Calculation Sheet

ARUP

Job title	VA Iron Mountain Expand Pharmacy and Radiology	Job number	Sheet number	Revision
Calc title	100% CD Blast Calculations	Member/Location		
		Drg. Ref.		
		Made by BL	Date 11/29/2022	Chd. DB

1 Introduction

These calculations document the blast analyses performed for the VA Iron Mountain, Expand Pharmacy and Radiology in support of the 100% CD submittal. According to the Physical Security and Resilience Design Manual (PSRDM), space used for Security and Law Enforcement, and Imaging Center (inpatient) are considered Mission Critical (MC) facilities. Pharmacies are not explicitly listed in the designation lists and would therefore be proposed as a Life Safety (LS) facility with MC utilities. However, since the pharmacy shares the same building structure as the Police expansion, the entire structure will be designed for MC requirements. Assumptions including blast loading and response limits are per the PSRDM, unless noted otherwise.

These calculations supplement the Physical Security Basis of Design Narrative and contain sensitive information about vulnerabilities of the building. Neither this calculation set, nor the Physical Security Basis of Design Narrative should be provided to the Contractor or its subcontractors without written consent of the VA. All blast requirements detailed in these documents have been incorporated into the contract documents (drawings and specifications).

1.1 Software

Arup's in-house software, Oasys Ergo v.2.4 has been used for SDOF analysis. Ergo has been accepted as suitable for blast analysis by government organisations such as the Centre for Protection of National Infrastructure (CPNI), the US Army Corps of Engineers and the Ministry of Home Affairs in Singapore.

For dynamic glass analysis, Wingard PE© v. 5.5 has been used. WINGARD PE© is a software program developed by Applied Research Associates, Inc. under contract with the United States General Services Administration.

1.2 Blast Loads

A summary of the blast loads used are shown in Table 1.

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Table 1 Loading Summary

Location	**Governing Load**	**Pressure (psi)**	**Impulse (psi-ms)**
Police / Pharmacy Main Building Roof (CL A.1)	W2 @ Actual Standoff (incident)	53.38	100.88
Police / Pharmacy Main Building Roof (CL C.4)	W2 @ Actual Standoff (incident)	13.90	57.67
Radiology Main Building Roof	W2 @ Actual Standoff (incident)	20.20	67.46
Police / Pharmacy Penthouse Roof	W2 @ Actual Standoff (incident)	8.70	46.82
Radiology Penthouse Roof	W2 @ Actual Standoff (incident)	5.54	37.41
Police / Pharmacy Main Building Exterior Wall North Elevation Along CL A.1	W1 @ Actual Standoff (reflected)	233.00	182.43
Police / Pharmacy Main Building Exterior Wall North Elevation Along CL C.1	W1 @ Actual Standoff (reflected)	19.66	63.01
Police / Pharmacy Main Building Exterior Wall West Elevation	W1 @ Actual Standoff (reflected)	214.29	65.66
Police / Pharmacy Main Building Exterior Wall West Elevation (at window)	W1 @ Actual Standoff (reflected)	25.47	54.16
Police / Pharmacy Penthouse Exterior Wall	GP2	13.50	51.00
Radiology Main Building Exterior Wall North Elevation	W1 @ Actual Standoff (reflected)	81.90	12.85
Radiology Main Building Exterior East North Elevation	W1 @ Actual Standoff (reflected)	48.52	95.88
Radiology Penthouse Exterior Wall	GP2	13.50	51.00

2 Calculations

- 2.1 Roof Design
- 2.2 Exterior Wall Design
- 2.3 Façade Design

2.1 Roof Design

2.1.1 Performance Criteria

Both the main roof and the mechanical penthouse have been designed for blast loading. The following threats have been considered for each element:

- Main Roof: W2 @ actual standoff and 13 ft below roof
- Mechanical Penthouse Roof: W2 @ actual standoff and 26 ft below roof

The analysis was based on the following load assumptions, as provided from the structural drawings:

- Roof Superimposed Dead Load: 35 psf

  Penthouse Roof Superimposed Dead Load: 30 psf
- Roof Live Load: 20 psf

  Penthouse Roof Live Load: 20 psf
- Roof Snow Load: 51 psf

  Penthouse Roof Snow Load: 51 psf

The total superimposed load is taken as the governing of 0.9D + 0.5L and 0.9D + 0.2S. This was taken into account in addition to the blast loads outlined previously for the analysis of the roof members.

2.1.1.1 Main Roof

The current design of the main roof system consists of 4” of lightweight concrete on a 2” metal deck with a steel framed beam and column system. Roof beams are composite with shear studs. The roof system acts as a diaphragm and contributes to the overall stability of the structure.

Therefore, it is treated as part of the building's main lateral resisting system and is considered a part of the primary structure. The level of protection required by PSRDM in response to a blast load on a primary structural element in a mission critical facility is superficial damage. This corresponds to a maximum ductility ratio of 1 for compact steel beams and reinforced concrete flexural elements.

It is assumed that the composite roof slab-on-deck provides continuous bracing to the top flange of the roof beams against lateral torsional buckling. The bottom flange is assumed unbraced.

2.1.1.2 Penthouse Roof

The penthouse roof will be constructed of a 3" metal deck with no concrete, connected to the roof beams with puddle welds. The penthouse roof system acts as a diaphragm and encloses critical equipment. Therefore, it is considered a part of the secondary structure. The level of protection required by PSRDM in response to a blast load on a secondary structural element in a mission critical facility is moderate damage. For one-way corrugated metal decks, this corresponds to a rotation limit of 1º.

It is assumed that the roof deck provides continuous bracing to the top flange of the roof beams against lateral torsional buckling. The bottom flange is assumed unbraced.

2.1.2 Analysis Results

2.1.2.1 Roof Deck

The uplift reaction from the decks to the beams have been provided for the SEOR's design of the shear studs and puddle welds in tension. The downward reactions have also been provided, as well as the minimum amount of slab reinforcement required to resist the superimposed loads and blast loads. The results are summarized below:

Table 2 Roof Deck Construction and Reactions

Location	Deck	Ductility	Rotation	Downward Reaction (k/ft)	Uplift Reaction (k/ft)
Police / Pharmacy Main Building Roof Deck	Slab 6" Thick – 4" LWC above deck: 2" X 16 GA Metal Deck with #7 rebar in the lower deck grooves @ 12" o.c.	0.79	0.36	29.6	-25.3

Radiology Main Building Roof Deck	Slab 6” Thick – 4” LWC above deck: 2” X 16 GA Metal Deck with #7 rebar in the lower deck grooves @ 12” o.c.	0.58	0.14	30.4	-23
Police / Pharmacy Penthouse Roof Deck	16 Gauge 3N-24 Grade 40	.002	0.83	4.8	-4.8
Radiology Penthouse Roof Deck	16 Gauge 3N-24 Grade 40	.002	0.83	4.8	-4.8

2.1.2.2 Main Roof Beams and Girders

For beams and girders oriented in the North-South direction, Reaction 1 is the “North” reaction and Reaction 2 is the “South” reaction. For beams and girders oriented in the East-West direction, Reaction 1 is the “West” reaction and Reaction 2 is the “East” reaction. See below for an example of this.

Job title	VA Iron Mountain Expand Pharmacy and Radiology	Job number	Sheet number	Revision
Calc title	100% CD Blast Calculations	Member/Location		
		Drg. Ref.		
		Made by BL	Date 11/29/2022	Chd. DB

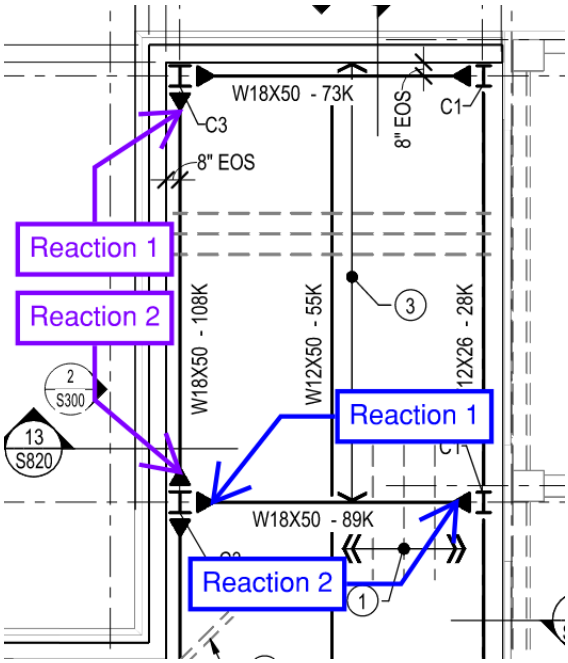

Figure 1 Beam and Girder Reaction Numbering Example

Reactions for the beams and girders have been provided for design of the connections. Note that the connections need to be able to resist the reactions provided in both directions, downward and uplift.

Table 3 Police / Pharmacy Roof Beams and Girders Sizes and Reactions

Member Size	Type	Location	Ductility	Downward Reaction (kip)	Uplift Reaction 1 (kip)	Downward Reaction 2 (kip)	Uplift Reaction 2 (kip)
W18X50	Beam	Along 20.2, from A.1-C.2	0.95	107.7	-107.4	107.7	-107.4
W12X50	Beam	Between 20.2 & 21.2 from A.1-C.2	0.99	54.9	-54.7	54.9	-54.7
W12X26	Beam	Along 21.2, from A.1-C.2	0.98	27.9	-27.8	27.9	-27.8

W18X50	Beam	Along 20.2, from C.2-E.01	0.54	54.8	-54.6	54.8	-54.6
W12X35	Beam	Between 20.2 & 21.2 from C.2-E.01	0.96	46.8	-36.4	46.8	-36.4
W12X26	Beam	Along 21.2, from C.2-E.01	0.41	9.8	-9.8	9.8	-9.8
W12X19	Beam	Along 18, from C.4-E.01	0.97	29.3	-29.2	29.3	-29.2
W18X50	Beam	Between 19.1 & 20 from C.4-E.01	0.45	88.5	-71.0	88.5	-71.0
W18X50	Girder	Along A.1, from 20.2-21.2	0.53	72.7	-70.1	72.7	-70.1
W18X50	Girder	Along C.2, from 20.2-21.2	0.70	88.9	-88.4	88.9	-88.4
W18X76	Girder	Along C.4, from 18-20.2	0.13	*	*	*	*
W12X40	Girder	Along D, from 18-20.2	0.22	31.2	-26.0	31.2	-26.0
W12X43	Girder	Along D, from 20.2-21.2	0.38	*	*	*	*
W18X35	Girder	Along E.01, from 18-19.1	0.66	45.9	-45.8	45.9	-45.8
W14X22	Girder	Along E.01, from 19.1-17.3	0.45	21.4	-21.3	21.4	-21.3

Notes:

* Design connections to resist reactions produced when element is loaded to maximum flexural capacity under a uniformly distributed load.

Table 4 Radiology Roof Beams and Girders Sizes and Reactions

Member Size	Type	Location	Ductility	Downward Reaction 1 (kip)	Uplift Reaction 1 (kip)	Downward Reaction 2 (kip)	Uplift Reaction 2 (kip)
W12X19	Beam	Between 27 & 31 from A.5-C.3	0.83	14.5	-13.0	14.5	-13.0
W24X62	Beam	Between 20.2 & 21.2 from A.5-C.3	0.70	108.6	-13.0	108.6	-13.0
W12X19	Beam	Between 20.2 & 21.2 from C.3-E.01	0.83	14.5	-13.0	14.5	-13.0
W24X62	Beam	Between 20.2 & 21.2 from C.3-E.01	0.19	52.6	-13.0	52.6	-13.0
W16X31	Beam	Between 20.2 & 21.2 from C.3-E.01	0.43	27.5	-27.5	27.5	-27.5
W24X68	Girder	Along A.5, from 27 - 30.5	0.99	*	*	*	*
W24X62	Girder	Along A.5, from 30.5-30.9	0.91	418.5	-304.1	418.5	-304.1
W24X68	Girder	Along C.3, from 27 - 30.5	0.92	*	*	*	*
W24X62	Girder	Along C.3, from 30.5-30.9	0.91	418.5	-304.1	418.5	-304.1

W12X40	Girder	Along E, from 27 - 30.9	0.17	28.2	-14.2	28.2	-14.2
W24X104	Girder	Along E.02, from 27 -30.5	0.56	*	*	*	*
W24X62	Girder	Along E.02, from 30.5-30.9	0.91	418.5	-304.1	418.5	-304.1

Notes:

* Design connections to resist reactions produced when element is loaded to maximum flexural capacity under a uniformly distributed load.

2.1.2.3 Penthouse Beams and Girders

Reactions for the beams and girders have been provided for design of the connections. Note that the connections need to be able to resist the reactions provided in both directions, downward and uplift.

Table 5 Police / Pharmacy Penthouse Roof Beams and Girders Sizes and Reactions

Member Size	Type	Location	Ductility	Downward Reaction 1 (kip)	Uplift Reaction 1 (kip)	Downward Reaction 2 (kip)	Uplift Reaction 2 (kip)
W14X22	Beam	Along 17.3 & 21.2, from E.01-E.8	0.74	23.9	-23.4	23.9	-23.4
W12X16	Beam	Between 17.3 & 21.2, from E.01-E.8	0.74	17.8	-77.3	17.8	-77.3
W18X50	Beam	Along 19.1 & 20.2, from E.01-E.8	0.71	109.5	-51.1	109.5	-51.1
W12X19	Beam	Along 20.2 & 21.2, from E.01-E.8	0.65	18.2	-12.8	18.2	-12.8
W14X22	Girder	Along E.01 and E.8	0.84	29.2	-29.1	29.2	-29.1

W16X31	Girder	Along E.01, from 19.1-20.2	0.58	32.5	-32.4	32.5	-32.4
W18X40	Girder	Along E.8, from 19.1-20.2	0.98	95.7	-68.2	95.7	-68.2

Notes:

[a] For beams and girders oriented in the N-S direction, Reaction 1 is the "North" reaction and Reaction 2 is the "South" reaction. For beams and girders oriented in the East-West direction, Reaction 1 is "West" reaction and Reaction 2 is the "East Direction".

Table 6 Radiology Penthouse Roof Beams and Girders Sizes and Reactions

Member Size	Type	Location	Ductility	Downward Reaction 1 (kip)	Uplift Reaction 1 (kip)	Downward Reaction 2 (kip)	Uplift Reaction 2 (kip)
W12X26	Beam	Along 27, from E.02-E.9	0.63	22.1	-21.9	22.1	-21.9
W12X14	Beam	Between 28.8 & 30.5, from E.02-E.9	0.66	13.4	-8.9	13.4	-8.9
W18X50	Beam	Along 29.4 & 30.5, from E.02-E.9	0.48	73.2	-34.4	73.2	-34.4
W12X19	Beam	Between 30.5 & 30.9, from E.02-E.9	0.43	9.9	-9.1	9.9	-9.1
W12X19	Girder	Along 30.9, from E.02-G	0.93	15.8	-14.1	48.3	-37.5
W12X14	Girder	Between 29.4 & 30.5, from E.9-G	0.66	13.4	-8.9	13.4	-8.9
W18X50	Girder	Along 29 & 29.5, from E.9-G	0.41	83.8	-46.2	N/A	N/A

W16X26	Girder	Along E.02, from 27-29.4	0.52	36.9	-16.3	106.7	-16.3
W18X40	Girder	Along E.02, from 29.4-30.5	0.75	74.7	-39.7	74.7	-39.7
W12X14	Girder	Along E.02, from 30.5-30.9	0.69	24.4	-24.4	24.4	-24.4
W30X90	Girder	Along E.9, from 27-30.9	0.22	125.5	-59.0	166.6	-59.0
W12X14	Beam	Along G, from 27-30.5	0.8	8.1	-7.2	29.0	-7.2
W12X14	Beam	Along G, from 30.5-30.9	0.69	15.7	-11.7	N/A	N/A

Notes:

[a] For beams and girders oriented in the N-S direction, Reaction 1 is the "North" reaction and Reaction 2 is the "South" reaction. For beams and girders oriented in the East-West direction, Reaction 1 is "West" reaction and Reaction 2 is the "East Direction".

2.1.3 Police / Pharmacy Main Building Roof Slab, Example

A 6-inch concrete on 16 GA metal deck with #7 rebar in the lower deck grooves @ 12" o.c. was analyzed as an equivalent reinforced concrete section.

Titles

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Job number:           Initials:           27-Dec-2021
Job Title:
Subtitle:
Calc. heading:
File:                 2in_16GA_w_4in_LWC_wnum7_12in_oc_Police_Pharm.ergo
Written by version:   2.4.0.9
```

Element

Span	7.330ft
Loaded width, w	1.000ft
Section	Explicit
Bending axis	Major
Second moment of area, I_{xx}	**51.39in4**
Second moment of area, I_{yy}	51.39in4
Zuser	**5.360in³**
Zuser	5.360in³
Added mass per unit length	35.00lb/ft
Mass per unit length	45.83lb/ft

Total mass per unit length	80.83lb/ft
Total mass	592.5lb
Elastic modulus, E	29010.ksi
Material yield stress	60.00ksi
Static yield stress, $\sigma_{y,stat}$	60.00ksi
Dynamic yield stress, $\sigma_{y,dyn}$	70.20ksi
Dynamic factor	1.170
Damping ratio, ζ	0.05000
Boundary condition	Propped cantilever - distributed load

Resistance Function

Displacement [in]	Resistance [kip]
-0.6657	-67.31
-0.3046	-45.11
0.0	0.0
0.2949	43.67
0.6559	65.87

Load

Load type	Shock front
Peak force	58.12psi
End time	0.0ms

Time [ms]	Load [kip]
0.0	61.35
3.594	0.0

Summary

R_{ult}	65.87kip
K_{elas} +ve	1777.kip/ft
K_{elas} -ve	1777.kip/ft
Mass	592.5lb
Frequency	55.98Hz
Period, T	17.86ms
Load period, t_d	3.594ms
t_d/T	0.2012

Signed absolute maximum

	Value	At
Displacement	0.2321in	5.500ms
Plastic displacement	0.0in	0.0ms
Velocity	-6.302ft/s	9.900ms
Acceleration	4271.ft/s²	0.0ms
Ductility	0.7869	5.500ms
Resistance	34.37kip	5.500ms
Reaction at left end	14.78kip	5.500ms
Reaction at right end	8.935kip	5.500ms
Reaction (total)	23.71kip	5.500ms
Rotation at left end	0.2613°	5.500ms
Rotation at right end	0.3586°	5.500ms

Maximum

	Value	At
Displacement	0.2321in	5.500ms
Plastic displacement	0.0in	0.0ms
Velocity	5.572ft/s	2.500ms
Acceleration	4271.ft/s²	0.0ms

Ductility	0.7869	5.500ms
Resistance	34.37kip	5.500ms
Reaction at left end	14.78kip	5.500ms
Reaction at right end	8.935kip	5.500ms
Reaction (total)	23.71kip	5.500ms
Rotation at left end	0.2613°	5.500ms
Rotation at right end	0.3586°	5.500ms

Minimum

	Value	At
Displacement	-0.1983in	14.50ms
Plastic displacement	0.0in	0.0ms
Velocity	-6.302ft/s	9.900ms
Acceleration	-2404.ft/s²	5.200ms
Ductility	0.0	0.0ms
Resistance	-29.37kip	14.50ms
Reaction at left end	-12.63kip	14.50ms
Reaction at right end	-7.635kip	14.50ms
Reaction (total)	-20.26kip	14.50ms
Rotation at left end	-0.2583°	14.50ms
Rotation at right end	-0.2583°	14.50ms

2.1.4 Radiology Penthouse Roof Deck, Example

Titles

Job number: Initials: 27-Dec-2021
Job Title:
Subtitle:
Calc. heading:
File: Radiology_16_Guage_3N-24_Grade_40.ergo
Written by version: 2.4.0.9

Element

Span	7.420ft
Loaded width, w	1.000ft
Section	Explicit
Bending axis	Major
Second moment of area, I_{xx}	**1.682in4**
Second moment of area, I_{yy}	1.682in4
Zuser	**734.6in³**
Zuser	734.6in³
Added mass per unit length	35.00lb/ft
Mass per unit length	4.100lb/ft
Total mass per unit length	39.10lb/ft
Total mass	290.1lb
Elastic modulus, E	29010.ksi
Material yield stress	51.49ksi
Static yield stress, $\sigma_{y,stat}$	51.49ksi
Dynamic yield stress, $\sigma_{y,dyn}$	60.24ksi
Dynamic factor	1.170
Damping ratio, ζ	0.001000
Boundary condition	Propped cantilever - distributed load

Resistance Function

Displacement Resistance
[in] [kip]

-685.5	-5964.
-311.0	-3976.
0.0	0.0
310.9	3976.
685.4	5964.

Load

Load type	Shock front
Peak force	8.954psi
End time	0.0ms

Time [ms]	Load [kip]
0.0	9.567
10.59	0.0

Summary

R_{ult}	5964.kip
K_{elas} +ve	153.4kip/ft
K_{elas} -ve	153.4kip/ft
Mass	290.1lb
Frequency	23.51Hz
Period, T	42.54ms
Load period, t_d	10.59ms
t_d/T	0.2490

Signed absolute maximum

	Value	At
Displacement	0.5457in	14.10ms
Plastic displacement	0.0in	0.0ms
Velocity	-6.706ft/s	24.80ms
Acceleration	1360.ft/s²	0.0ms
Ductility	0.001755	14.10ms
Resistance	6.977kip	14.10ms
Reaction at left end	3.000kip	14.10ms
Reaction at right end	1.814kip	14.10ms
Reaction (total)	4.814kip	14.10ms
Rotation at left end	-0.7000°	35.40ms
Rotation at right end	0.8330°	14.10ms

Maximum

	Value	At
Displacement	0.5457in	14.10ms
Plastic displacement	0.0in	0.0ms
Velocity	6.685ft/s	46.00ms
Acceleration	1360.ft/s²	0.0ms
Ductility	0.001755	14.10ms
Resistance	6.977kip	14.10ms
Reaction at left end	3.000kip	14.10ms
Reaction at right end	1.814kip	14.10ms
Reaction (total)	4.814kip	14.10ms
Rotation at left end	0.6070°	14.10ms
Rotation at right end	0.8330°	14.10ms

Minimum

	Value	At
Displacement	-0.5440in	35.40ms
Plastic displacement	0.0in	0.0ms
Velocity	-6.706ft/s	24.80ms
Acceleration	-992.0ft/s²	14.10ms
Ductility	0.0	0.0ms

Resistance	-6.956kip	35.40ms
Reaction at left end	-2.991kip	35.40ms
Reaction at right end	-1.808kip	35.40ms
Reaction (total)	-4.799kip	35.40ms
Rotation at left end	-0.7000°	35.40ms
Rotation at right end	-0.7000°	35.40ms

2.1.5 Police / Pharmacy Main Building W18X50 Composite Beam, Example

The W18X50 beam is located Along 20.2, from C.2-E.01. The beam is analyzed by accounting for the shift of the neutral axis up due to the composite nature of the beam-deck system.

Titles

Job number:	Initials:	28-Dec-2021
Job Title:		
Subtitle:		
Calc. heading:		
File:	6_W18X50_20.2-C.2-E.01_Beam_Comp.ergo	
Written by version:	2.4.0.9	

Element

Span	21.79ft
Loaded width, w	7.816ft
Section	GEO P M(95.5|-105.354) L(95.5|-119.854) L(4.51|-119.854) L(4.51|-547.854) L(95.5|-547.854) L(95.5|-562.354) L(-95.5|-562.354) L(-95.5|-547.854) L(-4.51|-547.854) L(-4.51|-119.854) L(-95.5|-119.854) L(-95.5|-105.354)
Bending axis	Major
Second moment of area, I_{xx}	**793.2in4**
Second moment of area, I_{yy}	40.52in4
Plastic modulus, Z_{px}	**99.99in³**
Plastic modulus, Z_{py}	16.67in³
Added mass per unit length	219.0lb/ft
Mass per unit length	794.2lb/ft
Total mass per unit length	1013.lb/ft
Total mass	22080.lb
Elastic modulus, E	29010.ksi
Material yield stress	51.49ksi
Static yield stress, $\sigma_{y,stat}$	56.64ksi
Dynamic yield stress, $\sigma_{y,dyn}$	66.27ksi
Dynamic factor	1.170
Damping ratio, ζ	0.001000
Boundary condition	Fixed - distributed load

Resistance Function

Displacement Resistance

[in]	[kip]
-1.686	-427.6
-0.6603	-326.3
0.0	0.0
0.5704	281.9

1.596	383.2

Load

Load type	Shock front
Peak force	15.17psi
End time	0.0ms

Time [ms]	Load [kip]
0.0	372.0
7.886	0.0

Summary

R_{ult}	383.2kip
K_{elas} +ve	5929.kip/ft
K_{elas} -ve	5929.kip/ft
Mass	22080.lb
Frequency	16.86Hz
Period, T	59.31ms
Load period, t_d	7.886ms
t_d/T	0.1330

Signed absolute maximum

	Value	At
Displacement	0.3079in	17.44ms
Plastic displacement	0.0in	0.0ms
Velocity	-2.714ft/s	32.27ms
Acceleration	703.9ft/s²	0.0ms
Ductility	0.5398	17.44ms
Resistance	152.2kip	17.44ms
Reaction at left end	54.77kip	17.44ms
Reaction at right end	54.77kip	17.44ms
Reaction (total)	109.5kip	17.44ms
Rotation at left end	0.1349°	17.44ms
Rotation at right end	0.1349°	17.44ms

Maximum

	Value	At
Displacement	0.3079in	17.44ms
Plastic displacement	0.0in	0.0ms
Velocity	2.705ft/s	61.92ms
Acceleration	703.9ft/s²	0.0ms
Ductility	0.5398	17.44ms
Resistance	152.2kip	17.44ms
Reaction at left end	54.77kip	17.44ms
Reaction at right end	54.77kip	17.44ms
Reaction (total)	109.5kip	17.44ms
Rotation at left end	0.1349°	17.44ms
Rotation at right end	0.1349°	17.44ms

Minimum

	Value	At
Displacement	-0.3070in	47.10ms
Plastic displacement	0.0in	0.0ms
Velocity	-2.714ft/s	32.27ms
Acceleration	-287.9ft/s²	17.44ms
Ductility	0.0	0.0ms
Resistance	-151.7kip	47.10ms
Reaction at left end	-54.60kip	47.10ms
Reaction at right end	-54.60kip	47.10ms
Reaction (total)	-109.2kip	47.10ms

```
Rotation at left end     -0.1345°         47.10ms
Rotation at right end    -0.1345°         47.10ms
```

2.1.6 Police / Pharmacy Main Building W18X50 Composite Girder, Example

The W18X50 beam is located Along A.1, from 20.2-21.2. The beam is analyzed by accounting for the shift of the neutral axis up due to the composite nature of the beam-deck system.

Titles

```
Job number:           Initials:           28-Dec-2021
Job Title:
Subtitle:
Calc. heading:
File:                 9.1_W18X50_A.1-20.2-21.2_Girder_Comp.ergo
Written by version:   2.4.0.9
```

Element

Span	17.87ft
Loaded width, w	5.177ft
Section	GEO P M(95.5|-97.632) L(95.5|-112.132) L(4.51|-112.132) L(4.51|-540.132) L(95.5|-540.132) L(95.5|-554.632) L(-95.5|-554.632) L(-95.5|-540.132) L(-4.51|-540.132) L(-95.5|-112.132) L(-95.5|-97.632)
Bending axis	Major
Second moment of area, I_{xx}	**793.2in4**
Second moment of area, I_{yy}	40.52in4
Plastic modulus, Z_{px}	**99.99in³**
Plastic modulus, Z_{py}	16.67in³
Added mass per unit length	219.0lb/ft
Mass per unit length	794.2lb/ft
Total mass per unit length	1013.lb/ft
Total mass	18110.lb
Elastic modulus, E	29010.ksi
Material yield stress	51.49ksi
Static yield stress, $\sigma_{y,stat}$	56.64ksi
Dynamic yield stress, $\sigma_{y,dyn}$	66.27ksi
Dynamic factor	1.170
Damping ratio, ζ	0.001000
Boundary condition	Fixed - distributed load

Resistance Function

Displacement [in]	Resistance [kip]
-1.124	-512.5
-0.4344	-388.9
0.0	0.0
0.3937	352.5
1.084	476.0

Load

```
Load type                Shock front
```

Peak force 13.88psi
End time 0.0ms

Time [ms]	Load [kip]
0.0	185.0
8.297	0.0

Summary

R_{ult}	476.0kip
K_{elas} +ve	10740.kip/ft
K_{elas} -ve	10740.kip/ft
Mass	18110.lb
Frequency	48.67Hz
Period, T	20.55ms
Load period, t_d	8.297ms
t_d/T	0.4038

Signed absolute maximum

	Value	At
Displacement	0.2182in	7.800ms
Plastic displacement	0.0in	0.0ms
Velocity	-5.551ft/s	13.00ms
Acceleration	1695.ft/s²	18.10ms
Ductility	0.5342	7.800ms
Resistance	195.4kip	7.800ms
Reaction at left end	72.65kip	7.300ms
Reaction at right end	72.65kip	7.300ms
Reaction (total)	145.3kip	7.300ms
Rotation at left end	0.1166°	7.800ms
Rotation at right end	0.1166°	7.800ms

Maximum

	Value	At
Displacement	0.2182in	7.800ms
Plastic displacement	0.0in	0.0ms
Velocity	5.533ft/s	23.20ms
Acceleration	1695.ft/s²	18.10ms
Ductility	0.5342	7.800ms
Resistance	195.4kip	7.800ms
Reaction at left end	72.65kip	7.300ms
Reaction at right end	72.65kip	7.300ms
Reaction (total)	145.3kip	7.300ms
Rotation at left end	0.1166°	7.800ms
Rotation at right end	0.1166°	7.800ms

Minimum

	Value	At
Displacement	-0.2175in	18.10ms
Plastic displacement	0.0in	0.0ms
Velocity	-5.551ft/s	13.00ms
Acceleration	-1690.ft/s²	28.40ms
Ductility	0.0	0.0ms
Resistance	-194.7kip	18.10ms
Reaction at left end	-70.11kip	18.10ms
Reaction at right end	-70.11kip	18.10ms
Reaction (total)	-140.2kip	18.10ms
Rotation at left end	-0.1162°	18.10ms
Rotation at right end	-0.1162°	18.10ms

2.1.7 Radiology Penthouse W12X14 Beam, Example

The W12X14 beam is located between CL 29.9 and 30.5, from E.02-E.9.

Titles

Job number: Initials: 29-Dec-2021
Job Title:
Subtitle:
Calc. heading:
File: 2_W12X14_E.02-E.9_Beam.ergo
Written by version: 2.4.0.9

Element

Span	18.17ft
Loaded width, w	5.354ft
Section	CAT W W12x14
Bending axis	Major
Second moment of area, I_{xx}	**88.65in4**
Second moment of area, I_{yy}	2.359in4
Plastic modulus, Z_{px}	**17.39in³**
Plastic modulus, Z_{py}	1.898in³
Added mass per unit length	405.8lb/ft
Mass per unit length	14.11lb/ft
Total mass per unit length	419.9lb/ft
Total mass	7628.lb
Elastic modulus, E	29010.ksi
Material yield stress	51.49ksi
Static yield stress, $\sigma_{y,stat}$	56.64ksi
Dynamic yield stress, $\sigma_{y,dyn}$	66.27ksi
Dynamic factor	1.170
Damping ratio, ζ	0.001000
Boundary condition	Simple - distributed load

Resistance Function

Displacement Resistance

[in]	[kip]
-2.625	-50.04
0.0	0.0
1.812	34.54

Load

Load type Shock front
Peak force 8.690psi
End time 0.0ms

Time [ms]	**Load** [kip]
0.0	121.7
10.76	0.0

Summary

R_{ult}	34.54kip
K_{elas} +ve	228.8kip/ft
K_{elas} -ve	228.8kip/ft
Mass	7628.lb

Frequency	5.598Hz
Period, T	178.6ms
Load period, t_d	10.76ms
t_d/T	0.06024

Signed absolute maximum

	Value	At
Displacement	1.202in	48.23ms
Plastic displacement	0.0in	0.0ms
Velocity	-3.517ft/s	92.90ms
Acceleration	658.2ft/s²	0.0ms
Ductility	0.6633	48.23ms
Resistance	22.91kip	48.23ms
Reaction at left end	13.39kip	0.0ms
Reaction at right end	13.39kip	0.0ms
Reaction (total)	26.78kip	0.0ms
Rotation at left end	0.6318°	48.23ms
Rotation at right end	0.6318°	48.23ms

Maximum

	Value	At
Displacement	1.202in	48.23ms
Plastic displacement	0.0in	0.0ms
Velocity	3.506ft/s	182.2ms
Acceleration	658.2ft/s²	0.0ms
Ductility	0.6633	48.23ms
Resistance	22.91kip	48.23ms
Reaction at left end	13.39kip	0.0ms
Reaction at right end	13.39kip	0.0ms
Reaction (total)	26.78kip	0.0ms
Rotation at left end	0.6318°	48.23ms
Rotation at right end	0.6318°	48.23ms

Minimum

	Value	At
Displacement	-1.198in	137.6ms
Plastic displacement	0.0in	0.0ms
Velocity	-3.517ft/s	92.90ms
Acceleration	-123.9ft/s²	48.23ms
Ductility	0.0	0.0ms
Resistance	-22.84kip	137.6ms
Reaction at left end	-8.908kip	137.6ms
Reaction at right end	-8.908kip	137.6ms
Reaction (total)	-17.82kip	137.6ms
Rotation at left end	-0.6298°	137.6ms
Rotation at right end	-0.6298°	137.6ms

2.2 Exterior Wall Design

2.2.1 Performance Criteria

Both the main building and the penthouse walls have been designed for blast loading. The following threats have been considered for each element:

- Main Building Wall: W1 @ actual standoff

- Penthouse Wall: GP2

2.2.1.1 Main Building

The main building exterior walls are comprised of reinforced concrete. The following are assumptions for the exterior wall.

- 4 ksi strength, normal weight concrete
- 10” thick concrete
- 60 ksi strength reinforcing rebar
- Non-load bearing
- Not part of main lateral resistance system
- Cladding weight consists of glazing system and/or brick (40 psf)
- The base of the first-floor wall is connected to the slab to create a fixed end condition

As the reinforced concrete is not part of the main lateral force resisting system, it has a moderate damage level of protection for the blast loading and a heavy damage level of protection for a balanced design. Therefore, the maximum allowable rotation is 2 degrees under the blast load.

2.2.1.2 Penthouse

The penthouse exterior wall is comprised of steel tubes, metal studs and a proprietary blast resistant cladding. The penthouse exterior wall is not part of the main lateral force resisting system and therefore has a moderate damage level of protection for the blast loading and a heavy damage level of protection for a balanced design. Therefore, the maximum allowable ductility is 1 under the blast load for a metal stud and an allowable ductility of 3 with an allowable rotation of 3 degrees for a hot rolled steel HSS section.

2.2.2 Analysis Results

2.2.2.1 Main Building Exterior Wall

Table 7 Main Building Exterior Wall Construction and Reactions

Location	Wall Type	Construction	Inward Reaction (k/ft)		Outward Reaction (k/ft)	
			Bottom	Top	Bottom	Top
Pharmacy / Police: West Elevation CL: A.1-C.4	Typical Wall (not at opening)	Vert. #5 rebar E.F. @ 12" o.c.	7.5	4.8	-6.2	-3.9
Pharmacy / Police: West Elevation CL: A.1-C.4	At Window Opening	26" wide Jamb: Vert. #5 rebar E.F. @ 9" o.c. Header and Sill: Hor. #5 rebar E.F. @ 12" o.c.	9.3	5.6	-8.2	-5.2
Pharmacy / Police: North Elevation CL: 20.2-22	Typical Wall (not at opening)	Vert. #5 rebar E.F. @ 12" o.c.	6.1	3.7	-5.2	-3.2
Pharmacy / Police: North Elevation CL: 28-20.3	Typical Wall (not at opening)	Vert. #5 rebar E.F. @ 12" o.c.	6.1	3.7	-5.2	-3.2
Pharmacy / Police: North Elevation CL: 18-20.2	At Window Opening	26" wide Jamb: Vert. #5 rebar E.F. @ 9" o.c. Header and Sill: Hor. #5 rebar E.F. @ 12" o.c.	9.3	5.6	-8.2	-5.2
Pharmacy / Police: North Elevation CL: 18-20.2	At Police Door Opening	Jambs: Vert. #5 rebar E.F. @ 12" o.c. (same as for typical wall) Header: Horiz. #5 rebar E.F. @ 12" o.c.	16.2	10.4	-13.3	-8.5
Radiology: North Elevation CL: 27-31	Typical Wall (not at opening)	Vert. #5 rebar E.F. @ 12" o.c.	7.5	4.8	-6.2	-3.9
Radiology: North Elevation CL: 27-31	At Window Opening	26" wide Jamb: Vert. #5 rebar E.F. @ 9" o.c. Header and Sill: Hor. #5 rebar E.F. @ 12" o.c.	9.3	5.6	-8.2	-5.2
Radiology: North Elevation CL: 27-31	At Door Opening	Jambs: Vert. #5 rebar E.F. @ 12" o.c. (same as for typical wall) Header: Horiz. #5 rebar E.F. @ 12" o.c.	9.3	5.6	-8.2	-5.2

Radiology: East Elevation CL: A.5-C.3	Typical Wall (not at opening)	Vert. #5 rebar E.F. @ 12" o.c.	7.5	4.8	-6.2	-3.9

2.2.2.2 Penthouse Exterior Wall

Two configurations of metal studs are proposed in Table 8 for the penthouse wall spans 11.125 ft.

Table 8 Penthouse Metal Stud Design Option

Location	Wall Type	Construction	Ductility	Rotation (degrees)	Inward Reaction at Top and Bottom of Wall (kip)	Outward Reaction at Top and Bottom of Wall (kip)
Pharmacy/Police and Radiology Penthouse	Metal Stud Wall	800S350-118 @ 12" o.c.	0.92	N/A	5.7	-4.9
Radiology Penthouse	Louver Opening	Edge Jambs: HSS8x4x3/16 (A500 gr. C) Header and Sill: HSS8x4x1/8 (A500 gr. C)	0.67	1.75	8.4	-7.2
West Penthouse	Louver Opening	Edge Jambs: HSS8x4x3/16 (A500 gr. C) Header and Sill: HSS8x4x1/8 (A500 gr. C)	1.15	2.32	9.71	-8.30
Pharmacy/Police Penthouse	Louver Opening	v Jambs: HSS8x4x3/16 (A500 gr. C) Header and Sill: HSS8x4x1/8 (A500 gr. C)	1.99	2.20	18.11	-12.98

2.2.3 Main Wall, Example

The example analysis shown is for the wall located at the Radiology building on the North Elevation between CL 27 and 31.

Job title	VA Iron Mountain Expand Pharmacy and Radiology	Job number	Sheet number	Revision
Calc title	100% CD Blast Calculations	Member/Location		
		Drg. Ref.		
		Made by BL	Date 11/29/2022	Chd. DB

Titles

Job number: Initials: 23-Nov-2022
Job Title:
Subtitle:
Calc. heading:
File: North Elevation Typical Wall.ergo
Written by version: 2.4.0.9

Element

Span	13.00ft
Loaded width, w	1.000ft
Section	
Bending axis	Major
Second moment of area, I_{xx}	**0.0in4**
Second moment of area, I_{yy}	0.0in4
Plastic modulus, Z_{px}	**0.0in³**
Plastic modulus, Z_{py}	0.0in³
Added mass per unit length	40.00lb/ft
Mass per unit length	125.0lb/ft
Total mass per unit length	165.0lb/ft
Total mass	2145.lb
Elastic modulus, E	29000.ksi
Material yield stress	60.00ksi
Static yield stress, $\sigma_{y,stat}$	66.00ksi
Dynamic yield stress, $\sigma_{y,dyn}$	77.22ksi
Dynamic factor	1.170
Damping ratio, ζ	100.0E-6
Boundary condition	Propped cantilever - distributed load

Resistance Function

Displacement Resistance

[in]	[kip]
-0.2221	-16.16
-0.1008	-10.77
0.0	0.0
0.1008	10.77
0.2221	16.16

Load

Load type Shock front
Peak force 34.30psi
End time 0.0ms

Time [ms]	Load [kip]
0.0	64.21
4.768	0.0

Summary

R_{ult}	16.16kip
K_{elas} +ve	1283.kip/ft
K_{elas} -ve	1283.kip/ft
Mass	2145.lb
Frequency	25.00Hz
Period, T	40.00ms
Load period, t_d	4.768ms
t_d/T	0.1192

Signed absolute maximum

	Value	At
Displacement	0.2496in	13.70ms
Plastic displacement	0.09846in	13.70ms
Velocity	2.617ft/s	4.100ms
Acceleration	1235.ft/s²	0.0ms
Ductility	2.477	13.70ms
Resistance	16.16kip	9.900ms
Reaction at left end	12.20kip	0.0ms
Reaction at right end	7.706kip	0.0ms
Reaction (total)	19.91kip	0.0ms
Rotation at left end	0.1833°	13.70ms
Rotation at right end	0.1833°	13.70ms

Maximum

	Value	At
Displacement	0.2496in	13.70ms
Plastic displacement	0.09846in	13.70ms
Velocity	2.617ft/s	4.100ms
Acceleration	1235.ft/s²	0.0ms
Ductility	2.477	13.70ms
Resistance	16.16kip	9.900ms
Reaction at left end	12.20kip	0.0ms
Reaction at right end	7.706kip	0.0ms
Reaction (total)	19.91kip	0.0ms
Rotation at left end	0.1833°	13.70ms
Rotation at right end	0.1833°	13.70ms

Minimum

	Value	At
Displacement	-0.05865in	34.50ms
Plastic displacement	0.0in	0.0ms
Velocity	-1.978ft/s	23.70ms
Acceleration	-310.8ft/s²	9.900ms
Ductility	0.0	0.0ms
Resistance	-13.27kip	34.50ms
Reaction at left end	-6.150kip	34.50ms
Reaction at right end	-3.938kip	34.50ms
Reaction (total)	-10.09kip	34.50ms
Rotation at left end	-0.04308°	34.50ms
Rotation at right end	-0.04308°	34.50ms

2.2.4 Window Jamb Design, Example

The example analysis shown is for the wall located at the Radiology building on the North Elevation between CL 30.9 and 30.5.

Titles

Job number: Initials: 20-Oct-2022
Job Title:
Subtitle:
Calc. heading:
File: North Elevation Window Jamb.ergo
Written by version: 2.4.0.9

Element

Span 13.00ft

Loaded width, w	4.833ft
Section	
Bending axis	Major
Second moment of area, I_{xx}	**0.0in4**
Second moment of area, I_{yy}	0.0in4
Plastic modulus, Z_{px}	**0.0in³**
Plastic modulus, Z_{py}	0.0in³
Added mass per unit length	40.00lb/ft
Mass per unit length	270.8lb/ft
Total mass per unit length	310.8lb/ft
Total mass	4041.lb
Elastic modulus, E	29000.ksi
Material yield stress	60.00ksi
Static yield stress, $\sigma_{y,stat}$	66.00ksi
Dynamic yield stress, $\sigma_{y,dyn}$	77.22ksi
Dynamic factor	1.170
Damping ratio, ζ	100.0E-6
Boundary condition	Propped cantilever - distributed load

Resistance Function

Displacement Resistance

[in]	[kip]
-0.2848	-46.51
-0.1292	-31.00
0.0	0.0
0.1292	31.00
0.2848	46.51

Load

Load type	Shock front
Peak force	38.49psi
End time	0.0ms

Time [ms]	**Load** [kip]
0.0	348.3
3.413	0.0

Summary

R_{ult}	46.51kip
K_{elas} +ve	2880.kip/ft
K_{elas} -ve	2880.kip/ft
Mass	4041.lb
Frequency	27.29Hz
Period, T	36.64ms
Load period, t_d	3.413ms
t_d/T	0.09315

Signed absolute maximum

	Value	At
Displacement	0.5545in	14.50ms
Plastic displacement	0.3608in	14.50ms
Velocity	5.622ft/s	3.100ms
Acceleration	3555.ft/s²	0.0ms
Ductility	4.293	14.50ms
Resistance	46.51kip	5.500ms
Reaction at left end	66.17kip	0.0ms
Reaction at right end	41.79kip	0.0ms

Reaction (total)	108.0kip	0.0ms
Rotation at left end	0.4073°	14.50ms
Rotation at right end	0.4073°	14.50ms

Maximum

	Value	At
Displacement	0.5545in	14.50ms
Plastic displacement	0.3608in	14.50ms
Velocity	5.622ft/s	3.100ms
Acceleration	3555.ft/s²	0.0ms
Ductility	4.293	14.50ms
Resistance	46.51kip	5.500ms
Reaction at left end	66.17kip	0.0ms
Reaction at right end	41.79kip	0.0ms
Reaction (total)	108.0kip	0.0ms
Rotation at left end	0.4073°	14.50ms
Rotation at right end	0.4073°	14.50ms

Minimum

	Value	At
Displacement	0.0in	0.0ms
Plastic displacement	0.0in	0.0ms
Velocity	-3.009ft/s	23.00ms
Acceleration	-561.2ft/s²	9.800ms
Ductility	0.0	0.0ms
Resistance	-38.20kip	32.10ms
Reaction at left end	-17.70kip	32.10ms
Reaction at right end	-11.33kip	32.10ms
Reaction (total)	-29.03kip	32.10ms
Rotation at left end	0.0°	0.0ms
Rotation at right end	0.0°	0.0ms

2.2.5 Window Jamb Balanced Design, Example

The example analysis shown is for the wall found at the Radiology building on the North Elevation between CL 30.9 and 30.5.

Titles

Job number: Initials: 23-Nov-2022
Job Title:
Subtitle:
Calc. heading:
File: North Elevation Window Jamb - Balanced.ergo
Written by version: 2.4.0.9

Element

Span	13.00ft
Loaded width, w	4.833ft
Section	
Bending axis	Major
Second moment of area, I_{xx}	**0.0in4**
Second moment of area, I_{yy}	0.0in4
Plastic modulus, Z_{px}	**0.0in³**
Plastic modulus, Z_{py}	0.0in³
Added mass per unit length	40.00lb/ft
Mass per unit length	270.8lb/ft

Total mass per unit length	310.8lb/ft
Total mass	4041.lb
Elastic modulus, E	29000.ksi
Material yield stress	60.00ksi
Static yield stress, $\sigma_{y,stat}$	66.00ksi
Dynamic yield stress, $\sigma_{y,dyn}$	77.22ksi
Dynamic factor	1.170
Damping ratio, ζ	100.0E-6
Boundary condition	Propped cantilever - distributed load

Resistance Function

Displacement Resistance

[in]	[kip]
-0.2848	-46.51
-0.1292	-31.00
0.0	0.0
0.1292	31.00
0.2848	46.51

Load

Load type	Shock front
Peak force	29.65psi
End time	0.0ms

Time [ms]	Load [kip]
0.0	268.3
5.340	0.0

Summary

R_{ult}	46.51kip
K_{elas} +ve	2880.kip/ft
K_{elas} -ve	2880.kip/ft
Mass	4041.lb
Frequency	27.29Hz
Period, T	36.64ms
Load period, t_d	5.340ms
t_d/T	0.1457

Signed absolute maximum

	Value	At
Displacement	0.7150in	16.60ms
Plastic displacement	0.5212in	16.60ms
Velocity	6.287ft/s	4.500ms
Acceleration	2739.ft/s²	0.0ms
Ductility	5.534	16.60ms
Resistance	46.51kip	5.300ms
Reaction at left end	50.97kip	0.0ms
Reaction at right end	32.19kip	0.0ms
Reaction (total)	83.16kip	0.0ms
Rotation at left end	0.5252°	16.60ms
Rotation at right end	0.5252°	16.60ms

Maximum

	Value	At
Displacement	0.7150in	16.60ms
Plastic displacement	0.5212in	16.60ms
Velocity	6.287ft/s	4.500ms
Acceleration	2739.ft/s²	0.0ms

Ductility	5.534	16.60ms
Resistance	46.51kip	5.300ms
Reaction at left end	50.97kip	0.0ms
Reaction at right end	32.19kip	0.0ms
Reaction (total)	83.16kip	0.0ms
Rotation at left end	0.5252°	16.60ms
Rotation at right end	0.5252°	16.60ms

Minimum

	Value	At
Displacement	0.0in	0.0ms
Plastic displacement	0.0in	0.0ms
Velocity	-3.009ft/s	25.10ms
Acceleration	-561.2ft/s²	8.300ms
Ductility	0.0	0.0ms
Resistance	-38.20kip	34.20ms
Reaction at left end	-17.70kip	34.20ms
Reaction at right end	-11.34kip	34.20ms
Reaction (total)	-29.03kip	34.20ms
Rotation at left end	0.0°	0.0ms
Rotation at right end	0.0°	0.0ms

2.2.6 Penthouse Wall, Example

The example analysis shown is for the typical penthouse walls without openings.

Titles

Job number: Initials: 17-Dec-2021
Job Title:
Subtitle:
Calc. heading:
File: Wallstuds_800S350-118_12oc.ergo
Written by version: 2.4.0.9

Element

Span	12.13ft
Loaded width, w	1.000ft
Section	Explicit
Bending axis	Major
Second moment of area, I_{xx}	**20.04in4**
Second moment of area, I_{yy}	20.04in4
Zuser	**4.762in³**
Zuser	4.762in³
Added mass per unit length	10.00lb/ft
Mass per unit length	6.795lb/ft
Total mass per unit length	16.80lb/ft
Total mass	203.6lb
Elastic modulus, E	29000.ksi
Material yield stress	50.00ksi
Static yield stress, $\sigma_{y,stat}$	55.00ksi
Dynamic yield stress, $\sigma_{y,dyn}$	60.50ksi
Dynamic factor	1.100
Damping ratio, ζ	0.05000
Boundary condition	Simple - distributed load

Resistance Function

Job title	VA Iron Mountain Expand Pharmacy and Radiology	Job number	Sheet number	Revision
Calc title	100% CD Blast Calculations	Member/Location		
		Drg. Ref.		
		Made by BL	Date 11/29/2022	Chd. DB

Displacement Resistance

[in]	[kip]
-1.093	-15.84
0.0	0.0
1.093	15.84

Load

Load type	Shock front
Peak force	13.50psi
End time	0.0ms

Time [ms]	**Load** [kip]
0.0	23.57
7.556	0.0

Summary

R_{ult}	15.84kip
K_{elas} +ve	173.9kip/ft
K_{elas} -ve	173.9kip/ft
Mass	203.6lb
Frequency	29.87Hz
Period, T	33.48ms
Load period, t_d	7.556ms
t_d/T	0.2257

Signed absolute maximum

	Value	At
Displacement	1.010in	10.60ms
Plastic displacement	0.0in	0.0ms
Velocity	-14.64ft/s	18.80ms
Acceleration	4774.ft/s²	0.0ms
Ductility	0.9240	10.60ms
Resistance	14.64kip	10.60ms
Reaction at left end	5.708kip	10.60ms
Reaction at right end	5.708kip	10.60ms
Reaction (total)	11.42kip	10.60ms
Rotation at left end	0.7954°	10.60ms
Rotation at right end	0.7954°	10.60ms

Maximum

	Value	At
Displacement	1.010in	10.60ms
Plastic displacement	0.0in	0.0ms
Velocity	12.51ft/s	35.50ms
Acceleration	4774.ft/s²	0.0ms
Ductility	0.9240	10.60ms
Resistance	14.64kip	10.60ms
Reaction at left end	5.708kip	10.60ms
Reaction at right end	5.708kip	10.60ms
Reaction (total)	11.42kip	10.60ms
Rotation at left end	0.7954°	10.60ms
Rotation at right end	0.7954°	10.60ms

Minimum

	Value	At
Displacement	-0.8631in	27.40ms
Plastic displacement	0.0in	0.0ms
Velocity	-14.64ft/s	18.80ms
Acceleration	-2980.ft/s²	10.10ms
Ductility	0.0	0.0ms

Resistance	-12.51kip	27.40ms
Reaction at left end	-4.878kip	27.40ms
Reaction at right end	-4.878kip	27.40ms
Reaction (total)	-9.755kip	27.40ms
Rotation at left end	-0.6797°	27.40ms
Rotation at right end	-0.6797°	27.40ms

2.2.7 Penthouse Jamb around Louver, Example

The example analysis shown is for the edge jamb located at the Radiology penthouse that supports the louvers.

Titles

Job number:	Initials: 21-Nov-2022
Job Title:	
Subtitle:	
Calc. heading:	
File:	LouverJamb4'_HSS8x4x0.1875.ergo
Written by version:	2.4.0.9

Element

Span	11.12ft
Loaded width, w	2.500ft
Section	CAT HSS-R HSS8x4x0.1875
Bending axis	Minor
Second moment of area, I_{xx}	33.15in4
Second moment of area, I_{yy}	**11.29in4**
Plastic modulus, Z_{px}	10.19in³
Plastic modulus, Z_{py}	**6.346in³**
Added mass per unit length	20.00lb/ft
Mass per unit length	14.54lb/ft
Total mass per unit length	34.54lb/ft
Total mass	384.3lb
Elastic modulus, E	29000.ksi
Material yield stress	50.00ksi
Static yield stress, $\sigma_{y,stat}$	55.00ksi
Dynamic yield stress, $\sigma_{y,dyn}$	65.45ksi
Dynamic factor	1.190
Damping ratio, ζ	0.05000
Boundary condition	Simple - distributed load

Resistance Function

Displacement Resistance

[in]	[kip]
-2.355	-24.89
0.0	0.0
2.355	24.89

Load

Load type	Shock front
Peak force	13.50psi
End time	0.0ms

Time [ms]	**Load** [kip]

```
   0.0       54.07
 7.556        0.0
```

Summary

R_{ult}	24.89kip
K_{elas} +ve	126.8kip/ft
K_{elas} -ve	126.8kip/ft
Mass	384.3lb
Frequency	18.57Hz
Period, T	53.85ms
Load period, t_d	7.556ms
t_d/T	0.1403

Signed absolute maximum

	Value	At
Displacement	2.045in	15.62ms
Plastic displacement	0.0in	0.0ms
Velocity	-18.42ft/s	28.65ms
Acceleration	5803.ft/s²	0.0ms
Ductility	0.8682	15.62ms
Resistance	21.61kip	15.62ms
Reaction at left end	8.429kip	15.62ms
Reaction at right end	8.429kip	15.62ms
Reaction (total)	16.86kip	15.62ms
Rotation at left end	1.754°	15.62ms
Rotation at right end	1.754°	15.62ms

Maximum

	Value	At
Displacement	2.045in	15.62ms
Plastic displacement	0.0in	0.0ms
Velocity	17.98ft/s	6.031ms
Acceleration	5803.ft/s²	0.0ms
Ductility	0.8682	15.62ms
Resistance	21.61kip	15.62ms
Reaction at left end	8.429kip	15.62ms
Reaction at right end	8.429kip	15.62ms
Reaction (total)	16.86kip	15.62ms
Rotation at left end	1.754°	15.62ms
Rotation at right end	1.754°	15.62ms

Minimum

	Value	At
Displacement	-1.747in	42.54ms
Plastic displacement	0.0in	0.0ms
Velocity	-18.42ft/s	28.65ms
Acceleration	-2331.ft/s²	14.75ms
Ductility	0.0	0.0ms
Resistance	-18.47kip	42.54ms
Reaction at left end	-7.202kip	42.54ms
Reaction at right end	-7.202kip	42.54ms
Reaction (total)	-14.40kip	42.54ms
Rotation at left end	-1.499°	42.54ms
Rotation at right end	-1.499°	42.54ms

2.3 Façade Design

2.3.1 Performance Criteria

The exterior glazing and façade will be evaluated for the following load:

- W1 threat @ actual standoff

Glazing must meet a Performance Condition 2 (glass may crack but must remain in the frame) for MS facilities and 3b for LS facilities. Glazing shall be secured in the frame with a minimum of ½" bite and a bead of structural silicone sealant. Deformations are not to exceed L/40 for blast loading and L/20 for balanced design loading.

Note that the glass and façade analysis is proof-of-concept only for cost-estimation and feasibility concept development. The final design will be provided by the contractor's glazing manufacturer in accordance with the performance specifications which include the blast requirements.

2.3.2 Analysis Results

2.3.2.1 Glazing

The layup to achieve the required GSA Performance Condition 2 is shown below in Figure 2. To assess the glass layup using a balanced design, the capacity of the window was evaluated for the highest load the layup can withstand while still meeting GSA Performance Condition 2. The reactions are then applied to the mullion to determine the appropriate size under a balanced design. This was completed for windows with blast only requirements such as the MRI window and the Pharmacy window. Windows with forced entry and ballistic requirements, like the police window, are not governed by the blast load. Note that this is proof-of-concept only.

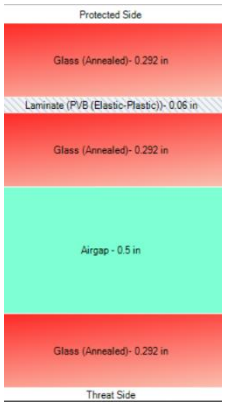

Figure 2 Blast Glazing for MRI Window

Table 9: Window Summary

Location	Pane Size (H x W)	Number of Panes in grouping	Window System Basis of Design	IGU Thickness	Balanced Design Edge Reaction Inward (kip/ft)	Balanced Design Edge Reaction Outward (kip/ft)
Police	30.38" x 21.63"	4	USAW800 6" deep mullion 2-1/2" wide mullion Embed plates expected for forced entry requirements	Expected to be 2-3/8" (governed by forced entry and ballistic requirements)	40.896	-0.588
Pharmacy	30.38" x 21.63"	4	USAW400 4-1/2" deep mullion 2-1/2" wide mullion Embed plate not expected	Expected to be 1.5" with 0.06" PVB interlayer for blast loads	3.516	-0.358
MRI	30.38" x 21.63"	4	USAW400 4-1/2" deep mullion 2-1/2" wide mullion Embed plate not expected.	Expected to be 1.25" with 0.06" PVB interlayer for blast loads	2.05	-0.10

2.3.2.2 Mullions and Framing

Windows at the MRI and pharmacy are expected to use 2.5" x 4.5" mullions. The police window is expected to use 2.5" x 6" mullions. These are designed for the maximum capacity loading from each respective window.

The reactions from the mullions that would need to be transferred in the structure are provided:

Table 10: Mullion Summary for Blast Design

Location	Size (in)	Inbound Reaction (k)	Rebound Reaction (k)
Police	2.5x6.0 with Steel Stiffener	13.89	-9.51
Pharmacy	2.5x4.5x0.25x0.25	7.49	-6.32
MRI	2.5x4.5 x0.25x0.25	4.19	-4.19

Table 11: Mullion Summary for Balanced Design

Location	Size (in)	Inbound Reaction (k)	Rebound Reaction (k)
Police	2.5x6.0 with Steel Stiffener	9.48	-7.49
Pharmacy	2.5x4.5x0.25x0.25	9.48	-7.49
MRI	2.5x4.5 x0.25x0.25	4.31	-4.35

2.3.3 Radiology Window, Example

```
WINGARD PE 5.5.1 (WINdow Glazing Analysis Response and Design) - AUGUST 2008
Window System      = Radiology
Run Date  = 10/21/2022      Time  = 15:24:41

 WINDOW INPUT
  Height                     =       30.38 in
  Width                      =       21.63 in
  Height above floor         =       41.63 in
  Height to center of window =       56.82 in
  Opening Area               =      657.12 sq in
  Percent Critical Damping   =        2.00 %
  Wet-Glazed on all Four Edges
    Silicone depth           =        0.25 in
    Silicone strength        =      350.00 psi

 GLAZING PROPERTIES
  STATISTICAL GLASS PARAMETERS
   Property               |   Coef.   |   Static Design    |   Dynamic Design   |
   Name                   | Variation |   (Pf)   |    psi   |  (Pf)   |   psi    |
```

```
  ------------------------------------------------------------------------------
  Annealed               |     0.280 |    8.0  |   4000.0 |  750.0  |  14609.5 |

 GLASS
  Property               | Modulus | Poisson | Density |Max. Defl.|Ductility|  Stress  |
  Name                   |   ksi   |  Ratio  |   pcf   |(F*thick) | Factor  |    psi   |
  ------------------------------------------------------------------------------------
  Annealed               |  10000. |    0.22 | 155.520 |     10.0 |    1.00 |  14609.5 |

 LAMINATE AND FILM
  Property               | Modulus | Poisson | Density | Strength | Elong.  |
  Name                   |   ksi   |  Ratio  |   pcf   |    psi   |at Break |
  ------------------------------------------------------------------------
  PVB (Elastic-Plastic)  |     50. |    0.47 |  65.664 |   3000.0 |    2.05 |

GLAZING LAYUP (BEGINS AT INSIDE FACE)
   Pane | Plate | Layer |Property              |Thickness|       Weight      |  Lam   |
    No. |  No.  |  No.  |Name                  |    in   |    lb   |   psf   | Factor |
  ------------------------------------------------------------------------------------
     1  |    1  |    1  |Annealed              |   0.292 |   17.27 |   3.784 |  0.74  |
     1  |    1  |    2  |PVB (Elastic-Plastic) |   0.060 |    1.50 |   0.328 |
     1  |    1  |    3  |Annealed              |   0.292 |   17.27 |   3.784 |
        |    2  |    1  |Airgap                |   0.500 |         |         |
     2  |    3  |    1  |Annealed              |   0.292 |   17.27 |   3.784 |  1.00  |
                                               ------------------------------
                                               |   1.436 |   53.31 |  11.681 |

AIRBLAST INPUT
 Method                    =   Pressure and Time
 Time of arrival           =        0.00 msec
 Pressure                  =       34.30 psi     Input
 Positive load ends at     =        4.78 msec

CALCULATED PARAMETERS (BEGINS AT INSIDE FACE)
   Pane  |  Ultimate  |  Ultimate  | Effective |  Maximum   |  Average   | Natural |
    No.  | Resistance | Deflection |   Mass    | Stiffness  | Stiffness  | Period  |
         |     psi    |      in    | psi-msec^2|  psi/in    |  psi/in    |  msec   |
  ------------------------------------------------------------------------------------
     1   |      28.04 |       4.03 |   103.265 |    124.086 |    120.964 |    5.81 |
     2   |       7.78 |       0.42 |    49.486 |     26.521 |     16.088 |   11.02 |

PEAK EDGE SHEAR GLAZING REACTION LOADS (DYNAMIC)
            |  Corner  |        Edge         |        Total        |        Avg        |
  Direction |          |   Long   |  Short   |  Long    |  Short   |  Long   |  Short  |
            |   lb     |   lb     |   lb     |   lb     |   lb     |  lb/in  |  lb/in  |
  ------------------------------------------------------------------------------------
  Inward    |   -992.6 |    6192. |    4147. |    5199. |    3154. |   171.1 |   145.8 |
  Outward   |      2.1 |    -246. |    -149. |    -246. |    -149. |    -8.1 |    -6.9 |
  In-plane                                   |    5470. |    1830. |   180.0 |    84.6 |


RESULTS
 Plate  3, Layer  1, Fails at Time =       1.20 msec
   Pane  2 Failure
```

```
      Displacement at Failure       =       0.42 in
      Velocity at Failure           =     587.77 in/sec
  Contact First Occurs at Time      =       1.37 msec
  Plate  1, Layer  1, Fails at Time =       2.07 msec
  Plate  1, Layer  3, Fails at Time =       2.66 msec
  Pane  1 Does Not Fail
      Maximum Displacement          =       3.72  in
      Time at Maximum Displacement  =      12.33 msec
  Calculation Ends at Time          =      64.48 msec

*******************************************************************************
*      GSA PERFORMANCE CONDITION 2    |   UK HAZARD RATING = BREAKS SAFELY     *
*******************************************************************************

 Bite Required to Achieve Full Capacity of System =       0.50 in
 Bite Required to Resist Provided Load            =       0.50 in

*******************************************************************************
* Note: The current implementation for analysis of wet-glazed systems is       *
*       preliminary, and has not been tested or validated significantly.       *
*       This option should be used with great care.                            *
*******************************************************************************
*******************************************************************************
* Note: This report was produced using WINGARD PE.  The developers of          *
*       this software (GSA and Applied Research Associates,Inc.) highly        *
*       recommend that all blast-resistant and hazard-mitigating window        *
*       designs and analyses be performed by trained and qualified blast       *
*       analysts.  The use of this software and all results are controlled     *
*       by the software license agreement and associated disclaimers.          *
*******************************************************************************
```

2.3.4 Radiology Window, Capacity of Pane for Balanced Design, Example

```
WINGARD PE 5.5.1 (WINdow Glazing Analysis Response and Design) - AUGUST 2008
Window System      = Radiology
Run Date  = 10/21/2022      Time  = 15:24:41

 WINDOW INPUT
  Height                     =       30.38 in
  Width                      =       21.63 in
  Height above floor         =       41.63 in
  Height to center of window =       56.82 in
  Opening Area               =      657.12 sq in
  Percent Critical Damping   =        2.00 %
  Wet-Glazed on all Four Edges
    Silicone depth           =        0.25 in
    Silicone strength        =      350.00 psi

 GLAZING PROPERTIES
  STATISTICAL GLASS PARAMETERS
   Property              |   Coef.   |   Static Design    |   Dynamic Design   |
   Name                  | Variation |   (Pf)  |    psi   |  (Pf)   |   psi    |
   ---------------------------------------------------------------------------
```

```
  Annealed               |     0.280 |    8.0  |   4000.0 |  750.0  |  14609.5 |

 GLASS
  Property               | Modulus | Poisson | Density |Max. Defl.|Ductility|  Stress  |
  Name                   |   ksi   |  Ratio  |   pcf   |(F*thick) | Factor  |    psi   |
  ---------------------------------------------------------------------------------------
  Annealed               |  10000. |    0.22 | 155.520 |     10.0 |    1.00 |  14609.5 |

 LAMINATE AND FILM
  Property               | Modulus | Poisson | Density | Strength | Elong.  |
  Name                   |   ksi   |  Ratio  |   pcf   |    psi   |at Break |
  ---------------------------------------------------------------------------
  PVB (Elastic-Plastic)  |     50. |    0.47 |  65.664 |   3000.0 |    2.05 |

GLAZING LAYUP (BEGINS AT INSIDE FACE)
   Pane | Plate | Layer |Property              |Thickness|       Weight      |  Lam   |
    No. |  No.  |  No.  |Name                  |    in   |    lb   |   psf   | Factor |
  ------------------------------------------------------------------------------------
     1  |    1  |    1  |Annealed              |   0.292 |   17.27 |   3.784 |  0.74  |
     1  |    1  |    2  |PVB (Elastic-Plastic) |   0.060 |    1.50 |   0.328 |        |
     1  |    1  |    3  |Annealed              |   0.292 |   17.27 |   3.784 |        |
        |    2  |    1  |Airgap                |   0.500 |         |         |        |
     2  |    3  |    1  |Annealed              |   0.292 |   17.27 |   3.784 |  1.00  |
                                               ----------------------------
                                               |   1.436 |   53.31 |  11.681 |

AIRBLAST INPUT
 Method                    =   Pressure and Time
 Time of arrival           =        0.00 msec
 Pressure                  =       34.30 psi     Input
 Positive load ends at     =        4.78 msec

CALCULATED PARAMETERS (BEGINS AT INSIDE FACE)
   Pane  |  Ultimate  |  Ultimate  | Effective |  Maximum   |  Average   | Natural |
    No.  | Resistance | Deflection |   Mass    | Stiffness  | Stiffness  | Period  |
         |     psi    |      in    | psi-msec^2|  psi/in    |  psi/in    |  msec   |
  ---------------------------------------------------------------------------------
     1   |      28.04 |       4.03 |   103.265 |    124.086 |    120.964 |    5.81 |
     2   |       7.78 |       0.42 |    49.486 |     26.521 |     16.088 |   11.02 |

PEAK EDGE SHEAR GLAZING REACTION LOADS (DYNAMIC)
            |  Corner  |        Edge         |        Total        |        Avg        |
  Direction |          |   Long   |  Short   |  Long    |  Short   |  Long   |  Short  |
            |   lb     |   lb     |   lb     |   lb     |   lb     | lb/in   | lb/in   |
  ---------------------------------------------------------------------------------------
  Inward    |   -992.6 |    6192. |    4147. |    5199. |    3154. |   171.1 |   145.8 |
  Outward   |      2.1 |    -246. |    -149. |    -246. |    -149. |    -8.1 |    -6.9 |
  In-plane                                   |    5470. |    1830. |   180.0 |    84.6 |


RESULTS
 Plate  3, Layer  1, Fails at Time =       1.20 msec
   Pane  2 Failure
     Displacement at Failure       =       0.42 in
```

```
     Velocity at Failure           =     587.77 in/sec
  Contact First Occurs at Time     =       1.37 msec
  Plate  1, Layer  1, Fails at Time =       2.07 msec
  Plate  1, Layer  3, Fails at Time =       2.66 msec
  Pane  1 Does Not Fail
     Maximum Displacement          =       3.72  in
     Time at Maximum Displacement  =      12.33 msec
  Calculation Ends at Time         =      64.48 msec

*******************************************************************************
*      GSA PERFORMANCE CONDITION 2    |   UK HAZARD RATING = BREAKS SAFELY     *
*******************************************************************************

 Bite Required to Achieve Full Capacity of System =       0.50 in
 Bite Required to Resist Provided Load            =       0.50 in

*******************************************************************************
* Note: The current implementation for analysis of wet-glazed systems is       *
*       preliminary, and has not been tested or validated significantly.       *
*       This option should be used with great care.                            *
*******************************************************************************
*******************************************************************************
* Note: This report was produced using WINGARD PE.  The developers of          *
*       this software (GSA and Applied Research Associates,Inc.) highly        *
*       recommend that all blast-resistant and hazard-mitigating window        *
*       designs and analyses be performed by trained and qualified blast       *
*       analysts.  The use of this software and all results are controlled     *
*       by the software license agreement and associated disclaimers.          *
*******************************************************************************
```

2.3.5 Radiology Mullion for Blast Design, Example

Titles

```
Job number:           Initials:           20-Oct-2022
Job Title:
Subtitle:
Calc. heading:
File:                 Radiology Blast.ergo
Written by version:   2.4.0.9
```

Element

Span	5.750ft
Loaded width, w	1.000ft
Section	STD RHS 114 50 5 5
Bending axis	Major
Second moment of area, I_{xx}	**5.823in4**
Second moment of area, I_{yy}	1.520in4
Plastic modulus, Z_{px}	**3.313in³**
Plastic modulus, Z_{py}	1.809in³
Added mass per unit length	0.0lb/ft
Mass per unit length	44.87lb/ft
Total mass per unit length	44.87lb/ft
Total mass	258.0lb
Elastic modulus, E	10010.ksi

Material yield stress	40.00ksi
Static yield stress, $\sigma_{y,stat}$	40.00ksi
Dynamic yield stress, $\sigma_{y,dyn}$	46.80ksi
Dynamic factor	1.170
Damping ratio, ζ	0.001000
Boundary condition	Simple - distributed load

Resistance Function

Displacement Resistance

[in]	[kip]
-1.320	-17.98
0.0	0.0
1.320	17.98

Summary

R_{ult}	17.98kip
K_{elas} +ve	163.5kip/ft
K_{elas} -ve	163.5kip/ft
Mass	258.0lb
Frequency	103.0Hz
Period, T	9.711ms
Load period, t_d	81.41ms
t_d/T	8.383

Signed absolute maximum

	Value	At
Displacement	1.790in	13.60ms
Plastic displacement	0.4699in	13.60ms
Velocity	64.46ft/s	11.20ms
Acceleration	41810.ft/s²	8.700ms
Ductility	1.356	13.60ms
Resistance	17.98kip	3.400ms
Reaction at left end	7.540kip	12.50ms
Reaction at right end	7.540kip	12.50ms
Reaction (total)	15.08kip	12.50ms
Rotation at left end	2.969°	13.60ms
Rotation at right end	2.969°	13.60ms

Maximum

	Value	At
Displacement	1.790in	13.60ms
Plastic displacement	0.4699in	13.60ms
Velocity	64.46ft/s	11.20ms
Acceleration	41810.ft/s²	8.700ms
Ductility	1.356	13.60ms
Resistance	17.98kip	3.400ms
Reaction at left end	7.540kip	12.50ms
Reaction at right end	7.540kip	12.50ms
Reaction (total)	15.08kip	12.50ms
Rotation at left end	2.969°	13.60ms
Rotation at right end	2.969°	13.60ms

Minimum

	Value	At
Displacement	-0.6209in	28.30ms
Plastic displacement	0.0in	0.0ms
Velocity	-63.24ft/s	16.10ms
Acceleration	-40670.ft/s²	4.300ms
Ductility	0.0	0.0ms

Resistance	-14.86kip	28.30ms
Reaction at left end	-5.794kip	28.30ms
Reaction at right end	-5.794kip	28.30ms
Reaction (total)	-11.59kip	28.30ms
Rotation at left end	-1.031°	28.30ms
Rotation at right end	-1.031°	28.30ms

2.3.6 Radiology Mullion for Balanced Design, Example

Summary

R_{ult}	17.98kip
K_{elas} +ve	163.5kip/ft
K_{elas} -ve	163.5kip/ft
Mass	258.0lb
Frequency	25.73Hz
Period, T	38.87ms
Load period, t_d	81.41ms
t_d/T	2.095

Signed absolute maximum

	Value	At
Displacement	-0.7925in	75.10ms
Plastic displacement	0.0in	0.0ms
Velocity	10.42ft/s	85.10ms
Acceleration	3535.ft/s²	1.800ms
Ductility	0.5914	15.90ms
Resistance	-10.80kip	75.10ms
Reaction at left end	-4.347kip	75.00ms
Reaction at right end	-4.347kip	75.00ms
Reaction (total)	-8.694kip	75.00ms
Rotation at left end	-1.316°	75.10ms
Rotation at right end	-1.316°	75.10ms

Maximum

	Value	At
Displacement	0.7805in	15.90ms
Plastic displacement	0.0in	0.0ms
Velocity	10.42ft/s	85.10ms
Acceleration	3535.ft/s²	1.800ms
Ductility	0.5914	15.90ms
Resistance	10.63kip	15.90ms
Reaction at left end	4.313kip	15.80ms
Reaction at right end	4.313kip	15.80ms
Reaction (total)	8.626kip	15.80ms
Rotation at left end	1.296°	15.90ms
Rotation at right end	1.296°	15.90ms

Minimum

	Value	At
Displacement	-0.7925in	75.10ms
Plastic displacement	0.0in	0.0ms
Velocity	-10.39ft/s	104.6ms
Acceleration	-1682.ft/s²	94.80ms
Ductility	0.0	0.0ms
Resistance	-10.80kip	75.10ms
Reaction at left end	-4.347kip	75.00ms
Reaction at right end	-4.347kip	75.00ms

Job title	VA Iron Mountain Expand Pharmacy and Radiology	Job number	Sheet number	Revision
Calc title	100% CD Blast Calculations	Member/Location		
		Drg. Ref.		
		Made by BL	Date 11/29/2022	Chd. DB

Reaction (total)	-8.694kip	75.00ms
Rotation at left end	-1.316°	75.10ms
Rotation at right end	-1.316°	75.10ms

Memorandum

To	Jeff Pogrant, Dan Drain (BSA)	Date	November 29, 2022
Copies	Nick Decent, Steve Roloff (RA Smith)	Reference number	
From	Deborah Blass, Brian Luster (Arup)	File reference	
Subject	VA Iron Mountain Expand Pharmacy and Radiology 100CD Physical Security Narrative		

The Pharmacy, Police, and Radiology Expansion at the Oscar G. Johnson VA Medical Center in Iron Mountain, Michigan, has been evaluated for compliance with the new Physical Security and Resilience Design Manual (PSRDM), dated October 2020. As required by Section 1.3 of the PSRDM, the new version shall be applied given the project had not proceeded past 35% design at the date the new standard was issued.

This project is an addition of two new buildings to an existing facility on the campus. There is also alteration/renovation of existing spaces. Table 1 outlines the applicable project scopes and the requirements that must be followed, which was taken from Table 2-1 of the PSRDM:

Table 1: Project Scope and Corresponding PSRDM Requirement Extents

Project Scope	**Baseline Physical Security and Resiliency Requirements**
Addition (horizontal expansion) to an existing building	Comply with requirements for new construction for the building addition.
Alteration/renovation (<50% of area of existing building)	Comply with requirements for "Alteration/Renovation of Existing Facilities" only for the area being altered or renovated.

In previous versions of the PSRDM, requirements for interior alterations/renovations were less defined. To meet the new PSRDM, interior areas undergoing renovations have been reviewed for compliance.

According to the PSRDM, space used for Security and Law Enforcement, and Imaging Center (inpatient) are considered Mission Critical (MC) facilities. Pharmacies are not explicitly listed in the designation lists and would therefore be proposed as a Life Safety (LS) facility with MC utilities. However, since the pharmacy shares the same building structure as the Police expansion, the entire structure will be designed for MC requirements.

Table 2 summarizes each of the relevant standards and their status for incorporation into the design of the new additions.

- C: indicates the design will achieve compliance with PSRDM-MC provisions.

- NC: indicates the design is not conforming to the strict provisions and alternative physical security designs are proposed to achieve acceptable physical security protection.
- TBD: indicates conformance of the design to the standard is to be determined, as the design is not detailed enough to have sufficiently incorporated the standard.
- NA: indicates the standard is not applicable to the design.

Table 2: Summary of Compliance with PSDM

PSRDM-MC Provision		**C**	**NC**	**TBD**	**NA**
Site Considerations	3.3 Standoff Distances		X		
	3.6 Anti-ram Rated Vehicle Barriers				X
	3.8 Site Lighting	X			
	3.10 Signage	X			
Building Entrances & Exits	4.4 Building Exits and Life Safety Considerations	X			
Functional Areas	5.2 Caches: Pharmacy Caches	X			
	5.12 Pharmacy		X		
	5.13 Police Operations Room and Holding Room	X			
Building Envelope	6.2 Walls (Non-load Bearing)	X			
	6.3 Façade Fenestration & Doors	X			
	6.5 Roof Structure, Skylights and Penthouses	X			
	6.6 Critical Equipment Protection (Penthouses)	X			
Structural System	7.2 Blast Resistance	X			
	7.3 Design for Global Stability of the Structure	X			
	7.4 Prevention of Progressive Collapse				X
Utilities and Security Systems	8 Utilities and Building Services	X			
	9 Building Systems	X			
	10 Security Systems	X			

At the 100% CD stage, all items are resolved; refer to the respective sections for discussion around the non-compliant aspects of the Standoff Distances and Pharmacy.

In addition, it is noted there are 2 unresolved confirmations required from the VA. We believe our proposed interpretations and remediations as discussed herein are appropriate and have taken that assumption in absence of a decision from the VA, however it can be revisited if necessary.

1) Standoff deviation (submitted as part of 65% resubmission)

2) 100-year floodplain deviation as it relates to basement electrical equipment (submitted as part of 90% submission)

Summary of Assessment

The primary item of note is that the minimum standoff requirement of 50-ft is not met for the new additions and therefore the buildings will not be compliant with the PSRDM. In absence of a risk assessment for the building, site and/or campus, Arup's approach to achieve the intent of the PSRDM has been to meet the blast requirements of Chapter 6 & 7 by designing the envelope and structure for the actual/on-site standoffs (standoff varies between 16.75-ft and 41.25-ft). In addition, we recommend providing vehicle security barriers on the site to physically maintain the limited standoff that is available, however we understand that no sitework is being done as part of this project and therefore this should be considered as part of a future project.

In accordance with the PSRDM Section 2.3, this deviation in approach should be approved by the VA AHJ through an exception or deviation process. It is noted that the approach we have proposed to harden the facility for existing/available standoffs is typically found acceptable by the VA, but without confirmation we cannot declare compliance of the facilities. For the revised 65% submission, a memo was submitted with information about our approach to the standoff deviation.

The following sections provide more detailed discussion of compliance with the PSRDM requirements. Utilities design requirements of the PSRDM have been communicated to the appropriate engineers for incorporation into their designs.

1 Chapter 3 Site Considerations

The following sections in Chapter 3 apply to this project:

- Section 3.3 Standoff Distance
- Section 3.6 Anti-Ram Rated Vehicle Barriers
- Section 3.8 Site Lighting
- Section 3.10 Signage

The other sections and their requirements are not expected to apply to this project.

1.1 Section 3.3 Standoff Distance

Even for an alteration/renovation of existing facilities, the requirements of the standoff must still meet the requirements outlined in PSRDM Section 3.3. Unscreened vehicles must not be permitted to park or travel closer than the minimum standoff distance to any side of the facility. A screened vehicle is a motor vehicle that has been examined systematically to determine

whether or not a security threat that needs to be mitigated is present. From the designations described previously, the required standoff distances for each facility are summarized in Table 3.

Table 3: Required Standoffs

Space	Designation	Required Standoff
Police	MC	50’
Pharmacy	LS*	25’*
Radiology	MC	50’

* Although technically proposed as LS, due to the building layout, MC classification and standoffs will by default apply to the pharmacy.

For both buildings, the required standoff is not met for the main building, but the penthouses on all roofs meet the required standoff. A deviation was submitted for the main building, which proposes an alternative approach for the new building construction to be hardened for the threats at the actual standoffs. See Figure 1 for the actual standoffs to the main building and Figure 2 and Figure 3 for standoffs to the penthouses. Note that the electrical penthouse is located 38’ above ground level in addition to being offset 38’ from the face of the building.

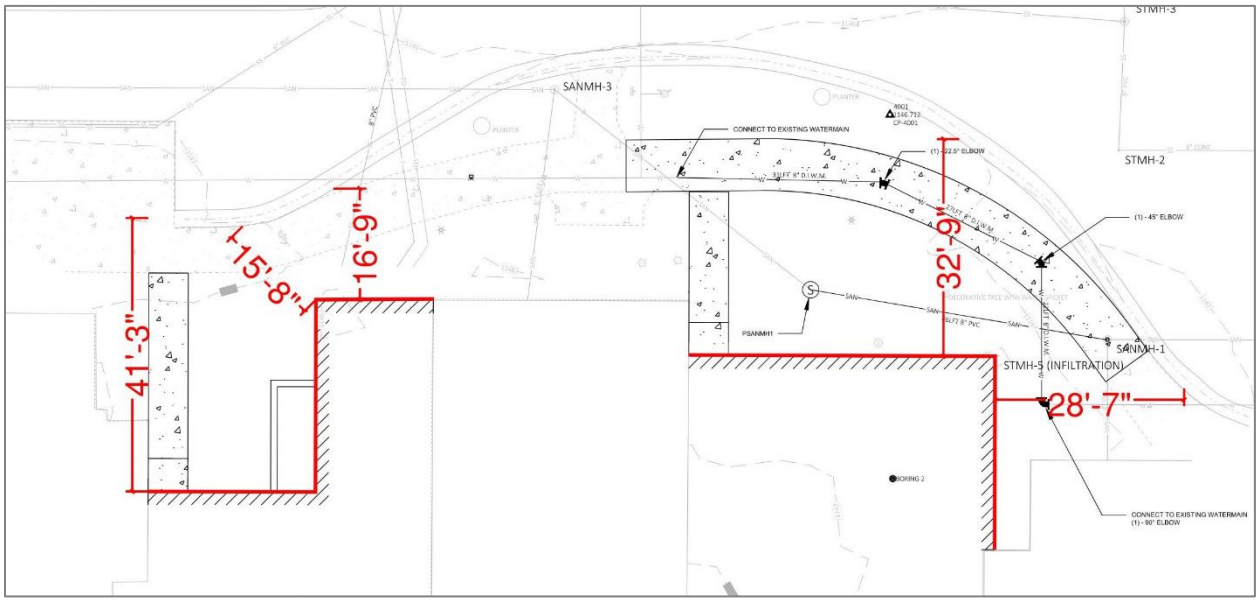

Figure 1: Standoff distances to main building

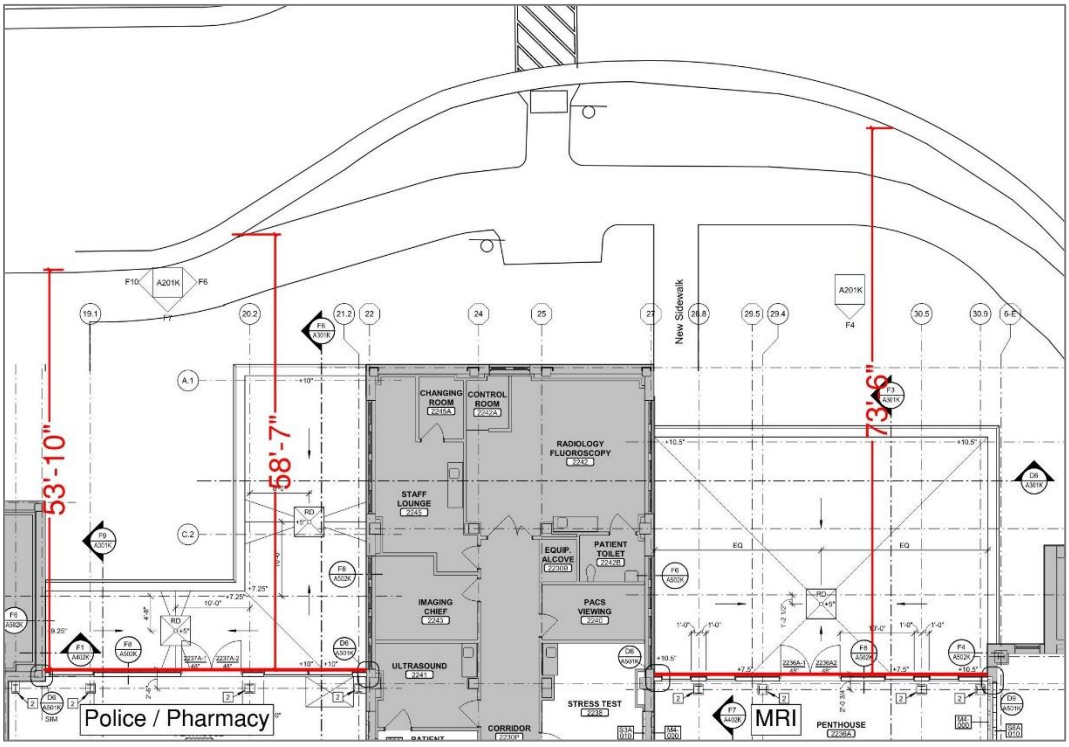

Figure 2: Standoff distances to police/pharmacy and radiology penthouses

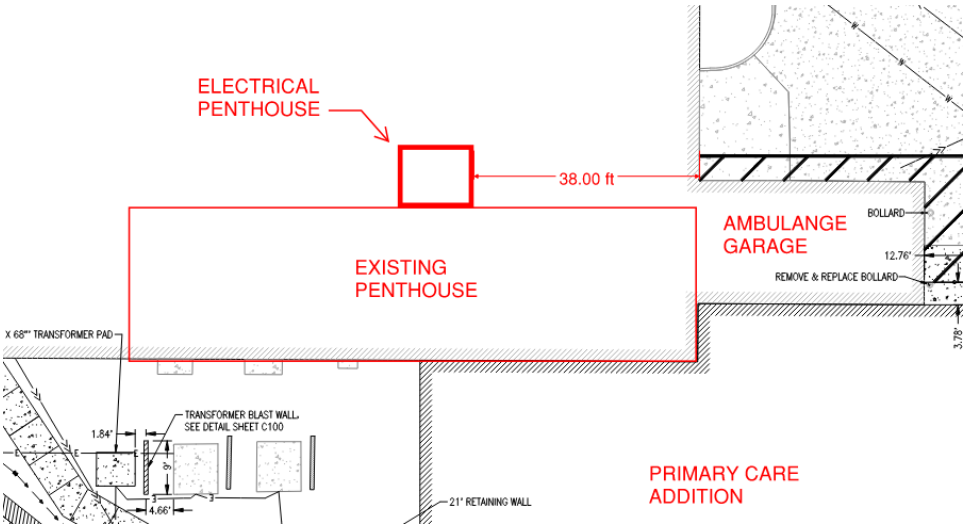

Figure 3: Standoff distance electrical penthouse

1.2 Section 3.6 Anti-Ram Rated Vehicle Barriers

MC Facilities that have access points allowing vehicles to travel within the minimum standoff distance require active anti-ram vehicle barriers. There are no access points up to the facilities,

however minimum standoffs are not maintained. We understand site modifications are beyond the scope of this project, however, not incorporating any protective anti-ram measures to maintain the smaller, actual standoffs will then be dependent upon the VA AHJ's approval of our proposal to provide blast hardening.

Both MC and LS Facilities require passive vehicle barriers at hospital main entrances, lobby entrances, and utility connections, emergency power supplies, hazardous-materials storage, HVAC, and external critical telecom and IT resources. It is assumed that none of these conditions occur in this project scope, therefore passive vehicle barriers are not required.

1.3 Section 3.8 Site Lighting

The PSRDM requires minimum illumination levels for pedestrian pathways. Two new sidewalks leading to two new exterior doors at both buildings are shown on the plans. Both pathways and entrances will require adequate lighting as per the PSRDM. The Architect has confirmed the lighting provided at the building exterior will provide sufficient lighting for the pathways.

1.4 Section 3.10 Signage

Signs that identify sensitive areas such as air intakes, fuel supply valves, gas, or power distribution locations should be avoided, unless required by other codes or standards. Penthouse and basement electrical distribution areas are restricted to staff only and no signage is provided outside of the room indicating specific utilities within.

2 Chapter 4 Building Entrances and Exits

The following PSRDM sections in Chapter 4 apply to this project:

- Section 4.4 Building Exits and Life Safety Considerations

The other PSRDM sections and their requirements are not expected to apply to this project.

2.1 Section 4.4 Buildings Exits and Life Safety Considerations

Two new exterior doors are planned for the buildings. The new exterior door at Police will be for access and egress. The new exterior door at Radiology will be for egress from Stair 3 and the Radiology facility. These door locations are shown in Figure 4.

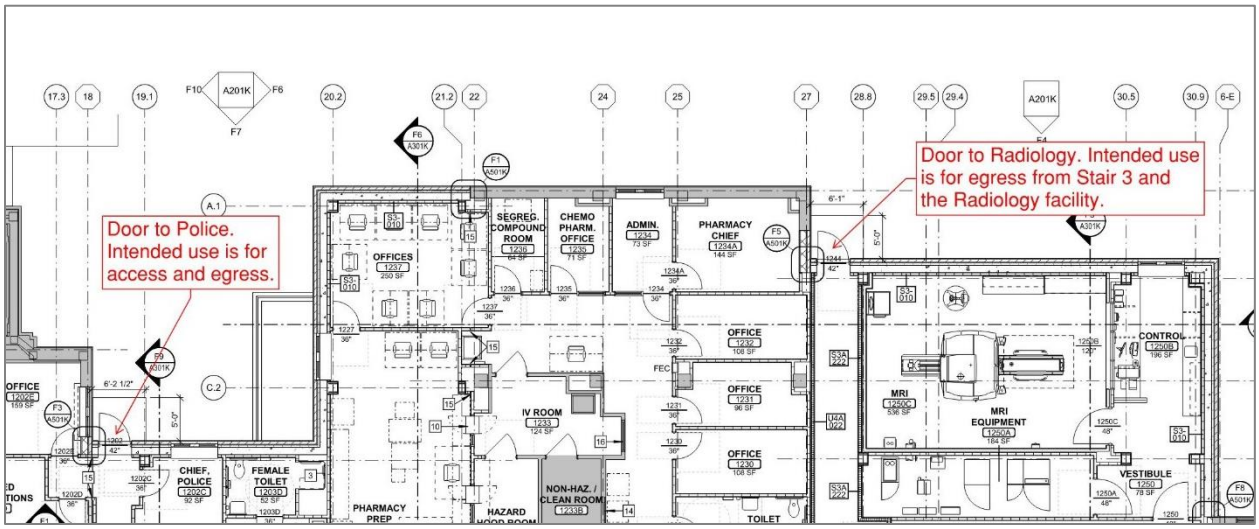

Figure 4: New Exterior Door Locations

All egress locations will need an unobstructed and adequately lighted path from each exit to a safe location outside the building in accordance with National Fire Protection Association (NFPA) 101. Dual light/build fixtures must be used. Compliance with this provision has been coordinated with the Architect and Electrical Engineer.

Where means of egress are accessible to persons with disabilities, there must be an accessible route to a safe location outside of the building. The egress paths must also be planned so that they are not obstructed by any anti-ram barriers or similar devices. These requirements appear to be met from the plans.

Blast requirements for the doors are provided in Chapter 6 of the PSRDM (discussed below in Section 4.2 of this Narrative). Additionally, the doors will be provided with a card reader for authorized users and door status monitor to indicate unauthorized use if the exit door does not also function as an access point for the building. Security cameras will also be provided at locations with alarmed exits.

3 Chapter 5 Functional Areas

The following PSRDM sections in Chapter 5 apply to this project:

- Section 5.2 Caches: All-Hazards Emergency Cache and Pharmacy Caches
- Section 5.12 Pharmacy
- Section 5.13 Police Operations Room and Holding Room

The other PSRDM sections and their requirements are not expected to apply to this project.

3.1 Section 5.2 Caches: All-Hazards Emergency Cache and Pharmacy Cache

This section in the PSRDM outlines requirements for Caches, including Pharmacy caches. Note that for alterations/renovations of existing facilities, all requirements in this section still apply. The following documents also need to be referenced regarding Pharmacy Cache requirements:

- Program Guide PG-18-9, Space Planning for VA Facilities, #268 Pharmacy Service
- VA Handbook 0730 Security and Law Enforcement, Appendix B, as they apply to Pharmacy drug storage also apply to Pharmacy Caches
- VA Program Guide PG-18-3, Design and Construction Procedures

Caches located within the main facility must be on a corridor leading to the Loading Dock. The perimeter of the Cache enclosure must be no less than 50 ft from the Loading Dock and from the Mailroom, if applicable. From the floor plans provided, this appears to be met. They must also not be located on an exterior wall, and not be directly below a roof. This requirement is met, as the Pharmacy Cache is in the basement.

The door leading into the Pharmacy Cache will need to be opaque hollow metal and controlled with physical hardening and security systems. Additionally, the cache must be provided with 15-minute forced-entry resistant construction, including interior partitions that separate it from non-secure areas. The Pharmacy Cache interior partitions can be constructed from either of the following assemblies, the latter has been incorporated for this project:

- Minimum 8” fully grouted CMU reinforced, slab-to-slab, with 9-guage expanded metal mesh as prescribed by PSRDM, or
- Minimum 8” fully grouted CMU reinforced with two layers of #8 steel reinforcing bars spaced at 3-1/2” on center.

No windows, hatches, or access panels are permitted in Caches.

Currently, air circulation ducts pass through the Cache’s interior walls. Any air circulation duct with a cross sectional area greater than 100 square inches requires a ventilation grill that must be reinforced to prevent its removal from outside the room, as per Handbook 0730, Appendix B. This has been coordinated with the mechanical engineer.

In terms of security devices, the following guidance is provided:

- The Pharmacy Cache must have door and lock status sensors, and motion detectors. They must be monitored by an intrusion detection system (both boundary and volumetric).
- The door into the Cache requires a card reader to control entry. Cypher locks are not acceptable.
- Security Surveillance Television (SSTV) must be used at the door into the Pharmacy Cache, as well as at service interaction areas.

Additionally, the PSRDM Appendix B Security System Application Matrix requirements are required.

All requirements for the cache have been coordinated into the design.

3.2 Section 5.12 Pharmacy

The requirements in this section apply to the Pharmacy on the 1st floor. Note that for alterations/renovations of existing facilities, only the requirements noted in Section 5.12.4 Security apply to the areas being altered or renovated. In addition to the requirements in this section, the following documents apply:

- Program Guide PG-18-9, Space Planning Criteria for VA Facilities, #268 Pharmacy Service, *Clinical Series Pharmacy Service VA Design Guide,* and *the Primer Series Pharmacy Design Guide*
- VA Handbook 0730 Security and Law Enforcement, Appendix B, as they apply to pharmacies

The pharmacy addition is not located adjacent to a loading dock, mailroom, or other high-risk areas. In addition, there are no entrances planned to the pharmacy from the outside, which would need to meet additional requirements. The pharmacy location is compliant with the PSRDM.

Exterior walls will be reinforced concrete and thus have no additional requirements. This project is only altering portions of the existing pharmacy walls. Interior partitions between the Pharmacy and surrounding spaces that are being renovated will include the 15-minute forced entry masonry wall construction.

At dispensing partitions and openings, the following construction will be implemented:

- Partitions, doors, glazed openings, teller windows, and transaction trays at dispensing windows must be UL 752 Level 3 ballistic resistant and 15-minute forced entry resistant. This has been incorporated into the specifications.

Currently there is one exterior window planned at the west elevation of the Pharmacy. The window is expected to be less than 18 feet above the adjacent finish grade; therefore, it must include forced entry resistant construction. This requirement is shown in Figure 5.

The blast and forced entry requirements have been included in performance specifications. The IDA requirement has been coordinated with the Architect for incorporation into the design.

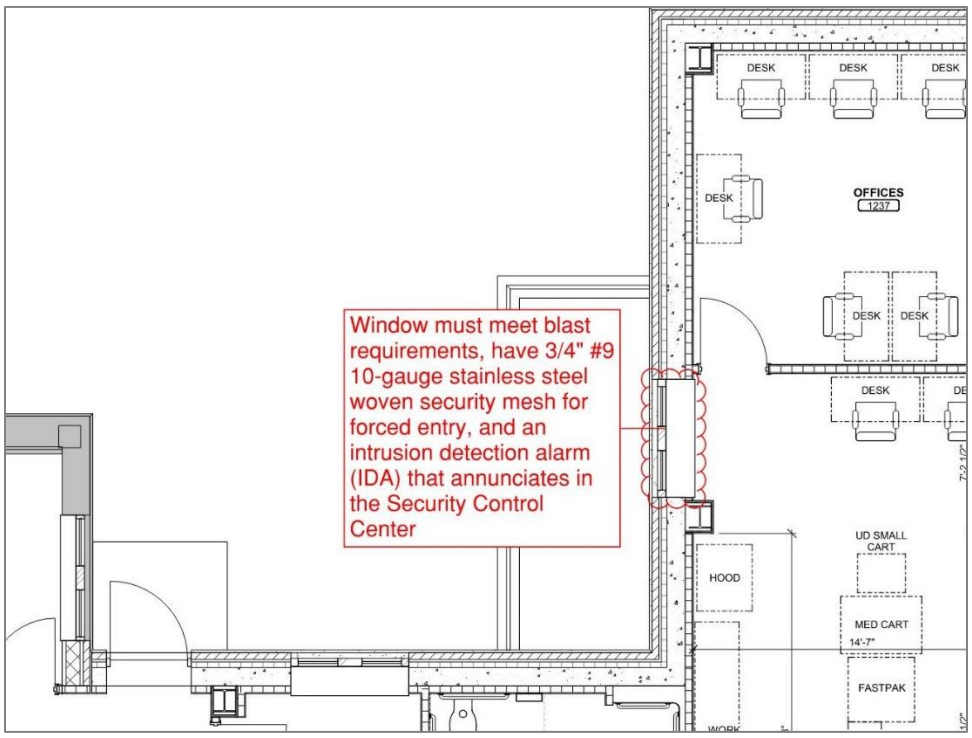

Figure 5: Pharmacy Exterior Windows

Currently, no vents, ducts, and similar openings enter or pass through the Pharmacy.

Per PSRDM Section 3.12.4, the required security devices are outlined in the PSRDM in Appendix B Security System Application Matrix. In addition to devices in the Matrix, SSTV monitoring of Pharmacy dispensing area, vault entrance, and controlled substance storage should be provided, where applicable. The following is additional direction on how those devices are to be installed:

- Provide door and lock status sensors and motion detectors in Pharmacy. When the Pharmacy is in continuous operation, volumetric intrusion detection is not required.
- Pharmacy entry and narcotic vaults must be controlled via card readers. Mechanical cypher locks cannot be used.
- Provide duress alarm at patient transaction counter and patient/pharmacist consult areas, and as required by the program.
- SSTV must be used at entry points, exits points, service interaction areas and windows, and waiting areas.

These requirements have been coordinated with the Architect for incorporation into the door schedules and hardware specifications.

A new pharmacy entrance door is located at the south of the pharmacy as seen in Figure 6. This door does not meet the requirement that the pharmacy can only be accessed by a door to a

corridor which is accessible only to employees. The existing corridor is accessible to all, and there is no room in the floor plan to add a secondary corridor. To meet the intent of the criteria, the door will be monitored via CCTV, the door will be access controlled and the pharmacy will have a duress button inside. The VA should be aware from an operational perspective that there is only a single layer of access into the Pharmacy, which presents a vulnerability even with the additional mitigations noted (e.g., tailgating is easier). The VA may choose to monitor the area more closely, if desired.

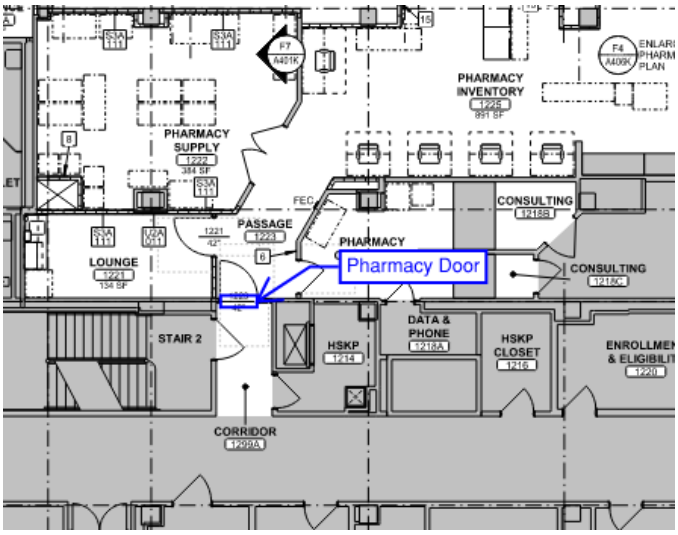

Figure 6: New Pharmacy Door

3.3 Section 5.13 Police Operations Room and Holding Room

The requirements in this PSRDM section supplement the following documents:

- Program Guide PG-18-9, Space Planning Criteria Facilities, #279 Police Service
- VA Handbook 0730 Security and Law Enforcement that is in effect at the time the PSDRM is published

The police operations room will be located on the 1st floor of the main patient care building and located to enable appropriate response and deployment. Additionally, domiciliary, substance abuse, and Veteran's assistance facilities cannot be located near the Police Operations Room. The current location appears to meet these criteria, as it will be located next to the existing visitor screening vestibule and pharmacy.

The adjacent areas to the Police Operations Room expansion have been confirmed for their accessibility to the public. The PSRDM requires that when the Police Operations Room is adjacent to or opens onto areas occupied by unscreened public, such as lobbies, elevator lobbies, Emergency Departments, and public corridors, all construction (including partitions from slab to slab, doors, windows, and other openings) must be UL 752 Level 3 ballistic-resistant and 15-minute forced entry resistant construction.

There is a screening vestibule that visitors ideally would be screened at. However, it is our understanding that screening is only being performed when the level of security is heightened, not continuously, and therefore unscreened people may be accessing the building. The resulting forced entry and ballistic resistance construction extents are shown in Figure 7. This has been coordinated with the Architect, and the performance requirements have been incorporated into the project specifications.

Additionally, the door leading to the Police Vestibule must be used only by staff and be controlled and monitored.

The holding room must have a hollow metal steel door, be protected with 15-minute forced entry resistant construction, and meet the following construction requirements, which have been coordinated with the Architect:

- Walls to be constructed of reinforced masonry and extended to the underside of the structure above. The holding cell walls will be constructed of 8" fully grouted and reinforced CMU, which also meets the forced entry requirement.
- An observation window consisting of reflective glass protected by clear polycarbonate must be provided. This window will be provided in the door.
- Interrogation table must be firmly anchored to the floor and to one wall, or firmly anchored to the floor. This is not applicable; no interrogation table is provided.
- Shackle hasps must be anchored to the wall and be capable of resisting pullout of not less than 1000 lbs. The VA has decided not to provide shackles.
- Vandal resistant products must be used within the space. All exposed fasteners must be tamper resistant. There are no features in the room that have exposed fasteners.
- Construction and materials must eliminate opportunities for detainee to inflict self-injury and improvise weapons that could be used to harm others. The only furniture in is a detention bench, and therefore this standard is met.

Additionally, SSTV surveillance of the entire Holding Room must be provided. This is confirmed.

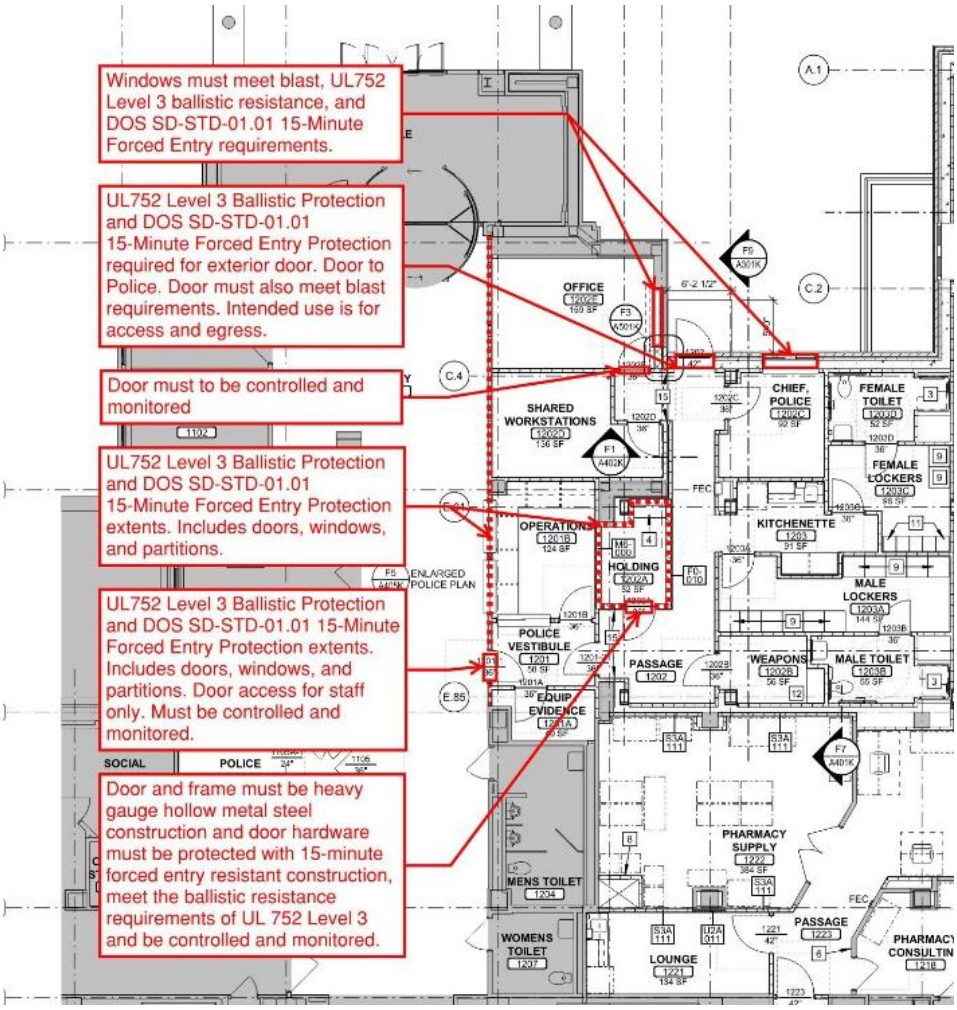

Figure 7: Police Operations and Holding Room Addition and Expected Ballistic and Forced Entry Resistance Extents

For electrical and communications, all circuits, data, communicates, and other utilities serving the Police Operations Room must be backed by the emergency/standby electrical system. This has been coordinated with MEP, and the VA Electrical Design Manual for specific loads to be connected to the Essential Electrical System (EES).

The required security devices for the Police Operations Room are provided in the PSRDM in Appendix B, Security System Application Matrix. The VA PM has confirmed there will be records storage within the Office; the Office door is required to be controlled and monitored.

4 Chapter 6 Building Envelope

The following PSRDM sections in Chapter 6 apply to this project:

- Section 6.2 Non-Load Bearing Exterior Walls

- Section 6.3 Fenestration and Doors
- Section 6.5 Roofs
- Section 6.6 Critical Equipment Protection (Penthouses)

4.1 Section 6.2 Non-Load Bearing Exterior Walls

For both buildings, the exterior walls will be 10-inch non-load bearing reinforced concrete walls. There are two blast design requirements for the walls:

1. Non-load bearing exterior walls are required to be designed to resist the peak pressures and impulses from the blast weights, but no greater than the maximum GP blast loading. However, since we do not meet the standoff requirements, the walls have been designed to the actual blast loads. The level of acceptable damage is Moderate Damage, as described in ASCE 59-11. The walls must span from slab to slab and not be attached directly to gravity load bearing elements unless analysis is done to demonstrate this load path is acceptable; we do not anticipate this being the case.
2. The walls supporting windows must also be designed to accept a blast load equal to the maximum capacity of the weakest lite of support glass (i.e., balanced design). These loads are larger, however for this requirement, the walls can accept Heavy Damage as described in ASCE 59-11.

Table 4 outlines the reinforcement provided in the structure that has been confirmed to meet the blast requirements..

Table 4 Main Building Exterior Wall Construction

Location	**Wall Type**	**Construction**
Pharmacy / Police: West Elevation CL: A.1-C.4	Typical Wall (Not at opening)	Vert. #5 rebar E.F. @ 12” o.c.
Pharmacy / Police: West Elevation CL: A.1-C.4	At Window Opening	26” wide Jamb: Vert. #5 rebar E.F. @ 9” o.c. Header and Sill: Hor. #5 rebar E.F. @ 12” o.c.
Pharmacy / Police: North Elevation CL: 20.2-22	Typical Wall (Not at opening)	Vert. #5 rebar E.F. @ 12” o.c.
Pharmacy / Police: North Elevation CL: 21-20.2	Typical Wall (Not at opening)	Vert. #5 rebar E.F. @ 11” o.c.
Pharmacy / Police: North Elevation CL: 18-20.2	At Window Opening	26” wide Jamb: Vert. #5 rebar E.F. @ 9” o.c. Header and Sill: Hor. #5 rebar E.F. @ 12” o.c.
Pharmacy / Police: North Elevation CL: 18-20.2	At Police Door Opening	Jambs: Vert. #5 rebar E.F. @ 12” o.c. (same as for typical wall) Header: Horiz. #5 rebar E.F. @ 12” o.c.

Radiology: North Elevation CL: 27-31	Typical Wall (Not at opening)	Vert. #5 rebar E.F. @ 12” o.c.
Radiology: North Elevation CL: 27-31	At Window Opening	26” wide Jamb: Vert. #5 rebar E.F. @ 9” o.c. Header and Sill: Hor. #5 rebar E.F. @ 12” o.c.
Radiology: North Elevation CL: 27-31	At Door Opening	Jambs: Vert. #5 rebar E.F. @ 12” o.c. (same as for typical wall) Header: Horiz. #5 rebar E.F. @ 12” o.c.
Radiology: East Elevation CL: A.5-C.3	Typical Wall (Not at opening)	Vert. #5 rebar E.F. @ 12” o.c.

4.2 Section 6.3 Fenestration and Doors

All new exterior glazing (including door glazing) must be:

- laminated glass,
- restrained within the mullion frames with a minimum ½” bite and minimum 3/8” continuous bead of structural silicone, and
- designed for the defined explosive weights, including the mullions and frames.

Some windows also have ballistic and forced entry requirements, as described in Section 3.2 for the Pharmacy and 3.3 for the Police Operations of this report.

The window and door systems will be a delegated design with requirements incorporated into the specifications, however a design concept has been developed for verification of feasibility.

4.2.1 Windows

The requirements for the exterior windows are shown in Figure 8.

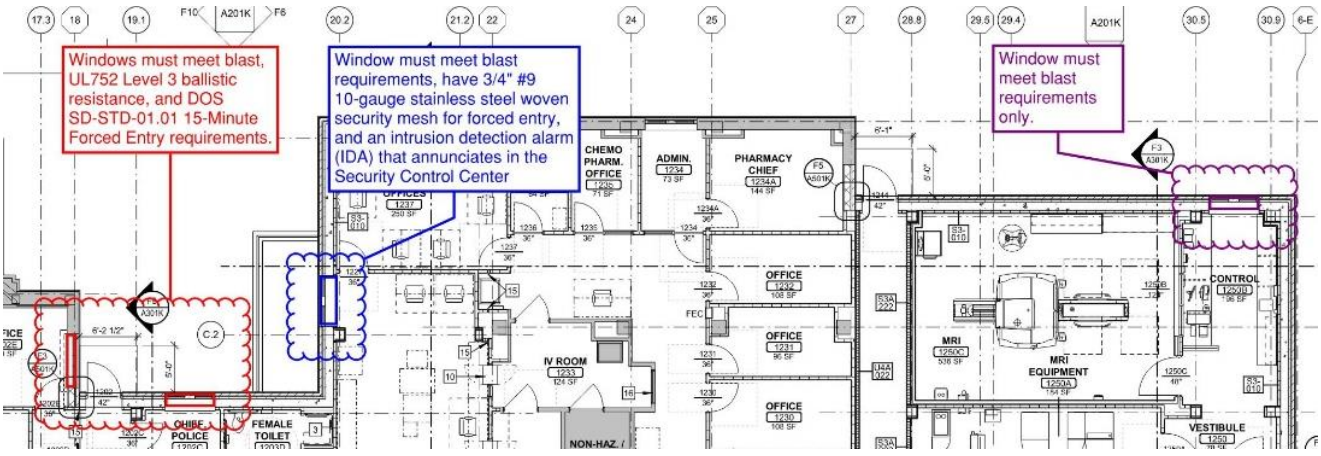

Figure 8: Exterior Windows and Corresponding Requirements

A 0.5” laminated inner pane as shown in Table 5 will meet the PSRDM requirements for the pharmacy and MRI windows. However, the police window is governed by the forced entry and ballistic requirements and is expected to have a thickness of approximately 2-3/8”. As final design will be provided by the window manufacturer, the detailed proof-of-concept layup should not be included on the drawings or in the specifications. The specifications will include the interlayer and performance requirements.

Table 5 Proof-of-concept glazing layup for pharmacy and MRI

Layer	Thickness	Orientation
Annealed Glass	5/16"	Protected Side
PVB	0.06"	
Annealed Glass	5/16"	
Airgap	0.50"	
Annealed Glass	5/16"	Threat Side

Table 6 summarizes the window requirements and basis of design.

Table 6: Exterior Window Requirements Summary

Location	Blast Requirements	Ballistic Requirements	Forced Entry Requirements	Window System Basis of Design	IGU Thickness
Police	Glass may crack but must remain in frame (GSA Condition 2)	UL752 Level 3	15 minutes Per DOS SD-STD-01.01	USAW800 6” deep x 2-1/2” wide mullion with steel stiffener Embed plates expected for forced entry requirements	Expected to be 2-3/8” (governed by forced entry and ballistic requirements)
Pharmacy	Glass may crack but must remain in frame (GSA Condition 2)	None	¾” #9 10-GA steel woven security mesh anchored to frame	USAW400 4-1/2” deep x 2-1/2” wide mullion	Expected to be 1.25” with 0.06” PVB interlayer for blast loads
MRI	Glass may crack but must remain in frame (GSA Condition 2)	None	None	USAW400 4-1/2” deep x 2-1/2” wide mullion	Expected to be 1.25” with 0.06” PVB interlayer for blast loads

The supporting structure (non-load bearing RC walls) will be designed and detailed on the structural drawings to accommodate the expected blast reactions from the window system. A clear and simple load path should be provided from the window frame, allowing for anchorage into the supporting structure. These details will be coordinated with the SEOR and the Architect.

4.2.2 Doors

Exterior doors are required to be 14-gauge minimum and/or fitted with laminated glass. The frames and support structure are required to be designed for blast loads, but not the operable leaf itself. This has been incorporated in the project specifications.

The door leading to the police area must meet additional forced entry and ballistic requirements as discussed in PSRDM Section 5.13 (see Section 3.3 of this report). Table 7 summarizes the requirements.

Table 7: Exterior Door Requirements Summary

Location	Blast Requirements	Ballistic Requirements	Forced Entry Requirements	Door Basis of Design	Hardware Requirements
Police	Frame deformation limit of L/40	UL 752 Level 3	15 minutes Per DOS SD-STD-01.01	Krieger Specialty Products	Certified FEBR Hinges and Locks Locks consist of two deadbolts
MRI	Frame deformation limit of L/40	None	None	Kawneer Insulpour	None
Penthouse (both buildings)	Frame deformation limit of L/40	None	None	Not specified	None

In accordance with the PSRDM, an armory door is not explicitly required to have forced entry or ballistic resistance unless it is part of the SCC.

Embedded steel plates along the jambs and header of the door openings are required for mounting of all forced-entry and ballistics rated doors. This has been coordinated with the structural engineer and architect.

4.3 Section 6.5 Roof Structure

Because the roof structure will contribute to the lateral system to resolve the blast reactions from the walls and the blast base shear force, it has been designed in accordance with the Structural requirements of PSRDM Chapter 7 (see Section 5.1 of this report). The requirements have been coordinated with the structural engineer.

4.4 Section 6.6 Critical Equipment Protection

All penthouses are determined to house critical equipment for facility operations and therefore must have a blast resistant enclosure; roof level equipment may be open above. Cladding on the enclosure must be designed to resist the applicable blast pressures and impulses.

The penthouses are enclosed with light gauge stud framed walls and metal deck at the roofs. To meet the blast requirements, the basis of design options for the wall studs are 800S350-118 @ 12" o.c. To support the larger louvers, steel tubes are required. This has been coordinated with the structural engineer, however final blast design of the stud walls is deferred to the Contractor through Specification 05 40 00.

The proposed basis of design product for the metal panels is by Centria. The panels also require blast design; the final design has similarly been deferred to the Contractor and has been incorporated into a performance specification and coordinated with the Architect.

Two louvers are located on the Radiology Penthouse and three louvers are located on the Police / Pharmacy Penthouse. Louvers (exhaust or intake) located on the exterior of each penthouse must be blast rated and should deny a direct line of sight from the design level threat located at the standoff distance to the critical infrastructure within.

A performance specification has been provided for the louvers which defers responsibility to the Contractor for coordination of the blast loads between the final design of the louvers and stud walls. Final determination of the basis of design product, acceptability of the louver size and the louver support structure is still being coordinated.

5 Chapter 7 Structural System

The following PSRDM sections in Chapter 7 apply to this project:

- Section 7.2 Blast Resistance
- Section 7.3 Design for Global Stability of the Structure
- Section 7.4 Prevention of Progressive Collapse

The other PSRDM sections and their requirements are not expected to apply to this project.

5.1 Section 7.2 Blast Resistance

All exterior structural elements have been designed to withstand blast resistance to acceptable levels in ASCE 59-11 as defined in the PSRDM. This includes the exterior walls, roof framing members, and roof deck. The section properties need to meet blast flexural and shear response limits. In addition, structural element connections are being designed to withstand the blast reactions. Columns must also be able to resist the blast base shear force (see Section 5.2 of this report). This has been coordinated with the SEOR.

For the main building roof, a concrete on metal deck roof will be used with shear studs to transfer the blast downward and uplift reactions from the deck to the beams. To meet blast and structural requirements the roof deck consists of:

- 6” thick slab – 4” LWC above deck: 2” X 16 GA Metal Deck with #7 rebar in the lower deck grooves @ 12” o.c.

For the penthouse roof, a metal deck roof will be used with puddle welds to transfer the blast downward and uplift reactions from the deck to the beams. The penthouse roof will consist of 16 Gauge 3N-24 Grade 40 metal decking.

Blast analysis of roof beams and girders was performed for the main buildings and for the pharmacy/police and radiology penthouses. An addendum will be submitted with the final design of the electrical penthouse. The beam and girder section sizes for the main buildings meet the blast loading and performance requirements in PSRDM, and results have been coordinated with the SEOR.

It is assumed there are no interior public areas in the program which require internal blast assessment.

5.2 Section 7.3 Design for Global Stability of the Structure

This new PSRDM provision requires the building additions to be designed to accommodate a blast base shear force if it governs over wind and seismic base shears. The base shear resulting from the blast governs for this project.

Assumptions required for the blast base shear calculation such as the fundamental period of the building and the design ductility have been provided by the SEOR.

Both buildings have been analyzed in the North-South direction and East-West direction since they are exposed to the roadway in either direction. The total force is proportional to the amount of exposed elevation above grade to a potential threat location on the road. The buildings’ lateral resisting system will be designed for the forces shown in Table 8. The structural engineer has confirmed the load path for the blast base shear will be through the roof diaphragm, into the steel frame structure, and resolved down to the buildings’ foundations.

Table 8 Blast Base Shears

Location	Direction	Natural Frequency	Period (s)	Base Shear (kips)
Pharmacy/Police	N-S	1.2132	0.824	68
	E-W	2.2066	0.453	34
Radiology	N-S	1.1056	0.904	44
	E-W	1.2133	0.824	20

5.3 Section 7.4 Prevention of Progressive Collapse

Single- and two-story structures are exempt from progressive collapse requirements. Per the PSRDM, unoccupied stories, including interstitial mechanical spaces, mechanical penthouses, are not considered a story. Below grade floors will be considered a story if there is any space that

is designated for human occupancy. There is a basement only at the Police and Pharmacy building. This means that the Police and Pharmacy building is a 2-story building. The Radiology building is considered a 1-story building. Therefore, this project does not require progressive collapse prevention for either building.

6 Chapter 8 Utilities and Building Services

The following PSRDM sections in Chapter 8 apply to this project:

- Section 8.3 Site Distribution

6.1 Section 8.3 Distribution

The requirements from Section 8.3.2 refer to the electrical distribution on site. The use of a basement space is proposed to house associated electrical equipment that is fed from a generator in another building, and not the generator itself. All electrical distribution components must not be located within the 100-year floodplain or with the applicable storm surge. A floodplain survey was conducted by third party engineers to establish that the site and elevation are outside of the 100-year floodplain. This information is being reviewed by the VA.

7 Building Services

Chapters 8-10 of the PSRDM outline many requirements associated with building systems designs to promote resiliency and redundancy. The utilities engineers have reviewed these design requirements (water, fuel, telecom, electrical, mechanical, security systems).

Arup has coordinated the requirements, but specific design of these systems is outside of our scope of work.

It is worth noting that there are new qualifications requirements for the Electronic Security Systems designers in Chapter 10, including a GISCP or CISSP, a RCDD, and CSI, CAFD, CST or PSP. The project team should verify that their electronic security systems designers meet the qualifications listed in Chapter 10.