Table 6.19.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$995	$9,716
Lowest Cost Median	$814	$7,949
β (COV)	0.37	0.1

Table 6.19.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	0.84	2.99
Lowest Median Repair Time (Days)	0.69	1.49
β (COV)	0.44	0.27

Table 6.19.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	Yes
Affected Area	– –	15.0 SF
Serious Injury Median	–	0.05
Serious Injury β	–	0.5
Loss of Life Median	–	0.0
Loss of Life β	–	0.0
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.20 D3041.012d #1: (D3041.012d) HVAC Galvanized Sheet Metal Ducting - 6 sq. ft cross sectional area or greater, SDC D, E, or F (OSHPD or sim)

NISTIR Classification	D3041.012d
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.20.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.20.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Individual supports fail and duct sags - 1 failed support per 1000 feet of ducting.	Replace failed supports and repair ducting in vicinity of failed supports.	Not Available
DS2	Several adjacent supports fail and sections of ducting fall - 60 feet of ducting fail and fall per 1000 foot of ducting.	Replace sections of failed ducting and supports.	Not Available

Table 6.20.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	3.75	4.5
β	0.4	0.4

Table 6.20.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Cost Median	$1,454	$12,164
Lowest Cost Median	$1,189	$9,952
β (COV)	0.26	0.08

Table 6.20.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	1.0	1.0
Upper Qty.	5.0	5.0
Highest Median Repair Time (Days)	1.23	3.74
Lowest Median Repair Time (Days)	1.01	1.87
β (COV)	0.36	0.26

Table 6.20.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	Yes
Affected Area	– –	50.0 SF
Serious Injury Median	–	0.1
Serious Injury β	–	0.5
Loss of Life Median	–	0.0
Loss of Life β	–	0.0
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

6.21 D3041.032d #1: (D3041.032d) HVAC Drops / Diffusers without ceilings - supported by ducting only - No independent safety wires, SDC D, E, or F (OSHPD or sim)

NISTIR Classification	D3041.032d
Author	Not Given
Normalized Unit	10.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.21.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.21.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	HVAC drops or diffusers dislodges and falls.	Replace diffuser/drop and sections of ceiling and ducting in vicinity to which diffuser/drop is connected.	Not Available

Table 6.21.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1
Type	Sequential
Probability	–
Median	1.5
β	0.4

Table 6.21.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Cost Median	$4,590
Lowest Cost Median	$3,756
β (COV)	0.21

Table 6.21.5. Parameters for the repair time distributions.

	DS1
Distribution Type	Normal
Lower Qty.	1.0
Upper Qty.	5.0
Highest Median Repair Time (Days)	3.88
Lowest Median Repair Time (Days)	3.18
β (COV)	0.32

Table 6.21.6. Life safety information.

	DS1
Non-collapse casualties	Yes
Affected Area	4.0 SF
Serious Injury Median	0.1
Serious Injury β	0.5
Loss of Life Median	0.0
Loss of Life β	0.0
Can Cause Red Tag	No
Unsafe Placard Median	–
Unsafe Placard β	–

6.22 D3041.103c #1: (D3041.103c) HVAC Fan - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility

NISTIR Classification	D3041.103c
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.22.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.22.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Anchorage failure.	Repair anchorage and remount equipment.	
DS1b	Anchorage failure & Equipment damaged beyond repair.	Repair anchorage and replace equipment.	Not Available
DS1c	Damaged, Inoperative but anchorage is OK	Repair equipment.	Not Available

Table 6.22.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS1c
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.
Probability	0.35	0.15	0.5
Median	1.066	1.066	1.066
β	0.5	0.5	0.5

Table 6.22.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS1c
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0
Highest Cost Median	$1,071	$5,126	$4,055
Lowest Cost Median	$876	$4,194	$3,317
β (COV)	0.34	0.18	0.14

Table 6.22.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS1c
Distribution Type	LogNormal	LogNormal	LogNormal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0
Highest Median Repair Time (Days)	0.91	0.79	3.43
Lowest Median Repair Time (Days)	0.74	0.2	2.81
β (COV)	0.42	0.31	0.29

Table 6.22.6. Life safety information.

	DS1a	DS1b	DS1c
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.23 D3067.012c #1: (D3067.012c) Control Panel - Capacity: all - Equipment that is either hard anchored or is vibration isolated with seismic snubbers/restraints - Combined anchorage/isolator & equipment fragility

NISTIR Classification	D3067.012c
Author	Not Given
Normalized Unit	1.0 each
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	1
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	HVAC
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.23.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.23.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1a	Anchorage failure.	Repair anchorage and concrete pad and remount equipment.	Not Available
DS1b	Anchorage failure & Equipment damaged beyond repair.	Replace equipment including attached utilities in addition to repairing anchorage and concrete pad.	
DS1c	Damaged, Inoperative but anchorage is OK	Replace some components (relays, circuit boards	Not Available

Table 6.23.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1a	DS1b	DS1c
Type	Mut. Excl.	Mut. Excl.	Mut. Excl.
Probability	0.35	0.15	0.5
Median	1.598	1.598	1.598
β	0.5	0.5	0.5

Table 6.23.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1a	DS1b	DS1c
Distribution Type	Normal	Normal	Normal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0
Highest Cost Median	$765	$7,115	$6,350
Lowest Cost Median	$626	$5,821	$5,195
β (COV)	0.28	0.19	0.18

Table 6.23.5. Parameters for the repair time distributions.

	DS1a	DS1b	DS1c
Distribution Type	Normal	Normal	Normal
Lower Qty.	1.0	1.0	1.0
Upper Qty.	5.0	5.0	5.0
Highest Median Repair Time (Days)	0.24	6.02	5.37
Lowest Median Repair Time (Days)	0.12	4.92	4.39
β (COV)	0.38	0.32	0.31

Table 6.23.6. Life safety information.

	DS1a	DS1b	DS1c
Non-collapse casualties	No	No	No
Affected Area	– –	– –	– –
Serious Injury Median	–	–	–
Serious Injury β	–	–	–
Loss of Life Median	–	–	–
Loss of Life β	–	–	–
Can Cause Red Tag	No	No	No
Unsafe Placard Median	–	–	–
Unsafe Placard β	–	–	–

6.24 D4011.024a #1: (D4011.024a) Fire Sprinkler Water Piping - Horizontal Mains and Branches - Old Style Victaulic - Thin Wall Steel - with designed bracing, SDC D, E, or F (OSHPD or sim), PIPING FRAGILITY

NISTIR Classification	D4011.024a
Author	Not Given
Normalized Unit	1000.0 lf
Engineering Demand Parameter	Peak Floor Acceleration
Number of Damage States	2
Is correlated?	No
Is directional?	No

Component modifications applied:

Component Group	Other Nonstructural
Quantity Scale Factor	1.0
Damage Median Scale Factor	1.0
Total Cost Scale Factor	1.391
User cost modification factor	1.0
Regional Cost Scale Factor	1
Date multiplier (to convert from 2011 USD)	1.391
Occupancy Cost Scale Factor	1
Building Value Cost Scale Factor	1

Table 6.24.1. Per-level fragility modifications (applied in addition to the values shown for the fragility).

Location	Cost	Time	Capacity
G-R	1	1	1

Table 6.24.2. Damage state progression.

Damage State	Description	Repair Description	Image
DS1	Spraying & Dripping Leakage at joints - 0.02 leaks per 20 ft section of pipe.	Replace leaking joints and minor water cleanup.	Not Available
DS2	Joints Break - Major Leakage - 0.02 breaks per 20 ft section of pipe.	Replace 20 ft section of pipe, joints and major water cleanup at leaking joints.	Not Available

Table 6.24.3. Parameters for the damage state distributions. The medians reflect a scale factor of **1.0** applied to the default values.

	DS1	DS2
Type	Sequential	Sequential
Probability	–	–
Median	1.9	3.4
β	0.4	0.4

Table 6.24.4. Parameters for the cost distributions. The cost values reflect a total scale factor of **1.391** applied to the default values. This scale factor includes the user input scale factor, a regional scale factor, an occupancy scale factor, building value scale factor, and scale factor to convert the initial 2011 cost estimate to modern day costs.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Cost Median	$536	$4,055
Lowest Cost Median	$438	$3,317
β (COV)	0.65	0.41

Table 6.24.5. Parameters for the repair time distributions.

	DS1	DS2
Distribution Type	LogNormal	LogNormal
Lower Qty.	3.0	3.0
Upper Qty.	10.0	10.0
Highest Median Repair Time (Days)	0.45	0.94
Lowest Median Repair Time (Days)	0.37	0.31
β (COV)	0.7	0.48

Table 6.24.6. Life safety information.

	DS1	DS2
Non-collapse casualties	No	No
Affected Area	– –	– –
Serious Injury Median	–	–
Serious Injury β	–	–
Loss of Life Median	–	–
Loss of Life β	–	–
Can Cause Red Tag	No	No
Unsafe Placard Median	–	–
Unsafe Placard β	–	–

7 DISCLAIMER