



**PDHonline Course C426 (3 PDH)**

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## **Building a (Storm-Resistant) Safe Room**

*Instructor: Mark P. Rossow, Ph.D, PE Retired*

**2020**

**PDH Online | PDH Center**

5272 Meadow Estates Drive  
Fairfax, VA 22030-6658  
Phone: 703-988-0088  
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# IN-RESIDENCE AND SMALL BUSINESS SAFE ROOM DESIGNS DEPARTMENT OF HOMELAND SECURITY

LIMIT OF LIABILITY:

THE DESIGNS IN THIS BOOKLET 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 EXTREME WINDSTORMS (TORNADOES AND HURRICANES.) 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 EXTREME WIND EVENT.

BECAUSE IT IS NOT POSSIBLE TO PREDICT OR TEST ALL CONDITIONS THAT MAY OCCUR DURING EXTREME WINDSTORMS, OR CONTROL THE QUALITY OF CONSTRUCTION, AMONG OTHER THINGS, THE DESIGNER DOES NOT GUARANTEE THE DESIGN.

THE DESIGNER DOESN'T MANUFACTURE OR SELL SAFE ROOMS BUILT FROM THIS DESIGN. THE DESIGNERS HAVE NOT MADE AND DO NOT MAKE ANY REPRESENTATION, WARRANTY, OR COVENANT, EXPRESSED 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.

IN-RESIDENCE AND SMALL BUSINESS SAFE ROOM DRAWING LIST	
DRAWING NUMBER	TITLE
T-01	INDEX SHEET
G-01	GENERAL NOTES
IG-01	IN-GROUND SAFE ROOM – SECTIONS AND DETAILS
B-01	BASEMENT LEAN-TO SAFE ROOM
B-02	BASEMENT SAFE ROOM – CORNER LOCATION
AG-01	CMU – CONCRETE ALTERNATIVE PLANS
AG-02	CMU – CONCRETE WALL SECTIONS
AG-03	CMU – CONCRETE SECTIONS CEILING ALTERNATIVES
AG-04	VENTILATION DETAILS
AG-05	WOOD-FRAME SAFE ROOM PLAN – PLYWOOD SHEATHING WITH CMU INFILL
AG-06	WOOD-FRAME SAFE ROOM PLAN – PLYWOOD AND STEEL WALL SHEATHING
AG-07	WOOD-FRAME SAFE ROOM – FOUNDATION SECTIONS
AG-08	INSULATING CONCRETE FORM PLANS
AG-09	INSULATING CONCRETE FORM SECTIONS
MS-01	MISCELLANEOUS DETAILS
MS-02	DOOR DETAILS AND SIGNAGE DETAILS
ML-01	MATERIALS LISTS
ML-02	MATERIALS LISTS


INDEX SHEET

DRAWING NO: T-01

SHEET 1 OF 18

DATE: OCTOBER 1998

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GENERAL NOTES

1. CONCRETE:

A. ALL CONCRETE SHOULD HAVE STONE AGGREGATE (NORMAL WEIGHT). 28-DAY COMPRESSIVE STRENGTH (f'c) SHOULD BE 3,000 PSI MINIMUM FOR CAST-IN-PLACE CONCRETE.

B. REINFORCING BARS SHOULD BE MILD STEEL WITH A MINIMUM YIELD STRENGTH OF 60 KSI.

C. REINFORCING BAR PROTECTION:

1. CONCRETE PLACED AGAINST EARTH – 3"

2. CONCRETE PLACED IN FORMS – 1-1/2"

D. REINFORCING BAR PLACEMENT TOLERANCE IS 1/2" IN ANY DIRECTION.

E. SPLICING OF REINFORCEMENT IS NOT PERMITTED EXCEPT AS SHOWN ON THE DRAWINGS. BARS SHOULD BE LAP SPLICED AT ALL CORNERS. SPLICE LENGTHS AS FOLLOWS:

1. #4 BARS – 24"

2. #5 BARS – 30"

F. WELDED WIRE REINFORCEMENT: LAP ONE AND ONE-HALF MESH SPACES AT SPLICES AND WIRE IN CONTACT.

G. FIELD WELDING OF REINFORCEMENT SHOULD NOT BE PERMITTED.

H. ALL REINFORCING BAR BENDS SHOULD BE MADE MECHANICALLY. HEAT-BENDING SHOULD NOT BE PERMITTED.
2. MASONRY:

A. MASONRY SHOULD HAVE SPECIFIED COMPRESSIVE STRENGTH (f'm) OF 1,500 PSI AT MINIMUM 28-DAYS.

B. MORTAR SHOULD BE TYPE M OR S PER ASTM C270-97.

C. REINFORCING BARS SHOULD BE MILD STEEL WITH A MINIMUM YIELD STRENGTH OF 60 KSI.

D. REINFORCING BAR PLACEMENT TOLERANCE IS 1/2" IN ANY DIRECTION.

E. SPLICING OF REINFORCEMENT SHOULD NOT BE PERMITTED EXCEPT AS SHOWN ON THE DRAWINGS. SPLICE LENGTHS AS FOLLOWS:

1. #4 BARS – 24"

2. #5 BARS – 30"

3. #6 BARS – 36"
3. WOOD:

A. FRAMING LUMBER TO HAVE MODULUS OF ELASTICITY = 1,200,000 PSI MIN. AND F = 850 PSI MIN. FOR NORMAL DURATION LOADING. EXAMPLES OF ACCEPTABLE GRADE AND SPECIES OF FRAMING LUMBER INCLUDE #2 AND BETTER SOUTHERN PINE, DOUGLAS FIR, HEM-FIR, AND SPRUCE-PINE-FIR.

B. PLYWOOD SHOULD BE RATED SHEATHING SPAN RATING 32/16, MIN. 23/32 THICKNESS.

C. ALL WOOD SILL PLATES SHOULD BE PRESSURE-PRESERVATIVE TREATED FOR ABOVE GROUND CONTACT USE.

D. NAILS SHOULD BE COMMON WIRE NAILS.
4. COLD-FORMED (LIGHT GAUGE) SHEATHING:

A. YIELD STRENGTH FOR METAL IS 36 KSI MINIMUM.

B. ALL METAL SHOULD BE BE G60 GALVANIZED BY THE MANUFACTURER (ONLY FOR SAFE ROOMS IN HURRICANE-PRONE REGIONS).

C. THE CONTRACTOR SHOULD VERIFY AND COORDINATE ALL DIMENSIONS AND QUANTITIES PRIOR TO STARTING CONSTRUCTION.
6. THE CONSTRUCTION DRAWINGS SHOULD NOT BE SCALED. DIMENSIONS APPLY.
7. IF THERE IS A CONFLICT AMONG THE GENERAL NOTES, SPECIFICATIONS, AND PLANS, THE ORDER OF PRECEDENCE IS NOTES, THEN SPECIFICATIONS, THEN PLANS.

8. THE CONSTRUCTION DRAWINGS REPRESENT THE FINISHED STRUCTURE. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR PROVIDING ALL MEASURES NECESSARY TO ENSURE THAT THE STRUCTURE IS PROTECTED DURING CONSTRUCTION. THESE MEASURES INCLUDE (BUT ARE NOT LIMITED TO) SHORING AND BRACING FOR CONSTRUCTION LOADS AND WORKER SAFETY PURPOSES.
9. FOLLOW MANUFACTURER’S RECOMMENDATIONS FOR NAILING REQUIREMENTS OF UPLIFT/SHEAR RESISTANCE CONNECTORS.
10. ALL PLYWOOD JOINTS SHOULD BE SOLIDLY BLOCKED W/2X4’S
11. WALL & CEILING PENETRATIONS THROUGH THE MISSILE PROTECTION SHEATHING SHOULD BE MINIMIZED
12. CONDUITS & OTHER VERTICAL RUNS IN WALLS SHOULD BE COLLECTED AND RUN IN THE CHASE.
13. DO NOT DRILL THROUGH WALL STUDS OR TOP AND BOTTOM PLATES FOR PLUMBING SUPPLY LINES OR VENTS. INSTALL ALL PLUMBING SUPPLY LINES AND VENTS IN PLUMBING CHASE.
15. VENTILATION IS TO BE PROVIDED IN ACCORDANCE WITH THE LOCAL BUILDING CODE. VENTILATION MAY BE EITHER NATURAL OR MECHANICAL SUCH THAT MINIMUM VENTILATION IS 0.5 AIR CHANGES / HOUR.
16. THE DESIGNS SHOWN ARE COMPLIANT WITH THE 1997 NEHRP RECOMMENDED PROVISIONS.
17. TO ENSURE THE SAFE ROOM PROVIDES THE DESIRED LEVEL OF PROTECTION, A PROFESSIONAL ENGINEER OR ARCHITECT SHOULD BE CONSULTED FOR ANY DESIGN CONDITIONS FOUND TO BE DIFFERENT FROM THOSE REPRESENTED BY THESE PLANS.
18. SEE SHEETS 17 AND 18 OF 18 FOR THE MATERIALS LIST FOR EACH SAFE ROOM.
19. TO OBTAIN AN EQUIVALENT LEVEL OF PROTECTION, SAFE ROOM DESIGNS NOT MEETING THE SPECIFIC REQUIREMENTS OF THE DESIGNS IN THESE PLANS SHOULD BE DESIGNED TO MEET THE FEMA SAFE ROOM CRITERIA SET FORTH IN FEMA 361 "DESIGN AND CONSTRUCTION GUIDANCE FOR COMMUNITY SAFE ROOMS."
20. THE DOORS SHOWN IN THESE PLANS WERE LABORATORY-TESTED FOR DEBRIS IMPACT FOR DOOR WIDTHS FROM 2’-6” TO 3’-0”. DHS STRONGLY ENCOURAGES INDIVIDUALS TO USE A MINIMUM DOOR WIDTH OF 2’-8” FOR WHEELCHAIR ACCESS.
21. FOR ALL CONSTRUCTION, USE ONLY UNITED STATES MANUFACTURED SCREWS AND HARDWARE AS THERE HAVE BEEN HIGH RECORDED FAILURE RATES OF SCREWS AND HARDWARE IMPORTED FROM OTHER COUNTRIES.

DESIGN BASIS

1. LIVE LOADS USED IN DESIGN:

A. WIND PRESSURES DEVELOPED FROM 250-MPH 3-SEC. GUST IN ACCORDANCE THE WIND LOAD CALCULATION PROCEDURE IN ASCE7-05, SECTION 6.5 METHOD 2-ANALYTICAL METHOD AS MODIFIED BY FEMA 361, CHAPTER 3 FOR SAFE ROOM DESIGN AND LIFE-SAFETY PROTECTION.

B. WINDBORNE DEBRIS (MISSILE) IMPACT LOADS CREATED BY A 15-LB 2X4 TRAVELING HORIZONTALLY AT 100 MPH, TRAVELING VERTICALLY AT 67 MPH, AND IMPACTING NORMAL TO WALL SURFACE.
2. SOIL BEARING CAPACITY OF 2,000 PSF MIN. HAS BEEN ASSUMED.

ABBREVIATIONS


A.B.	ANCHOR BOLT
CMU	CONCRETE MASONRY UNIT
CONC.	CONCRETE
DBL.	DOUBLE
DIA	DIAMETER
E.W.	EACH WAY
GA.	GAUGE
GYP	GYPSUM
ICF	INSULATING CONCRETE FORMS
KSI	THOUSAND LBS PER SQUARE INCH
MAX	MAXIMUM
M.H.	MANHOLE
MIN.	MINIMUM
N.T.S	NOT TO SCALE
O.C.	ON CENTER
P.T.	PRESSURE TREATED
REQD.	REQUIRED
S.F.	SQUARE FOOT
SYP	SOUTHERN YELLOW PINE
TYP	TYPICAL
WWF	WELDED WIRE FABRIC
W/	WITH

GENERAL NOTES

DRAWING NO: G-01 | SHEET 2 OF 18

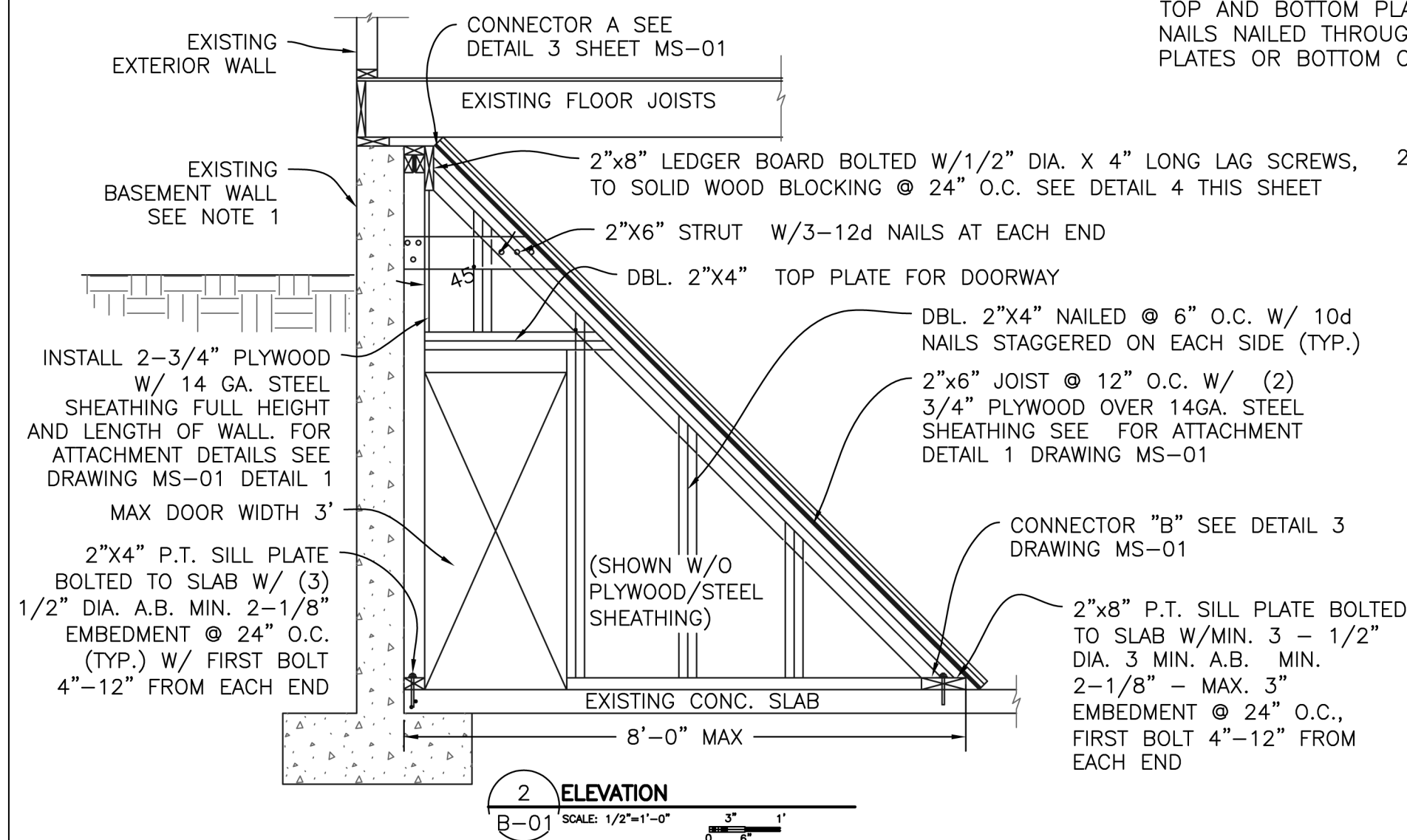
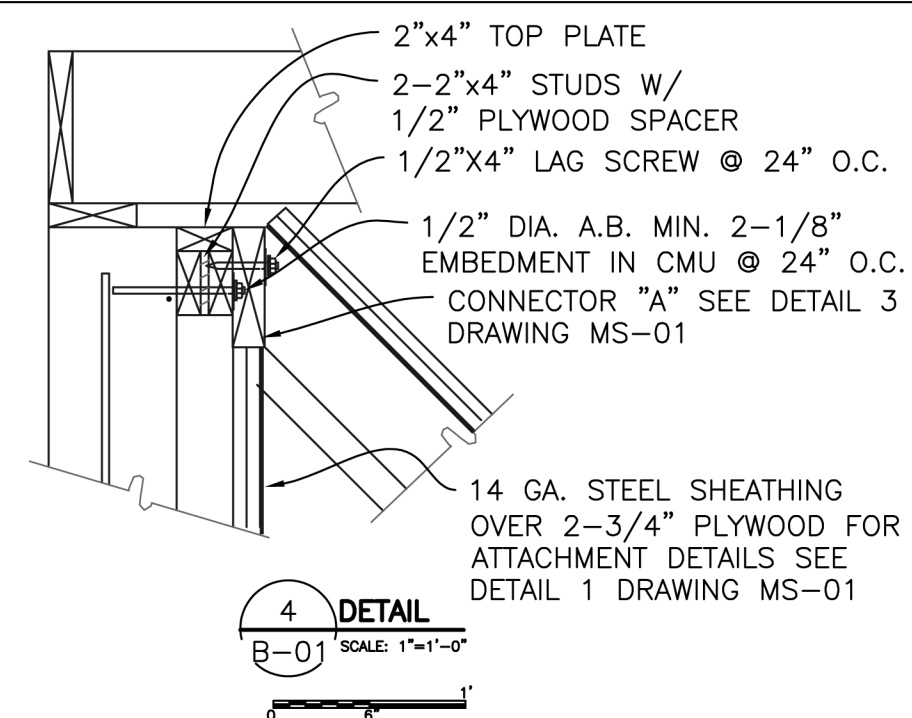
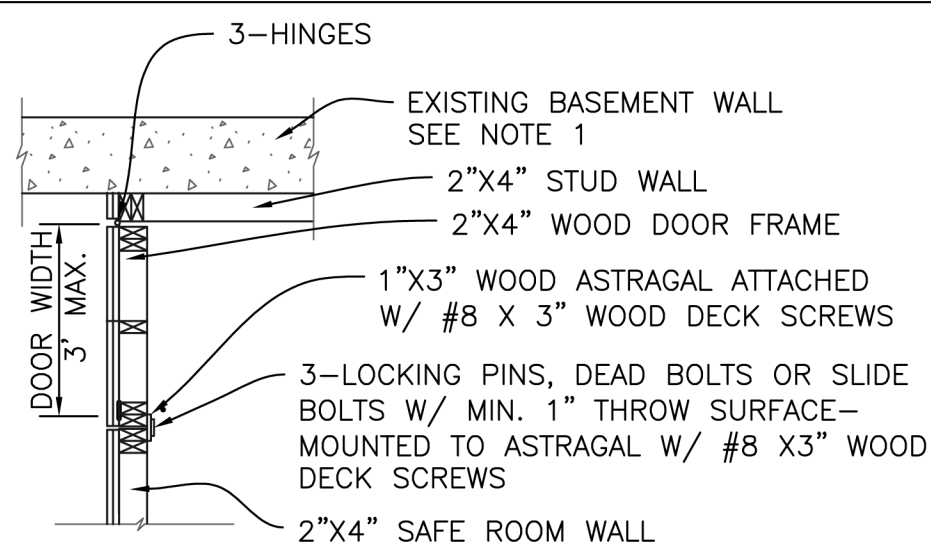
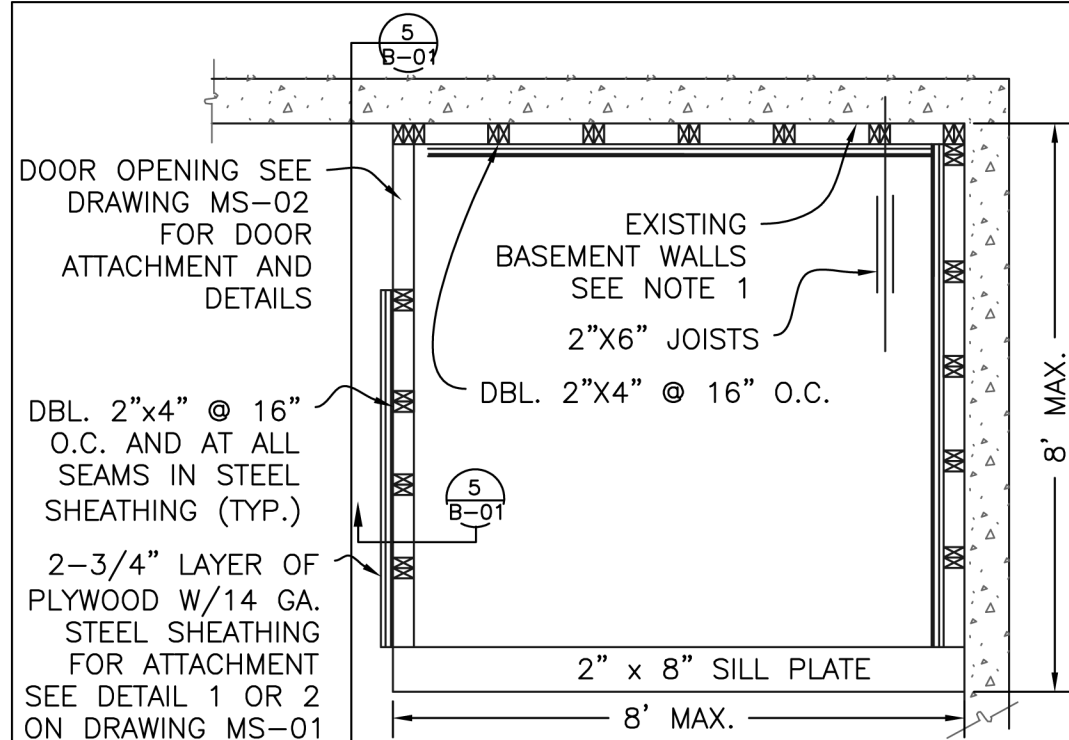
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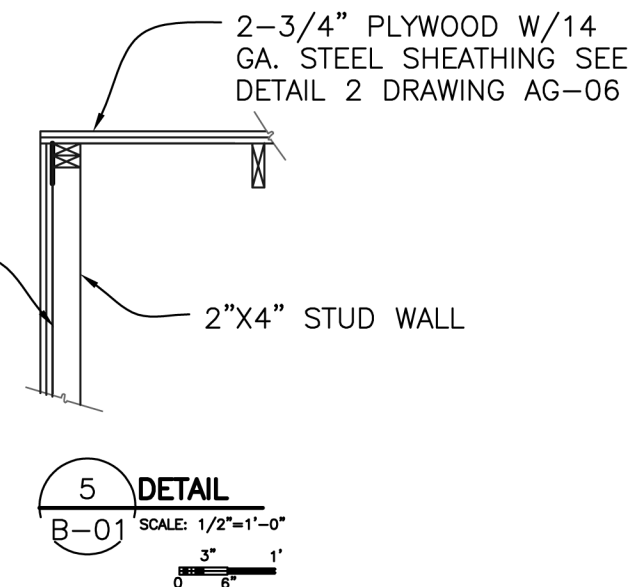






NOTE:  
ALL WALL STUDS TO BE ATTACHED TO TOP AND BOTTOM PLATES W/ 2-16d NAILS NAILED THROUGH FROM TOP OF PLATES OR BOTTOM OF PLATES.

2-3/4" PLYWOOD W/14 GA. STEEL SHEATHING SEE DETAIL 2 DRAWING AG-06



NOTE:  
1. EXISTING CONCRETE OR MASONRY BASEMENT WALLS MUST HAVE APPROPRIATE REINFORCEMENT.

BASEMENT LEAN-TO SAFE ROOM

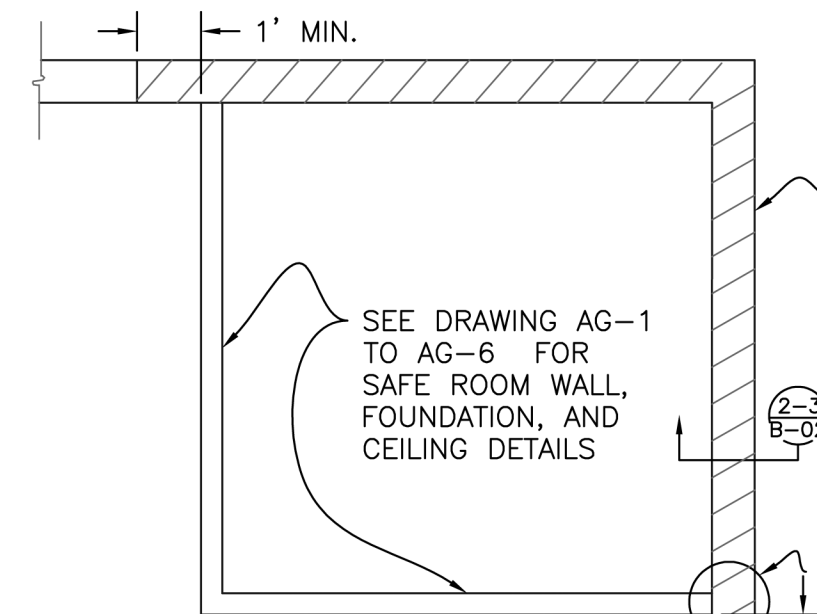
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DATE: OCTOBER 1998

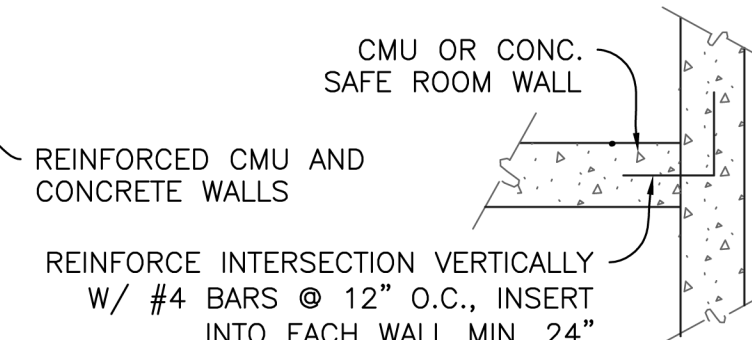
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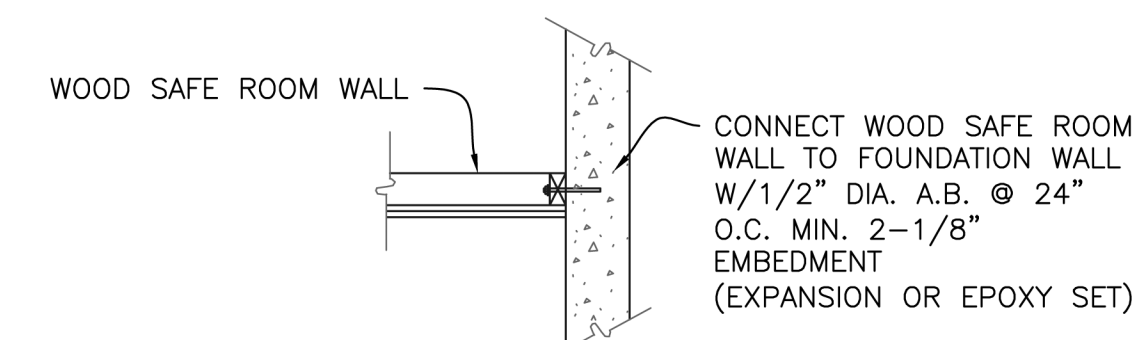
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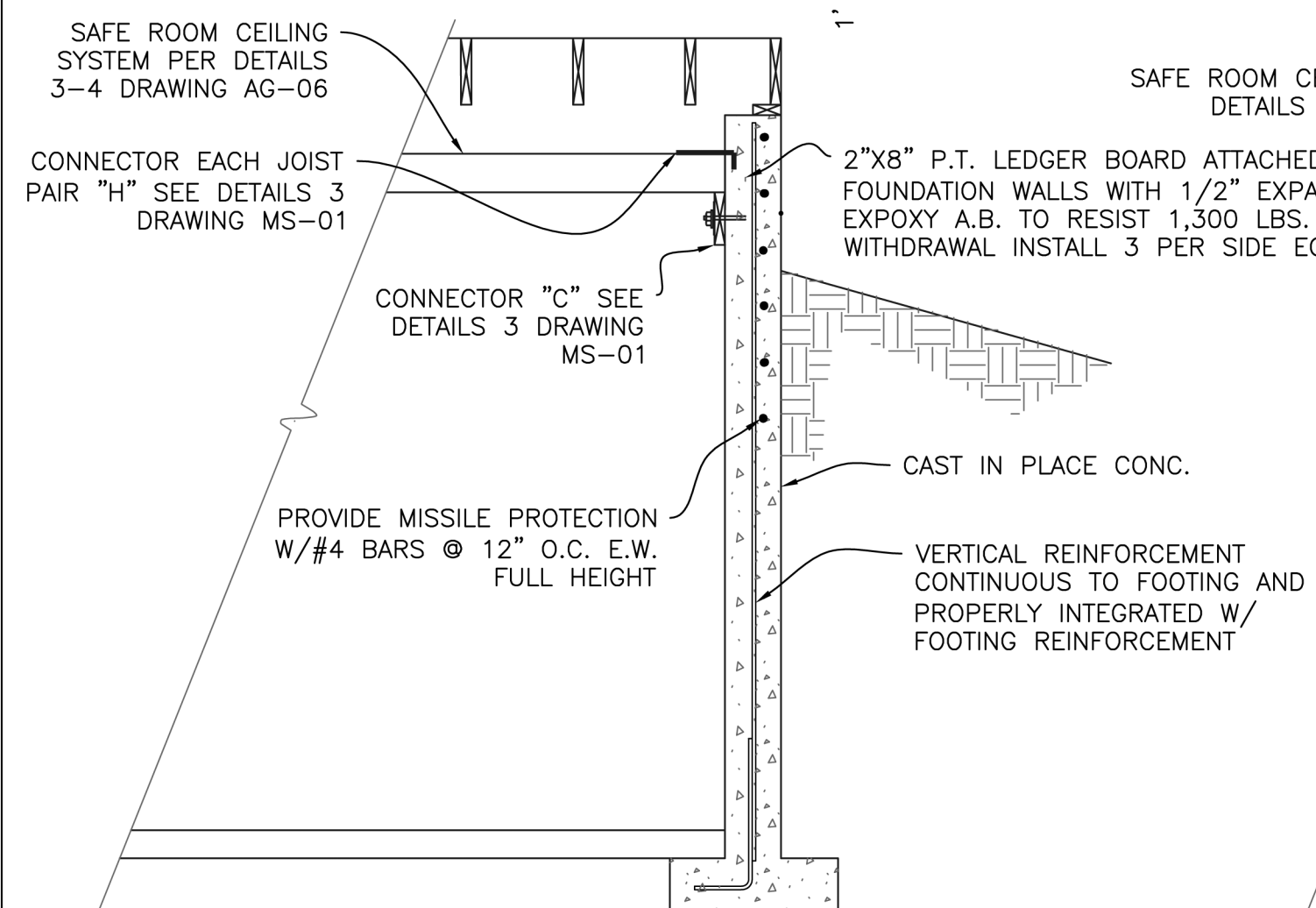
**1 CORNER SAFE ROOM PARTIAL PLAN**  
B-02 SCALE: 1/2"=1'-0" 0 6" 1' 2'



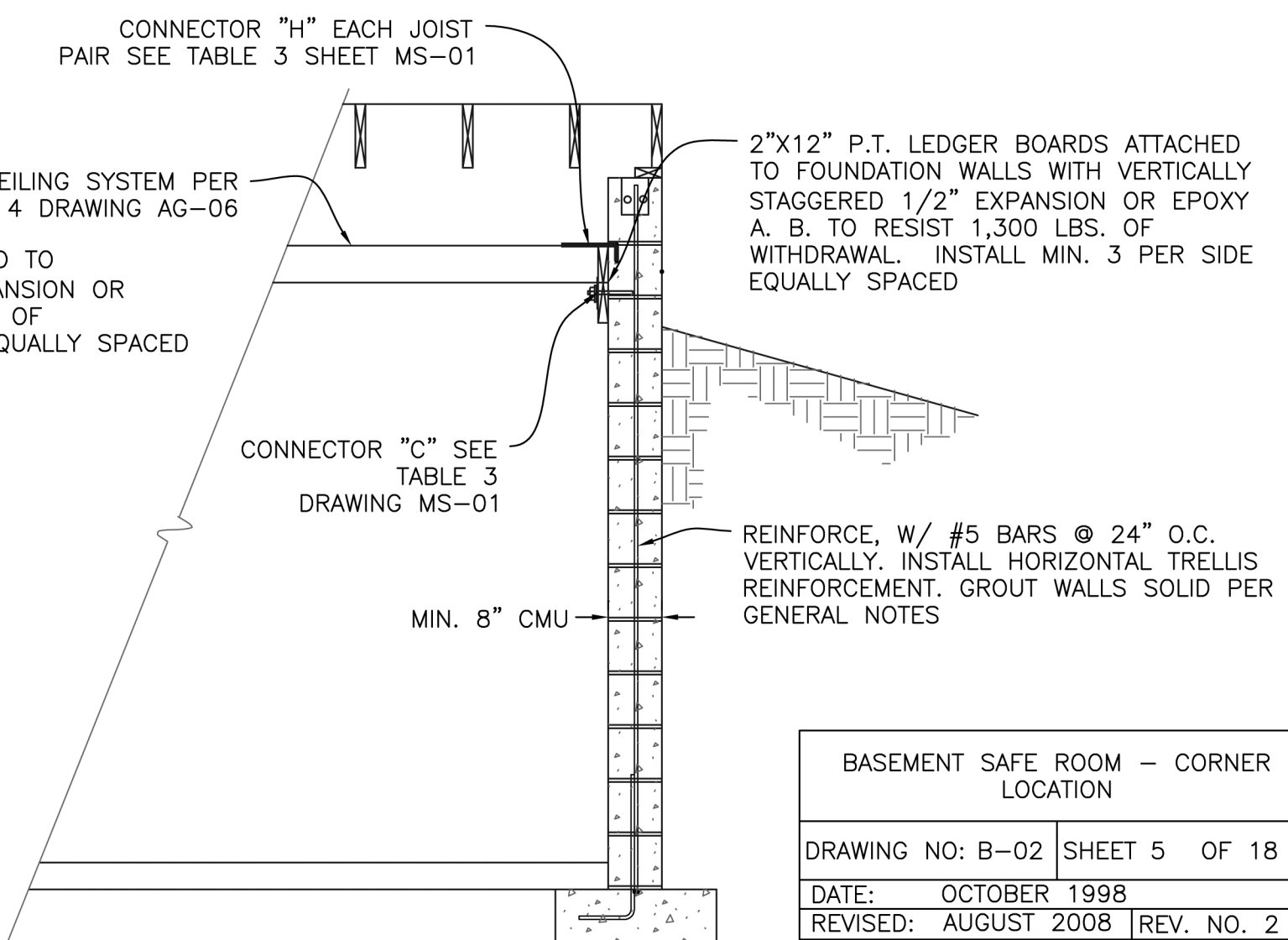
**4 ALTERNATIVE: CMU SAFE ROOM TO FOUNDATION WALL DETAIL**  
B-02 SCALE: 1/2"=1'-0" 0 6" 1' 2'



**4A ALTERNATIVE: WOOD SAFE ROOM TO FOUNDATION WALL DETAIL**  
B-02 SCALE: 1/2"=1'-0" 0 6" 1' 2'



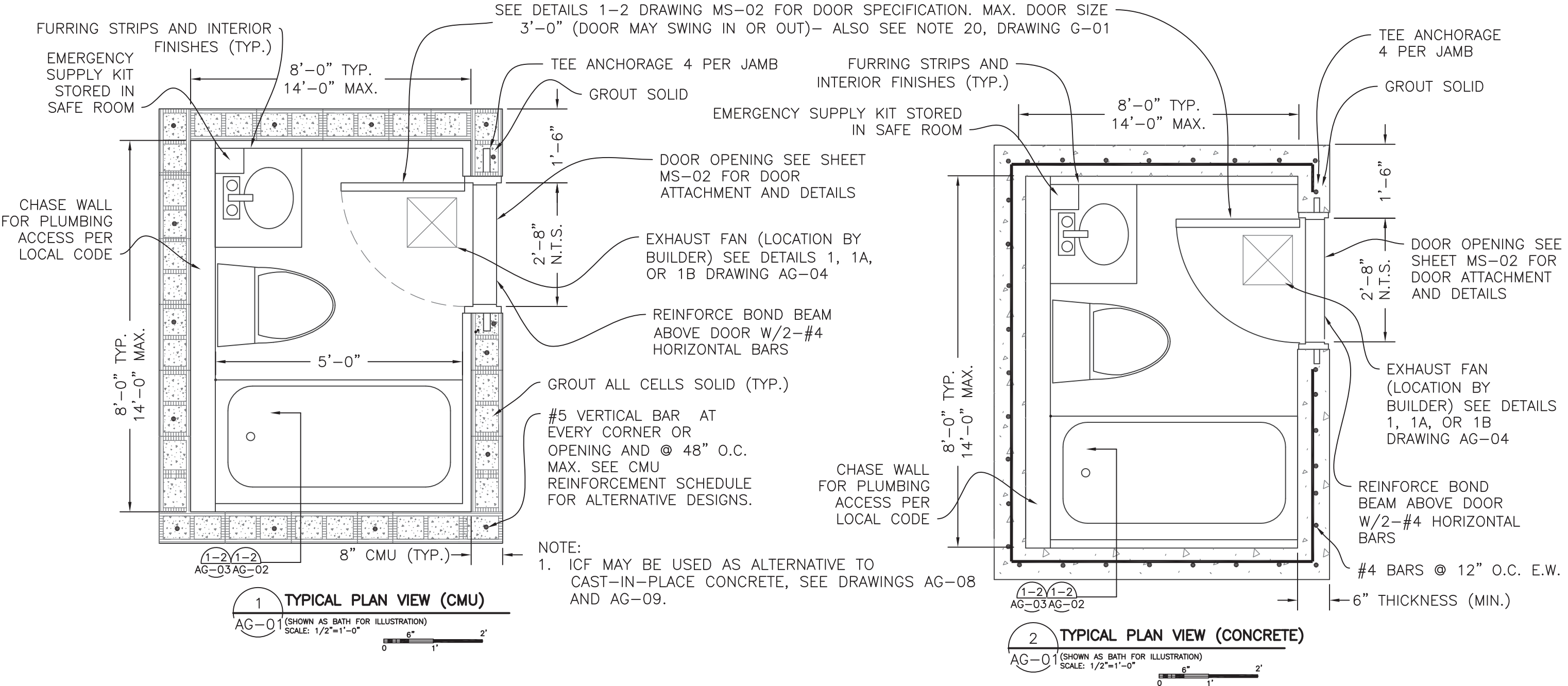
**2 ALTERNATIVE: CAST-IN-PLACE CONCRETE FOUNDATION ELEVATION**  
B-02 SCALE: 1/2"=1'-0" 0 6" 1' 2'



**3 ALTERNATIVE: CMU FOUNDATION ELEVATION**  
B-02 SCALE: 1/2"=1'-0" 0 6" 1' 2'

BASEMENT SAFE ROOM – CORNER LOCATION	
DRAWING NO: B-02	SHEET 5 OF 18
DATE: OCTOBER 1998	
REVISED: AUGUST 2008	REV. NO. 2

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CMU REINFORCEMENT SCHEDULE			
DIMENSIONS	CMU THICKNESS	WALL GROUTING AND REINFORCEMENT	CONCRETE ROOF OPTIONS SLAB THICKNESS AND REINFORCEMENT
8'X8'X8'	6"	FULLY GROUTED CELLS WITH #4 VERTICAL REINFORCEMENT @ 16" O.C. AND AT EVERY OPENING AND EACH CORNER	4" THICK CONCRETE ROOF SLAB REINFORCED WITH #4 BARS EACH WAY @ 12" O.C.
8'X8'X8'	8"	FULLY GROUTED CELLS WITH #5 VERTICAL REINFORCEMENT @ 48" O.C. AND AT EVERY OPENING AND EACH CORNER	4" THICK CONCRETE ROOF SLAB REINFORCED WITH #4 BARS EACH WAY @ 12" O.C.
14'X14'X8'	8"	FULLY GROUTED CELLS WITH #6 VERTICAL REINFORCEMENT @ 40" O.C. AND AT EVERY OPENING AND EACH CORNER ALTERNATIVE REINFORCEMENT : FULLY GROUTED CELLS WITH #5 VERTICAL REINFORCEMENT @ 32" O.C. AND AT EVERY OPENING AND EACH CORNER	6" THICK CONCRETE ROOF SLAB REINFORCED WITH #4 BARS EACH WAY @ 18" O.C.



TABLE NOTE:  
VERTICAL REINFORCEMENT SHALL TERMINATE IN BOND BEAM WITH A STANDARD HOOK. IF CEILING SYSTEM IS A REINFORCED CONCRETE SLAB, A SEPARATE BOND BEAM IS NOT REQUIRED. GROUT WALLS SOLID AS PER NOTES.

CMU – CONCRETE ALTERNATIVE PLANS

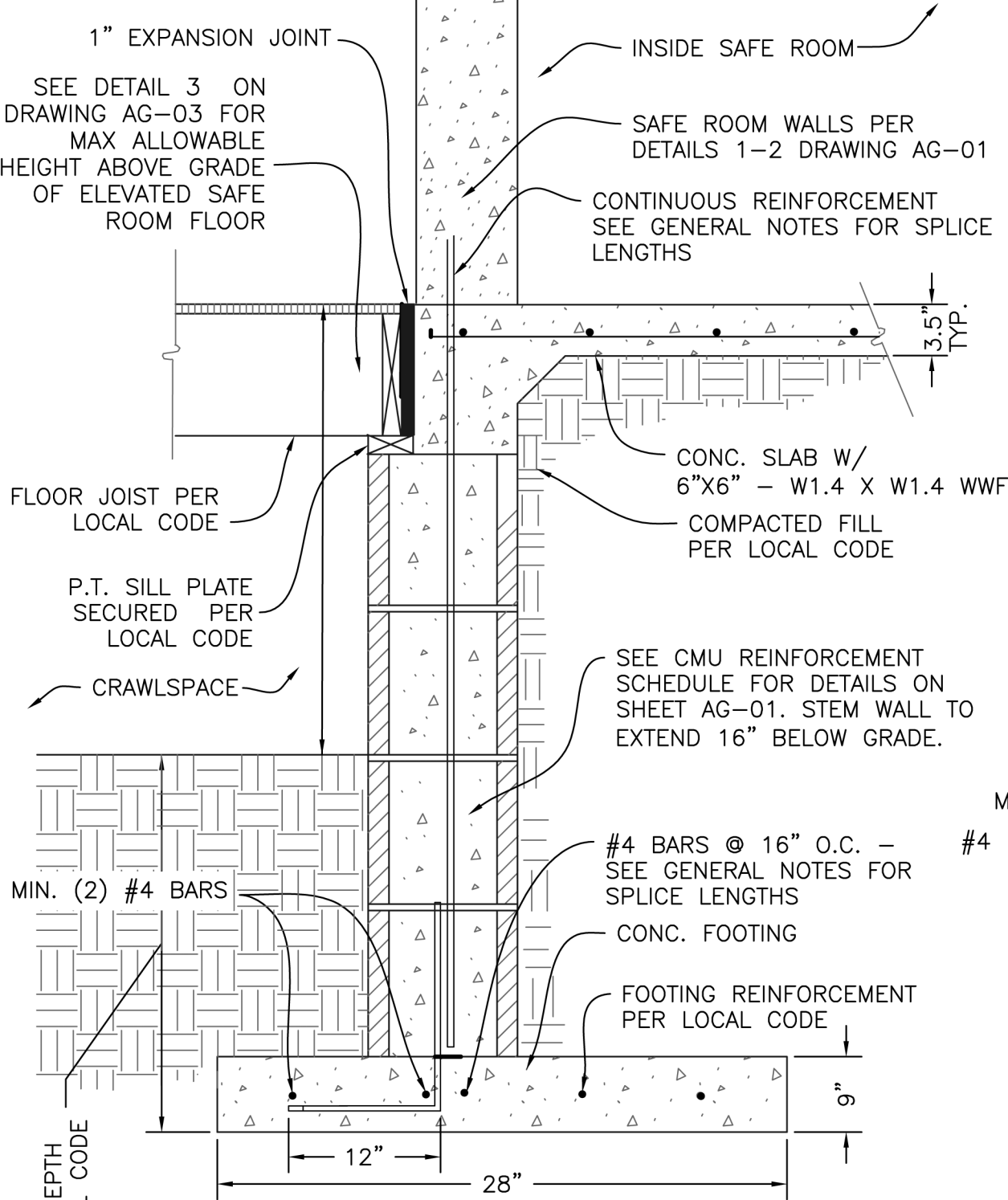
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DATE: OCTOBER 1998

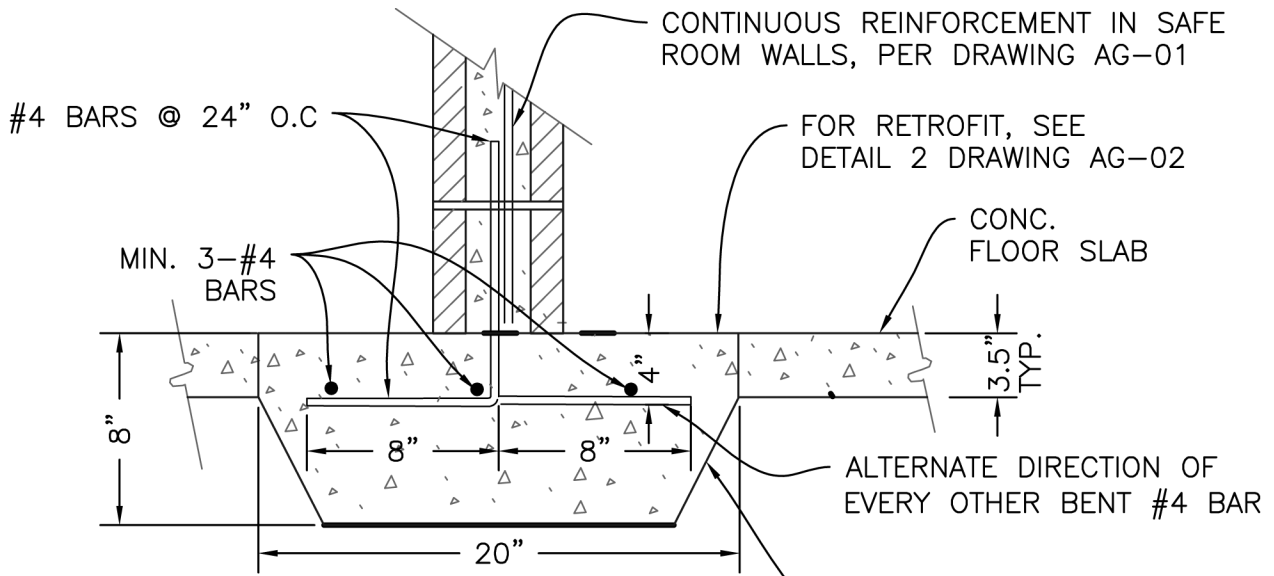
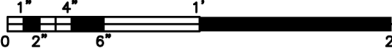
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NOTE:  
FOR MAX. ELEVATIONS FOR  
SAFE ROOMS, SEE DETAIL 3  
DRAWING AG-03

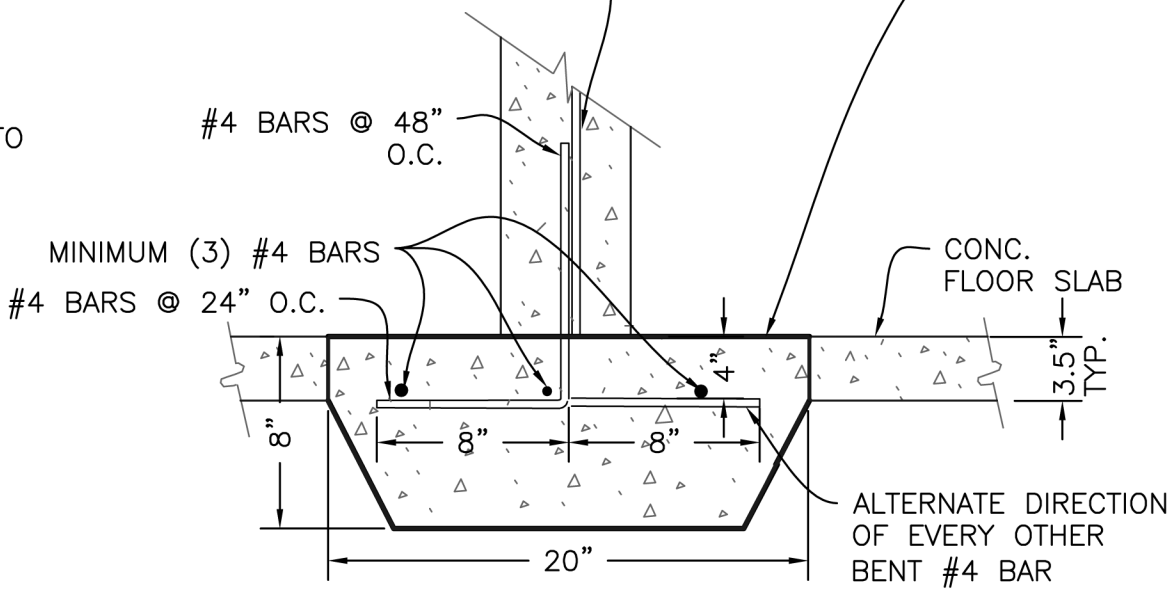


3 TYPICAL ANCHOR DETAIL FOR ELEVATED SAFE ROOM WITH CMU STEM WALL  
AG-02 SCALE: 1"=1'-0"



1 TYPICAL ANCHOR DETAIL FOR CMU WALL ON SLAB-ON-GRADE FOUNDATION  
AG-02 SCALE: N.T.S.

CONTINUOUS REINFORCEMENT  
IN SAFE ROOM WALLS, PER  
DETAIL 2 DRAWING AG-01





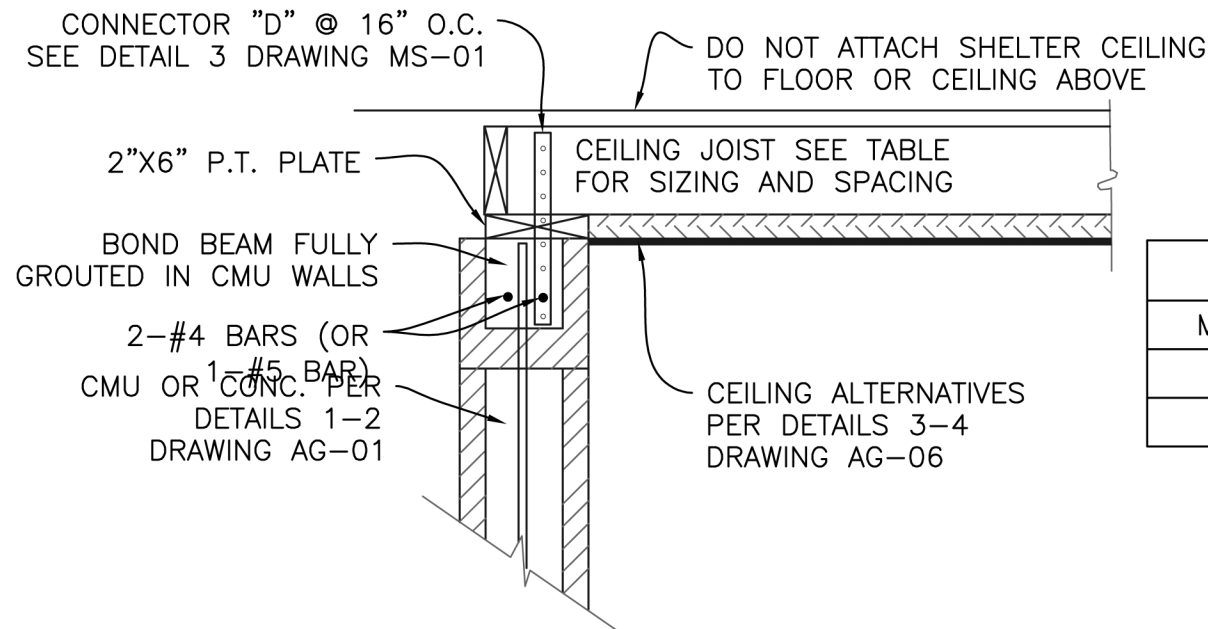
2 TYPICAL ANCHOR DETAIL FOR CONCRETE WALL ON SLAB-ON-GRADE FOUNDATION  
AG-02 SCALE: N.T.S.

WHEN PERMITTED BY CODE, A RETROFIT  
SAFE ROOM MAY BE ANCHORED TO AN  
EXISTING SLAB IF EXISTING SLAB IS  
FOUND TO HAVE ADEQUATE THICKNESS  
AND REINFORCING AT EACH CORNER AND  
EACH SIDE OF DOORWAYS MIN. AND AT  
A MINIMUM #4 BARS MUST BE DOWELLED  
AND EPOXY SET INTO THE SLAB SUCH  
THAT THEY PROVIDE 1,000 lbs TENSILE  
AND 800 lbs SHEAR CAPACITY.

NOTE:  
THE OVERALL HEIGHT OF THE SAFE  
ROOM CANNOT EXCEED THE SHORTEST  
PLAN DIMENSION BY 10%. (I.E. IF THE  
SHELTER MEASURES 8'x6' IN PLAN  
DIMENSION, THE MAXIMUM OVERALL  
HEIGHT OF THE SHELTER IS 6'-7").

CMU - CONCRETE WALL SECTIONS	
DRAWING NO: AG-02	SHEET 7 OF 18
DATE: OCTOBER 1998	
REVISED: AUGUST 2008	REV. NO. 2





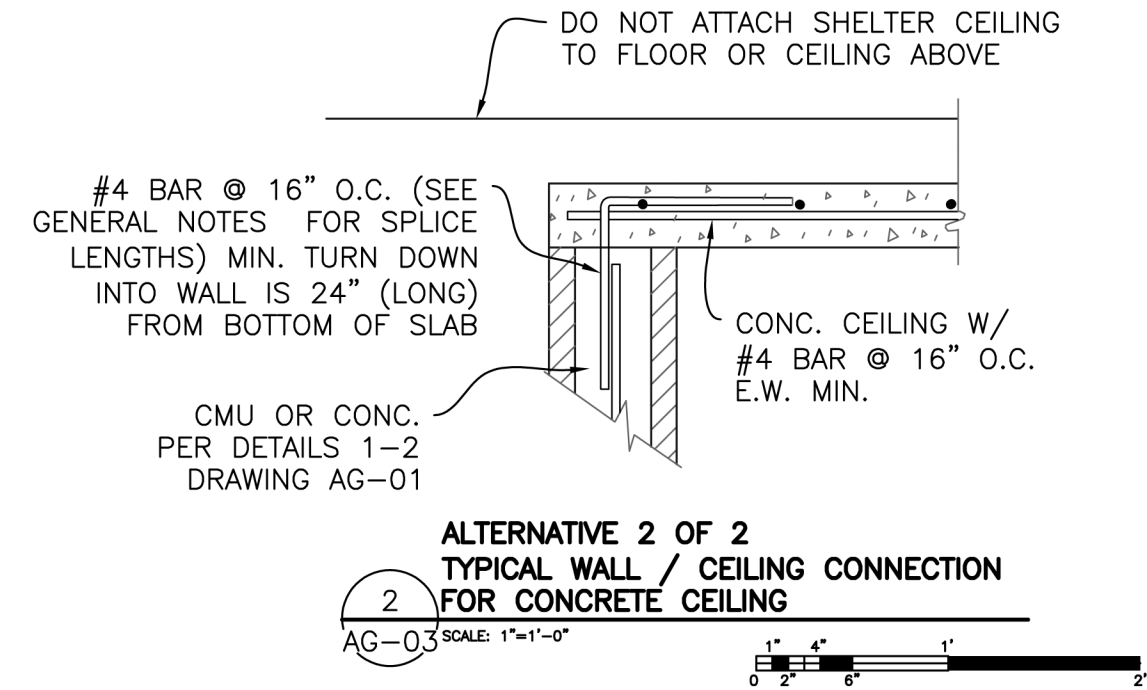
WOOD JOIST CEILING SCHEDULE	
MAX. SPAN	MAX. JOIST SPACING
8'	2-2"X6" @ 19-1/4" O.C.
14'	2-2"X10" @ 16 O.C.

TYPE OF CONSTRUCTION	MAXIMUM FLOOR ELEVATION (FT.) ABOVE GRADE
CONCRETE	5
CMU	5
WOOD W/ CMU INFILL	5
WOOD W/ STEEL SHEATHING	3

**ALTERNATIVE 1 OF 2**  
**TYPICAL WALL / CEILING CONNECTION WOOD FRAMING USING EMBEDDED ANCHOR STRAP**  
 1  
 AG-03 SCALE: 1"=1'-0"

**NOTE:**  
 CONCRETE ROOF OPTIONS SHOWN ARE FOR 8'X8'X8' SAFE ROOMS. FOR 14'X14'X8' SAFE ROOMS, SEE SPECIFICATIONS ON DRAWING AG-01.

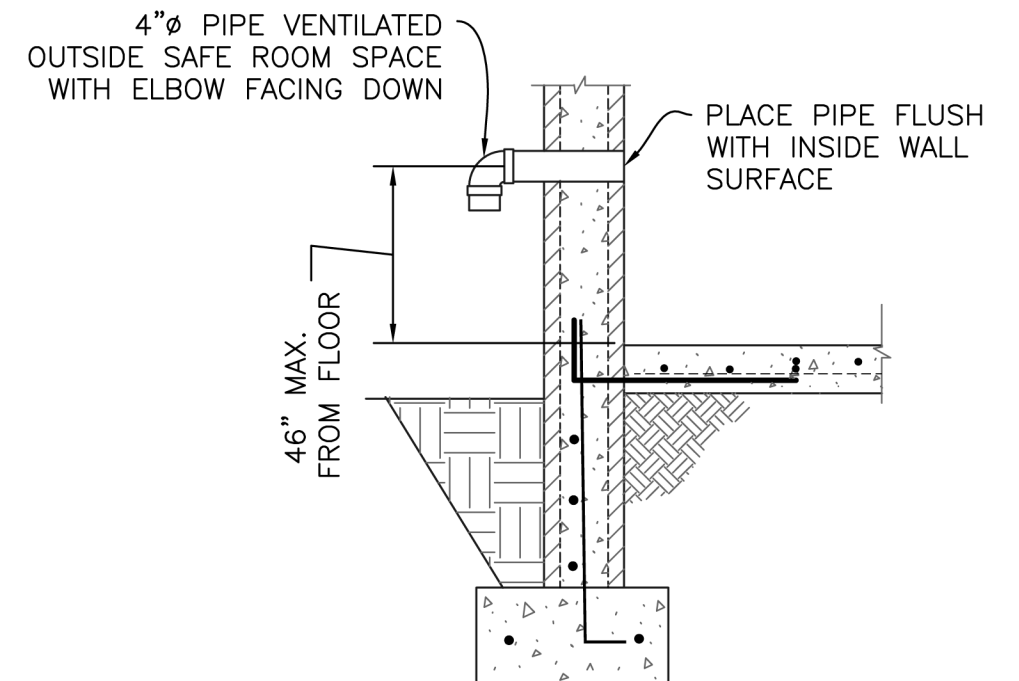
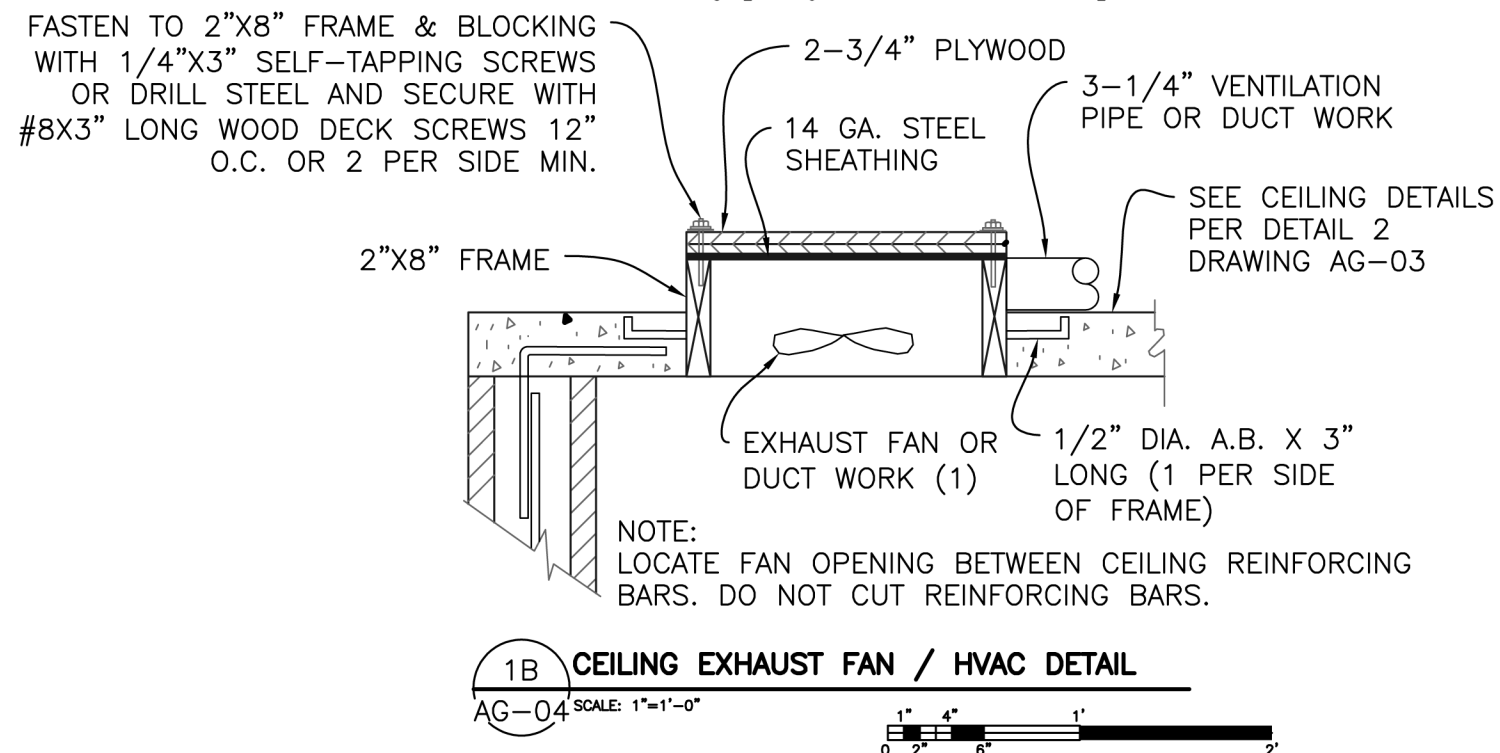
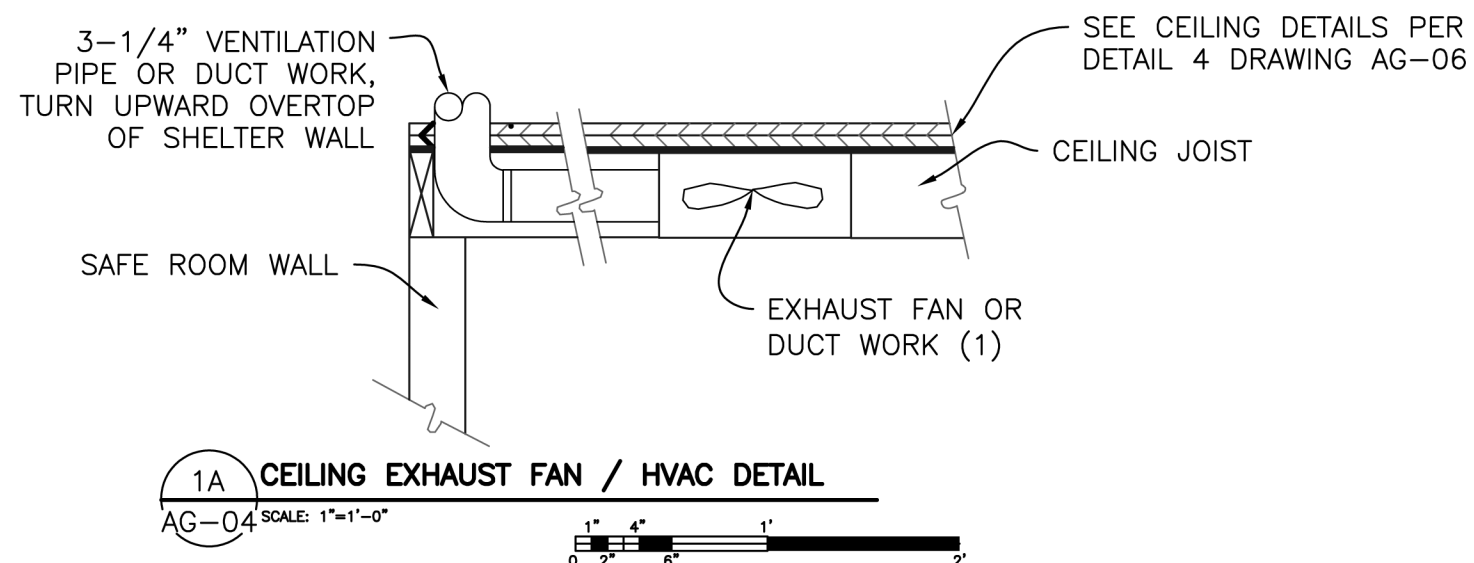
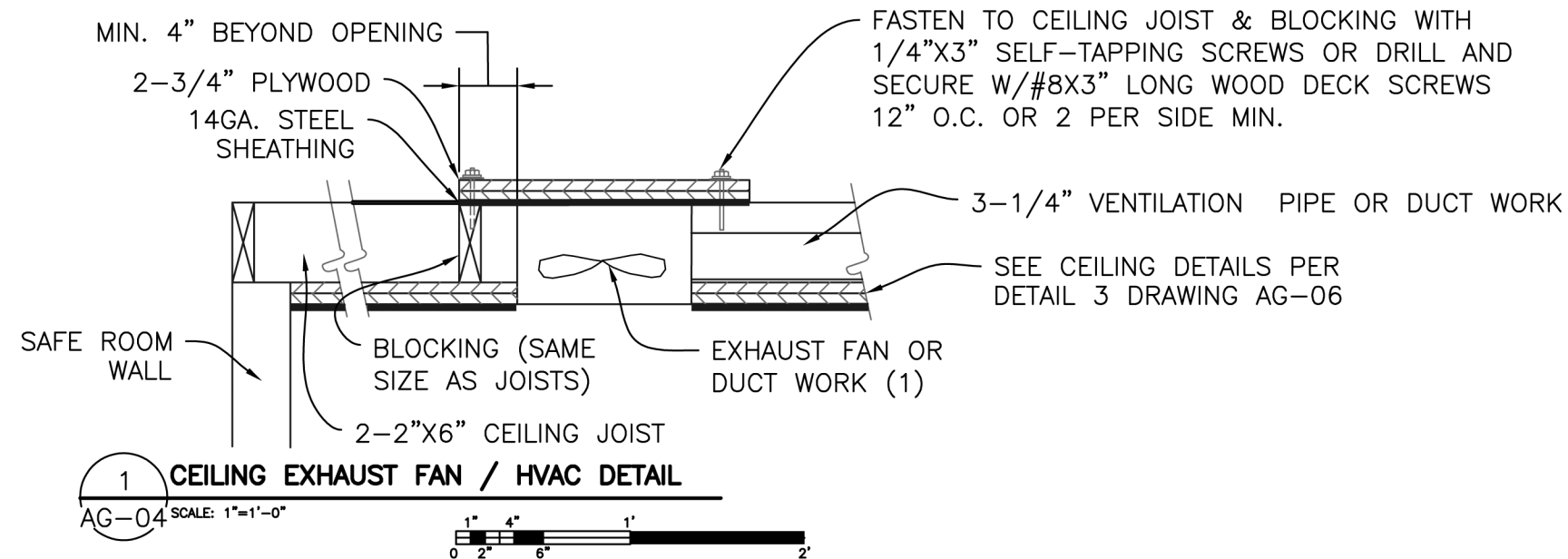
**3 MAXIMUM ALLOWABLE FLOOR ELEVATION FOR SAFE ROOMS**  
 AG-03



**ALTERNATIVE 2 OF 2**  
**TYPICAL WALL / CEILING CONNECTION FOR CONCRETE CEILING**  
 2  
 AG-03 SCALE: 1"=1'-0"

CMU - CONCRETE SECTIONS CEILING ALTERNATIVES	
DRAWING NO: AG-03	SHEET 8 OF 18
DATE: OCTOBER 1998	
REVISED: AUGUST 2008	REV. NO. 2





NOTE:

1. INDICATES NORMAL EXHAUST VENTILATION OF BATHROOM OR HVAC DUCTWORK TO A ROOM. THE SAFE ROOM DESIGN DOES NOT RELY ON THIS VENTILATION TO ENSURE OCCUPANT SAFETY.
2. POWERED EXHAUST FANS ARE ONLY REQUIRED FOR SAFE ROOMS AS BATHROOMS.
3. IF ALTERNATE VENTILATION APPARATUS ARE USED ON THE SAFEROOM, THE DUCTING OF THE VENTILATION MUST BE HARDENED TO PREVENT THE PASSAGE OF WINDBORNE DEBRIS INTO THE SAFEROOM

CMU - CONCRETE SECTIONS CEILING ALTERNATIVES

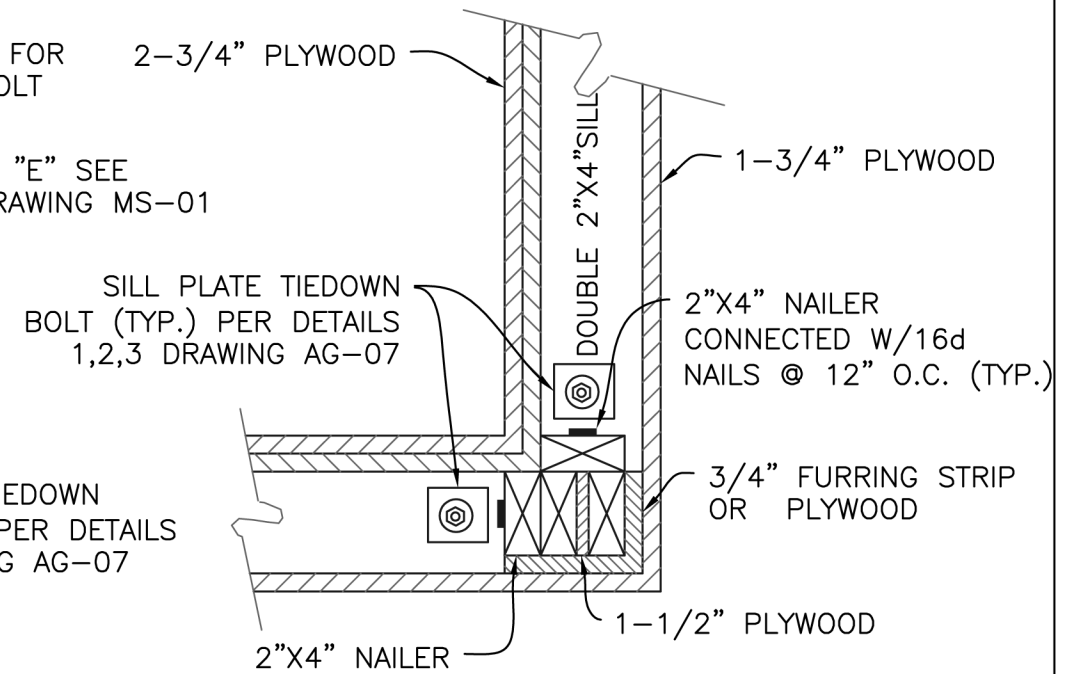
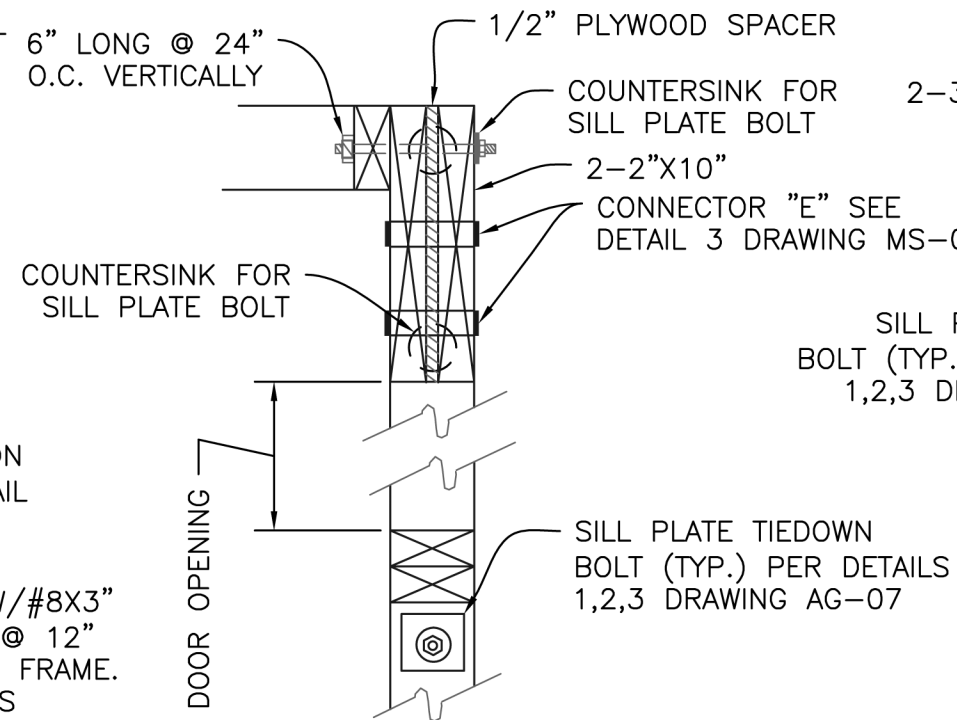
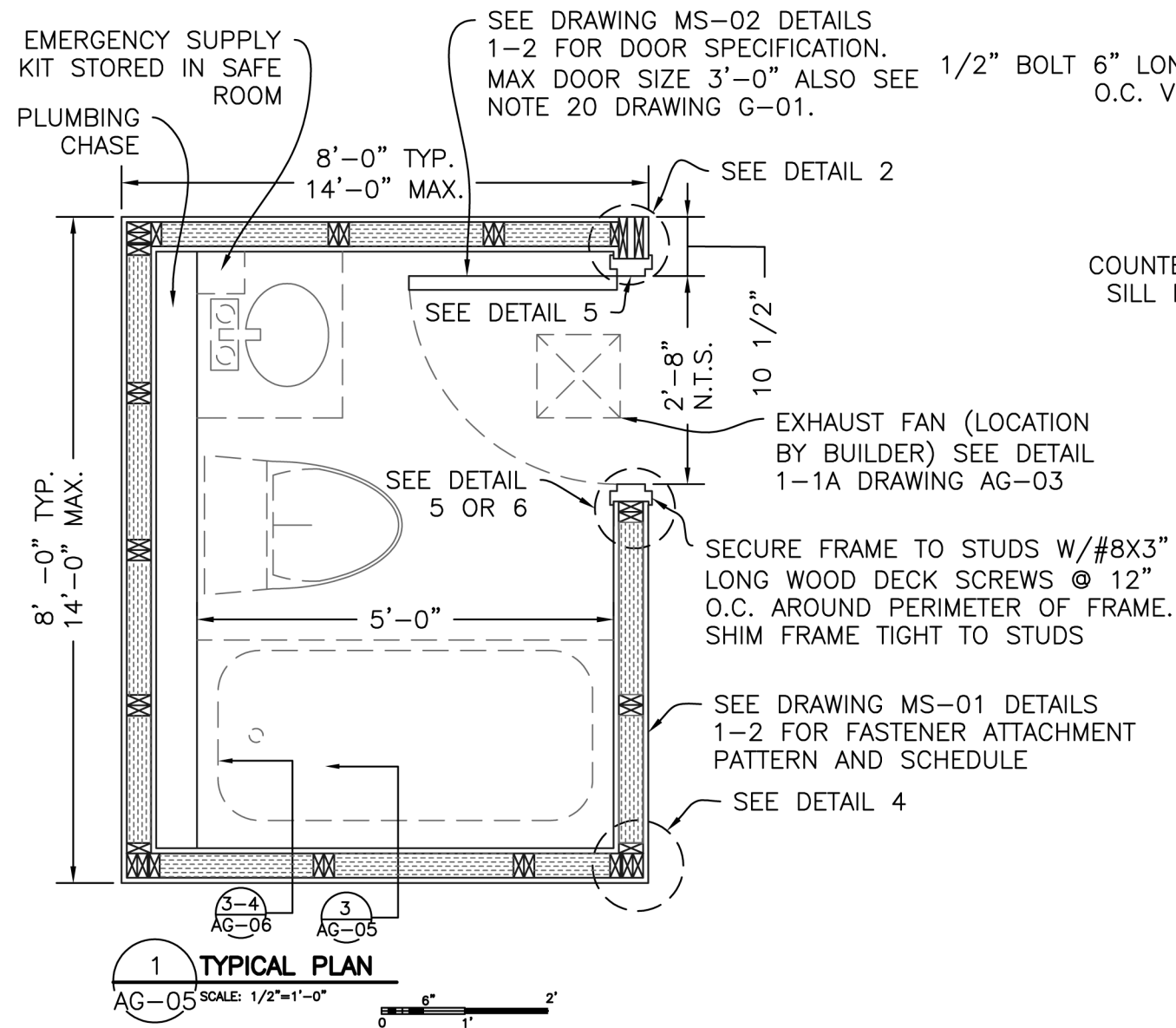
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DATE: OCTOBER 1998

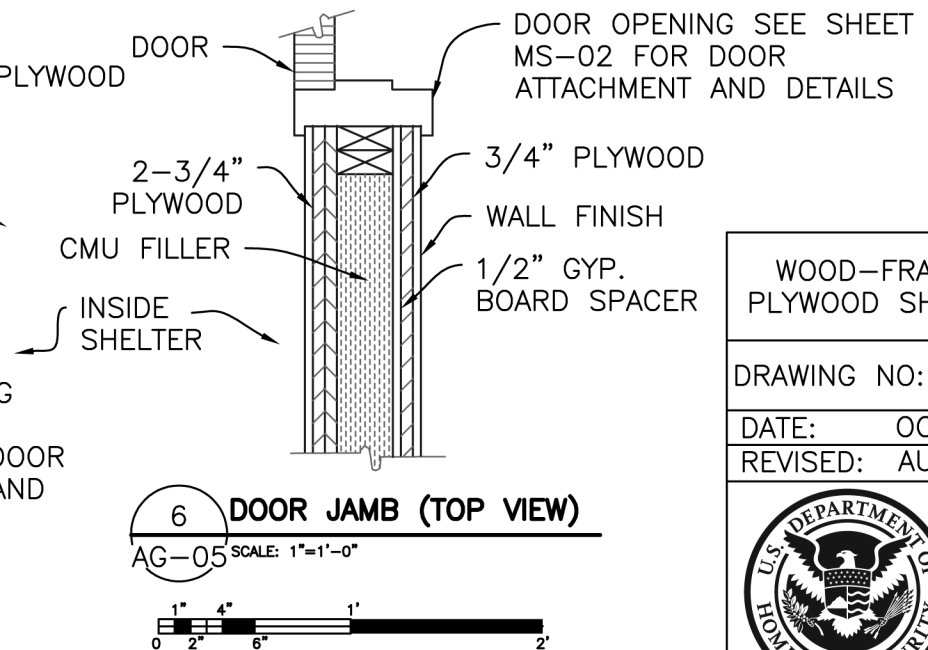
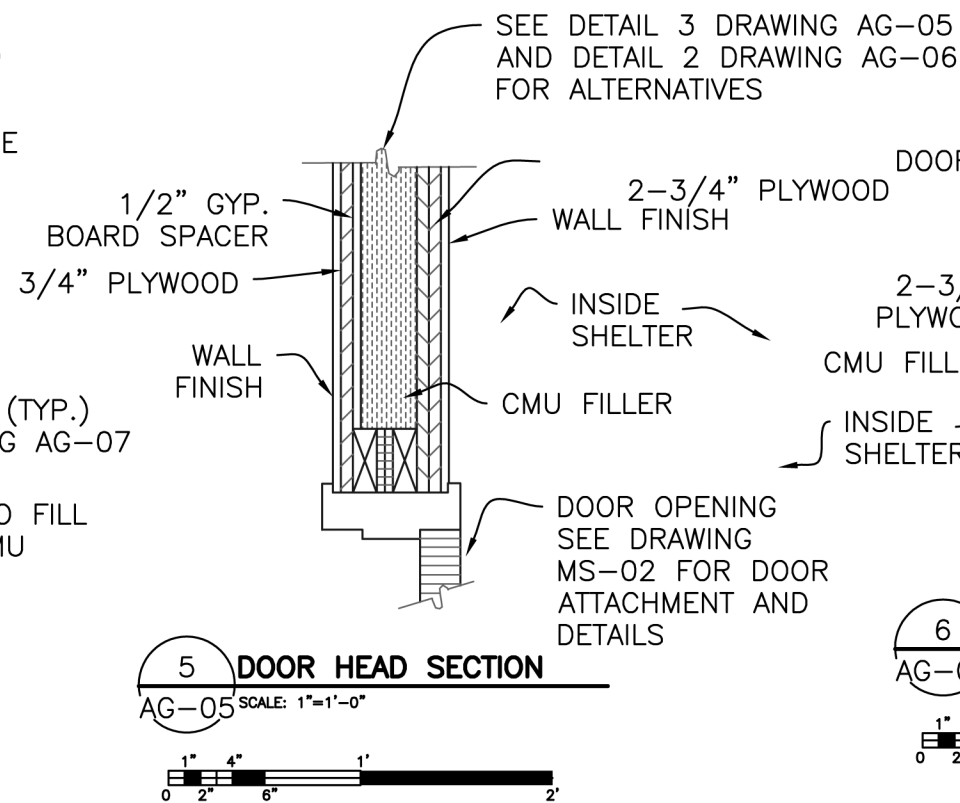
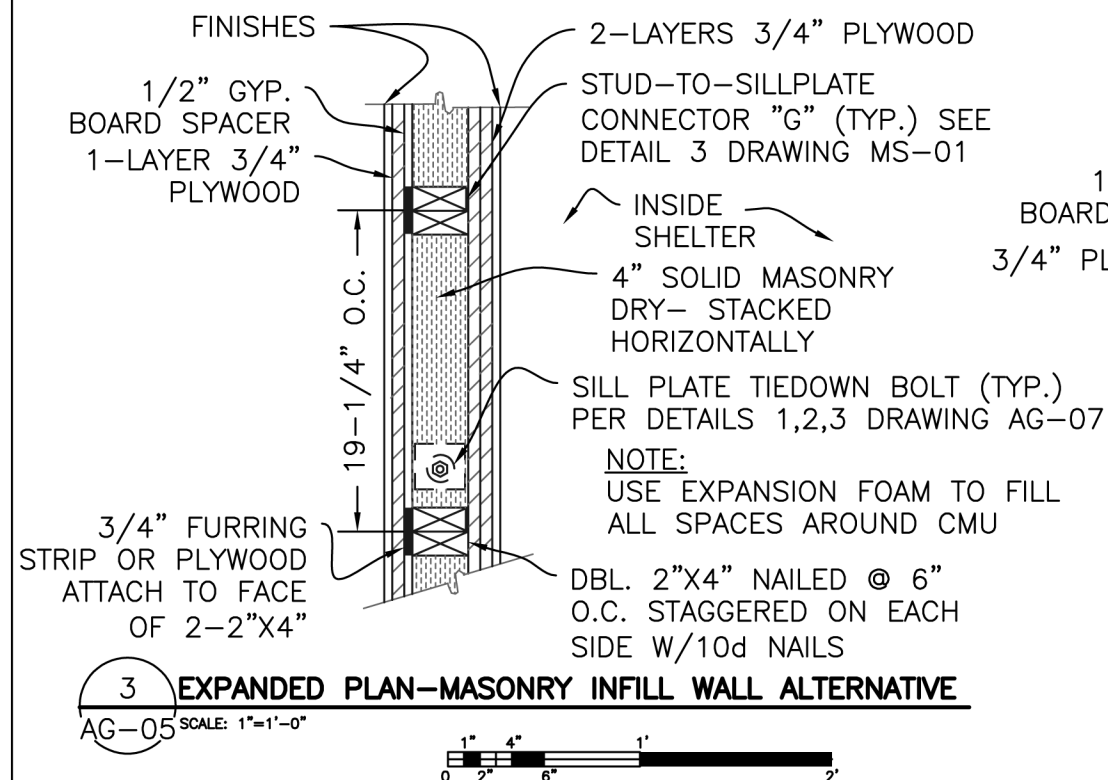
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NOTE:  
ALL WALL STUDS SHOULD BE ATTACHED W/ 2-16d NAILS TO SINGLE TOP AND BOTTOM PLATES, NAILED THROUGH FROM OUTSIDE, PRIOR TO ATTACHMENT OF SECOND TOP AND BOTTOM PLATES.



WOOD-FRAME SAFE ROOM PLAN -  
PLYWOOD SHEATHING WITH CMU INFILL

DRAWING NO: AG-05 SHEET 10 OF 18

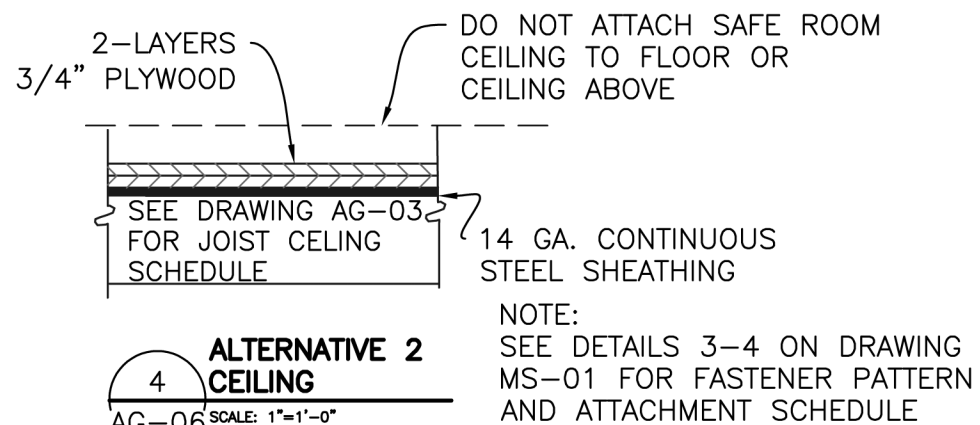
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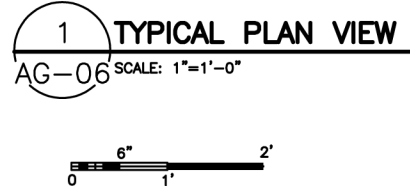
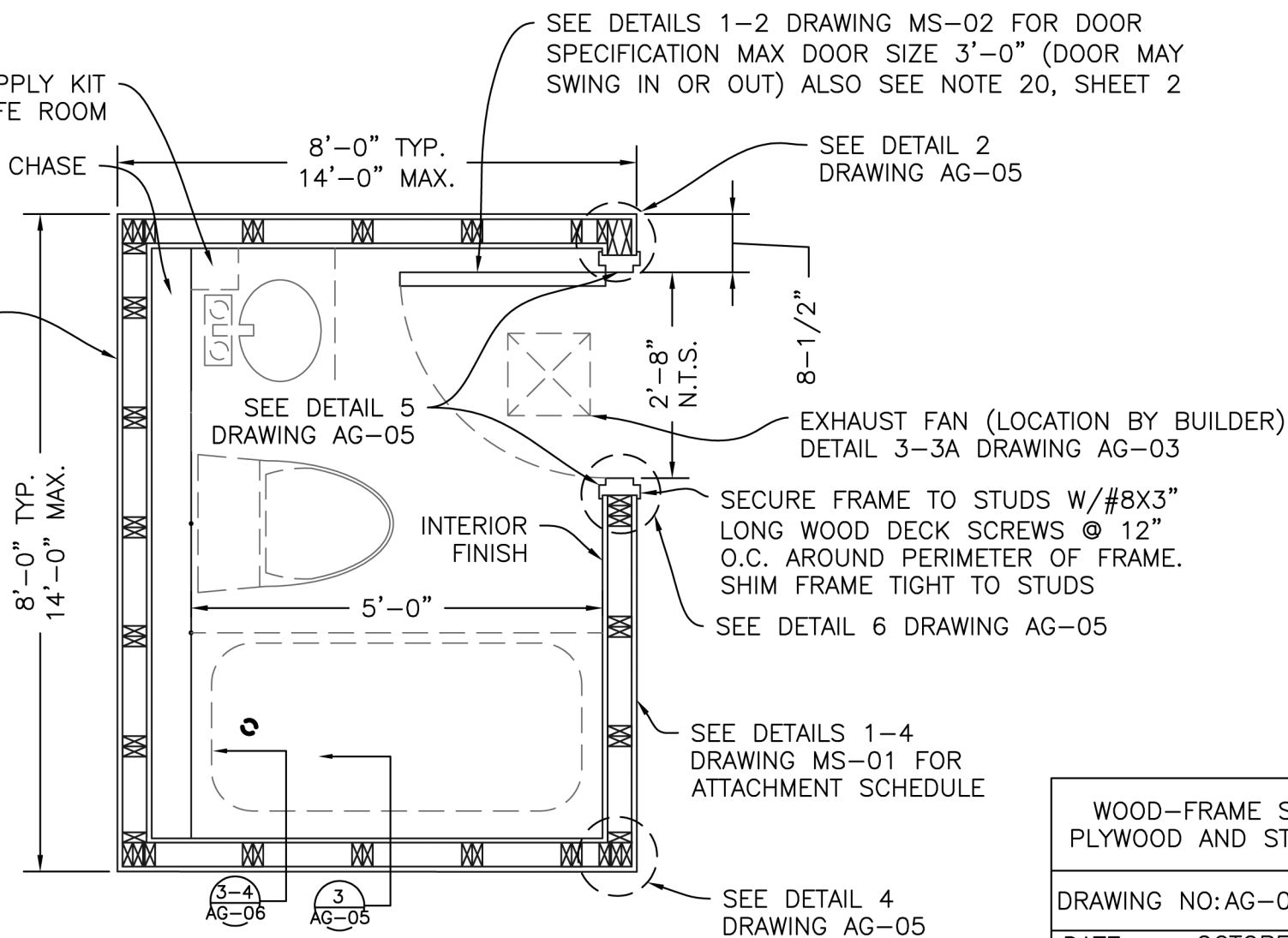
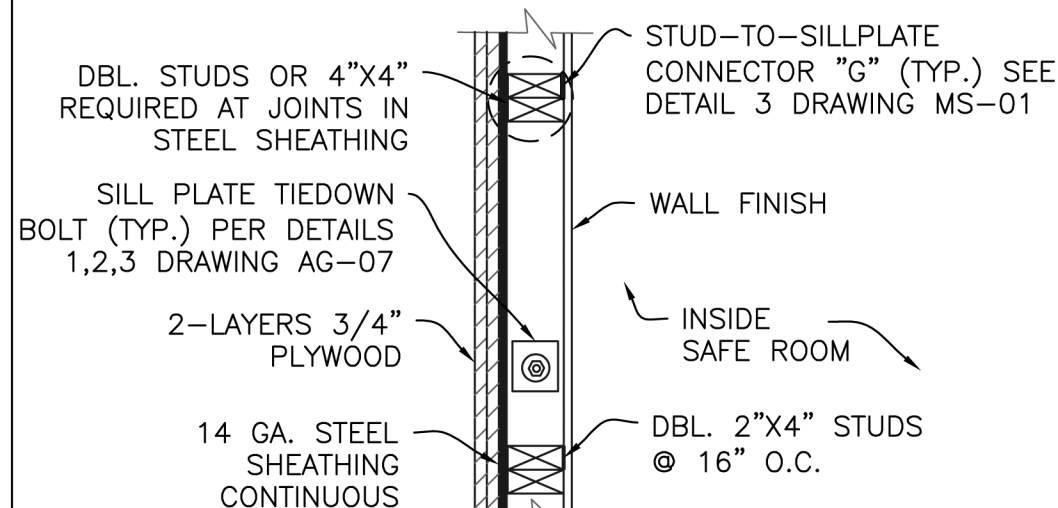
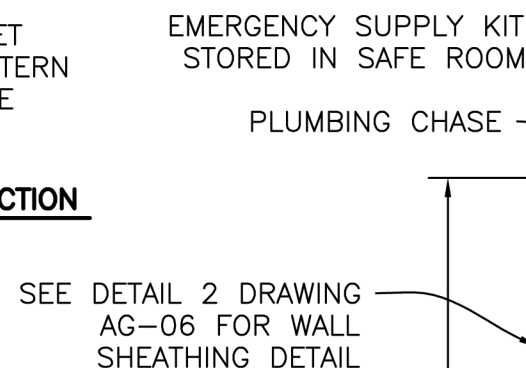


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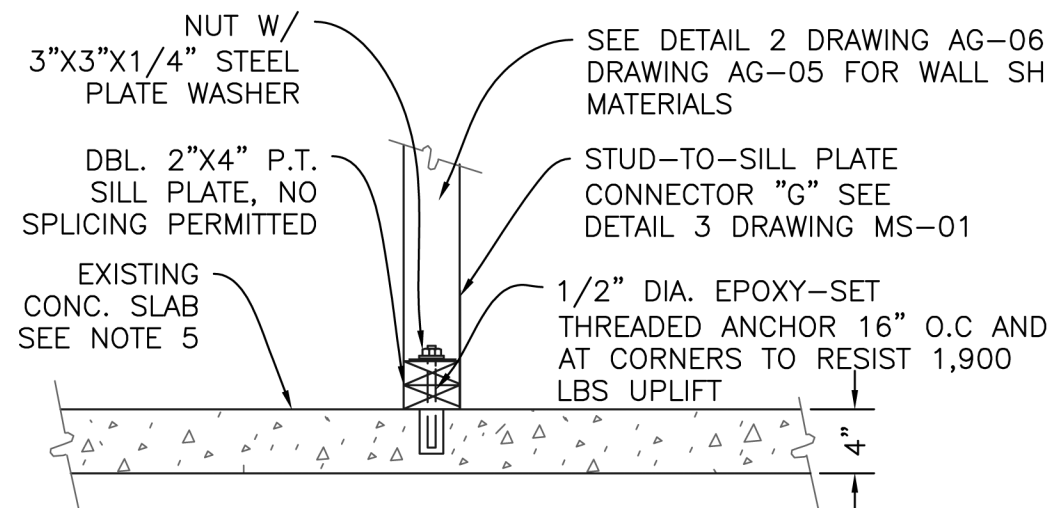
- NOTES:
1. SAFE ROOM W/ STEEL SHEATHING COVERED W/ GYP. BOARD FINISH OR OTHERWISE SEPARATED FROM CONTACT BY SAFE ROOM OCCUPANTS NEED NOT BE GROUNDED.
  2. SAFE ROOM W/ STEEL SHEATHING UNCOVERED AND AVAILABLE FOR CONTACT BY SAFE ROOM OCCUPANTS MUST BE GROUNDED AT A SINGLE LOCATION W/COPPER WIRE & GROUND ROD TO MEET NATIONAL ELECTRIC CODE & LOCAL REQUIREMENTS.
  3. ALL WALL STUDS TO BE ATTACHED W/ (2) 16d NAILS TO SINGLE TOP AND BOTTOM PLATES, NAILED THROUGH FROM TOP AND BOTTOM, PRIOR TO ATTACHMENT OF SECOND TOP AND BOTTOM PLATES.
  4. WALL SHEATHING ORIENTATION TO VARY 90° BY LAYER.



WOOD-FRAME SAFE ROOM PLAN - PLYWOOD AND STEEL WALL SHEATHING		
DRAWING NO:AG-06	SHEET 11 OF 18	
DATE:	OCTOBER 1998	
REVISED:	AUGUST 2008	REV. NO. 2

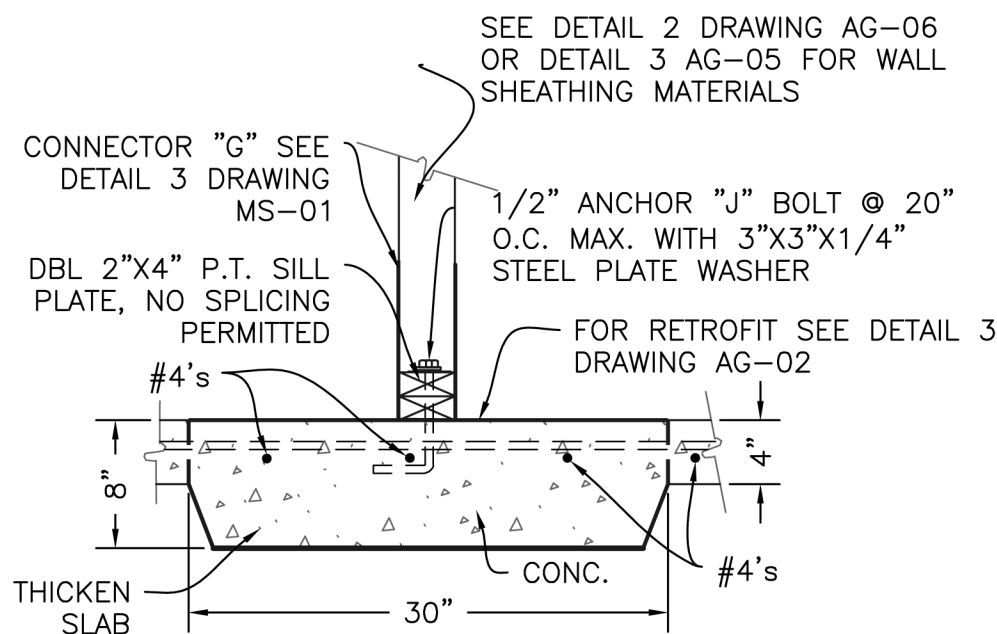


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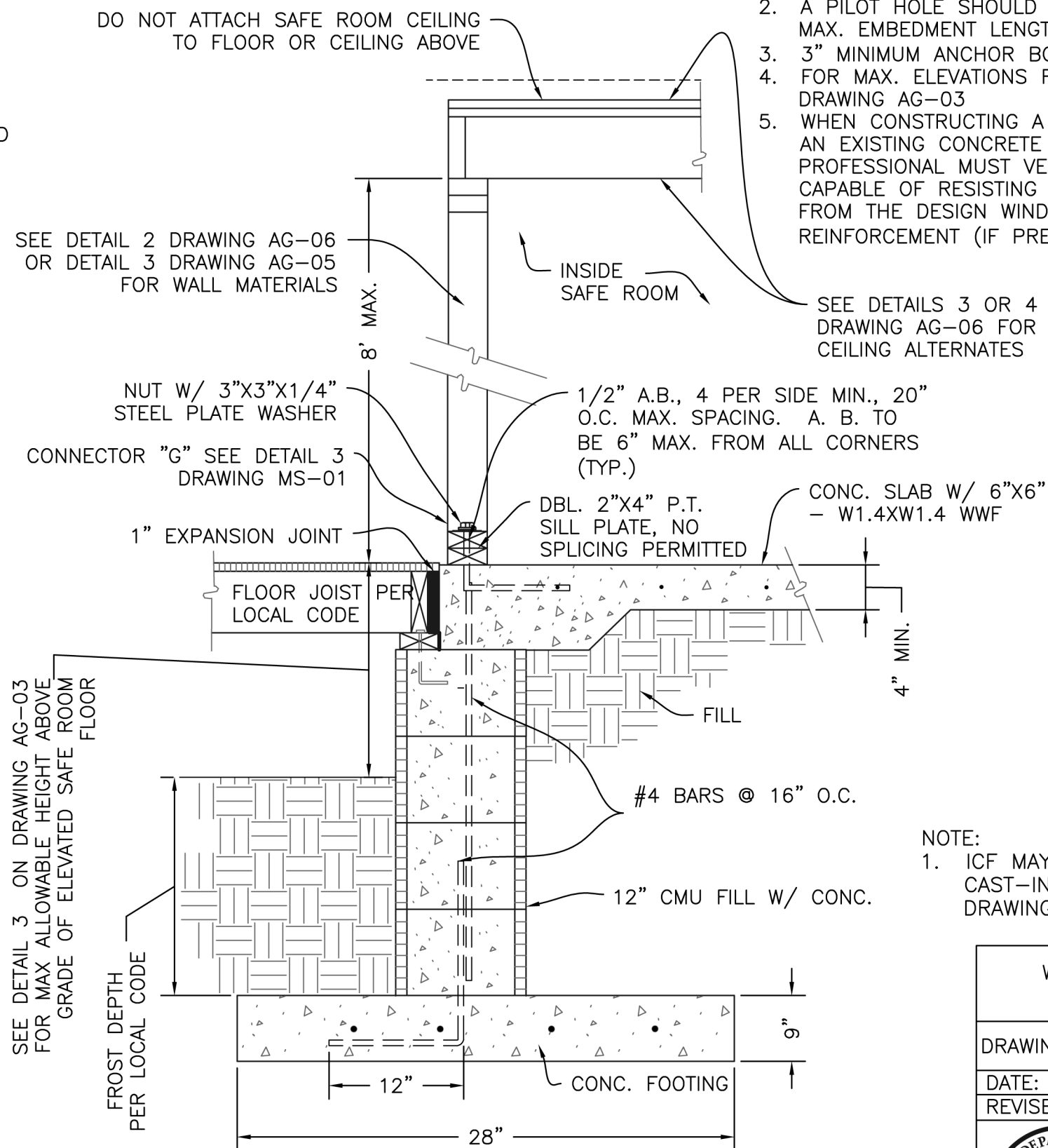


**1**  
**AG-07** **ALTERNATIVE 1 OF 2**  
**TYPICAL HOLD DOWN ANCHOR DETAIL FOR WOOD**  
SCALE: 1"=1'-0"

\* NOTE:  
IF A DIRECT DOWEL FOUNDATION IS TO BE USED, THE OVERALL HEIGHT OF THE SAFE ROOM CANNOT EXCEED THE SHORTEST PLAN DIMENSION BY 10%. (I.E. IF THE SHELTER MEASURES 8'x6' IN PLAN DIMENSION, THE MAXIMUM OVERALL HEIGHT OF THE SHELTER IS 6'-7").



**2**  
**AG-07** **ALTERNATIVE 2 OF 2**  
**TYPICAL ANCHOR DETAIL NEW SLAB-ON-GRADE FOUNDATION WITH WOOD WALLS**  
SCALE: 1"=1'-0"



**3**  
**AG-07** **ANCHOR DETAIL FOR CRAWLSPACE FOUNDATION WITH WOOD WALLS**  
SCALE: 1"=1'-0"

**NOTES:**

1. TO OBTAIN FULL A.B. PULLOUT RESISTANCE, THE BOTTOM OF THE DRILLED HOLE FOR A.B. SHOULD BE NO CLOSER THAN 1/2" TO THE BOTTOM OF THE CONC. SLAB.
2. A PILOT HOLE SHOULD BE DRILLED TO DETERMINE THE MAX. EMBEDMENT LENGTH.
3. 3" MINIMUM ANCHOR BOLT EMBEDMENT DEPTH
4. FOR MAX. ELEVATIONS FOR SAFE ROOMS SEE DETAIL 3 DRAWING AG-03
5. WHEN CONSTRUCTING A WOOD-FRAMED SAFE ROOM ON AN EXISTING CONCRETE SLAB, A REGISTERED DESIGN PROFESSIONAL MUST VERIFY THAT THE EXISTING SLAB IS CAPABLE OF RESISTING LOADS IMPARTED ON THE SLAB FROM THE DESIGN WIND LOAD DUE TO ITS WEIGHT AND REINFORCEMENT (IF PRESENT IN THE SLAB).

**NOTE:**

1. ICF MAY BE USED AS ALTERNATIVE TO CAST-IN-PLACE CONCRETE, SEE DRAWINGS AG-08 AND AG-09.

WOOD-FRAME SAFE ROOM -  
FOUNDATION SECTIONS

DRAWING NO:AG-07 SHEET 12 OF 18

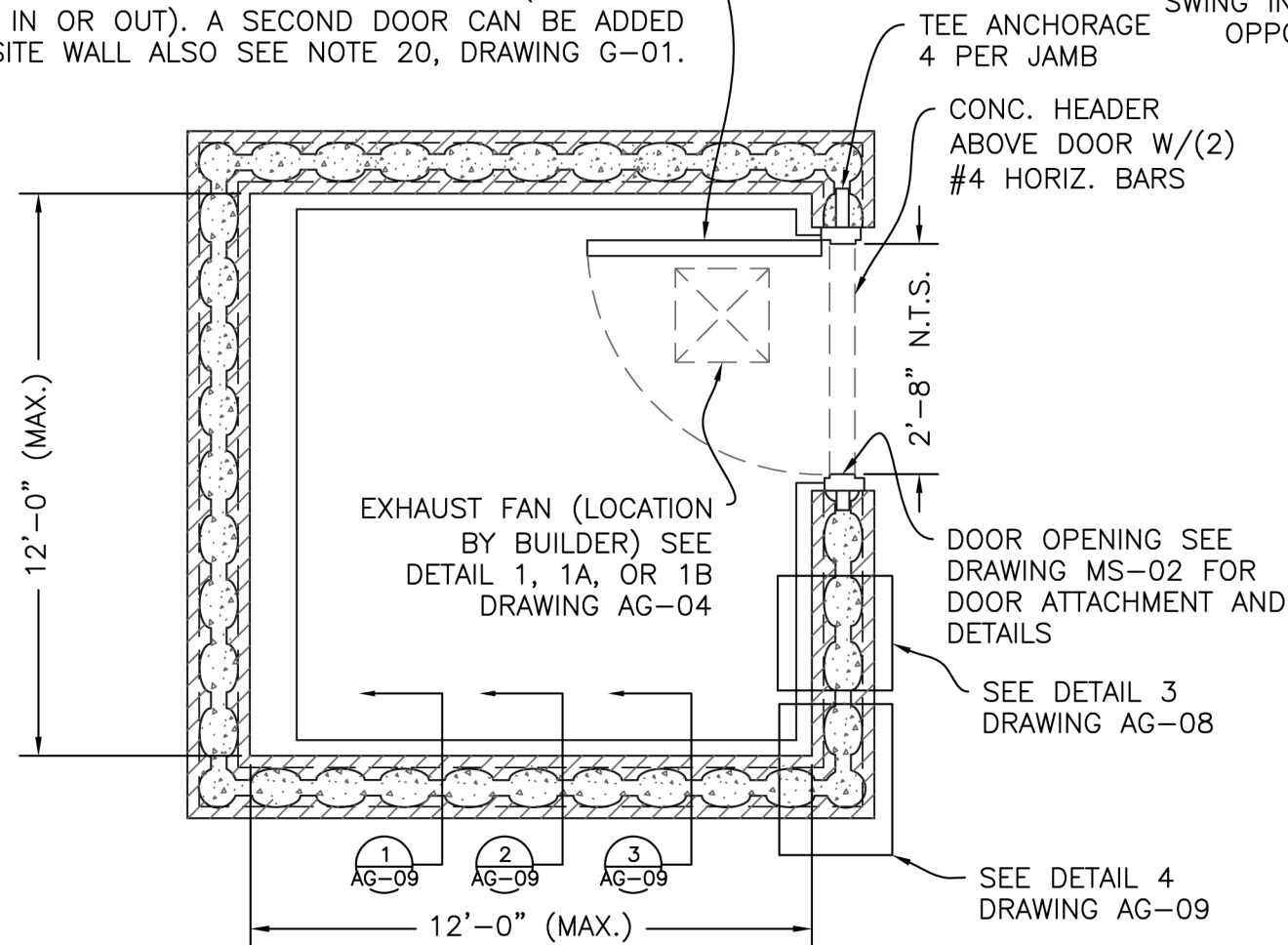
DATE: OCTOBER 1998

REVISED: AUGUST 2008 REV. NO. 2



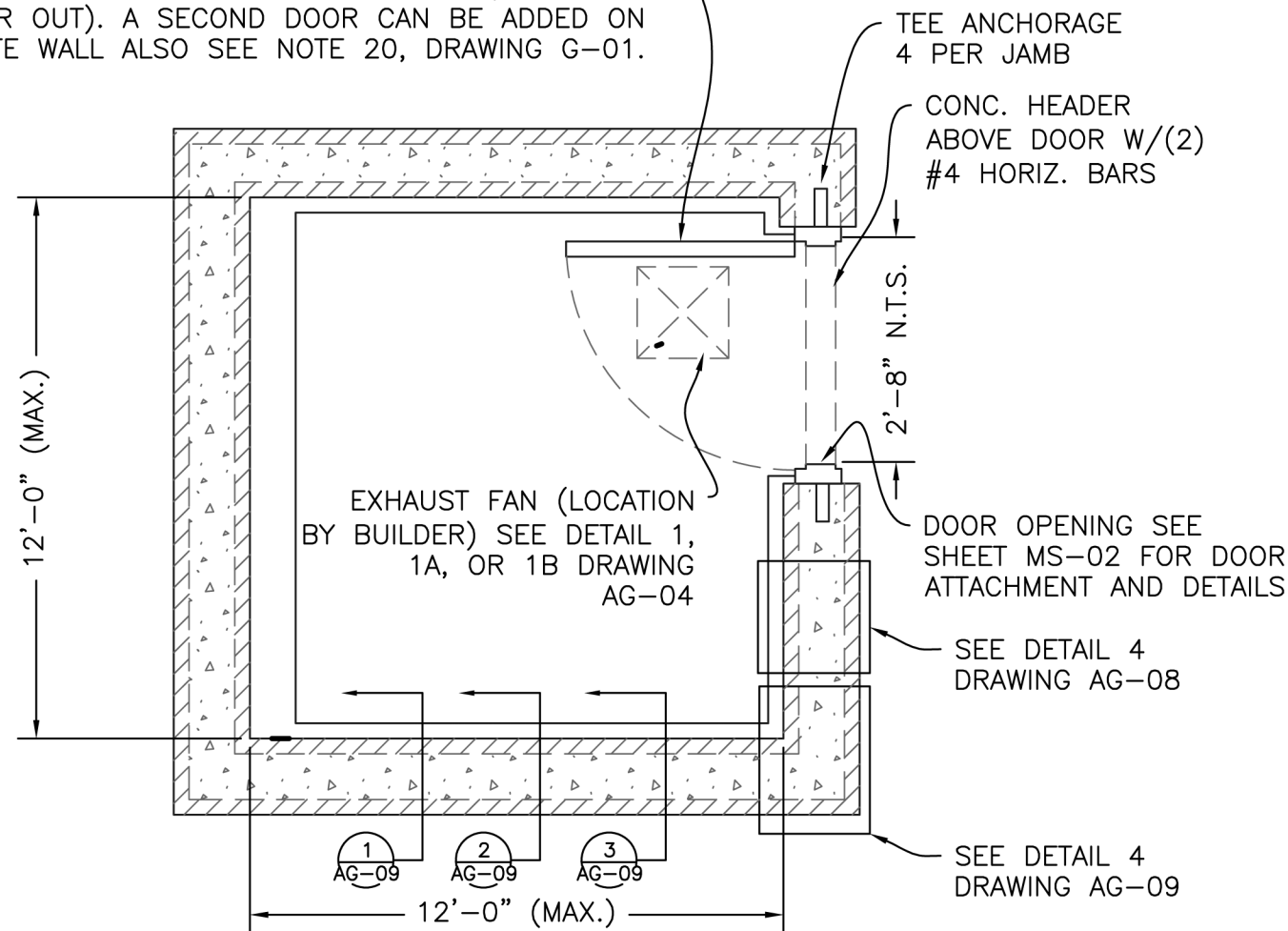
**FEMA**

SEE DETAILS 1 OR 2 DRAWING MS-02 FOR DOOR SPECIFICATION. MAX. DOOR SIZE 3'-0" (DOOR MAY SWING IN OR OUT). A SECOND DOOR CAN BE ADDED ON OPPOSITE WALL ALSO SEE NOTE 20, DRAWING G-01.



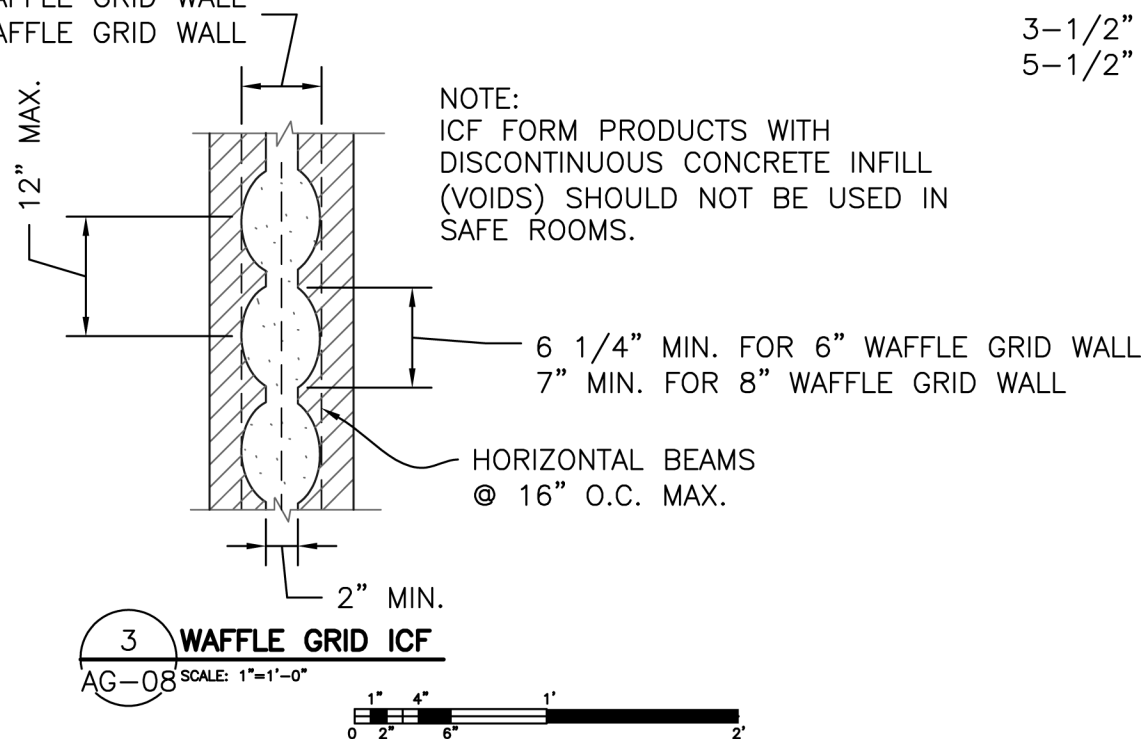
1 Waffle Grid ICF System Plan  
AG-08 SCALE: 1/2"=1'-0"

SEE DETAILS 1 OR 2 DRAWING MS-02 FOR DOOR SPECIFICATION. MAX. DOOR SIZE 3'-0" (DOOR MAY SWING IN OR OUT). A SECOND DOOR CAN BE ADDED ON OPPOSITE WALL ALSO SEE NOTE 20, DRAWING G-01.



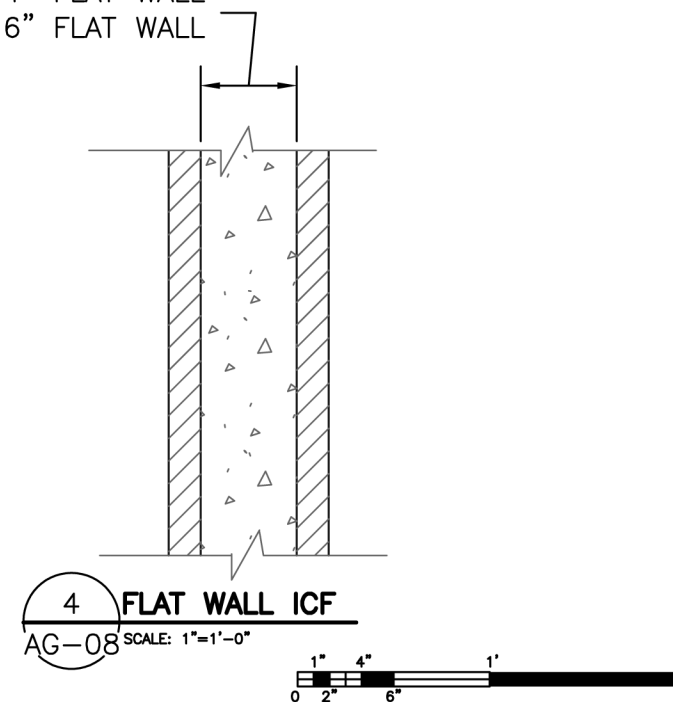
2 Flat Wall ICF System Plan  
AG-08 SCALE: 1/2"=1'-0"

5" MIN. FOR 6" WAFFLE GRID WALL  
7" MIN. FOR 8" WAFFLE GRID WALL



3 Waffle Grid ICF  
AG-08 SCALE: 1"=1'-0"

3-1/2" MIN. FOR 4" FLAT WALL  
5-1/2" MIN. FOR 6" FLAT WALL



4 Flat Wall ICF  
AG-08 SCALE: 1"=1'-0"

INSULATING CONCRETE FORM PLANS

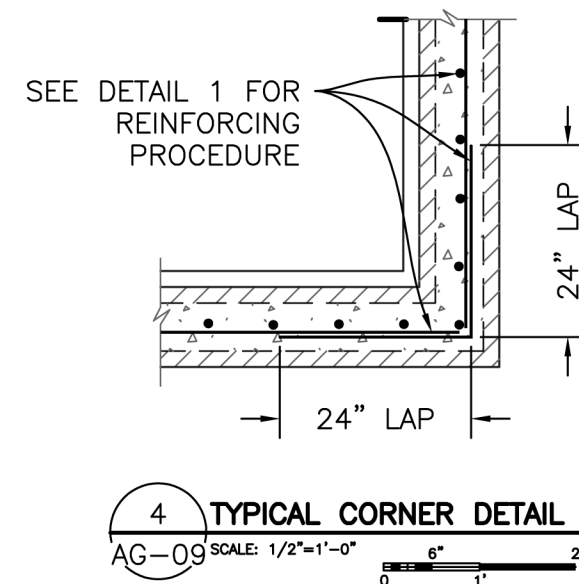
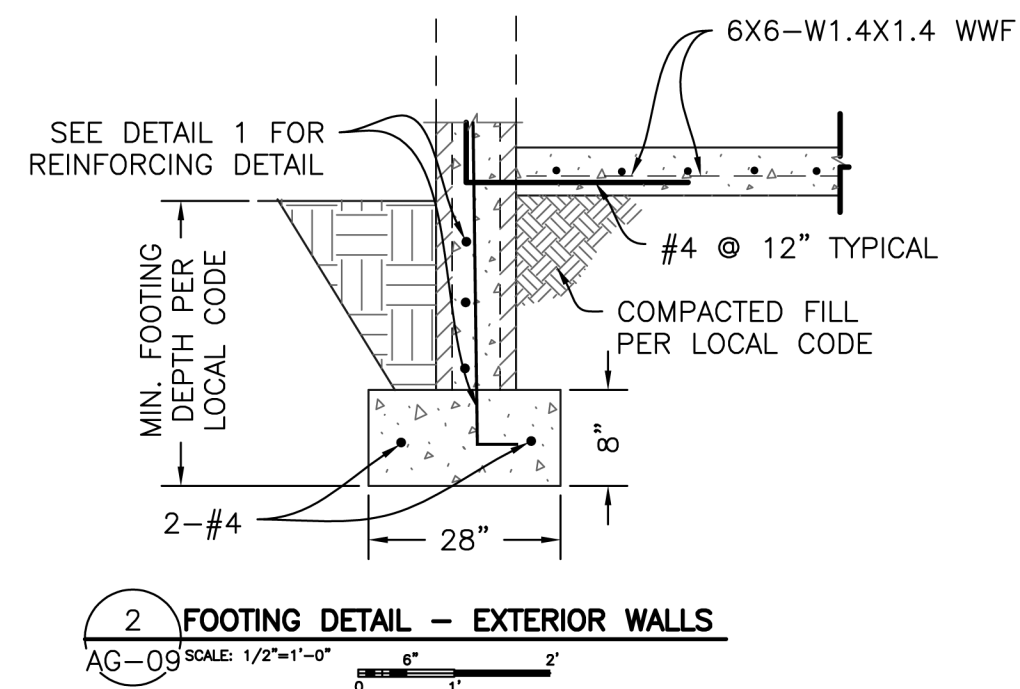
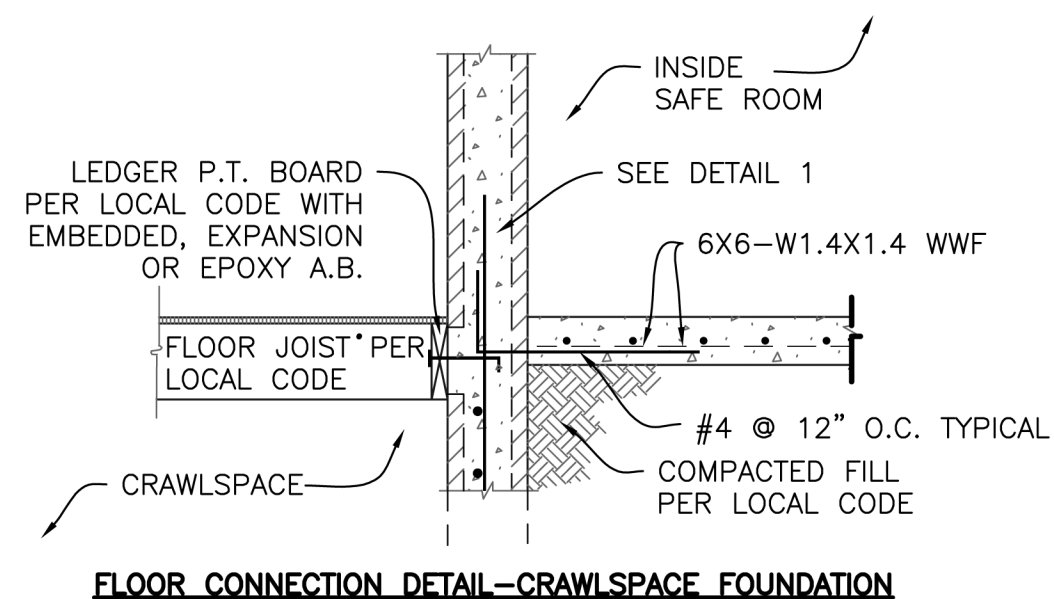
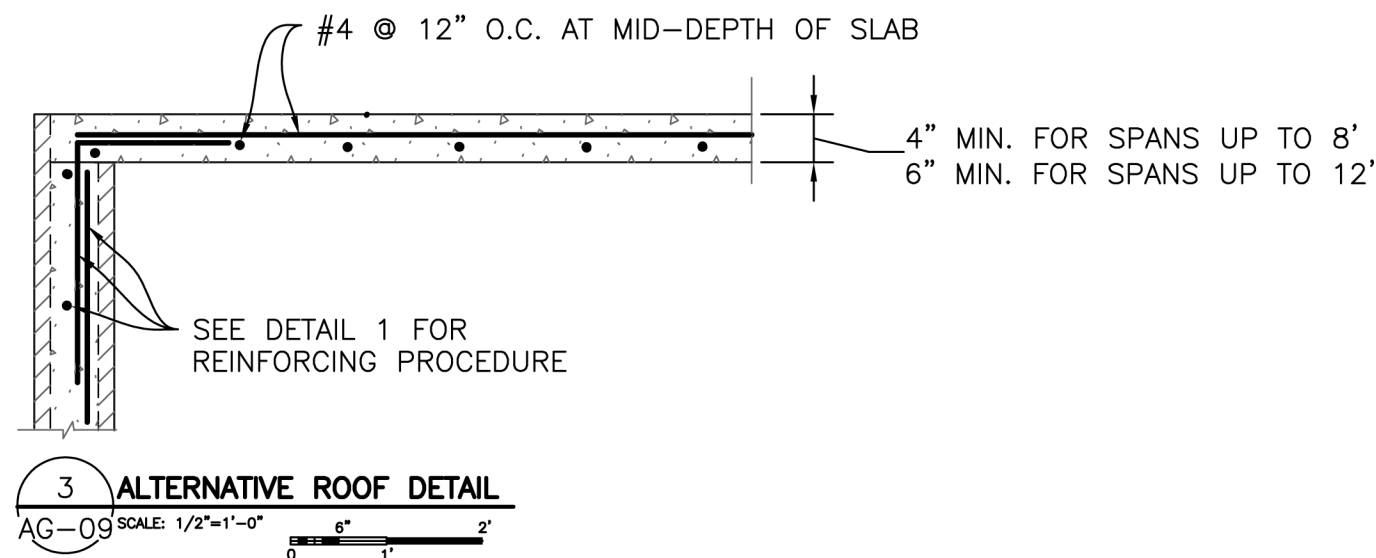
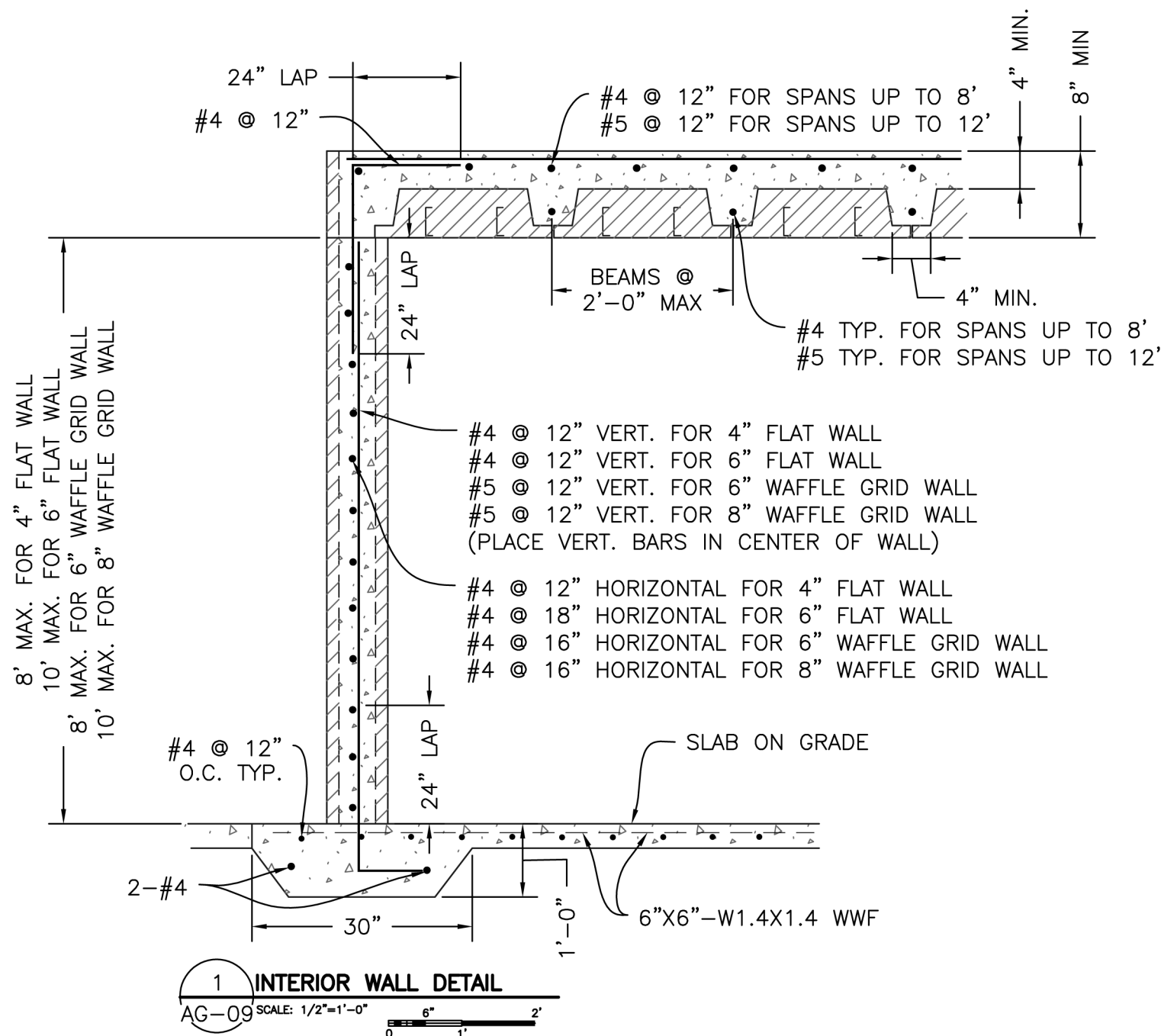
DRAWING NO: AG-08 SHEET 13 OF 18

DATE: AUGUST 1999

REVISED: AUGUST 2008 REV. NO. 2



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INSULATING CONCRETE FORM SECTIONS

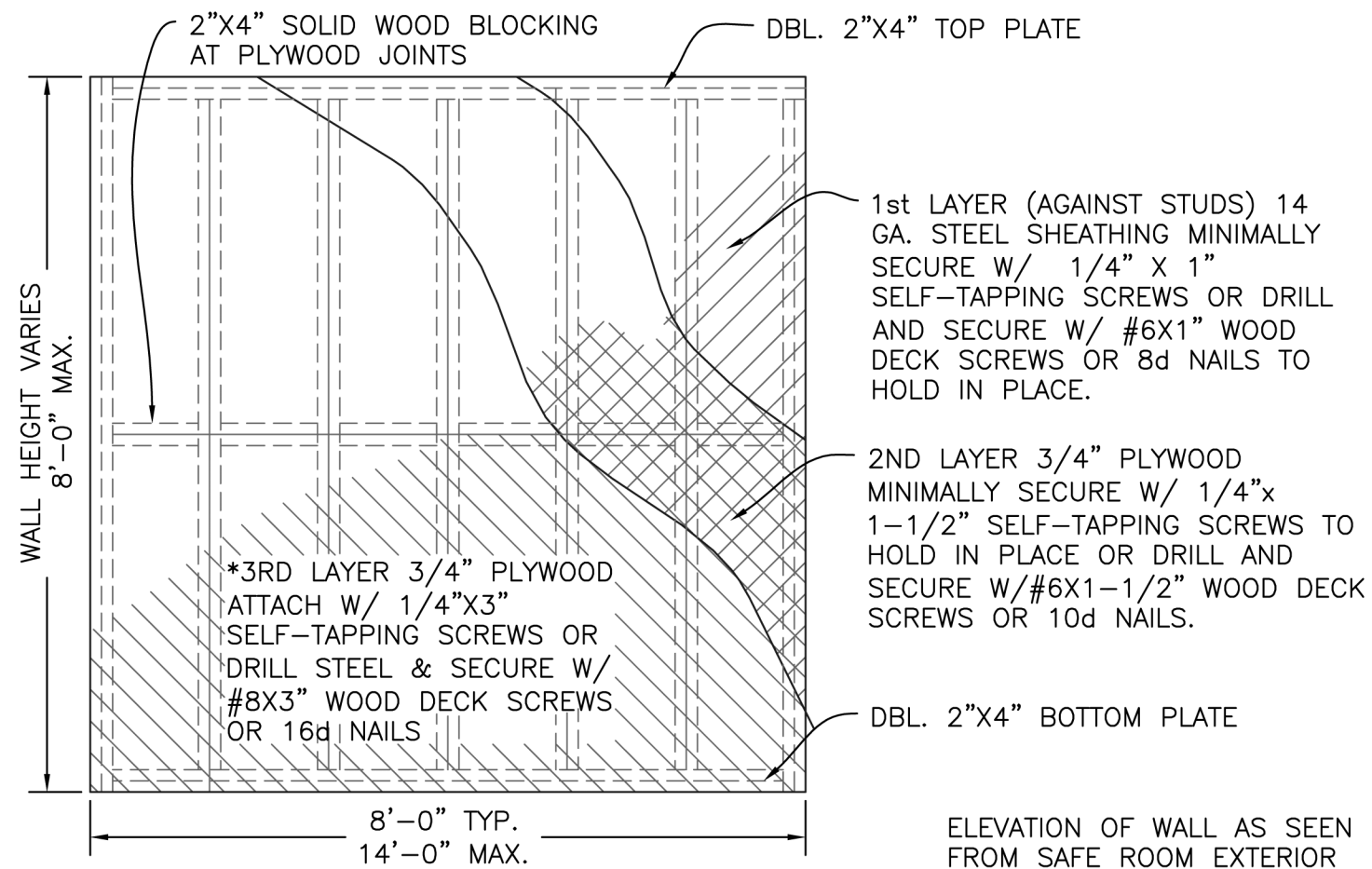
DRAWING NO: AG-09 SHEET 14 OF 18

DATE: AUGUST 1999

REVISED: AUGUST 2008 REV. NO. 2

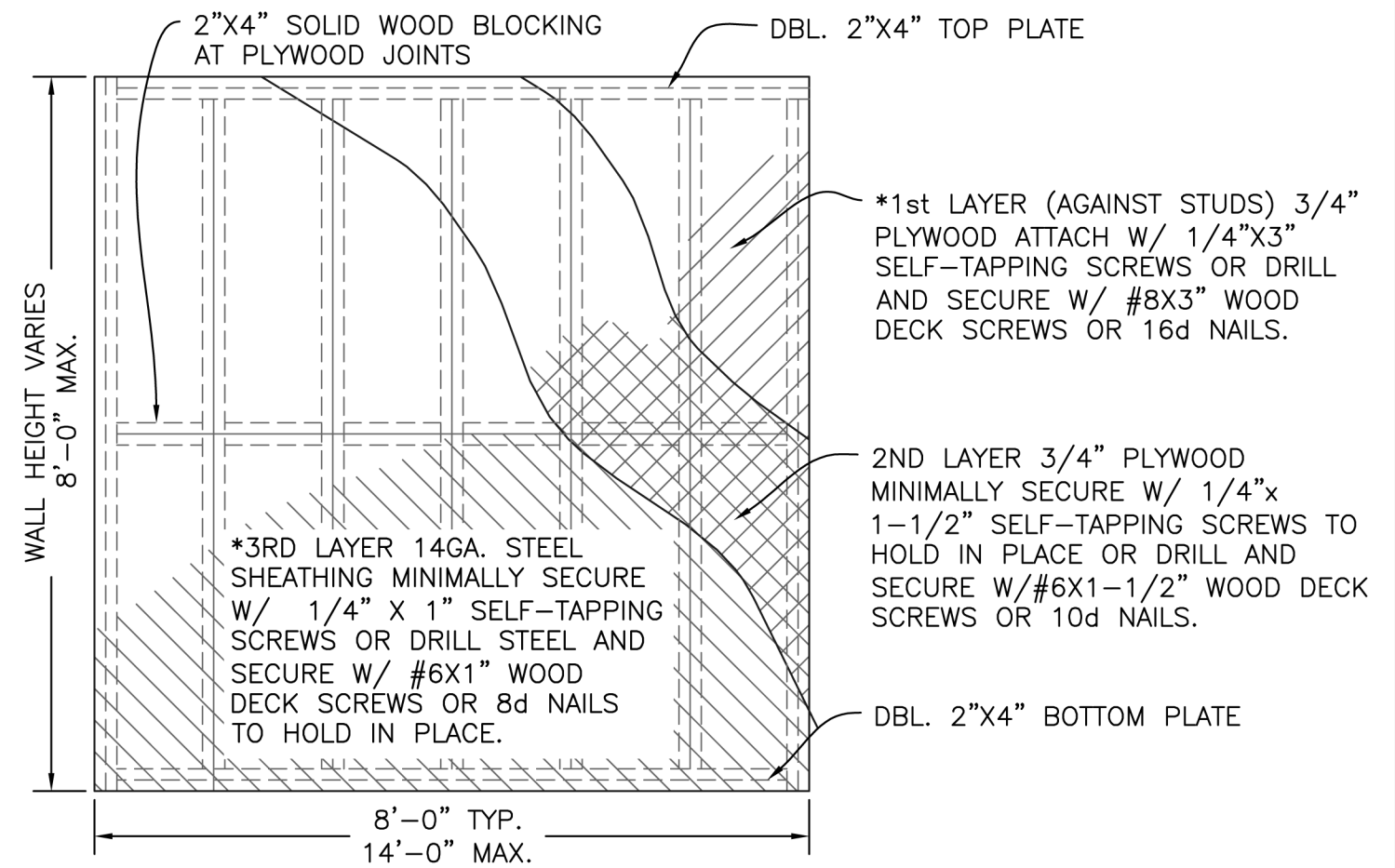


FEMA



1 PLYWOOD SHEATHING ATTACHMENT PATTERN FOR SAFE ROOMS WITH PROTECTION LAYERS ON EXTERIOR

MS-01 SCALE: 1/2"=1'-0" 0 6" 1' 2'



2 PLYWOOD SHEATHING ATTACHMENT PATTERN FOR SAFE ROOMS WITH PROTECTION LAYERS ON INTERIOR

MS-01 SCALE: 1/2"=1'-0" 0 6" 1' 2'

LOCATION	REQUIRED UPLIFT CAPACITY (LBS)	SIMPSON STRONG-TIE	UNITED STEEL PRODUCTS
A	375	H3	RT3
B	375	H3	RT3
C	1,700	2-MTS12	2-MTW12
D	1,900	HHETA16	2-MTA12
E	1,000	SPH4	SPTH4
F	1,700	LGT2	LUGT2
G	1,700	2-SPH4	2-SPTH4
H	1,700	HHETA 16 OR PAI23	2-HTA12

WALL LENGTH	16d NAILS	#8X3" WOOD DECK SCREWS	1/4" X 3" SELF TAPPING SCREWS
3'-6" TO 5'-0"	2" O.C. @ EDGES 6" O.C. IN FIELD	2" O.C. @ EDGES 6" O.C. IN FIELD	3" O.C. @ EDGES 6" O.C. IN FIELD
5'-1" TO 7'-0"	3" O.C @ EDGES 6" O.C. IN FIELD	3" O.C @ EDGES 6" O.C. IN FIELD	4" O.C @ EDGES 6" O.C. IN FIELD
7'-1" TO 14'-0"	4" O.C. @ EDGES 6" O.C. IN FIELD	4" O.C. @ EDGES 6" O.C. IN FIELD	6" O.C. @ EDGES 6" O.C. IN FIELD

4 ATTACHMENT SCHEDULE MS-01

NOTES:  
BECAUSE NOT ALL CONTRACTORS ARE FAMILIAR WITH THE TYPE OF STRUCTURAL CONNECTORS SHOWN IN THESE DRAWINGS, THE NAMES OF TWO COMPANIES THAT MANUFACTURE CONNECTORS HAVE BEEN INCLUDED IN THIS TABLE. THE LIST OF COMPANIES IS NOT, HOWEVER, EXHAUSTIVE. ADDITIONALLY, THIS LIST IS NOT INTENDED TO EXPRESS A PREFERENCE FOR THOSE MANUFACTURERS AND/OR THEIR PRODUCTS BY THE UNITED STATES GOVERNMENT NOR IS IT AN ENDORSEMENT OF THOSE MANUFACTURERS AND/OR THEIR PRODUCTS.

3 CONNECTOR SCHEDULE MS-01

NOTES:

1. ATTACHMENT SCHEDULE VARIES BASED ON WALL LENGTH SEE DETAIL 4 FOR ATTACHMENT SCHEDULE ON DRAWING MS-01.
2. PROTECTION LAYERS ARE TO BE INSTALLED ALTERNATING THE LONG AXIS OF THE MATERIAL FROM HORIZONTAL TO VERTICAL TO HORIZONTAL OR VERTICAL TO HORIZONTAL TO VERTICAL.
3. MINIMUM UNBROKEN WALL LENGTH IS 3'-6".

MISCELLANEOUS DETAILS

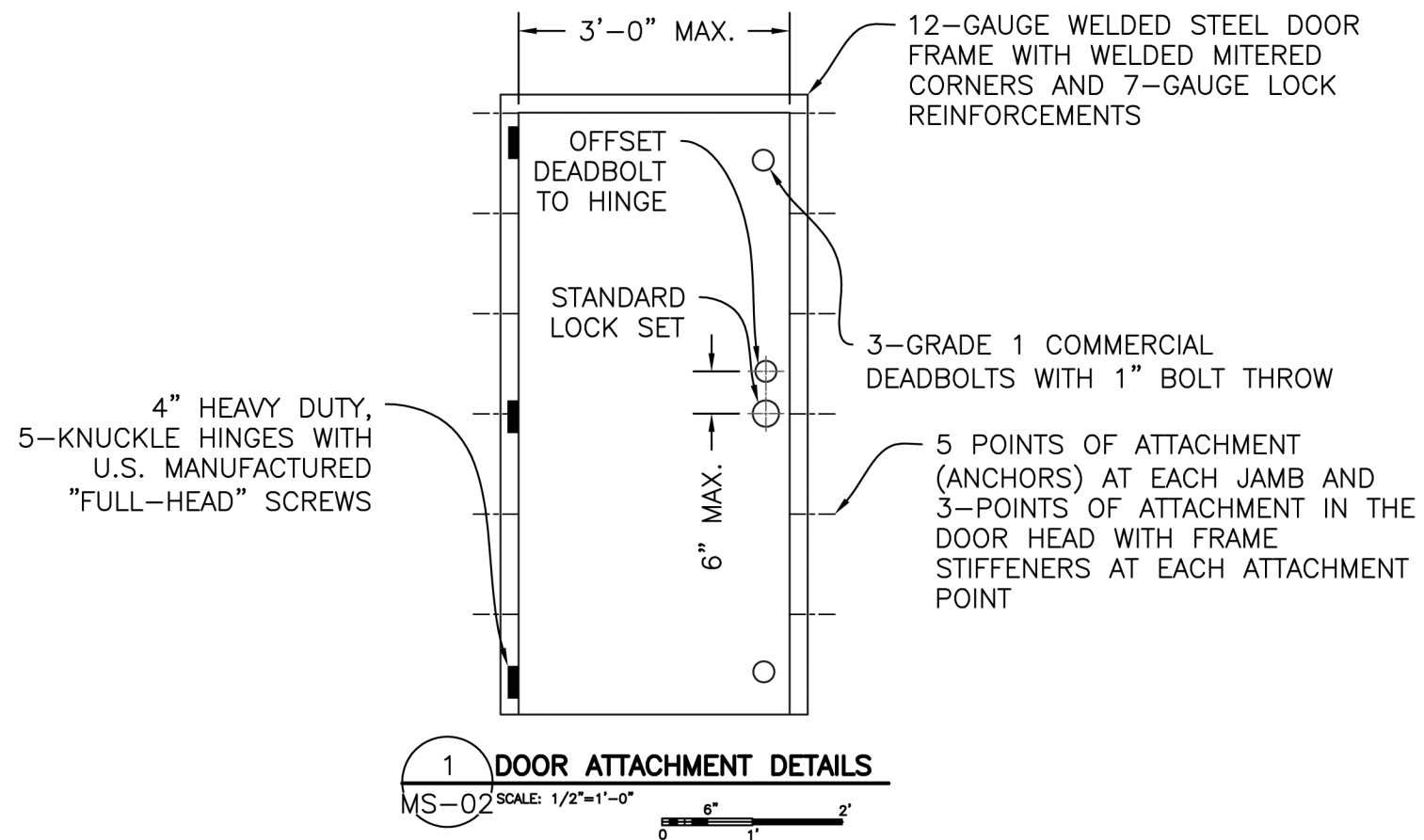
DRAWING NO:MS-01 SHEET 15 OF 18

DATE: OCTOBER 1998

REVISED: AUGUST 2008 REV. NO. 2

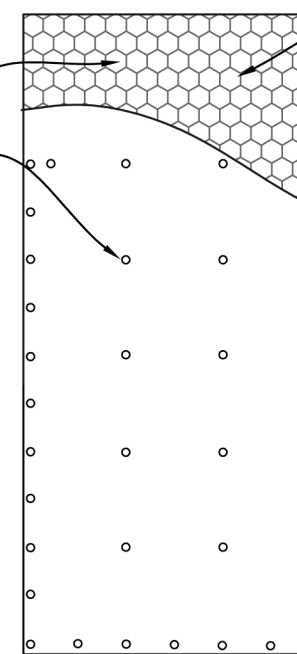


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14\* OR 12 ++GA. STEEL SHEATHING\*

NOTE:  
DOORS CAN BE EITHER  
14 GA. SKIN OR 12 GA.  
SKIN. SEE CONSTRUCTION  
DETAILS BELOW FOR  
CLARIFICATION.



\*STEEL DOOR 14 GA. SKIN  
W/ HONEYCOMB CORE

ALTERNATIVE DOOR:  
12 GA. SKIN W/20 GA. METAL  
RIBS, HONEYCOMB CORE OR  
POLYSTYRENE IN-FILL (NO EXTRA  
ARMOR PLATING REQUIRED)  
ATTACH SKIN PER 14 GA. SKIN  
DOOR SPECIFICATIONS BELOW.

\*CONSTRUCTION OF 14 GA. SKIN DOOR AS FOLLOWS:

1. VERTICAL STEEL STIFFENERS
2. CLOSER REINFORCEMENT
3. 7-GAUGE HINGE REINFORCEMENT
4. REINFORCED LOCK BOXES
5. ADDITIONAL 14 GAUGE SKIN ATTACHED TO DOOR WITH 1/4"x1 1-1/4" SELF TAPPING SCREWS W/ HEXAGON WASHER HEADS SPACED AT 6" O.C. ALONG PERIMETER AND 12" O.C. IN THE FIELD.

++CONSTRUCTION OF 12 GA. SKIN DOOR AS FOLLOWS:

1. 12 GA. VERTICAL STEEL STIFFENERS
2. 12 GA. FULL PERIMETER CHANNEL ALONG THE DOOR EDGES (DOUBLED AT DOOR HEAD)
3. 7 GA. HINGE REINFORCEMENT
4. 7 GA. CLOSER REINFORCEMENT
5. 12 GA. REINFORCED LOCK BOXES
5. ADDITIONAL 12 GAUGE SKIN ATTACHED TO DOOR WITH 1/4"x1 1-1/4" SELF TAPPING SCREWS W/ HEXAGON WASHER HEADS SPACED AT 6" O.C. ALONG PERIMETER AND 12" O.C. IN THE FIELD.

#### RECOMMENDED SIGNAGE CRITERIA (SEE ALSO ICC-500)

1. INSTALL A PLAQUE, SIGN, OR OTHER MARKING TO CLEARLY IDENTIFY:
  - 250 MPH, 3-SECOND GUST SAFE ROOM DESIGN WIND SPEED
  - MISSILE IMPACT RESISTANCE RATING FOR:
    - A. 15-Ib 2X4 TRAVELING HORIZONTALLY AT 100 MPH
    - B. 15-Ib 2X4 TRAVELING VERTICALLY AT 67 MPH
    - C. NAME OF SHELTER MANUFACTURER OR BUILDER
2. THE SIGN SHALL BE MOUNTED ON THE INSIDE WALL OF THE SAFE ROOM IN A PROMINENT LOCATION 60" ABOVE THE FLOOR.

DOOR DETAILS AND SIGNAGE DETAILS

DRAWING NO:MS-02 SHEET 16 OF 18

DATE: OCTOBER 1998

REVISED: AUGUST 2008 REV. NO. 2



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NOTE:  
ALL QUANTITIES SHOWN ARE BASED ON  
AN 8’x8’x8’ SAFE ROOM.  
QUANTITIES MAY VARY BY APPLICATION.

SAFE ROOM:    LEAN–TO

WALL MATERIALS

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
SYP. LUMBER	2" X 4" X 8'	EACH	26	
SYP. LUMBER	2" X 4" X 12'	EACH	2	
P.T. LUMBER	2" X 4" X 8'	EACH	4	
P.T. LUMBER	2" X 6" X 8'	EACH	1	
SYP. LUMBER	2" X 8" X 8'	EACH	1	
SYP. LUMBER	2" X 6" X 12'	EACH	9	
PLYWOOD	3/4"	4' X 8' SHEET	11	
STEEL SHEATHING	14 GA.	4' X 8' SHEET	7	

HARDWARE

MATERIAL	DIAMETER	LENGTH	MEASURE	QUANTITY	REMARKS
DOOR			EACH	1	MADE ON SITE
HINGES		MIN. 3/1/2" LONG	EACH	3	SEE DETAIL 3 ON DRAWING MS–01
SLIDE BOLTS/ DEADBOLTS			EACH	3	SEE DETAIL 3 ON DRAWING MS–01
ANCHOR BOLTS	1/2"	MIN. 2–1/8" EMBED.	EACH	20	SEE DETAIL 4 ON DRAWING B–01 MAX EMBED. DEPTH 3"
TYPE "A" CONNECTORS			EACH	9	SEE DETAIL 2 ON DRAWING MS–01
TYPE "B" CONNECTORS			EACH	9	SEE DETAIL 2 ON DRAWING MS–01
LAG BOLTS	1/2"		EACH	4	
16d NAILS			LB	10	

SAFE ROOM:    CMU WALL ON SLAB–ON–GRADE

WALLS

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
HOLLOW CMU	8" X 8" X 16"	EACH	240	W/ CONCRETE GROUT
REINFORCING BAR	#5	LINEAR FEET	120	
MORTAR MIX	80 LB	BAG	10	

SLAB–ON–GRADE FOUNDATION

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
REINFORCING BAR	#4 X 3'	EACH	24	BENT 2' X 8"
CONCRETE		CUBIC YARDS	2	
WIRE MESH REINFORCEMENT	6"X6"–W2.9XW2.9	EA.	1	

ALTERNATIVE 1 REINFORCED CONCRETE CEILING

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
REINFORCING BAR	#4 X 4'	EACH	24	BENT 2' X 2'
REINFORCING BAR	#4 X 8'	LINEAR FEET	96	
CONCRETE		CUBIC YARDS	1	

ALTERNATIVE 2 WOOD–FRAME CEILING

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
SYP. LUMBER	2" X 6" X 8'	EACH	10	
PLYWOOD	3/4"	4' X 8' SHEET	4	
STEEL SHEATHING	14 GA.	4' X 8' SHEET	2	

HARDWARE

MATERIAL	MEASURE	QUANTITY	REMARKS
DEADBOLTS	EACH	3	SEE DETAIL 3 ON DRAWING MS–01
DOORFRAME	EACH	1	SEE DETAIL 1 ON DRAWING AG–01
DOOR	EACH	1	SEE DETAIL 1 AND 2 ON DRAWING MS–02
TYPE "D" CONNECTOR*	EACH	20	SEE DETAIL 2 ON DRAWING MS–01 USE TYPE "C" AND "M" WHEN LEDGER IS USED

\* REQUIRED ONLY FOR ALTERNATIVE (1 OF 2) WOOD–FRAME CEILING

CHASE WALL

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
P.T. LUMBER	2" X 6" X 8'	EACH	1	
SYP. LUMBER	2" X 6" X 8'	EACH	10	

SAFE ROOM:    CONCRETE WALL ON SLAB–ON–GRADE

WALLS

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
CONCRETE		CUBIC YARD	5	
REINFORCING BAR	#4	LINEAR FEET	232	

SLAB–ON–GRADE FOUNDATION

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
REINFORCING BAR	#4 X 3'	EACH	16	BENT 2' X 1'
REINFORCING BAR	#4 X 8'	LINEAR FEET	96	
CONCRETE		CUBIC YARD	2	
WIRE MESH REINFORCEMENT	6"X6"–W2.9XW2.9	EA.	1	

ALTERNATIVE 1 REINFORCED CONCRETE CEILING

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
REINFORCING BAR	#4 X 4'	EACH	24	BENT 2' X 2'
REINFORCING BAR	#4 X 8'	LINEAR FEET	96	
CONCRETE		CUBIC YARD	1	

ALTERNATIVE 2 WOOD–FRAME CEILING

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
SYP. LUMBER	2" X 6" X 8'	EACH	10	
PLYWOOD	3/4"	4' X 8' SHEET	4	
STEEL SHEATHING	14 GA.	4' X 8' SHEET	2	

HARDWARE

MATERIAL	MEASURE	QUANTITY	REMARKS
DEADBOLTS	EACH	3	SEE DETAIL 3 ON DRAWING MS–01
DOOR FRAME	EACH	1	SEE DETAIL 2 ON DRAWING AG–01
DOOR	EACH	1	SEE DETAIL 3 AND 4 ON DRAWING MS–01
TYPE "D" CONNECTOR*	EACH	20	SEE DETAIL 3 ON DRAWING USE TYPE "C" AND "M" WHEN LEDGER IS USED

\* REQUIRED ONLY FOR ALTERNATIVE (1 OF 2) WOOD–FRAME CEILING

CHASE WALL

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
P.T. LUMBER	2" X 6" X 8'	EACH	1	
SYP. LUMBER	2" X 6" X 8'	EACH	10	

MATERIALS LISTS

DRAWING NO: ML–01 | SHEET 17 OF 18

DATE:        OCTOBER 1998

REVISED: AUGUST 2008 | REV. NO. 2



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SAFE ROOM: INSULATING CONCRETE FORMS ON SLAB-ON-GRADE

INSULATING CONCRETE FORMS-FLAT WALL ALTERNATIVE

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
FORMS		SQUARE FEET	256	
CONCRETE 4" FLAT WALL		CUBIC YARDS	3	
CONCRETE 6" FLAT WALL		CUBIC YARDS	5	
REINFORCING BARS 4" FLAT WALL	#4	LINEAR FEET	672	
REINFORCING BARS 6" FLAT WALL	#4	LINEAR FEET	528	

INSULATING CONCRETE FORMS-WAFFLE GRID WALL ALTERNATIVE

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
FORMS		SQUARE FEET	256	
CONCRETE 6" WAFFLE GRID WALL		CUBIC YARDS	3.5	
CONCRETE 8" WAFFLE GRID WALL		CUBIC YARDS	5	
REINFORCING BARS	#4 #5	LINEAR FEET	416 256	

SLAB-ON-GRADE FOUNDATION

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
CONCRETE		CUBIC YARDS	2	
REINFORCING BARS	#4	LINEAR FEET	192	
WIRE MESH REINFORCEMENT	6"x6"-W2.9XW2.9	EA.	1	

INSULATING CONCRETE FORM ROOF ALTERNATIVE

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
FORMS		SQUARE FEET	64	
CONCRETE		CUBIC YARDS	1	
REINFORCING BARS	#4 #5	LINEAR FEET	128 32	

FLAT CONCRETE ROOF ALTERNATIVE

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
CONCRETE		CUBIC YARDS	1	
REINFORCING BARS	#4	LINEAR FEET	128	

HARDWARE

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
DEADBOLTS		EACH	3	SEE DETAIL 3 ON DRAWING MS-01
DOOR FRAME		EACH	1	SEE DETAIL 1 ON DRAWING AG-01
DOOR		EACH	1	SEE DETAIL 3 AND 4 ON DRAWING MS-01

NOTE:  
ALL QUANTITIES SHOWN ARE BASED ON AN 8'x8'x8' SAFE ROOM.  
QUANTITIES MAY VARY BY APPLICATION.

SAFE ROOM: WOOD-FRAME WITH CMU INFILL WALL ON SLAB-ON-GRADE

WALLS

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
SYP. LUMBER	2" X 4" X 8'	EACH	38	
P.T. LUMBER	2" X 4" X 8'	EACH	4	
SYP. LUMBER	2" X 6" X 8'	EACH	1	
PLYWOOD	3/4"	4' X 8' SHEET	24	
SOLID BLOCK	4" X 8" X 16"	EACH	128	DRY - STACK
SYP. LUMBER	2" X 8" X 10"	EACH	2	
SYP. LUMBER	1" X 4" X 8'	EACH	19	

CEILING

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
SYP. LUMBER	2" X 6" X 8'	EACH	10	
PLYWOOD	3/4"	4" X 8" SHEET	4	
STEEL SHEATHING	14 GA.	4' X 8' SHEET	2	

HARDWARE

MATERIAL	DIAMETER	LENGTH	MEASURE	QUANTITY	REMARKS
DOOR FRAME			EACH	1	SEE DETAILS 5 AND 6 ON DRAWING AG-05
DOOR			EACH	1	SEE DETAIL 3 AND 4 ON DRAWING MS-01
ANCHOR BOLTS	1/2"	MIN. 2-1/8" EMBED.	EACH	25	
TYPE "E" CONNECTORS			EACH	2	SEE DETAIL 2 ON DRAWING MS-01
TYPE "F" CONNECTORS			EACH	14	SEE ITEM 2 ON DRAWING MS-01
TYPE "G" CONNECTORS			EACH	14	SEE DETAIL 2 ON DRAWING MS-01
DEADBOLTS			EACH	3	SEE DETAIL 3 ON DRAWING MS-01
16D NAILS			LB	20	

CHASE WALL

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
P.T. LUMBER	2" X 6" X 8'	EACH	1	
SYP. LUMBER	2" X 6" X 8'	EACH	10	

SAFE ROOM: WOOD-FRAME WITH PLYWOOD AND STEEL SHEATHING WALL ON SLAB-ON-GRADE

WALLS

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
SYP. LUMBER	2" X 4" X 8'	EACH	58	
P.T. LUMBER	2" X 4" X 8'	EACH	4	
PLYWOOD	3/4"	4' X 8' SHEET	16	
STEEL SHEATHING	14 GA.	4' X 8' SHEET	8	
SYP. LUMBER	2" X 10" X 8'	EACH	2	
SYP. LUMBER	2" X 6" X 8'	EACH	1	

CEILING

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
SYP. LUMBER	2" X 6" X 8'	EACH	10	
PLYWOOD	3/4"	4' X 8' SHEET	4	
STEEL SHEATHING	14 GA.	4' X 8' SHEET	2	

HARDWARE

MATERIAL	DIAMETER	LENGTH	MEASURE	QUANTITY	REMARKS
DOOR FRAME			EACH	1	SEE DETAILS 5 AND 6 ON DRAWING AG-05
DOOR			EACH	1	SEE DETAIL 3 AND 4 ON DRAWING MS-01
ANCHOR BOLTS	1/2"	MIN. 2-1/8" EMBED.	EACH	25	
TYPE "E" CONNECTORS			EACH	2	SEE DETAIL 2 ON DRAWING MS-01
TYPE "F" CONNECTORS			EACH	14	SEE DETAIL 2 ON DRAWING MS-01
TYPE "G" CONNECTORS			EACH	14	SEE DETAIL 2 ON DRAWING MS-01
DEADBOLTS			EACH	3	SEE DETAIL 3 ON SHEET MS-01
16D NAILS			LB.	20	

CHASE WALL

MATERIAL	SIZE	MEASURE	QUANTITY	REMARKS
P.T. LUMBER	2" X 6" X 8'	EACH	1	
SYP. LUMBER	2" X 6" X 8'	EACH	10	

MATERIALS LISTS

DRAWING NO:ML-02 SHEET 18 OF 18

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