SIERRA SANDS UNIFIED SCHOOL DISTRICT

MEEHLEIS MODULAR BUILDINGS

NEW MURRAY MIDDLE SCHOOL

SUMMARY OF RESISTANCE TO BLAST LOADS

BUILDING TYPES A, C, AND D

PHASE 1

PROTECTIVE TECHNOLOGIES GROUP

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SECTION 1: GENERAL

The following report provides a summary of the capability of the proposed multi-purpose and classroom buildings (types A, C, and D) for the SSUSD Murray Middle School project to resist the design blast loads and provide a Low Level of Protection (LLOP) per UFC 4-010-01. Structural components and connections have been analyzed using single-degree-of-freedom methods, finite element analyses, and hand calculations. The drawings referenced in subsequent sections are found in the Baseline Drawings provided by Meehleis Modular Buildings. In general, analyses show that nearly all structural members can be used as shown, but many connections require upgrade. The following comments and assumptions are applicable to the response summaries found in subsequent sections:

- It is assumed that NAVFAC will accept the use of Douglas-Fir Larch wood studs and a wall supported weight in the range of 8-12 psf to qualify as Conventional Construction per UFC 4-010-01.
- Required nailing and straps around shear wall openings will need to be determined in Phase 2.
- Local effects due to roof supported components such as heat pumps or mechanical systems will not be evaluated until actual locations have been finalized.
- It is assumed that roof overhangs/eaves will not be used for any of the buildings.
- It is assumed that blocking will be provided at all wood panel edges for roof and shearwall diaphragms.
- Foundation design/analysis work will be conducted during Phase 2 if required.
- It is assumed that the lateral force-resisting system for the sloped-roof portion of building A2 is wood shear walls at grid lines A8, A15, AA, and AE of the IBI DSA drawings.
- 3D rigid frame modules are either 12'x40' or 10'x32', with the exceptions of A2 and B1 (gym annex).
- Changes to the configurations shown in the provided drawings will likely require additional analysis. It is important to note that stronger members than those shown will have a significant effect on reaction forces and, thus, negate the validity of completed blast analyses. Stronger members do not necessarily correspond to an equivalent level of protection for blast.
- Adjustments for members or connections marked “No Good” are provided with a reasonably high level of confidence but cannot be guaranteed until Phase 2. These adjustment notes are provided to develop a more realistic baseline and expectation of the magnitude of required changes to resist the design blast loads.
- In addition to providing the response of components and connections to the design blast loads, Protective Technologies Group (PTG) has made a best effort to begin considering upgrade options where insufficient components exist. After review of this report, a follow-up meeting will be needed to discuss such considerations and the options available.
- It is very important that project details outlined in the project bid criteria from PTG be considered during the estimating phase. This includes, but is not limited to, items such as equipment placement, overhead mounted features, air intakes roof access, and emergency mass notification systems. PTG is available to provide guidance on any of these details as needed.

SECTION 2: RESPONSE SUMMARY FOR SITE-BUILT PANELIZED SECTION OF BUILDING A2

Part	Section	Detail(s) / Drawing(s)	Member	Connections
Roof Purlin	C6x4x14ga	1/S-3A2	OK	OK
Roof Beam (Interior)	C30.25x6.5x10ga	1/S-3A2	No Good (See Note 1.)	No Good (See Note 2.)
Roof Beam (Exterior)	C30.25x6.5x10ga	1/S-3A2	TBD (See Note 2.)	No Good (See Note 2.)
Roof Header Beam	C30.25x6.5x10ga	1/S-3A2	TBD (See Note 2.)	No Good (See Note 2.)
Roof Materials – Option 1	(See Note 3.)	1/S-3A2	OK	TBD (See Note 5.)
Roof Materials – Option 2	(See Note 4.)	1/S-3A2	OK	TBD (See Note 5.)
Chord Ties	TBD (See Note 6.)	1/S-3A2	TBD (See Note 6.)	TBD (See Note 6.)
Wood Studs	2x8 @ 16" o.c., 16'	1/S-3A2 R2/S-3A1, F2/S-3A1	OK (See Note 7.)	No Good (See Note 2.)
Wood Studs	2x8 @ 16" o.c., 9'-3"	1/S-3A2 R2/S-3A1, F2/S-3A1	OK (See Note 7.)	No Good (See Note 2.)
Top Plates	2x8 (Qty 2)	R2/S-3A1	OK	No Good (See Note 2.)
Bottom Plate	2x8	F2/S-3A1	OK	No Good (See Note 8.)
Sill Plate	4x8	F2/S-3A1	OK	No Good (See Note 8.)
Fiber Cement Lap Siding	5/16"	R2/S-3A1	OK	OK
Wall Plywood / OSB	1/2"	R2/S-3A1, F2/S-3A1	No Good – Use 3/4"	TBD (See Note 5)
Wall Gyp Board	1/2"	R2/S-3A1, F2/S-3A1	No Good – Use 5/8"	OK
Tackable Surface	TBD	R2/S-3A1, F2/S-3A1	OK	OK

Section 2 Notes:

1) Use stiffeners at 4' o.c. for all beams. 1 1/2" welds at beam web should be spaced at no more than 5" o.c. Welds at beam flange should be full length of connection.
2) A35 clips, 5/8" metal bolts @ 32" o.c., and top plate nailing insufficient for out-of-plane shear, in-plane shear, and uplift from roof rebound (uplift) due to blast. Multiple scenarios must be considered for blast response:
    a. For single stud and double stud locations at the short wall (east side) which do not support a roof beam end, use (2) ML26Z clips and (2) Simpson Strong Drive SDWS

Timber Screws with 0.22" diameter and 6" length (out-of-plane shear) through top plates into end grain of each stud.

b. For single stud and double stud locations at the tall wall (west side) which do not support a roof beam, use (2) ML26Z clips (out-of-plane shear).
c. For locations in which the roof beam ends bear on the short wall, use double 2x8 studs with (2) ML26Z clips, (2) Simpson Strong Drive SDWS Timber Screws with 0.22" diameter and 6" length, and significant tie-down mechanisms (example for estimating: (2) Simpson Strong-Tie HDQ8-SDS3 at top and bottom of double studs at beam supports, (4) total holdowns at each double stud).
d. For locations in which the roof beam ends bear on the tall wall, use double 2x8 studs with (2) ML26Z clips and significant tie-down mechanisms (example for estimating: (2) Simpson Strong-Tie HDQ8-SDS3 at top and bottom of double studs at beam supports, (4) total holdowns at each double stud), an additional angle may be necessary to be welded to the beams to connect the new all-thread rods to.

Because the response of the top plates and C30.25x6.5x10ga header beam is dependent on the nature of the upgraded connection scheme, Phase 2 work will be required to provide an accurate analysis of these sections. For estimating purposes, it should be expected that the header beam will require welded 10 gage stiffener plates at 4'-0" o.c. at a minimum.

3) Roof section consists of Class-A Single Ply Roofing over 1/2" Substrate over R30 Rigid Insulation over 18 Gage Metal B-Deck.
4) Roof section consists of Class-A Single Ply Roofing over 1/2" Substrate over R30 Rigid Insulation over 3/4" T&G Plywood.
5) Roof and wall materials are satisfactory for resisting the design blast loads, but fastener requirements must be determined in Phase 2 once further detail regarding panel layouts and fastener selections has been provided. For plywood fastener estimating purposes, assume boundary nailing @ 4", edge nailing @ 6", field nailing @ 12", fasteners with diameter = .148", 1.5" penetration into wood members.
6) Clarification is required regarding the method for developing a continuous chord for connected modular buildings.
7) Double 2x8 stud required at locations where roof beam ends bear on wall.
8) Nailed connections between bottom plates and sill plates will require modification, with spacings to be determined in Phase 2. The requirement for sill bolts can be estimated at this point to be on the order of 5/8" diameter at 16" o.c., minimum.

SECTION 3: RESPONSE SUMMARY FOR 3D RIGID FRAME MODULES (A1, A2, C, D1, D2, D3, D4, D5)

Part	Section	Detail(s) / Drawing(s)	Member	Connections
Roof Purlin, 10 ft	C6x4x14ga	Multiple	OK	OK
Roof Purlin, 12 ft	C6x4x14ga	Multiple	OK	OK
Roof Beam (Interior), 30"	C30x6.5x10ga	2/S-3A2	OK (See Note 1.)	No Good (See Note 2.)
Roof Beam (Exterior), 30"	C30x6.5x10ga	2/S-3A2	TBD (See Note 2.)	No Good (See Note 2.)
Roof Header Beam, 30"	C30x6.5x10ga	2/S-3A2	TBD (See Note 2.)	No Good (See Note 2.)
Roof Beam (Interior), 20"	C20x6.5x10ga	1/S-3A1, 1/S-3C, 2/S-3D1	OK (See Note 1.)	No Good (See Note 2.)
Roof Beam (Exterior), 20"	C20x6.5x10ga	1/S-3A1, 1/S-3C, 2/S-3D1	TBD (See Note 2.)	No Good (See Note 2.)
Roof Header Beam, 20"	C20x6.5x10ga	1/S-3A1, 1/S-3C, 2/S-3D1	TBD (See Note 2.)	No Good (See Note 2.)
Roof Beam (Interior), 16"	C16x6.5x10ga	1/S-3D1 1/S-3D2 1/S-3D3 1/S-3D4 1/S-3D5	OK (See Note 1.)	No Good (See Note 2.)
Roof Beam (Exterior), 16"	C16x6.5x10ga	1/S-3D1 1/S-3D2 1/S-3D3 1/S-3D4 1/S-3D5	TBD (See Note 2.)	No Good (See Note 2.)
Roof Header Beam, 16"	C16x6.5x10ga	1/S-3D1 1/S-3D2 1/S-3D3 1/S-3D4 1/S-3D5	TBD (See Note 2.)	No Good (See Note 2.)
Roof Materials – Option 1	(See Note 3.)	Multiple	OK	TBD (See Note 5.)
Roof Materials – Option 2	(See Note 4.)	Multiple	OK	TBD (See Note 5.)
Chord Ties	TBD (See Note 6.)	Multiple	TBD (See Note 6.)	TBD (See Note 6.)
Wood Studs	2x6 @ 16" o.c., ~9'-0"	Multiple	OK (See Note 7.)	No Good (See Note 8.)
Wood Studs	2x6 @ 16" o.c., ~8'-5"	Multiple	OK (See Note 7.)	No Good (See Note 8.)
Top Plates	2x6 (Qty 2)	R1/S-3A1	OK	No Good (See Note 2.)
Sill Plate	4x8	F1/S-3A1	OK	No Good (See Note 9.)
Floor Beam / Header	HSS2x6x1/4"	F1/S-3A1	OK	No Good (See Note 10.)

Fiber Cement Lap Siding	5/16"	R1/S-3A1	OK	OK
Wall Plywood / OSB	1/2"	R2/S-3A1, F2/S-3A1	No Good – Use 3/4"	TBD (See Note 5.)
Wall Gyp Board	1/2"	R2/S-3A1, F2/S-3A1	No Good – Use 5/8"	OK
Tackable Surface	TBD	R2/S-3A1, F2/S-3A1	OK	OK
Parapet Materials	All	Multiple	OK	OK
Steel Corner Columns	HSS6x4x3/8"	Multiple	OK	No Good (See Note 11)

Section 3 Notes:

1) Interior roof beams should conform to the bolt and stiffener plate layouts shown in Section 5.
2) 5/8" metal bolts @ 32" o.c. and top plate nailing insufficient for in-plane shear and uplift from roof rebound (uplift) due to blast. Because the response of the top plates and header beam (or exterior beam) is dependent on the nature of the upgraded connection scheme, Phase 2 work will be required to provide an accurate analysis of these sections. For estimating purposes, it should be expected that the header beams will require welded 10 gage stiffener plates at 4'-0" o.c. at a minimum.
3) Roof section consists of Class-A Single Ply Roofing over 1/2" Substrate over R30 Rigid Insulation over 18 Gage Metal B-Deck.
4) Roof section consists of Class-A Single Ply Roofing over 1/2" Substrate over R30 Rigid Insulation over 3/4" T&G Plywood.
5) Roof and wall materials are satisfactory for resisting the design blast loads, but fastener requirements must be determined in Phase 2 once further detail regarding panel layouts and fastener selections has been provided. For plywood fastener estimating purposes, assume boundary nailing @ 4", edge nailing @ 6", field nailing @ 12", fasteners with diameter = .148", 1.5" penetration into wood members.
6) Clarification is required regarding the method for developing a continuous chord for connected modular buildings.
7) Based on the first assumption in Section 1, wood studs will qualify for DoD Conventional Construction and not require blast analysis. Members and standard out-of-plane shear connections as shown in Baseline Drawings will be satisfactory.
8) Because the module roofs do not qualify for Conventional Construction, roof connections to the wall must be shown through analysis to provide adequate resistance for the design blast loads. Thus, the in-plane shear (from roof diaphragm) and uplift connections will require upgrade as discussed in Note 2.
9) The requirement for sill bolts can be estimated at this point to be on the order of 5/8" diameter at 16" o.c., minimum.
10) The welded connection between the HSS2x6x1/4" and foundation weld plate is insufficient. Welded angles at the back side of the HSS should be considered for estimating purposes. PTG will make every effort to develop a connection scheme which is efficient for the modular fabrication and installation.
11) Larger welds are likely required at the base of each column.

SECTION 4: RESPONSE SUMMARY FOR HSS MEMBERS SUPPORTING STRUCTURAL ELEMENTS FOR DOOR AND WINDOW OPENINGS (ALL BUILDINGS)

***See Critical Note 1 Below

Part	Section	Detail(s) / Drawing(s)	Member	Connections
Vertical Posts for RFM	HSS4x3x3/16"	1/S-2	OK	No Good (See Note 2.)
Vertical Posts for Gym	HSS4x3x3/16"	2/S-2	No Good (See Note 4.)	No Good (See Note 3.)
Vertical Posts for A2-SBP	HSS4x3x3/16"	2/S-2	OK	No Good (See Note 3.)
Horizontal Beams for RFM	HSS4x3x3/16"	1/S-2	OK	OK
Horizontal Beams for Gym	HSS4x3x3/16"	2/S-2	OK	OK
Horizontal Beams for A2-SBP	HSS4x3x3/16"	2/S-2	OK	OK
Wood Plates for RFM	2x6	1/S-2	TBD (See Note 5.)	TBD (See Note 5.)
Wood Plates for Gym	2x12	2/S-2	TBD (See Note 5.)	TBD (See Note 5.)
Wood Plates for A2-SBP	2x8	2/S-2	TBD (See Note 5.)	TBD (See Note 5.)

Section 4 Notes:

1) Nearly all HSS4x3x3/16" members provide adequate resistance to the design blast loads, but the use of this section must be verified with the selected blast-resistant window and door suppliers to ensure that proper connections can be made. Protective Technologies Group has utilized HSS for previous blast-resistant construction involving openings.
2) Welds as shown are insufficient to resist end reaction moments at header beam and floor beam. For estimating purposes, assume HSS vertical post will require a 6" deep “L” cut and be fully welded to the HSS2x6x1/4" floor beam (approximately 19" total weld including fillets and flare bevel groove at front face). Assume upper connection will require additional welded parts (i.e. small steel angle) at back face of HSS vertical post.
3) Assume upper connection will require re-configuration at back face of HSS vertical post. Lower connection also requires upgrade (TBD in Phase 2).
4) Gymnasium framing at the openings may require upgrade in Phase 2.
5) Acceptability of wood nailers inside of framed openings will be dependent on requirements from blast-resistant window and door suppliers. Door/window frames may need to be attached directly to steel members.

SECTION 5: BOLT AND STIFFENER PLATE CONFIGURATIONS FOR INTERIOR COLD-FORMED ROOF BEAMS

The images below are provided to show the desired bolt and stiffener plate spacing for interior roof beams. Sizes and spacings are not to scale and only intended for use as rough schematic outlines for locations. Typical edge distances and sizes should be used. The layouts shown maintain the maximum spacing of 8' as shown in the Baseline Drawings. Exterior roof beams should use typical spacing patterns with all welded stiffeners at 4' o.c. as noted in the Baseline Drawings. Figure 3 is typical for all 60' interior beam spans. The 1 1/2" stiffener welds at beam web should be spaced at no more than 5" o.c. Welds at beam flange should be the full length of the beam.

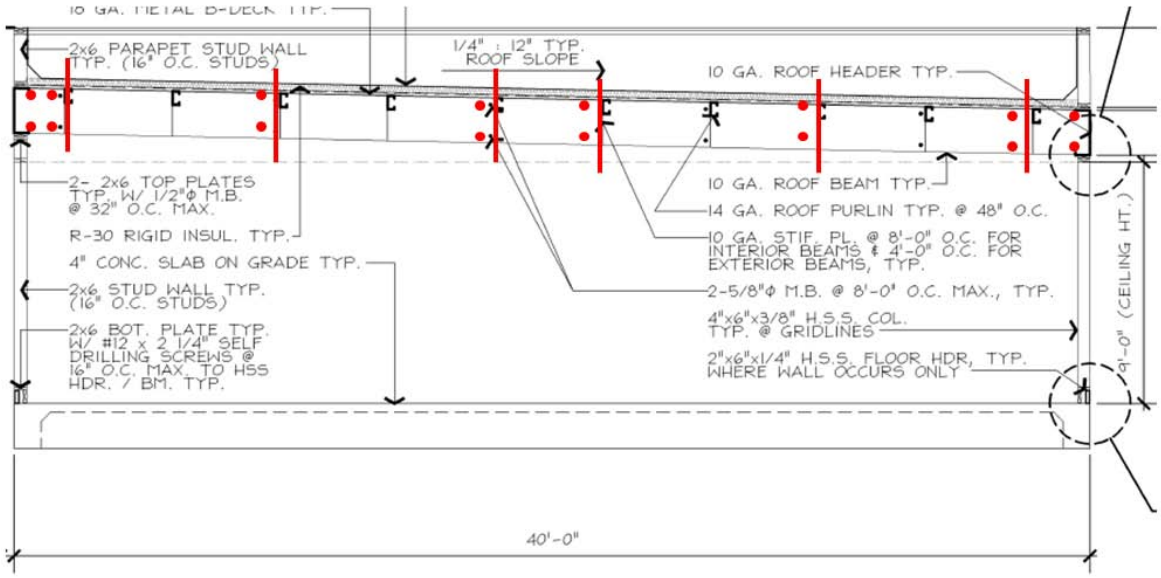

Figure 1: Bolt and Stiffener Plate Locations for 12x40 Modules

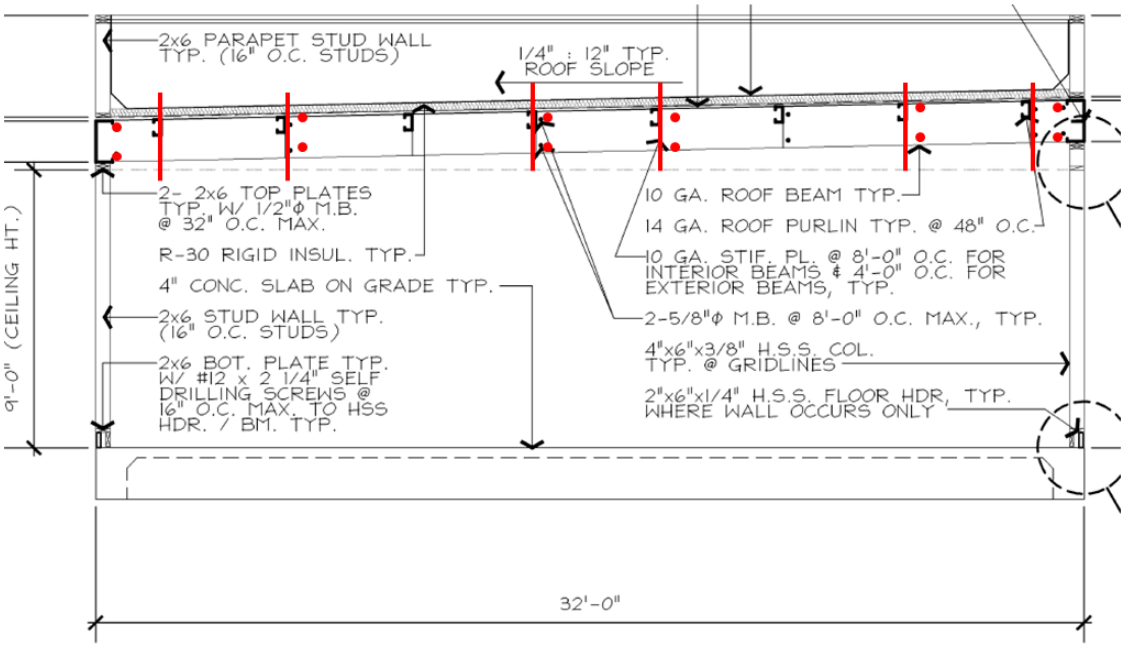

Figure 2: Bolt and Stiffener Plate Locations for 10x32 Modules

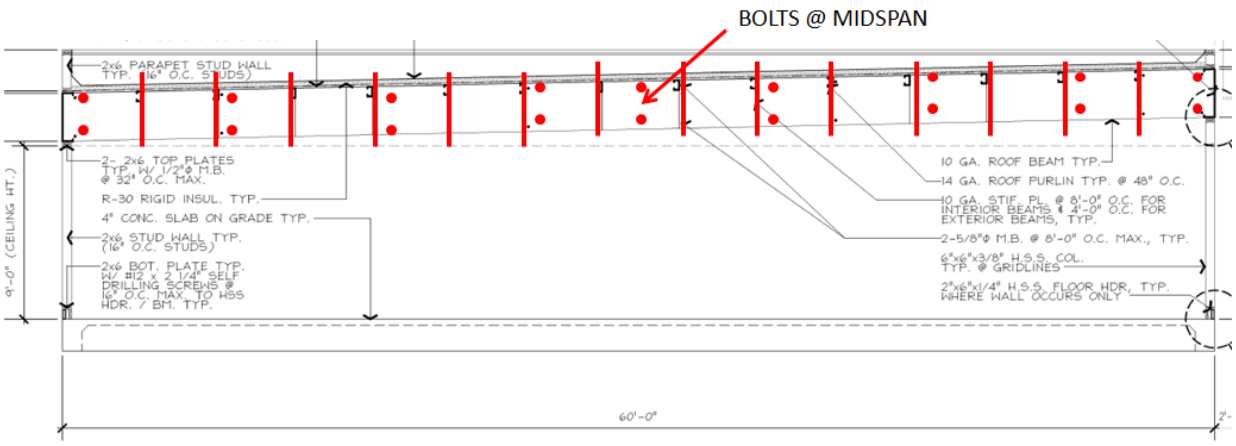

Figure 3: Bolt and Stiffener Plate Locations for 60' Beam Spans

SECTION 6: STATEMENT OF LIMITATIONS

This report has been prepared for the sole use of Meehleis Modular Buildings and Sierra Sands Unified School District. The scope of services performed for this investigation may not be appropriate to satisfy the needs of other users, and any use or re-use of this document or of the findings, conclusions, or recommendations presented herein is at the sole risk of said user. The interpretations and conclusions contained in this report are based on the expertise and experience of PTG in conducting similar assessments at similar sites with similar loadings.

Background information, design basis, and other data have been furnished to PTG by Meehleis Modular Buildings, Sierra Sands Unified School District, and/or other third parties, which PTG has used in preparing this report. PTG has relied on this information as furnished, and is neither responsible for nor have we confirmed the accuracy of this information.

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