
Case Study – School Community Safe Room: Southeast Kansas

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

Introduction

This case study presents an example of a tornado safe room that meets or exceeds the design criteria set forth in FEMA P-361 and ICC 500. The safe room is part of a larger middle school addition to an existing high school in [REDACTED]. The community safe room was designed to accommodate students and staff of both schools.

This project, one of three safe rooms funded by a local bond issue, was built because of the concerns of the community after the 2011 Joplin, MO tornado, which initially touched down approximately [REDACTED] miles [REDACTED]. Subsequently, in April 2014, shortly after opening all three safe rooms, an EF-2 tornado carved a path through the community, damaging over 100 homes and businesses and injuring approximately 24 people. None of the three safe rooms were hit by this event.

Items related to this project have been included in this case study, including:

- Initial wind load calculations for the safe room.
- A sample of the original conceptual design drawings for the Southeast Kansas safe room project.

Overview

[REDACTED], commissioned a [REDACTED] architectural firm to incorporate tornado safe rooms into the three school sites in the school district. The safe rooms

were designed to be multi-use and sized to shelter students and staff. They were not designed for public use.

The architectural firm recommended making a classroom wing for the new middle school that would serve the middle school students and also have space for high school students and staff. This would allow almost all occupants to access the shelter through the middle school addition without going outside. A major advantage of the design plan is that it can be implemented without disrupting school activities.

The new addition replaced a 1920 vintage multi-story building that has since been sold to developers who are repurposing it. This safe room has enough space—approximately 4,710 square feet of usable floor space—to support approximately 730 occupants. It is constructed with fully grouted and reinforced concrete masonry unit (CMU) walls and a reinforced concrete roof slab on composite metal deck supported by steel beams. The design meets the requirements of the newest local building codes for normal building use and technical guidelines in FEMA P-361 and ICC 500 documents for tornado community safe room use, including a design wind speed of 250 mph.

It's important to note that certain features of the case study may or may not apply to other safe room projects. For example, ICC 500 Section 702.3, Emergency Lighting, requires community tornado storm shelters to be provided with emergency lighting systems for shelter, shelter support and egress areas. The case study design plans address the emergency lighting requirement through a battery system that does not rely on an emergency generator for stand-by power. However, other tornado safe rooms may include additional critical support systems that call for use of an emergency generator for stand-by power. Commentary on emergency lighting and standby power may be found in FEMA P-361 Sections B7.2.4 and B7.2.5.

Design plans for the new addition for the [REDACTED] School Safe Room are provided in this case study. The plans are preceded by the wind load analysis on which the design is based.

Safe Room

Wind Loads per the ASCE 7-10

General Data

H = 15.33 ft.	Building Height
L = 85.33 ft.	Building Length
B = 79.20 ft.	Building Width
P = 17.33 ft.	Parapet Height
V = 250 mph	Safe Room Design Wind Speed
Exposure C	Site Exposure
K _d = 1.0	Directionality Factor
K _{zt} = 1.0	Topographic Factor
GC _{pi} = ±0.55	Internal Pressure Coefficient
G = 0.85	Gust Effect Factor

Reference

Figure B3-1 of FEMA P-361
Section B.3.2.4.3 of FEMA P-361
Section B.3.2.4.3 of FEMA P-361
Section B.3.2.4.3 of FEMA P-361
Section B.3.2.4.3.1 of FEMA P-361
Section B.3.2.4.3.1 of FEMA P-361

MWFRS (Directional Procedure) per Chapter 27 of ASCE 7-10

Velocity Pressure

$q_z = q_h = 0.00256K_zK_{zt}K_dV^2$ (lb/ft ²)	Eq. 27.3-1 of ASCE 7-10
$K_z = K_h = 0.853$	$K_p = 0.873$ Table 27.3-1 of ASCE 7-10
$q_z = q_n = 136.4$ psf	$g_p = 139.7$ psf

Wall Pressures

$p = qGC_p - q_i$ (GC _{pi})	Eq. 27.4-1 of ASCE 7-10
C_p Varies	
L/B = 1.08	
Windward Wall	$C_p = 0.8$
Leeward Wall	$C_p = -0.5$
Side Wall	$C_p = -0.7$
	} Figure 27.4-1 of ASCE 7-10

Roof Pressure

$$p = qGC_p - q_i (GC_{pi})$$

Eq. 27.4-1 of ASCE 7-10

C_p Varies

H/L = 0.18

0 to H/2 $C_p = -0.9, -0.18$

H/2 to H $C_p = -0.9, -0.18$

H to 2H $C_p = -0.5, -0.18$

>2H $C_p = -0.3, -0.18$

Figure 27.4-1 of ASCE 7-10

Parapet Pressures

$$p_p = q_p (GC_{pn})$$

Eq. 27.4-4 of ASCE 7-10

$GC_{pn} = +1.5$

$GC_{pn} = -1.0$

Section 27.4.5 of ASCE 7-10

MWFRS Load Summary

Surface	$q_h GC_p$	$q_h GC_{pi}$	Pressure w/ $+GC_{pi}$ (psf)	Pressure w/ $-GC_{pi}$ (psf)
Windward Wall	92.8	+/- 75.0	167.8	17.8
Leeward Wall	-58.0	+/- 75.0	17.0	-133
Side Wall	-81.2	+/- 75.0	-6.2	-156.2
Leeward Roof	Included in Windward Roof			
Windward Roof				
0 to H/2	-104.3	+/- 75.0	-29.3	-179.3
H/2 to H	-104.3	+/- 75.0	-29.3	-179.3
H to 2H	-58.0	+/- 75.0	17.0	-133.0
> 2H	-34.8	+/- 75.0	40.2	-109.8

Windward Parapet = 209.6 psf

Leeward Parapet = -139.7 psf

Components and Cladding (Part 1) per Chapter 30 of ASCE 7-10

Velocity Pressure

$$q_z = q_h = 0.00256K_zK_{zt}K_dV^2 \text{ (lb/ft}^2\text{)}$$

Eq. 30.3-1 of ASCE 7-10

$$K_z = K_h = 0.853$$

Table 30.3-1 of ASCE 7-10

$$q_h = 136.4 \text{ psf}$$

Wall Pressures

$$p = q_n [(GC_p) - (GC_{pi})]$$

Eq. 30.4-1 of ASCE 7-10

GC_p Varies

Figure 30.4-1 of ASCE 7-10

Note: Values of GC_p may be reduced 10% for roofs w/ slope < 10° but were not used here.

Effective Area = 10 sf

Negative Zone 4 $GC_p = -1.1$

Negative Zone 5 $GC_p = -1.4$

Positive Zone 4 & 5 $GC_p = 1.0$

Effective Area = 100 sf
 Negative Zone 4 $GC_p = -0.92$
 Negative Zone 5 $GC_p = -1.04$
 Positive Zone 4 & 5 $GC_p = 0.82$

Effective Area = 500 sf
 Negative Zone 4 $GC_p = -0.8$
 Negative Zone 5 $GC_p = -0.8$
 Positive Zone 4 & 5 $GC_p = +0.7$

Corner Zone Width
 $a = > 0.10 (B) = 7.92 \text{ ft.}$
 $0.4 (H) = 6.13 \text{ ft.}$
 $0.04 (B) = 3.17 \text{ ft.}$
 Minimum Width = 3.0 ft.

Figure 30.4-1 of ASCE 7-10
 $< =$ Governs

Roof Pressures

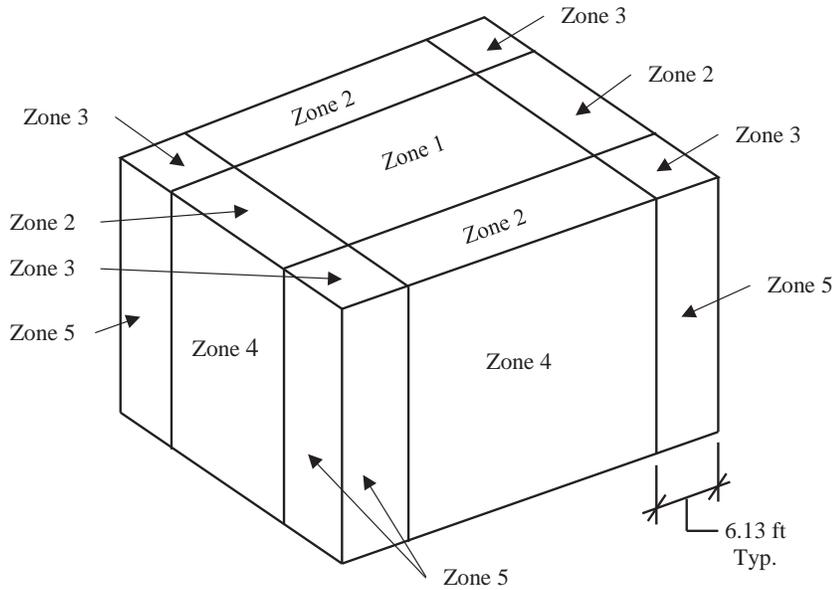
$p = q_h [(GC_p) - (GC_{pi})]$ Eq. 30.4-1 of ASCE 7-10
 GC_p Varies

Effective Area = 10 sf		
Negative Zone 1	$GC_p = -1.0$	} Figure 30.4-2A of ASCE 7-10
Negative Zone 2	$GC_p = -1.8$	
Negative Zone 3	$GC_p = -2.8$	
Positive Zones 1, 2, & 3	$GC_p = 0.3$	
Effective Area = 100 sf		
Negative Zone 1	$GC_p = -0.9$	} Figure 30.4-2A of ASCE 7-10
Negative Zone 2	$GC_p = -1.1$	
Negative Zone 3	$GC_p = -1.1$	
Positive Zones 1, 2, & 3	$GC_p = 0.2$	
Effective Area = 500 sf		
Negative Zone 1	$GC_p = -0.9$	} Figure 30.4-2A of ASCE 7-10
Negative Zone 2	$GC_p = -1.1$	
Negative Zone 3	$GC_p = -1.1$	
Positive Zones 1, 2, & 3	$GC_p = 0.2$	

Corner Zone Width
 $a = > 0.10 (B) = 7.92 \text{ ft.}$
 $0.4 (H) = 6.13 \text{ ft.}$
 $0.04 (B) = 3.17 \text{ ft.}$
 Minimum Width = 3.0 ft.

Figure 30.4-2A of ASCE 7-10
 $< =$ Governs

Components and Cladding Load Summary



Surface	Zone	10 SF Trib. Pressure (psf)	100 sf Trib. Pressure (psf)	500 sf Trib. Pressure (psf)
Roof	Negative Zone 1	-211.4	-197.8	-197.8
	Negative Zone 2	-320.5	-225.1	-225.1
	Negative Zone 3	-456.9	-225.1	-225.1
	Positive All Zones	115.9	102.3	102.3
Wall*	Negative Zone 4	-225.1	-200.5	-184.1
	Negative Zone 5	-266.0	-216.9	-184.1
	Positive All Zones	211.4	186.9	170.5

*Note GC_p values for the walls was not reduced due to the roof slope

SCHOOL TORNADO SAFE ROOM

SOUTHEAST KANSAS

DRAWING INDEX	
COVER SHEET	
SITE PLAN	SP1.1
CODE ANALYSIS PLAN – BASE AND ALTERNATE	CS1.1
SAFE ROOM SITE AND FLOOR PLAN	CS1.2
FLOOR PLAN	A1.1
FLOOR PLAN – DIMENSIONS	A1.2
ROOF PLAN	A2.1
ELEVATIONS	A3.1
ELEVATIONS AND DETAIL	A4.1
ARCHITECTURAL DETAILS	A5.1
ARCHITECTURAL DETAILS	A6.1
CEILING PLAN	A7.1
STRUCTURAL NOTES	S0.1
FOUNDATION PLAN	S1.1
LOW ROOF FRAMING PLAN	S2.1
STRUCTURAL DETAILS – FOUNDATION AND WALLS	S3.1
STRUCTURAL DETAILS – ROOF AND WALLS	S4.1
MECHANICAL SYMBOL SCHEDULE AND NOTES	M0.1
MECHANICAL FLOOR PLAN	M1.1
MECHANICAL ROOF PLAN	M2.1
MECHANICAL DETAILS	M3.1
MECHANICAL DETAILS	M3.2
WASTE & VENT PLUMBING FLOOR PLAN	P1.1
PLUMBING FLOOR PLAN	P2.1
PLUMBING SCHEDULES AND DETAIL	P3.1
PLUMBING DIAGRAMS	P3.2
ELECTRICAL SCHEDULES AND NOTES	E0.1
ELECTRICAL DETAILS	E1.1
ELECTRICAL POWER FLOOR PLAN	E2.1
ELECTRICAL LIGHTING FLOOR PLAN	E3.1

**SCHOOL TORNADO
SAFE ROOM
SOUTHEAST KANSAS**

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

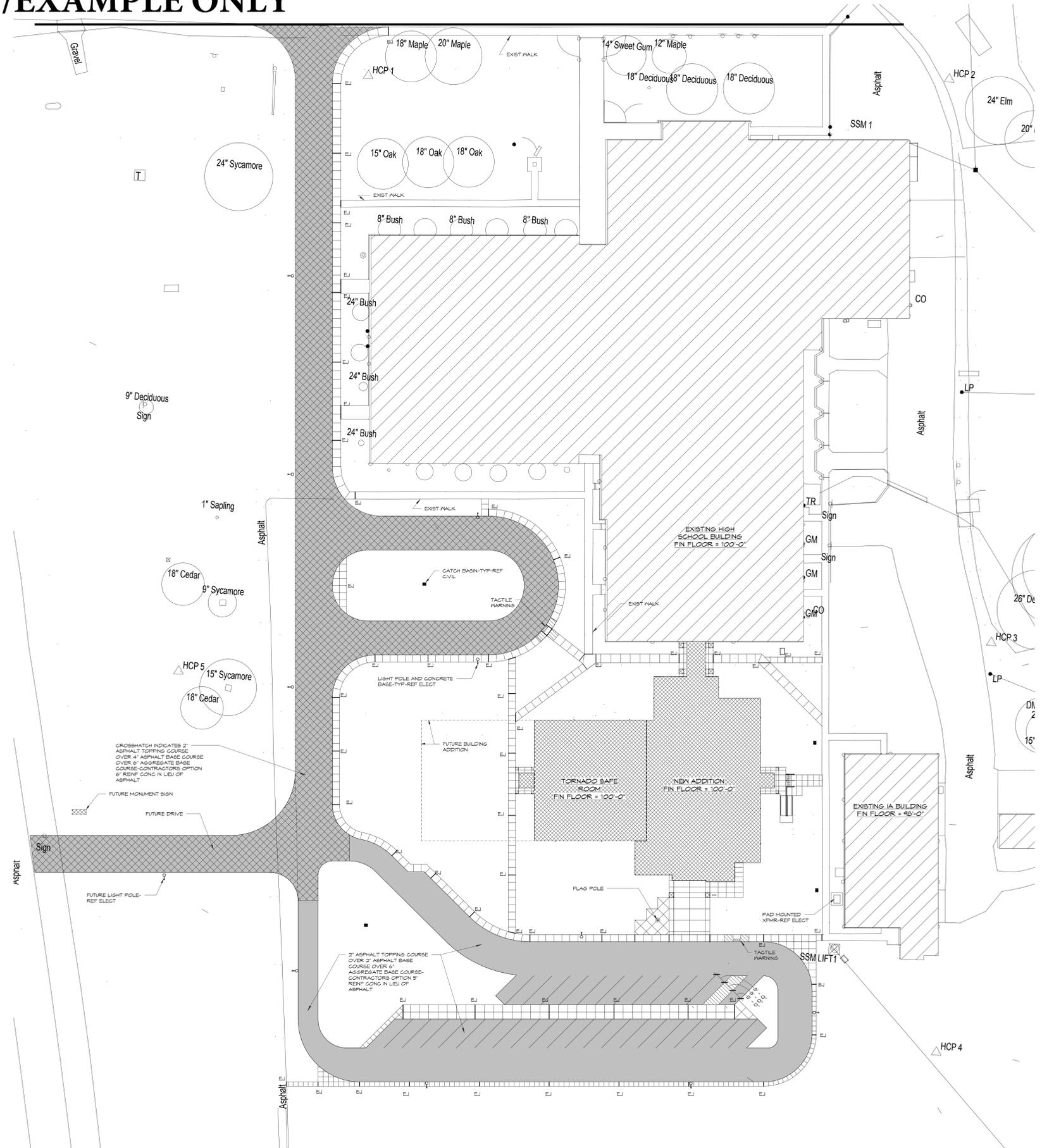
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

COVER SHEET

SHEET NO.:

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



SITE PLAN
1" = 30'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements. FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

NOT FOR CONSTRUCTION/EXAMPLE ONLY

CODE INFORMATION - BASE

PROJECT INFORMATION

- PROJECT CONSTRUCTION PURPOSE: NEW CONST, ADDITION, REMODEL
- REASON FOR SUBMITTAL: NEW CONST, ADDITION, REMODEL
- TO THE BEST OF THE ARCHITECT'S & DESIGN CONSULTANTS KNOWLEDGE, THIS PROJECT COMPLIES WITH THE FOLLOWING:
 - 2006 INTERNATIONAL BUILDING CODE (IBC)
 - 2006 INTERNATIONAL FIRE CODE (IFC)
 - 2006 INTERNATIONAL MECHANICAL CODE (IMC)
 - 2006 UNIFORM PLUMBING CODE (UPC)
 - 2009 NATIONAL ELECTRICAL CODE (NFPA-70)
 - 1991 AMERICAN DISABILITIES ACT (ADA)
- FUTURE ADDITIONS-N/A
- OWNER: [REDACTED]
- DATE DEVELOPED: 11/21/2012 DATE OF RECORD
- ARCHITECT: [REDACTED]
- ARCHITECT'S SEAL: SEE STAMP AT RIGHT
- DESIGN CONSULTANTS:
 - STRUCTURAL: [REDACTED]
 - MECHANICAL: [REDACTED]
 - ELECTRICAL: [REDACTED]
- FIRE SERVICE: [REDACTED]
- LOCAL BUILDING INSPECTION DEPT: [REDACTED]

BUILDING #1 - EXISTING CONSTRUCTION

- OCCUPANCY: A2.1, A-3 ASSEMBLY & E EDUCATIONAL- MIXED USE
- TYPE OF CONSTRUCTION: I-B, NONCOMPLIANT
- EXISTING BUILDING AREA: 69,075 SF
- EXISTING WALKWAY: 9,648 SF
- TOTAL EXISTING CONSTRUCTION: 78,723 SF

BUILDING #2 - NEW ADDITION

- OCCUPANCY: E EDUCATIONAL
- TYPE OF CONSTRUCTION: I-B, SPRINKLED
- BASIC ALLOWABLE AREA: 14,500 SF
- ALLOWABLE AREA INCREASE FOR OPEN PERIMETER (SEE CALCULATIONS THIS SHT): 9,700 SF
- TOTAL ALLOWABLE AREA (REF. 503.1.2): 24,200 SF
- ACTUAL BLDG AREA: 11,027 SF
- ALLOWABLE STORES: 2
- ALLOWABLE HEIGHT: 95 FT
- ACTUAL STORES: 1
- ACTUAL HEIGHT: 20 FT

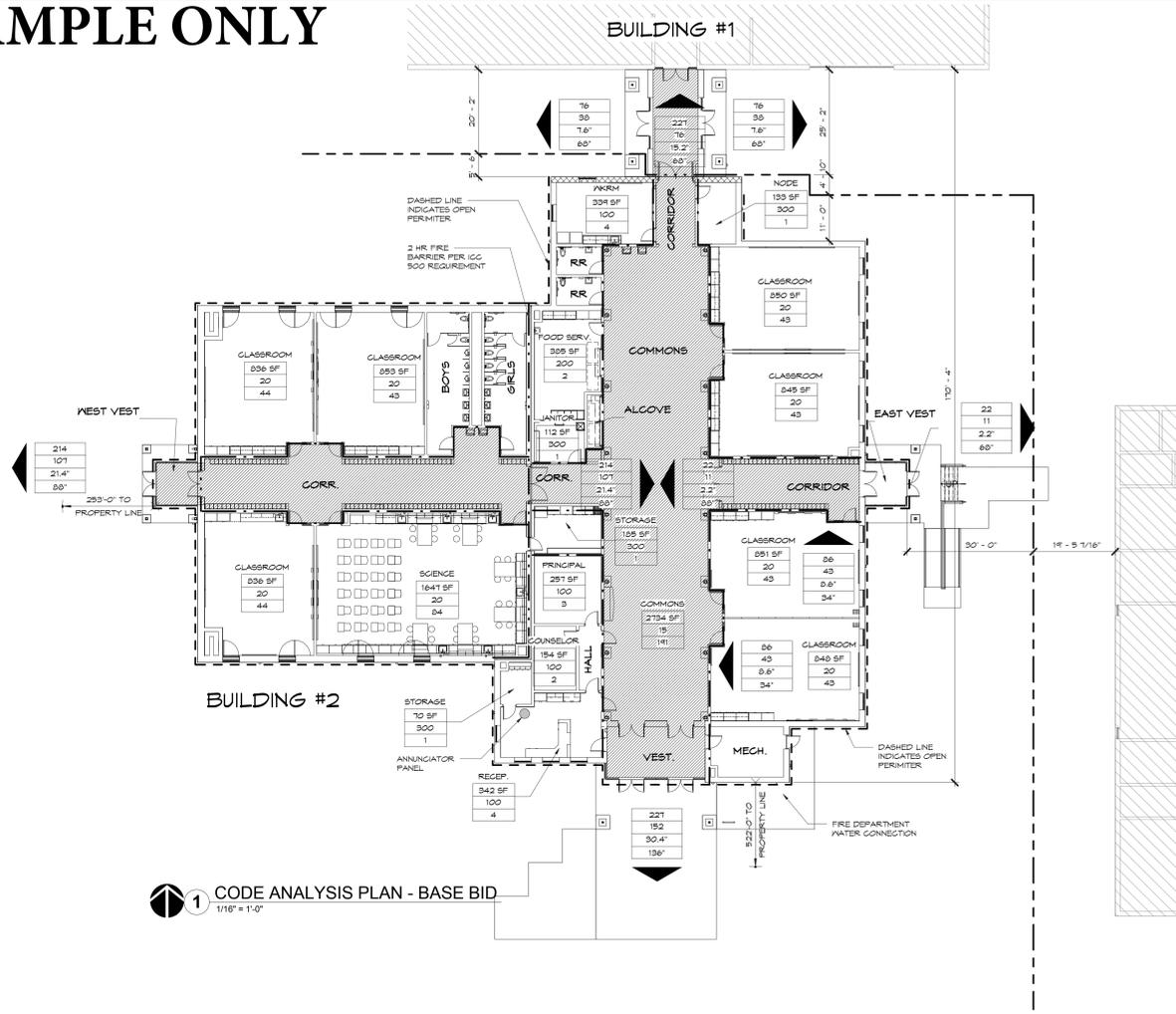
BUILDING #3

- TYPE OF CONSTRUCTION: I-B, SPRINKLED
- OCCUPANCY: E
- BASIC ALLOWABLE AREA: 14,500 SF
- ALLOWABLE AREA INCREASE FOR OPEN PERIMETER (SEE CALCULATIONS THIS SHT): 9,700 SF
- TOTAL ALLOWABLE AREA (REF. 503.1.2): 24,200 SF
- ACTUAL BLDG AREA: 11,027 SF
- ALLOWABLE STORES: 2
- ALLOWABLE HEIGHT: 95 FT
- ACTUAL STORES: 1
- ACTUAL HEIGHT: 20 FT

- NO AUTOMATIC FIRE SUPPRESSION SYSTEM PRESENT AT BUILDING #2. NO AUTOMATIC FIRE SUPPRESSION SYSTEM PRESENT OR REQUIRED AT EXISTING BUILDINGS.
- SUPERVISED AND ADDRESSABLE MONITORING SYSTEM CONSISTING OF REMOTE ANNUNCIATOR/CONTROL PANEL, FIRE ALARM HORNS AND STROBES, FIRE ALARM ACTIVATION DEVICES, SMOKE DETECTORS, BATTERY BACKUP SYSTEM.
- BATTERY BACKUP EXIT & EGRESS LIGHTING
- SMOKE CONTROL SYSTEM: AUTOMATIC AIR HANDLING EQUIPMENT SHUTDOWN WITH DUCT SMOKE DETECTORS
- WATER SUPPLY REQUIREMENTS FOR FIRE SUPPRESSION: CITY FIRE HYDRANTS
- ALTERNATIVE DESIGN AND/OR ALTERNATIVE METHODS OF CONSTRUCTION: N/A
- IN COMPLIANCE TO KANSAS ADMINISTRATIVE REGULATION (K.A.R.) 22-1-7 ADOPTED JULY 9, 2004 BY THE KANSAS STATE FIRE MARSHALL - PUBLIC BUILDING OWNERS / OPERATORS OF NEW CONSTRUCTION, ADDITIONS, OR CHANGE OF USE SHALL PROVIDE AND PERMANENTLY MAINTAIN A "CODE FOOTPRINT" ON SITE AVAILABLE TO FIRE AUTHORITIES.

PLUMBING FIXTURES (TABLE 202.1 FOR E OCCUPANCY)

300 OCCUPANT LOAD	REG'D	ACTUAL
WATER CLOSETS-MEN 1/2/50	3.0	6
WATER CLOSETS-WOMEN 1/2/50	3.0	6
LAVATORIES (MEN & WOMEN) 1/2/50	3.0	4
DRINKING FOUNTAINS 300/100	3.0	4



1 CODE ANALYSIS PLAN - BASE BID
1/8" = 1'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

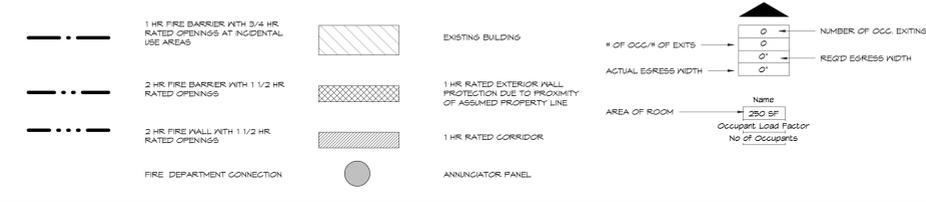
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

CODE ANALYSIS PLAN - BASE AND ALTERNATE

SHEET NO.: CS1.1

DATE: AUGUST 2014

CODE LEGEND



CODE INFORMATION - ALT

PROJECT INFORMATION

- PROJECT CONSTRUCTION PURPOSE: NEW CONST, ADDITION, REMODEL
- REASON FOR SUBMITTAL: NEW CONST, ADDITION, REMODEL
- TO THE BEST OF THE ARCHITECT'S & DESIGN CONSULTANTS KNOWLEDGE, THIS PROJECT COMPLIES WITH THE FOLLOWING:
 - 2006 INTERNATIONAL BUILDING CODE (IBC)
 - 2006 INTERNATIONAL FIRE CODE (IFC)
 - 2006 INTERNATIONAL MECHANICAL CODE (IMC)
 - 2006 UNIFORM PLUMBING CODE (UPC)
 - 2009 NATIONAL ELECTRICAL CODE (NFPA-70)
 - 1991 AMERICAN DISABILITIES ACT (ADA)
- FUTURE ADDITIONS-N/A
- OWNER: [REDACTED]
- DATE DEVELOPED: 11/21/2012 DATE OF RECORD
- ARCHITECT: [REDACTED]
- ARCHITECT'S SEAL: SEE STAMP AT RIGHT
- DESIGN CONSULTANTS:
 - STRUCTURAL: [REDACTED]
 - MECHANICAL: [REDACTED]
 - ELECTRICAL: [REDACTED]
- FIRE SERVICE: [REDACTED]
- LOCAL BUILDING INSPECTION DEPT: [REDACTED]

BUILDING #1 - EXISTING CONSTRUCTION

- OCCUPANCY: A2.1, A-3 ASSEMBLY & E EDUCATIONAL- MIXED USE
- TYPE OF CONSTRUCTION: I-B, NONCOMPLIANT
- EXISTING BUILDING AREA: 69,075 SF
- EXISTING WALKWAY: 9,648 SF
- TOTAL EXISTING CONSTRUCTION: 78,723 SF

BUILDING #2-NEW ADDITION

- OCCUPANCY: E EDUCATIONAL
- TYPE OF CONSTRUCTION: I-B, SPRINKLED
- BASIC ALLOWABLE AREA: 14,500 SF
- ALLOWABLE AREA INCREASE FOR OPEN PERIMETER (SEE CALCULATIONS THIS SHT): 10,875 SF
- 300% ALLOWABLE AREA INCREASE FOR FULLY SPRINKLED BLDG (SEE CALCULATIONS THIS SHT): 43,500 SF
- TOTAL ALLOWABLE AREA (REF. 503.1.2): 68,875 SF
- ACTUAL BLDG AREA: 11,023 SF
- ALLOWABLE STORES: 2
- ALLOWABLE HEIGHT: 95 FT
- ACTUAL STORES: 1
- ACTUAL HEIGHT: 20 FT

BUILDING #3

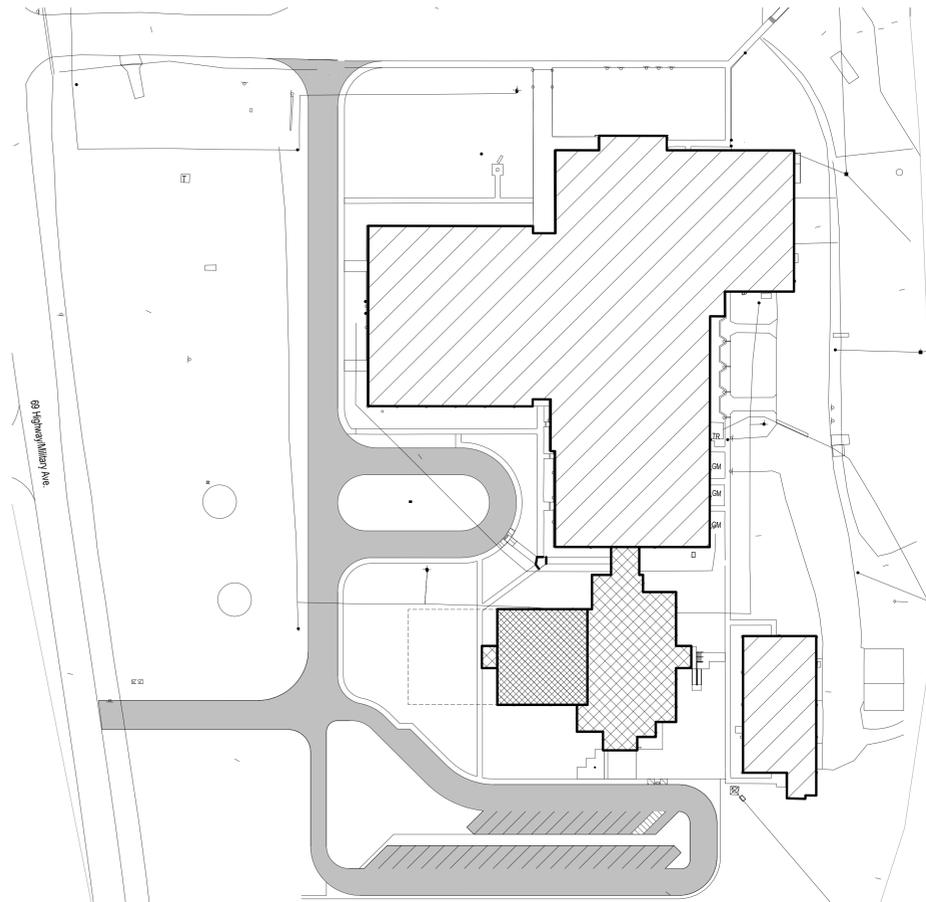
- TYPE OF CONSTRUCTION: I-B, SPRINKLED
- OCCUPANCY: E
- BASIC ALLOWABLE AREA: 14,500 SF
- ALLOWABLE AREA INCREASE FOR OPEN PERIMETER (SEE CALCULATIONS THIS SHT): 9,700 SF
- TOTAL ALLOWABLE AREA (REF. 503.1.2): 24,200 SF
- ACTUAL BLDG AREA: 11,023 SF
- ALLOWABLE STORES: 2
- ALLOWABLE HEIGHT: 95 FT
- ACTUAL STORES: 1
- ACTUAL HEIGHT: 20 FT

- AUTOMATIC FIRE SUPPRESSION SYSTEM PRESENT AT BUILDING #2. NO AUTOMATIC FIRE SUPPRESSION SYSTEM PRESENT OR REQUIRED AT EXISTING BUILDINGS.
- SUPERVISED AND ADDRESSABLE MONITORING SYSTEM CONSISTING OF REMOTE ANNUNCIATOR/CONTROL PANEL, FIRE ALARM HORNS AND STROBES, FIRE ALARM ACTIVATION DEVICES, SMOKE DETECTORS, BATTERY BACKUP SYSTEM.
- BATTERY BACKUP EXIT & EGRESS LIGHTING
- SMOKE CONTROL SYSTEM: AUTOMATIC AIR HANDLING EQUIPMENT SHUTDOWN WITH DUCT SMOKE DETECTORS
- WATER SUPPLY REQUIREMENTS FOR FIRE SUPPRESSION: CITY FIRE HYDRANTS
- ALTERNATIVE DESIGN AND/OR ALTERNATIVE METHODS OF CONSTRUCTION: N/A
- IN COMPLIANCE TO KANSAS ADMINISTRATIVE REGULATION (K.A.R.) 22-1-7 ADOPTED JULY 9, 2004 BY THE KANSAS STATE FIRE MARSHALL - PUBLIC BUILDING OWNERS / OPERATORS OF NEW CONSTRUCTION, ADDITIONS, OR CHANGE OF USE SHALL PROVIDE AND PERMANENTLY MAINTAIN A "CODE FOOTPRINT" ON SITE AVAILABLE TO FIRE AUTHORITIES.

PLUMBING FIXTURES (TABLE 202.1 FOR E OCCUPANCY)

300 OCCUPANT LOAD	REG'D	ACTUAL
WATER CLOSETS-MEN 1/2/50	3.0	6
WATER CLOSETS-WOMEN 1/2/50	3.0	6
LAVATORIES (MEN & WOMEN) 1/2/50	3.0	4
DRINKING FOUNTAINS 300/100	3.0	4

NOT FOR CONSTRUCTION/EXAMPLE ONLY



FEMA SHELTER SITE PLAN
1" = 60'-0"

PROJECT INFORMATION
 TYPE OF CONSTRUCTION: NEW CONSTRUCTION
 DESCRIPTION: COMMUNITY SAFE ROOM
 LOCATION: ██████████
 COUNTY: ██████████
 CITY: ██████████
 OWNER: ██████████
 USE: EDUCATION, MIDDLE SCHOOL/HIGH SCHOOL

CODE COMPLIANCE
 FEMA 361, 2ND EDITION 2009
 ICC-500
 LOCAL PERMITS OBTAINED

SAFE ROOM INFORMATION
 TYPE: COMMUNITY, MULTIPLE (CLASSROOMS)
 NUMBER OF EGRESS POINTS: 2
 DURATION: 2 HOURS
 GROSS AREA: 6,504 SF
 NON-OCCUPYABLE AREA: 110 SF
 USABLE AREA: 5,914 SF
 MAXIMUM ALLOWABLE OCCUPANCY: 100
 WHEEL CHAIR = 20 SF/10 SF/OCCUPANT + 2
 CLASSROOMS = (2,759 SF - 30 SF (HC)) X .65/5 SF/OCCUPANT = 356
 SCIENCE RM = (1,176 SF X 5.15 SF/OCCUPANT = 160
 CORRIDOR = (1,131 SF X .85/5 SF/OCCUPANT = 112
 BEDROOM: 0
 OCCUPANCY PROPOSED: 125 (STUDENT POPULATION + STAFF)
 TOTAL REQUIRED AREA MINIMUM: 125 X 9 SF/OCCUPANT = 3,625 SF
 ROOF LIVE LOAD: 100 PSF

WIND HAZARD
 DESIGN METHODOLOGY: FEMA 361, 2ND EDITION, 2009
 ICC-500, ASCE 7-10 DIRECTIONAL PROCEDURE
 SAFE ROOM DESIGN WIND ZONE: IV
 SAFE ROOM DESIGN WIND SPEED: 250 MPH (3-SEC GUST)
 DESIGN EXPOSURE CATEGORY: 0
 ENCLOSURE CLASSIFICATION: PARTIALLY ENCLOSED
 DIRECTIONALITY FACTOR (Kd): 1.0
 IMPORTANCE FACTOR (I): 1.0
 INTERNAL PRESSURE COEFFICIENT (Cpi): 0.55
 TOPOGRAPHIC EFFECTS (Kzt): 1.0
 DEBRIS IMPACT CRITERIA
 MISSILE SIZE: 15 LB, 2X4
 HORIZONTAL MISSILE SPEED: 100 MPH
 VERTICAL MISSILE SPEED: 67 MPH

FLOOD HAZARD
 SFHA: N/A
 FIRM PANEL NUMBER: 2002100340C
 FLOOD ZONE: X
 BASE FLOOD ELEVATION (1% CHANCE OF ANNUAL EXCEEDANCE): N/A
 0.2% CHANCE OF ANNUAL EXCEEDANCE ELEVATION: N/A
 LOWEST FLOOR FFE: 828.36' ± 100'-0"
 LOWEST FLOOR FFE (MEAL): 828.36' ± 100'-0"
 DATUM: NAVD83

OTHER HAZARDS
 NEHRP COMPLIANCE: N/A
 OTHER: SAFE ROOM IS NOT DESIGNED TO WITHSTAND DAMAGE FROM COLLAPSE OF ADJACENT SCHOOL STRUCTURE (NO ADJACENT TALL STRUCTURES PRESENT ON SITE)

WALLS/OPENINGS/DOOR ASSEMBLIES/WINDOW & WINDOW ASSEMBLIES
 WALL CONSTRUCTION: FULLY REINFORCED AND GROUTED CMU
 ROOF CONSTRUCTION: REINFORCED CONCRETE ON COMPOSITE METAL DECK
 SYSTEM TEST METHOD FOR TORNADO:
 ICC-500, SECTION 804, FEMA P-361, SECOND EDITION, APPENDIX E
 RESULTS: PASS
 GLAZING TEST METHOD:
 NOT APPLICABLE PER ICC 500 SECTION 306.3.2, EXCEPTION #2
 RESULTS: N/A
 OPENING PROTECTION: DOORS AND SHUTTERS
 TEST METHOD: ICC-500, SECTION 306.4.804
 RESULTS: PASS
 SOIL COVERAGE: N/A (SAFE ROOM COMPLETELY ABOVE GRADE)
 AUTHORITY HAVING JURISDICTION: CITY MUNICIPALITY AND KANSAS STATE FIRE MARSHAL

MECHANICAL/VENTILATION/ELECTRICAL
 VENTILATION METHOD: NATURAL
 TOTAL VENTING AREA: 4,350 SQ IN FREE AREA (25% LOU, 75% HIGH)
 VENTING AREA PER OCCUPANT: 6 SQ IN
 LIGHTING: EMERGENCY LIGHTING BATTERY POWERED
 OPENING PROTECTION: FULLY REINFORCED CMU ALCOVES, ENGINEERED STEEL DUCT OPENINGS, AND ENGINEERED STEEL VENTILATION ROOF OPENINGS
 METHOD OF PROTECTION EQUIPMENT:
 WIND FORCES: ICC-500
 DEBRIS IMPACT: ICC-500
 FLOODING: N/A
 SEISMIC: N/A
 MANMADE: N/A

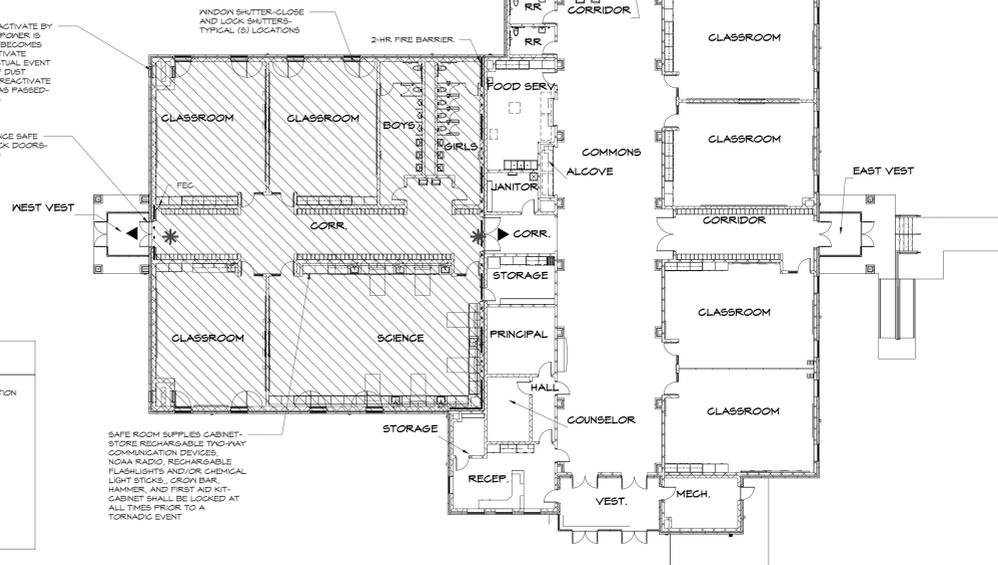
ADA REQUIREMENTS
 SAFE ROOM IS ACCESSIBLE TO INDIVIDUALS WITH DISABILITIES LOCATED ON GROUND LEVEL.

TOILETS
 THREE (3) FLUSH TOILETS ARE PROVIDED WITHIN THE SAFE ROOM (ADA ACCESSIBLE).

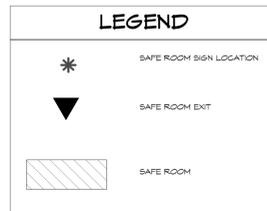
SIGNAGE
 SAFE ROOM DIRECTIONAL SIGN: INSIDE EACH ROOM IN EXISTING BUILDING AND NEW ADDITION, SAFE ROOM SIGN AT EACH ENTRY DOOR, TOTAL OF (2)

NATURAL VENTILATION-ACTIVATE BY FLIPPING SWITCH ONCE POWER IS LOST AND SAFE ROOM BEGINS UNCOMFORTABLE-INACTIVATE SYSTEM DURING THE ACTUAL EVENT TO MINIMIZE AMOUNT OF DUST ENTERING SAFE ROOM-REACTIVATE SYSTEM ONCE EVENT HAS PASSED-TYPICAL (2) LOCATIONS

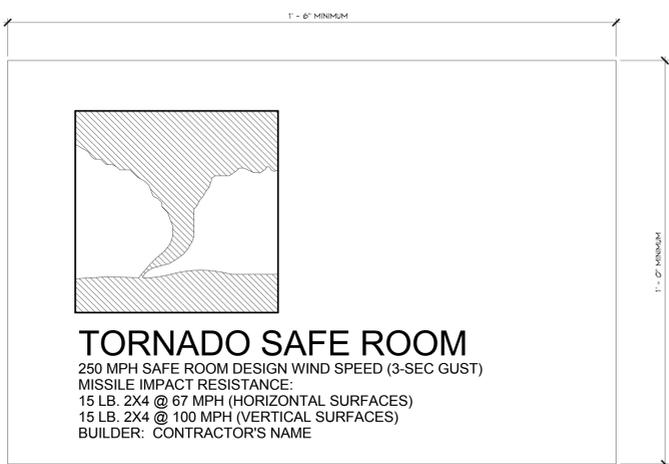
SAFE ROOM DOORS-ONCE SAFE ROOM IS OCCUPIED LOCK DOORS-TYPICAL (2) LOCATIONS



FEMA SAFE ROOM PLAN
1/16" = 1'-0"



SAFE ROOM SUPPLIES CABINET, STORE RECHARGEABLE TWO-WAY COMMUNICATION DEVICES, NOAA RADIO, RECHARGEABLE FLASHLIGHTS AND/OR CHEMICAL LIGHT STICKS, GROUND BARE HAMMER AND FIRST AID KIT. CABINET SHALL BE LOCKED AT ALL TIMES PRIOR TO A TORNADO EVENT



NOTE: ALL SIGN INFORMATION TO BE PROVIDED IN BRAILLE PER ADAAG STANDARDS

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

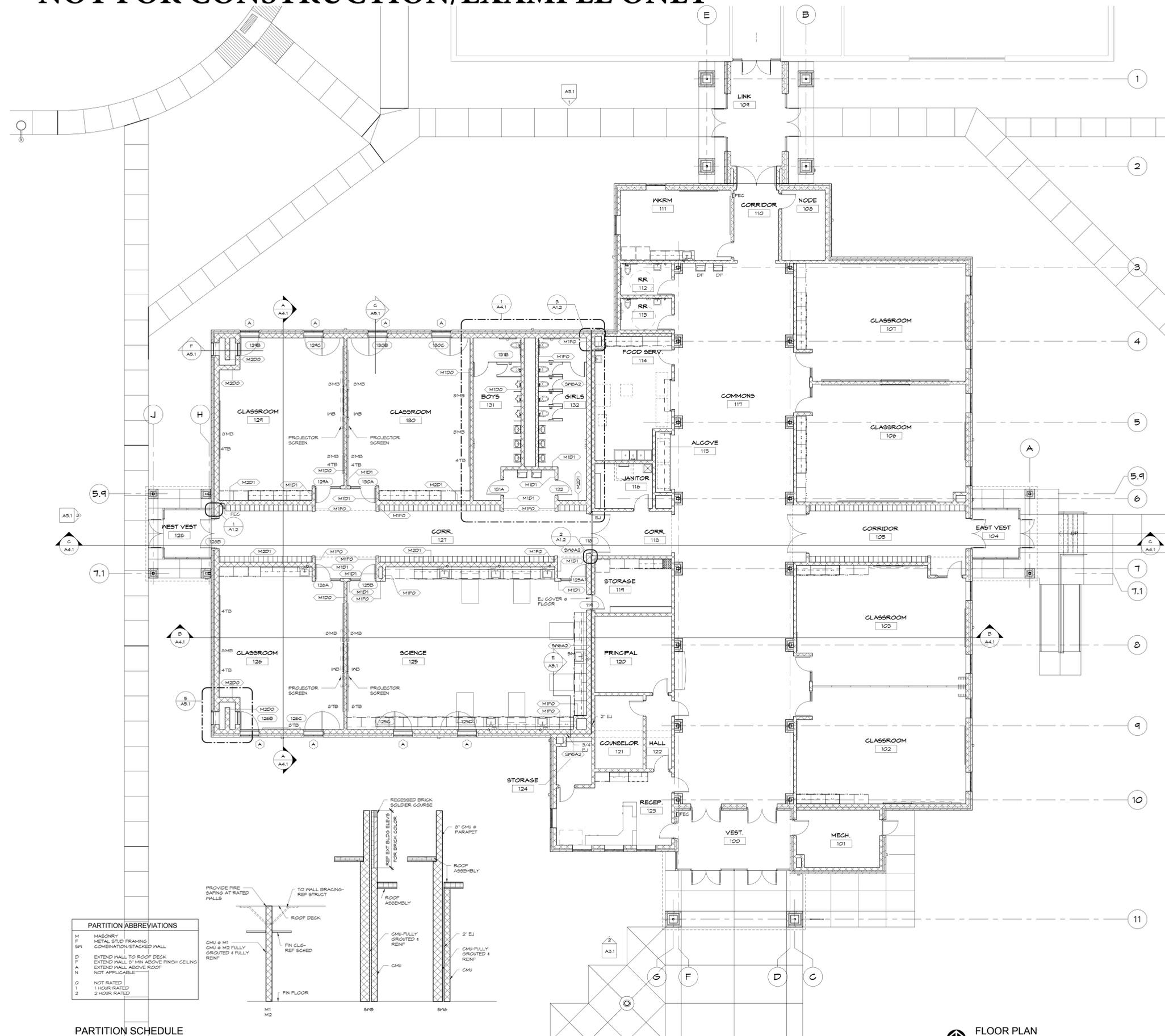
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

SAFE ROOM SITE AND FLOOR PLAN

SHEET NO.: **CS12**

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



PARTITION ABBREVIATIONS	
M	MASONRY
F	METAL STUD FRAMING
SM	CONVENTIONAL PACKED WALL
D	EXTEND WALL TO ROOF DECK
F	EXTEND WALL 6" MIN ABOVE FINISH CEILING
A	EXTEND WALL ABOVE ROOF
N	NOT APPLICABLE
G	NOT RATED
1	1 HOUR RATED
2	2 HOUR RATED

PARTITION SCHEDULE
1/4" = 1'-0"

FLOOR PLAN
1/8" = 1'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

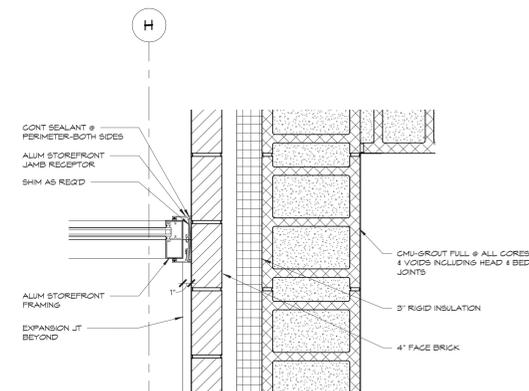
FLOOR PLAN

SHEET NO.: **A1.1**

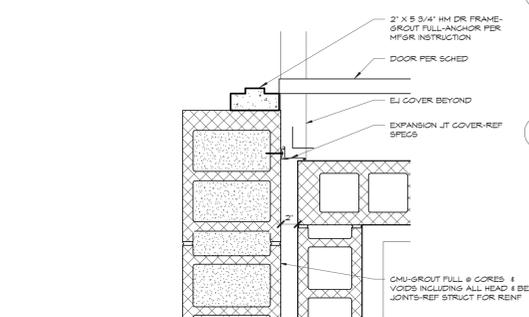
DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

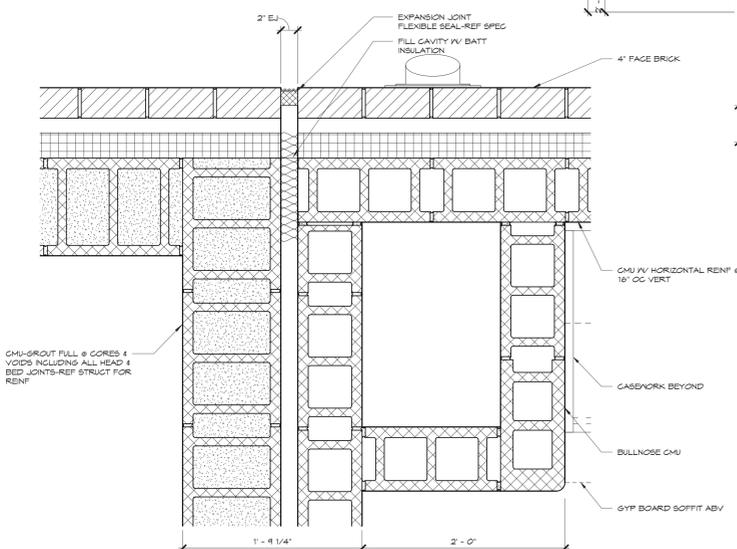
SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS



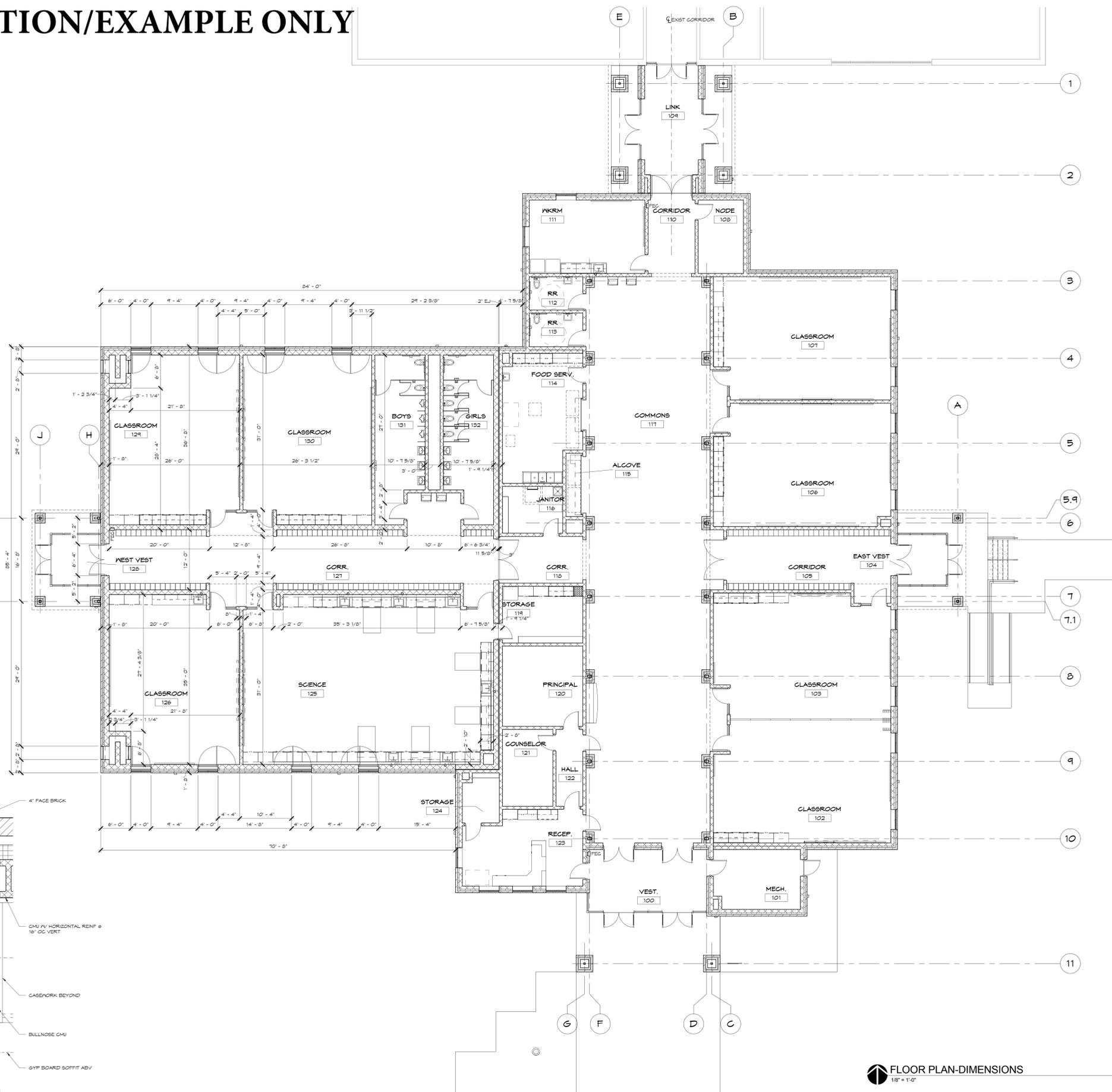
1 EXPANSION JT DETAIL @ VESTIBULE
1/12" = 1'-0"



2 EXPANSION JT DETAIL- DOOR 118
1/12" = 1'-0"



3 EXPANSION JT DTL @ FOOD SERV.
1/12" = 1'-0"



FLOOR PLAN-DIMENSIONS
1/8" = 1'-0"

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

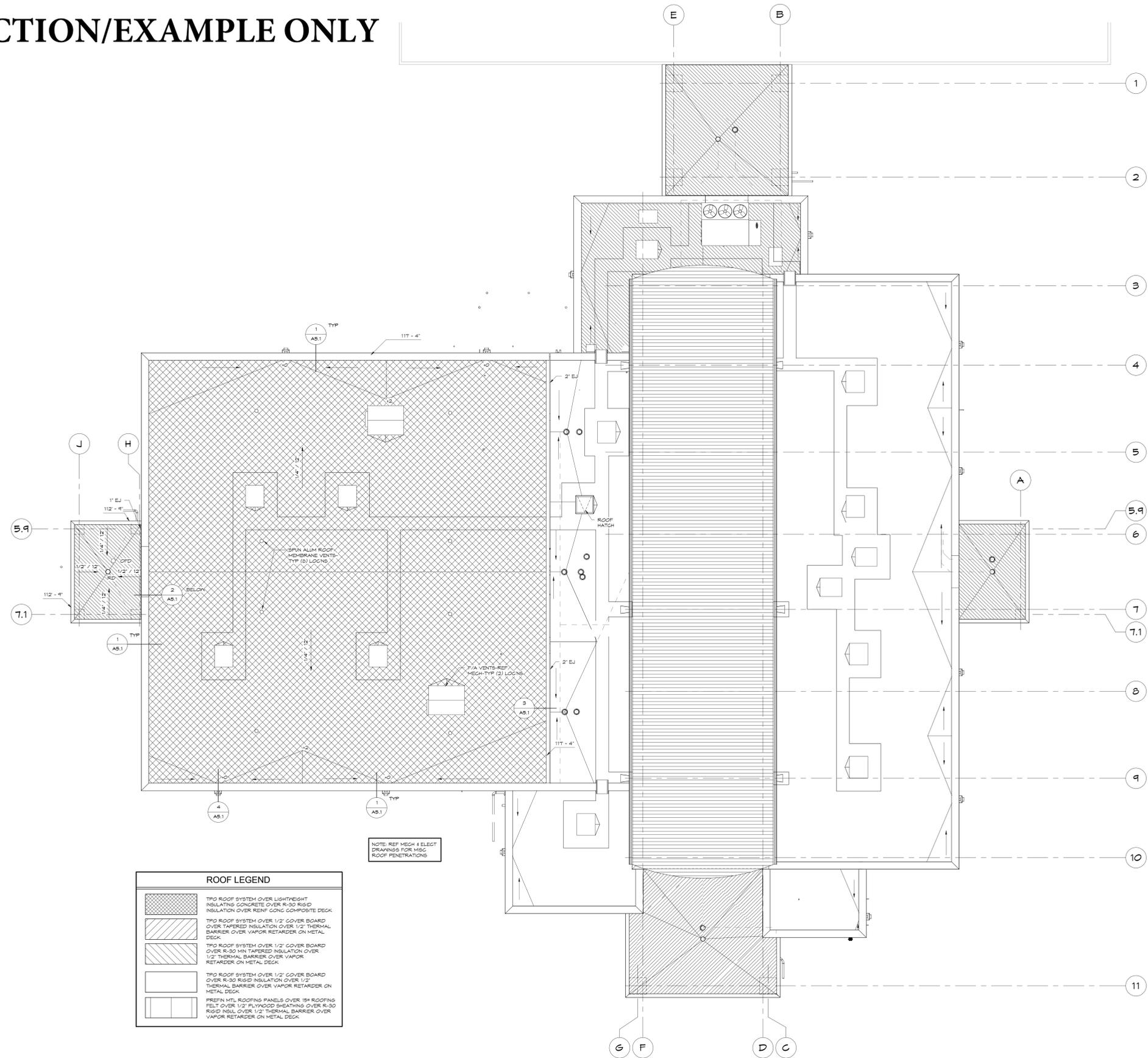
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

FLOOR PLAN - DIMENSIONS

SHEET NO.: A1.2

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



ROOF LEGEND	
	TPO ROOF SYSTEM OVER LIGHTWEIGHT INSULATING CONCRETE OVER R-30 RISID INSULATION OVER REINFORCING COMPOSITE DECK
	TPO ROOF SYSTEM OVER 1/2" COVER BOARD OVER TAPERED INSULATION OVER 1/2" THERMAL BARRIER OVER VAPOR RETARDER ON METAL DECK
	TPO ROOF SYSTEM OVER 1/2" COVER BOARD OVER R-30 RISID INSULATION OVER 1/2" THERMAL BARRIER OVER VAPOR RETARDER ON METAL DECK
	TPO ROOF SYSTEM OVER 1/2" COVER BOARD OVER R-30 RISID INSULATION OVER 1/2" THERMAL BARRIER OVER VAPOR RETARDER ON METAL DECK
	PREFIN MET. ROOFING PANELS OVER 1/2" ROOFING FELT OVER 1/2" PLYWOOD SHEATHING OVER R-30 RISID NSUL OVER 1/2" THERMAL BARRIER OVER VAPOR RETARDER ON METAL DECK

NOTE: REF MECH & ELECT DRAWINGS FOR MSC ROOF PENETRATIONS

ROOF PLAN
1/8" = 1'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

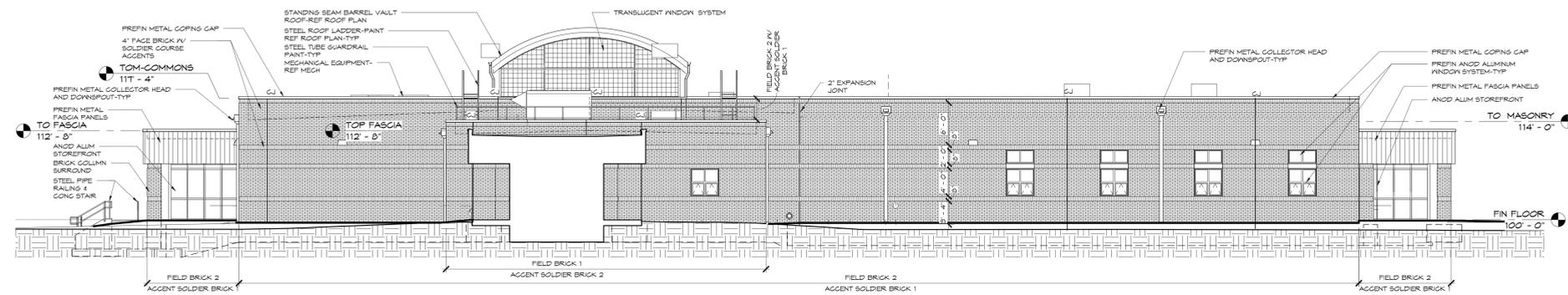
FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements. FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:
The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

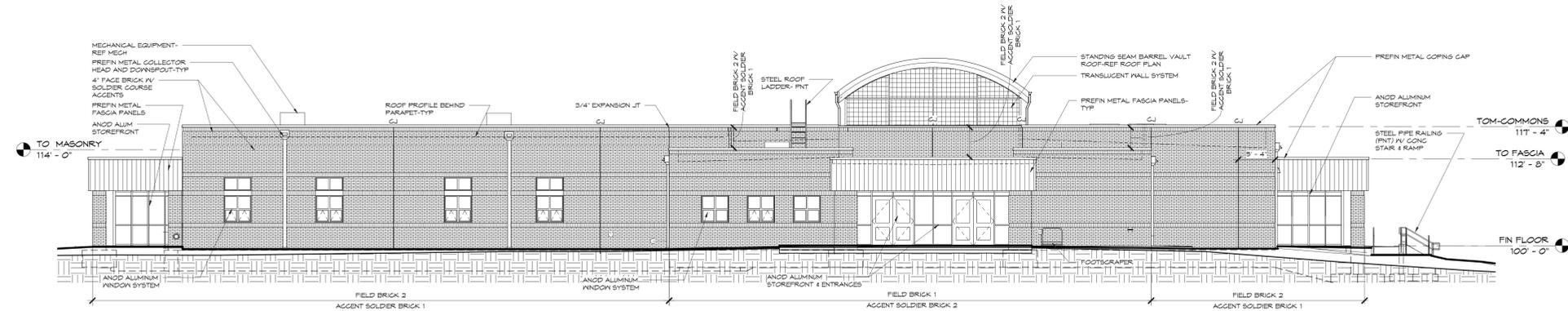
Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes. Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design. The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

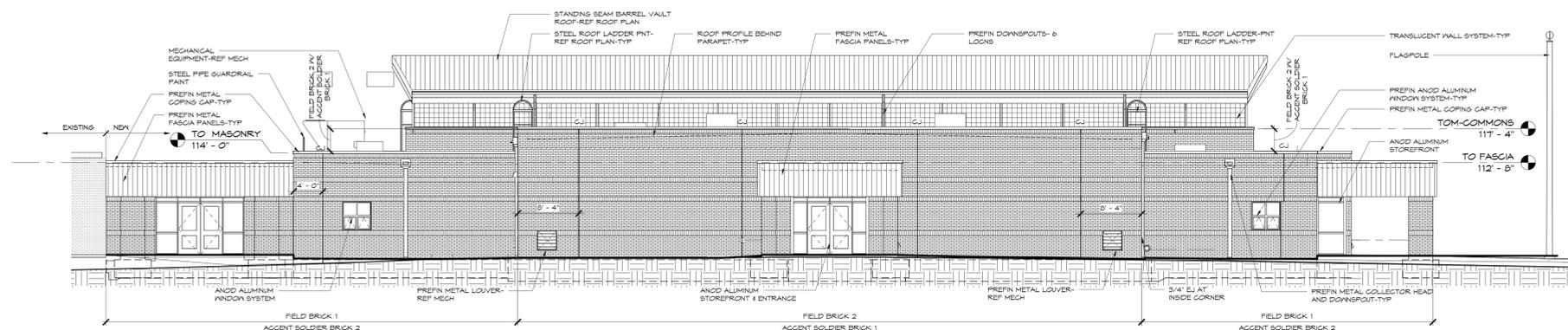
NOT FOR CONSTRUCTION/EXAMPLE ONLY



1 NORTH BUILDING ELEVATION
1/8" = 1'-0"



2 SOUTH BUILDING ELEVATION
1/8" = 1'-0"



3 WEST BUILDING ELEVATION
1/8" = 1'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-381 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

ELEVATIONS

SHEET NO.: A3.1

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:
The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

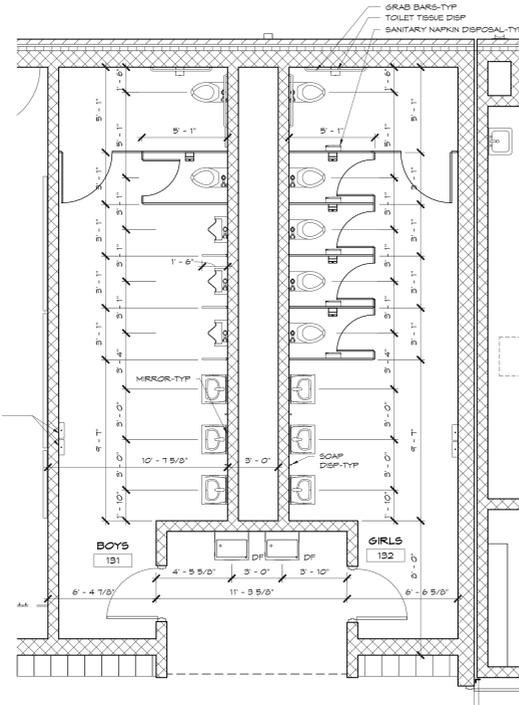
Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

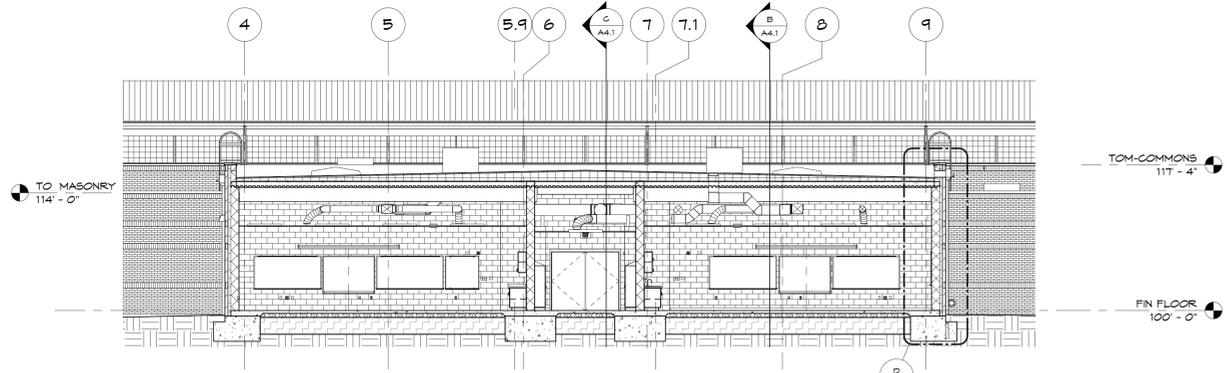
ELEVATIONS AND DETAIL

SHEET NO.: **A4.1**

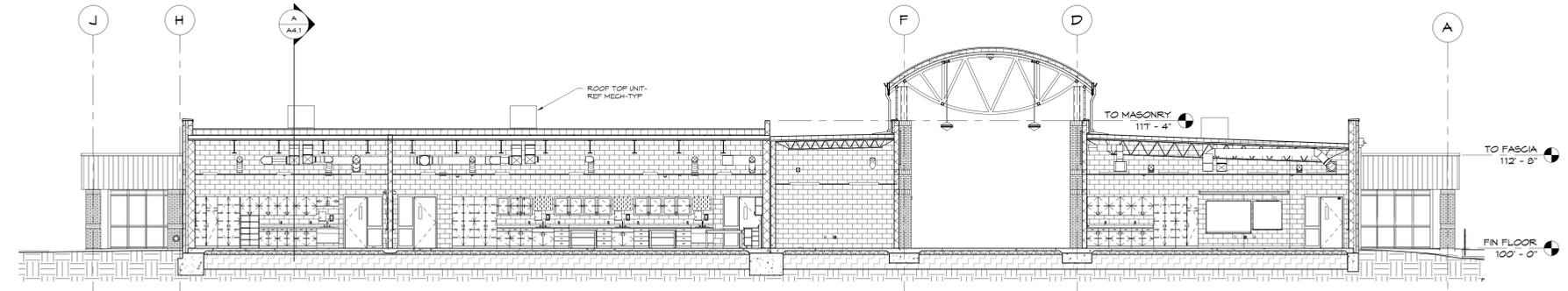
DATE: AUGUST 2014



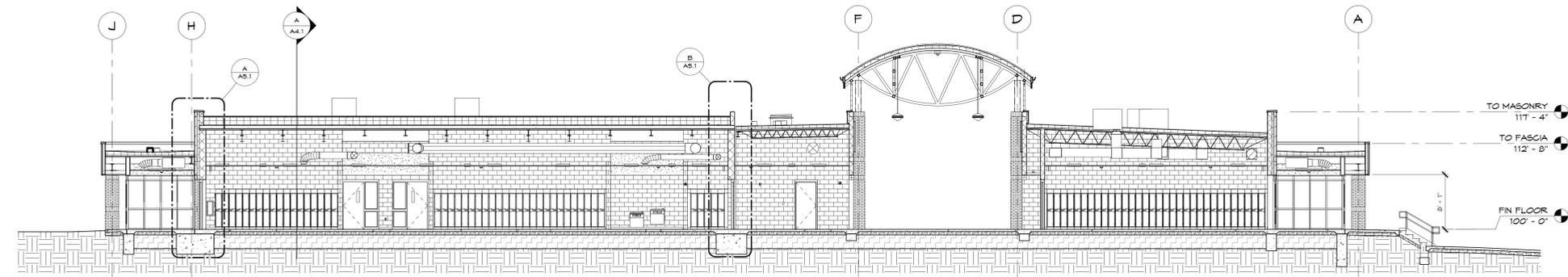
1 ENLARGED MAIN RESTROOM
1/4" = 1'-0"



A N-S BUILDING SECTION-CLASSRMS 126 & 129
1/8" = 1'-0"

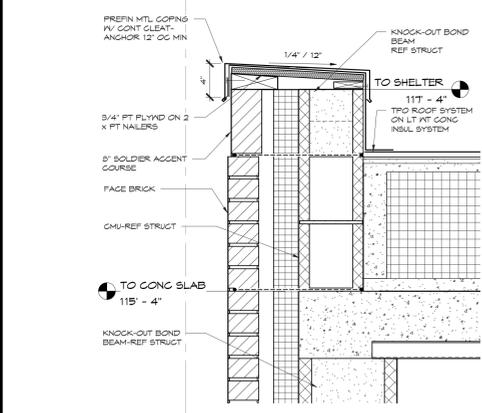


B E-W BUILDING SECTION- SCIENCE 125
1/8" = 1'-0"

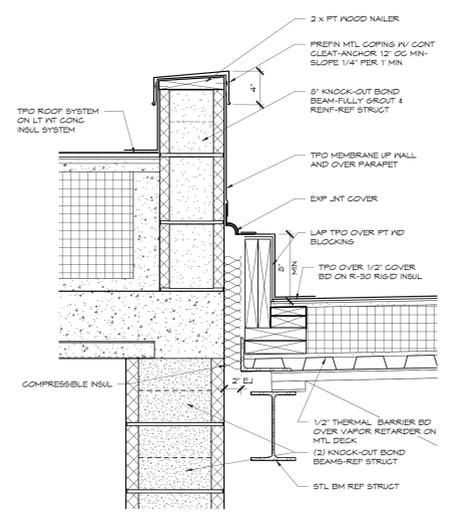


C E-W BUILDING SECTION-CORRIDORS 127 & 105
1/8" = 1'-0"

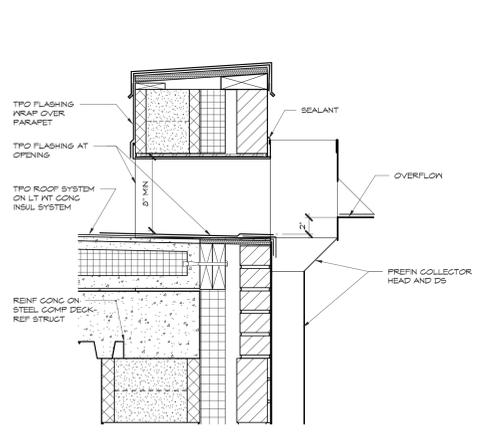
NOT FOR CONSTRUCTION/EXAMPLE ONLY



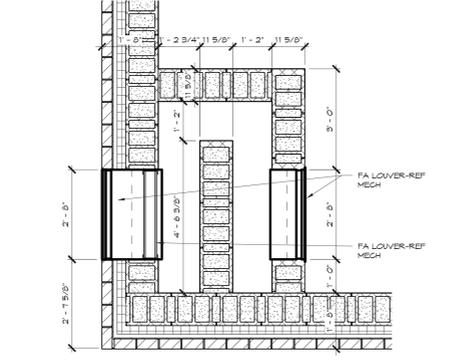
1 COPING-SHELTER WALL
1 1/2" = 1'-0"



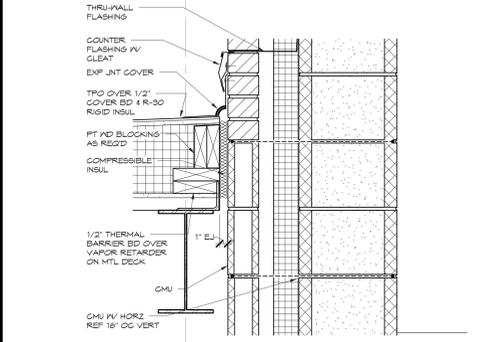
3 ROOF-SHELTER AND LOW WALL
1 1/2" = 1'-0"



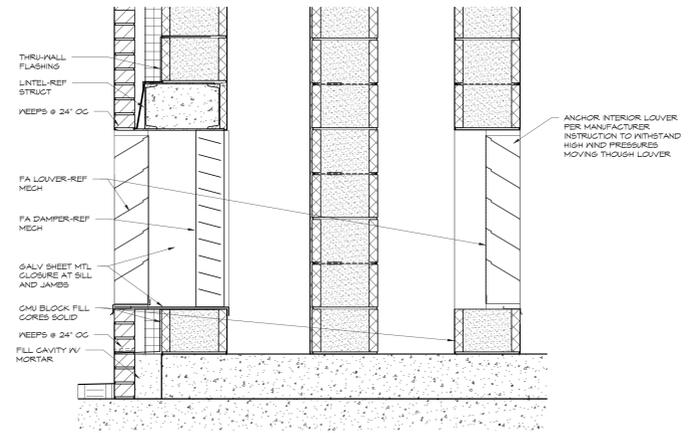
4 PARAPET-SCUPPER
1 1/2" = 1'-0"



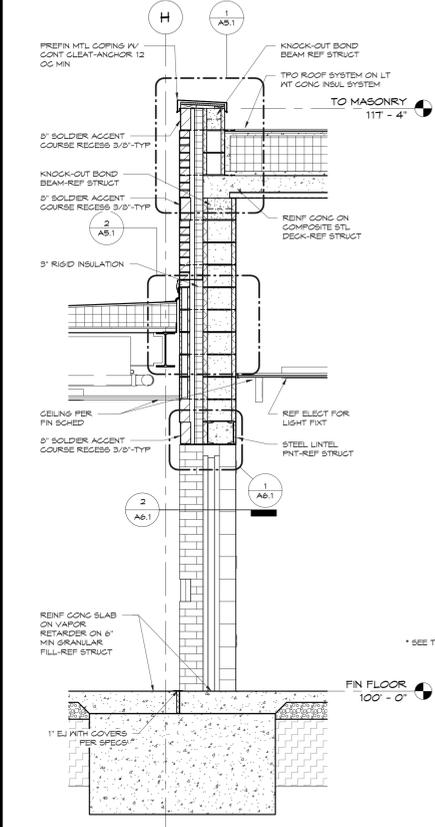
5 PLAN DTL - LOUVER
1/2" = 1'-0"



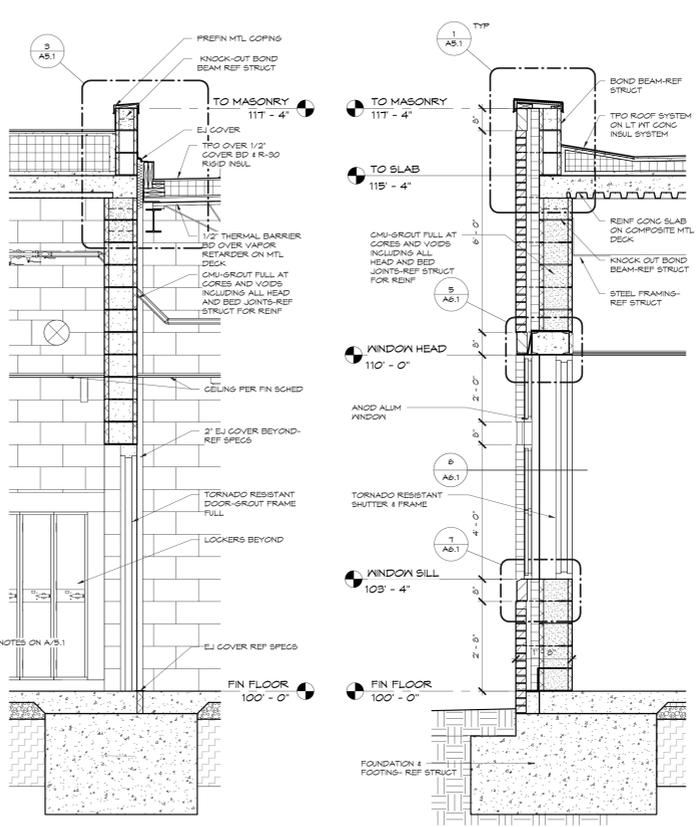
2 ROOF- EXP JT ABOVE DOOR 128B
1 1/2" = 1'-0"



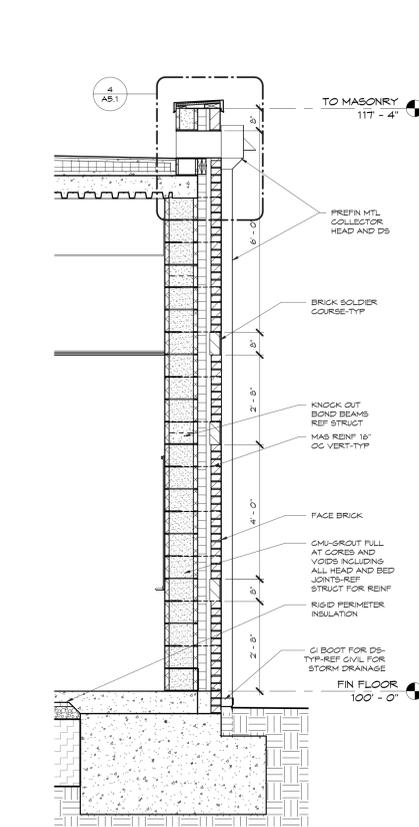
6 SILL DETAIL - LOUVER
1" = 1'-0"



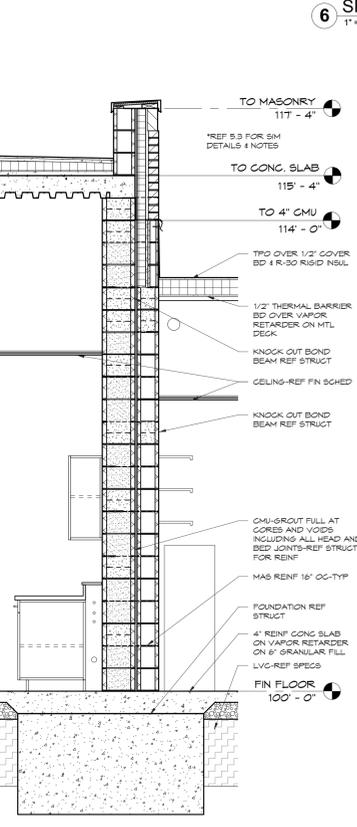
A WALL-VEST. 128 EXTERIOR
1/2" = 1'-0"



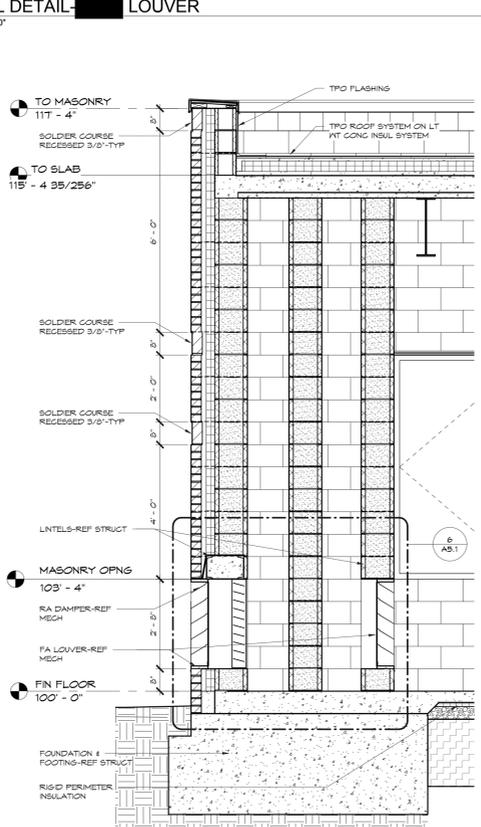
B WALL-SHELTER CORRIDOR 118
1/2" = 1'-0"



C WALL-WINDOW
1/2" = 1'-0"



D WALL-ALUMINUM SCUPPER TYP
1/2" = 1'-0"



F WALL SEC - LOUVER
1/2" = 1'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:
The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

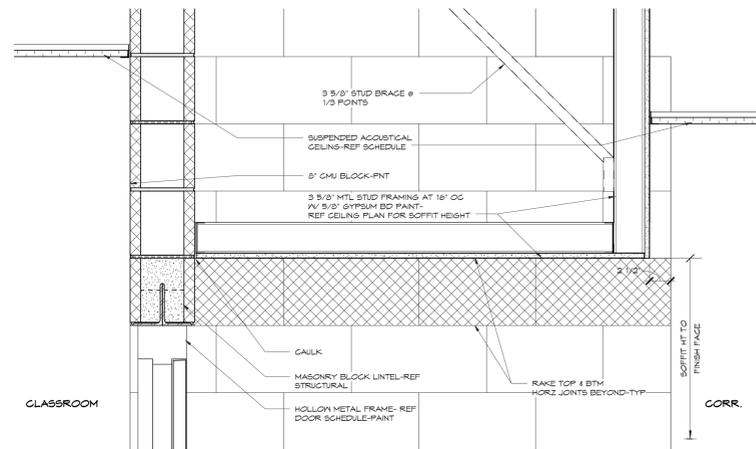
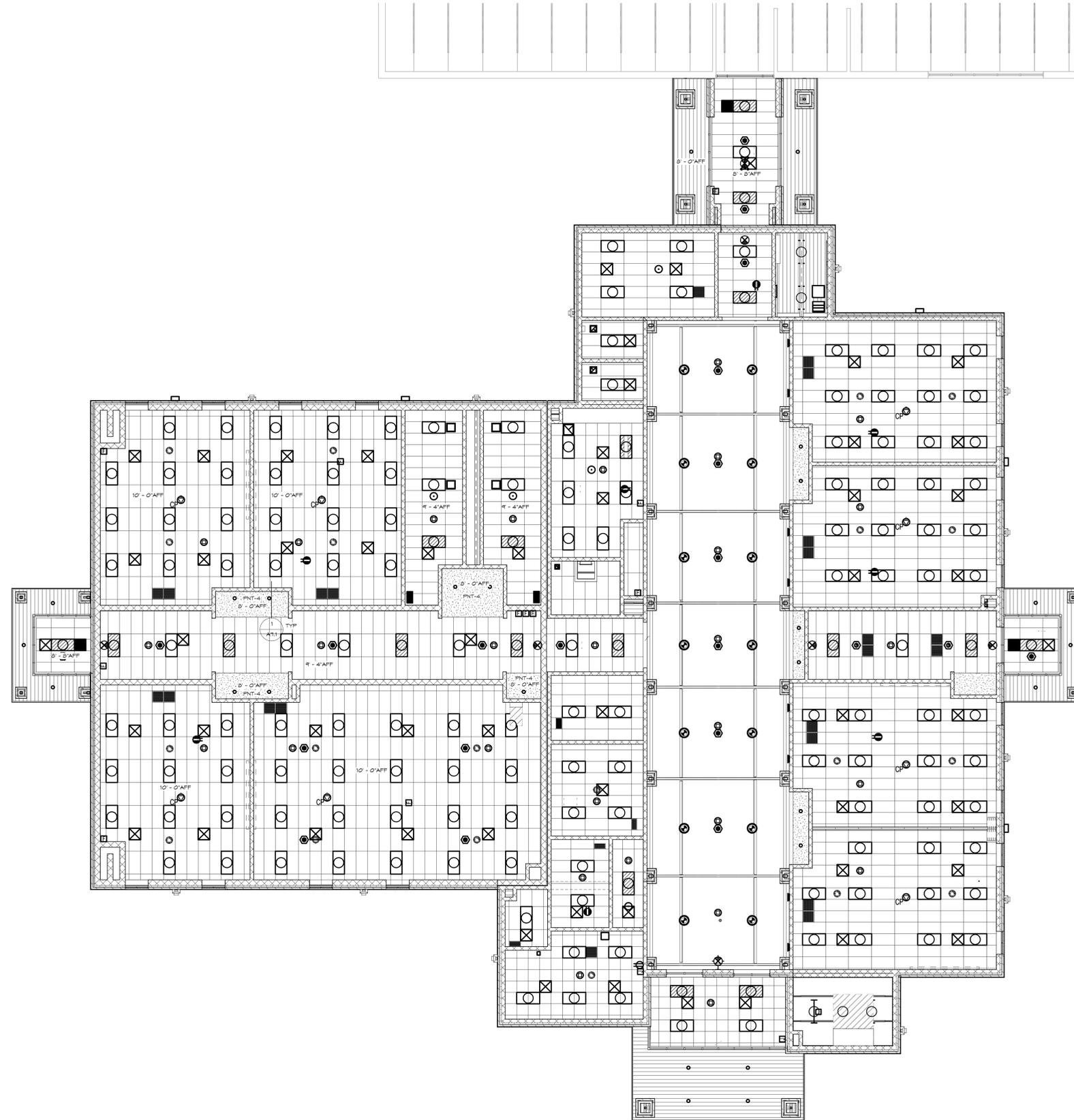
ARCHITECTURAL DETAILS

SHEET NO.: **A5.1**

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS



1 CLG DTL-SOFFIT CLASSROOM TYP
1 1/2" = 1'-0"

CEILING PLAN
1/8" = 1'-0"

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

CEILING PLAN

SHEET NO.: A7.1

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

STRUCTURAL DESIGN CRITERIA

- BUILDING CODE: INTERNATIONAL BUILDING CODE (IBC), 2006 EDITION. THE STRUCTURE IS CLASSIFIED AS AN OCCUPANCY CATEGORY II STRUCTURE. THE STRUCTURE HAS BEEN DESIGNED IN ACCORDANCE WITH THE BUILDING CODE AND ASBC MANUAL OF STEEL CONSTRUCTION, ALLOWABLE STRESS DESIGN, THIRTEENTH EDITION.
- EXISTING CONSTRUCTION INFORMATION IS SHOWN FOR REFERENCE ONLY AS A COURTESY TO THE CONTRACTOR, AND IS NOT DESIGNED, VERIFIED, OR REVIEWED BY [REDACTED] IF CONDITIONS DIFFER FROM THOSE SHOWN, NOTIFY ENGINEER PRIOR TO PROCEEDINGS.

DESIGN LIVE LOADS:

ROOF:	20 PSF OR 300 LBS (NON-REDUCIBLE)
GROUND SNOW LOAD:	15 PSF
FLAT ROOF SNOW LOAD:	16.6 PSF
SNOW EXPOSURE FACTOR:	1.0
SNOW IMPORTANCE FACTOR:	1.1
THERMAL FACTOR:	1.0

DESIGN LATERAL LOADS (PER ASCE 7-05):

WIND:	BASIC WIND SPEED: 90 MPH (3 SECOND GUST)
WIND IMPORTANCE FACTOR:	1.15
WIND EXPOSURE:	C
INTERNAL PRESSURE COEFF. COMPONENTS AND GLADDINGS*:	V1: 0.18 S0 PSF, UNLESS NOTED OTHERWISE

SEISMIC:	SEISMIC IMPORTANCE FACTOR: 1.25
	SDS: 0.147 SDS: 0.115
	S1: 0.073 SD1: 0.039
	SITE CLASSIFICATION: SC
	SEISMIC CATEGORY: B
	GRID REINF. MASONRY SHEAR WALL AND STRUCTURAL STEEL SYSTEMS NOT DETAILED FOR SEISMIC RESISTANCE
	SEISMIC SYSTEM: EQUIVALENT LATERAL FORCE
	SEISMIC RESPONSE COEFF. METHOD OF ANALYSIS:

*COMPONENTS AND GLADDINGS PRESSURE SHALL BE USED FOR DESIGN OF EXTERIOR COMPONENTS AND GLADDINGS MATERIALS NOT SPECIFICALLY SHOWN ON THE STRUCTURAL DRAWINGS.

ADDITIONAL DESIGN LOADS:

THE AREA DESIGNATED BY THE ARCHITECT AS A SHELTER HAS BEEN DESIGNED IN ACCORDANCE WITH FEMA 361, SECOND EDITION, DESIGN AND CONSTRUCTION GUIDANCE FOR COMMUNITY SAFE ROOMS*.

ROOF LIVE LOAD:	100 PSF
-----------------	---------

WIND:	BASIC WIND SPEED: 250 MPH (3 SECOND GUST)
WIND EXPOSURE:	C
INTERNAL PRESSURE FACTOR:	1.0
DIRECTIONALITY FACTOR:	1.0
TOPOGRAHY FACTOR:	1.0
INTERNAL PRESSURE COEFF. COMPONENTS AND GLADDINGS*:	V1: 0.55 234 PSF, UNLESS NOTED OTHERWISE

GENERAL REQUIREMENTS

- THE SPECIFICATIONS ARE PART OF THE CONSTRUCTION DOCUMENTS AND MUST BE USED IN CONJUNCTION WITH THE PLANS. WHERE CONFLICTS OCCUR, THE MOST STRINGENT REQUIREMENT SHALL CONTROL.
 - DO NOT SCALE DRAWINGS FOR THE PURPOSE OF ESTABLISHING DIMENSIONS. VERIFY ALL DIMENSIONS AND ELEVATIONS THAT MAY AFFECT THE NEW CONSTRUCTION.
 - THE STRUCTURAL PLANS REPRESENT THE STRUCTURE IN THE COMPLETED CONDITION. SLABS ON GRADE AND ELEVATED SLABS ARE NOT DESIGNED TO SUPPORT GRANES, FORK-LIFTS, MAN-LIFTS, OR TRUCK TRAFFIC (UNLESS NOTED AS SUCH). IT IS THE CONTRACTOR'S RESPONSIBILITY FOR THE MEANS AND METHODS OF CONSTRUCTING THE STRUCTURE TO DETERMINE IF CONSTRUCTION EQUIPMENT CAN BE SAFELY OPERATED ON EXISTING CONSTRUCTION AND PREVENT OR REPAIR DAMAGE TO THE STRUCTURE THAT HAS BEEN COMPLETED.
 - THE CONTRACTOR SHALL DESIGN AND MAINTAIN ALL TEMPORARY SHORING OR BRACING REQUIRED TO SAFELY CONSTRUCT THE STRUCTURE. SHORING AND BRACING METHODS SHALL REMAIN IN PLACE UNTIL ALL MEMBERS AND CONNECTIONS HAVE BEEN COMPLETED.
 - THE CONTRACTOR SHALL REVIEW AND APPROVE ALL SHOP DRAWINGS PRIOR TO SUBMITTAL. NOTICES ALL CHANGES MADE THAT DO NOT COMPLY WITH THE CONSTRUCTION DOCUMENTS. ALL CONSTRUCTION MATERIALS SHALL BE FREE OF DETEIORATION AND HAVE DOCUMENTATION OF MATERIAL PROPERTIES.
 - ON EXISTING CONSTRUCTION, THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING DIMENSION, ELEVATIONS, AND EXISTING CONDITIONS. REFERENCE ARCHITECTURAL, MECHANICAL, AND ELECTRICAL DOCUMENTS FOR THE EXACT LOCATIONS OF THE CONSTRUCTION, NEW OPENINGS, AND REPAIR OR INFILL REQUIREMENTS. NOTIFY THE ENGINEER OF ALL DISCREPANCIES BETWEEN SHOWN ITEMS AND FIELD CONSTRUCTION, OR IF ADDITIONAL MODIFICATIONS ARE NEEDED THAT ARE NOT SHOWN ON THESE DRAWINGS.
- ANY DAMAGED, BROKEN, DETEIORATED, QUESTIONABLE, ETC. STRUCTURE THAT IS TO REMAIN SHALL BE BROUGHT TO THE ARCHITECT/ENGINEER'S ATTENTION FOR REVIEW.
- USE EXTREME CARE AND CAUTION WHILE PERFORMING THE NECESSARY DEMOLITION TO NOT DAMAGE THE EXISTING CONSTRUCTION WHICH IS TO REMAIN.
- EXISTING ABANDONED ELEMENTS THAT INTERFERE WITH NEW CONSTRUCTION SHALL BE REMOVED.
- THE CONTRACTOR SHALL VERIFY ALL ARCHITECTURAL, ELECTRICAL, AND MECHANICAL OPENINGS AND EQUIPMENT HEIGHTS PRIOR TO COMMENCING CONSTRUCTION.
 - AT THE SHELTER CONSTRUCTION, ALL PENETRATIONS IN THE SHELTER ENVELOPE GREATER THAN 3 1/2 SQUARE INCHES OR 2" IN DIAMETER SHALL BE PROTECTED IN ACCORDANCE WITH THE FEMA 361 GUIDELINES. NOTIFY ENGINEER OF ANY PENETRATION REQUIREMENTS EXCEEDING THESE SIZES THAT ARE NOT INDICATED ON THE DRAWINGS.

FOUNDATIONS/SOILS

- THE FOUNDATION SYSTEM IS DESIGNED AS RECOMMENDED IN THE GEOTECHNICAL INVESTIGATION. A COPY IS IN THE SPECIFICATIONS OR IS AVAILABLE FOR INSPECTION AT THE ARCHITECT'S PLACE OF BUSINESS. ALL GEOTECHNICAL WORK SHALL BE PERFORMED UNDER THE SUPERVISION OF A LICENSED GEOTECHNICAL ENGINEER.
- IF THE EXISTING CONDITIONS DO NOT COMPLY WITH THE ABOVE, NOTIFY THE ARCHITECT/ENGINEER IMMEDIATELY.
- REMOVE TOP SOIL CONTAINING ORGANIC MATERIAL, INCLUDING ALL UNDOCUMENTED FILL, AND PREPARE THE BUILDING PAD IN ACCORDANCE WITH THE GEOTECHNICAL INVESTIGATION. PREPARE OR MODIFY THE SOILS UNDER THE BUILDING PAD PER THE GEOTECHNICAL INVESTIGATION AND SPECIFICATION.
- SOIL SUPPORTED FOUNDATIONS:
ALLOWABLE BEARING PRESSURE (NET) IS 3,000 PSF MINIMUM FOR FOUNDATIONS BEARING ON UNDISTURBED SOIL, OR APPROVED ENGINEERED FILL MATERIAL. BEARING MATERIALS SHALL BE VERIFIED BY A LICENSED GEOTECHNICAL ENGINEER.
ALL FOOTINGS BELOW GRADE MAY HAVE EARTH FORMED SIDES, THE TOP 1 1/4" OF THE FOUNDATION SHALL BE FORMED TO THE DESIGN DIMENSION AT TRENCH FOOTINGS. THE CONSTRUCTED FOUNDATION DIMENSION SHALL BE NO LESS THAN THE DESIGN DIMENSION, AND NO MORE THAN 1/8" GREATER THAN THE DESIGN DIMENSION. FOUNDATION WALLS, PLASTERS, AND COLUMNS SHALL BE FORMED.
- DO NOT BACKFILL FOUNDATION WALLS UNTIL ADEQUATE BRACING IS IN PLACE. ALL BACKFILL SHALL BE PLACED AND COMPACTED IN ACCORDANCE WITH THE SPECIFICATION.
- SLABS ON GRADE SHALL BE CONSTRUCTED IN ACCORDANCE WITH ACI 302.

CAST-IN-PLACE CONCRETE

- CAST-IN-PLACE CONCRETE HAS BEEN DESIGNED IN ACCORDANCE WITH ACI 318, THE BUILDING CODE, AND SHALL BE IN CONFORMANCE WITH THE CURRENT ACI MANUAL OF CONCRETE PRACTICE.
- CONCRETE SHALL HAVE THE FOLLOWING PROPERTIES AND BE SUBMITTED FOR APPROVAL:
CEMENT SHALL CONFORM TO ASTM C150, TYPE OR II, FLY ASH CONFORMING TO ASTM C610 TYPE C OR F MAY BE USED TO REPLACE A MAXIMUM OF 20% OF THE CEMENT.
CONCRETE SHALL HAVE THE FOLLOWING MINIMUM COMPRESSIVE STRENGTHS AT 28 DAYS, WATER/CEMENT RATIO, AND AIR ENTRAINMENTS:

FOUNDATIONS:	3000 PSI	V1<0.52 MAX.	4% TO 7% AIR
EXTERIOR SLABS:	4000 PSI	V1<0.45 MAX.	4% TO 7% AIR
INTERIOR FLOOR SLABS:	3000 PSI	V1<0.52 MAX.	3% MAX. AIR
SLAB ON METAL DECK:	3000 PSI	V1<0.52 MAX.	NO AIR REQUIREMENT
- ALL EXPOSED EDGES OF CONCRETE SHALL BE CHAMFERED 3/4" INSIDE FORMS OR TOOLED TO 3/4" RADIUS, UNLESS NOTED OTHERWISE.
- SLABS ON GRADE SHALL HAVE CONSTRUCTION JOINTS AND CONTROL JOINTS (SAWN JOINTS) TO DIVIDE THE SLAB INTO PANELS NOT TO EXCEED 256 SQUARE FEET. THE LONG DIMENSION SHALL NOT EXCEED THE SHORT DIMENSION BY MORE THAN 20%. CONTRACTOR SHALL SUBMIT PROPOSED LOCATIONS FOR APPROVAL. (2) 4X4'-0" REINFRANT BARS ARE REQUIRED AT ALL DISCONTINUOUS LOCATIONS.
- NO ALUMINUM SHALL BE EMBEDDED IN CONCRETE. CONDUITS AND PIPING EMBEDDED IN CONCRETE WALLS SHALL BE SPACED A MINIMUM OF FOUR DIAMETERS AND THE OUTSIDE DIAMETER SHALL BE LESS THAN 50% OF THE MEMBER THICKNESS PLACED BETWEEN LAYERS OF REINFORCING. NO CONDUIT MAY BE EMBEDDED IN SLABS ON METAL DECK UNLESS SPECIFICALLY DETAILED OR NOTED OTHERWISE.
- CONCRETE BASES FOR MECHANICAL OR ELECTRICAL EQUIPMENT SHALL BE 4" THICK ON TOP OF A CONCRETE SLAB PURPOSELY ROUGHENED TO 1/4", AND REINFORCED WITH 4 BARS AT 12" O.C., EACH WAY, UNLESS NOTED OTHERWISE.
- CONCRETE SHALL BE MIXED, BATCHED, AND TRANSPORTED PER ASTM C94.

CONCRETE REINFORCEMENT

- REINFORCEMENT SHALL CONFORM TO THE FOLLOWING:
REINFORCING BARS SHALL MEET ASTM A615, GRADE 60. WELDING OF REINFORCEMENT IS PROHIBITED UNLESS SHOWN ON THE DRAWINGS OR APPROVED BY THE ENGINEER. REINFORCEMENT TO BE WELDED SHALL MEET ASTM A706, GRADE 60, AND BE WELDED ACCORDING TO AWS D1.4.
- REINFORCEMENT SHALL BE DETAILED IN ACCORDANCE WITH ACI 318:
REINFORCING BARS SHALL BE CONTINUOUS OR LAPPED AS REQUIRED PER ACI 318.
LAP BARS IN CORNERS WITH CORNER BARS OF THE SAME SIZE AND SPACING AS THE ADJACENT REINFORCING EXCEPT AT CONTINUOUS SPREAD FOOTINGS. AT INTERSECTIONS OF CONTINUOUS SPREAD FOOTINGS, EXTEND ALL BARS TO THE FAR SIDE OF THE INTERSECTING FOOTINGS.
- REINFORCEMENT PLACEMENT SHALL BE AS FOLLOWS:
ALL REINFORCING (BARS, EMBEDMENTS, WAF, ETC.) SHALL BE SUPPORTED ON CHAIRS/BOLSTERS TO THE DESIGN DIMENSIONS PER ACI AND CRSI SUGGESTED METHODS. REINFORCING MATS SHALL BE TIED AT ALTERNATE INTERSECTIONS.
REINFORCEMENT SHALL MAINTAIN CLEAR COVER PER ACI REQUIREMENTS, UNLESS NOTED OTHERWISE.
FAN REINFORCING AROUND ALL OPENINGS IN CONCRETE WALLS AND SLABS. OPENINGS SHALL BE REINFORCED WITH (2) 18X4'-0" LONGER THAN THE OPENING DIMENSION ON ALL SIDES OF THE OPENING, UNLESS OTHERWISE NOTED. DO NOT CUT ANY REINFORCEMENT WITHOUT THE APPROVAL OF THE ENGINEER.

CONCRETE MASONRY

- MASONRY HAS BEEN DESIGNED AND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE BUILDING CODE AND ACI 530.
ALL CONCRETE MASONRY UNITS (CMU) SHALL BE TWO-CELL, LIGHTWEIGHT AGGREGATE UNITS WITH A SPECIFIED MINIMUM COMPRESSIVE STRENGTH OF 1800 PSI OR NET AREA (1800 PSI ON GROSS AREA) AT 28 DAYS CONFORMING TO ASTM C90. CMU USED IN SHELTER AREA CONSTRUCTION SHALL BE SQUARE-END, SOLID WEB UNITS OR RECESSED-END UNITS WITH ALL JOINTS FILLED WITH GROUT.
- ALL MORTAR SHALL BE TYPE 'S' WITH A MINIMUM MORTAR COMPRESSIVE STRENGTH OF 1800 PSI AT 28 DAYS CONFORMING TO ASTM C270. THE MINIMUM COMPRESSIVE STRENGTH (F_m) OF A FIRM ASSEMBLED OF CMU AND MORTAR SHALL BE 1500 PSI AT 28 DAYS ON THE NET AREA.
GROUT SHALL CONFORM TO ASTM C476 WITH COARSE AGGREGATE WHEREVER ALLOWED BY CODE AND A MAXIMUM SLUMP OF 8 INCHES. THE MINIMUM GROUT COMPRESSIVE STRENGTH (F_c) SHALL BE 2800 PSI.
ALL POCKETS AND PARTIAL HEIGHT BLOCK IN CONCRETE MASONRY CONSTRUCTION (BEAM BEARING, JOIST BEARING, PIPE PENETRATION, ETC.) SHALL BE GROUTED SOLID AFTER INSTALLATION.
- REINFORCING STEEL SHALL MEET THE REQUIREMENTS OF ASTM A615, GRADE 60. JOINT REINFORCING STEEL SHALL MEET THE REQUIREMENTS OF ASTM A305 WITH A MINIMUM YIELD GREATER THAN 10 KSI.
LONGITUDINAL WRES SHALL BE #4 (0.1483" DIA.) WITH LADDER-TYPE WRES CONNECTED AT 16" CENTERS. REINFORCING SHALL BE MILL GALVANIZED PER ASTM A641, CLASS 5.
REINFORCING BARS SHALL BE CONTINUOUS, OR LAPPED AS REQUIRED PER ACI 302. LAP BARS IN CORNERS WITH CORNER BARS OF THE SAME SIZE AND SPACING AS THE ADJACENT REINFORCING.
JOINT REINFORCING SHALL LAP TWO SQUARES PLUS 2"; DISCONTINUE JOINT REINFORCING AT CONTROL JOINTS.
- VERTICAL REINFORCING SHALL BE AS INDICATED ON THE DRAWINGS IN FULLY GROUTED CELLS AND HELD IN PLACE BY REBAR POSITIONERS. REINFORCEMENT SHALL BE LOCATED IN THE CENTER OF THE CELL, UNLESS THE CELL IS DOUBLY REINFORCED. WHEN MORE THAN ONE BAR PER CELL IS REQUIRED, PROVIDE A MINIMUM OF 1/2" GROUT BETWEEN THE REINFORCEMENT AND MASONRY UNIT.
PROVIDE AN ADDITIONAL VERTICAL REINFORCING BAR LOCATION IN FULLY GROUTED CELLS, WITH SAME SIZE AND NUMBER AS THE NORMAL REINFORCING BAR, AT EACH END OF THE WALL, EACH SIDE OF A CONTROL JOINT, INTERSECTIONS OF WALLS, EACH SIDE OF A WALL OPENING, AND EACH BEAM BEARING LOCATION.
VERTICAL REINFORCING SHALL EXTEND FROM THE TOP OF THE SUPPORTING MEMBER TO THE TOP BOND BEAM IN 4'-0" MAXIMUM WALL LIFTS. THERE SHALL BE A DOUBLE, CAST INTEGRAL WITH THE SUPPORTING MEMBER, FOR EACH VERTICAL REINFORCING BAR.
- HORIZONTAL WALL REINFORCING LOCATIONS SHALL BE AS INDICATED ON THE DRAWINGS WITH A MINIMUM OF (2) #4 CONTINUOUS IN FULLY-GROUTED KNOCK-OUT BOND BEAMS UNLESS AT OPENING LOCATIONS. AT OPENING LOCATIONS THE REINFORCING SHALL BE PLACED IN SOLID BOTTOM LITEL BLOCKS.
PROVIDE HORIZONTAL REINFORCING IN CMU WALLS ABOVE AND BELOW OPENING LOCATIONS, AT BEARING LOCATIONS, AT THE TOP OF THE WALL, AND OTHER LOCATIONS NOTED ON THE DRAWINGS.
LAP HORIZONTAL BARS IN CORNERS WITH CORNER BARS OF THE SAME SIZE AND SPACING AS THE ADJACENT REINFORCING.
- LOCATION AND DETAILS OF CONTROL AND ISOLATION JOINTS SHALL BE PER THE ARCHITECTURAL DRAWINGS. JOINTS SHALL NOT BE LOCATED LESS THAN 2'-0" FROM ANY OPENING OR CLOSER THAN 4'-0" FROM ANY CORNER. CONTRACTOR SHALL SUBMIT A JOINT LAYOUT PLAN FOR APPROVAL PRIOR TO CONSTRUCTION.
- LITELS SHALL BEAR A MINIMUM OF 8" ON EACH END ON SOLID GROUTED CELLS, UNLESS NOTED OTHERWISE.
- NOT ALL LITEL LOCATIONS ARE INDICATED ON THE STRUCTURAL DRAWINGS. REFERENCE ARCHITECTURAL, MECHANICAL, AND ELECTRICAL DRAWINGS FOR ADDITIONAL LOCATIONS. NOTIFY ENGINEER FOR LITEL REQUIREMENTS NOT ADDRESSED ON THE DRAWINGS OR IN THE LITEL SCHEDULE.

STRUCTURAL STEEL

- STRUCTURAL STEEL SHALL MEET THE LATEST CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES, AND HAS BEEN DESIGNED IN ACCORDANCE WITH THE BUILDING CODE AND ASBC MANUAL OF STEEL CONSTRUCTION, ALLOWABLE STRESS DESIGN, THIRTEENTH EDITION.
- STRUCTURAL STEEL SHALL MEET THE FOLLOWING REQUIREMENTS UNLESS NOTED OTHERWISE ON THE DRAWINGS:

K SHAPES:	ASTM A992	GRADE 50
PLATES, CHANNELS & ANGLES:	ASTM A572	GRADE 50 (F _y =46 KSI)
HOLLOW STRUCTURAL SECTIONS (HSS):	ASTM A500	GRADE 50
STRUCTURAL BOLTS:	ASTM A325	GRADE 10.9/10.9S
HEADED ANCHOR STUDS:	ASTM A1029	GRADE 36
ANCHOR BOLTS:	ASTM F1554	GRADE 36
- STRUCTURAL STEEL SHALL BE DETAILED IN ACCORDANCE WITH THE ASBC CODE OF STANDARD PRACTICE. SHOP DRAWINGS SHALL INCLUDE DETAILS OF ALL MEMBERS, CONNECTIONS (INCLUDING SHOP AND FIELD WELDS/BOLTS), AND ERECTION DRAWINGS. STEEL FABRICATOR SHALL INCORPORATE ADDITIONAL MATERIALS AND DETAILS TO COMPLY WITH THE OSHA ERECTION REQUIREMENTS.
STEEL FRAMING MEMBERS SHALL ONLY BE SPliced AT LOCATIONS AS SHOWN ON THE DESIGN DRAWINGS OR AS SHOWN AND APPROVED ON THE SHOP DRAWINGS.
NO OPENINGS SHALL BE FIELD-CUT IN THE FLANGE OR WEB OF STEEL MEMBERS WITHOUT THE APPROVAL OF THE ENGINEER, UNLESS NOTED OR DETAILED OTHERWISE.
- ALL CONNECTIONS NOT DETAILED OR OTHERWISE NOTED SHALL BE DESIGNED BY THE FABRICATOR AND HIGHLIGHTED FOR THE REVIEW OF THE ENGINEER.
BEAM SHEAR CONNECTIONS SHALL BE STANDARD AISC DOUBLE ANGLE BOLTED CONNECTIONS, UNLESS NOTED OTHERWISE.
ALL BOLTED CONNECTIONS SHALL BE STANDARD AISC BEARING-TYPE FRAMING CONNECTIONS. BOLTS SHALL BE SNUG-TIGHTENED, UNLESS NOTED OTHERWISE.
ALL WELDING SHALL BE IN ACCORDANCE WITH LATEST AWS STRUCTURAL STEEL WELDING CODE, D1.1. ALL WELDS SHALL USE E70XX WELD MATERIAL.
- ALL BOLTS SET IN CONCRETE SHALL BE FURNISHED WITH DOUBLE NUTS AND SET WITH A TEMPLATE.
- GALVANIZED STRUCTURAL STEEL SHALL CONFORM TO ASTM A123 FOR MEMBERS AND ASTM A153 FOR CONNECTION ELEMENTS.
- ALL STEEL BEAMS USED IN COMPOSITE SYSTEMS HAVE BEEN DESIGNED FOR UNSHORED CONSTRUCTION.
COMPOSITE SLAB SHEAR CONNECTIONS INDICATED AS (QUANTITY) ON THE DRAWINGS SHALL BE 3/4" DIAMETER X 7'-4" HEADED STUDS AND SHALL BE SPACED EQUALLY ALONG THE CENTERLINE OF THE BEAM. WHERE SHEAR CONNECTIONS ARE NOT CALLED FOR ON DRAWINGS, PROVIDE SHEAR CONNECTIONS FOR ALL BEAMS SUPPORTING COMPOSITE SLABS AT 1'-0" O.C. MAX.

STEEL DECKING

- STEEL DECKING SHALL MEET THE STEEL DECK INSTITUTES SPECIFICATIONS AND 'SDI' MANUAL OF CONSTRUCTION WITH STEEL DECK. STEEL DECK SHALL BE FABRICATED BY A MEMBER OF THE SDI.
- STEEL DECK SHALL BE DETAILED IN ACCORDANCE WITH SDI STANDARD PRACTICES.
SHOP DRAWINGS SHALL INCLUDE DETAILS OF ALL MEMBERS AND CONNECTIONS (INCLUDING WELDS AND SIDE LAPS).
WELDS SHALL BE IN CONSTRUCTED AND INSPECTED IN ACCORDANCE WITH AWS D1.3 AND HAVE A MINIMUM FUSION DIAMETER OF 5/8" WITH AN E6022 ELECTRODE.
PROVIDE ALL CLOSURES, POUR STOPS, FILLERS, ETC. AS REQUIRED TO COMPLETE ALL DECKING CONNECTIONS.
- COMPOSITE METAL DECK SHALL BE 2" DEEP, 20 GA., COMPOSITE METAL DECKING WITH THE FOLLOWING MINIMUM PROPERTIES: F150 KSI, 190 KOR (4), 190-020R (4), 590-341 (3), 590-346 (3).
COMPOSITE DECK SHALL RECEIVE GALVANIZED FINISH CONFORMING TO ASTM A754, S60. DECK SHALL BE CONTINUOUS OVER A MINIMUM OF THREE SPANS. EACH DECK UNIT SHALL BE ATTACHED TO SUPPORTING MEMBERS PER THE MANUFACTURER'S RECOMMENDATIONS, WITH A MAXIMUM FASTENER SPACING OF 18 INCHES.

POST-INSTALLED ANCHORING SYSTEMS

- EACH ANCHOR INSTALLER SHALL RECEIVE INSTALLATION TRAINING FROM THE ANCHOR SUPPLIER PRIOR TO ANCHOR INSTALLATION. ALL ANCHORS SHALL BE INSTALLED AND RECEIVE SPECIAL INSPECTIONS PER THE ANCHORS ICC-ES REPORT TO ACHIEVE THE FULL VALUE OF THE ANCHOR FOR ITS INDICATED CONDITION.
- ADHESIVE ANCHORS OR REINFORCEMENT INSTALLED IN PREVIOUSLY CAST CONCRETE OR SOLID GROUTED MASONRY SHALL BE BY AN APPROVED MANUFACTURER FOR THE CONDITIONS INDICATED.
- ANCHOR RODS SHALL BE THREE-PRONG ANCHORS IN ACCORDANCE WITH ADHESIVE ANCHOR MANUFACTURER, UNLESS NOTED OTHERWISE. REINFORCING BARS ANCHORED IN CONCRETE SHALL BE IN ACCORDANCE WITH ASTM A615, GRADE 60, UNLESS NOTED OTHERWISE. FINISH OF RODS AND REBAR SHALL BE IN ACCORDANCE WITH THE ANCHORING PRODUCT USED AND PER THE MANUFACTURER'S RECOMMENDATIONS.

STRUCTURAL TESTS, INSPECTIONS, AND QUALITY ASSURANCE

- ALL STRUCTURAL TESTS AND INSPECTIONS SHALL BE PERFORMED PER THE REFERENCED BUILDING CODE, INCLUDING CHAPTER 11 (SPECIAL INSPECTIONS), WITH LOCAL SUPPLEMENTS, UNLESS MORE STRINGENT REQUIREMENTS ARE SPECIFIED.
- THE STRUCTURE SHALL BE SPECIAL INSPECTED AND REPORTS SHALL BE DEVELOPED BY QUALIFIED PERSONNEL PER SECTION 1104.1 OF THE IBC. APPROVED FABRICATORS MUST SUBMIT THE NATIONALLY RECOGNIZED CERTIFICATION DOCUMENTATION PRIOR TO CONSTRUCTION.
FABRICATION OF LOAD BEARING ASSEMBLIES AND MEMBERS IN A SHOP NOT APPROVED PER SECTION 1104.2.2 OF THE IBC. APPROVED FABRICATORS MUST SUBMIT THE NATIONALLY RECOGNIZED CERTIFICATION DOCUMENTATION PRIOR TO CONSTRUCTION.
FABRICATION OF DEBRIS IMPACT ASSEMBLIES FOR THE SHELTER MUST BE INSPECTED AND LABELED BY AN APPROVED AGENCY THAT MEETS THE REQUIREMENTS OF FEMA 361 AND ICC-ESOO. INSTALLATION OF THESE ASSEMBLIES SHALL BE INSPECTED.
STEEL CONSTRUCTION SHALL BE INSPECTED PER SECTION 1104.3 AND TABLE 1104.3 OF THE IBC.
CONCRETE CONSTRUCTION SHALL BE INSPECTED PER SECTION 1104.4 AND TABLE 1104.4 OF THE IBC. CONCRETE FOOTINGS, ISOLATED AND CONTIGUOUS, SHALL BE INSPECTED. SLABS ON GRADE SHALL BE INSPECTED WITHIN THE SHELTER AREA, BUT ARE EXEMPT IN NON-SHELTER AREAS.
MASONRY CONSTRUCTION WITHIN THE SHELTER AREA SHALL BE INSPECTED PER SECTION 1104.5 AND TABLE 1104.5.3 OF THE IBC FOR LEVEL 2 SPECIAL INSPECTION. MASONRY CONSTRUCTION NOT WITHIN THE SHELTER AREA SHALL BE INSPECTED PER SECTION 1104.5 AND TABLE 1104.5.1 OF THE IBC FOR LEVEL 1 SPECIAL INSPECTION.
EXISTING SITE SOIL CONDITION AND EARTHWORK SHALL BE INSPECTED PER SECTION 1104.7 AND TABLE 1104.7 OF THE IBC. THE EXCEPTION FOR FILL PLACEMENT LESS THAN 12' SHALL NOT APPLY WITHIN THE SHELTER AREA.
POST-INSTALLED ANCHORING SYSTEMS SHALL BE INSPECTED PER THE ANCHORS ICC-ES REPORT PROVIDED BY THE ANCHOR MANUFACTURER.
ITEMS NOT LISTED HERE, BUT IN THE OPINION OF THE BUILDING OFFICIAL, OWNER, OR ARCHITECT NEED INSPECTION, SHALL BE INSPECTED.

THE SPECIAL INSPECTOR SHALL BE INDEPENDENT OF THE TESTING AGENCY AND AS APPROVED BY THE OWNER. THE COORDINATION OF THE SPECIAL INSPECTION WITH THE CONSTRUCTION OF THE INSPECTED ITEMS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

- THE SHELTER PORTION OF THE STRUCTURE SHALL HAVE A QUALITY ASSURANCE PLAN, PREPARED BY A PROFESSIONAL ENGINEER, UNREVIEWED, DOCUMENTED, AND ENFORCED BY THE CONTRACTOR PER SECTION 3.10 OF FEMA 361 PRIOR TO THE START OF CONSTRUCTION. THE PLAN SHALL IDENTIFY THE MAIN WIND-FORCE RESISTING SYSTEMS AND WIND RESISTING COMPONENTS, TYPE AND FREQUENCY OF THE SPECIAL INSPECTIONS, TYPE AND FREQUENCY OF THE TESTING REQUIREMENTS, STRUCTURAL OBSERVATIONS, AND THE REQUIRED DISTRIBUTION, TYPE, AND FREQUENCY OF TEST REPORTS, INSPECTION REPORTS, AND STRUCTURAL OBSERVATION REPORTS.

THE FOLLOWING ITEMS ARE REQUIRED TO BE INCLUDED IN THE QUALITY ASSURANCE PLAN:

- SOILS, INCLUDING, BUT NOT LIMITED TO, MATERIALS, CAPACITIES, AND PLACEMENT PROCEDURES.
CONCRETE FOUNDATIONS, INCLUDING, BUT NOT LIMITED TO, CONNECTIONS TO THE SLAB ON GRADE, CONNECTIONS TO THE WALL ELEMENTS, MATERIALS, BAR PLACEMENT, CONCRETE PLACEMENT, CURING, AND FINISHING PROCEDURES.
CONCRETE SLAB ON GRADE, INCLUDING, BUT NOT LIMITED TO, CONNECTIONS TO THE FOUNDATION, CONNECTIONS TO THE WALL ELEMENTS, MATERIALS, BAR PLACEMENT, CONCRETE PLACEMENT, CURING, AND FINISHING PROCEDURES.
WALL GLADDINGS (MASONRY), FRAMING, AND DEBRIS IMPACT ASSEMBLIES, INCLUDING, BUT NOT LIMITED TO, CONNECTIONS TO THE FOUNDATION, CONNECTIONS TO THE SLAB ON GRADE, CONNECTIONS TO THE ROOF STRUCTURE, CONNECTIONS OF THE DEBRIS IMPACT ASSEMBLIES, MATERIALS, BAR PLACEMENT, LITELS, AND WELDING PROCEDURES.
ROOF GLADDINGS, FRAMING, AND DEBRIS IMPACT ASSEMBLIES, INCLUDING, BUT NOT LIMITED TO, CONNECTIONS TO THE WALL, FRAMING, CONNECTIONS OF THE DEBRIS IMPACT ASSEMBLIES, MATERIALS, AND WELDING PROCEDURES.
CONCRETE TOPPING, INCLUDING, BUT NOT LIMITED TO, CONNECTIONS TO THE WALL ELEMENTS, CONNECTIONS TO THE ROOF ELEMENTS, CONNECTIONS OF THE DEBRIS IMPACT ASSEMBLIES, MATERIALS, BAR PLACEMENT, CONCRETE PLACEMENT, CURING, AND FINISHING PROCEDURES.
ROOF AND FLOOR DIAPHRAGMS, INCLUDING, BUT NOT LIMITED TO, CHORD BARS, COLLECTORS, DRAG STRUTS, AND BOUNDARY ELEMENTS.
- WRITTEN DOCUMENTATION OF FABRICATION AND INSTALLATION OF COMPONENTS AND ASSEMBLIES REQUIRED TO MEET IMPACT RESISTANCE REQUIREMENTS.
- THE CONTRACTOR SHALL PROVIDE A WRITTEN CONTRACTOR'S STATEMENT OF RESPONSIBILITY FOR THE SHELTER PORTION OF THE STRUCTURE PER SECTION 1106 OF THE INTERNATIONAL BUILDING CODE AND SECTION 3.10.3 OF FEMA 361 PRIOR TO THE START OF THE SHELTER CONSTRUCTION.
- STRUCTURAL OBSERVATIONS, BY THE STRUCTURAL ENGINEER OF RECORD, WILL BE REQUIRED AT (3) DIFFERENT STAGES OF THE SHELTER PORTION OF CONSTRUCTION FOR GENERAL CONFORMANCE OF THE STRUCTURAL SYSTEM. THE CONTRACTOR SHALL NOTIFY THE ENGINEER FOR THE OBSERVATIONS AT THE FOLLOWING TIMES DURING CONSTRUCTION:
AFTER THE FOUNDATIONS ARE APPROXIMATELY 50% CONSTRUCTED.
AFTER THE FOUNDATIONS ARE COMPLETE AND THE WALLS ARE APPROXIMATELY 50% COMPLETE.
AFTER THE WALLS AND ALL ROOF FRAMING, INCLUDING CONNECTIONS, HAVE BEEN COMPLETED, BUT PRIOR TO POURING THE TOPPING ON THE ROOF STRUCTURE.

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

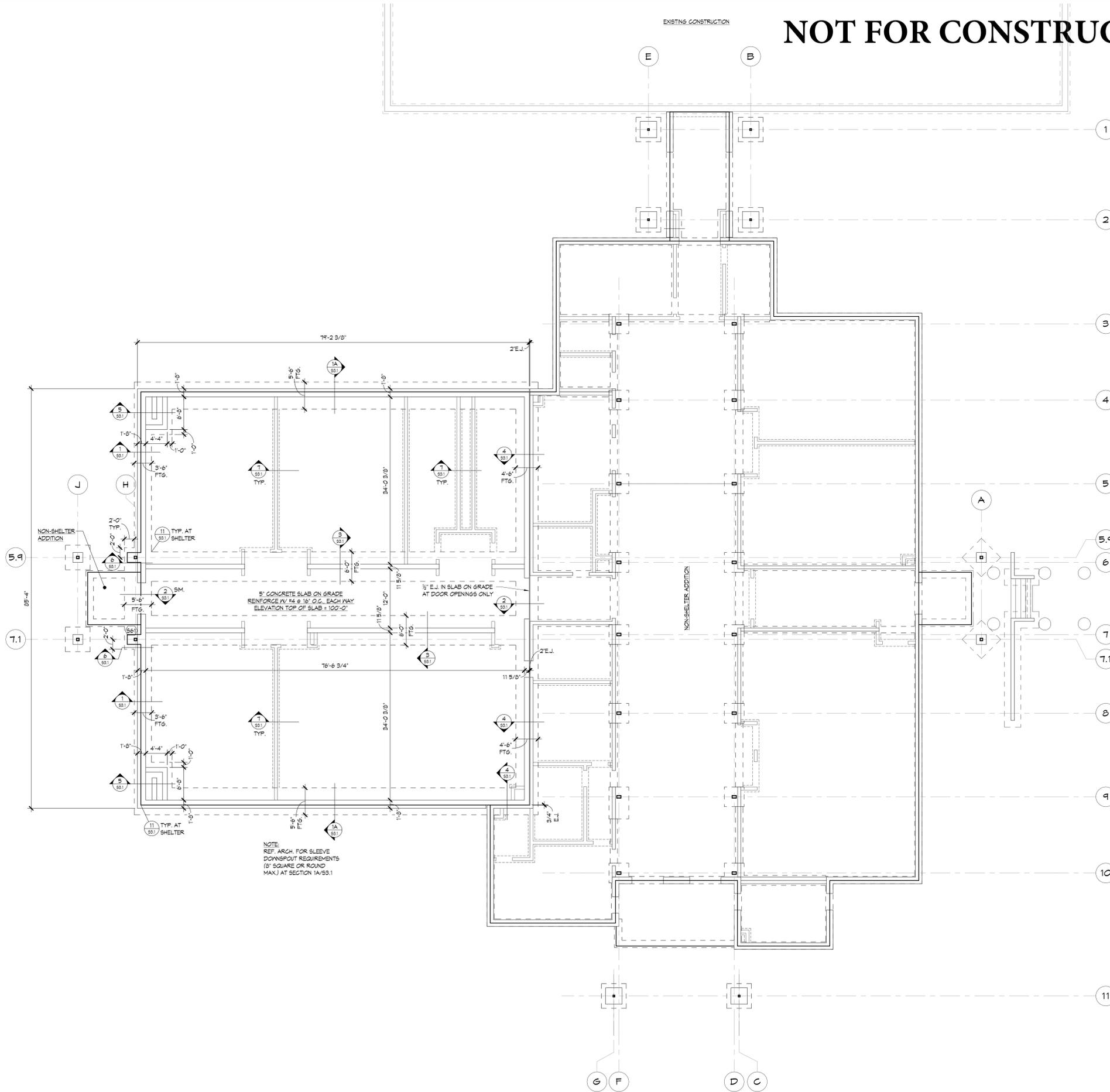
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

STRUCTURAL NOTES

SHEET NO.: **S0.1**

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



FOUNDATION PLAN NOTES

- REFERENCE SHEET S0.1 FOR THE STRUCTURAL GENERAL NOTES.
- PERIMETER FOUNDATION PLAN DIMENSIONS ARE TO THE FACE OF VENEER, CMU OR CONCRETE SLAB, TYP.
- REFERENCE ARCHITECTURAL FOR THE DIMENSIONAL LOCATION OF NON-LOAD BEARING MASONRY WALLS, TYP.
- CENTER ALL FOOTINGS BELOW WALLS AND COLUMNS, UNLESS SHOWN OR NOTED OTHERWISE.
- PROVIDE AND INSTALL 1/2" EXPANSION JOINT MATERIAL BETWEEN THE BUILDING WALLS AND EXTERIOR CONCRETE, TYP.
- REFERENCE DETAILS 8 & 9/S3.1 FOR THE TYPICAL SLAB ON GRADE JOINT DETAIL AND THE TYPICAL CORNER BAR DETAIL. AT SHELTER FOOTINGS, REFERENCE DETAIL 11/S3.1.
- REFERENCE DETAIL 10/S3.1 FOR THE TYPICAL MASONRY CONTROL JOINT DETAIL. REFERENCE ARCHITECTURAL AND THE STRUCTURAL GENERAL NOTES FOR LOCATIONS.

NOTE:
REF ARCH FOR SLEEVE
DOWNSPOUT REQUIREMENTS
(8' SQUARE OR ROUND
MAX) AT SECTION 1A/S3.1

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

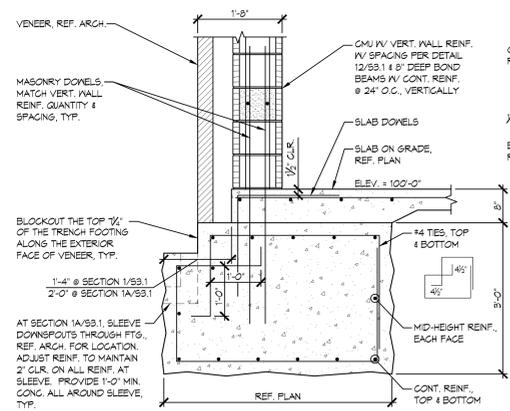
Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

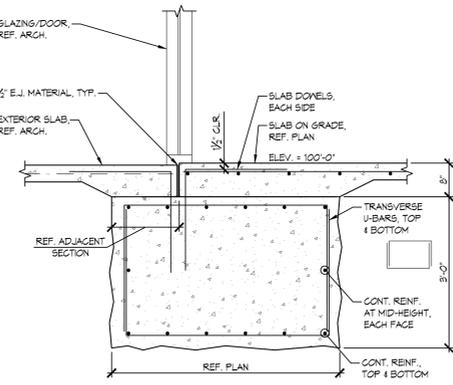
Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

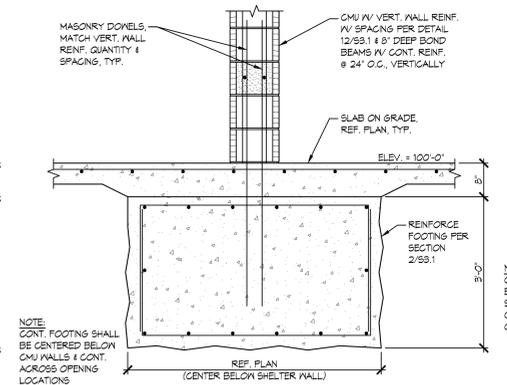
NOT FOR CONSTRUCTION/EXAMPLE ONLY



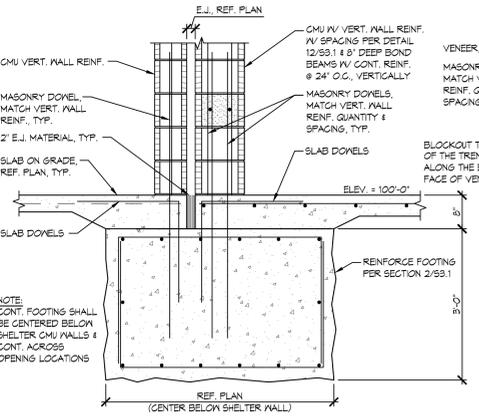
1A FOUNDATION SECTION



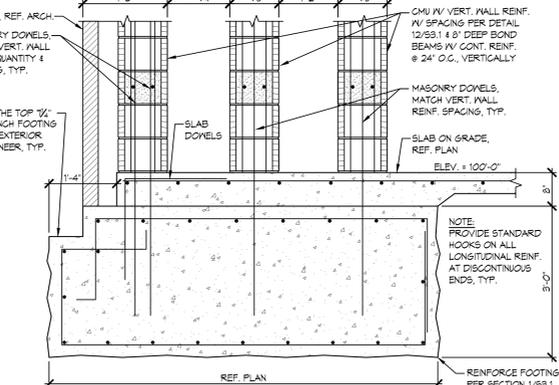
2 FOUNDATION SECTION



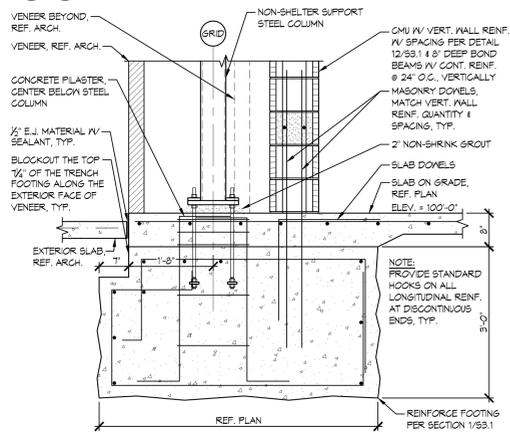
3 FOUNDATION SECTION



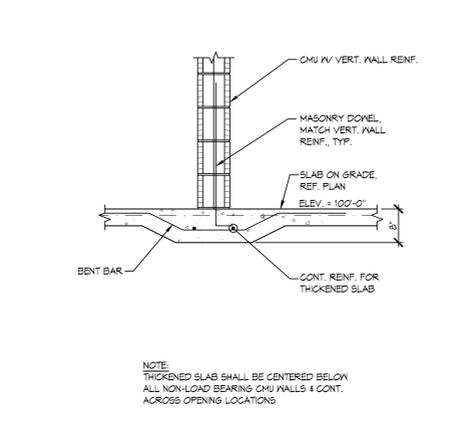
4 FOUNDATION SECTION



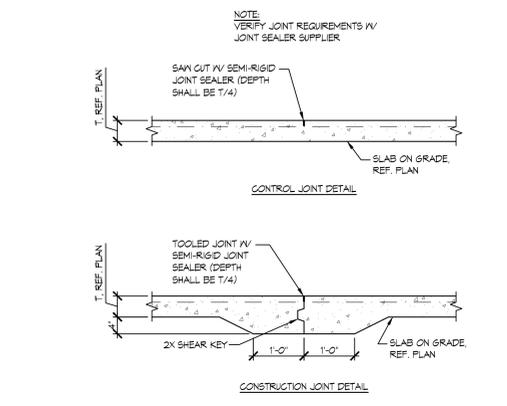
5 FOUNDATION SECTION



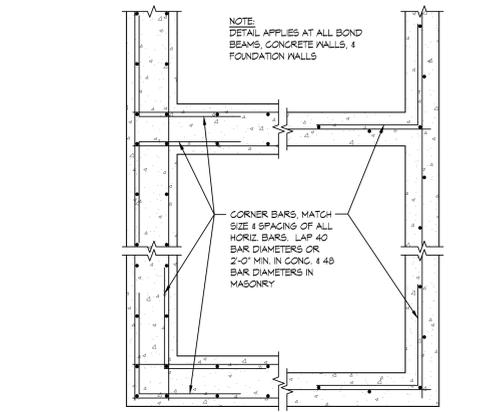
6 FOUNDATION SECTION



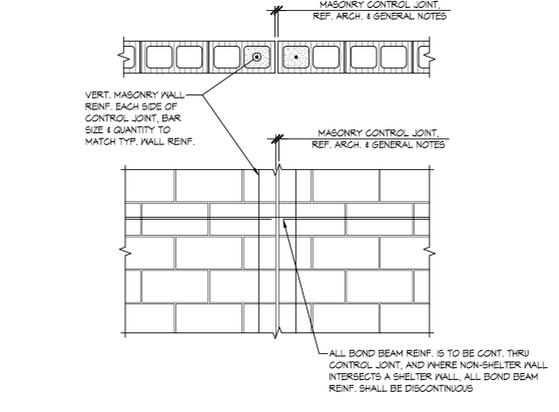
7 FOUNDATION SECTION



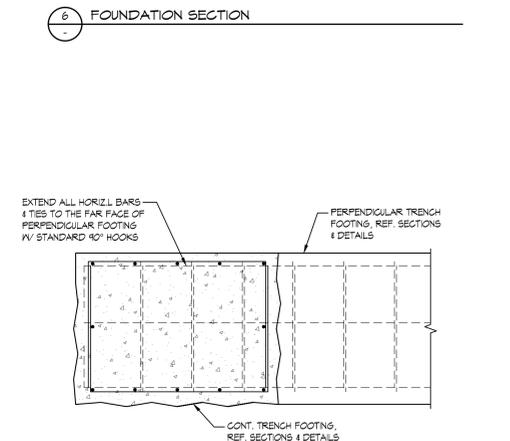
8 SLAB ON GRADE JOINT DETAILS



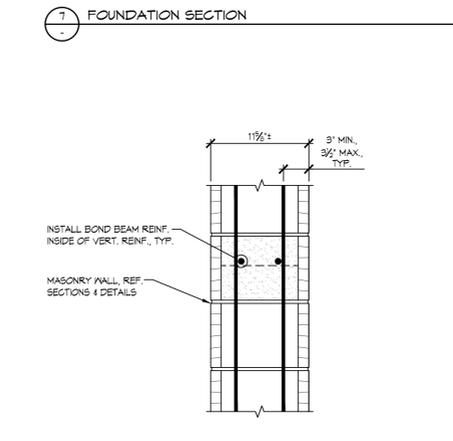
9 CORNER BAR DETAIL



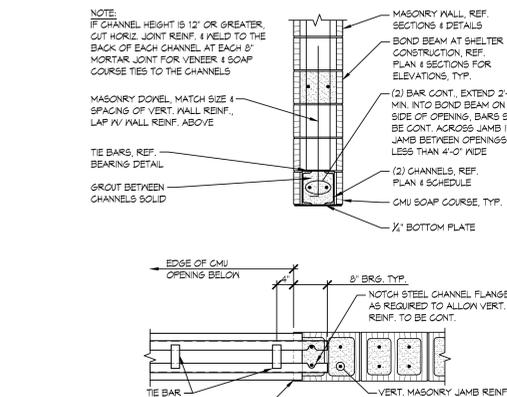
10 MASONRY CONTROL JOINT DETAIL



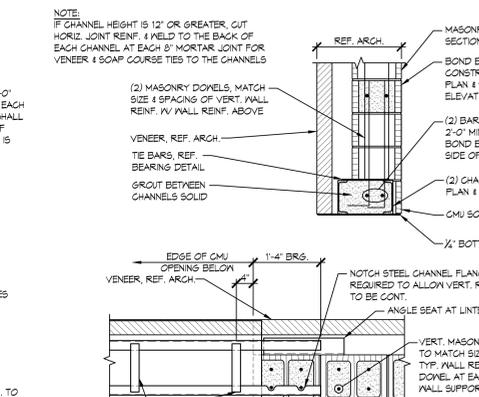
11 DETAIL AT SHELTER TRENCH FOOTINGS



12 TYPICAL 12' CMU DOUBLE REINF. DETAIL



13 INTERIOR STEEL CHANNEL LINTEL DETAIL



14 EXTERIOR STEEL CHANNEL LINTEL DETAIL

STEEL LINTEL SCHEDULE				
MARK	MEMBERS SIZES	LINTEL CROSS SECTION	SUPPORTS	
			LEFT	RIGHT
L/R	(2) C8 CHANNEL LINTEL	14/53.1	14/53.1	14/53.1
L/10	(2) C12 CHANNEL LINTEL	14/53.1	14/53.1	14/53.1
L/11	(2) C8 CHANNEL LINTEL	13/53.1	13/53.1	13/53.1
L/12	(2) C12 CHANNEL LINTEL	13/53.1	13/53.1	13/53.1

LINTEL SCHEDULE NOTES:

- LEFT AND RIGHT SUPPORTS ARE SUPPORTS WHEN VIEWING THE SHEET FROM THE BOTTOM OR RIGHT HAND (TITLE BLOCK) SIDE OF THE SHEET.
- EXPOSED PORTIONS OF LINTELS, TO INCLUDE BOTTOM PLATES, SHALL BE TREATED AS ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS).
- OPENING DIMENSIONS NOTED BELOW REFER TO THE WIDTH OF THE OPENING IN THE CMU WALL.
- AT EACH OPENING WITH CMU BELOW OPENING: INSTALL (2) 8" DEEP BOND BEAMS WITH (2) #4 CONT. IN EACH. EXTEND BOND BEAMS AND REINFORCEMENT 4'-0" MINIMUM ON EACH SIDE OF OPENING. REFERENCE ARCHITECTURAL FOR BILL CONDITIONS EFFECTING BOND BEAM ELEVATION.
- AT EACH OPENING IN CMU WALLS WITH CMU BELOW THE OPENING: HOOK TOP OF MASONRY DOVEL WHEN THE HEIGHT OF CMU BELOW THE OPENING IS LESS THAN 2'-0". WHEN THE HEIGHT OF MASONRY BELOW THE OPENING IS GREATER THAN 2'-0", INSTALL HOOKED DOVEL AT EACH VERTICALLY REINFORCED MASONRY CORE.
- FOR EXTERIOR CMU WALLS W/ VENEER: INSTALL A 1/2" PLATE 1/2" LESS THAN THE WIDTH OF THE WALL ASSEMBLY AND BEARING 2" MINIMUM ON EACH SIDE. AT OPENINGS 14" OR LESS THAT DO NOT OCCUR BELOW OR WITHIN 24" OF A JOIST/BREAM BEARING LOCATION.
- NO OPENINGS IN ANY CMU WALL SHALL BE PLACED BELOW OR WITHIN 24" OF A BEAM BEARING LOCATION UNLESS SPECIFICALLY NOTED ON THE STRUCTURAL PLANS OR AS APPROVED BY THE ENGINEER.
- NOTIFY ENGINEER FOR STEEL LINTEL REQUIREMENTS AT LOCATIONS NOT SPECIFICALLY ADDRESSED ON PLAN OR IN THE LINTEL SCHEDULE NOTES.
- ALL EXTERIOR LINTELS SHALL BE GALVANIZED, REF. GENERAL NOTES AND SPECIFICATIONS.

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-381 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:
The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

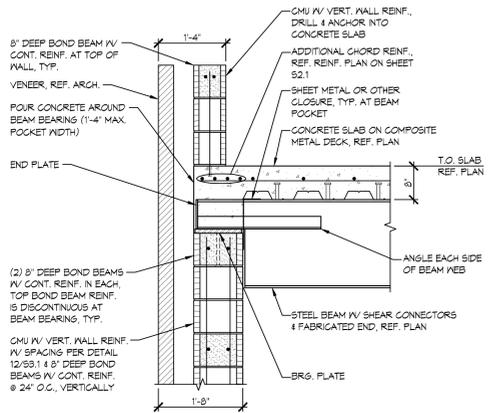
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

STRUCTURAL DETAILS - FOUNDATION AND WALLS

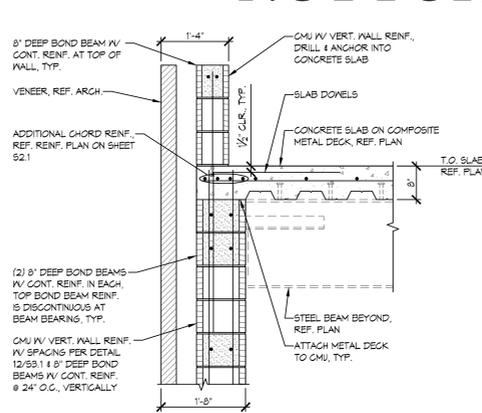
SHEET NO.: S3.1

DATE: AUGUST 2014

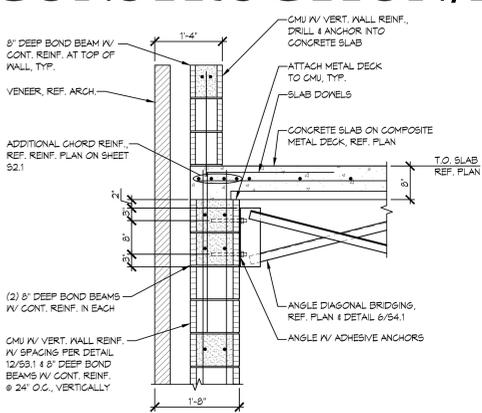
NOT FOR CONSTRUCTION/EXAMPLE ONLY



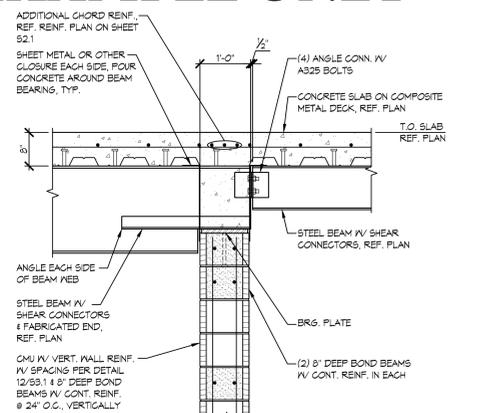
1 SHELTER ROOF FRAMING SECTION



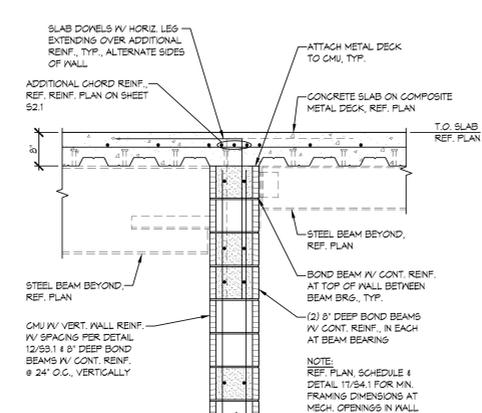
2 SHELTER ROOF FRAMING SECTION



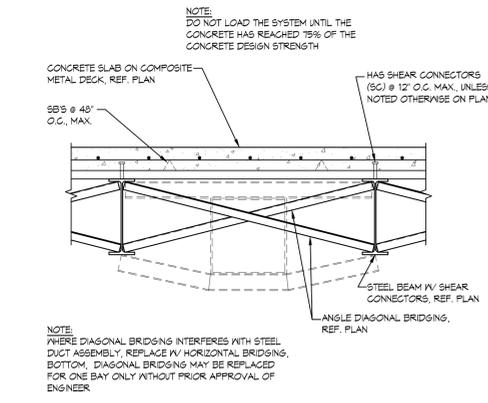
3 SHELTER ROOF FRAMING SECTION



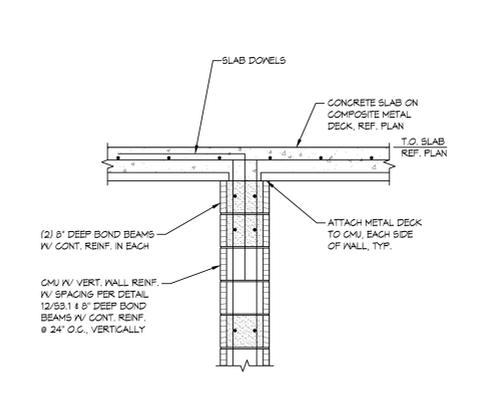
4 SHELTER ROOF FRAMING SECTION



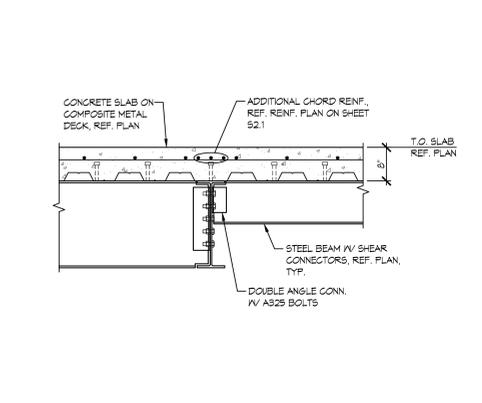
5 SHELTER ROOF FRAMING SECTION



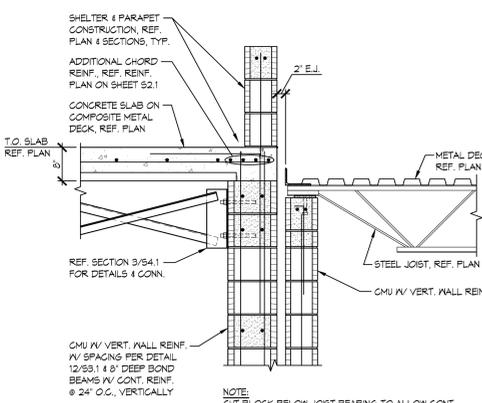
6 SHELTER ROOF FRAMING SECTION



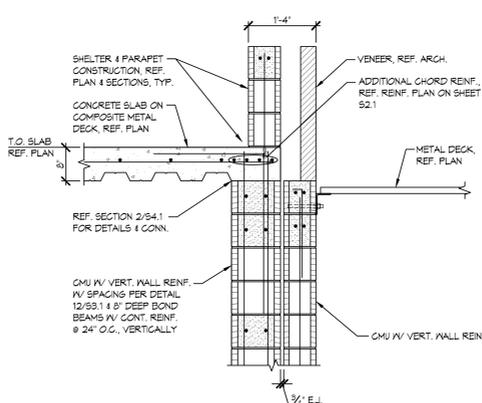
7 SHELTER ROOF FRAMING SECTION



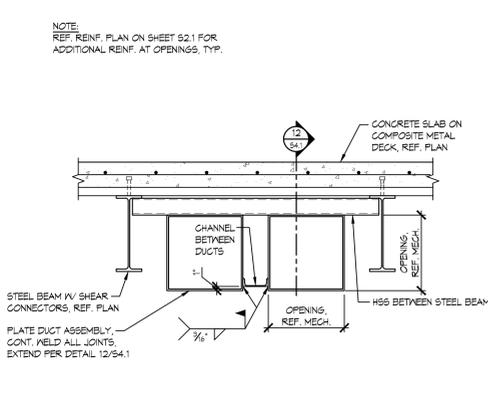
8 SHELTER ROOF FRAMING SECTION



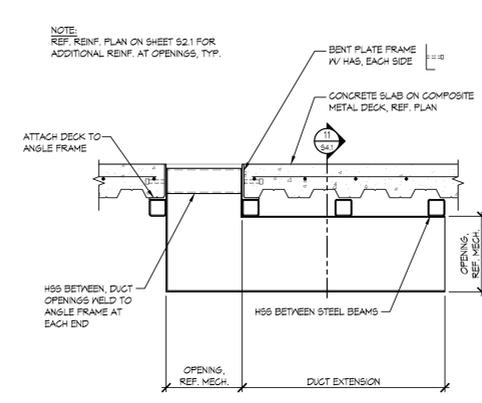
9 SHELTER ROOF FRAMING SECTION



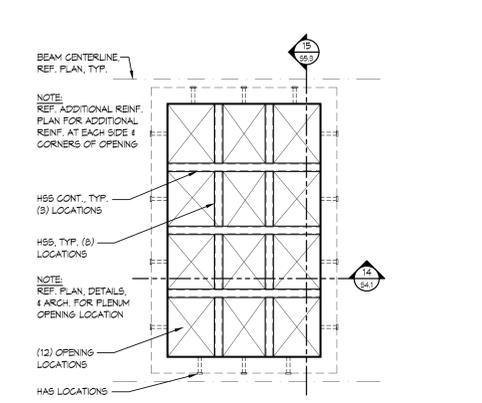
10 SHELTER ROOF FRAMING SECTION



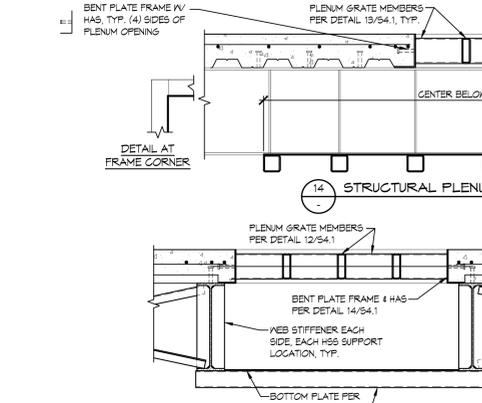
11 STRUCTURAL DUCT ASSEMBLY DETAIL



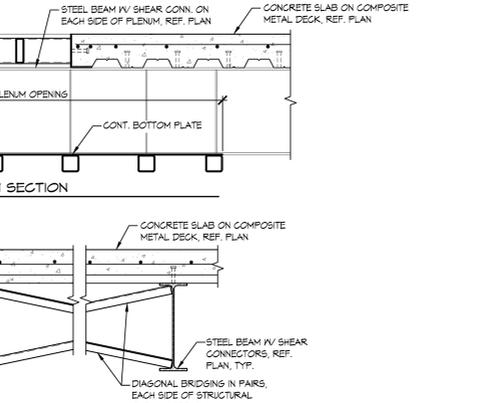
12 STRUCTURAL DUCT ASSEMBLY DETAIL



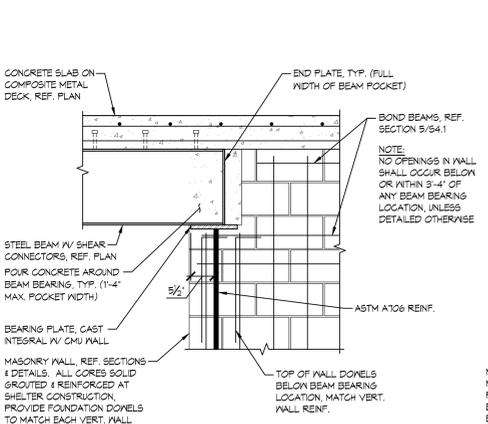
13 STRUCTURAL PLENUM GRATE DETAIL



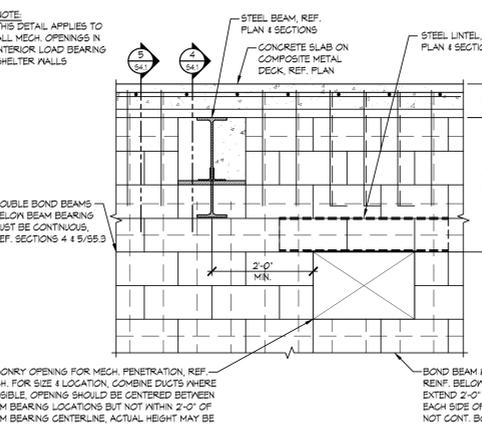
14 STRUCTURAL PLENUM SECTION



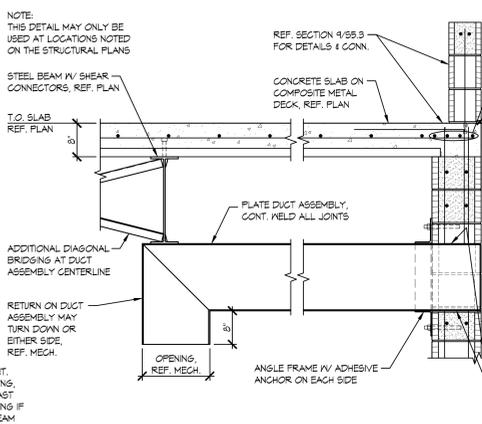
15 STRUCTURAL PLENUM SECTION



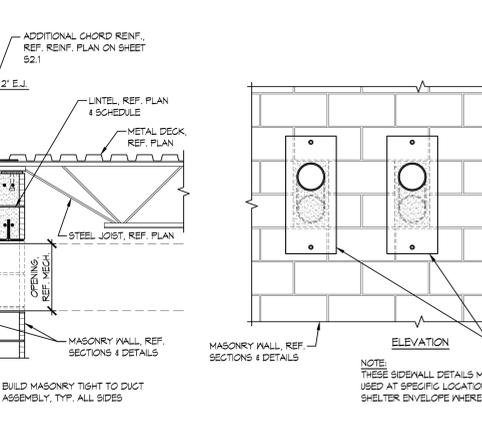
16 STEEL BEAM BEARING DETAIL



17 HIGH OPENING IN SHELTER INTERIOR WALL ELEV.



18 STRUCTURAL SIDEWALL DUCT ASSEMBLY DETAIL



19 STRUCTURAL SIDEWALL PIPE PENETRATION DETAIL

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, (FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:
The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

STRUCTURAL DETAILS - ROOF AND WALLS

SHEET NO.: **S4.1**

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

HVAC & PLUMBING SYMBOL SCHEDULE

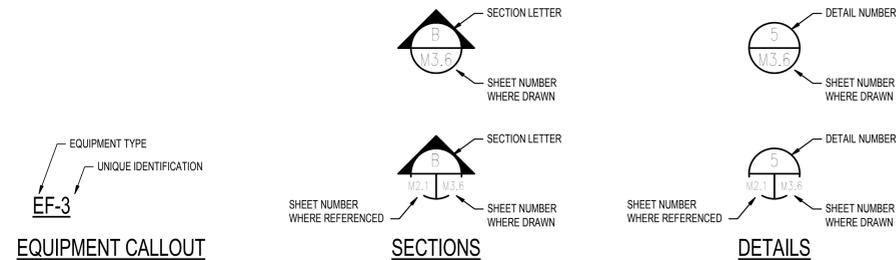
TYPE	SYMBOL	DESCRIPTION	TYPE	SYMBOL	DESCRIPTION
①		DOMESTIC COLD WATER LINE (CW)	③		WAFER CHECK VALVE
①		DOMESTIC HOT WATER LINE (HW)	③		CHECK VALVE
①		HOT WATER RECIRC LINE (HWC)	③		HYDRAULIC VALVE
①		DOMESTIC TEMPERED WATER LINE (TW)	③		EMERGENCY VALVE WITH FIRE LINK
①		ABOVE FLOOR WASTE LINE (W)	③		CALIBRATED BALANCE VALVE
①		BELOW FLOOR OR GRADE WASTE LINE (W)	③		AUTOMATIC FLOW CONTROL VALVE
①		ABOVE FLOOR PLUMBING VENT LINE (V)	④		STRAINER
①		BELOW FLOOR OR GRADE PLUMBING VENT LINE (V)	④		PLUG VALVE
①		CONDENSATE DRAIN LINE (CD)	④		CALIBRATED ORIFICE PLATE FLOW METER
①		RAIN LEADER (RL)	④		SPRING HANGER
①		OVERFLOW RAIN LEADER (ORL)	④		PIPE HANGER
①		STORM SEWER (SS)	④		THERMOMETER
①		NATURAL GAS LINE (G)	④		PRESSURE GAUGE
①		VENT THROUGH ROOF	⑤		(UP) DUCT SECTION, POSITIVE PRESSURE (FIRST SIZE IS TOP DIMENSION)
①		FLOOR DRAIN	⑤		(DOWN) DUCT SECTION, POSITIVE PRESSURE (FIRST SIZE IS TOP DIMENSION)
①		FLOOR SINK	⑤		(UP) DUCT SECTION, NEGATIVE PRESSURE (FIRST SIZE IS TOP DIMENSION)
①		EXTERIOR CLEANOUT	⑤		(DOWN) DUCT SECTION, NEGATIVE PRESSURE (FIRST SIZE IS TOP DIMENSION)
①		EXTERIOR 2-WAY CLEANOUT	⑤		SUPPLY DUCT DROP
①		WALL CLEANOUT	⑤		RETURN DUCT RISER
①		PLUMBING FIXTURE CALLOUT	⑤		RETURN DUCT DROP
①		WATER HAMMER ARRESTOR - PDI SIZE	⑤		RETURN DUCT RISER
①		FLOW LINE ELEVATION	⑤		FLEXIBLE DUCT
①		WALL HYDRANT	⑤		TURNING VANES
①		ROOF HYDRANT	⑤		SIDE WALL SUPPLY REGISTER
①		ROOF DRAIN	⑤		DUCT SIZE, FIRST FIGURE IS SIDE SHOWN (CLEAR INSIDE DIMENSIONS)
①		OVERFLOW ROOF DRAIN	⑤		CHANGE OF DUCT ELEVATION, RISE (R) OR DROP (D)
①		CAST IRON	⑤		FLEXIBLE CONNECTION
①		POLYVINYL CHLORIDE PIPE	⑤		OPPOSED BLADE BALANCING DAMPER W/ MANUAL LOCKING QUADRANT (RECT DUCT)
①		MECHANICAL JOINT	⑤		BUTTERFLY BALANCING DAMPER W/ MANUAL LOCKING QUADRANT (ROUND DUCT)
①		CAP	⑤		OPPOSED BLADE BALANCING DAMPER W/ MOTORIZED LOCKING QUADRANT (RECT DUCT)
①		PIPE RISE	⑤		BUTTERFLY BALANCING DAMPER W/ MOTORIZED LOCKING QUADRANT (ROUND DUCT)
①		PIPE DROP	⑤		BOTTOM OF DUCT ELEVATION ABOVE FLOOR
①		UNION OR FLANGE CONNECTION	⑤		TOP OF DUCT ELEVATION ABOVE FLOOR
①		DIRECTION OF FLOW	⑤		BOTTOM OF STEEL
①		ANCHOR	⑤		BOTTOM OF JOIST
①		CONCENTRIC REDUCER OR INSEALER	⑤		OPPOSED BLADE DAMPER
①		ECCENTRIC REDUCER	⑤		PARALLEL BLADE DAMPER
①		TOP CONNECTION, 45° OR 90°	⑤		AIR HANDLING UNIT
①		BOTTOM CONNECTION, 45° OR 90°	⑤		ROOFTOP UNIT
①		SIDE CONNECTION	⑤		AIR CONDITIONER
①		CAPPED OUTLET	⑤		SPLIT SYSTEM
①		BOTTOM OF PIPE ELEVATION ABOVE FLOOR	⑤		CONDENSING UNIT
①		TOP OF PIPE ELEVATION ABOVE FLOOR	⑤		CONDENSING UNIT
②		REFRIGERANT LIQUID LINE (RL)	⑤		ELECTRIC WALL HEATER
②		REFRIGERANT SUCTION LINE (RS)	⑤		DEDICATED OUTDOOR AIR SYSTEM
②		2-WAY DIGITAL CONTROL VALVE	⑤		WATER HEATER
②		3-WAY DIGITAL CONTROL VALVE	⑤		SUPPLY AIR
②		DOUBLE CHECK BACKFLOW ASSEMBLY	⑤		OUTDOOR AIR
②		NORMALLY OPEN	⑤		RETURN AIR
②		NORMALLY CLOSED	⑤		EXHAUST AIR
②		COMMON	⑤		FIRE DAMPER IN WALL (VERTICAL POSITION)
②		REDUCED PRESSURE ZONE BACKFLOW ASSEMBLY	⑤		FIRE DAMPER IN FLOOR (HORIZONTAL POSITION)
②		GAS COCK	⑤		SMOKE DAMPER
②		VALVE IN DROP	⑤		COMBINATION FIRE/SMOKE DAMPER (VERTICAL POSITION)
②		VALVE IN RISER	⑤		COMBINATION FIRE/SMOKE DAMPER (HORIZONTAL POSITION)
②		GATE VALVE / SHUT OFF VALVE	⑤		THERMOSTAT
②		GLOBE VALVE	⑤		ELECTRIC WIRING (WITH 2 WIRES) - LOW VOLTAGE
②		3 PIECE BALL VALVE	⑤		120V POWER WIRING
②		BALL VALVE	⑤		CONTROL COMMUNICATION WIRING
②		BUTTERFLY VALVE	⑤		DRY BULB TEMPERATURE
②		PRESSURE REDUCING VALVE (PRV)	⑤		WET BULB TEMPERATURE
②		PRESSURE AND TEMPERATURE RELIEF VALVE (P&T)	⑤		DEW POINT TEMPERATURE
			⑤		RELATIVE HUMIDITY
			⑤		TEMPERATURE CONTROL CONTRACTOR
			⑤		MECHANICAL CONTRACTOR
			⑤		PLUMBING CONTRACTOR
			⑤		ELECTRICAL CONTRACTOR
			⑤		GENERAL CONTRACTOR
			⑤		MANUFACTURER
			⑤		UNLESS INDICATED OTHERWISE
			⑤		CUBIC FEET PER MINUTE
			⑤		FEET PER MINUTE
			⑤		PRESSURE DROP
			⑤		EXISTING
			⑤		ROOM CALLOUT
			⑤		REVISION NUMBER
			⑤		CONNECT NEW TO EXISTING, VERIFY EXACT LOCATION
			⑤		REFER TO PLAN NOTES

TYPE ① PLUMBING ② HVAC PIPING ③ VALVE ④ PIPING ACCESSORIES ⑤ DUCTWORK ⑥ EQUIPMENT

GENERAL PROJECT NOTES

- COORDINATE ALL WORK WITH OTHER TRADES PRIOR TO INSTALLATION.
- UNLESS OTHERWISE INDICATED, INSTALL ALL SPACE THERMOSTATS AND TEMPERATURE SENSORS AT THE SAME ELEVATION AS LIGHT SWITCHES PER ADA REQUIREMENTS. COORDINATE EXACT LOCATIONS WITH ARCHITECT PRIOR TO INSTALLATION.
- MECHANICAL CONTRACTOR SHALL PROVIDE OPENING IN DUCT AND ACCESS PANEL FOR ALL FIRE, SMOKE, AND MOTORIZED DAMPERS.
- THE GENERAL CONTRACTOR SHALL PROVIDE ACCESS PANELS IN WALLS, CEILINGS, AND FLOORS AS REQUIRED FOR ACCESS TO MECHANICAL EQUIPMENT, VALVES, DAMPERS, AND OTHER DEVICES, AND COORDINATE SIZES OF PANELS WITH THE MECHANICAL CONTRACTOR. REFER TO ARCHITECTURAL SPECIFICATIONS FOR PANEL REQUIREMENTS. LOCATIONS OF ACCESS PANELS SHALL BE APPROVED BY THE ARCHITECT.
- REFER TO ARCHITECTURAL REFLECTED CEILING PLANS FOR EXACT LOCATION OF ALL CEILING MOUNTED AIR DEVICES.
- CUTTING OF STRUCTURAL MEMBERS IS NOT ALLOWED.
- ALL EQUIPMENT SUPPORT STANDS SHALL BE PRIMED AND PAINTED. REFER TO ARCHITECTURAL SPECIFICATIONS.
- COORDINATE ROUTING OF PIPING WITH DUCTWORK, LIGHTS, CEILINGS, AND STRUCTURAL ELEMENTS. PIPING AND DUCTWORK SHALL RISE AND DROP, JOG OR OFFSET AS REQUIRED TO AVOID CONFLICTS. DUCTWORK SHALL TAKE PRECEDENCE OVER ALL PIPING, INCLUDING FIRE SPRINKLER PIPING, EXCEPT WHERE GRADE MUST BE MAINTAINED FOR DRAINAGE. PROVIDE ADDITIONAL AIR VENTS FOR PIPING WHERE REQUIRED FOR PIPING TO OFFSET. THE FIRE PROTECTION CONTRACTOR SHALL PROVIDE ADDITIONAL DRAINS AS REQUIRED TO DRAIN SYSTEM.
- ALL CEILING DIFFUSERS ARE 4-WAY BLOW UNLESS INDICATED OTHERWISE ON THE DRAWINGS.
- DO NOT ROUTE PIPING OR DUCTWORK OVER ELECTRICAL PANELS OR EQUIPMENT. COORDINATE WITH THE ELECTRICAL CONTRACTOR.
- ALL FLOOR MOUNTED MECHANICAL EQUIPMENT SHALL BE MOUNTED ON 4" THICK CONCRETE HOUSEKEEPING PADS BY THE GENERAL CONTRACTOR. COORDINATE DIMENSIONS AND LOCATION OF PADS WITH THE GENERAL CONTRACTOR.
- MAINTAIN MINIMUM 10'-0" SEPARATION OF PLUMBING VENTS, EXHAUST FAN DISCHARGES, AND EXHAUST LOUVERS FROM FRESH AIR INTAKES.
- ALL PENETRATIONS THROUGH FIRE RATED ASSEMBLIES SHALL BE FIRE STOPPED BY THE TRADE MAKING THE PENETRATION. REFER TO SPECIFICATIONS FOR REQUIREMENTS.
- PROVIDE DAMPER WITH LOCKING QUADRANT IN ALL BRANCH DUCTS WHERE AIRFLOW IS INDICATED AT THE SERVED AIR DEVICE, EXCEPT WHERE AN OPPOSED BLADE DAMPER IS SUPPLIED AT THE DEVICE.
- UNLESS OTHERWISE INDICATED, INSTALL ALL PIPING ABOVE CEILINGS AND CONCEALED IN WALLS, CHASES, AND FUR OUTS (WHERE INDICATED), ON WARM SIDE OF INSULATION.
- PROVIDE PVC JACKET ON ALL EXPOSED PIPING INSULATION UP TO 9'-0" ABOVE FINISHED FLOOR.
- COORDINATE ALL BELOW FLOOR PIPE ROUTING WITH STRUCTURAL FOOTINGS AND FOUNDATIONS. SEE STRUCTURAL DRAWINGS.
- THESE DRAWINGS ARE ACCOMPANIED BY SPECIFICATIONS. REFER TO SPECIFICATIONS FOR FURTHER INFORMATION.

DRAWING SYMBOLS



SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria. FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

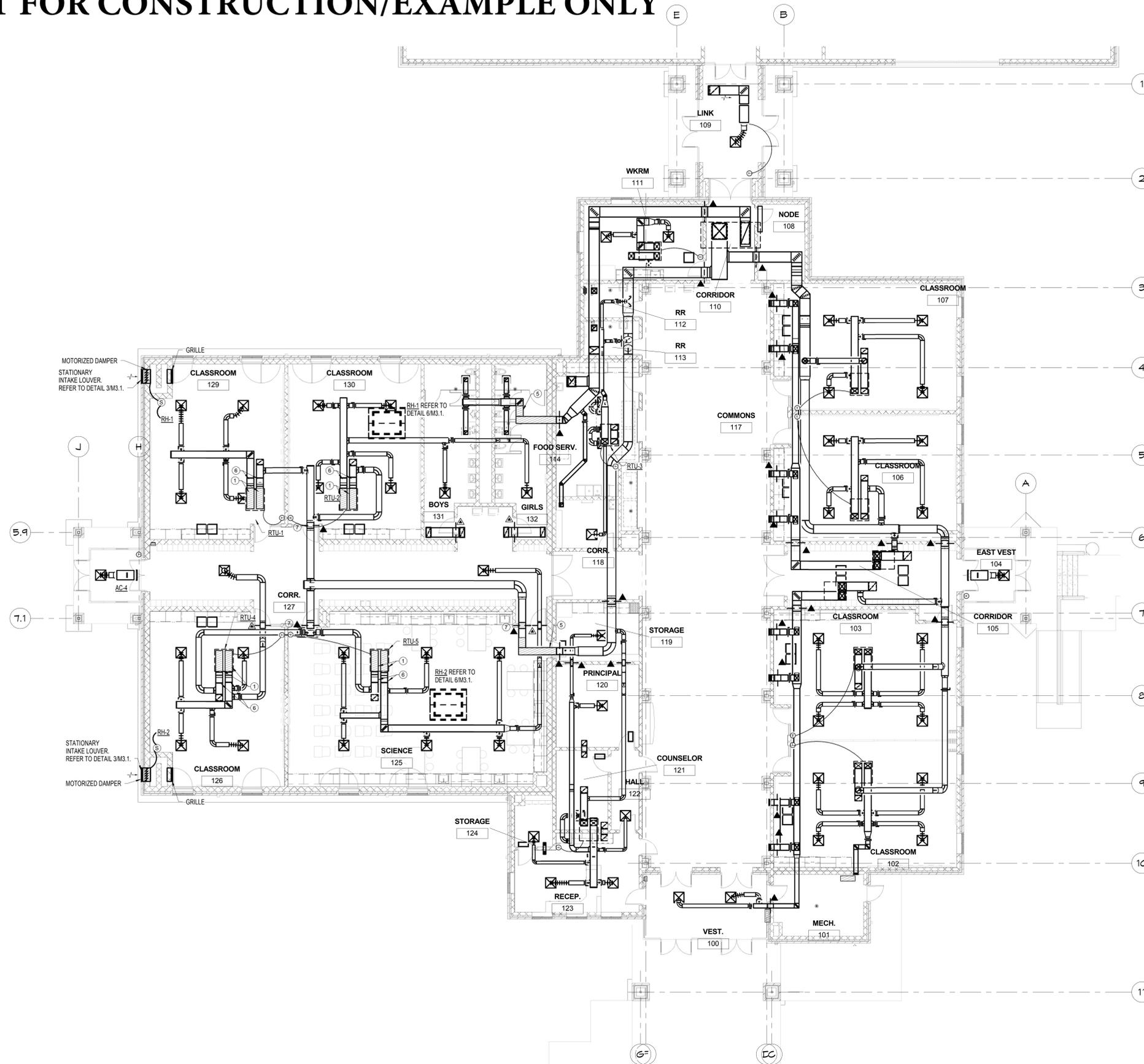
MECHANICAL SYMBOL SCHEDULE AND NOTES

SHEET NO.: **MO.1**

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

SCHOOL TORNADO
SAFE ROOM
SOUTHEAST KANSAS



- GENERAL NOTES:**
- COORDINATE LOCATION OF DUCTS WITH AVAILABLE CEILING SPACE, BUILDING STRUCTURE, PLUMBING PIPING AND LIGHT FIXTURES.
 - ALL THERMOSTATS SHALL BE MOUNTED AT THE SAME ELEVATION AS WALL SWITCHES, BUT NO HIGHER THAN 48" ABOVE FINISHED FLOOR.
 - ALL REFRIGERANT PIPE SIZING AND ROUTING SHALL BE APPROVED BY SPLIT SYSTEM SUPPLIER.
 - PROVIDE BALANCE DEVICES IN ALL BRANCH DUCT RUN-OUTS.
 - PROVIDE HIGH EFFICIENCY DUCT TAKE-OFF PER DETAILS 3&5/M3.2. SPIN IN TAPS ARE NOT APPROVED.
 - PROVIDE SOUND TRAPS AT EACH RETURN GRILLE PER DETAIL 4/M3.2.
 - ALL FIRE DAMPER SHALL BE DYNAMIC TYPE.
 - FLEXIBLE DUCT MAY NOT BE USED FOR SUPPLY DUCT ASSOCIATED WITH DOAS UNIT, OR EXHAUST DUCT. FLEXIBLE DUCT MAY BE USED ON LOW VELOCITY SUPPLY DUCT IF LIMITED TO A MAXIMUM OF 6 FT IN LENGTH. MINIMUM BEND RADIUS IS DESCRIBED PER DETAIL 3/M3.2.
- PLAN NOTES:**
- STRUCTURAL DUCT. REFER TO DETAILS 11/12 SHEET S5.3. EXTERNALLY INSULATE AS MUCH AS POSSIBLE. INSERT TURNING VANES INTO ELBOW.
 - PROVIDE STEEL SUPPLY OR RETURN GRILLE WITH RADIATION DAMPER.
 - CENTER SIDEWALL DIFFUSER ON ACOUSTICAL PANEL.
 - PROVIDE "FRONT ACCESSIBLE" TYPE FIRE DAMPER.
 - STRUCTURAL DUCT. REFER TO STRUCTURAL DETAILS. EXTERNALLY INSULATE SUPPLY DUCT AS MUCH AS POSSIBLE. INSERT TURNING VANE INTO ELBOW.
 - DUCTS CONNECT TO STRUCTURAL DUCT AND OFFSET DOWN BELOW BEAM SPACE.
 - FIRE DAMPER MAY BE OMITTED UNDER ALTERNATE CODE FOOTPRINT. SEE DIVISION 1 SECTION FOR DESCRIPTION OF ALTERNATES.

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

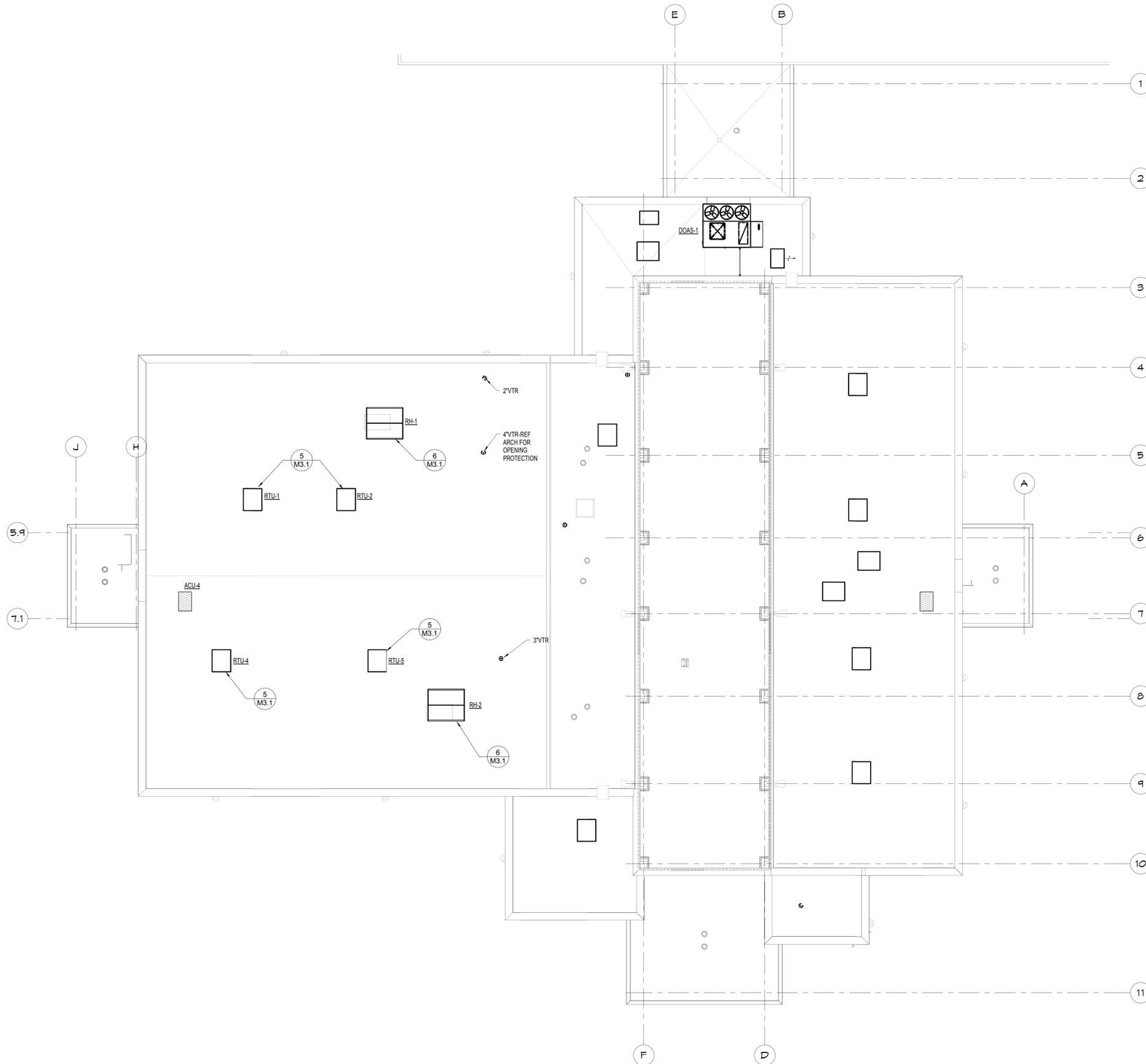
1 HVAC FLOOR PLAN
1/8" = 1'-0"

MECHANICAL FLOOR PLAN

SHEET NO.: M1.1

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



GENERAL NOTES:

1. USE MANUFACTURER'S RECOMMENDED MAINTENANCE AND AIRFLOW CLEARANCES.
2. LOCATE EQUIPMENT A MINIMUM OF 10'-0" FROM EDGE OF ROOF. PROVIDE 42" HIGH HAND RAIL AROUND ANY PORTION OF THE ROOF WITHIN 10'-0" OF EQUIPMENT.
3. METHODS OF PENETRATING ROOF MEMBRANE AND LOCATIONS IN PROXIMITY TO OTHER ITEMS SUCH AS CLEAR STORY OR PARAPET ROOFS SHALL BE APPROVED BY ROOF PROVIDER.
4. SHIM ALL EQUIPMENT CURBS LEVEL. SEE DETAIL SHEET M3.1 FOR FURTHER DETAILS.
5. ATTACH BOTH ROOF MOUNTED EQUIPMENT AND ASSOCIATED CURBS TO ROOF STRUCTURE.
6. COORDINATE ROOF CURB HEIGHT REQUIREMENT WITH ROOF PROVIDER AND ROOF INSTALLATION.
7. INSTALL GASKETS ON ROOF CURB PRIOR TO SETTING ROOF MOUNTED EQUIPMENT.

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

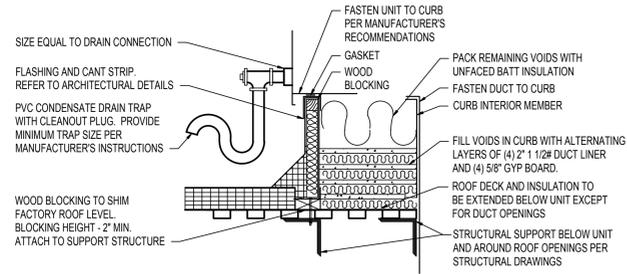
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

MECHANICAL ROOF PLAN

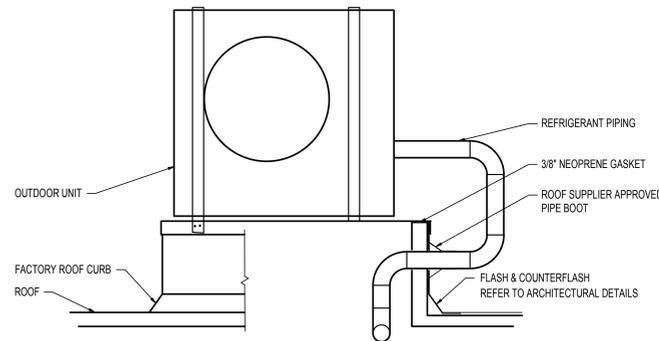
SHEET NO.: **M2.1**

DATE: AUGUST 2014

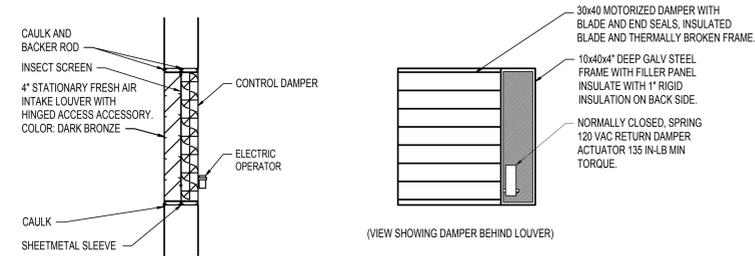
NOT FOR CONSTRUCTION/EXAMPLE ONLY



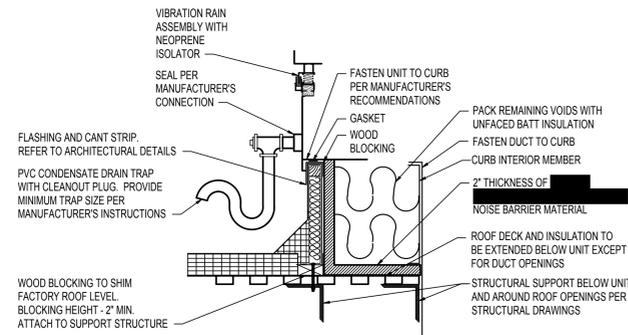
1 RTU-3,6,7,8,9,10,11,12 & 13 ROOF CURB DETAIL
SCALE: NONE



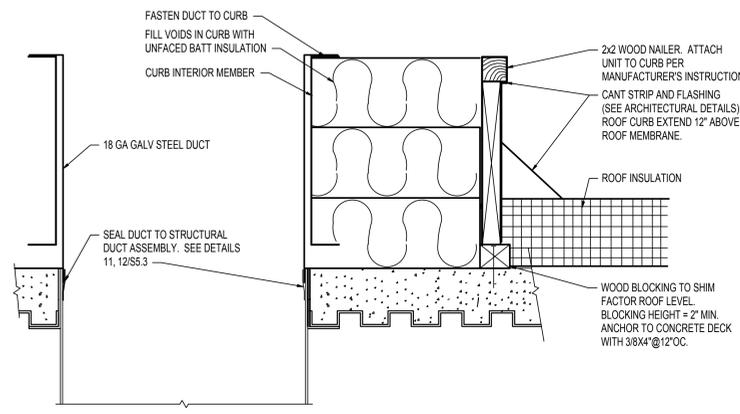
2 ACU-1 & 2 CURB DETAIL
SCALE: NONE



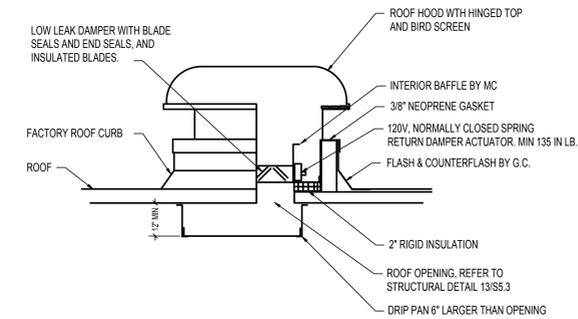
3 INTAKE LOUVER DETAIL
SCALE: NONE



4 DOAS-1 ROOF CURB DETAIL
SCALE: NONE

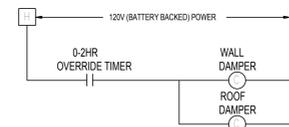


5 RTU-1, 2,4 & 5 ROOF CURB DETAIL
SCALE: NONE



6 ROOF HOOD DETAIL
SCALE: NONE

SEQUENCE OF OPERATION:
WALL AND ROOF DAMPERS ARE DE-ENERGIZED DURING NORMAL OPERATION VIA SPRING RETURN MOTORS. IN THE EVENT OF A DISASTER AND VENTILATION IS DESIRED, 0-2 HR WALL TIMER IS UTILIZED TO OPEN THE DAMPERS FOR A PRE-DETERMINED AMOUNT OF TIME. ONCE THE TIMER EXPIRES, THE DAMPERS RETURN TO THEIR CLOSED POSITIONS.



7 WALL/ROOF DAMPER WIRING DETAIL
SCALE: NONE

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-381 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

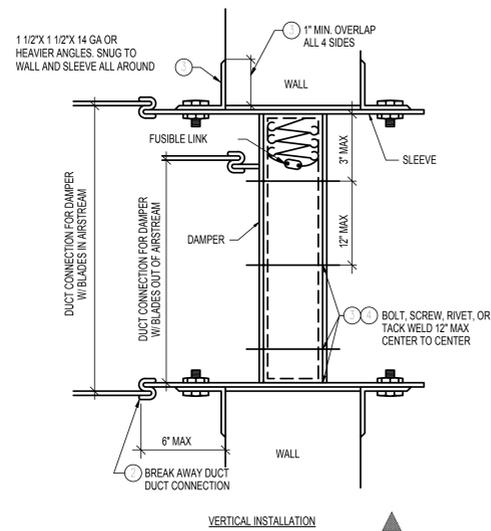
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

MECHANICAL DETAILS

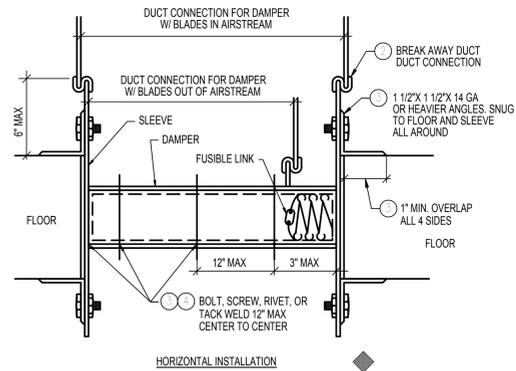
SHEET NO.: M3.1

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



VERTICAL INSTALLATION

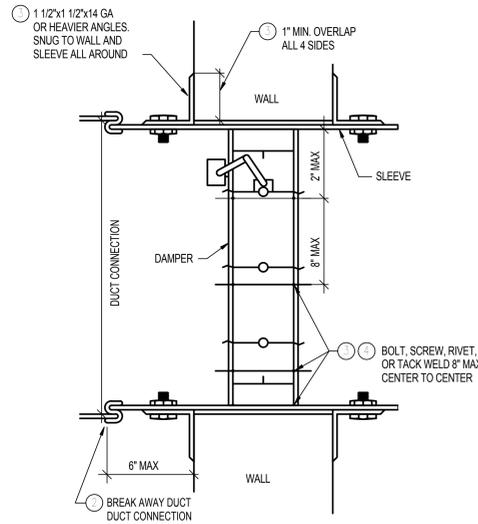


HORIZONTAL INSTALLATION

NOTES:

1. OPENINGS IN FLOOR OR WALL SHALL BE 1/4" TO 1/2" LARGER THAN OVERALL SIZE OF FIRE DAMPER AND SLEEVE ASSEMBLY.
2. ALL CONNECTIONS TO DUCTS SHALL CONFORM TO U.L. 555 AND NFPA 90-A.
3. MOUNTING ANGLES SHALL BE MIN. OF 1 1/2" X 1 1/2" X 14 GA. AND BOLTED TACK WELDED, RIVETED, OR SCREWED TO SLEEVE AT MAX. SPACING OF 12" AND MIN. OF 2 CONNECTIONS PER SIDE, TOP, AND BOTTOM. MOUNTING ANGLES SHALL OVERLAP WALL AND FLOOR OPENING MIN. OF 1" ON ALL SIDES.
4. DAMPER SHALL BE ATTACHED TO SLEEVE IN SAME MANNER AND SPACING AS MOUNTING ANGLES.
5. THE LENGTH OF THE SLEEVE EXTENDING BEYOND THE WALL OR FLOOR OPENING SHALL NOT EXCEED 6" ON EACH SIDE.
6. FIRE DAMPER INSTALLATION SHALL BE IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND SHALL CONFORM TO NFPA 90-A AND U.L. 555.
7. HARDCAST ALL FRAMES PRIOR TO INSTALLATION.

1 FIRE DAMPER INSTALLATION DETAIL
SCALE: NONE

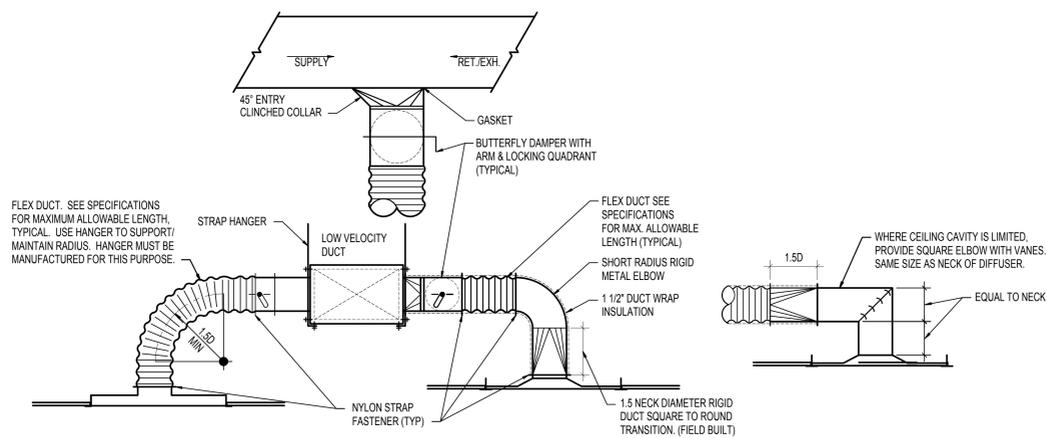


VERTICAL INSTALLATION

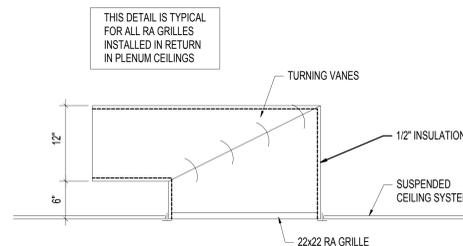
NOTES:

1. OPENINGS IN WALL SHALL BE 1/4" TO 1/2" LARGER THAN OVERALL SIZE OF DAMPER AND SLEEVE ASSEMBLY.
2. ALL CONNECTIONS TO DUCTS SHALL CONFORM TO U.L. 555 AND NFPA 90-A.
3. MOUNTING ANGLES SHALL BE MIN. OF 1 1/2" X 1 1/2" X 14 GA. AND BOLTED TACK WELDED, RIVETED, OR SCREWED TO SLEEVE AT MAX. SPACING OF 8" AND MIN. OF 2 CONNECTIONS PER SIDE, TOP, AND BOTTOM. MOUNTING ANGLES SHALL OVERLAP WALL AND FLOOR OPENING MIN. OF 1" ON ALL SIDES.
4. DAMPER SHALL BE ATTACHED TO SLEEVE IN SAME MANNER AND SPACING AS MOUNTING ANGLES.
5. THE LENGTH OF THE SLEEVE EXTENDING BEYOND THE WALL OPENING SHALL NOT EXCEED 6" ON EACH SIDE.
6. DAMPER INSTALLATION SHALL BE IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND SHALL CONFORM TO NFPA 90-A AND U.L. 555.
7. HARDCAST ALL FRAMES PRIOR TO INSTALLATION.

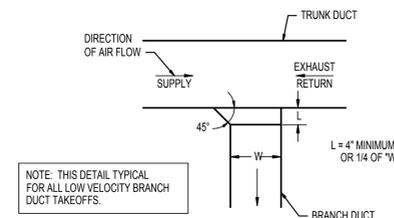
2 FIRE/SMOKE DAMPER INSTALLATION DETAIL
SCALE: NONE



3 DIFFUSER INSTALLATION DETAIL
SCALE: NONE



4 RETURN AIR GRILLE SOUND TRAP DETAIL
SCALE: NONE



5 LOW VELOCITY BRANCH CONNECTION DETAIL
SCALE: NONE

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

MECHANICAL DETAILS

SHEET NO.: **M3.2**

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

GENERAL NOTES:

1. SEE ARCHITECTURAL ELEVATION VIEWS FOR EXACT LOCATION OF WALL NOZZLES.
2. COORDINATE LOCATION OF RAINLEADERS WITH FOUNDATION WALLS.
3. FLOOR DRAINS LOCATED ON TILE OR VCT FLOORS SHALL HAVE SQUARE TOPS. FLOOR DRAIN LOCATED ON CARPETED OR FINISH CONCRETE SHALL HAVE ROUND TOPS.
4. PROVIDE CLEANOUTS FOR ALL LAVATORIES, SINKS AND DRINKING FOUNTAINS.

PENETRATING FLOOR SLABS AND FOUNDATION WALLS.

FINISHED GRADE.

7. DO NOT PLACE PIPING BELOW BUILDING FOOTINGS. FOOTINGS MUST BE COVERED AND SLEEVED IN SUCH CASE. SEE STRUCTURAL DETAILS.

8. REFER TO PLUMBING FIXTURE SCHEDULE FOR BRANCH LINE SIZES UNLESS SPECIFICALLY NOTED.

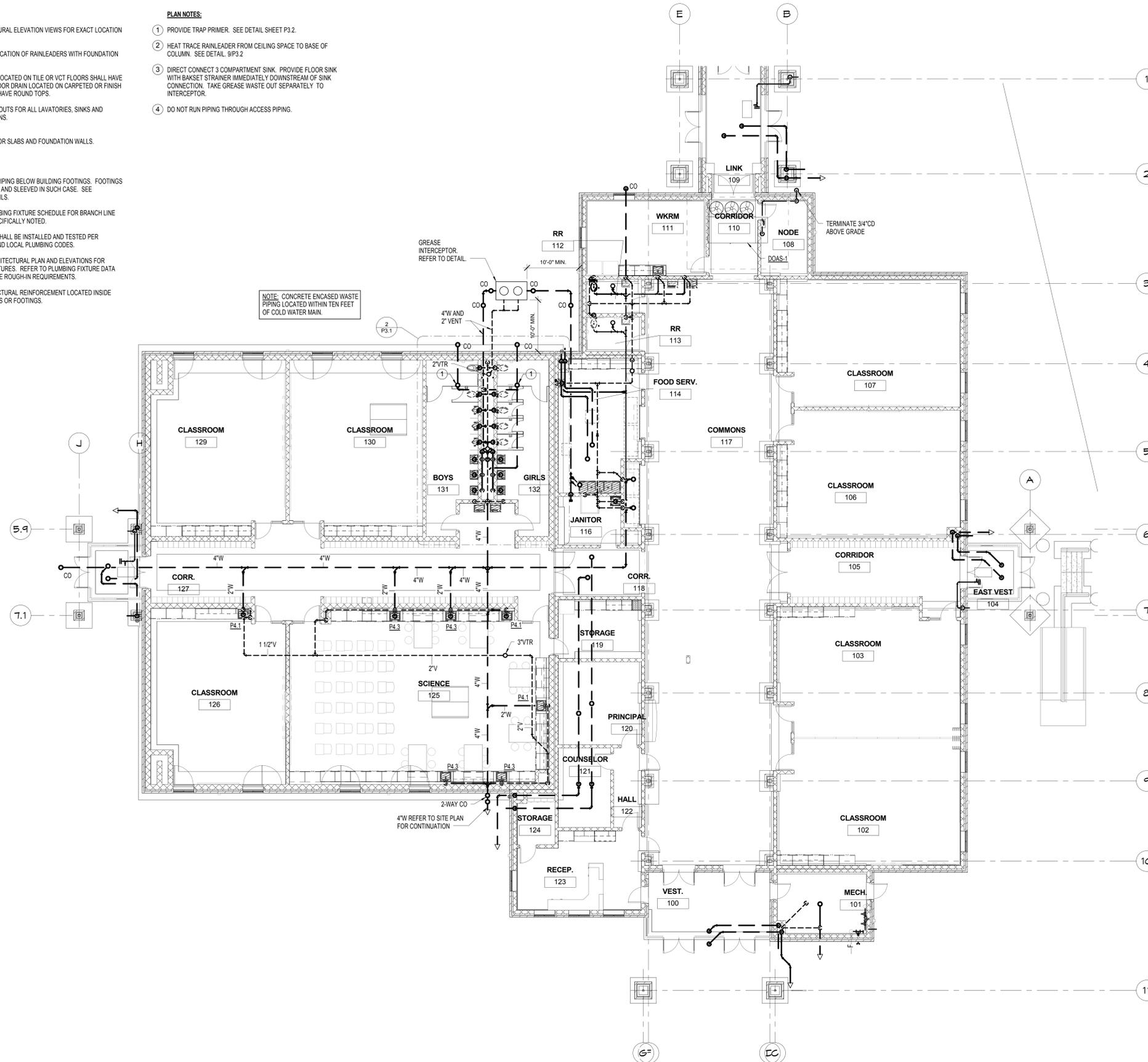
9. ALL PLUMBING SHALL BE INSTALLED AND TESTED PER SPECIFICATIONS AND LOCAL PLUMBING CODES.

10. REFER TO ARCHITECTURAL PLAN AND ELEVATIONS FOR LOCATIONS OF FIXTURES. REFER TO PLUMBING FIXTURE DATA FOR EXACT FIXTURE ROUGH-IN REQUIREMENTS.

DO NOT CUT STRUCTURAL REINFORCEMENT LOCATED INSIDE FOUNDATION WALLS OR FOOTINGS.

PLAN NOTES:

1. PROVIDE TRAP PRIMER. SEE DETAIL SHEET P3.2.
2. HEAT TRACE RAINLEADER FROM CEILING SPACE TO BASE OF COLUMN. SEE DETAIL 9P3.2
3. DIRECT CONNECT 3 COMPARTMENT SINK. PROVIDE FLOOR SINK WITH BASKET STRAINER IMMEDIATELY DOWNSTREAM OF SINK CONNECTION. TAKE GREASE WASTE OUT SEPARATELY TO INTERCEPTOR.
4. DO NOT RUN PIPING THROUGH ACCESS PIPING.



1 WASTE & VENT PLUMBING FLOOR PLAN
1/8" = 1'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

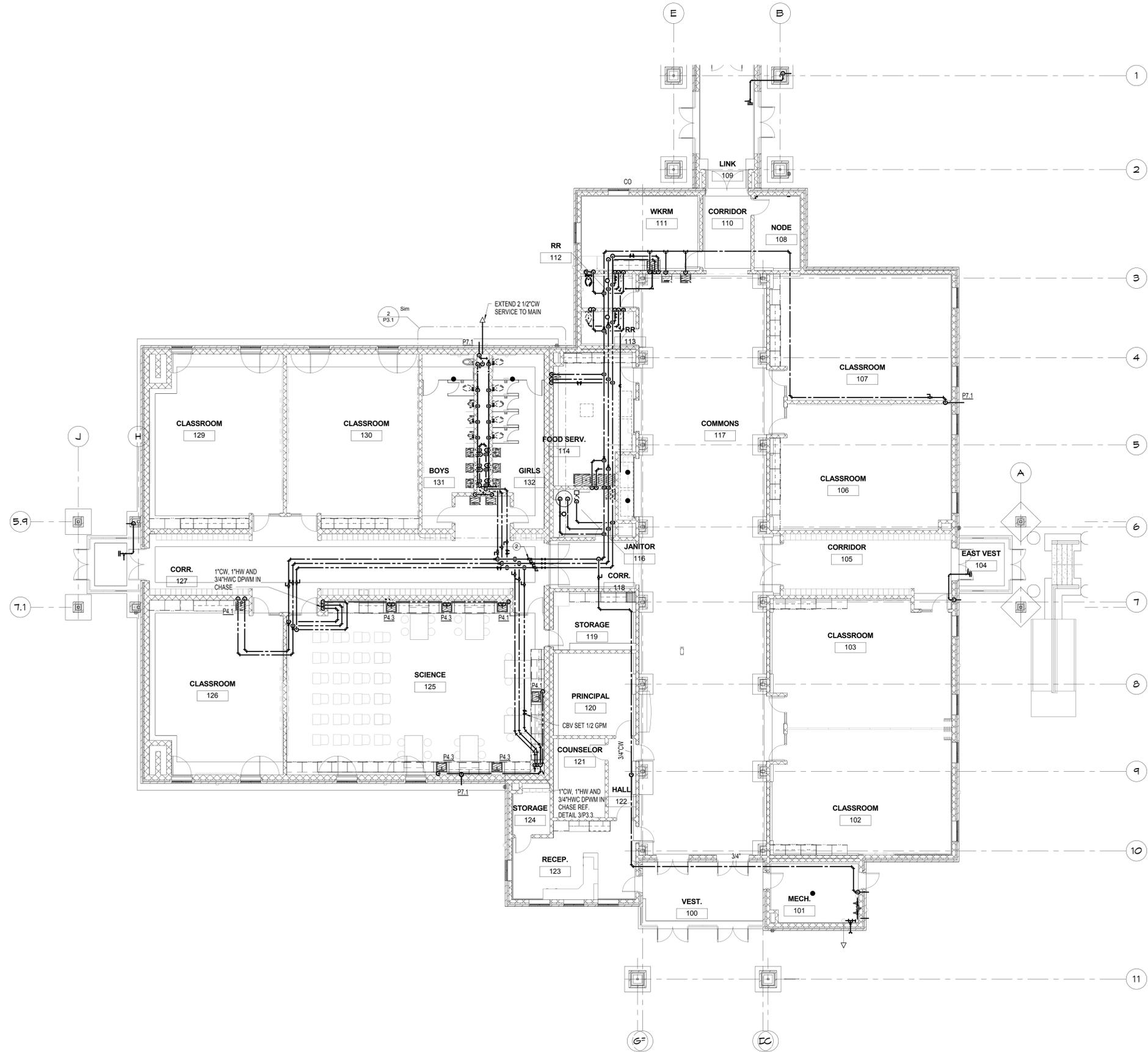
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

WASTE AND VENT PLUMBING
FLOOR PLAN

SHEET NO.: P1.1

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



GENERAL NOTES:

1. COORDINATE PIPING LOCATION WITH BUILDING ELEMENTS SUCH AS CEILING HEIGHT, ROOF STRUCTURE, MECHANICAL EQUIPMENT AND DUCTS. ROUTE AND OFFSET PIPING AS REQUIRED.
2. REFER TO ARCHITECTURAL PLAN AND ELEVATION VIEWS FOR EXACT LOCATION OF PLUMBING FIXTURES.
3. ALL PLUMBING SHALL BE INSTALLED AND TESTED PER SPECIFICATIONS AND LOCAL PLUMBING CODED.
4. DO NOT PENETRATE STRUCTURAL MEMBERS.
5. DO NOT CUT STRUCTURAL REINFORCEMENT LOCATED INSIDE FOUNDATION WALL, FOOTING OR LOAD BEARING WALLS.
6. SLEEVE PIPING THRU ALL MASONRY WALLS.

PLAN NOTES:

- ① PIPING RISES THRU 45 DEGREE ANGLED SLEEVED OPENING IN STRUCTURE.
- ② PROVIDE NORMALLY CLOSED SPRING RETURN MOTORIZED BALL VALVE. CONNECT TO 120V POWER AND ENERGIZE CONTINUOUSLY.
- ③ FIRE SPRINKLER SERVICE IS INCLUDED UNIT ALTERNATE PRICING. SEE DIVISION I SPECIFICATION FOR BID ALTERNATE DESCRIPTIONS.

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

NOT FOR CONSTRUCTION/EXAMPLE ONLY

WATER HEATER SCHEDULE

MARK	LOC. AT ROOM	TYPE	MIN. CAPACITY		GAS			ELECTRIC			EXP. TANK	REMARKS	RECIRC PUMP REF	ELECT REF
			GAL STOR	GPH RECOVERY AT 100' RISE	INPUT MBH	VENT DIA	VENT H.P.	ELECT	TOTAL KW	NO. ELEMENTS				
WH-1	JAN	TANK	50	37	--	--	--	9	2	208/3	②	①	HWRP-1	
① BASED ON [REDACTED] COMMERCIAL ELECTRIC HOT WATER HEATER. ② [REDACTED] TANK WITH 2 GAL VOLUME AND 1 GAL ACCEPTANCE														

PUMP SCHEDULE

MARK	LOC. AT ROOM	TYPE	MIN CAPACITY		MIN SIZE CONN.		MOTOR (BY M.C.)						REMARKS	ELECT REF
			GPM	FEET HEAD	EFF	SUCTION	DISCH	HP	RPM	SPEED	ELECT	STARTER		
HWRP-1	JAN	CART	4	25	--	3/4	3/4	1/8	--	1	120V	--	①	
① BASED ON [REDACTED]														

PLUMBING FIXTURE SCHEDULE

P NO.	FIXTURE	WATER				WASTE		VENT	REMARKS
		COLD		HOT		RUNOUT	CONN.		
		RUNOUT	CONN.	RUNOUT	CONN.				
P1.1	WATER CLOSET (FV)	1 1/4"	1"	--	--	4"	3"	2"	
P1.2	WATER CLOSET (FV)	1 1/4"	1"	--	--	4"	3"	2"	HANDICAP ACCESSIBLE
P1.3	WATER CLOSET (FV)	1 1/4"	1"	--	--	4"	3"	2"	HANDICAP ACCESSIBLE
P2.1	URINAL (FV)	1"	3/4"	--	--	3"	2"	1-1/2"	HANDICAP ACCESSIBLE
P2.2	URINAL (FV)	1"	3/4"	--	--	3"	2"	1-1/2"	
P3.1	LAVATORY	1/2"	3/8"	1/2"	3/8"	2"	1-1/4"	1 1/2"	HANDICAP ACCESSIBLE
P4.1	CLASSROOM SINK	1/2"	3/8"	1/2"	3/8"	2"	1-1/2"	2"	HANDICAP ACCESSIBLE
P4.2	3 COMPARTMENT SINK	1/2"	3/8"	1/2"	3/8"	2"	1-1/2"	2"	
P5.1	MOP BASIN	3/4"	1/2"	3/4"	1/2"	3"	3"	2"	
P6.1	DRINKING FOUNTAIN	1/2"	3/8"	--	--	2"	1-1/4"	1-1/4"	HANDICAP ACCESSIBLE
P6.2	DRINKING FOUNTAIN	1/2"	3/8"	--	--	2"	1-1/4"	1-1/4"	
P7.1	WALL HYDRANT	3/4"	1/2"	--	--	--	--	--	
P8.1	ROOF HYDRANT	3/4"	1"	--	--	--	--	--	
P4.3	CLASSROOM SINK	1/2"	3/8"	1/2"	3/8"	2"	1-1/2"	2"	

P1.1 Water Closet:
 wall-hung [REDACTED] toilet with 1-1/2" top spud - [REDACTED] flush valve with vacuum breaker - 1.6 gallon flush - white plastic elongated open front seat, less cover - [REDACTED] Mount rim at 15" A.F.F.

P1.2 Water Closet (ADA Accessible):
 wall-hung [REDACTED] toilet with 1-1/2" top spud - [REDACTED] flush valve with vacuum breaker - 1.6 gallon flush - white plastic elongated open front seat, less cover - [REDACTED] Mount rim at 16.5" A.F.F. and centerline of bowl shall be 18" from nearest finished wall. Mount flush valve handle on wide side of stall per ADA requirements.

P1.3 Water Closet (ADA Accessible):
 floor mounted [REDACTED] toilet with 1 1/2" top spud - [REDACTED] flush valve with vacuum breaker - 1.6 gallon flush - white plastic elongated open front seat less cover. Centerline of bowl shall be 18" from nearest finished wall. Unit shall be ADA compliant.

P2.1 Urinal (ADA Accessible):
 wall-hung [REDACTED] urinal with 3/4" top spud, 2" outlet, wall hangers - [REDACTED] flush valve with vacuum breaker - Mount rim at 17" A.F.F. and the flush valve handle no more than 44" A.F.F.

P2.2 Urinal:
 wall-hung [REDACTED] urinal with 3/4" top spud, 2" outlet, wall hangers - [REDACTED] flush valve with vacuum breaker - Mount rim at 24" A.F.F.

P3.1 Lavatory (ADA Accessible):
 wall hung [REDACTED] lavatory with front overflow, faucet holes on 4" centers, drilled for concealed arm carrier - [REDACTED] single handle faucet with aerator - offset drain with grid strainer - chrome plated supplies with loose key stops - 1 1/4" chrome plated cast brass "P" trap. Wade concealed arm carrier. Mount rim at 34" AFF and insulate "P" trap and hot water supply with pre-manufactured insulating cover. Unit shall be ADA compliant.

P4.1 Classroom Sink:
 self rimming 18 gauge stainless steel sink, 15"x17 1/2"x5 1/2" deep, 3-hole drilling, 4" centers, fully undercoated, [REDACTED] 2 handle chrome plated faucet with 11" gooseneck spout, ceramic seats, wrist blade handles, aerator, [REDACTED] stainless steel strainer with stopper, chrome plated angle wall supplies with stops. Set sink, install piping, insulate exposed hot water supply to meet ADA standards and to fit within architectural enclosure.

P4.2.3 Compartment Sink
 three compartment, 14 gauge stainless steel sink with 11" high splash - [REDACTED] heavy duty swing spout faucet with faucet holes on 8" centers with 1-1/2" waste in center of sink bowl - lever operated drain body with stainless steel grid. - chrome plated wall supplies with loose key stops - 1-1/2" chrome plated cast brass "P" trap manifolds all compartments.

P4.3 Classroom Sink:
 self rimming 18 gauge stainless steel sink, 15"x17 1/2"x8" deep, 3-hole drilling, 4" centers, fully undercoated, [REDACTED] 2 handle chrome plated faucet with 11" gooseneck spout, ceramic seats, wrist blade handles, aerator, [REDACTED] stainless steel strainer with stopper, chrome plated angle wall supplies with stops. Set sink and install piping, to fit within architectural enclosure.

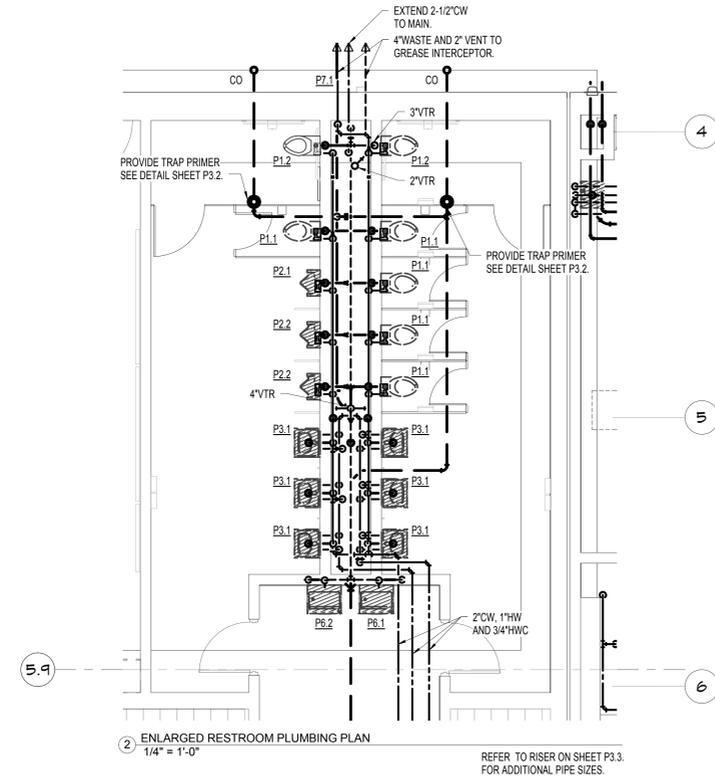
P5.1 Mop Basin:
 molded stone mop basin with stainless steel curb caps and wall guard #302 combination dome strainer and line basket, color #219, #500-AA chrome plated service faucet with vacuum breaker, integral stops, wall brace, pail hook, and 3/4" hose thread on spout.

P6.1 Drinking Fountain - Single ADA
 wall mounted wheelchair accessible electric water cooler with stainless steel top, self-closing pushbar operated bubbler, capacity of 8 GPH of 50° water at ARI conditions - 325W, 3.7 FLA, 120/60/1 compressor - 5 year refrigeration warranty - cold water supply with loose key stop - 1-1/4" cast brass "P" trap - color as selected by architect from manufacturer's standard colors. Mount bubbler at 36 1/2". Unit must meet ADA requirements.

P6.2 Drinking Fountain (single):
 wall mounted wheelchair accessible electric water cooler with stainless steel top, self-closing pushbar operated bubbler, capacity of 8 GPH of 50° water at ARI conditions - 325W, 3.7 FLA, 120/60/1 compressor - 5 year refrigeration warranty - cold water supply with loose key stop - 1-1/4" cast brass "P" trap - color as selected by architect from manufacturer's standard colors.

P7.1 Wall Hydrant:
 series automatic draining freezeless wall hydrant with backflow preventer - field testable with no sprayback.

P8.1. Roof Hydrant
 automatic draining, backflow protected, freezeless roof hydrant with 1-1/4" galvanized steel pipe casing, adjustable link, one piece plunger, galvanized steel operating rod with guide, 3/4" male hose thread outlet, separate cast iron hydrant support for installation in roof assembly prior to hydrant installation, and EPDM support boot and well seal. Shim support as necessary for roof pitch. Pipe fixture drain to approved location.



SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

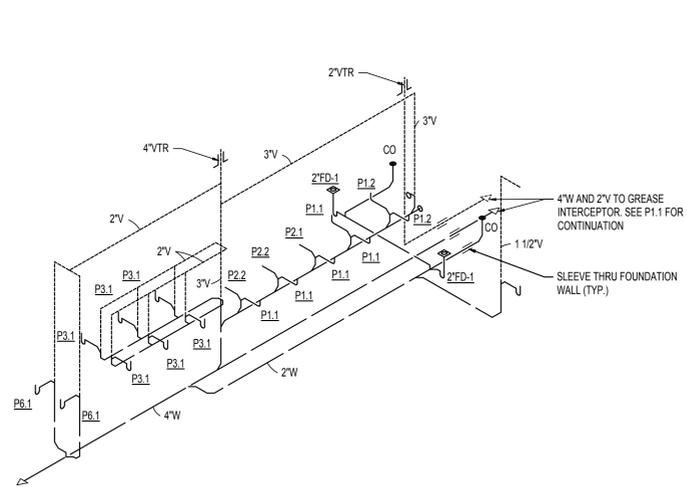
PLUMBING SCHEDULES AND DETAIL

SHEET NO.: **P3.1**

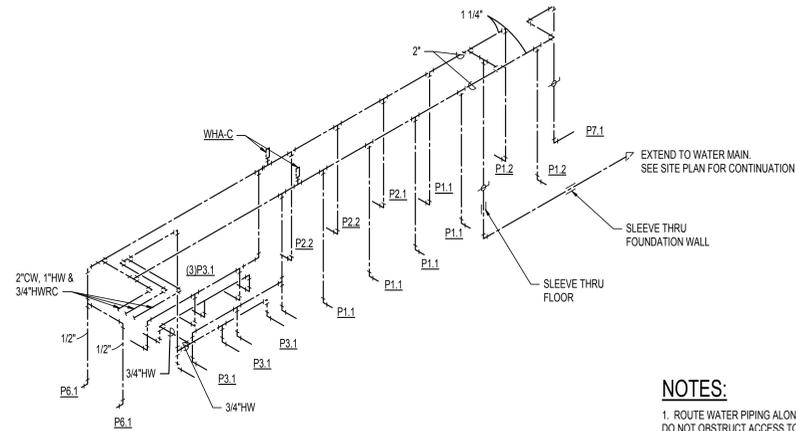
DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS



1 RESTROOM WASTE/VENT RISER DIAGRAM
SCALE: NONE



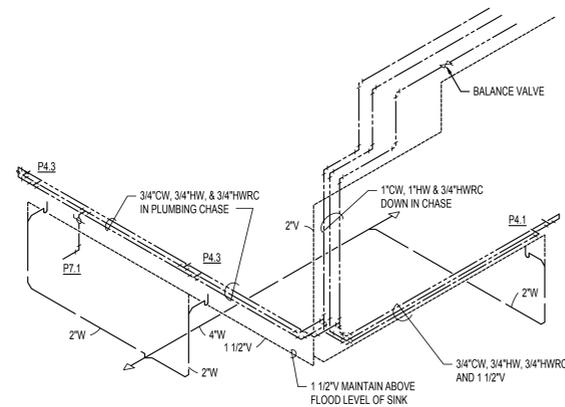
2 RESTROOM WATER PIPING RISER DIAGRAM
SCALE: NONE

NOTES:

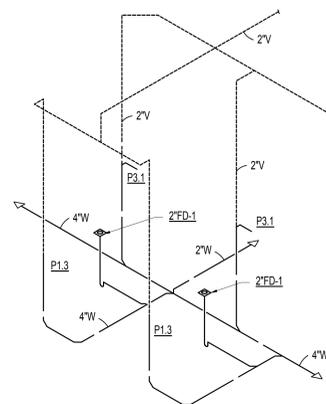
- ROUTE WATER PIPING ALONG SIDES OF PLUMBING CHASE. DO NOT OBSTRUCT ACCESS TO PLUMBING CHASE.
- RE-CIRCULATE HOT WATER PIPING DOWN TO FIXTURE SUPPLIES.

GENERAL NOTES:

- PIPING IS LARGELY SCHEMATIC IN NATURE. CONTRACTOR MUST COORDINATE PIPING LOCATION W/ BUILDING ELEMENTS, PLUMBING FIXTURE DIMENSIONS AND OTHER PIPING. ISOMETRIC DETAILS SHOWN HERE ARE INTENDED TO COMMUNICATE PROJECT INTENT.
- WASTE PIPING LOCATED ABOVE FLOOR SHALL BE SERVICE WEIGHT CAST IRON PIPE AND NO HUB FITTINGS. PIPING LOCATED BELOW SLAB MAY BE PLASTIC PIPE. SEE SPECIFICATIONS FOR DETAILS.
- UNLESS SPECIFICALLY NOTED ON DRAWINGS, DO NOT PENETRATE WALLS OF SHELTER WITH PIPING PENETRATIONS.



3 SCIENCE RM 125 PLUMBING RISER
SCALE: NONE



4 RR 112 & RR 113 WASTE/VENT PIPING RISER
SCALE: NONE

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-381 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

PLUMBING DIAGRAMS

SHEET NO.: P3.2

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

LIGHTING FIXTURE SCHEDULE (P.E.C.)										
FIXT LTR	MANUFACTURER CATALOG NUMBER	MANUFACTURER CATALOG NUMBER	MANUFACTURER CATALOG NUMBER	MANUFACTURER CATALOG NUMBER	DESCRIPTION SEE NOTES	LAMP TYPE NO. VOLTS	LENS/LOUVER/FINISH REMARKS	W	L	D
A2					2X4 LAY-IN F32835 2 UNV	F32835 2 UNV	ACRYLIC	2.0	4.0	
A2E					2X4 LAY-IN F32835 2 UNV	F32835 2 UNV	ACRYLIC	2.0	4.0	
PROVIDE WITH A 2-LAMP, 1100 LUMEN EMERGENCY BATTERY BALLAST PER SPECIFICATIONS										
A2S					2X4 LAY-IN F32835 2 UNV	F32835 2 UNV	ACRYLIC	2.0	4.0	
PROVIDE WITH STEP DIM BALLAST										
A3					2X4 LAY-IN F32835 3 UNV	F32835 3 UNV	ACRYLIC	2.0	4.0	
A3E					2X4 LAY-IN F32835 3 UNV	F32835 3 UNV	ACRYLIC	2.0	4.0	
PROVIDE WITH ONE 2-LAMP BALLAST AND ONE 1-LAMP BALLAST FOR MULTI-LEVEL SWITCHING										
A4					2X4 LAY-IN F32835 4 UNV	F32835 4 UNV	ACRYLIC	2.0	4.0	
A4E					2X4 LAY-IN F32835 4 UNV	F32835 4 UNV	ACRYLIC	2.0	4.0	
PROVIDE WITH A 2-LAMP, 1100 LUMEN EMERGENCY BATTERY BALLAST PER SPECIFICATIONS										
AM					2X4 LAY-IN F32835 3 UNV	F32835 3 UNV	MASTER	2.0	4.0	
PROVIDE WITH ONE 4-LAMP BALLAST, ONE 2-LAMP BALLAST, AND 11' LONG WHIP										
AME					2X4 LAY-IN F32835 3 UNV	F32835 3 UNV	MASTER	2.0	4.0	
SAME AS "AM" EXCEPT PROVIDE WITH AN 120 MINUTE, 1100LM, 2-LAMP EMERGENCY BATTERY BALLAST										
AS					2X4 LAY-IN F32835 3 UNV	F32835 3 UNV	ACRYLIC	2.0	4.0	
CV					SURFACE F32835 2 UNV	F32835 2 UNV	POLYCARBONATE VANDAL RESISTANT - HIGH IMPACT POLYCARBONATE LENS	7.62	4.25	2.917
PROVIDE WITH GASKETING										
F4					4 STRIP F32835 2 UNV	F32835 2 UNV	WHITE PROVIDE WITH WIRE GUARD		4.0	
F4E					4 STRIP F32835 2 UNV	F32835 2 UNV	WHITE PROVIDE WITH WIRE GUARD		4.0	
PROVIDE WITH A 2-LAMP, 1100 LUMEN EMERGENCY BATTERY BALLAST PER SPECIFICATIONS										
FM					4 STAG STRIP F32835 2 UNV	F32835 2 UNV	WHITE		4.0	
PROVIDE WITH 34"x34" PARABOLIC LOUVER, COORDINATE LOUVER SIZE WITH ARCHITECT										
HA					RECESSED 32W T10CK 4-PN 1 UNV	32W T10CK 4-PN 1 UNV	LOW REDUCESCENT VERTICAL TRIPLE WIDE BEAM DOWNLIGHT	5		
HF					RECESSED 32W DTT0K 4-PN 2 UNV	32W DTT0K 4-PN 2 UNV	LOW REDUCESCENT	615		
WIDE-SEC. BALLAST, C91 LENS W/SHADE										
HFE					RECESSED 32W DTT0K 4-PN 2 UNV	32W DTT0K 4-PN 2 UNV	LOW REDUCESCENT	615		
SAME AS "HF" EXCEPT PROVIDE WITH A REMOTE MOUNTED EM BATTERY BALLAST										
P2					AREA LIGHT 320W FMH 1 208	320W FMH 1 208	BY ARCH TYPE II			
30FT ROUND TAPERED STEEL POLE WITH HOLE AND BOLT COVERS. POLE TO MEET TOTAL FIXTURE EPA REDITS FOR WIND SPEEDS IN THIS REGION										
P3					AREA LIGHT 320W FMH 1 208	320W FMH 1 208	BY ARCH TYPE III			
30FT ROUND TAPERED STEEL POLE WITH HOLE AND BOLT COVERS. POLE TO MEET TOTAL FIXTURE EPA REDITS FOR WIND SPEEDS IN THIS REGION										
P4					AREA LIGHT 320W FMH 1 208	320W FMH 1 208	BY ARCH TYPE IV			
30FT ROUND TAPERED STEEL POLE WITH HOLE AND BOLT COVERS. POLE TO MEET TOTAL FIXTURE EPA REDITS FOR WIND SPEEDS IN THIS REGION										
RD					WALL PACK 100W FMH 1 120	100W FMH 1 120	BY ARCH			
MOUNT AT 11'-0" AFD. VERIFY WITH ARCHITECT PRIOR TO ROUGH-IN										
S1					GLASS PENDANT 250W FMH 1 120	250W FMH 1 120	REMOTE BALLAST			
16'-0" AFF. FINISH TO BE STANDARD PAINT COLOR SELECTED BY ARCHITECT										
S1E					GLASS PENDANT 250W FMH 1 120	250W FMH 1 120	REMOTE BALLAST			
SAME AS "S1" EXCEPT PROVIDE WITH STANDBY RELAY FOR CONNECTION TO INVERTER SYSTEM										
SL					STEP LIGHT LED 120		BY ARCH			
COORDINATE MOUNTING AND ROUTING OF CONDUIT WITH CONCRETE POUR										
SP3					AREA LIGHT 100W FMH 1 120	100W FMH 1 120	BY ARCH TYPE III			
12FT ROUND TAPERED STEEL POLE WITH HOLE AND BOLT COVERS. POLE TO MEET TOTAL FIXTURE EPA REDITS FOR WIND SPEEDS IN THIS REGION										
XA					1 FACE EM EXIT LED UNV	CAST ALUMINUM RED W/ BATTERY		1.67	1.1	7
XB					2 FACE EM EXIT LED UNV	CAST ALUMINUM RED W/ BATTERY		1.67	1.1	7

- GENERAL CONTRACTOR SHALL PROVIDE FIREPROOFING AROUND RECESSED FIXTURES INSTALLED IN FIRE RATED CEILING PER U.L. REQUIREMENTS. ELECTRICAL CONTRACTOR WILL COORDINATE.
- LIGHT FIXTURES SHALL BE PROVIDED WITH PROGRAM START ELECTRONIC BALLASTS. COMPACT FLUORESCENT ELECTRONIC BALLASTS SHALL HAVE END-OF-LIFE PROTECTION CIRCUIT TO PREVENT WELDING OF LAMPS IN SOCKETS OR LAMP BREAKAGE. SEE THE SPECIFICATIONS. ALL FLUORESCENT LAMPS SHALL BE LOW MERCURY AND SHALL MEET ALL E.P.A. GUIDELINES FOR PASSING "TCLP" TESTS. ALL INDOOR FLUORESCENT BALLASTS SHALL HAVE A DISCONNECTING MEANS MEETING THE REQUIREMENTS OF NEC SECTION 410.130(G), EXCEPT FOR THOSE INSTALLED IN CORD-AND-PLUG CONNECTED FIXTURES. ELECTRONIC BALLASTS FOR EXTERIOR LOCATED LIGHT FIXTURES SHALL HAVE A MINIMUM STARTING TEMPERATURE OF -20 DEGREES FAHRENHEIT.
- PROVIDE ARROWS AND FACES AS INDICATED ON THE DRAWINGS.
- MANUFACTURERS LISTED IN THIS SCHEDULE OR APPROVED BY WRITTEN ADDENDUM WILL BE THE ONLY APPROVED MANUFACTURERS TO BID THE LIGHTING FIXTURES FOR THIS PROJECT. CONTRACTORS AND SUPPLIERS USING PRICING FROM MANUFACTURERS NOT LISTED ON SCHEDULE OR BY ADDENDUM DO SO AT THEIR OWN RISK.
- LIGHT FIXTURE SELECTIONS ARE BASED ON THE MANUFACTURER IN THE LEFT MOST COLUMN AS LISTED IN THE SCHEDULE. FIXTURES APPROVED AS EQUALS IN THIS SCHEDULE OR BY ADDENDUM SHALL BE EQUAL TO THE UNIT SPECIFIED IN THE LEFT MOST COLUMN, I.E. SPRING LOADED LATCHES, POST PAINTED FINISH, AND PHOTOMETRICS.
- ALL LIGHT FIXTURES SHALL BE SECURED TO THE CEILING FRAMING SYSTEM BY MECHANICAL MEANS (SUCH AS BOLTS, SCREWS, OR RIVETS) OR BY CLIPS IDENTIFIED FOR USE WITH THE TYPE OF CEILING FRAMING MEMBER AND LIGHT FIXTURE.
- REMOTE MOUNTED EMERGENCY BATTERY BALLAST SHALL BE MOUNTED ON THE INTERIOR SIDE OF THE BUILDING ABOVE ACCESSIBLE CEILING. MOUNT WITHIN A NEMA-1 ENCLOSURE WITH COVER.
- REMOTE MOUNT BALLAST TANK ABOVE ADJACENT ACCESSIBLE CEILING. CONTRACTOR TO COORDINATE WITH G.C. TO CONCEAL ALL CONDUITS TO PENDANT FIXTURES. PROVIDE ALL REQUIRED COMPONENTS (STEMS, CANOPY, SWIVEL BASES, ETC.) AS REQUIRED FOR A COMPLETE INSTALLATION.

PEN WEIGHT LEGEND	
SYMBOL	DESCRIPTION
	ALL DEVICES, LIGHT FIXTURES, ETC., DRAWN IN DARK SOLID LINES ARE NEW TO BE INSTALLED.
	NEW DUPLEX GROUNDED RECEPTACLE
	NEW LIGHT FIXTURE
	EXISTING DUPLEX GROUNDED RECEPTACLE TO REMAIN
	EXISTING LIGHT FIXTURE TO REMAIN
	ALL DEVICES, LIGHT FIXTURES, ETC., DRAWN IN DARK DASHED LINES ARE TO BE REMOVED.
	DUPLEX GROUNDED RECEPTACLE TO BE REMOVED
	LIGHT FIXTURE TO BE REMOVED

SPECIAL OUTLET SCHEDULE	
SYMBOL	DESCRIPTION
	CEILING MOUNTED PROJECTOR LOCATION. CONTRACTOR TO PROVIDE (1) 20A, 2P, 3W, 125V, GROUNDED DUPLEX RECEPTACLE FLUSH MOUNTED ON PROJECTOR MOUNTING HARDWARE AS SPECIFIED BY ARCHITECT. PROVIDE POWER WHIP WITH 6FT OF SLACK TO ALLOW FOR RELOCATION OF PROJECTOR. IN THE KNOCKOUT ADJACENT TO THE RECEPTACLE, PROVIDE A COVERPLATE WITH MINIMUM 1" DIAMETER RUBBER GROMMET FOR ROUTING OF FLYING LEADS FROM SPECIAL OUTLET "TDI". COVERPLATES AND DEVICE ON CEILING SHALL BE WHITE IN COLOR.
	FLUSH MOUNTED WALL BOX FOR FUTURE CONNECTION OF WALL MOUNTED SMARTBOARD. PROVIDE A STAINLESS STEEL COVERPLATE DEVICE WITH TYPE "A" USB CONNECTOR ON THE FRONT. USB CONNECTOR SHALL ALLOW FOR THE CONNECTION OF THE USB CABLE ROUTED FROM SPECIAL OUTLET "TDI" (ON BACKSIDE OF DEVICE).
	WALL MOUNTED RAPID RUN AV/VIDEO PASSIVE INTERFACE PLATE. PLATE TO HAVE VGA (RGBHV) INPUT, HDMI, RCA COMPOSITE AUDIO/VIDEO, AND TYPE "A" USB CONNECTION FOR POWER TO SMARTBOARD. FROM BOX, ROUTE (1) 1-1/4" CONDUIT UP AND TURNED OUT INTO ACCESSIBLE CEILING CAVITY. PROVIDE AND ROUTE MULTI-FORMAT CABLE, USB CABLE (CAT-5E IF USING A, USB EXTENDER), AND DIGITAL RUNNER CABLE BETWEEN AN INTERFACE PLATE AND OWNER PROVIDED PROJECTOR/SMARTBOARD (VIA RACEWAYS AND PLENUM). PROVIDE WITH 3" MINIMUM SLACK. CABLES SHALL BE "CABLES-TO-GO" RAPIDRUN PLENUM TYPE PC/VIDEO RUNNER OR EQUAL. PROVIDE USB PATCH CABLE (LENGTH AS REQUIRED) FOR CONNECTION TO THE SMARTBOARD. A USB EXTENDER MODULE SHALL BE PROVIDED AND INSTALLED IF USB LENGTH TO SMARTBOARD EXCEEDS MANUFACTURER'S RECOMMENDED LENGTHS.
	FLUSH MOUNTED WALL BOX FOR FUTURE CONNECTION OF A FLAT PANEL TELEVISION/MONITOR. PROVIDE A FSR (OR APPROVED EQUAL) #PWB-250 WITH (1) 20A, 125V, 2P, 3W, NEMA 5-20R DUPLEX RECEPTACLE. FROM BOX, ROUTE (1) 1-1/4" CONDUIT WITH PULLROPE AND TURN OUT INTO ACCESSIBLE CEILING FOR FUTURE ROUTING OF CABLE. MOUNT DEVICE AT 74" AFF., UNLESS OTHERWISE NOTED.

ELECTRICAL SHEET INDEX	
SHEET NO.	DESCRIPTION
E0.1	ELECTRICAL LEAD SHEET
E0.2	ELECTRICAL ONE-LINE DIAGRAM
E0.3	ELECTRICAL SCHEDULES
E1.1	ELECTRICAL DETAILS
E1.2	ELECTRICAL DETAILS
E3.1	ELECTRICAL SITE PLAN
E4.1	ELECTRICAL POWER FLOOR PLAN
E5.1	ELECTRICAL LIGHTING FLOOR PLAN

GENERAL NOTES	
1.	ALL ELECTRICAL WORK SHALL COMPLY WITH THE LATEST EDITION OF THE NATIONAL ELECTRICAL CODE (NEC) & THE AMERICANS WITH DISABILITIES ACT (ADA).
2.	REFER TO RELATED ARCHITECTURAL, MECHANICAL, AND STRUCTURAL DRAWINGS FOR RELATED INFORMATION.
3.	REFER TO THE SPECIFICATIONS FOR DATA NOT ON THE DRAWINGS.
4.	I.C. SHALL REFER TO MECHANICAL DRAWINGS AND SPECIFICATIONS FOR THE REQUIREMENTS ASSOCIATED WITH WIRING AND CONNECTION OF INTERLOCKING AND CONTROLS OF MECHANICAL UNITS AND THERMOSTAT LOCATIONS.
5.	COORDINATE OUTLET BOX LOCATIONS WITH MASONRY TO MINIMIZE CUTTING OF BRICK OR BLOCK.
6.	ALL MOUNTING HEIGHTS TO CENTERLINE OF ITEM UNLESS OTHERWISE NOTED. VERIFY ALL OUTLET LOCATIONS ON THE JOB PRIOR TO ROUGH-IN.
7.	CONDUIT RUN W/CONDUCTORS AS INDICATED & GROUND WIRE SIZED PER N.E.C. 250.122. CONDUIT SIZE AS REQUIRED.
8.	WHEN INCREASED CONDUCTOR SIZES ARE SHOWN ON THE PLANS, THE LARGER CONDUCTOR SIZE SHALL BE USED THROUGHOUT THE LENGTH OF THE CIRCUIT, INCLUDING NEUTRAL AND GROUND.
9.	"C" INDICATED ADJACENT TO DEVICE INDICATES DEVICE MOUNTED ABOVE BACKSPASH OF COUNTER TOP. VERIFY EXACT HEIGHT WITH ARCHITECTURAL PLANS AND ELEVATIONS.
10.	BRANCH CIRCUITS ARE INDICATED AS ONE CIRCUIT HOME RUNS WITH INDIVIDUAL NEUTRALS. A MAXIMUM OF THREE CIRCUITS (MAXIMUM OF THREE PHASE CONDUCTORS) MAY BE GROUPED IN A SINGLE CONDUIT. WHERE MULTIPLE CIRCUITS ARE LOCATED IN THE SAME RACEWAY, JUNCTION BOX OR ENCLOSURE, NEUTRALS SHALL BE MARKED OR LABELED TO INDICATE WHICH CIRCUIT THEY ARE ASSOCIATED WITH. SEE SPECIFICATION SECTION "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES" FOR ADDITIONAL INFORMATION.
11.	LABEL THE FRONT OF EACH RECEPTACLE COVERPLATE WITH PANEL DESIGNATION AND CIRCUIT NUMBER USING CLEAR THERMAL TRANSFER (ELECTRONIC DYMO) LABELS WITH 1/8" HIGH BLACK LETTERS (OR CONTRASTING COLOR IF PLATES ARE BLACK OR BROWN). LABELS SHALL BE SUITABLE FOR INDOOR/OUTDOOR USE. LABEL THE BACK OF EACH LIGHT SWITCH COVERPLATE WITH PANEL DESIGNATION AND CIRCUIT NUMBER USING A FINE BLACK PERMANENT MARKER.
12.	JUNCTION BOX OR RECEPTACLE FOR DRINKING FOUNTAINS SHALL BE LOCATED BEHIND THE EQUIPMENT SKIRT UNLESS OTHERWISE NOTED. COORDINATE CONNECTION TYPE AND LOCATION WITH EQUIPMENT PROVIDED.
13.	CONTRACTOR TO PROVIDE 18" LONG (MIN.) CONDUIT SLEEVES THRU ALL WALLS WHERE CABLES ARE INDICATED OR REQUIRED TO PASS THRU WALLS. PROVIDE BUSHINGS ON BOTH ENDS. SIZE CONDUIT FOR CABLES INSTALLED. MAXIMUMS SHALL BE: 2" = 10 CABLES 3" = 30 CABLES 2 1/2" = 20 CABLES 4" = 50 CABLES
F1.	FIELD VERIFY LOCATION OF AREA SMOKE DETECTORS AND HEAT DETECTORS. DO NOT LOCATE WITHIN 36" OF A HVAC DIFFUSER (SUPPLY OR RETURN), IN A DIRECT AIR FLOW OR WITHIN 36" OF A SPRINKLER HEAD. SMOKE DETECTORS FOR DOOR RELEASE SHALL BE LOCATED ON THE CENTER LINE OF THE DOOR AND A MAXIMUM OF 5 FEET FROM THE DOOR. THE MINIMUM DISTANCE FROM THE DOOR IS THE DEPTH OF THE WALL SECTION ABOVE THE DOOR, BUT NOT LESS THAN 12".
F2.	LABEL REMOTE ALARM INDICATOR FOR DUCT MOUNTED SMOKE DETECTORS (IE: RTU-1 SUPPLY, RTU-2 RETURN, FIRESMOKE DAMPER, ETC.). DUCT DETECTORS SHOULD BE LOCATED IN THE AREA BETWEEN 6 AND 10 DUCT EQUIVALENT DIAMETERS OF STRAIGHT, UNINTERRUPTED DUCTWORK. DUCT DETECTORS FOR FIRESMOKE DAMPERS SHOULD BE LOCATED BETWEEN THE LAST INLET OR OUTLET UPSTREAM OF THE DAMPER AND THE FIRST INLET OR OUTLET DOWNSTREAM OF THE DAMPER.
F3.	FAN SHUTDOWN RELAY WIRING SHALL BE LOCATED WITHIN 3 FEET OF THE FAN CONTROLS AND THE WIRING TO THE RELAY SHALL BE MONITORED.
F4.	PROVIDE 120V POWER AND FUSAT FOR EACH FIRE/SMOKE DAMPER. INTERLOCK WITH FIRE ALARM CONTROL PANEL TO CLOSE FIRE/SMOKE DAMPER UPON ANY ALARM AT THE FIRE ALARM CONTROL PANEL AND TO SHUTDOWN ASSOCIATED MECHANICAL UNIT.
T1.	EACH DATA, TELEPHONE, VIDEO, OR OTHER SYSTEMS OUTLET REQUIRES 1" WITH PULL ROPE STUBBED 6" ABOVE NEAREST ACCESSIBLE CEILING UNLESS OTHERWISE NOTED ON PLANS. CONDUITS STUBBED UP ABOVE CEILINGS SHALL BE TURNED OUT 90°. PROVIDE INSULATED BUSHINGS ON ALL CONDUITS. LABEL CONDUIT TO IDENTIFY ITS INTENDED USE (IE: TELEPHONE, DATA, ETC.).

SYMBOL LIST		
SYMBOL	DESCRIPTION	MOUNTING
	CCTV CAMERA - FIXED	CLG
	MAGNETIC LOCK	
	HANDICAP DOOR RELEASE PUSHBUTTON	46" AFF
	LOW VOLTAGE SWITCH	46" AFF
	ULTRASONIC SENSOR <1000SF	CEILING
	DUAL TECHNOLOGY SENSOR <1000SF	CEILING
	ELECTRONIC TIME SWITCH	46" AFF
	1 RELAY WALL MTD PIR SENSOR	46" AFF
	2 RELAY WALL MTD PIR SENSOR	46" AFF
	1-DATA OUTLET (GEN NOTE T1)	17" AFF
	1-VOICE/2-DATA OUTLET (GEN NOTE T1)	17" AFF
	1-VOICE/1-DATA OUTLET (GEN NOTE T1)	17" AFF
	1-VOICE/2-DATA OUTLETS (GEN NOTE T1)	17" AFF
	2-VOICE/2-DATA OUTLETS (GEN NOTE T1)	17" AFF
	1-VOICE/3-DATA OUTLETS (GEN NOTE T1)	17" AFF
	4-DATA OUTLETS (GEN NOTE T1)	17" AFF
	CABLE TV OR VIDEO OUTLET (GEN NOTE T1)	17" AFF
	WALL	46" AFF
	INTERCOM SYSTEM WIRACK	FLOOR
	CEILING MOUNTED SPEAKER	CEILING
	SYSTEM CLOCK (A=ANALOG, D=DIGITAL)	WALL
	VOLUME CONTROL	46" AFF

SYMBOL LIST		
SYMBOL	DESCRIPTION	MOUNTING
	LIGHT FIXTURE & FIXTURE LETTER	CEILING
	STRIP LIGHT FIXTURE & FIXTURE LETTER	CEILING
	LIGHT FIXTURE & FIXTURE LETTER	CEILING
	EXT LIGHT (SHADING DENOTES EXT FACE SIDE)	CEIL/WALL
	LIGHT FIXTURE & FIXTURE LETTER	WALL
	FIXTURE WITH SHADED LAMP(S) ON EMERG. POWER	CEILING
	LOW VOLTAGE MOMENTARY SWITCH	46" AFF
	SWITCHES (1-POLE, 2-POLE, 3-WAY, 4-WAY)	46" AFF
	PILOT LIGHT SWITCH	46" AFF
	INDICATES SWITCHING SCHEME	
	NIGHT LIGHT-WIRE AHEAD OF CONTROLS	
	WEATHERPROOF	
	SEE GENERAL NOTE 9	
	ABOVE FINISHED FLOOR	
	DRINKING FOUNTAIN (SEE GEN NOTE 12)	
	UNLESS OTHERWISE NOTED	
	DUPLEX GROUNDED RECEPTACLE	17" AFF
	CLG-MTD DUPLEX GROUNDED RECEPT.	CEILING MTD
	DOUBLE DUPLEX GROUNDED RECEPTACLE	17" AFF
	GROUND FAULT DUPLEX RECEPTACLE	17" AFF
	SPECIAL OUTLET (SEE SCHEDULE OR AS NOTED)	FLOOR/WALL
	SPECIAL DEVICE (AS NOTED)	
	JUNCTION BOX	
	FUSIST BUSS ASSY	
	BRANCH CIRCUIT PANEL & PANEL DESIG.	72" TO TOP
	ELECTRICAL DISTRIBUTION EQUIPMENT	
	EQUIPMENT - SEE EQUIPMENT CONNECTION SCHEDULE	
	FEEDER DESIGNATION	
	MASTER/SLAVE FIXTURE WHIP	CEILING
	CONDUIT HOME RUN, 1 CIRCUIT, 2#10 & 1#10 GRD. GEN. NOTE 7 & 8	CEIL/WALL
	CONDUIT RUN 2#12 & 1#12 GRD-1/2"	CEIL/WALL
	CONDUIT RUN 2#12 & 1#12 GRD-3/4"	EARTH/FLOOR
	CONDUIT HOME RUN, 1 CIRCUIT, 2#12 & 1#12 GRD, 1/2"	CEIL/WALL
	CONDUIT HOME RUN, 2 CIRCUITS, 4#12 & 1#12 GRD, 1/2"	CEIL/WALL
	CONDUIT HOME RUN, 3 CIRCUITS, 6#12 & 1#12 GRD, 1/2"	CEIL/WALL
	CONDUIT RUN PARTIAL CIRCUIT, 2#12 & 1#12 GRD, 1/2"	CEIL/WALL
	CONDUIT HOME RUN, 2 CIRCUITS PHASE CONDUCTORS (#12 UON) NEUTRAL CONDUCTOR (#12 UON) SWITCH LEGS (#12 UON) GROUND CONDUCTOR (#12 UON)	CEIL/WALL
	FIRE ALARM CONTROL PANEL	WALL
	FIRE ALARM MANUAL STATION	46" AFF
	FIRE ALARM VISUAL SIGNAL	80" TO BOTTOM
	COMB. F.A. HORN & VISUAL SIGNAL	80" TO BOTTOM
	F.A. RELAY (GEN NOTE F3)	
	CONZATION AREA SMOKE DETECTOR (GEN NOTE F1)	CEILING
	PHOTO ELECTRIC AREA SMOKE DETECTOR (GEN NOTE F1)	CEILING
	DUCT SMOKE DETECTOR (GEN NOTE F2)	DUCTWORK
	DUCT SMOKE DETECTOR & FIRE/SMOKE DAMPER (GEN NOTE F2 & F4)	
	HEAT DETECTOR (GEN NOTE F1)	CEILING
	FIRE SPRINKLER TAMPER SWITCH	SPRINKLER RISER
	FIRE SPRINKLER WATER FLOW SWITCH	SPRINKLER RISER
	ELECTROMAGNETIC DOOR HOLDER	WALL

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements. FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

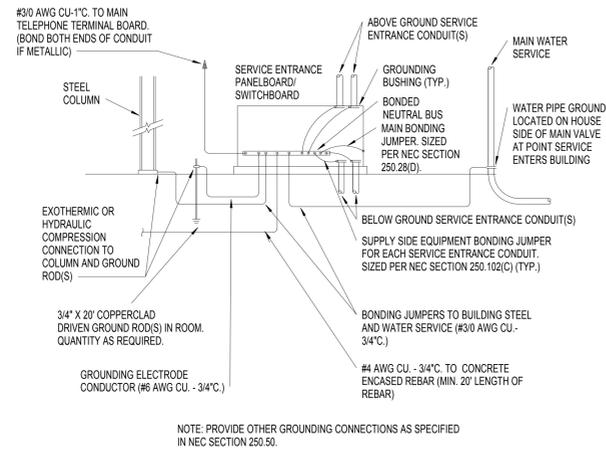
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

ELECTRICAL SCHEDULES AND NOTES

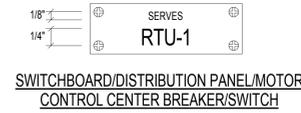
SHEET NO.: **E0.1**

DATE: AUGUST 2014

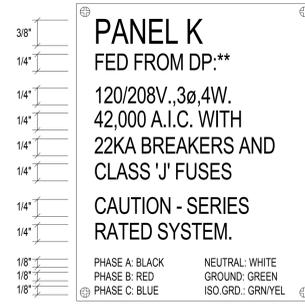
NOT FOR CONSTRUCTION/EXAMPLE ONLY



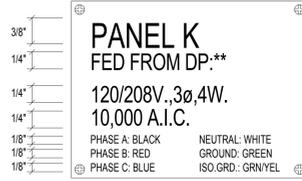
① SYSTEM GROUNDING DETAIL - PANEL
NO SCALE



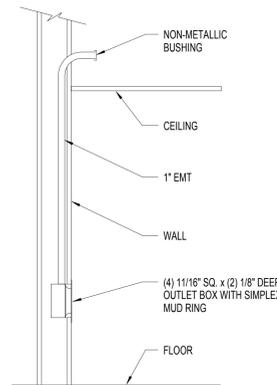
② TYPICAL NAME PLATES
NO SCALE



③ TYPICAL RECEPTACLE MOUNTING DETAIL
NO SCALE



④ TYPICAL COMPUTER WORKSTATION OUTLET
NO SCALE



⑤ DATACOM OUTLET DETAIL
NO SCALE



⑥ TYPICAL LAY-IN FIXTURE INSTALLATION DETAIL
NO SCALE

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

ELECTRICAL DETAILS

SHEET NO: E1.1

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY

KEYED NOTES:

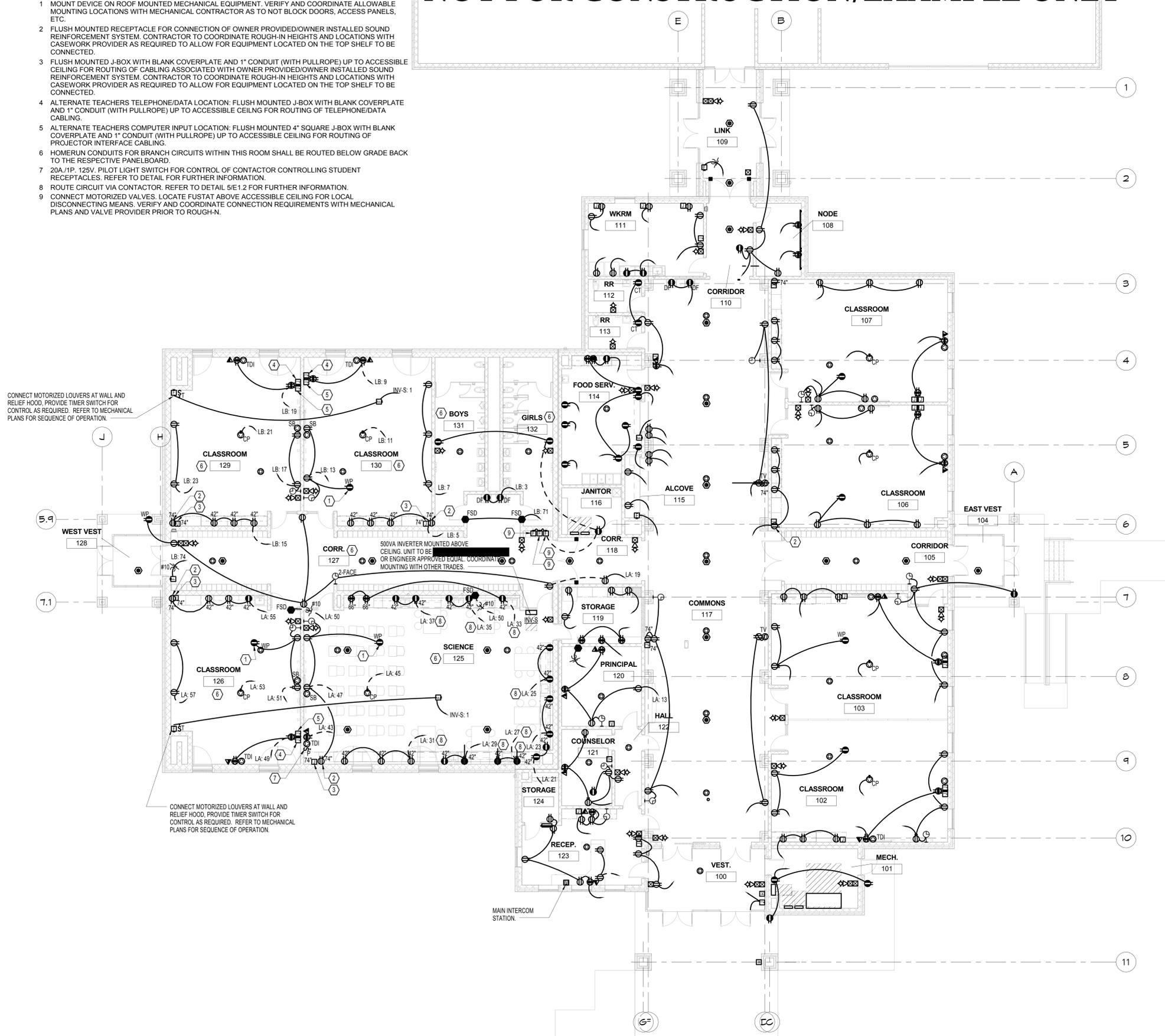
- 1 MOUNT DEVICE ON ROOF MOUNTED MECHANICAL EQUIPMENT. VERIFY AND COORDINATE ALLOWABLE MOUNTING LOCATIONS WITH MECHANICAL CONTRACTOR AS TO NOT BLOCK DOORS, ACCESS PANELS, ETC.
- 2 FLUSH MOUNTED RECEPTACLE FOR CONNECTION OF OWNER PROVIDED/OWNER INSTALLED SOUND REINFORCEMENT SYSTEM. CONTRACTOR TO COORDINATE ROUGH-IN HEIGHTS AND LOCATIONS WITH CASEWORK PROVIDER AS REQUIRED TO ALLOW FOR EQUIPMENT LOCATED ON THE TOP SHELF TO BE CONNECTED.
- 3 FLUSH MOUNTED J-BOX WITH BLANK COVERPLATE AND 1" CONDUIT (WITH PULLROPE) UP TO ACCESSIBLE CEILING FOR ROUTING OF CABLING ASSOCIATED WITH OWNER PROVIDED/OWNER INSTALLED SOUND REINFORCEMENT SYSTEM. CONTRACTOR TO COORDINATE ROUGH-IN HEIGHTS AND LOCATIONS WITH CASEWORK PROVIDER AS REQUIRED TO ALLOW FOR EQUIPMENT LOCATED ON THE TOP SHELF TO BE CONNECTED.
- 4 ALTERNATE TEACHERS TELEPHONE/DATA LOCATION: FLUSH MOUNTED J-BOX WITH BLANK COVERPLATE AND 1" CONDUIT (WITH PULLROPE) UP TO ACCESSIBLE CEILING FOR ROUTING OF TELEPHONE/DATA CABLING.
- 5 ALTERNATE TEACHERS COMPUTER INPUT LOCATION: FLUSH MOUNTED 4" SQUARE J-BOX WITH BLANK COVERPLATE AND 1" CONDUIT (WITH PULLROPE) UP TO ACCESSIBLE CEILING FOR ROUTING OF PROJECTOR INTERFACE CABLING.
- 6 HOMERUN CONDUITS FOR BRANCH CIRCUITS WITHIN THIS ROOM SHALL BE ROUTED BELOW GRADE BACK TO THE RESPECTIVE PANELBOARD.
- 7 20A/1P, 125V, PILOT LIGHT SWITCH FOR CONTROL OF CONTACTOR CONTROLLING STUDENT RECEPTACLES. REFER TO DETAIL FOR FURTHER INFORMATION.
- 8 ROUTE CIRCUIT VIA CONTACTOR. REFER TO DETAIL S/E 1.2 FOR FURTHER INFORMATION.
- 9 CONNECT MOTORIZED VALVES. LOCATE JUST ABOVE ACCESSIBLE CEILING FOR LOCAL DISCONNECTING MEANS. VERIFY AND COORDINATE CONNECTION REQUIREMENTS WITH MECHANICAL PLANS AND VALVE PROVIDER PRIOR TO ROUGH-IN.

PLAN NOTES:

- 1 BRANCH CIRCUITS ARE INDICATED AS ONE CIRCUIT HOME RUNS WITH INDIVIDUAL NEUTRALS. A MAXIMUM OF THREE CIRCUITS (MAXIMUM OF THREE PHASE CONDUCTORS) MAY BE GROUPED IN A SINGLE CONDUIT. WHERE MULTIPLE CIRCUITS ARE LOCATED IN THE SAME RACEWAY, JUNCTION BOX OR ENCLOSURE, NEUTRALS SHALL BE MARKED OR LABELED TO INDICATE WHICH CIRCUIT THEY ARE ASSOCIATED WITH. SEE SPECIFICATION SECTION "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES" FOR ADDITIONAL INFORMATION.
- 2 A GROUND CONDUCTOR SIZED PER N.E.C. ARTICLE 250 IS REQUIRED IN ALL CONDUITS.
- 3 FOR CONNECTION REQUIREMENTS TO MECHANICAL UNITS, SEE MECHANICAL EQUIPMENT CONNECTION SCHEDULE.
- 4 ALL PENETRATIONS IN THE RATED WALLS AND CEILINGS SHALL BE SEALED WITH A MATERIAL CAPABLE OF PREVENTING THE PASSAGE OF FLAMES AND HOT GASSES. THE SEALANT SHALL HAVE A T-RATING OF ONE HOUR.
- 5 ALL PIPING, CONDUIT, AND OUTLET BOXES (ELECTRIC, TELEPHONE, COMPUTER, ETC.) IN THE RATED WALLS OR CEILING SHALL BE CONSTRUCTED OF NON-COMBUSTIBLE MATERIAL.
- 6 OUTLET BOXES (ELECTRIC, TELEPHONE, COMPUTER, ETC.) SHALL BE LIMITED TO TWO OUTLET BOXES PER STUD SPACE. OUTLET BOXES ON OPPOSITE SIDES OF THE RATED WALLS SHALL BE SEPARATED BY A HORIZONTAL DISTANCE OF 24 INCHES.

CONNECT MOTORIZED LOUVERS AT WALL AND RELIEF HOOD, PROVIDE TIMER SWITCH FOR CONTROL AS REQUIRED. REFER TO MECHANICAL PLANS FOR SEQUENCE OF OPERATION.

CONNECT MOTORIZED LOUVERS AT WALL AND RELIEF HOOD, PROVIDE TIMER SWITCH FOR CONTROL AS REQUIRED. REFER TO MECHANICAL PLANS FOR SEQUENCE OF OPERATION.



ELECTRICAL POWER FLOOR PLAN

1/8" = 1'-0"

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

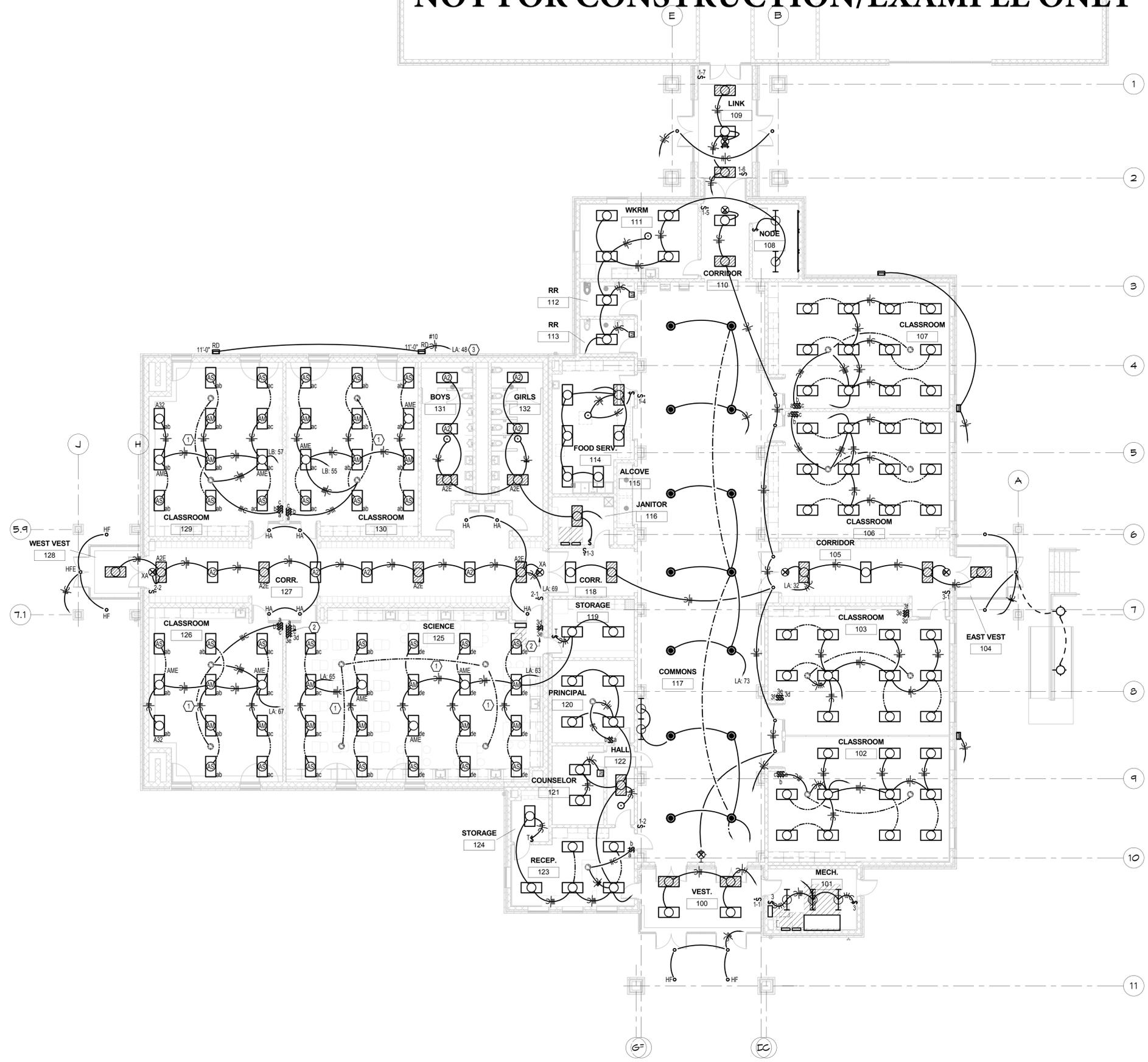
The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

ELECTRICAL POWER FLOOR PLAN

SHEET NO.: **E2.1**

DATE: AUGUST 2014

NOT FOR CONSTRUCTION/EXAMPLE ONLY



A ELECTRICAL LIGHTING FLOOR PLAN
 1/8" = 1'-0"

PLAN NOTES:

- BRANCH CIRCUITS ARE INDICATED AS ONE CIRCUIT HOME RUNS WITH INDIVIDUAL NEUTRALS. A MAXIMUM OF THREE CIRCUITS (MAXIMUM OF THREE PHASE CONDUCTORS) MAY BE GROUPED IN A SINGLE CONDUIT. WHERE MULTIPLE CIRCUITS ARE LOCATED IN THE SAME RACEWAY, JUNCTION BOX OR ENCLOSURE, NEUTRALS SHALL BE MARKED OR LABELED TO INDICATE WHICH CIRCUIT THEY ARE ASSOCIATED WITH. SEE SPECIFICATION SECTION "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES" FOR ADDITIONAL INFORMATION.
- A GROUND CONDUCTOR SIZED PER N.E.C. ARTICLE 250 IS REQUIRED IN ALL CONDUITS.
- ALL PENETRATIONS IN THE RATED WALLS AND CEILINGS SHALL BE SEALED WITH A MATERIAL CAPABLE OF PREVENTING THE PASSAGE OF FLAMES AND HOT GASSES. THE SEALANT SHALL HAVE A T-RATING OF ONE HOUR.
- ALL PIPING, CONDUIT, AND OUTLET BOXES (ELECTRIC, TELEPHONE, COMPUTER, ETC.) IN THE RATED WALLS OR CEILING SHALL BE CONSTRUCTED OF NON-COMBUSTIBLE MATERIAL.
- REFER TO ARCHITECTURAL REFLECTED CEILING PLANS FOR EXACT LIGHT FIXTURE LOCATIONS. VERIFY ALL DISCREPANCIES WITH ARCHITECT PRIOR TO ROUGH-IN.

KEYED NOTES:

- INTERLOCK OCCUPANCY SENSORS AS REQUIRED. VERIFY CONNECTION REQUIREMENTS WITH SENSOR MANUFACTURER.
- ROUTE LIGHT FIXTURES VIA LOCAL SWITCHES INDICATED WITHIN ROOM. OCCUPANCY SENSOR(S) WITHIN ROOM SHALL BE CONNECTED AHEAD OF ALL LOCAL LIGHT SWITCHES.
- CIRCUIT VIA LIGHTING RELAY PANEL. REFER TO LIGHTING RELAY PANEL SCHEDULE FOR CONTROL.

SCHOOL TORNADO SAFE ROOM SOUTHEAST KANSAS

FEMA is providing this case study as an example only. Registered design professionals are encouraged to use this case study to inform their safe room design efforts, but not to rely upon its accuracy, assumptions, or calculations for any individual safe room project's designs, decisions, and execution. The registered design professional of record for an individual safe room project and other accountable parties are responsible for ensuring the design meets FEMA P-361 criteria, FEMA grant funds requirements (when applicable), and all Federal, State and local building codes and permitting requirements.

FEMA does not endorse, approve, certify, or recommend any designs, contractors, individuals, firms, or products. Contractors, individuals, or firms shall not claim they or their products are "FEMA approved" or "FEMA certified."

LIMITS OF LIABILITY:

The designs included herein are based on extensive research of the causes and effects of windstorm damage to buildings.

Safe Rooms designed and built to these designs should provide a high degree of occupant protection during tornadoes.

Any substitution of either materials or design concepts may decrease the level of occupant protection and/or increase the possibility of personal injury during a severe wind event.

Because it is not possible to predict or test all conditions that may occur during severe windstorms, or control the quality of construction, among other things, the designer does not warrant the design.

The designer neither manufactures nor sells safe rooms built from this design. The designers have not made and do not make any representation, warranty, or covenant, express or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of the safe room in any respect whatsoever. Designers shall not be obligated or liable for actual, incidental, consequential, or other damages of or to users of safe rooms or any other person or entity arising out of or in connection with the use, condition, and/or performance of safe rooms built from this design or from the maintenance thereof.

ELECTRICAL LIGHTING FLOOR PLAN

SHEET NO.: **E3.1**

DATE: AUGUST 2014