US Army Corps
of Engineers
Huntsville Center

MODULAR STORAGE MAGAZINE, BOX-TYPE STD 421-80-08 WITH 14'-8" DOOR (REVISION 1)

US Army Corps
of Engineers
Huntsville Center

Revisions			
No.	Description	Date	Appr.
1	Removed Hasps. Modified ILD Door Details, implemented Lessons Learned. Electrical Updates	MAY 2023	

Designed by: JMU	Date: MAY 2023		
Drawn by: JMU	Scale:		
Checked by: RSW	Drawing code:		
Project Engineer/Architect: Jeff Coulston		Date:	

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND
SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

COVER SHEET

Sheet reference number:

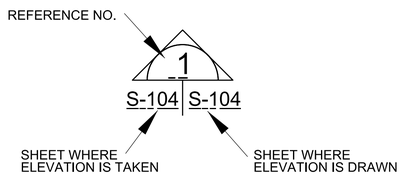
G-001

Sheet 1 of 29

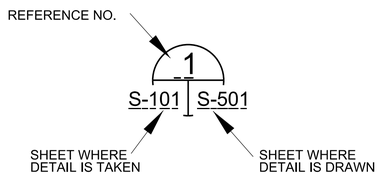
GENERAL ABBREVIATIONS

AFF	ABOVE FINISHED FLOOR
ALUM	ALUMINUM
APPROX	APPROXIMATELY
BLDG	BUILDING
BOTT	BOTTOM
BRG	BEARING
CIP	CAST-IN-PLACE
CJ	CONTROL JOINT
CL	CENTER LINE
CMU	CONCRETE MASONRY UNIT
CP	CENTER POINT
COL	COLUMN
COORD	COORDINATE
CONC	CONCRETE
CONT	CONTINUE, CONTINUOUS
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
EA	EACH
ELEV	ELEVATION
EF	EACH FACE
EJ	EXPANSION JOINT
EQ	EQUAL
E.W.	EACH WAY
(E) OR EXIST	EXISTING
EXT	EXTERIOR
FTG	FOOTING
FV	FIELD VERIFY
GALV	GALVANIZED
HD	HEADED
HT	HEIGHT
INT	INTERIOR
ID	INSIDE DIAMETER
LLH	LONG-LEG HORIZONTAL
LLV	LONG-LEG VERTICAL
MIN	MINIMUM
MANF	MANUFACTURER
NTS	NOT TO SCALE
O.C.	ON CENTER
OD	OUTSIDE DIAMETER
OH	OPPOSITE HAND
R	RADIUS
REINF	REINFORCEMENT
REQ'D	REQUIRED
SF	SQUARE FEET
SHT	SHEET
SIM	SIMILAR
SOG	SLAB-ON-GRADE
STIFFEN	STIFFENER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
VIF	VERIFY IN FIELD
WWF	WELDED WIRE FABRIC
WWR	WELDED WIRE REINFORCEMENT
W/	WITH
WP	WORKING POINT

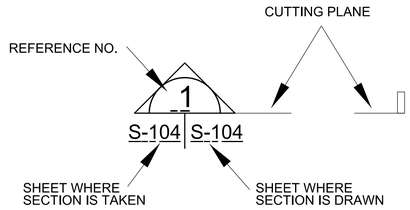
DRAWING SYMBOLS



ELEVATION REFERENCE



DETAIL REFERENCE



SECTION CUT

DRAWING INDEX

DISCIPLINE	SHEET NO.	SHEET REF. NO.	DRAWING CODE	SHEET TITLE	COMMENTS
GENERAL	G-001	1	XXXXXX	COVER SHEET	
	G-002	2	XXXXXX	INDEX, SYMBOLS, & ABBREVIATIONS	
STRUCTURAL	S-001	3	XXXXXX	GENERAL NOTES	
	S-002	4	XXXXXX	SPECIAL INSPECTIONS	
	S-101	5	XXXXXX	FOUNDATION PLAN	
	S-102	6	XXXXXX	ROOF FRAMING PLAN	
	S-201	7	XXXXXX	ELEVATIONS	
	S-202	8	XXXXXX	ELEVATIONS	
	S-301	9	XXXXXX	BUILDING SECTION	
	S-302	10	XXXXXX	BUILDING SECTION	
	S-303	11	XXXXXX	SECTIONS	
	S-501	12	XXXXXX	TYPICAL DETAILS	
	S-502	13	XXXXXX	TYPICAL DETAILS	SHEET ADDED
	S-701	14	XXXXXX	DOOR FRAME ELEVATION & DETAILS	DOOR MODIFIED FOR ILD SYSTEM
	S-702	15	XXXXXX	DOOR ELEVATIONS	DOOR MODIFIED FOR ILD SYSTEM
	S-703	16	XXXXXX	DOOR SECTIONS	DOOR MODIFIED FOR ILD SYSTEM
	S-704	17	XXXXXX	DOOR DETAILS	DOOR MODIFIED FOR ILD SYSTEM
	S-705	18	XXXXXX	INTERNAL LOCKING DEVICES	DOOR MODIFIED FOR ILD SYSTEM
ELECTRICAL	E-101	19	XXXXXX	GROUNDING AND LIGHTNING PROTECTION PLAN	
	E-201	20	XXXXXX	GROUNDING AND LIGHTNING PROTECTION DETAILS	
	E-202	21	XXXXXX	GROUNDING AND BONDING DETAILS	SHEET ADDED
	E-301	22	XXXXXX	ROLLING SPHERE METHOD ANALYSIS	
	E-302	23	XXXXXX	ROLLING SPHERE METHOD ANALYSIS	
	E-601	24	XXXXXX	ROLLING SPHERE METHOD ANALYSIS	SHEET ADDED
	E-101(A)	25	XXXXXX	GROUNDING AND LIGHTNING PROTECTION PLAN	SHEET ADDED
	E-201(A)	26	XXXXXX	GROUNDING AND LIGHTNING PROTECTION DETAILS	SHEET ADDED
	E-202(A)	27	XXXXXX	GROUNDING AND BONDING DETAILS	SHEET ADDED
	E-301(A)	28	XXXXXX	ROLLING SPHERE METHOD ANALYSIS	SHEET ADDED
	E-302(A)	29	XXXXXX	ROLLING SPHERE METHOD ANALYSIS	SHEET ADDED

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INDEX, SYMBOLS,
& ABBREVIATIONS

Sheet reference number:
G-002
Sheet 2 of 29

1.0 DESIGN CRITERIA:

A. BUILDING CODES AND SPECIFICATIONS:

1. INTERNATIONAL BUILDING CODE 2018 (IBC) AS MODIFIED BY UFC 1-200-01
2. AMERICAN CONCRETE INSTITUTE (ACI 318-14)
3. AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC 13th ED.)
4. AMERICAN WELDING SOCIETY, A.W.S.

B. LIVE LOADS

ROOF----------100 PSF
FLOOR----------500 PSF

SNOW LOAD:

GROUND SNOW LOAD (Pg) = 60 PSF
IMPORTANCE FACTOR (I) = 1.1
EXPOSURE CATEGORY (Ce) = 1.0
THERMAL CATEGORY (Ct) = 1.2

C. WIND LOAD:

BASIC WIND SPEED: 180 MPH
IMPORTANCE FACTOR (I): 1.0
EXPOSURE CATEGORY: C
ENCLOSURE CLASSIFICATION: ENCLOSED

D. EARTHQUAKE:

RISK CATEGORY=III
Ie= 1.25
Ss= 1.1g
Sds= 0.8 g
S1 = 0.52g
Sd1= 0.60g
SITE CLASS: D
BASIC SEISMIC-FORCE RESISTING SYSTEM=
INTERMEDIATE PRECAST SHEAR WALLS, R = 4
SEISMIC DESIGN CATEGORY= D
ANALYSIS PROCEDURE = EQUIVALENT LATERAL FORCE PROCEDURE

E. SOILS

SOIL DENSITY (ɣ): 120 PCF
ANGLE OF INTERNAL FRICTION OF THE SOIL (Φ) : 30 DEGREES
EQUIVALENT FLUID PRESSURE (EFP) : 60 PSF PER FOOT OF DEPTH

2.0 GENERAL

2.1 CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND SITE CONDITIONS PRIOR TO CONSTRUCTION/FABRICATION. CONTRACTOR SHALL NOTIFY CONTRACTING OFFICER OF ANY DISCREPANCIES PRIOR TO CONSTRUCTION.

2.2 THE STRUCTURE (MEMBERS AND CONNECTIONS) HAS BEEN DESIGNED TO SUPPORT IN-PLACE DESIGN LOADS ONLY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LIMITING CONSTRUCTION LOADS SUCH THAT THESE LOADS DO NOT EXCEED THE DESIGN LOADS NOTED ABOVE.

2.3 IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE CONSTRUCTION METHODS, PROCEDURES, AND SEQUENCES TO ENSURE STABILITY AND SAFETY DURING CONSTRUCTION. THE CONTRACTOR SHALL TAKE NECESSARY PRECAUTIONS TO PROTECT AND MAINTAIN THE STRUCTURAL INTEGRITY OF ALL NEW AND EXISTING CONSTRUCTION AT ALL STAGES.

2.4 SECTIONS AND DETAILS SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE CONSIDERED TYPICAL FOR SIMILAR CONDITIONS THAT DO NOT HAVE A SPECIFIC SECTION INDICATED.

2.5 THE CONTRACTOR SHALL COORDINATE STANDARD DRAWINGS WITH THE VENDOR/MANF. SHOP DRAWINGS TO VERIFY SIZES AND LOCATIONS OF OPENINGS, SLEEVES, INSERTS, DEPRESSIONS, FINISHES, SLOPES, ETC. ANY DISCREPANCY SHALL BE BROUGHT TO THE ATTENTION OF THE CONTRACTING OFFICER.

2.6 SEE CIVIL SITE LAYOUT DRAWINGS (PART OF SITE ADAPTATION) FOR ACTUAL FINISHED FLOOR ELEVATIONS (F.F.E.) FOR ALL BUILDINGS. ELEVATIONS SHOWN IN STRUCTURAL DOCUMENTS WILL BE BASED ON REFERENCED F.F.E. EQUAL TO 0'-0", U.O.N.

2.7 ANY DISCREPANCIES BETWEEN DRAWINGS, SPECIFICATIONS, REFERENCE STANDARDS, OR GOVERNING CODE, THE MORE STRINGENT REQUIREMENTS SHALL GOVERN. CONTRACTOR SHALL NOTIFY THE CONTRACTING OFFICER OF DISCREPANCIES AND OBTAIN DIRECTION PRIOR TO PROCEEDING.

2.8 CONTRACTOR SHALL PROVIDE TEMPORARY SHORING AND BRACING OF ALL STRUCTURAL WORK, AND SOIL EXCAVATION AS REQUIRED. SHORING AND BRACING SHALL NOT BE REMOVED UNTIL ALL FINAL CONNECTIONS HAVE BEEN COMPLETED IN ACCORDANCE WITH THE DRAWINGS, AND MATERIALS HAVE ACHIEVED DESIGN STRENGTH.

3.0 FOUNDATIONS

3.1 SEE CIVIL DRAWINGS AND SPECIFICATIONS (PART OF SITE ADAPTATION) FOR EARTHWORK PREPARATION OF FOUNDATIONS INCLUDING THE REMOVAL OF ORGANIC MATERIALS, COMPACTING SOILS BENEATH STRUCTURES, BACK FILL REQUIREMENTS FOR OVER EXCAVATION AND REMOVAL OF UNSUITABLE MATERIALS.

3.2 MAXIMUM ASSUMED NET SOIL BEARING PRESSURE USED FOR DESIGN: 3000 PSF .

3.3 ASSUMED UNIT WEIGHT OF SOIL USED FOR DESIGN: 120 PCF

3.4 ALL FOUNDATION BEARING SURFACES SHALL BE REVIEWED BY THE GEOTECHNICAL ENGINEER PRIOR TO PLACING CONCRETE TO ENSURE THEIR COMPLIANCE WITH THE PRESSURES NOTE ABOVE.

3.5 ALL FOOTINGS SHALL PROJECT AT LEAST 1'-6" INTO UNDISTURBED NATURAL SOIL OR COMPACTED ENGINEERED FILL HAVING A SOIL BEARING PRESSURE THAT MEETS OR EXCEEDS THAT SPECIFIED ABOVE.

3.6 ALL DISTURBED EARTH UNDER FOOTINGS SHALL BE REPLACED WITH LEAN CONCRETE.

3.7 CONCRETE SHALL NOT BE PLACED OVER FROZEN SOIL OR FOOTING EXCAVATIONS SUBJECTED TO WATER.

4.0 CONCRETE

4.1 ALL CONCRETE WORK INCLUDING DETAILING, FABRICATION, PLACEMENT OF REINFORCING, MIXING, HANDLING, PLACING, FINISHING, AND CURING SHALL CONFORM TO THE FOLLOWING DOCUMENTS:

ACI 301----------"STANDARD SPECIFICATIONS FOR STRUCTURAL CONCRETE"
ACI 315----------"MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES"
ACI 318----------"BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE"

4.2 ALL CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 4000 PSI AT 28 DAYS, U.O.N. ALL CONCRETE SHALL CONFORM TO ASTM C94.

4.3 REINFORCING BARS SHALL BE DEFORMED TYPE CONFORMING TO ASTM A615 GRADE 60 U.O.N.

4.4 WELDED WIRE REINFORCEMENT SHALL CONFORM TO ASTM A185. MINIMUM LAP AND EMBEDMENT TO BE THE GREATER OF ONE CROSS WIRE SPACING PLUS 2" OR 6", WHICHEVER IS GREATER.

4.5 FABRICATE AND PROVIDE BAR SUPPORTING ACCESSORIES IN ACCORDANCE WITH ACI MANUAL OF STANDARD PRACTICE AND C.R.S.I. SPECIFICATIONS. REINFORCING SHALL NOT BE WELDED IN ANY MANNER U.O.N. IN CONSTRUCTION DOCUMENTS.

4.6 REINFORCING SHALL BE CONTINUOUS WITH CLASS "B" TENSION LAP SPLICES, U.O.N.

4.7 CONCRETE COVERAGE OF REINFORCEMENT FOR CAST-IN-PLACE CONSTRUCTION U.O.N.:

CONCRETE CAST AGAINST EARTH:.....3 INCHES
FORMED CONCRETE EXPOSED TO EARTH OR WEATHER:
NO. 6 BAR AND LARGER.....2 INCHES
NO. 5 BAR AND SMALLER.....1 1/2 INCHES
CONCRETE NOT EXPOSED TO WEATHER:
SLABS, WALLS, JOISTS.....1 INCHES
BEAMS AND COLUMNS.....1 1/2 INCHES
SLAB ON GRADE.....MID-DEPTH OF SLAB

4.8 PROVIDE REINFORCING BARS IN CONCRETE FOOTINGS TO MATCH THE SIZE AND SPACING OF THE HORIZONTAL REINFORCING AT ALL CORNERS AND INTERSECTIONS OF STRIP FOOTINGS. PROVIDE LEG LENGTH EQUIVALENT TO CLASS "A" TENSION LAP SPLICE U.O.N.

4.9 PROVIDE DOWEL TO FOUNDATION WITH 90 DEGREE HOOK TO MATCH SIZE AND SPACING OF VERTICAL REINFORCING AT ALL PEDESTALS, WALLS, AND COLUMNS.

4.10 FOOTINGS AND SLABS SHALL HAVE NO HORIZONTAL JOINTS (POURED TO THEIR FULL DEPTHS IN ONE OPERATION). ANY STOP IN CONCRETE WORK SHALL BE BULKHEAD AND KEYED, U.O.N.

4.11 REINFORCEMENT SHALL NOT BE BENT OR STRAIGHTENED IN A MANNER THAT WILL DAMAGE THE MATERIAL. BARS WITH KINKS OR IMPROPER BENDS SHALL NOT BE USED.

4.12 REINFORCEMENT SHALL BE CONTINUOUS THROUGH ALL CONSTRUCTION JOINTS, BUT DISCONTINUOUS THROUGH ALL CONTROL JOINTS, U.O.N..

4.13 A CLASS C FINISH IS REQUIRED FOR EXPOSED FORMED SURFACES OF PRECAST PANELS. A CLASS D FINISH IS REQUIRED FOR SURFACES WHICH WILL BE BELOW GRADE OR NOT EXPOSED TO VIEW AFTER FINAL ASSEMBLY.

4.14 REFER TO GEOTECHNICAL REPORT FOR RECOMMENDATIONS RELATIVE TO SUBGRADE PREPARATION FOR SLAB ON GRADE WORK.

5.0 STRUCTURAL STEEL

5.1 STRUCTURAL STEEL FABRICATION, ERECTION, AND CONNECTION DESIGN SHALL CONFORM TO A.I.S.C.'S "SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS."

5.2 STRUCTURAL STEEL SHALL CONFORM TO THE FOLLOWING ASTM DESIGNATIONS:

W SHAPES.....ASTM A992
STEEL CHANNELS, ANGLES, PLATES AND BARS: .....ASTM A992 OR ASTM A572 GRADE 50
RECTANGULAR, SQUARE, AND ROUND HSS.....ASTM A500, GRADE C
STEEL PIPE (HSS).....ASTM A53, GRADE B

DOORS FABRICATED FROM ASTM A572 GRADE 50 STRUCTURAL STEEL SHALL NOT EXCEED 60 KSI FOR THE YIELD STRESS (Fy). TO ENSURE SATISFACTION OF THIS REQUIREMENT, THE DOOR FABRICATOR SHALL SUBMIT CERTIFIED MANUFACTURER'S MILL REPORT FOR ALL STRUCTURAL STEEL USED IN THE DOORS.

5.3 STRUCTURAL FASTENERS SHALL CONFORM TO THE FOLLOWING ASTM DESIGNATIONS:

ANCHOR BOLTS.....ASTM F1554
THREADED RODS.....ASTM A36
HEADED STUDS.....ASTM A108, GRADES 1015 TO 1020 (60 KSI TENSILE STRENGTH)

5.4 BOLTED CONNECTIONS SHALL CONFORM TO RCSC'S "SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS". ALL BOLTS SHALL BE 3/4" DIAMETER UNLESS OTHERWISE NOTED.

5.5 WELDED CONNECTIONS SHALL CONFORM TO AWS D1.1 "STRUCTURAL WELDING CODE-STEEL". MINIMUM SIZE FILLET WELDS SHALL BE 3/16" UNLESS OTHERWISE NOTED AND ELECTRODES SHALL BE E70xx. WELDERS SHALL BE QUALIFIED IN ACCORDANCE WITH AWS.

5.6 ALL EXTERIOR STEEL EXPOSED TO THE WEATHER SHALL BE HOT DIPPED GALVANIZED OR COATED WITH A HIGH PERFORMANCE COATING SYSTEM (HPCS). MEMBERS NOT REQUIRED FOR CORROSION PROTECTION SHALL RECEIVE ONE COAT OF STANDARD PRIMER PAINT. DO NOT PRIME OR PAINT SURFACES WHICH ARE TO RECEIVE FIELD WELDED HEADED SHEAR STUDS. PROVIDE 3" MINIMUM CONCRETE COVER FOR ALL STEEL BELOW GRADE AND PAINT WITH 2 COATS OF COAL TAR EPOXY. EPOXY SHALL MEET THE REQUIREMENTS OF PAINT SPECIFICATION SSPC-PAINT 16.

5.7 ALL STIFFENERS AND GUSSETS PLATES SHALL BE MINIMUM 3/8" THICK, UNLESS OTHERWISE NOTED.

6.0 STRUCTURAL PRECAST CONCRETE

6.1 ALL PRECAST ELEMENTS NOT DETAILED ON DRAWINGS SHALL BE DESIGNED FOR THE SPAN AND CONCRETE AND CONSTRUCTION LOADING CONDITIONS SHOWN ON THE DRAWINGS BY A LICENSED STRUCTURAL ENGINEER. ALL DESIGN CALCULATIONS, INCLUDING THE DESIGN OF ALL STRUCTURAL ELEMENTS AND LIFTING POINTS SHALL BE SUBMITTED TO THE CONTRACTING OFFICER FOR REVIEW PRIOR TO THE START OF FABRICATION.

6.2 THE PRECAST MANUFACTURER SHALL BE RESPONSIBLE FOR COORDINATION OF ALL DISCIPLINES AS THEY EFFECT THE PRECAST ELEMENTS.

6.3 THERE SHALL BE NO FIELD CUTTING OF PRECAST ELEMENTS WITHOUT THE APPROVAL OF THE CONTRACTING OFFICER.

6.4 CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH AT TWENTY-EIGHT DAYS OF 4000 PSI.

6.5 ALL GROUT SHALL BE NON-SHRINK, NON-METALLIC WITH F'c = 5000 PSI.

7.0 ELECTRICAL BONDING AND GROUNDING

7.1 ALL METAL PARTS, TO INCLUDE LOUVERS, VENTILATORS, DOORS AND DOOR FRAME MUST BE MADE ELECTRICALLY BONDED TO THE MAGAZINE REINFORCING CAGE.

7.2 THE REINFORCING CAGE MUST BE ELECTRICALLY BONDED BY WIRE TIES AT A MINIMUM OF 4'-0" O.C. IN EACH DIRECTION. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL DETAILS AND INFORMATION.

7.3 ELECTRICAL CONTINUITY SHALL BE PROVIDED ACROSS FLOOR EXPANSION AND ISOLATION JOINTS TO CONCRETE FOUNDATION WALLS, BETWEEN PRECAST WALL AND PRECAST ROOF PANELS, AND BETWEEN PRECAST WALLS AND CONCRETE PEDESTAL FOOTINGS DURING CONSTRUCTION. SEE ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION REGARDING ELECTRICAL BONDING.

DESIGNER NOTES: TO BE REMOVED WHEN PREPARING CONSTRUCTION DRAWINGS FOR SITE ADAPTION OF THIS DESIGN.

1. THE MAGAZINE HAS BEEN ANALYZED FOR THE LOADS LISTED ON THIS SHEET AND DETERMINED TO BE ADEQUATE UNDER THESE LOADINGS. HOWEVER, THE DESIGNER SHOULD VERIFY THE STRUCTURE FOR THE SITE-SPECIFIC LOADING CRITERIA. IF SITE-SPECIFIC LOADS EXCEED THESE LISTED ON THIS SHEET, THE DESIGNER SHOULD ADDRESS ALL DEFICIENCIES THAT DO NOT MEET CURRENT BUILDING CODES.
2. FOUNDATIONS SHALL BE REVISED TO REFLECT SPECIFIC SITE SOIL CONDITIONS INCLUDING LOCAL SITING, TOPOGRAPHIC CONDITIONS, AND FROST PENETRATION DEPTHS.
3. STRUCTURAL COMPONENTS, WITH THE EXCEPTION OF THE FOUNDATION (FOOTINGS), SLAB-ON-GRADE, AND WING WALLS SHALL NOT BE MODIFIED WITHOUT THE APPROVAL OF THE CONTRACTING OFFICER, WHO SHOULD CONSULT WITH THE U.S. ARMY ENGINEERING AND SUPPORT CENTER, HUNTSVILLE (STRUCTURAL BRANCH). STRUCTURE HAS BEEN DETERMINED TO BE ADEQUATE FOR THE DESIGN CRITERIA LISTED ON THIS SHEET.

STRUCTURAL DESIGNATION (7-BAR) NOTES:

1. ANY DEVIATION FROM THE STANDARD APPROVED DESIGN DRAWINGS FOR THE CONCRETE HEADWALL, STEEL DOOR, CONCRETE ROOF OR THEIR SUPPORTS WITHOUT WRITTEN APPROVAL FROM THE DEPARTMENT OF DEFENSE EXPLOSIVE SAFETY BOARD (DDESB) MAY REQUIRE THE MAGAZINE TO BE CONSIDERED AN UNDEFINED MAGAZINE AND MAY SEVERELY RESTRICT THE ALLOWABLE STORAGE CAPACITY.
2. IF CONSTRUCTED PER THESE DRAWINGS, FACILITY MEETS BLAST-RESISTANT DESIGN CRITERIA FOR A 7-BAR STRUCTURAL DESIGNATION PER DESR 6055.09. THIS DESIGNATION IN NO WAY IMPLIES VALIDATION OF THE DESIGN AGAINST OTHER LOAD CASES.

PHYSICAL SECURITY NOTE:

1. THIS DRAWING PACKAGE WAS DESIGNED TO MEET THE MINIMUM CONSTRUCTION AND SECURITY REQUIREMENTS PER DoDI 5100.76, DoDM 5100.76, DESR 6055.09, AND UFC 4-026-01/MILITARY HANDBOOK 1013/1A FOR STORING SECURITY RISK CATEGORY I AND II ITEMS SUBJECT TO A LEVEL III/MEDIUM THREAT SEVERITY LEVEL FORCED ENTRY DESIGN BASIS THREAT (DBT). UPDATES TO THIS DRAWING PACKAGE TO MAINTAIN OR EXCEED THIS MINIMUM STANDARD DESIGN SHALL BE CONDUCTED BY QUALIFIED ENGINEERS AND TRAINED PHYSICAL SECURITY SPECIALIST PRIOR TO DESIGN, CONTRACT AWARD, AND ACCEPTANCE FOR NEW CONSTRUCTION TO ENSURE COMPLIANCE WITH THE CRITERIA OF DoDI 5100.76, DoDM 5100.76, DESR 6055.09, AND UFC 4-026-01/MILITARY HANDBOOK 1013/1A.

1. THIS STANDARD DESIGN DRAWING PACKAGE DATED MAY 2023, STD 421-80-08 REVISION 1, SHEETS 1-29, UPDATES AND SUPERSEDES THE STANDARD DESIGN 421-80-08 DATED JUNE 2013, SHEETS 1-26.

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GENERAL NOTES

Sheet reference number:
S-001
Sheet 3 of 29

SPECIAL INSPECTION SCHEDULE/VERIFICATION

ITEM	EXTENT OF INSPECTION [1]	REFERENCE (IBC TABLE 1705.3)	COMMENTS/SCOPE
CONCRETE CONSTRUCTION			
REINFORCING STEEL PLACEMENT	P	ACI 318: Ch 20, 25.2, 25.3, 26.6.1-26.6.3	INSPECT SIZE, SPACING, COVER, POSITIONING AND GRADE OF REINFORCING STEEL. VERIFY THAT REINFORCING BARS ARE FREE OF FORM OIL OR OTHER DELETERIOUS MATERIALS. INSPECT BAR LAPS AND MECHANICAL SPLICES. VERIFY THAT BARS ARE ADEQUATELLY TIED AND SUPPORTED ON CHAIRS OR BOLSTERS
WELDING OF RIENFORCEMENT	C, P	AWS D1.4, ACI 318:26.6.4	VISUALLY INSPECT ALL REINFORCING STEEL WELDS. VERIFY WELDABILITY OF REINFORCING STEEL. INSPECT PREHEATING OF STEEL WHEN REQUIRED.
CONCRETE PLACEMENT	C	ACI 318: 26.5	INSPECT PLACEMENT OF CONCRETE. VERIFY THAT CONCRETE CONVEYANCE AND DEPOSITING AVOIDS SEGREGATION OR CONTAMINATION. VERIFY THAT CONCRETE IS PROPERLY CONSOLIDATED
SAMPLING AND TESTING OF CONCRETE	C	ASTM C 172 ASTM C 31 ACI 318: 26.5, 26.12	TEST CONCRETE COMPRESSIVE STRENGTH, SLUMP, AIR-CONTENT AND TEMPERATURE
CURING AND PROTECTION	P	ACI 318: 26.5.3-26.5.5	INSPECT CURING, COLD WEATHER PROTECTION AND HOT WEATHER PROTECTION PROCEDURES
FORMWORK	P	ACI 318: 26.11.1.2 (b)	INSPECT FORWORK FOR SHAPE, LOCATION, AND DIMENSIONS OF THE CONCRETE MEMBER BEING FORMED
PRECAST CONCRETE			
PLANT CERTIFICATION/QUALITY CONTROL PROCEDURES	S		REVIEW OF PLANT OPERATIONS AND QUALITY CONTROL PROCEDURES
MIX DESIGN	S		INSPECT CONCRETE BATCHING OPERATIONS AND VERIFY COMPLIANCE WITH APPROVED MIX DESIGN
MATERICAL CERTIFICATION	S		REVIEW FOR CONFORMANCE TO ACI 318
REINFORCEMENT INSTALLATION	P		INSPECT SIZE, SPACING, POSITION AND GRADE OF REINFORCING STEEL
CONNECTIONS/EMBEDDED ITEMS	P		INSPECT INTERFACE CONNECTIONS INCLUDING END AND EDGE DOWELING. INSPECT EMBEDMENTS FOR PROPER LOCATION AND WELDING OF CONNECTIONS
CONCRETE PLACEMENT	C	ACI 318: 26.5	INSPECT PLACEMENT OF CONCRETE. VERIFY THAT CONCRETE CONVEYANCE AND DEPOSITING AVOIDS SEGREGATION OR CONTAMINATION. VERIFY THAT CONCRETE IS PROPERLY CONSOLIDATED
SAMPLING AND TESTING	C		
CURING AND PROTECTION	P		
ERECTED PRECAST ELEMENTS	C	ACI 318: Ch. 26.9	INSPECT ERECTION OF PRECAST CONCRETE INCLUDING MEMBER CONFIGURATION, CONNECTIONS, WELDING AND GROUTING
DOOR CONSTRUCTION			
FABRICATOR CERTIFICATION/QUALITY CONTROL PROCEDURES	S		REVIEW OF FABRICATOR'S QUALITY CONTROL PROCEDURES OR AISC CERTIFICATION
FABRICATOR INSPECTION	P		INSPECT IN-PLANT FABRICATION, OR REVIEW FABRICATOR'S APPROVED INDEPENDENT INSPECTION AGENCY'S REPORTS
SPECIAL ITEMS RELATED TO THE OTHER EXPLOSIVES SAFETY RELATED ITEMS			
REBAR FARADAY-SHIELD	P	DWGS E-101/A; E-201/A; E-202/A UFC 4-420-01,3-8.5; 3-9	INSPECT REINFORCING STEEL TO ENSURE ELECTRICAL CONTINUITY BETWEEN THE CAP, WALLS, SLAB AND FOUNDATION THROUGH BONDING WELDS. DOCUMENT BONDS WITH PHOTOS AND CONTINUITY TEST.
GROUNDING ELECTRODE SYSTEM AND SUBSYSTEMS	P/S	DWGS E-101/A; E-201/A; E-202/A; DA PAM 385-64,17-28; NFPA 780,8.10; UFC 4-420-01,3-8.4.5	VISUALLY INSPECT GROUNDING ELECTRODE SYSTEM, INCLUDING BONDING CONNECTIONS, GROUNDING ELECTRODES, COUNTERPOISE CABLE, BONDING CABLES AND SUBSURFACE BONDING CABLES PRIOR TO BURIAL. DOCUMENT INSPECTION WITH REPORT AND PHOTOGRAPHS FOR SUBMISSION TO THE GOVERNMENT. DAMAGED, FRAYED, OR CORROSIVE COMPONENTS SHALL BE REPLACED.
GROUNDING ELECTRODE SYSTEM TESTS	P/S	DA PAM 385-64,17-28; NFPA 780,8.10; UFC 4-420-01,3-8.4	TEST THE GROUNDING ELECTRODE SYSTEM AFTER INSPECTION. DOCUMENT TEST RESULTS IN REPORT TO THE GOVERNMENT.
LIGHTNING PROTECTION BONDING INSPECTION AND TESTING	P/S	DWGS E-101/A; E-201/A; E-202/A; DA PAM 385-64,17-28; NFPA 780,8.10; UFC 4-420-01,3-8.4,5,6	INSPECT AND TEST 100% OF LPS BONDS PRIOR TO PROJECT COMPLETION. DOCUMENT TEST RESULTS FOR SUBMISSION TO THE GOVERNMENT. PROVIDE PHOTOGRAPHIC RECORDS OF SUBSURFACE BONDS.
LPS COMPONENTS	P	DWGS E-101/A; NFPA 780,8.10; DA PAM 385-64,17-27	INSPECT LPS COMPONENTS FOR SECURE MOUNTING AND PROTECTION AGAINST ACCIDENTAL MECHANICAL DISPLACEMENT.
EARTH COVER	P	DWGS S-301-302	INSPECT DEPTH GAUGES ON ROOF PRIOR TO EARTH COVER PLACEMENT FOR SIZE AND STABILITY. INSPECT EARTH COVER DEPTH AND SLOPE TO ENSURE A 2' MIN. IS PROVIDED ABOVE STRUCTURE
DOOR LAPS	C	DWG S-701	INSPECT DOOR LAPS AT TOP AND BOTTOM OF DOOR FRAME

SPECIAL INSPECTION NOTES:

1 INSPECTION INTERVALS ARE AS FOLLOWS:
C - Continuous: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed

P - Periodic: The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

S - Submittal

2 STRUCTURAL TEST AND SPECIAL INSPECTIONS ARE BASED ON CHAPTER 17 OF THE IBC 2018 EDITION

3 CONTRACTOR SHALL HIRE A QUALIFIED INSPECTION AND TESTING AGENCY TO PERFORM SPECIAL INSPECTIONS AND TESTING IN ACCORDANCE WITH THE IBC. SUBMIT INSPECTION REPORTS TO THE CONTRACTING OFFICER FOR EACH DAY SPECIAL INSPECTIONS AND TESTING IS PERFORMED.

DESIGNER NOTES: TO BE REMOVED WHEN PREPARING CONSTRUCTION DRAWINGS FOR SITE ADAPTION OF THIS DESIGN.

1. SPECIAL INSPECTION SCHEDULE SHALL BE REVISED TO REFLECT SPECIFIC PROJECT REQUIREMENTS IN ACCORDANCE WITH CHAPTER 17 OF THE INTERNATIONAL BUILDING CODE AND UFC 3-301-01; HOWEVER, AT A MINIMUM EDIT UFGS 01 45 35 "SPECIAL INSPECTIONS" TO INCORPORATE THE SPECIAL ITEMS RELATED TO THE 'OTHER EXPLOSIVES SAFETY RELATED ITEMS' FOR INSPECTION AS SHOWN ON THIS SCHEDULE.

US Army Corps of Engineers
Huntsville Center

Revisions

No.	Description	Date	Appr.
4	Removed Hasps; Modified ILD Door Details; Implemented Lessons Learned; Electrical Updates	MAY 2023	

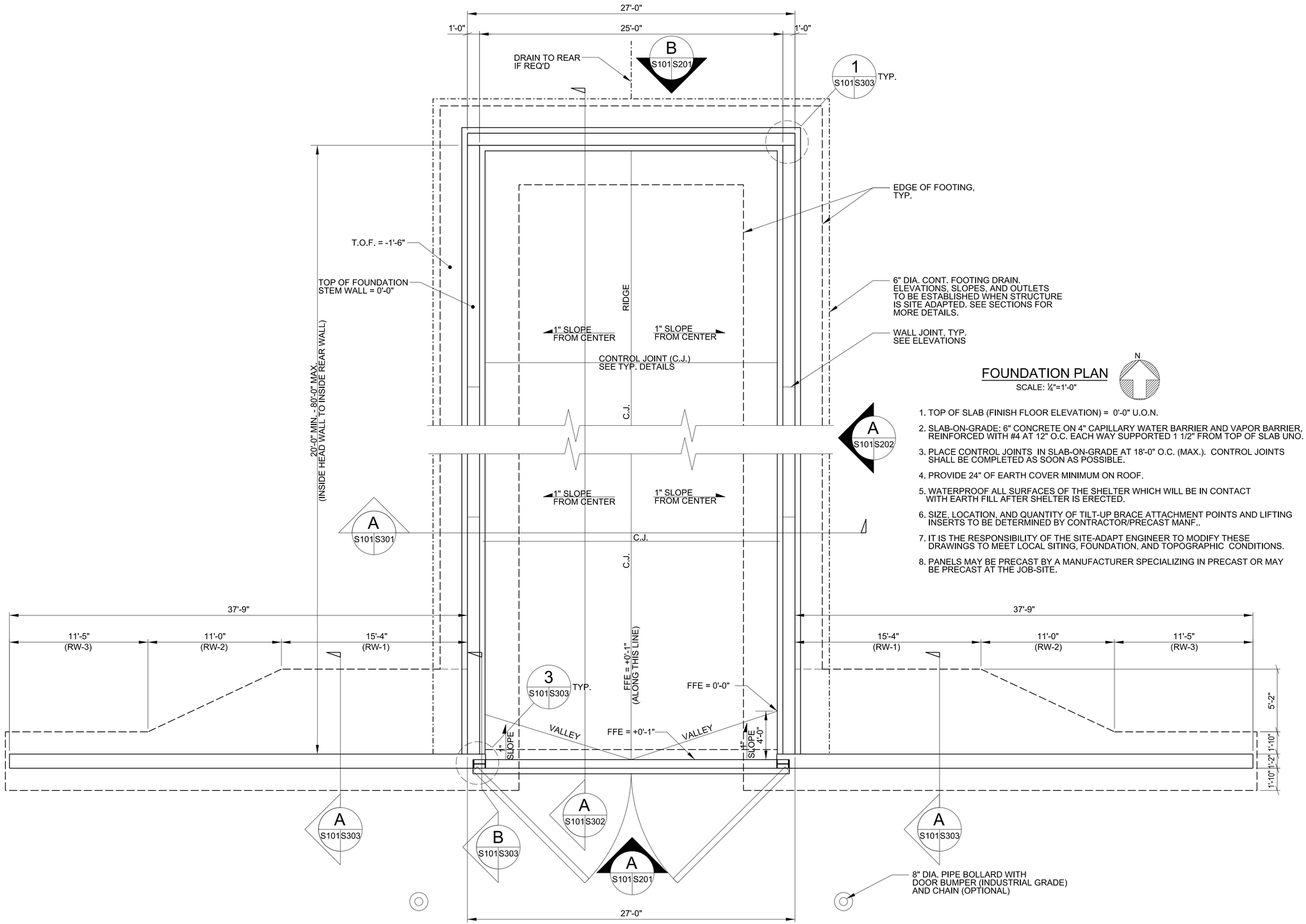
Date: MAY 2023
Scale:
Drawing code:
Designed by: JMU
Drawn by: JMU
Checked by: RSW
Project Engineer/Architect: Jeff Coulston
Date:

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND
SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

SPECIAL INSPECTIONS

Sheet reference number:
S-002
Sheet 4 of 29



FOUNDATION PLAN

SCALE: ¼"=1'-0"

N

1. TOP OF SLAB (FINISH FLOOR ELEVATION) = 0'-0" U.O.N.
2. SLAB-ON-GRADE: 6" CONCRETE ON 4" CAPILLARY WATER BARRIER AND VAPOR BARRIER, REINFORCED WITH #4 AT 12" O.C. EACH WAY SUPPORTED 1 1/2" FROM TOP OF SLAB UNO.
3. PLACE CONTROL JOINTS IN SLAB-ON-GRADE AT 18'-0" O.C. (MAX.). CONTROL JOINTS SHALL BE COMPLETED AS SOON AS POSSIBLE.
4. PROVIDE 24" OF EARTH COVER MINIMUM ON ROOF.
5. WATERPROOF ALL SURFACES OF THE SHELTER WHICH WILL BE IN CONTACT WITH EARTH FILL AFTER SHELTER IS ERECTED.
6. SIZE, LOCATION, AND QUANTITY OF TILT-UP BRACE ATTACHMENT POINTS AND LIFTING INSERTS TO BE DETERMINED BY CONTRACTOR/PRECAST MANF..
7. IT IS THE RESPONSIBILITY OF THE SITE-ADAPT ENGINEER TO MODIFY THESE DRAWINGS TO MEET LOCAL SITING, FOUNDATION, AND TOPOGRAPHIC CONDITIONS.
8. PANELS MAY BE PRECAST BY A MANUFACTURER SPECIALIZING IN PRECAST OR MAY BE PRECAST AT THE JOB-SITE.

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No.	Description	Date	Appr.
4	Removed Hasps. Modified ILD Door Details, implemented Lessons Learned. Electrical Updates	MAY 2023	

Designed by: JMU
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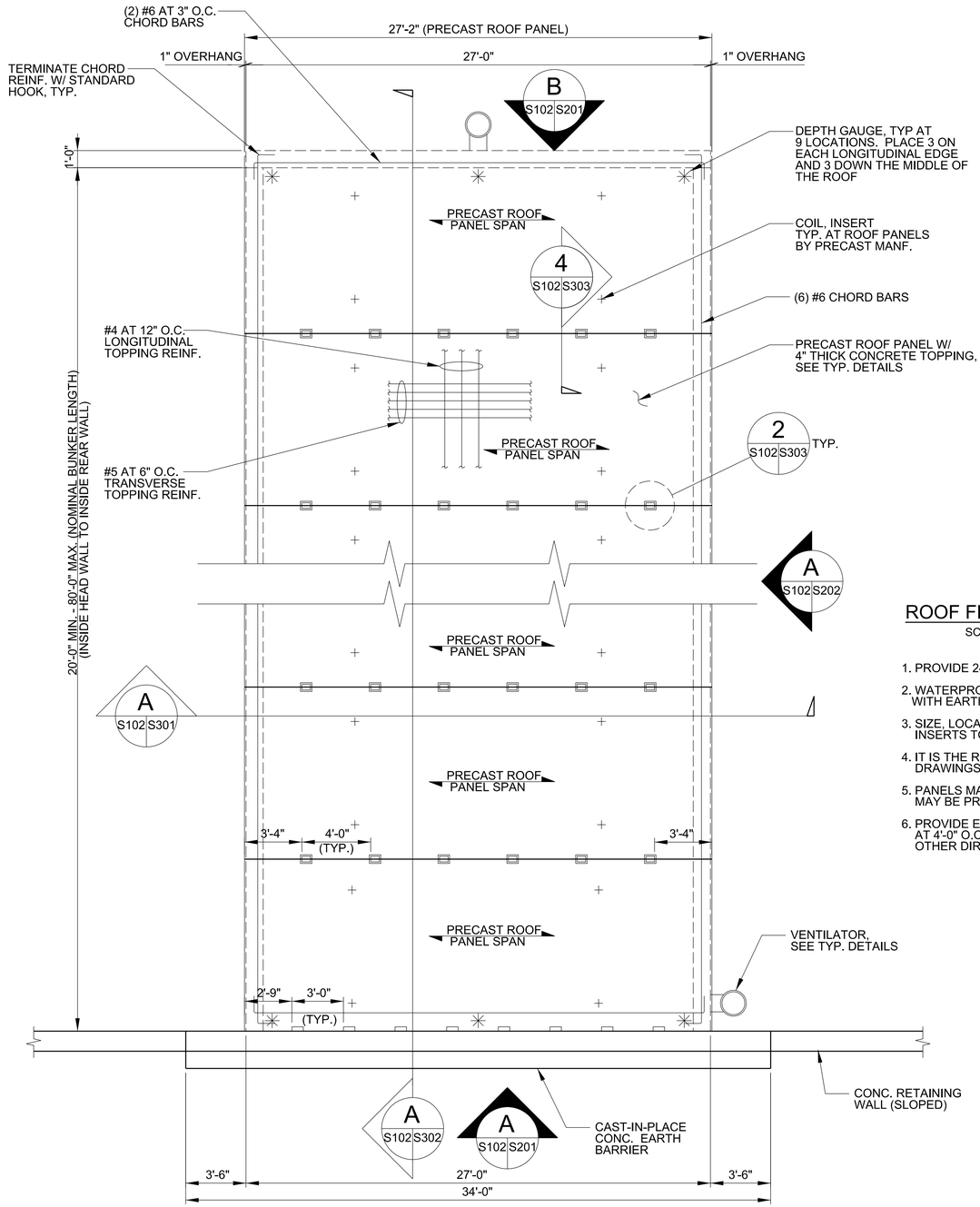
Checked by: RSW
Project Engineer/Architect: Jeff Coulston
Date: MAY 2023
Scale: AS SHOWN
Drawing code:
Date:

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

FOUNDATION PLAN

Sheet reference number:
S-101
Sheet 5 of 29



ROOF FRAMING PLAN

SCALE: ¼"=1'-0"

N

1. PROVIDE 24" OF EARTH COVER MINIMUM ON ROOF.
2. WATERPROOF ALL SURFACES OF THE SHELTER WHICH WILL BE IN CONTACT WITH EARTH FILL AFTER SHELTER IS ERECTED.
3. SIZE, LOCATION, AND QUANTITY OF TILT-UP BRACE ATTACHMENT POINTS AND LIFTING INSERTS TO BE DETERMINED BY CONTRACTOR/PRECAST MANF..
4. IT IS THE RESPONSIBILITY OF THE SITE-ADAPT ENGINEER TO MODIFY THESE DRAWINGS TO MEET LOCAL SITING, FOUNDATION, AND TOPOGRAPHIC CONDITIONS.
5. PANELS MAY BE PRECAST BY A MANUFACTURER SPECIALIZING IN PRECAST OR MAY BE PRECAST AT THE JOB-SITE.
6. PROVIDE ELECTRICAL CONTINUITY WITHIN THE PRECAST ROOF PANELS BY BONDING AT 4'-0" O.C. ACROSS TOP OF STIRRUPS TO END ANGLES IN ONE DIRECTION. IN THE OTHER DIRECTION, ELECTRICALLY BOND #4 BARS FROM BOTTOM PLATE TO #4 REINF.

US Army Corps of Engineers
Huntsville Center

No.	Description	Date	Appr.
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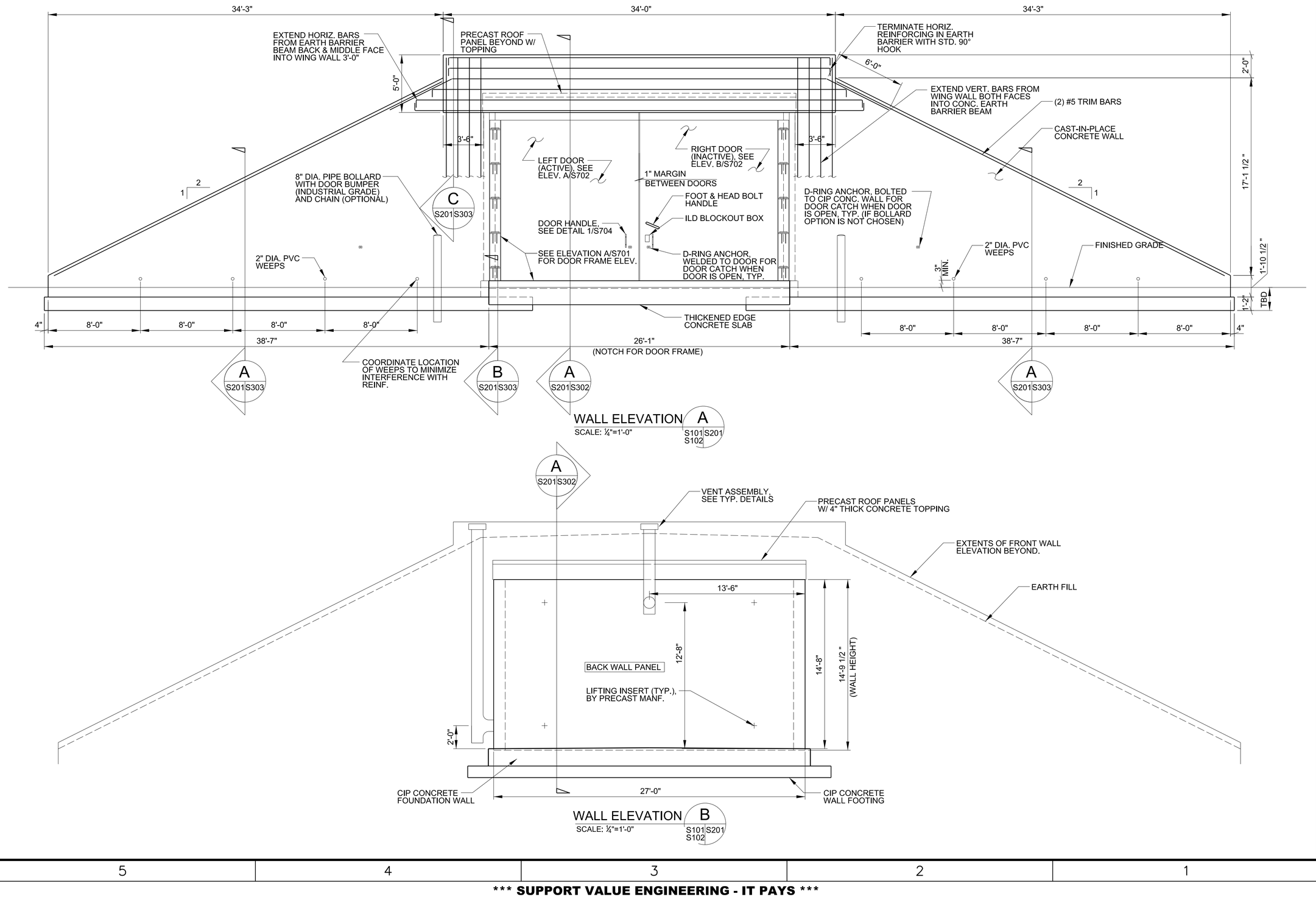
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

ROOF FRAMING PLAN

Sheet reference number:
S-102
Sheet 6 of 29



WALL ELEVATION A
SCALE: ¼"=1'-0"
S101 S201 S102

WALL ELEVATION B
SCALE: ¼"=1'-0"
S101 S201 S102

US Army Corps of Engineers
Huntsville Center

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Project Engineer/Architect: Jeff Coulston
Date:

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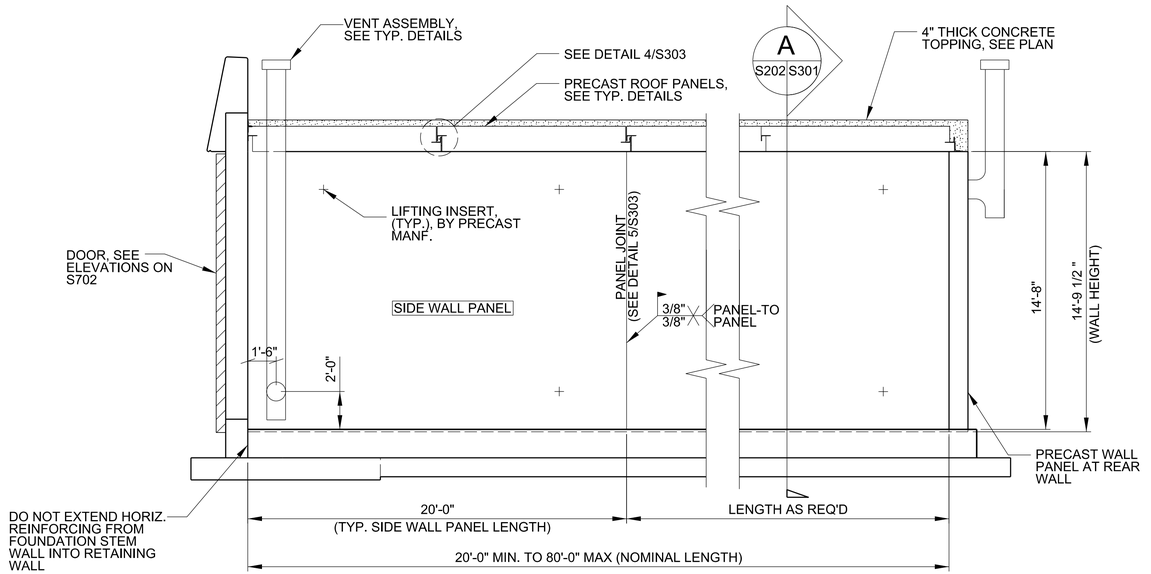
ENGINEERING AND SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

ELEVATIONS

Sheet reference number:
S-201
Sheet 7 of 29



WALL ELEVATION A
SCALE: ¼"=1'-0"
S101 S202 S102

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No.	Description	Date	Appr.
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HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

ELEVATIONS

Sheet reference number:

S-202

Sheet 8 of 29

WATERPROOFING MEMBRANE (60 MIL), TYP. AT ROOF AND WALLS

REASONABLY COHESIVE SOILS ONLY. SOLID OR WET CLAY SHALL NOT BE USED.

NOTE:
EARTH FILL SHALL CONTAIN NO STONES HEAVIER THAN 10 POUNDS OR LARGER THAN 6" (15.2) IN ANY DIMENSION

DEPTH GAUGE, SEE DETAIL F/S501. REFER TO ROOF PLAN FOR LOCATIONS

SEE PLAN

SLOPE FILL

SLOPE FILL

2'-0" MIN.

2'-0" MIN.

CHORD REINF., SEE PLAN

2 MIN. 1

2 MIN. 1

4" THICK CONCRETE TOPPING SLAB, SEE PLAN FOR REINF.

#4 BARS TO MATCH STIRRUP SPACING

#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO PL. AND REINF. FOR ELECTRICAL CONTINUITY. (SEE NOTE 6 ON S102)

1/2" DIA. x 8" HEADED STUDS AT 12" O.C., (START 4 3/4" FROM END)

(2) #4 CONT.

TYP. 1/4

1"

2" (TYP.)

1"

1"

1/2"x14"x9'-11 3/8" LONG PL. EACH END OF EACH PANEL

C12x20.7 CONT.

TYP. 3/8 3/8

#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO CHANNELS AND VERT. REINF. FOR ELECTRICAL CONTINUITY.

1/2" DIA. x 8" HEADED STUDS AT 12" O.C., STAGGERED.

#6 BARS CONT., TYP.

PRECAST ROOF PANELS, SEE TYP. DETAILS

(2) #5 HORZ. CONT. TOP & BOTT. TYP. AT TOP OF WALLS

#4 STIRRUPS AT 4" O.C., TYP. ENCLOSE HORIZ. REINFORCEMENT WITHIN STIRRUPS

10"

1'-2"

1'-4"

2" (TYP.)

WATERPROOFING MEMBRANE (60 MIL), TYP. AT ROOF AND WALLS

1" (TYP.)

NOTE:
STAGGER REBAR LAYERS TO FORM A 6"x6" SQUARE MESH PATTERN OF #5 AND #8 REBAR.

1'-0" (TYP.)

PRECAST WALL PANELS

#8 VERT. AT 12" O.C., TYP.

#5 HORZ. AT 12" O.C. W/ SEISMIC HOOK EA END, TYP.

6" SAND MATERIAL (SW)

3" DIAMETER GALV. CORRUGATED STEEL CONDUIT (24 GAUGE MIN.). GROUT SHALL BE 5000 PSI HIGH STRENGTH, NON-SHRINK

1 1/2" DIA. WEEPS AT 1'-8" O.C.

#7 DOWELS AT 12" O.C. ALTERNATE HOOK DIRECTION.

#5 DOWELS AT 12" O.C.

#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO STEM REINF. AND PRECAST WALL DOWELS

6" DIA. PERFORATED FOOTING DRAIN PIPE, TYP. (TURN PERFORATIONS DOWN)

FILTER FABRIC

3 1/2" (MIN.) WIDE PRE-SLOPED TRENCH CONT., PROVIDE BOTTOM OUTLETS/DRAINS (2" DIA.) AT 20'-0" O.C. MAX. RUN DRAINS THRU FOUNDATION STEM WALL AND TERMINATE WITHIN 6" OF FOOTING DRAIN PIPE. (NOT SHOWN)

4" MIN.

14'-8"

1 1/2" TYP.

1 1/2"

3"

4"

5000 PSI HIGH STRENGTH, NON-SHRINK GROUT

#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO REINF.

3" DIAMETER GALV. CORRUGATED STEEL CONDUIT (24 GAUGE MIN.). GROUT SHALL BE 5000 PSI HIGH STRENGTH, NON-SHRINK

#7 DOWELS AT 12" O.C. ALTERNATE HOOK DIRECTION.

4'-1" (EMBEDMENT)

JOINT SEALER,1/2" MIN. DEPTH

1/2" EXP. JOINT W/ JOINT FILLER

SLAB-ON-GRADE SEE PLAN

SLOPE

SLOPE

VARIES

WRAP END OF WEEPS WITH FILTER FABRIC, TYP.

1'-6"

1'-0"

#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO SLAB REINF. AND STEM REINF.

1'-6"

1'-0"

8" 3" 8"

2'-0" 1 12

#5 CONT. AT 12" O.C. TOP AND BOTT.

GRAVEL MATERIAL (GW)

#5 TRANSVERSE BARS AT 12" O.C. TOP AND BOTT.

#6 HORZ. CONT. AT 12" O .C.

10" 1'-9 1/2 " 1'-11" 2'-9 1/2 " 10"

6'-6"

2'-9 1/2 " 1'-11" 1'-9 1/2 " 10"

6'-6"

A SECTION
S101 S301
S102
S202
SCALE: 3/4"=1'-0"

US Army Corps of Engineers Huntsville Center

Revisions			
No.	Description	Date	Appr.
4	Removed Hasps. Modified ILD Door Details, implemented Lessons Learned. Electrical Updates	MAY 2023	

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Project Engineer/Architect: Jeff Coulston

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)

BUILDING SECTION

Sheet reference number:
S-301
Sheet 9 of 29

(16) #5 HORZ. CONT. AS SHOWN
1'-0"
1'-2"
1/2" SLOPE MIN.
CONT. SEALANT
24 GA. GALV. COUNTERFLASHING LAP 4" MIN.
ELASTOMERIC MEMBRANE
3x3 (MIN.) CANT STRIP CONT., ENSURE CANT STRIP ADEQUATELY RECESSES BOLT HEADS.
CAST-IN-PLACE CONC. EARTH BARRIER
#4 DOWEL AT 12" O.C.
#5 STIRRUPS AT 12" O.C.
#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO BENT PLATE AND STIRRUPS FOR ELECTRICAL CONTINUITY.
5/8" DIA. x 8" HEADED STUDS AT 12" O.C., STAGGERED SPACING
5'-0"
1 1/2"
6"
1/4
6" TYP. EA. EMBED
DRIP EDGE
14" x 1'-5" x 3/8 BENT PL. (LLV) CONT.
DOOR FRAME, SEE ELEVATIONS ON S701
DOOR, SEE ELEVATIONS ON S702
EXTENTS OF DOOR FRAME, SEE DETAILS ON S701
VARIES WITH FLOOR SLOPE (14'-8" AT SIDES AND 14'-7" AT CENTER)
WATERPROOFING MEMBRANE TYP. AT ROOF AND WALLS
REASONABLY COHESIVE SOILS ONLY. SOLID OR WET CLAY SHALL NOT BE USED.
NOTE: EARTH FILL SHALL CONTAIN NO STONES HEAVIER THAN 10 POUNDS OR LARGER THAN 6" (15.2) IN ANY DIMENSION
DEPTH GAUGE, SEE DETAIL F/S501. REFER TO ROOF PLAN FOR LOCATIONS
4" THICK CONCRETE TOPPING SLAB, SEE PLAN FOR REINF.
2'-0" MIN.
2 MIN.
1
PRECAST ROOF PANELS, SEE TYP. DETAILS
SEE DETAIL 4/S303
#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO ANGLE AND HORIZ. REINF. FOR ELECTRICAL CONTINUITY.(SEE NOTE 6 ON S102)
1/2" DIA. x 8" HEADED STUDS AT 12" O.C., START 5" FROM END
PRECAST ROOF PANEL, SEE TYP. DETAILS
1/2" x 9" PL. CONT.
3/8
C12x20.7 CONT.
1/2" DIA. x 8" HEADED STUDS AT 12" O.C., STAGGERED
1/4
60 MIL WATERPROOFING MEMBRANE
CONCRETE TOPPING SLAB, SEE PLAN FOR REINF.
L6x6x1/2" x 26'-8" LONG (LLV)
#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO CHANNELS AND VERT. REINF. FOR ELECTRICAL CONTINUITY.
BOND TOPPING SLAB REINF. TO PRECAST WALL PANEL WITH #2/0 AWG BARE CU WIRE AT 4'-0" O.C., EXOTHERMIC WELD MIN. 1 1/4" LENGTH.
NOTE: STAGGER REBAR LAYERS TO FORM A 6"x6" SQUARE MESH PATTERN OF #5 AND #8 REBAR.
#5 HORZ. AT 12" O.C. W/ SEISMIC HOOK EACH END, TYP.
#8 VERT. AT 12" O.C., TYP.
5000 PSI HIGH STRENGTH NON-SHRINK GROUT
4"
1 1/2" TYP.
VARIES FROM 1 1/2" TO 2 1/2"
VARIES FROM 3" TO 4"
4'-1" (EMBEDMENT)
#4 BAR AT 4'-0" O.C. ELECTRICALLY BONDED TO REINF.
WRAP END OF WEEPS WITH FILTER FABRIC, TYP.
1"
(TYP.)
1'-0"
(TYP.)
BOND TOPPING SLAB REINF. TO PRECAST WALL PANEL WITH #2/0 AWG BARE CU WIRE AT 4'-0" O.C., EXOTHERMIC WELD MIN. 1 1/4" LENGTH.
(2) #5 HORZ. CONT. TOP & BOTT. TYP. AT TOP OF WALLS
#4 STIRRUPS AT 4" O.C., TYP. ENCLOSE HORIZ. REINFORCEMENT WITHIN STIRRUPS
10"
1'-2"
WATERPROOFING MEMBRANE (60 MIL), TYP. AT ROOF AND WALLS
PRECAST WALL PANELS
6" SAND MATERIAL (SW)
3" DIAMETER GALV. CORRUGATED STEEL CONDUIT (24 GAUGE MIN.). GROUT SHALL BE 5000 PSI HIGH STRENGTH, NON-SHRINK
#7 DOWELS AT 12" O.C. ALTERNATE HOOK DIRECTION. AT BACK WALL ONLY, PROVIDE FOUR SETS OF (2) #7 BARS BUNDLED AT 12" O.C. TOTAL OF (8) BARS IN EACH WALL END IN LAST 4'-0" OF WALL PANEL NEAREST CORNER
1 1/2" DIA. WEEPS AT 1'-8" O.C.
#5 DOWELS AT 12" O.C.
6" DIA. PERFORATED FOOTING DRAIN PIPE, TYP. (TURN PERFORATIONS DOWN)
FILTER FABRIC
GRAVEL MATERIAL (GW)
#5 TRANSVERSE BARS AT 12" O.C. TOP AND BOTT.
#6 HORZ. CONT. AT 12" O.C.
#5 CONT. AT 12" O.C. TOP AND BOTT.
1'-6"
1'-0"
2'-9 1/2 "
1'-11"
1'-9 1/2 "
6'-6"
NOTE: PROVIDE RAMPS, FOR EXAMPLE, PRESSURE TREATED 2x MEMBERS SLOPED AS REQUIRED TO ALLOW FORKLIFTS TO SAFELY TRANSPORT MUNITIONS OVER DOOR SILL.
CAULK VOIDS AROUND DOOR FRAME
L6 x 3 1/2 x 3/8 (LLV) W/ 1/2" DIA. x 4" HEADED STUDS AT 12" O..C.
#5 DOWELS x 8'-0" LONG AT 1'-0" O.C. (ENSURE ELECTRICAL CONTINUITY IS MAINTAINED AT 4'-0" O.C. BETWEEN SLAB AND TURNDOWN FOOTING REINF.)
1/2" EXPANSION JOINT FILLER & SEALER
HSS 8x8x1/4
SLOPE DN.
SLAB-ON-GRADE SEE PLAN
0'-1" TOP OF SLAB AT DOOR
4"
2'-1"
1'-9"
7 1/2"
8 1/2 "
2'-1"
CONCRETE APRON, MAINTAIN SLOPE AWAY FROM DOOR FOR 13'-0" MIN..
1
3
(7) #5 BARS CONT AS SHOWN
#4 BARS AT 3'-0" O.C.
2'-0"

A SECTION
S101 | S302
S102
S201
SCALE: 3/4"=1'-0"

US Army Corps of Engineers Huntsville Center

No.	Description	Date	Appr.
4	Removed Hasps. Modified ILD Door Details, Implemented Lessons Learned. Electrical Updates	MAY 2023	

Date: MAY 2023
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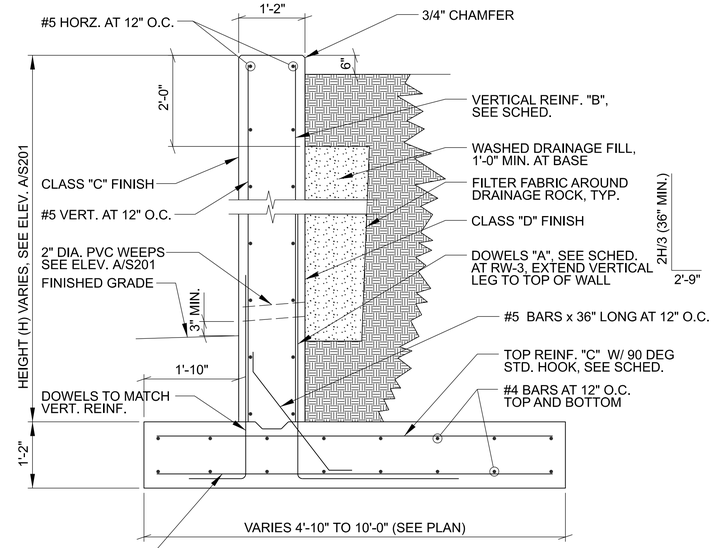
U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)

BUILDING SECTION

Sheet reference number:
S-302
Sheet 10 of 29

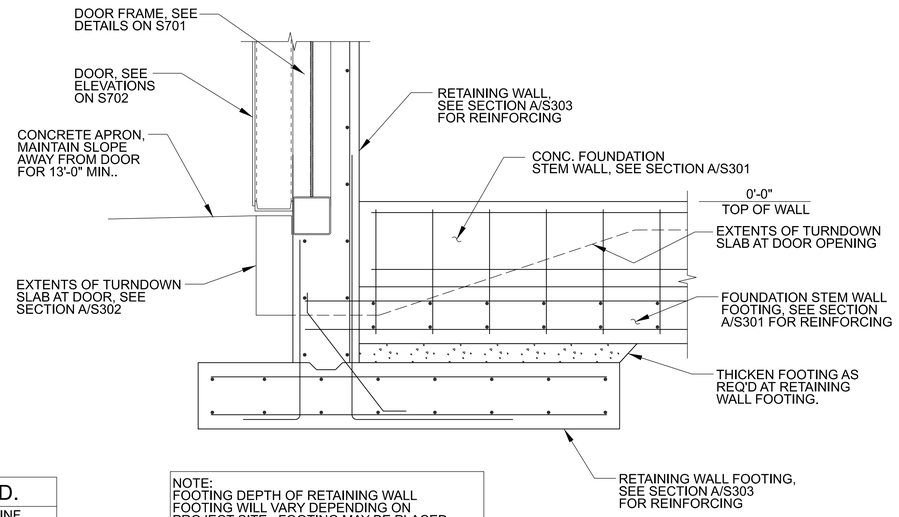


NOTES:

1. FRONT SIDE OF WALL MUST BE BACKFILLED AND COMPACTED BEFORE BACKFILLING BEHIND WALL.

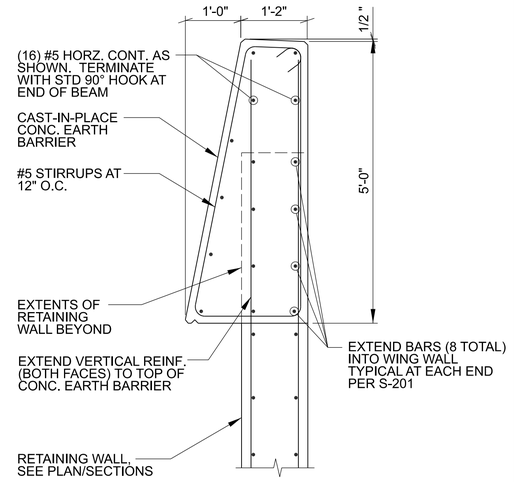
RETAINING WALL SCHED.				
WALL TYPE	STEM REINF.		FTG. REINF.	
	DOWELS "A"	VERTICAL "B"	TOP "C"	BOTTOM "D"
RW-1	#7 AT 5"	#7 AT 10"	#7 AT 5"	#5 AT 10"
RW-2	#7 AT 12"	#7 AT 12"	#7 AT 12"	#5 AT 12"
RW-3	#5 AT 12"	N/A	#5 AT 12"	#5 AT 12"

A SECTION
S101 | S303
S201
SCALE: 3/4"=1'-0"

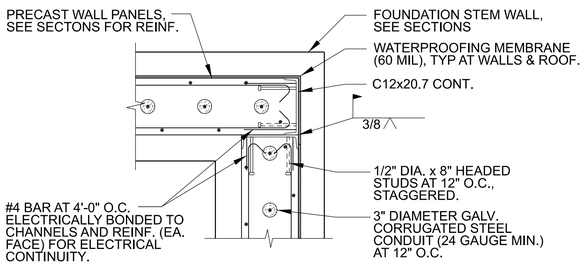


NOTE:
FOOTING DEPTH OF RETAINING WALL FOOTING WILL VARY DEPENDING ON PROJECT SITE. FOOTING MAY BE PLACED MONOLITHICALLY WITH SIDE WALL FOOTING IF PLACED AT THE SAME ELEVATION.

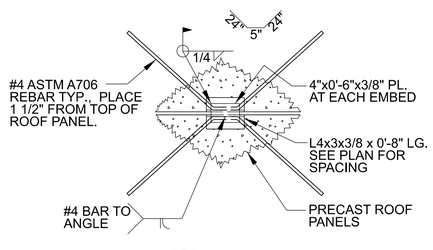
B SECTION
S101 | S303
S201
SCALE: 3/4"=1'-0"



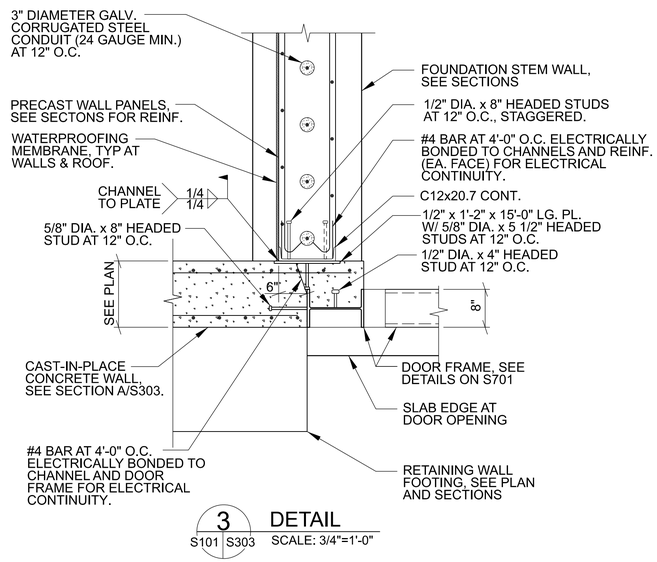
C SECTION
S201 | S303
SCALE: 3/4"=1'-0"



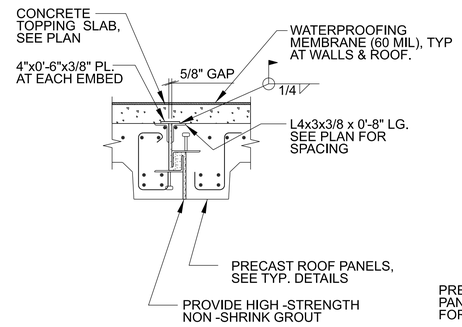
1 DETAIL
S101 | S303
SCALE: 3/4"=1'-0"



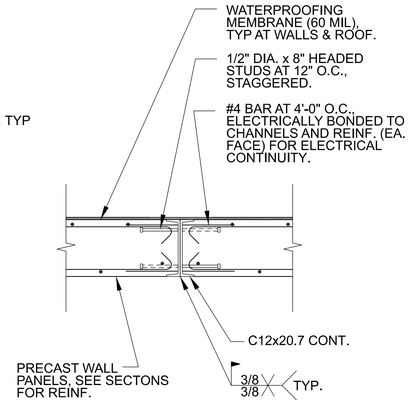
2 DETAIL
S102 | S303
SCALE: 3/4"=1'-0"



3 DETAIL
S101 | S303
SCALE: 3/4"=1'-0"



4 DETAIL
S102 | S303
S202
S302
SCALE: 3/4"=1'-0"



5 DETAIL
S202 | S303
SCALE: 3/4"=1'-0"

US Army Corps of Engineers
Huntsville Center

Revisions			
No.	Description	Date	Appr.
4	Removed Hasps. Modified ILD Door Details, Implemented Lessons Learned. Electrical Updates	MAY 2023	

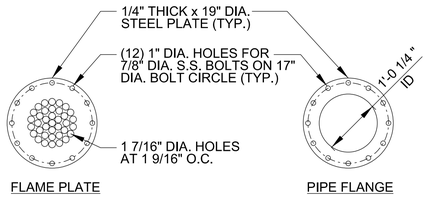
Designed by: JMU
Drawn by: JMU
Checked by: RSW
Date: MAY 2023
Scale: AS SHOWN
Drawing code:
Project Engineer/Architect: Jeff Coulston
Date:

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

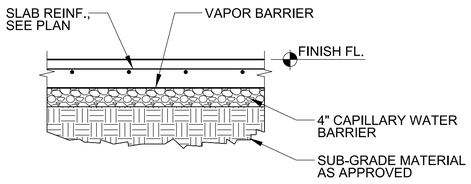
SECTIONS

Sheet reference number:
S-303
Sheet 11 of 29



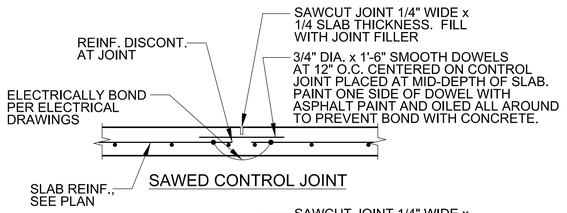
NOTE:
CLASS 150 FORGED FLANGES MAY BE SUBSTITUTED FOR FABRICATED PLATE FLANGES

VENTILATOR FLAME PLATE DETAIL A
SCALE: 3/4"=1'-0" — S501



SLAB-ON-GRADE DETAIL B
SCALE: 3/4"=1'-0" — S501

NOTES:
REFER TO GEOTECHNICAL REPORT FOR THE SUBGRADE PREPARATION AND EARTHWORK RECOMMENDATIONS.



SLAB CONTROL JOINT DETAIL C
SCALE: 3/4"=1'-0" — S501

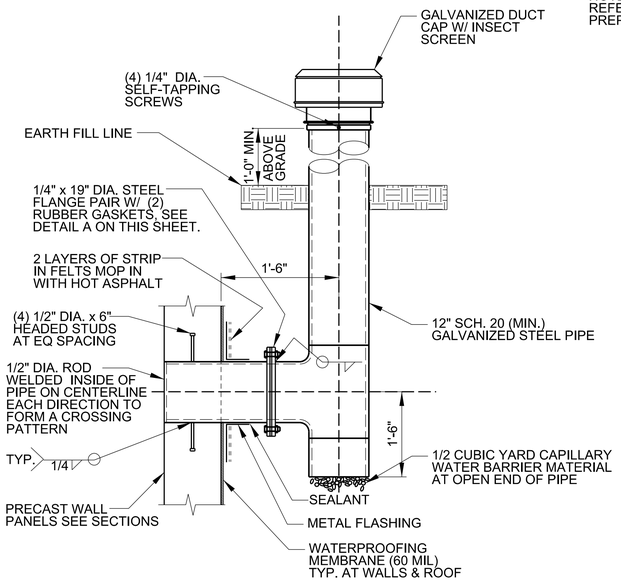
USE EITHER AT CONTRACTOR'S OPTION
SAWCUT JOINTS AS EARLY AS ALLOWED
HAND- TOOL AREAS INACCESSIBLE BY SAW

SPLICE LENGTHS					DEVELOPMENT LENGTHS	
BAR SIZE	f_c= 4000 PSI				f_c= 4000 PSI	
	TOP BARS		OTHER BARS		TOP BARS	OTHER BARS
NO.	A	B	A	B		
#3	19"	24"	15"	19"	19"	15"
#4	25"	32"	19"	25"	25"	19"
#5	31"	40"	24"	31"	31"	24"
#6	37"	48"	29"	37"	37"	29"
#7	54"	70"	42"	54"	54"	42"
#8	62"	80"	48"	60"	62"	48"
#9	78"	101"	60"	78"	70"	54"
#10	85"	111"	66"	85"	79"	61"

TOP BARS ARE HORIZONTAL REINF. WITH MORE THAN 12" ON CONCRETE CAST BELOW THE REINF.

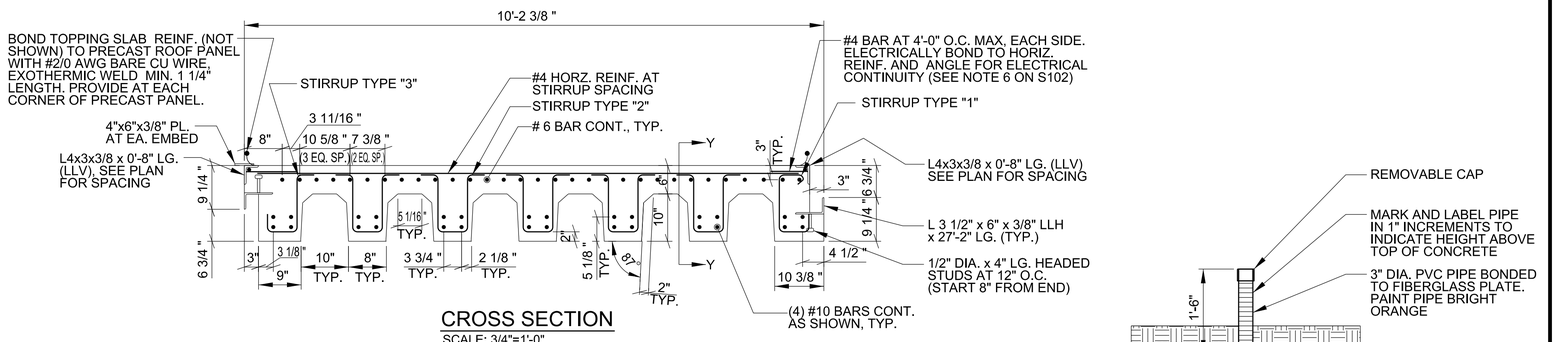
CONCRETE LAP LENGTHS SHALL BE INCREASED 20 PERCENT WHERE EPOXY COATING IS USED.

WHEN LAPPING TWO DIFFERENT SIZE BARS, USE THE LARGER OF THE LAP SPLICE DIMENSION OF THE SMALLER BAR OR THE DEVELOPMENT LENGTH OF THE LARGER BARS

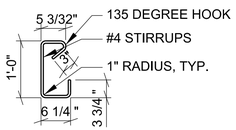


TYPICAL VENT DETAIL D
SCALE: 3/4"=1'-0" — S501

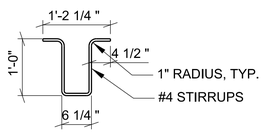
NOTE:
PROVIDE ELECTRICAL CONTINUITY BY BONDING VERTICAL AND HORZ. REINFORCEMENT TO VENT PIPE



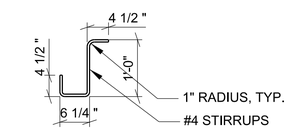
CROSS SECTION
SCALE: 3/4"=1'-0"



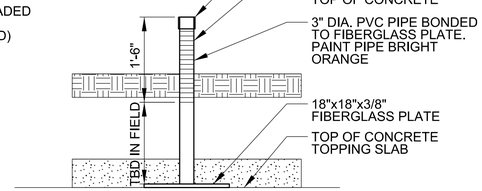
STIRRUP TYPE "1"
SCALE: 3/4"=1'-0"



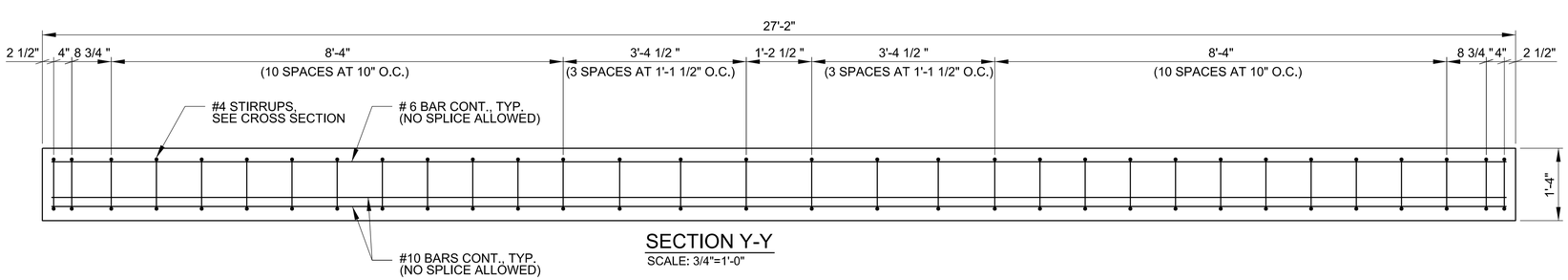
STIRRUP TYPE "2"
SCALE: 3/4"=1'-0"



STIRRUP TYPE "3"
SCALE: 3/4"=1'-0"



DEPTH GAUGE DETAIL F
SCALE: 3/4"=1'-0" — S501



SECTION Y-Y
SCALE: 3/4"=1'-0"

PRECAST ROOF PANEL DETAIL E
SCALE: 3/4"=1'-0" — S501

NOTES:
1. PROVIDE ELECTRICAL CONTINUITY WITHIN THE PRECAST ROOF PANEL BY BONDING AT 4'-0" O.C. ACROSS TOP OF STIRRUPS TO END ANGLES IN ONE DIRECTION. IN THE OTHER DIRECTION, ELECTRICALLY BOND #4 BARS FROM BOTTOM PLATE TO #4 REINF.
2. CONCRETE TOPPING SLAB NOT SHOWN FOR CLARITY.

US Army Corps of Engineers
Huntsville Center

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Designed by: JMU
Drawn by: JMU
Checked by: RSW
Project Engineer/Architect: Jeff Coulston
Date: MAY 2023
Scale: AS SHOWN
Drawing code:
Date:

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ENGINEERING AND
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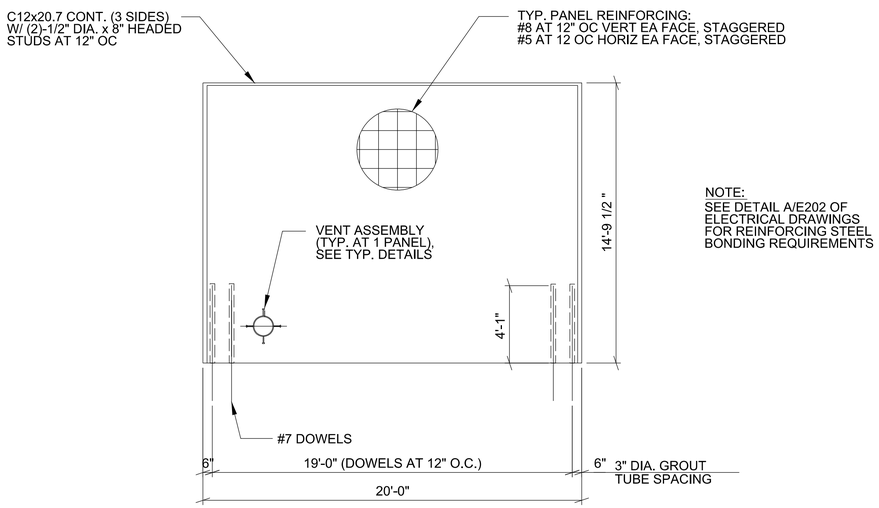
MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

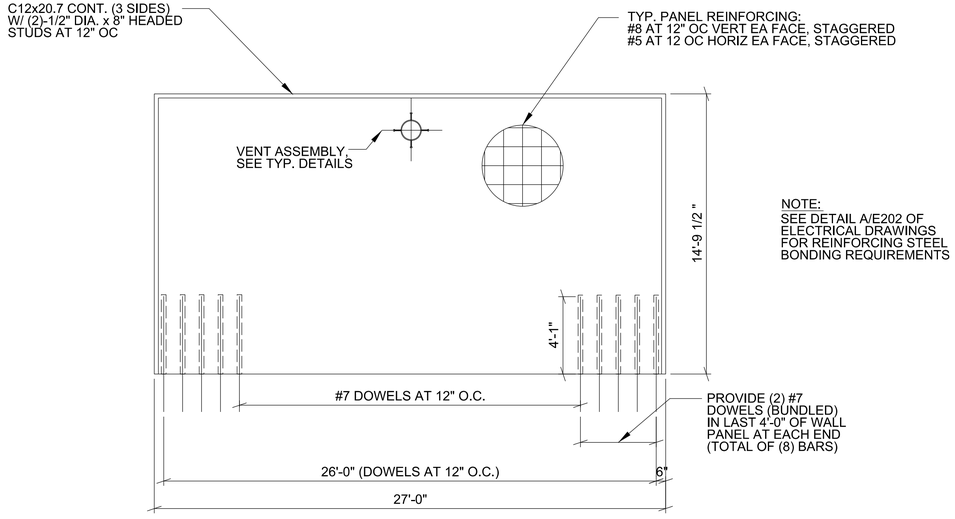
TYPICAL DETAILS

Sheet reference number:
S-501
Sheet 12 of 29



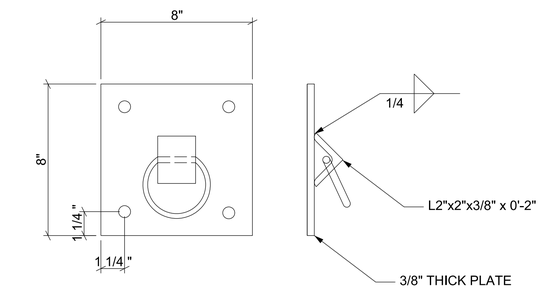
NOTE:
SEE DETAIL A/E202 OF ELECTRICAL DRAWINGS FOR REINFORCING STEEL BONDING REQUIREMENTS

SIDE WALL PANEL ELEVATION (A / S502)
SCALE: 1/4=1'-0"



NOTE:
SEE DETAIL A/E202 OF ELECTRICAL DRAWINGS FOR REINFORCING STEEL BONDING REQUIREMENTS

BACK WALL PANEL ELEVATION (B / S502)
SCALE: 1/4=1'-0"



RING SHALL BE 3/8" THICK, 2 1/2" DIA., SSC400 STEEL, GALVANIZED AND PAINTED SAFETY YELLOW.

D-RING DETAIL (C / S502)
SCALE: 3"=1'-0"

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Date:

Designed by: JMU
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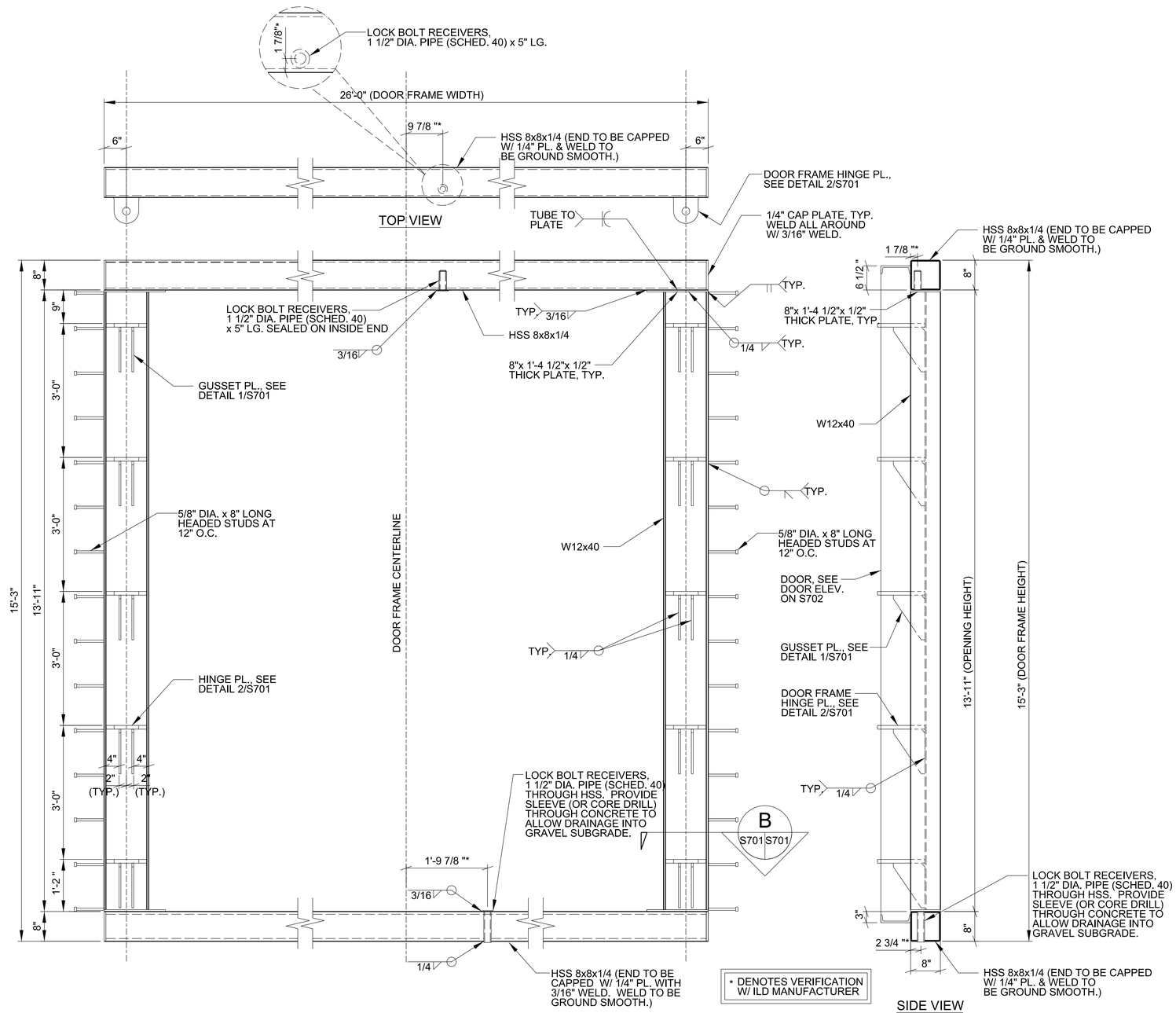
MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

TYPICAL WALL DETAILS

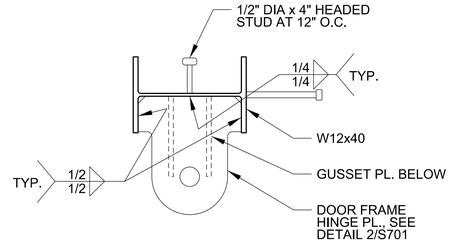
Sheet reference number:
S-502
Sheet 13 of 29



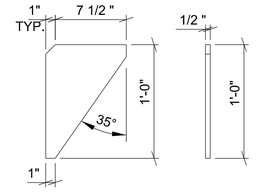
DOOR FRAME ELEVATION A
SCALE: 3/4"=1'-0"
S201 S701

NOTES:

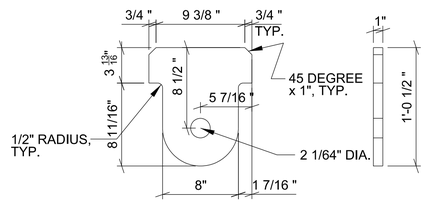
1. THE 6 1/2" AND 3" DOOR OVERLAP AT THE TOP AND BOTT. OF THE DOOR FRAME. RESPECTIVELY SHALL NOT BE REDUCED AS THIS IS IMPERATIVE TO CARRY OUT THE DESIGN INTENT.
2. PROVIDE HEAVY DUTY WEATHER STRIPPING/ SEALING AROUND INSIDE PERIMETER OF DOOR GAPS.
3. DOOR FRAME AND BLAST DOORS SHALL BE FACTORY PAINTED WITH HIGH PERFORMANCE COATING SYSTEM.



SECTION B
SCALE: 1 1/2"=1'-0"
S701 S701



GUSSET PL. DETAIL 1
SCALE: 1 1/2"=1'-0"
S701 S701



DOOR FRAME HINGE PL. DETAIL 2
SCALE: 1 1/2"=1'-0"
S701 S701

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US Army Corps of Engineers Huntsville Center

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Drawn by: JMU
Checked by: RSW
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Scale: AS SHOWN
Drawing code:
Project Engineer/Architect: Jeff Coulston
Date:

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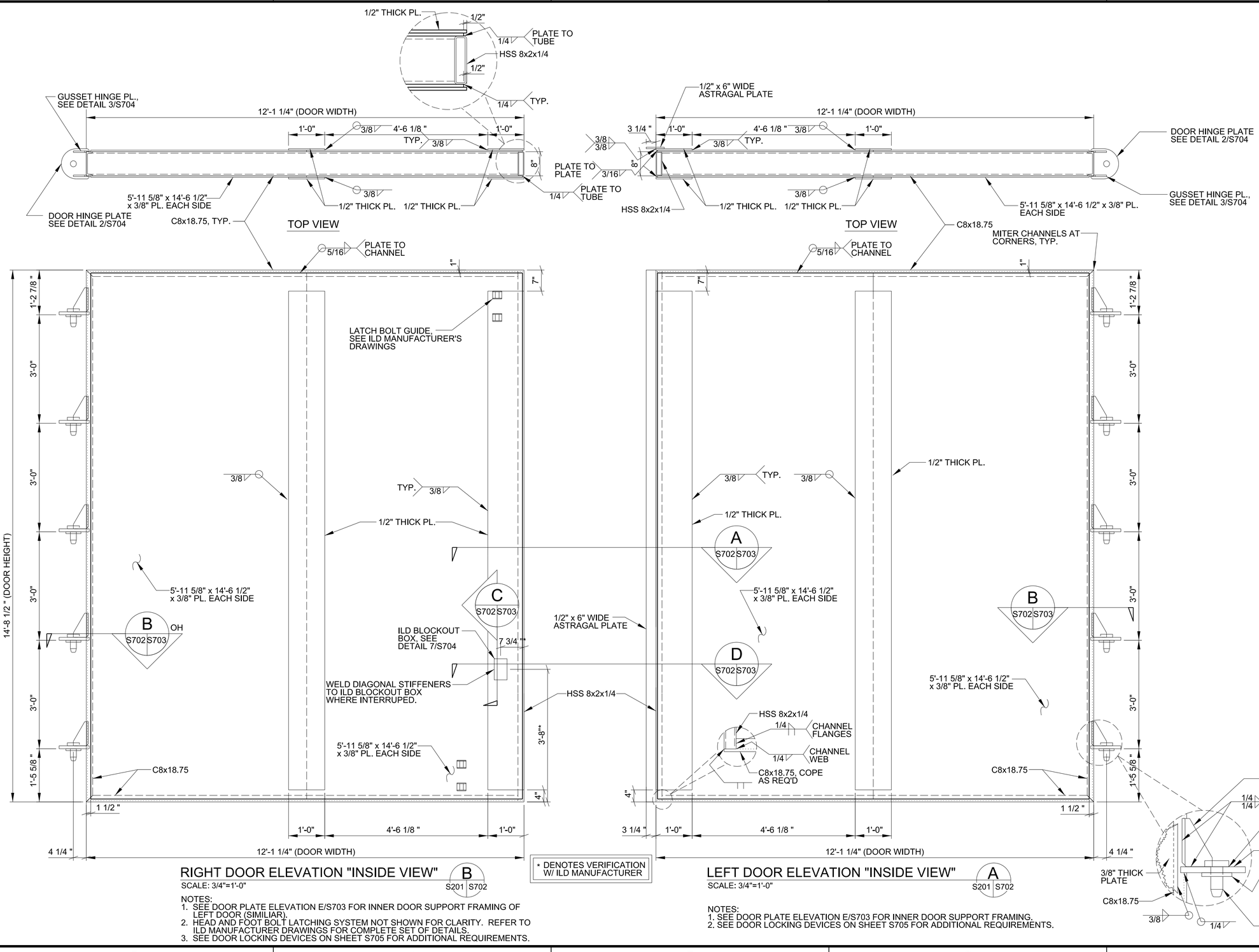
MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)

DOOR FRAME ELEVATIONS AND DETAILS

Sheet reference number:
S-701
Sheet 14 of 29



RIGHT DOOR ELEVATION "INSIDE VIEW"

SCALE: 3/4"=1'-0"

B S201 S702

NOTES:
1. SEE DOOR PLATE ELEVATION E/S703 FOR INNER DOOR SUPPORT FRAMING OF LEFT DOOR (SIMILIAR).
2. HEAD AND FOOT BOLT LATCHING SYSTEM NOT SHOWN FOR CLARITY. REFER TO ILD MANUFACTURER DRAWINGS FOR COMPLETE SET OF DETAILS.
3. SEE DOOR LOCKING DEVICES ON SHEET S705 FOR ADDITIONAL REQUIREMENTS.

LEFT DOOR ELEVATION "INSIDE VIEW"

SCALE: 3/4"=1'-0"

A S201 S702

NOTES:
1. SEE DOOR PLATE ELEVATION E/S703 FOR INNER DOOR SUPPORT FRAMING.
2. SEE DOOR LOCKING DEVICES ON SHEET S705 FOR ADDITIONAL REQUIREMENTS.

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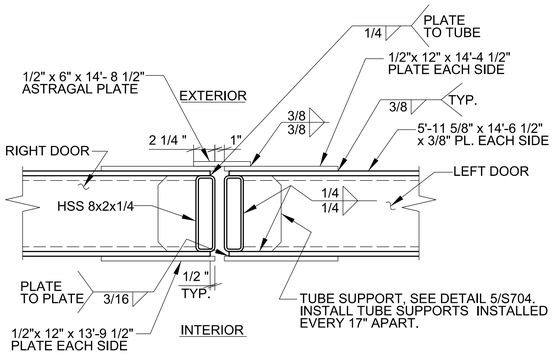
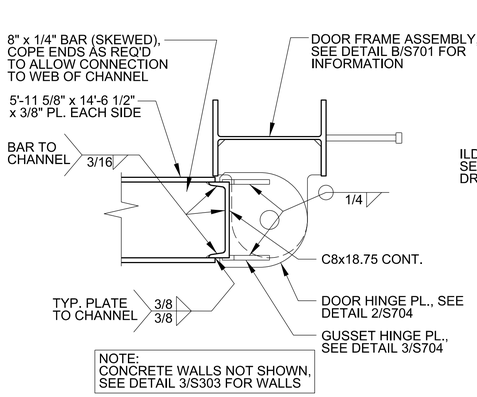
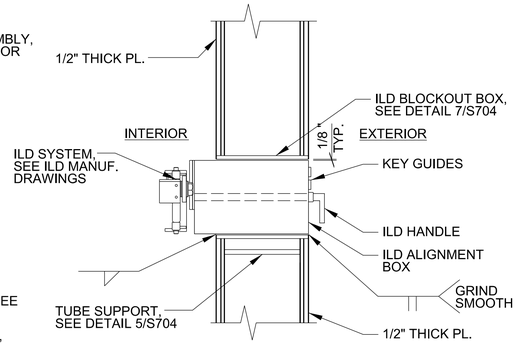
MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

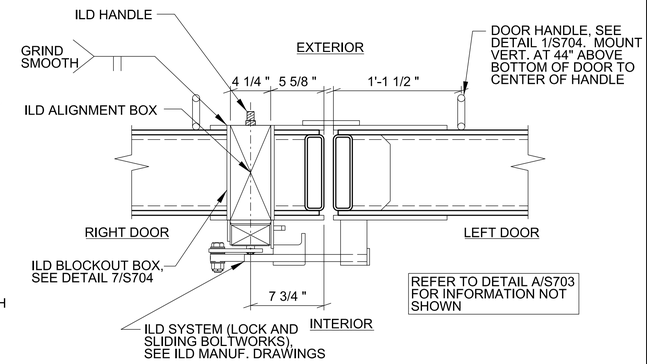
DOOR ELEVATIONS

Sheet reference number:
S-702
Sheet 15 of 29

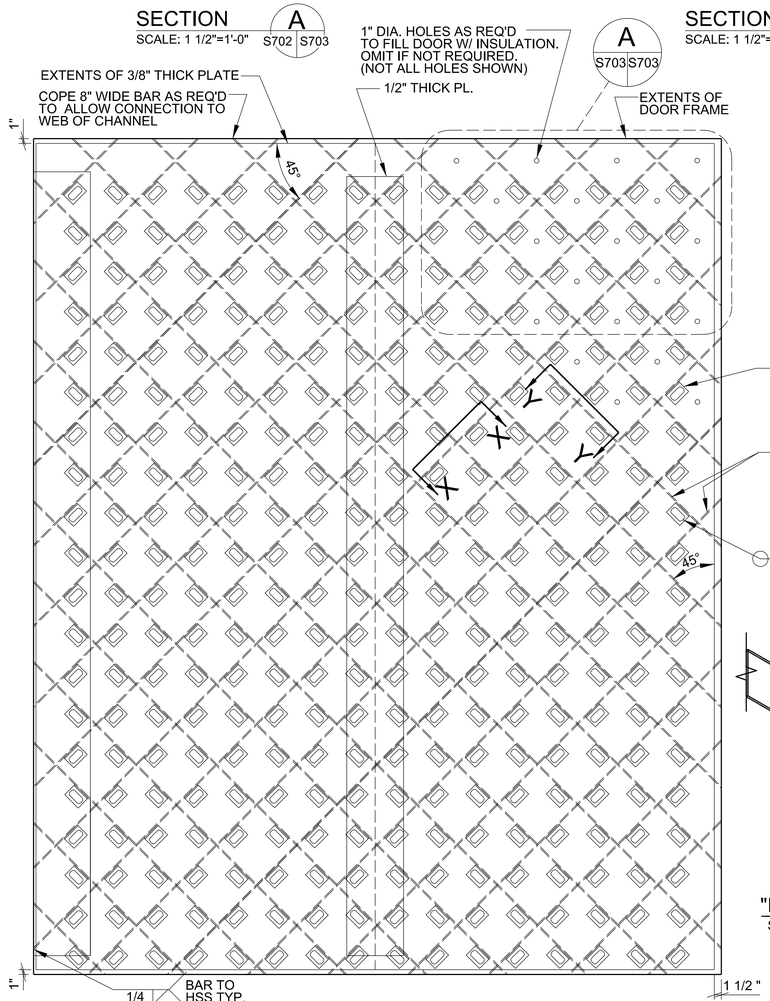








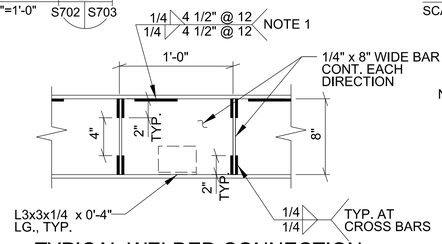
SECTION A
SCALE: 1 1/2"=1'-0" (A S702 | S703)



LEFT DOOR PLATE ELEVATION "INSIDE VIEW"
SCALE: 3/4"=1'-0" (E S702 | S703)

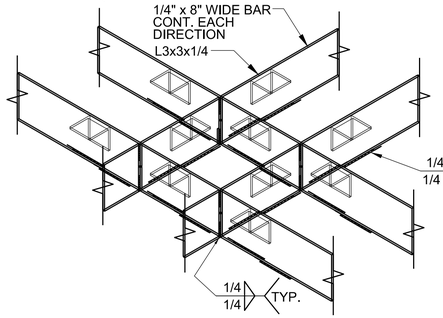
NOTE: RIGHT DOOR PLATE ELEVATION IS SIMILAR

SECTION B
SCALE: 1 1/2"=1'-0" (B S702 | S703)



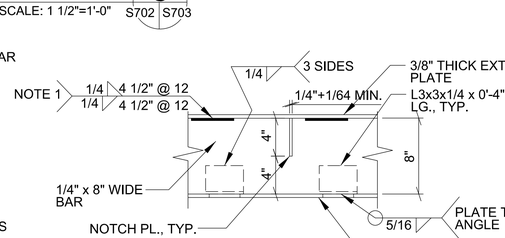
TYPICAL WELDED CONNECTION AT INTERSECTION OF CROSS BARS
SCALE: 1 1/2"=1'-0"

NOTE 1:
PLATE TO CROSS BAR (ALTERNATE WELDS ALONG CROSSING BARS)



"ISOMETRIC VIEW" OF WELDS AT CROSS BARS
SCALE: 1 1/2" = 1'-0"

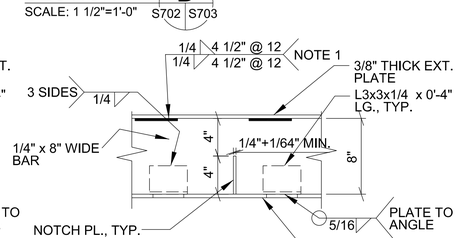
SECTION C
SCALE: 1 1/2"=1'-0" (C S702 | S703)



NOTE:
CROSS BAR NOT SHOWN FOR CLARITY

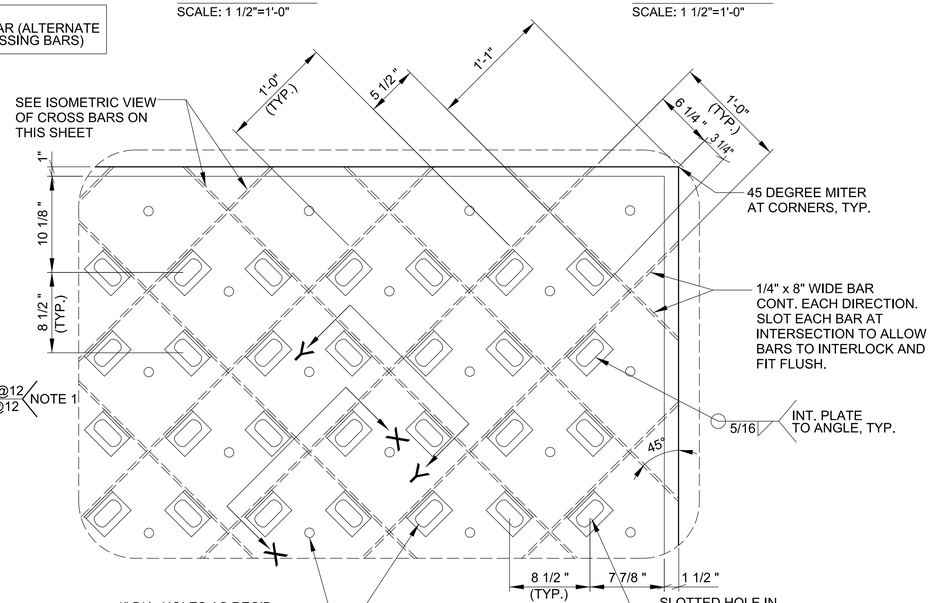
SECTION X-X
SCALE: 1 1/2"=1'-0"

SECTION D
SCALE: 1 1/2"=1'-0" (D S702 | S703)



NOTE:
CROSS BAR NOT SHOWN FOR CLARITY

SECTION Y-Y
SCALE: 1 1/2"=1'-0"



DETAIL
SCALE: 1 1/2"=1'-0" (A S703 | S703)

US Army Corps of Engineers
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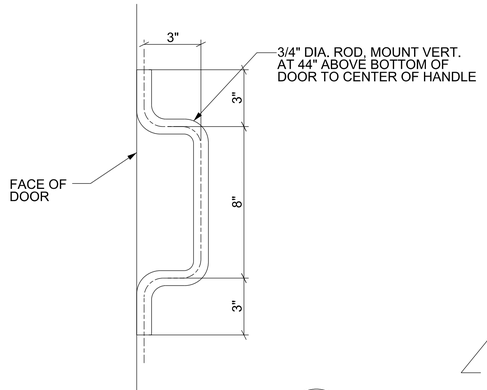
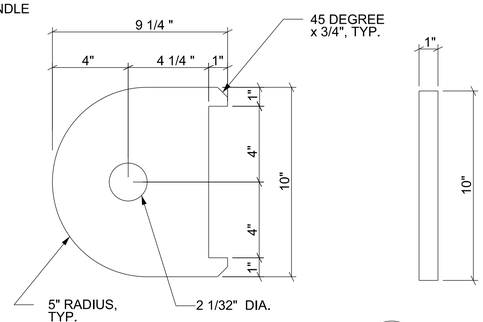
MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)

DOOR SECTIONS

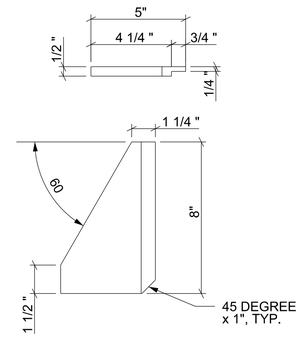
Sheet reference number:
S-703
Sheet 16 of 29



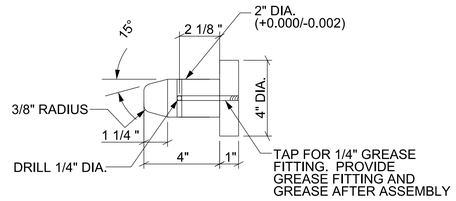
HANDLE DETAIL 1
SCALE: 3"=1'-0"
S201 S703 | S704



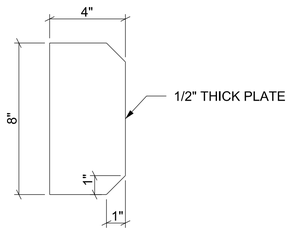
DOOR HINGE PL. DETAIL 2
SCALE: 3"=1'-0"
S702 S703 | S704



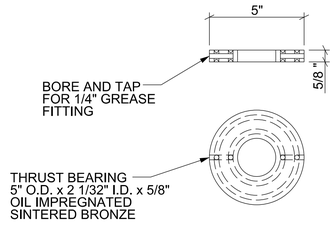
GUSSET HINGE PL. DETAIL 3
SCALE: 3"=1'-0"
S702 S703 | S704



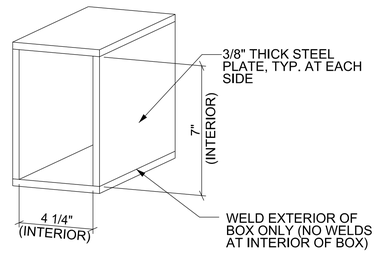
HINGE PIN DETAIL 4
SCALE: 3"=1'-0"
S702 S704



TUBE SUPPORT PL. DETAIL 5
SCALE: 3"=1'-0"
S703 S704



THRUST BEARING DETAIL 6
SCALE: 3"=1'-0"
S702 S704



ILD BLOCKOUT BOX DETAIL 7
SCALE: 3"=1'-0"
S702 S704

US Army Corps of Engineers
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No.	Description	Date	Appr.
1	Removed Hasps. Modified ILD Door Details, implemented Lessons Learned. Electrical Updates	MAY 2023	

Designed by: JMU
Drawn by: JMU
Checked by: RSW
Project Engineer/Architect: Jeff Coulston
Date: MAY 2023
Scale: AS SHOWN
Drawing code:
Date:

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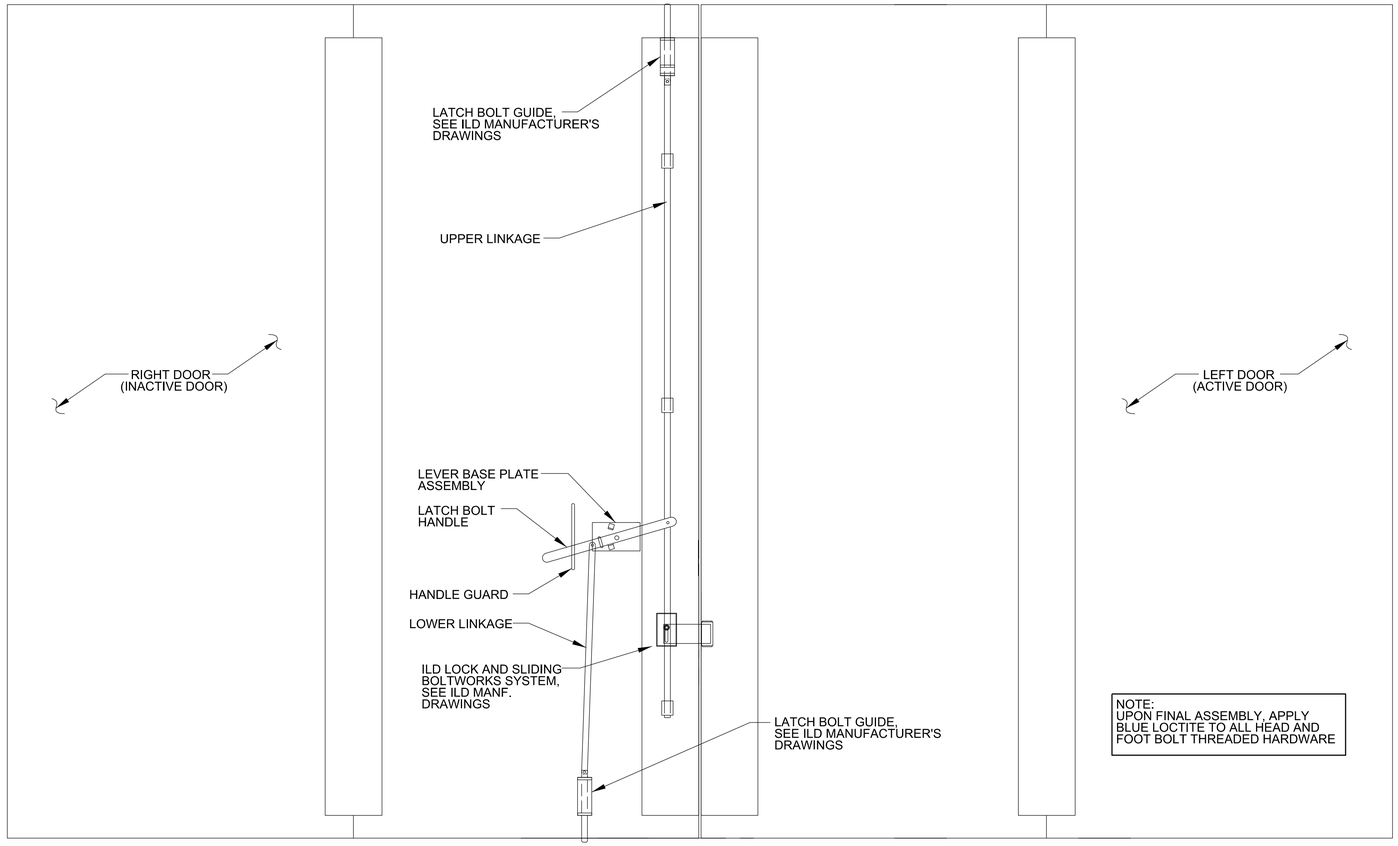
MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

DOOR DETAILS

Sheet reference number:
S-704
Sheet 17 of 29



INTERNAL LOCKING DEVICE (ILD) — A / S705

SCALE: NTS
VIEW FROM INSIDE OF MAGAZINE
FOOT & HEAD BOLT SHOWN LOCKED

DETAILS SHOW THE GENERAL ARRANGEMENT OF ILD SYSTEM WITH HEAD AND FOOT LATCH BOLTS. SEE ILD MANUF. DRAWINGS FOR A COMPLETE SET OF DETAILS AND REQUIREMENTS.

INTERNAL LOCKING DEVICE (ILD) NOTES:

1. THE INTERNAL LOCKING DEVICE (ILD), THE SLIDING BOLTWORKS, AND HEAD AND FOOT BOLT DRAWINGS ARE A U.S. GOVERNMENT DESIGNED AND PATENTED LOCKING SYSTEM. THE (ILD) LOCK SHALL BE PURCHASED FROM THE GOVERNMENT. THE SLIDING BOLTWORKS AND HEAD AND FOOT BOLT DRAWINGS SHALL BE PROCURED THROUGH THE GOVERNMENT WITH COORDINATION OF NAVAL FACILITIES ENGINEERING EXPEDITIONARY WARFARE CENTER, SECURITY ENGINEERING DIVISION (NAVFACEXWC). CONTACT CAN BE MADE VIA PHONE BY CALLING 805-982-1212 OR THEIR WEBSITE (https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_nfesc_pp/locks/) FOR ORDERING INFORMATION.
2. NO MODIFICATIONS AND/OR DEVIATIONS TO THE DOOR CONSTRUCTION SHOWN IN THE STANDARD DRAWINGS ARE PERMITTED TO ACCOMMODATE THE ILD UNLESS APPROVED BY THE U.S. ARMY ENGINEERING AND SUPPORT CENTER, HUNTSVILLE (STRUCTURAL BRANCH).
3. DOOR MANUFACTURER WILL COORDINATE WITH THE DOD LOCK PROGRAM ON THE FABRICATION OF THE ILD BOLTWORK AND INSTALLATION/ATTACHMENT DETAILS OF THE ILD. PROVIDE THE NECESSARY STIFFENERS AND ADDITIONAL FRAMING (IF REQUIRED) TO ACCOMMODATE THE ILD.
4. SEE ILD MANUFACTURERS INSTALLATION DRAWINGS FOR ADDITIONAL INFORMATION NOT SHOWN IN THESE DRAWINGS.
5. SEE DOOR FRAME AND DOOR DETAILS ON SHEETS S701 - S704.

US Army Corps of Engineers
Huntsville Center

Revisions			
No.	Description	Date	Appr.
4	Removed Hasps. Modified ILD Door Details, implemented Lessons Learned. Electrical Updates	MAY 2023	

Date: MAY 2023
Scale: AS SHOWN
Drawing code:
Date:

Designed by: JMU
Drawn by: JMU
Checked by: RSW
Project Engineer/Architect: Jeff Coulston

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND
SUPPORT CENTER,
HUNTSVILLE, ALABAMA

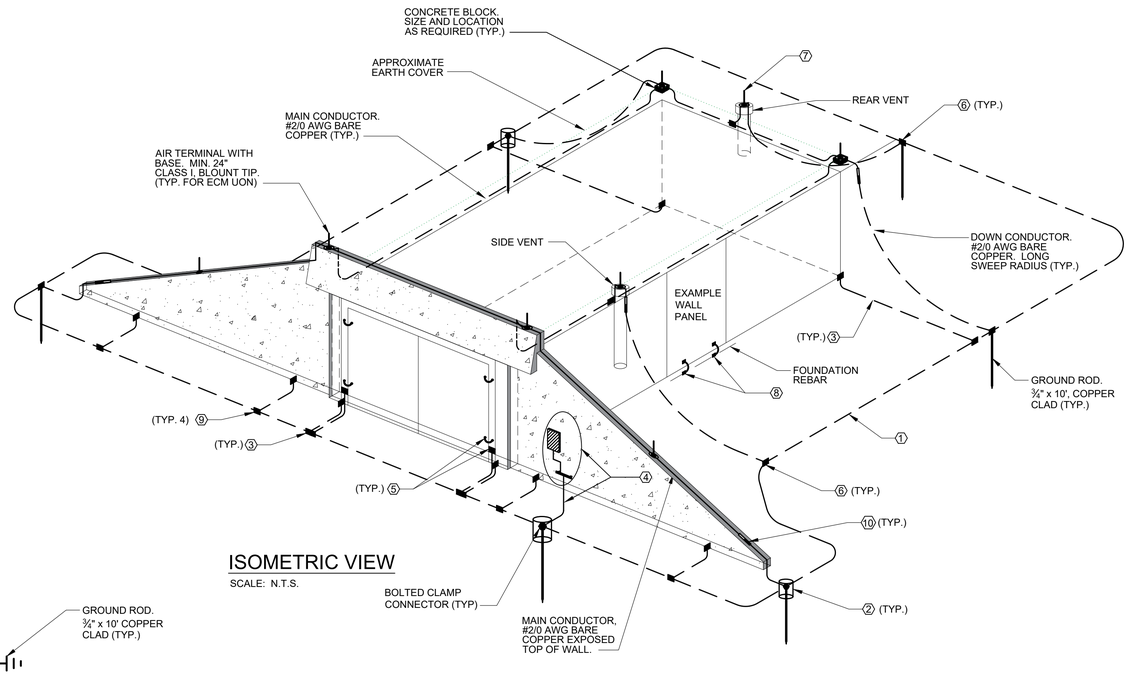
MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

INTERNAL LOCKING DEVICES

Sheet reference number:
S-705
Sheet 18 of 29

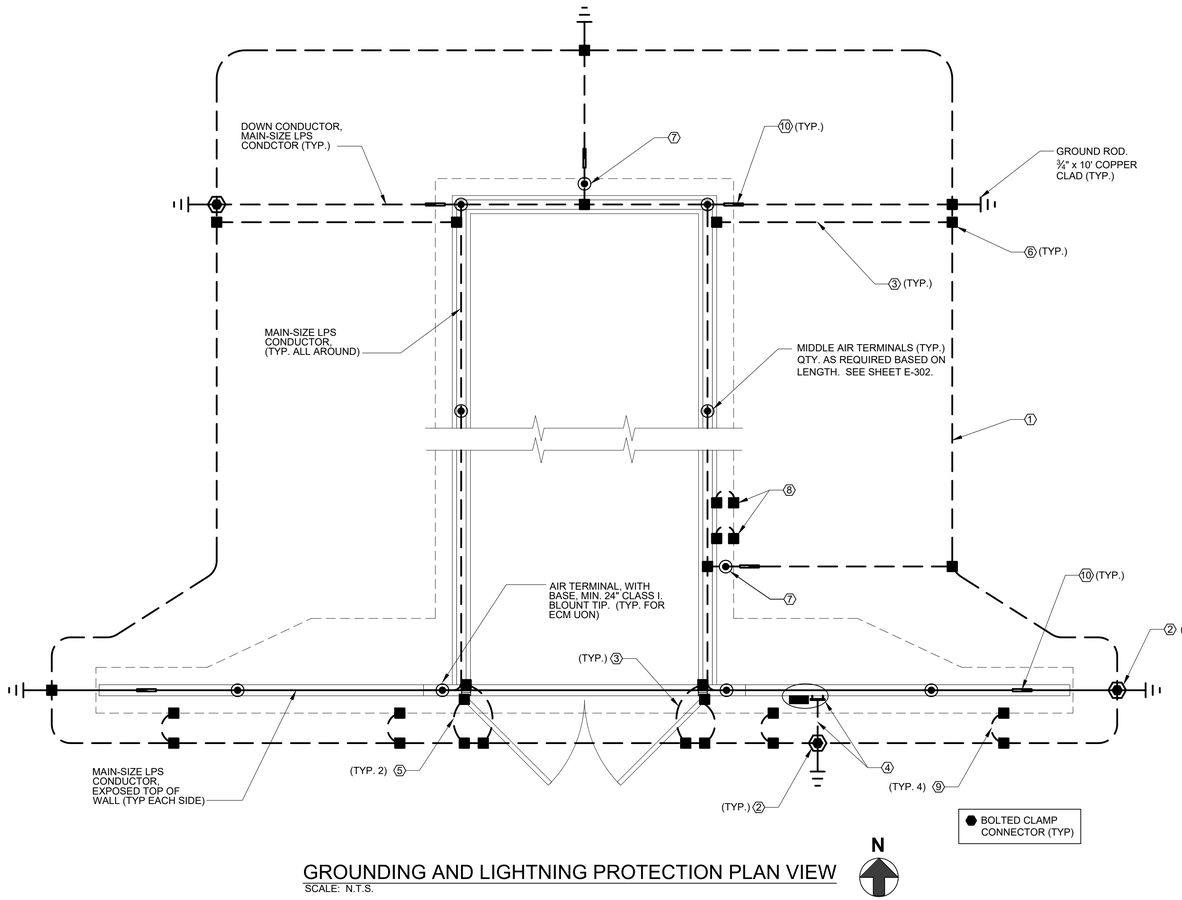
GENERAL NOTES:

1. THIS DRAWING SET REPRESENTS THE ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, (CEHNC) STANDARD GUIDANCE FOR LIGHTNING PROTECTION SYSTEM (LPS) DESIGN APPLICABLE TO EARTH COVERED MAGAZINES (ECM). THIS STANDARD IS A PERFORMANCE BASED DESIGN. DESIGNER SHALL ADAPT THE STANDARDS TO SPECIFIC SITE CONDITIONS AND CONSULT GOVERNING CRITERIA TO ENSURE A COMPLETE AND FUNCTIONAL LPS DESIGN.
2. AT ARMY INSTALLATIONS THE COMPLETED LPS SHALL RECEIVE AN UNDERWRITER'S LABORATORY (UL) MASTER LABEL CERTIFICATE IN COMPLIANCE WITH APPLICABLE GOVERNING CRITERIA. OTHER THAN ARMY, CERTIFICATION SHALL BE ACCORDING TO THE AHJ.
3. LPS COMPONENTS SHALL BEAR THE UL LISTING OR LABEL WHEN AVAILABLE (OR LOCAL EQUIVALENT).
4. THE LPS DESIGN MUST PROVIDE A ZONE-OF-PROTECTION BASED ON A 100' RADIUS STRIKING DISTANCE (*ds*) USING THE ROLLING SPHERE METHOD (RSM) ANALYSIS. REFER TO SHEETS E-301, E-302, AND E-601 FOR A RSM ANALYSIS EXAMPLE.
5. REINFORCING STEEL IN WALLS, FLOOR SLAB, ROOF PANELS OR BOX STRUCTURES MUST BE ELECTRICALLY CONTINUOUS THROUGH BONDING AND HAVE A SOLID, DIRECT CONNECTION TO THE PRIMARY GROUNDING ELECTRODE SYSTEM. MINIMUM REBAR OVERLAP IS 20 x DIAMETER (20D). METAL VENTILATORS, STEEL DOORS AND FRAMES SHALL BE BONDED TO THE PRIMARY GROUNDING ELECTRODE SYSTEM. PHOTO DOCUMENTATION OF THE BONDING AND GROUNDING WORKS IS MANDATORY BEFORE CONCEALING. REFERENCE STRUCTURAL DRAWINGS FOR ADDITIONAL BONDING INFORMATION.
6. INCOMING POWER AND AUXILIARY CONDUCTORS MUST RUN UNDERGROUND FOR AT LEAST 50' BEFORE ENTERING THE FACILITY. CONDUCTORS MUST BE SHIELDED OR INSTALLED IN METALLIC CONDUIT THAT IS BONDED TO THE PRIMARY GROUNDING ELECTRODE SYSTEM AT THE POINT OF ENTRY.
7. INTERIOR ELECTRICAL SYSTEMS ARE NOT INCLUDED IN THIS STANDARD SET. IF REQUIRED, INTERIOR ELECTRICAL SYSTEMS SHALL BE DESIGNED BASED ON USER REQUIREMENTS. HAZARDOUS CLASSIFICATIONS BASED ON NFPA 70, ARTICLE 500 SHALL BE DETERMINED BY THE DESIGNER DURING THE DESIGN PROCESS BASED ON INTENDED FACILITY USE AND CONTENTS.
8. STATIC GROUND BUS BAR NOT DEPICTED. IF REQUIRED, SEE DA PAM 385-64, SECTION II; UFC 3-575-01, CHAPTER 2 AND DETAIL 'D' ON SHEET E-201 FOR MORE INFORMATION.
9. PROVIDE SURGE PROTECTION DEVICES (SPD) FOR CONDUCTIVE MEDIA AT THE POINT OF ENTRY INTO THE FACILITY. SPD's SHALL BE COMPLIANT WITH NFPA 780.
10. CONSIDER METALLIC MASSES FOR SIDE FLASH POTENTIAL. METALLIC MASSES WITHIN SIDE FLASH DISTANCE SHALL BE BONDED TO THE LPS, OR BE MOVED OUTSIDE THE SIDE FLASH SEPARATION DISTANCE.
11. UNDERGROUND CONNECTIONS TO THE GROUNDING ELECTRODE SYSTEM SHALL BE WITH EXOTHERMIC WELDS. WITHIN GROUND TEST WELLS USE BOLTED CONNECTORS ONLY.
12. USE COPPER CONDUCTORS, ONLY. ALUMINUM CONDUCTORS NOT ALLOWED FOR ECM CONSTRUCTION. PROVIDE BI-METALLIC CONNECTORS, PLATING AND ACCEPTABLY PROTECTED MATERIALS AS REQUIRED TO PREVENT CORROSION DUE TO DISSIMILAR METALS CONTACT. SEE ANSI/UL 96 SUGGESTED COMPATIBLE METALS ON SHEET E-201.
13. TWO VENTILATORS SHOWN. IF OTHER VENTILATORS ARE REQUIRED, PROVIDE AIR TERMINALS, GROUNDING AND BONDING TYPICAL AS SHOWN. ALL OTHER LPS COMPONENTS AND DESIGN ASPECTS REMAIN UNCHANGED. SIDE VENTILATOR LOCATION IS APPROXIMATE. LOCATION SHOWN FOR CLARITY.
14. APPLY THE MOST STRINGENT CRITERIA WHERE CONFLICTS ARISE BETWEEN US STANDARDS AND LOCAL STANDARDS. SEE CRITERIA TABLE THIS SHEET.
15. LPS CONDUCTORS SHALL BE SIZED PER NFPA 780 TABLE 4.1.1.1.1 (CLASS I) OR TABLE 4.1.1.1.2 (CLASS II) AS NOTED. FOR ECMs, LPS CONDUCTORS SHALL BE MINIMUM MAIN-SIZE CLASS II, UON. REFER TO TABLE THIS SHEET FOR CORRESPONDING COMPARISON BETWEEN MAIN-SIZE LPS CONDUCTORS AND AWG-SIZED CONDUCTORS. BARE AWG CONDUCTORS TYPICALLY ARE NOT "LISTED FOR THE PURPOSE" FOR LIGHTNING PROTECTION BY A LISTING AUTHORITY.
16. REFER TO THE SPECIAL INSTRUCTIONS SCHEDULE ON SHEET S-002 FOR VERIFICATION PROCEDURES DURING CONSTRUCTION.



ISOMETRIC VIEW

SCALE: N.T.S.



GROUNDING AND LIGHTNING PROTECTION PLAN VIEW

SCALE: N.T.S.

KEYED NOTES:

1. #4/0 AWG BARE COPPER CONDUCTOR AND THE GROUNDING ELECTRODE SYSTEM (G.E.S.). INSTALL IN DIRECT CONTACT WITH EARTH 3' - 8' FROM EDGE OF EARTH COVER AND MIN. 30" BELOW GRADE.
2. GROUND TEST WELL WITH ¾" x 10' COPPER CLAD GROUND ROD. TEST WELLS SIZED AS REQ'D. PROVIDE TRAFFIC RATED COVER. ONLY BOLTED CLAMP CONNECTORS PERMITTED WITHIN GROUND TEST WELLS. SEE DETAIL 'A', SHEET E-201.
3. BOND FOUNDATION REBAR TO THE G.E.S. USING #4/0 AWG. TYPICAL EACH CORNER AND AT DISTANCES NOT TO EXCEED 60'.
4. WHEN REQUIRED, PROVIDE POWER PANEL AND FIELD LOCATE PER SITE REQUIREMENTS. MAY BE LOCATED OUTSIDE OR INSIDE MAGAZINE (OUTSIDE SHOWN). ELECTRICAL SERVICE GROUNDING SHALL BE INSTALLED PER NFPA 70 OR MORE STRINGENT LOCAL CODE. PROVIDE SURGE PROTECTION AT POWER PANEL. PROVIDE SINGLE POINT GROUND BAR FOR GROUNDING CONNECTIONS. SEE SHEET E-202, DETAIL 'G' FOR SINGLE POINT GROUND BAR DETAIL.
5. BOND DOOR FRAME TO G.E.S. WITH #2/0 AWG. TWO PLACES. BOND DOOR TO DOOR FRAME USING BRAIDED COPPER STRAP EQUAL TO #1/0 AWG. TOP AND BOTTOM EACH DOOR (SHOWN IN ISOMETRIC VIEW).
6. EXOTHERMIC WELD BONDING CONNECTION. PROVIDE APPLICABLE TYPE MOLD AS REQUIRED.
7. VENT MOUNTED AIR TERMINAL. PROVIDE AIR TERMINAL BASE COMPATIBLE WITH VENT MATERIAL TO PREVENT CORROSION RESULTING FROM DISSIMILAR METALS. AIR TERMINAL SHALL HAVE TWO PATHS TO GROUND.
8. PROVIDE BOND BETWEEN WALL PANELS AND FOUNDATION. TYPICAL TWO PER PANEL. SEE DETAIL 'C', SHEET E-201. SEE STRUCTURAL DRAWINGS FOR TYPICAL PANEL SIZE AND QUANTITY.
9. BOND WING-WALL RE-BAR TO THE G.E.S. USING #4/0 AWG BARE COPPER. MINIMUM TWO PLACES PER WING-WALL. SEE DETAIL 'D', SHEET E-202.
10. OPTIONAL PER USER REQUIREMENTS. PROVIDE A 4-BOLT INLINE CONNECTOR, OR EQUIVALENT OF MIN. 2" SURFACE CONTACT EACH CONDUCTOR, AT EACH DOWN CONDUCTOR EXTENDING FROM THE AIR TERMINAL SYSTEM IN ORDER TO SEPARATE THE BELOW GRADE FROM THE ABOVE GRADE SYSTEMS TO FACILITATE TESTING OF GROUNDING SYSTEMS. INSTALL EXPOSED AND WHERE ACCESSIBLE. ALL LOCATIONS MAY NOT BE SHOWN. SEE DETAIL 'E', SHEET E-202.

GOVERNING LIGHTNING PROTECTION SYSTEM CRITERIA PER DOD AGENCY		
DOD (APPLICABLE ALL AGENCIES)	NFPA 780	STANDARD FOR THE INSTALLATION OF LIGHTNING PROTECTION SYSTEMS
	DESR 6055.09	DEFENSE EXPLOSIVES SAFETY REGULATION
	UFC 4-420-01	AMMUNITION AND EXPLOSIVES STORAGE MAGAZINES
	UFC 3-575-01	LIGHTNING AND STATIC ELECTRICITY PROTECTION SYSTEMS
AIR FORCE	DESR 6055.09_AFMAN 91-201	EXPLOSIVES SAFETY STANDARDS
	AFMAN 32-1065	GROUNDING AND ELECTRICAL SYSTEMS
ARMY	DA PAM 385-64	EXPLOSIVES SAFETY STANDARDS
NAVY	NAVSEA OP 5	AMMUNITION AND EXPLOSIVES SAFETY ASHORE

LIGHTNING PROTECTION CONDUCTORS AND NEAREST CORRESPONDING AWG SIZES (NFPA 780 TABLE A.4.1.1.1)	
LIGHTNING CONDUCTORS	AREA (CIR. MILS)
• CLASS I MAIN-SIZE, COPPER	57,400
• #2 AWG COPPER	66,360
• CLASS II MAIN-SIZE, COPPER	115,000
• #2/0 AWG COPPER	133,100
• LIGHTNING BONDING, COPPER	26,240
• #6 AWG COPPER	26,240
ABOVE IS A COMPARISON BETWEEN LISTED LPS CONDUCTORS AND NEAREST AWG-SIZED CONDUCTORS. SEE GENERAL NOTE 15.	

LEGEND:

EXPOSED ——————

DIRECT BURIED — — — —

ABBREVIATIONS:

AHJ	AUTHORITY HAVING JURISDICTION
AWG	AMERICAN WIRE GAUGE
DOD	DEPARTMENT OF DEFENSE
DWG	DRAWING
ECM	EARTH COVERED MAGAZINE
G.E.S.	GROUNDING ELECTRODE SYSTEM
LPS	LIGHTNING PROTECTION SYSTEM
M	METER
MIN	MINIMUM
mm	MILLIMETERS
NTE	NOT TO EXCEED
QTY	QUANTITY
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED

US Army Corps of Engineers
Huntsville Center

Revisions			
No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -'A' Sheets for Mast-Type LPS Design.	MAY 2023	

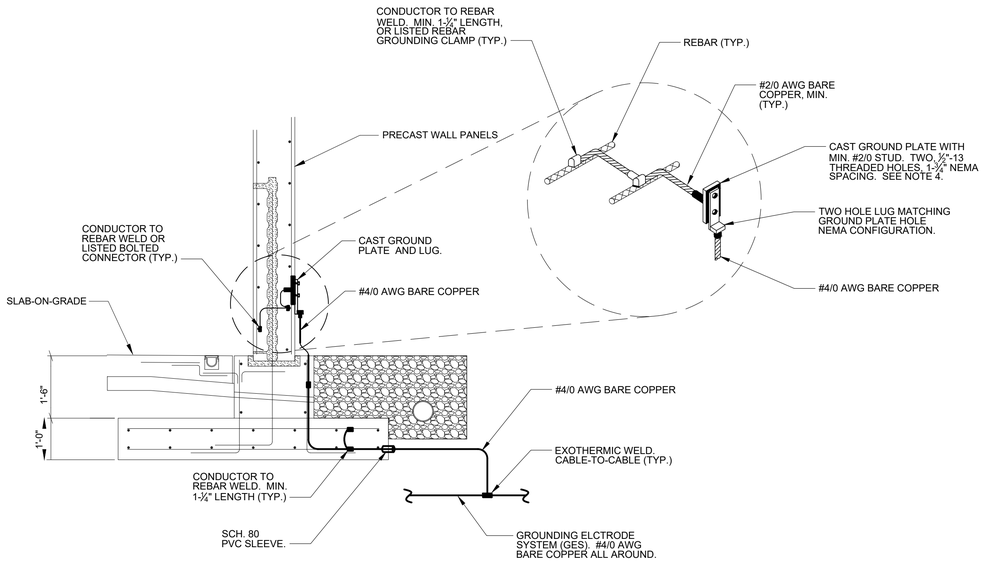
Designed by: JRD
Drawn by: JRD
Checked by: JTZ
Date: MAY 2023
Scale:
Drawing code:
Project Engineer/Architect: Jeff Coulston
Date:

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)

GROUNDING AND LIGHTNING PROTECTION PLAN

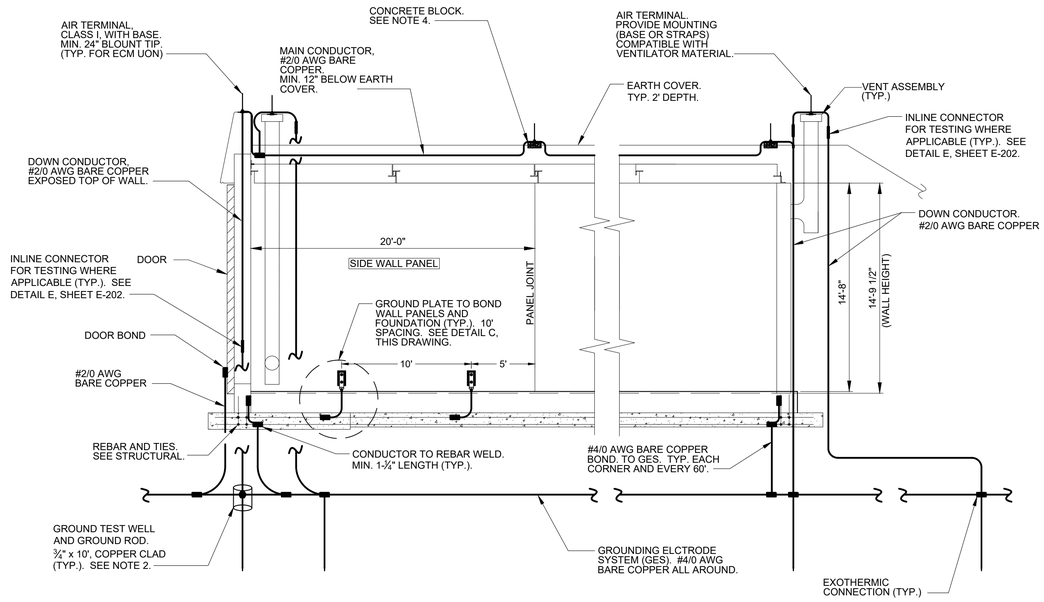
Sheet reference number:
E-101
Sheet 19 of 29



WALL PANEL TO FOUNDATION BONDING DETAIL

SCALE: N.T.S.

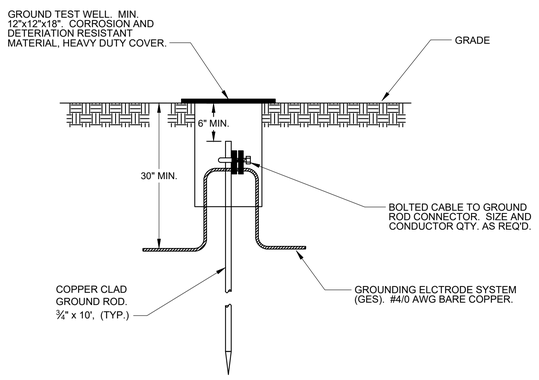
C | E-201 | E-201



TYPICAL ECM SECTION VIEW

SCALE: N.T.S.

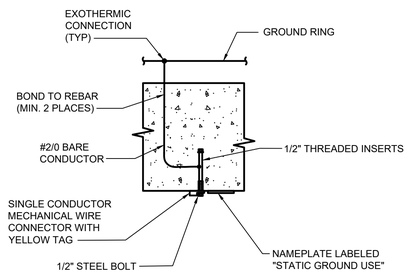
B | E-201 | E-201



GROUND TEST WELL DETAIL

SCALE: N.T.S.

A | E-101 | E-201



OPTIONAL STATIC GROUND INSERT DETAIL

SCALE: N.T.S.

D | E-201 | E-201

NOTES:

A. PROVIDE A REMOVABLE YELLOW MELAMINE PLASTIC TAG THAT ATTACHES TO THE STATIC GROUND INSERT. THE TAG SHALL INCLUDE THE FOLLOWING INFORMATION:

"NOT IN SERVICE - NO MAINTENANCE REQUIRED.

INSTALLATION MEETS STATIC/FACILITY GROUND REQUIREMENTS PER DA PAM 385-64. ACTIVITY SHALL PERFORM TESTING PER DA PAM 385-64 AND ENACT MAINTENANCE SCHEDULE WHEN THE STATIC/FACILITY GROUND INSERT IS PLACED IN SERVICE.

RETAIN THIS TAG TO RE-ATTACH WHEN REMOVED FROM SERVICE."

SUGGESTED COMPATIBLE METALS

CONFIRM METAL COMPATIBILITY WITH ANSI/UL 96.

STRUCTURAL METALS	LPS METALS
AL	AL
IRON	AL or TIN PLATED CU
COPPER	CU
BRONZE	CU
STEEL (GALV.)	AL
STEEL (STAINLESS)	AL or CU
STEEL	AL
TIN	AL or CU
ZINC	AL

ABBREVIATIONS:
AL - ALUMINUM
CU - COPPER
GALV. - GALVANIZED

NOTES:

1. GROUND TEST WELL WITH ¾" x 10' COPPER CLAD GROUND ROD. TEST WELLS SIZED AS REQ'D. PROVIDE TRAFFIC RATED COVER. ONLY BOLTED CLAMP CONNECTORS PERMITTED WITHIN GROUND TEST WELLS. SEE DETAIL B, THIS SHEET.
2. CONDUCTORS THIS SHEET SHALL BE COPPER, MINIMUM SIZE #2/0 AWG BARE COPPER, UON.
3. PROVIDE SOLID CONCRETE BLOCK ON WHICH TO MOUNT AIR TERMINALS. SIZE AS REQUIRED TO SUPPORT FOOTING AND ANCHORS. AIR TERMINAL TO MAINTAIN MINIMUM 2' ABOVE EARTH COVER.
4. CAST GROUND PLATE SHALL BE COPPER ALLOY. HOLE SPACING SHALL BE NEMA STANDARD FOR 2-HOLES. ½"-13 THREADED HOLES, ½" DEEP. PRODUCT SHALL BE EQUIVALENT TO CADWELD B16 SERIES CAST GROUND PLATE AND B122 SERIES TYPE GL LUG.
5. CABLE-TO-REBAR WELDING REQUIRES MINIMUM 1-¼" WELD LENGTH.
6. SEE GENERAL NOTES ON DRAWING E-101.

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No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -A' Sheets for Mast-Type LPS Design.	MAY 2023	

Date: MAY 2023
Scale:
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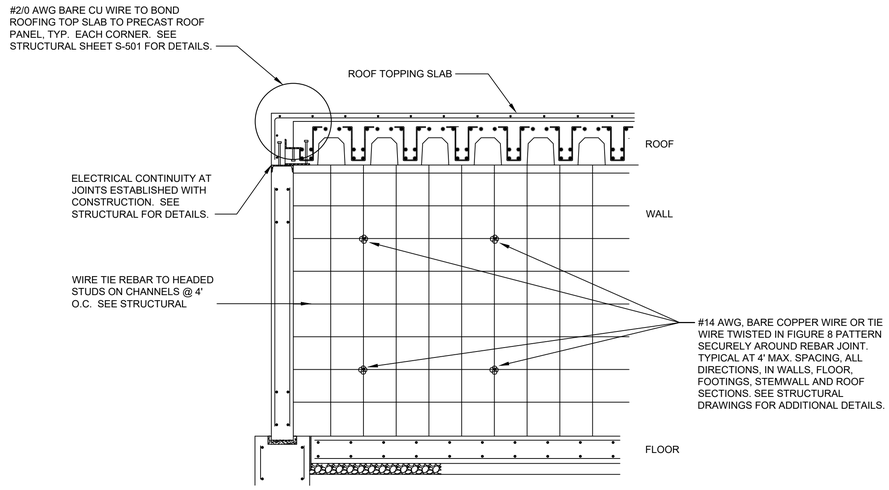
Designed by: JRD
Drawn by: JRD
Checked by: JTZ
Date:
Project Engineer/Architect: Jeff Coulston

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)
GROUNDING AND LIGHTNING PROTECTION DETAILS

Sheet reference number:
E-201
Sheet 20 of 29



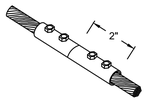
NOTES:

A. "TACK" WELDING MAY BE USED IN LIEU OF TIE WIRE FOR ELECTRICAL CONTINUITY.
B. BONDING AND GROUNDING NOTE: ELECTRICAL BONDING REQUIREMENTS INTERNAL TO PRECAST ROOF AND WALL PANELS SHALL BE PROVIDED BY THE PRECAST MANUFACTURER IN ACCORDANCE WITH THE STRUCTURAL DRAWINGS. ELECTRICAL BONDING REQUIREMENTS EXTERNAL TO PRECAST PANELS AND WITHIN CAST-IN-PLACE CONCRETE SLABS SHALL BE FIELD INSTALLED.
C. PANEL BONDING DETAIL IS GENERIC AND MAY NOT REFLECT EXACT CONSTRUCTION METHODS.
D. INSTALL SAME BONDING METHODS AT WING-WALL PANELS.

PANEL BONDING DETAILS (A)

SCALE: N.T.S.

E-202 | E-202



CONNECTOR SHALL PROVIDE MIN. 2" CONNECTION LENGTH EACH CONDUCTOR OR EQUIVALENT SURFACE AREA CONTACT.

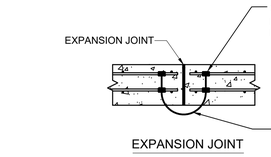
TYPICAL INLINE CONNECTOR (DISCONNECT) (E)

SCALE: N.T.S.

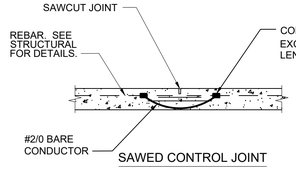
E-101 | E-202 | E-201

NOTES:

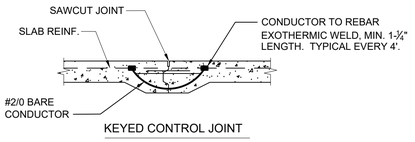
A. INLINE CONNECTOR MAY BE USED TO FACILITATE TESTING OF DIFFERENT PORTIONS OF THE LIGHTNING PROTECTION AND GROUNDING SYSTEM. FOR EXAMPLE, INLINE CONNECTORS MAY BE USED TO ISOLATE THE BELOW GRADE GROUNDING SYSTEM FROM THE ABOVE GRADE AIR TERMINALS AND MAIN CONDUCTORS SYSTEM. USER OPTION TO INSTALL.
B. INLINE CONNECTORS SHALL BE INSTALLED EXPOSED AND WHERE EASILY ACCESSIBLE.



EXPANSION JOINT



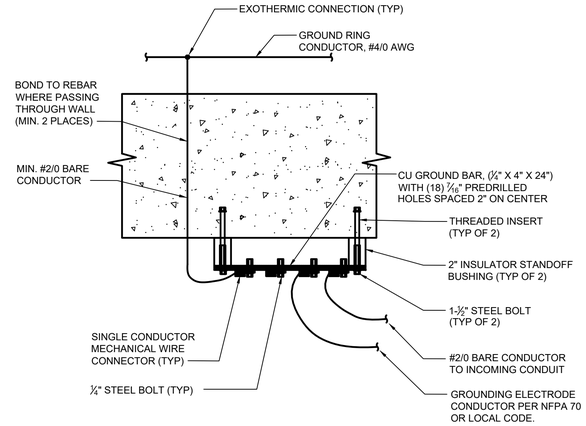
SAWED CONTROL JOINT



KEYED CONTROL JOINT

NOTES:

1. CONDUCTORS THIS SHEET SHALL BE COPPER, MINIMUM SIZE #2/0 AWG BARE COPPER, UON.
2. UNLESS OTHERWISE NOTED, BONDING AS SHOWN WITHIN THE DETAILS OF THIS SHEET SHALL BE MINIMUM EVERY 4' IN ALL DIRECTIONS.
3. CABLE-TO-REBAR WELDING REQUIRES MINIMUM 1-¾" WELD LENGTH.
4. SEE GENERAL NOTES ON DRAWING E-101.



SINGLE POINT GROUND BAR DETAIL (G)

SCALE: N.T.S.

E-101 | E-202

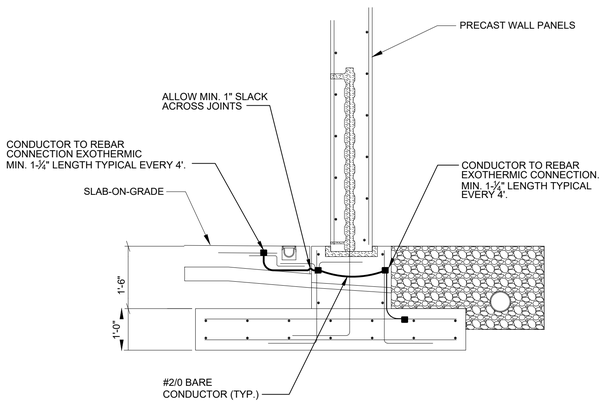
NOTES:

A. WHERE POWER IS PROVIDED TO THE MAGAZINE, PROVIDE A SINGLE POINT GROUND BAR AS DETAILED. LOCATE ADJACENT TO POWER PANEL, MIN. 18" ABOVE GRADE. INTERIOR DETAIL SHOWN.

TYPICAL BOND CONNECTION AT VARIOUS CONSTRUCTION JOINTS (B)

SCALE: N.T.S.

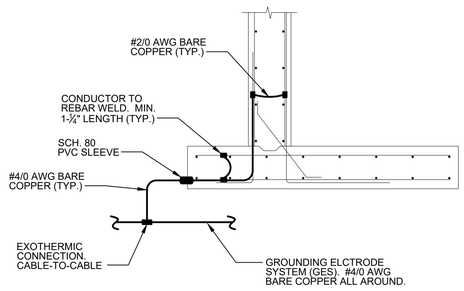
E-202 | E-202



FLOOR TO FOUNDATION BONDING DETAIL (C)

SCALE: N.T.S.

E-202 | E-202



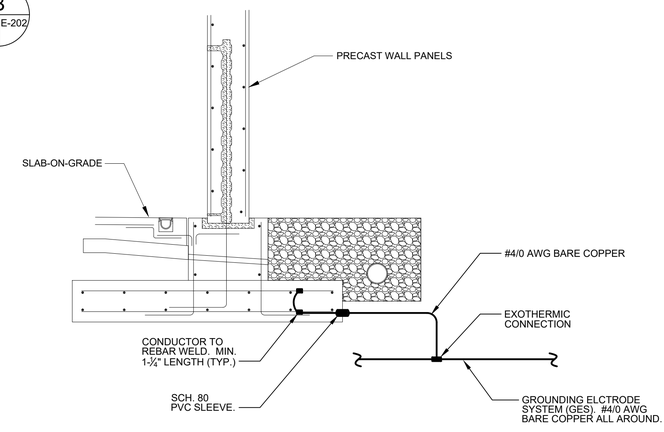
WING-WALL TO G.E.S. BONDING DETAIL (D)

SCALE: N.T.S.

E-101 | E-202

NOTES:

A. BOND WING WALL AS SHOWN A MINIMUM TWO PLACE FOR EACH WING WALL.



FOUNDATION TO G.E.S.BONDING DETAIL (F)

SCALE: N.T.S.

E-202 | E-202

NOTES:

A. TYPICAL FOUNDATION TO G.E.S BONDING DETAIL. PROVIDE AT EACH ECM CORNER AND AT DISTANCES NOT TO EXCEED (NTE) 60'.

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No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -A' Sheets for Mast-Type LPS Design.	MAY 2023	

Designed by: JRD
Drawn by: JRD
Checked by: JTZ
Date: MAY 2023
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Project Engineer/Architect: Jeff Coulston

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND
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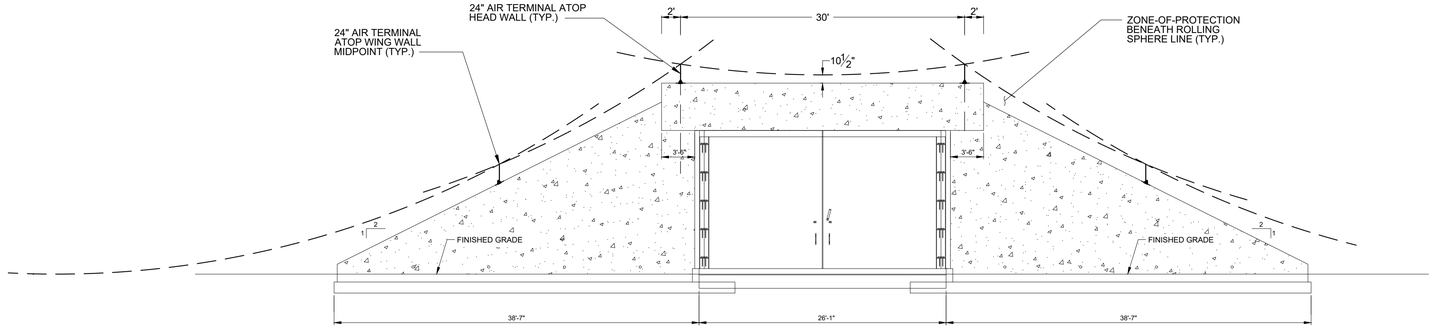
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)
GROUNDING AND BONDING
DETAILS

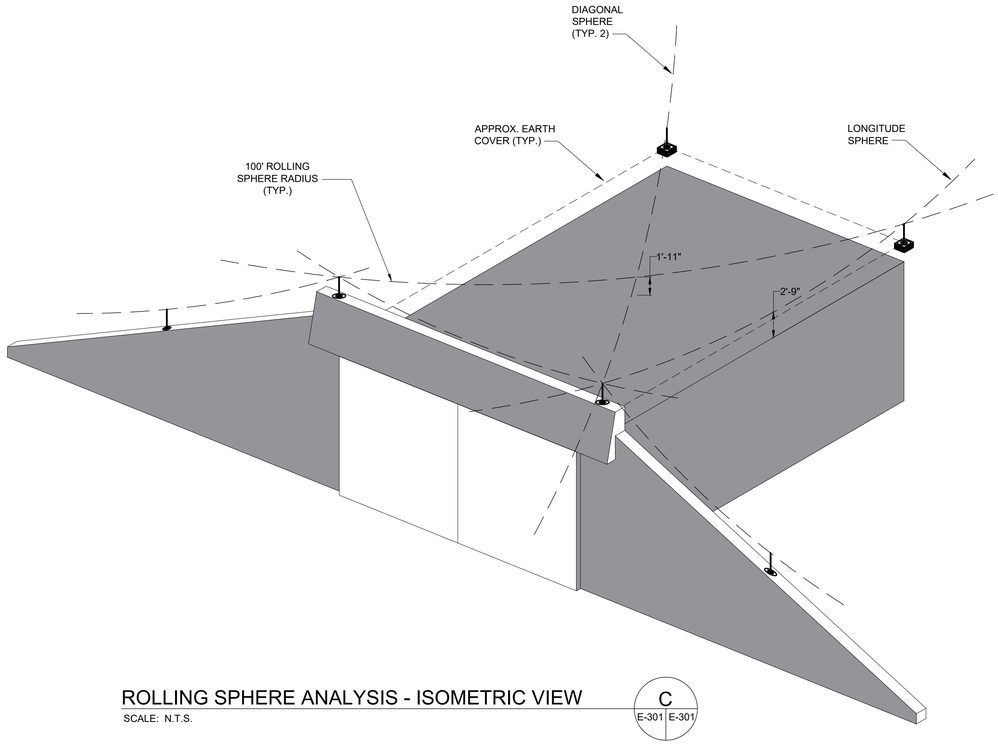
Sheet reference number:
E-202
Sheet 21 of 29



ROLLING SPHERE ANALYSIS - HEAD WALL VIEW

SCALE: N.T.S.

A E-301 | E-301



ROLLING SPHERE ANALYSIS - ISOMETRIC VIEW

SCALE: N.T.S.

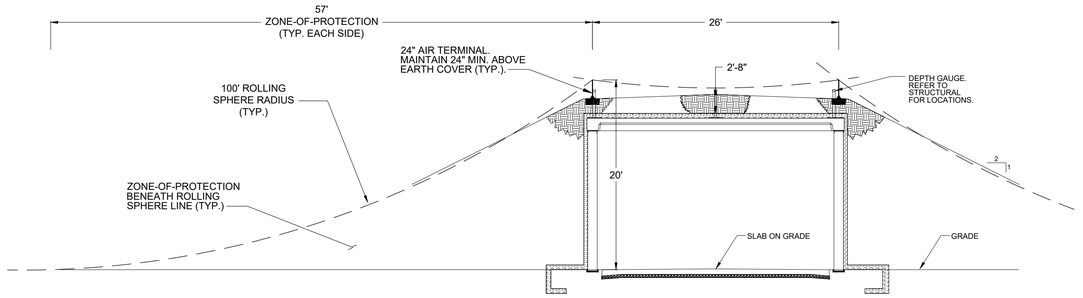
C E-301 | E-301

NOTES:

1. ISOMETRIC VIEW REPRESENTATIVE OF A STANDARD 40' LENGTH ECM.

NOTES:

1. ROLLING SPHERE METHOD (RSM) ANALYSIS DEMONSTRATES A ZONE-OF-PROTECTION BASED ON A 100' RADIUS STRIKING DISTANCE FOR THE ECM STRUCTURE AND HEAD WALL ASSEMBLY.
2. MEASURED CLEARANCES AND DIMENSIONS MAY VARY DEPENDING ON FINAL INSTALLATION CONDITIONS.
3. SEE DWG. E-601 FOR ADDITIONAL RSM ANALYSIS.
4. REFER TO STRUCTURAL DRAWINGS FOR COMPLETE DIMENSIONAL INFORMATION.
5. VENTILATORS ARE NOT FACTORED INTO THE BASE RSM ANALYSIS DUE TO POTENTIAL VARYING SITE CONDITIONS. REQUIRED AIR TERMINALS ON TOP OF THE VENTILATORS WILL BROADEN THE ZONE OF PROTECTION WHEN FACTORED INTO THE RSM ANALYSIS.
6. GROUNDING AND BONDING COMPONENTS / SYSTEMS ARE NOT REPRESENTED IN THE RSM ANALYSIS.
7. SEE GENERAL NOTES ON DRAWING E-101.



ROLLING SPHERE ANALYSIS - CROSS SECTIONAL VIEW

SCALE: N.T.S.

B E-301 | E-301

US Army Corps of Engineers Huntsville Center

Revisions

No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -A' Sheets for Mast-Type LPS Design.	MAY 2023	

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Date:

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Checked by: JTZ
Project Engineer/Architect: Jeff Coulston

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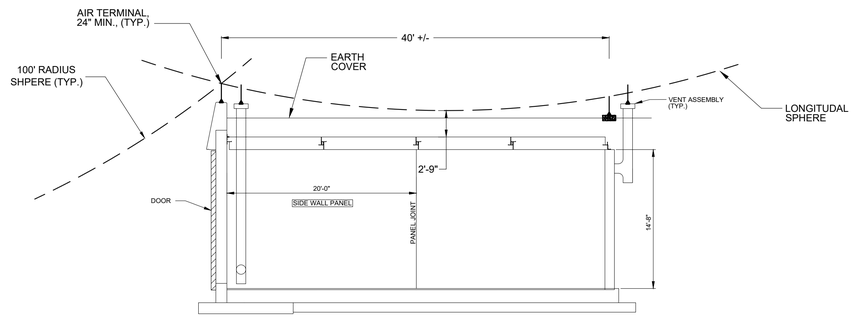
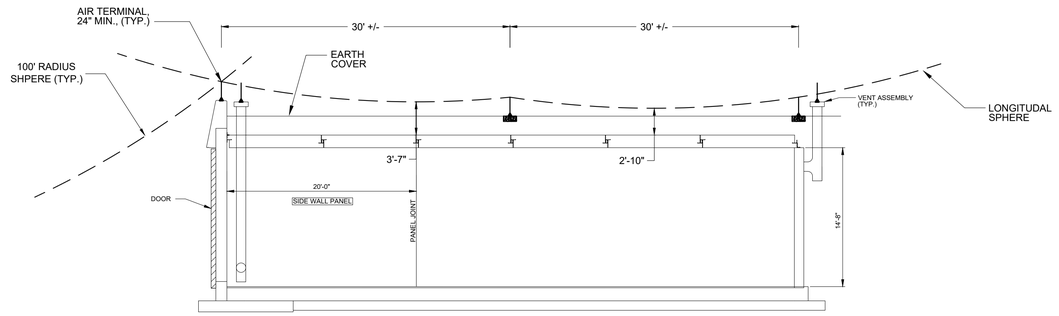
ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)
ROLLING SPHERE METHOD ANALYSIS

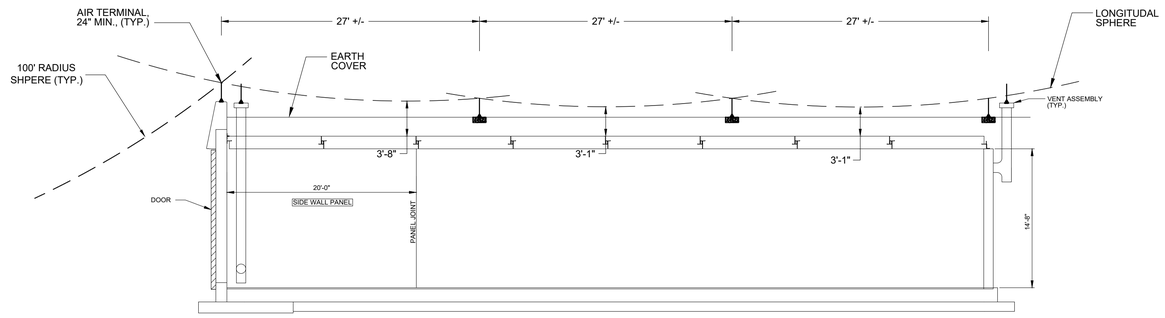
Sheet reference number:
E-301
Sheet 22 of 29



TYPICAL RSM ANALYSIS - 40' ECM (A) — SCALE: N.T.S. — E-302 | E-302



TYPICAL RSM ANALYSIS - 60' ECM (B) — SCALE: N.T.S. — E-302 | E-302



TYPICAL RSM ANALYSIS - 80' ECM (C) — SCALE: N.T.S. — E-302 | E-302

TYPICAL AIR TERMINAL PLACEMENT AND QUANTITIES FOR EARTH COVERED MAGAZINES STANDARD 421-80-08

NOMINAL ECM LENGTH	HEADWALL & WING-WALLS	LONGITUDINAL ECM EDGE	VENTILATOR(S)	MIN. AIR TERMINAL QTY.
40 FEET	4	2	2	8
60 FEET	4	4	2	10
80 FEET	4	6	2	12

NOTES:
A. QUANTITIES BASED ON 24" AIR TERMINALS.

NOTES:

1. ROLLING SPHERE METHOD (RSM) ANALYSIS DEMONSTRATES A ZONE-OF-PROTECTION BASED ON A 100' RADIUS STRIKING DISTANCE FOR THE ECM STRUCTURE AND HEAD WALL ASSEMBLY.
2. MEASURED CLEARANCES AND DIMENSIONS MAY VARY DEPENDING ON FINAL INSTALLATION CONDITIONS.
3. SEE SHEET E-601 FOR ADDITIONAL RSM ANALYSIS INFORMATION.
4. TALLER AIR TERMINALS MAY BE USED TO REDUCE THE NUMBER OF AIR TERMINALS REQUIRED. PROVIDE A DRAWING(S) DEMONSTRATING THE ZONE-OF-PROTECTION BASED ON THE TALLER AIR TERMINALS FOR FES-MCX APPROVAL. AIR TERMINALS EXCEEDING 24" IN HEIGHT MUST BE SUPPORTED AT A POINT NOT LESS THAN ONE-HALF OF THEIR HEIGHT.
5. REFER TO STRUCTURAL DRAWINGS FOR COMPLETE DIMENSIONAL INFORMATION.
6. VENTILATORS ARE NOT FACTORED INTO THE RSM ANALYSIS. REQUIRED AIR TERMINALS ON TOP OF THE VENTILATORS WILL BROADEN THE ZONE OF PROTECTION WHEN FACTORED INTO THE RSM ANALYSIS.
7. GROUNDING AND BONDING COMPONENTS / SYSTEMS ARE NOT REPRESENTED IN THE RSM ANALYSIS.
8. SEE GENERAL NOTES ON SHEET E-101.

US Army Corps of Engineers Huntsville Center

No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -A' Sheets for Mast-Type LPS Design.	MAY 2023	

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U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, ALABAMA

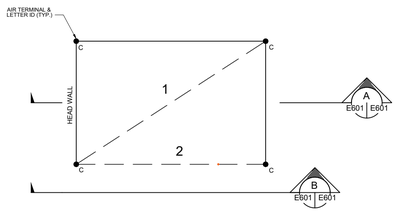
MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)
ROLLING SPHERE METHOD ANALYSIS

Sheet reference number:
E-302
Sheet 23 of 29

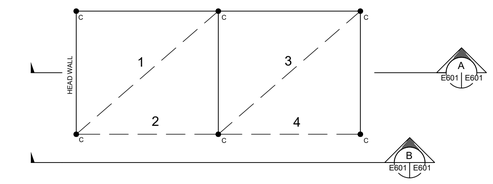
RSM VECTOR LINES - ECM PLAN VIEW

SCALE: N.T.S.

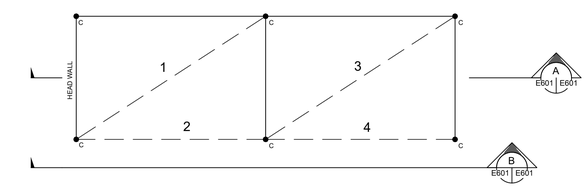
40' LENGTH



60' LENGTH

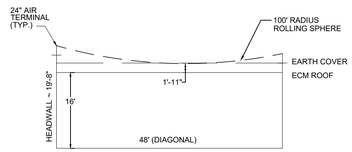


80' LENGTH



RSM DIAGRAMS - MID-SECTION VIEW (A)

SCALE: N.T.S.



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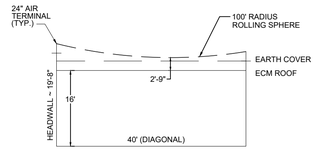

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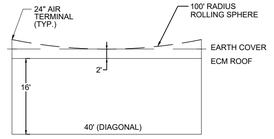

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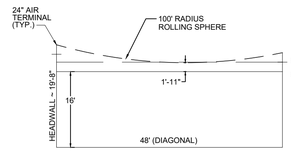

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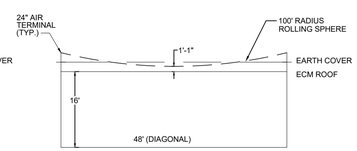
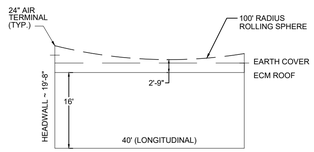


3

RSM DIAGRAMS - LONGITUDINAL VIEW (B)

SCALE: N.T.S.



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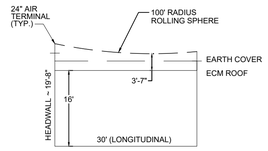

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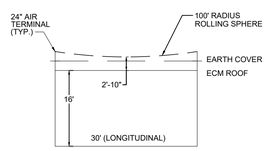

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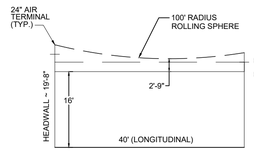

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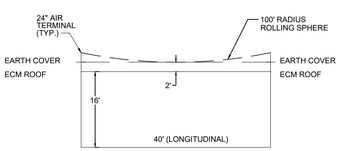

4

AIR TERMINAL DIMENSIONS		
ID	IMPERIAL STANDARDS	METRIC STANDARDS
A	10"	500 mm
B	18"	500 mm
C	24"	1000 mm
D	36"	1000 mm
E	48"	1500 mm
F	60"	1500 mm
G	72"	2000 mm

ROLLING SPHERE METHOD (RSM) ANALYSIS

FOR EARTH COVERED MAGAZINE (ECM) 421-80-08

SCALE: NONE

NOTES:

1. DIMENSIONS ARE BASED ON THE NOMINAL ECM's LENGTH RATHER THAN AIR TERMINAL PLACEMENT. MEASURED DIMENSIONS AND CLEARANCES WILL VARY DEPENDING ON FINAL INSTALLATION CONDITIONS AND EXACT AIR TERMINAL PLACEMENT. VARIANCES ARE NOT EXPECTED TO ALTER FINAL ANALYSIS.
2. VENTILATORS ARE NOT FACTORED INTO THE RSM ANALYSIS. REQUIRED AIR TERMINALS MOUNTED ON TOP OF THE VENTILATORS WILL BROADEN THE ZONE OF PROTECTION WHEN FACTORED INTO THE RSM ANALYSIS.

US Army Corps of Engineers
Huntsville Center

No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -A' Sheets for Mast-Type LPS Design.	MAY 2023	

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Checked by: JTZ
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Scale:
Drawing code:
Project Engineer/Architect: Jeff Coulson
Date:

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND
SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)
ROLLING SPHERE METHOD
ANALYSIS

Sheet reference number:
E-601
Sheet 24 of 29

GENERAL NOTES:

1. THIS DRAWING SET IS THE ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, (CEHNC) STANDARD GUIDANCE FOR LIGHTNING PROTECTION SYSTEM (LPS) DESIGN APPLICABLE TO EARTH COVERED MAGAZINES (ECM). THIS STANDARD REPRESENTS A PERFORMANCE BASED DESIGN. DESIGNER SHALL ADAPT THE STANDARDS TO SPECIFIC SITE CONDITIONS AND CONSULT GOVERNING CRITERIA TO ENSURE A COMPLETE AND FUNCTIONAL LPS DESIGN.
2. AT ARMY INSTALLATIONS THE COMPLETED LPS SHALL RECEIVE AN UNDERWRITER'S LABORATORY (UL) MASTER LABEL CERTIFICATE IN COMPLIANCE WITH APPLICABLE GOVERNING CRITERIA. OTHER THAN ARMY, CERTIFICATION SHALL BE ACCORDING TO THE AHJ.
3. LPS COMPONENTS SHALL BEAR THE UL LISTING OR LABEL WHEN AVAILABLE (OR LOCAL EQUIVALENT).
4. THE LPS DESIGN MUST PROVIDE A ZONE-OF-PROTECTION BASED ON A 100' (30.5 M) RADIUS STRIKING DISTANCE (*ds*) USING THE ROLLING SPHERE METHOD (RSM) ANALYSIS. REFER TO SHEETS E-301-A, E-302-A FOR A RSM ANALYSIS EXAMPLE.
5. REINFORCING STEEL IN WALLS, FLOOR SLAB, ROOF PANELS OR BOX STRUCTURES MUST BE ELECTRICALLY CONTINUOUS THROUGH BONDING AND HAVE A SOLID, DIRECT CONNECTION TO THE PRIMARY GROUNDING ELECTRODE SYSTEM. MINIMUM REBAR OVERLAP IS 20 x DIAMETER (20D). METAL VENTILATORS, STEEL DOORS AND FRAMES SHALL BE BONDED TO THE PRIMARY GROUNDING ELECTRODE SYSTEM. PHOTO DOCUMENTATION OF THE BONDING AND GROUNDING WORKS IS MANDATORY BEFORE CONCEALING. REFERENCE STRUCTURAL DRAWINGS FOR ADDITIONAL BONDING INFORMATION.
6. INCOMING POWER AND AUXILIARY CONDUCTORS MUST RUN UNDERGROUND FOR AT LEAST 50' (15 M) BEFORE ENTERING THE FACILITY. CONDUCTORS MUST BE SHIELDED OR INSTALLED IN METALLIC CONDUIT THAT IS BONDED TO THE PRIMARY GROUNDING ELECTRODE SYSTEM AT THE POINT OF ENTRY.
7. INTERIOR ELECTRICAL SYSTEMS ARE NOT INCLUDED IN THIS STANDARD SET. IF REQUIRED, INTERIOR ELECTRICAL SYSTEMS SHALL BE DESIGNED BASED ON USER REQUIREMENTS. HAZARDOUS CLASSIFICATIONS BASED ON NFPA 70, ARTICLE 500 SHALL BE DETERMINED BY THE DESIGNER DURING THE DESIGN PROCESS BASED ON INTENDED FACILITY USE AND CONTENTS.
8. STATIC GROUNDING OR BUS BARS NOT DEPICTED. IF REQUIRED, SEE DA PAM 385-64, SECTION II, UFC 3-575-01, CHAPTER 2 AND SHEET E-201-A, DETAIL 'D' FOR MORE INFORMATION
9. PROVIDE SURGE PROTECTION DEVICES (SPD) FOR CONDUCTIVE MEDIA AT THE POINT OF ENTRY INTO THE FACILITY. SPD's SHALL BE COMPLIANT WITH NFPA 780.
10. CONSIDER METALLIC MASSES FOR SIDE FLASH POTENTIAL. METALLIC MASSES WITHIN SIDE FLASH DISTANCE SHALL BE BONDED TO THE LPS, OR BE MOVED OUTSIDE THE SIDE FLASH SEPARATION DISTANCE.
11. UNDERGROUND CONNECTIONS TO THE GROUNDING ELECTRODE SYSTEM SHALL BE WITH EXOTHERMIC WELDS. WITHIN GROUND TEST WELLS USE BOLTED CONNECTORS ONLY.
12. USE COPPER CONDUCTORS, ONLY. ALUMINUM CONDUCTORS NOT ALLOWED FOR ECM CONSTRUCTION. PROVIDE BI-METALLIC CONNECTORS, PLATING AND ACCEPTABLY PROTECTED MATERIALS AS REQUIRED TO PREVENT CORROSION DUE TO DISSIMILAR METALS CONTACT. SEE ANSI/UL 96 SUGGESTED COMPATIBLE METALS ON SHEET E-201-A.
13. TWO VENTILATORS SHOWN. IF OTHER VENTILATORS ARE REQUIRED, PROVIDE AIR TERMINALS, GROUNDING AND BONDING TYPICAL AS SHOWN. ALL OTHER LPS COMPONENTS AND DESIGN ASPECTS REMAIN UNCHANGED. SIDE VENTILATOR LOCATION IS APPROXIMATE. LOCATION SHOWN FOR CLARITY.
14. APPLY THE MOST STRINGENT CRITERIA WHERE CONFLICTS ARISE BETWEEN US STANDARDS AND LOCAL STANDARDS. SEE CRITERIA TABLE THIS SHEET.
15. LPS CONDUCTORS SHALL BE SIZED PER NFPA 780 TABLE 4.1.1.1.1 (CLASS I) OR TABLE 4.1.1.1.2 (CLASS II) AS NOTED. FOR ECMs, LPS CONDUCTORS SHALL BE MINIMUM MAIN-SIZE CLASS II, UON. REFER TO TABLE THIS SHEET FOR CORRESPONDING COMPARISON BETWEEN MAIN-SIZE LPS CONDUCTORS AND AWG-SIZED CONDUCTORS. BARE AWG CONDUCTORS TYPICALLY ARE NOT "LISTED FOR THE PURPOSE" FOR LIGHTNING PROTECTION BY A LISTING AUTHORITY.
16. REFER TO THE SPECIAL INSTRUCTIONS SCHEDULE ON SHEET S-002 FOR VERIFICATION PROCEDURES DURING CONSTRUCTION.

KEYED NOTES:

1. #4/0 AWG BARE COPPER CONDUCTOR AND THE GROUNDING ELECTRODE SYSTEM (G.E.S.). INSTALL IN DIRECT CONTACT WITH EARTH 3' - 8' FROM EDGE OF EARTH COVER AND MIN. 30" BELOW GRADE.
2. GROUND TEST WELL WITH ¾" x 10' COPPER CLAD GROUND ROD. TEST WELLS SIZED AS REQ'D. PROVIDE TRAFFIC RATED COVER. ONLY BOLTED CLAMP CONNECTORS PERMITTED WITHIN GROUND TEST WELLS. SEE DETAIL A, SHEET E-201-A.
3. BOND FOUNDATION REBAR TO THE G.E.S. USING #4/0 AWG. TYPICAL EACH CORNER AND AT DISTANCES NOT TO EXCEED 60'.
4. WHEN REQUIRED, PROVIDE POWER PANEL AND FIELD LOCATE PER SITE REQUIREMENTS. MAY BE LOCATED OUTSIDE OR INSIDE MAGAZINE (OUTSIDE SHOWN). ELECTRICAL SERVICE GROUNDING SHALL BE INSTALLED PER NFPA 70 OR MORE STRINGENT LOCAL CODE. PROVIDE SURGE PROTECTION AT POWER PANEL. PROVIDE SINGLE POINT GROUND BAR FOR GROUNDING CONNECTIONS. SEE SHEET E-202-A, DETAIL 'E' FOR SINGLE POINT GROUND BAR DETAIL.
5. BOND DOOR FRAME TO G.E.S. WITH #2/0 AWG. TWO PLACES. BOND DOOR TO DOOR FRAME USING BRAIDED COPPER STRAP EQUAL TO #1/0 AWG. TOP AND BOTTOM EACH DOOR.
6. EXOTHERMIC WELD BONDING CONNECTION. PROVIDE APPLICABLE TYPE MOLD AS REQUIRED.
7. BOND VENTILATOR TO G.E.S. USING MIN. #2/0 AWG. TYPICAL FOR EACH VENTILATOR AS APPLICABLE. BONDING COMPONENTS SHALL BE OF COMPATIBLE MATERIALS TO PREVENT CORROSION DUE TO DISSIMILAR METALS.
8. PROVIDE BOND BETWEEN WALL PANELS AND FOUNDATION. TYPICAL TWO PER PANEL. SEE DETAIL C, SHEET E-201-A. SEE STRUCTURAL DRAWINGS FOR TYPICAL PANEL SIZE AND QUANTITY.
9. BOND WING-WALL REBAR TO THE G.E.S. USING #4/0 AWG BARE COPPER. MINIMUM TWO PLACES PER WING-WALL. SEE DETAIL D, SHEET E-202-A.
10. LPS MAST, WOOD OR METAL. WHERE WOOD MASTS ARE USED, PROVIDE MIN. 24" AIR TERMINALS ON TOP OF WOOD MASTS AND TWO #2/0 AWG DOWN CONDUCTORS ON OPPOSITE SIDES OF POLE. TERMINATE DOWN CONDUCTORS TO THE G.E.S. WITH A GROUND ROD. WHERE METAL MASTS ARE USED AS THE STRIKE TERMINATION DEVICE AND THE DOWN CONDUCTOR, THE MAST'S WALL AND TOP MUST MEET THE MINIMUM THICKNESS REQUIREMENTS AS SPECIFIED IN NFPA 780, AND THE MAST MUST BE ELECTRICALLY CONTINUOUS. METAL MASTS SHALL BE BONDED TO THE G.E.S IN TWO LOCATIONS. MAST HEIGHT AND LOCATIONS SHALL BE AS ILLUSTRATED IN THE ROLLING SPHERE METHOD ANALYSIS, SHEETS E-301-A AND E-302-A.

GOVERNING LIGHTNING PROTECTION SYSTEM CRITERIA PER DOD AGENCY		
DOD (APPLICABLE ALL AGENCIES)	NFPA 780	STANDARD FOR THE INSTALLATION OF LIGHTNING PROTECTION SYSTEMS
	DESR 6055.09	DEFENSE EXPLOSIVES SAFETY REGULATION
	UFC 4-420-01	AMMUNITION AND EXPLOSIVES STORAGE MAGAZINES
	UFC 3-575-01	LIGHTNING AND STATIC ELECTRICITY PROTECTION SYSTEMS
AIR FORCE	DOD 6055.09_AFMAN 91-201	EXPLOSIVES SAFETY STANDARDS
	AFMAN 32-1065	GROUNDING AND ELECTRICAL SYSTEMS
ARMY	DA PAM 385-64	EXPLOSIVES SAFETY STANDARDS
NAVY	NAVSEA OP 5	AMMUNITION AND EXPLOSIVES SAFETY ASHORE

LIGHTNING PROTECTION CONDUCTORS AND NEAREST CORRESPONDING AWG SIZES (NFPA 780 TABLE A.4.1.1.1)	
LIGHTNING CONDUCTORS	AREA (CIR. MILS)
• CLASS I MAIN-SIZE COPPER	57,400
• #2 AWG	66,360
• CLASS II MAIN-SIZE COPPER	115,000
• #2/0 AWG	133,100
• LIGHTNING BONDING COPPER	26,240
• #6 AWG	26,240
ABOVE IS A COMPARISON BETWEEN LISTED LPS CONDUCTORS AND NEAREST ALLOWED AWG-SIZED CONDUCTORS. SEE GENERAL NOTE 15.	

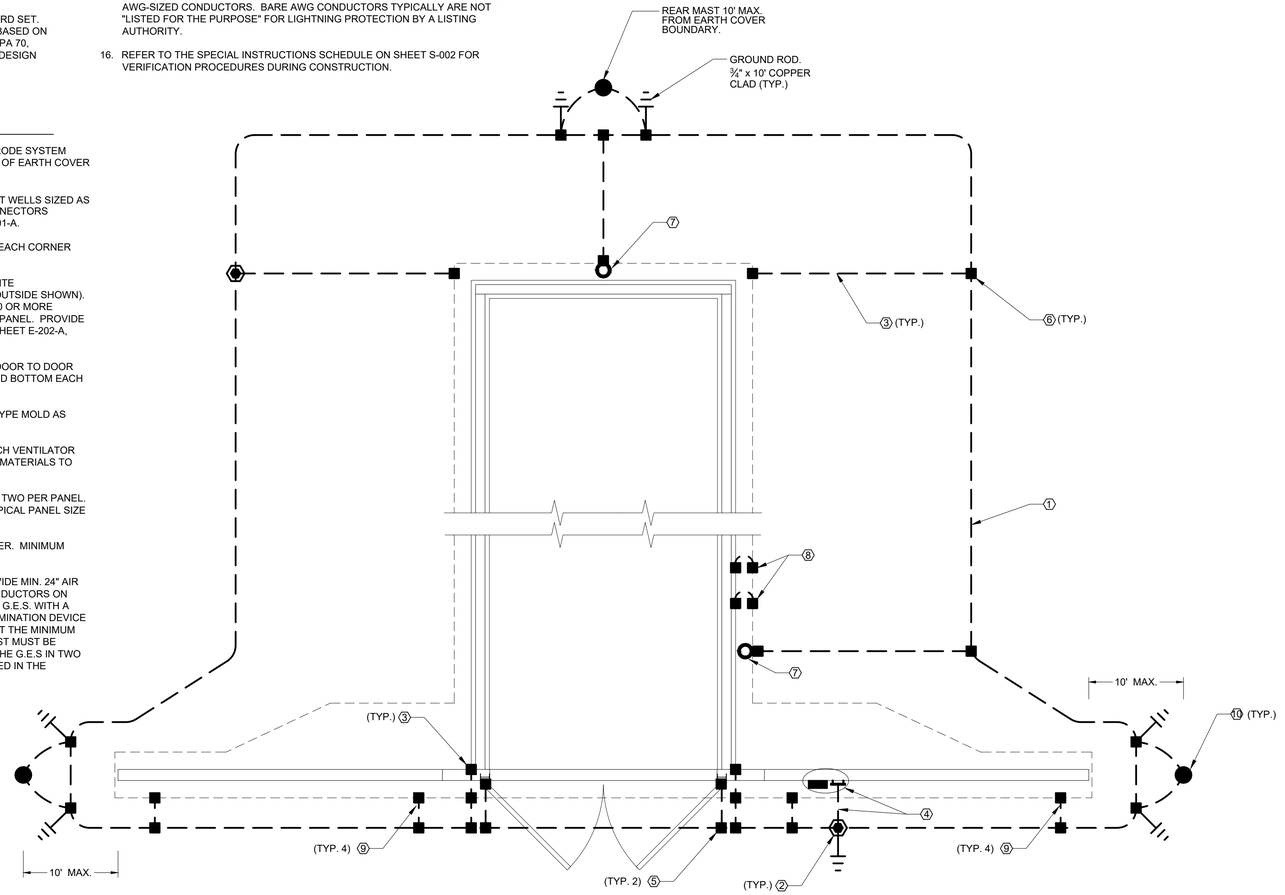
ABBREVIATIONS:

AHJ	AUTHORITY HAVING JURISDICTION
AWG	AMERICAN WIRE GAUGE
DOD	DEPARTMENT OF DEFENSE
DWG	DRAWING
ECM	EARTH COVERED MAGAZINE
G.E.S.	GROUNDING ELECTRODE SYSTEM
LPS	LIGHTNING PROTECTION SYSTEM
M	METER
MIN	MINIMUM
mm	MILLIMETERS
NTE	NOT TO EXCEED
QTY	QUANTITY
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED

LEGEND:

EXPOSED ——————

DIRECT BURIED — — —



GROUNDING AND LIGHTNING PROTECTION PLAN VIEW
SCALE: N.T.S.

ALTERNATE DESIGN GENERAL NOTES:

1. SEE GENERAL NOTES THIS SHEET.
2. USER AND OWNER HAS THE OPTION TO INSTALL EITHER PROTECTION SYSTEM. BONDING AND GROUNDING REQUIREMENTS ARE SHOWN ON SHEETS E-101-A, E-201-A AND E-202-A.
3. ROLLING SPHERE ANALYSIS FOR THE MAST-TYPE SYSTEM IS SHOWN ON SHEETS E-301-A AND E-302-A.

DESIGNER NOTE: TO BE REMOVED WHEN PREPARING CONSTRUCTION DRAWINGS FOR SITE ADAPTATION DESIGN

SHEETS E-101-A, E-201-A. E-202-A, E-301-A, AND E-302-A IDENTIFY AN ALTERNATE LIGHTNING PROTECTION SYSTEM USING A MAST-TYPE DESIGN INSTEAD OF AN INTEGRAL-TYPE DESIGN. DESIGNER SHALL VERIFY THE CORRECT TYPE OF DESIGN WITH THE CONTRACTING OFFICER AND REMOVE THE SHEETS IDENTIFYING THE NON-APPLICABLE DESIGN FROM THE CONSTRUCTION CONTRACT DOCUMENTS.

(A) - ALTERNATE LIGHTNING PROTECTION DESIGN

US Army Corps of Engineers Huntsville Center

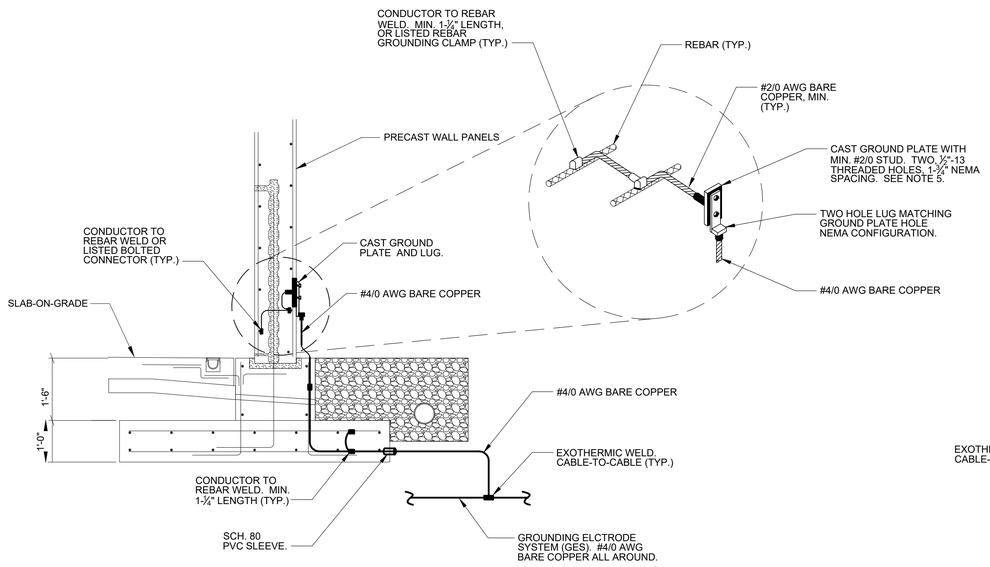
Revisions			
No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -'A' Sheets for Mast-Type LPS Design.	MAY 2023	

Designed by: JRD
Drawn by: JRD
Checked by: JTZ
Date: MAY 2023
Scale:
Drawing code:
Project Engineer/Architect: Jeff Coulston

U. S. ARMY CORPS OF ENGINEERS ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)
GROUNDING AND LIGHTNING PROTECTION PLAN

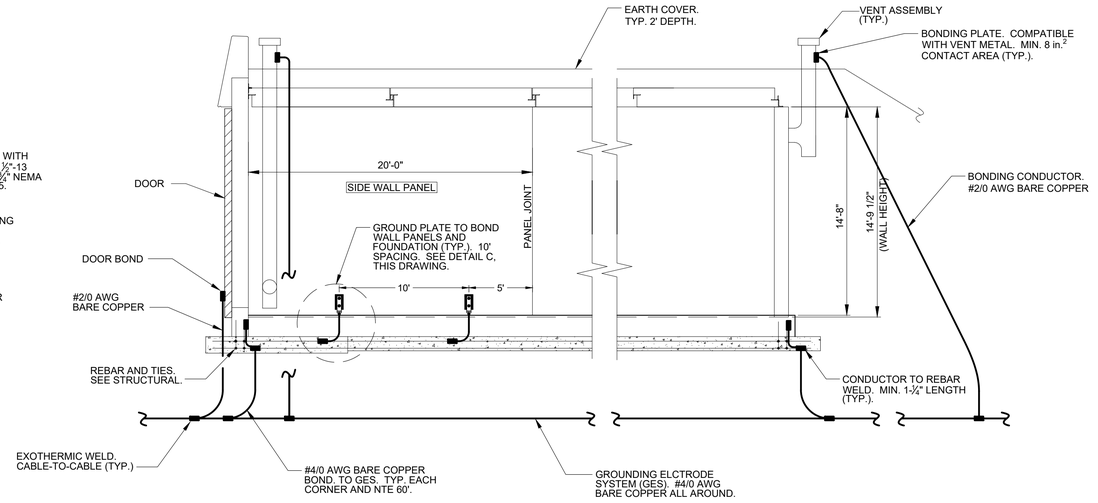
Sheet reference number:
E-101-A
Sheet 25 of 29



WALL PANEL TO FOUNDATION BONDING DETAIL

SCALE: N.T.S.

C — E-101-A | E-201-A



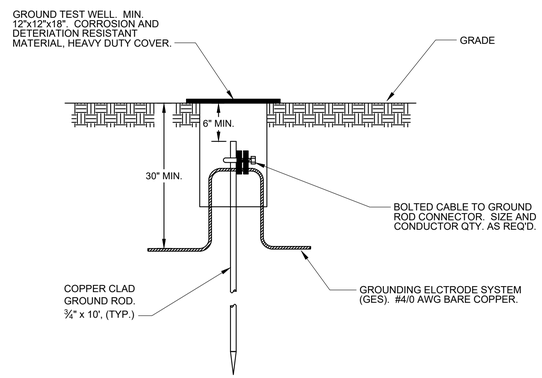
TYPICAL ECM SECTION VIEW

SCALE: N.T.S.

B — E-201-A | E-201-A

NOTES:

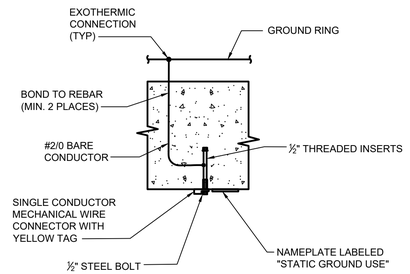
A. LPS MASTS NOT SHOWN.



GROUND TEST WELL DETAIL

SCALE: N.T.S.

A — E-101-A | E-201-A



OPTIONAL STATIC GROUND INSERT DETAIL

SCALE: N.T.S.

D — E-201-A | E-201-A

NOTES:

A. PROVIDE A REMOVABLE YELLOW MELAMINE PLASTIC TAG THAT ATTACHES TO THE STATIC GROUND INSERT. THE TAG SHALL INCLUDE THE FOLLOWING INFORMATION:

"NOT IN SERVICE - NO MAINTENANCE REQUIRED.

INSTALLATION MEETS STATIC/FACILITY GROUND REQUIREMENTS PER DA PAM 385-64. ACTIVITY SHALL PERFORM TESTING PER DA PAM 385-64 AND ENACT MAINTENANCE SCHEDULE WHEN THE STATIC/FACILITY GROUND INSERT IS PLACED IN SERVICE.

RETAIN THIS TAG TO RE-ATTACH WHEN REMOVED FROM SERVICE."

SUGGESTED COMPATIBLE METALS	
CONFIRM METAL COMPATIBILITY WITH ANSI/UL 96.	
STRUCTURAL METALS	LPS METALS
AL	AL
IRON	AL or TIN PLATED CU
COPPER	CU
BRONZE	CU
STEEL (GALV.)	AL
STEEL (STAINLESS)	AL or CU
STEEL	AL
TIN	AL or CU
ZINC	AL
ABBREVIATIONS: AL - ALUMINUM CU - COPPER	GALV. - GALVANIZED

NOTES:

1. IF ADDITIONAL VENTILATORS ARE PRESENT, PROVIDE AIR TERMINALS, GROUNDING AND BONDING TYPICAL FOR THOSE SHOWN. ALL OTHER LPS COMPONENTS AND DESIGN ASPECTS REMAIN UNCHANGED.
2. GROUND TEST WELL WITH ¾" x 10' COPPER CLAD GROUND ROD. TEST WELLS SIZED AS REQ'D. PROVIDE TRAFFIC RATED COVER. ONLY BOLTED CLAMP CONNECTORS PERMITTED WITHIN GROUND TEST WELLS. SEE DETAIL B, THIS SHEET.
3. CONDUCTORS SHALL BE COPPER, MINIMUM SIZE #2/0 AWG BARE COPPER, UON.
4. CAST GROUND PLATE SHALL BE COPPER ALLOY. HOLE SPACING SHALL BE NEMA STANDARD FOR 2-HOLES. ½"-13 THREADED HOLES, ½" DEEP. PRODUCT SHALL BE EQUIVALENT TO CADWELD B16 SERIES CAST GROUND PLATE AND B122 SERIES TYPE GL LUG.
5. CABLE-TO-REBAR WELDING REQUIRES MINIMUM 1-¼" WELD LENGTH.
6. SEE GENERAL NOTES ON DRAWING E-101-A.

DESIGNER NOTE: TO BE REMOVED WHEN PREPARING CONSTRUCTION DRAWINGS FOR SITE ADAPTATION DESIGN

SHEETS E-101-A, E-201-A. E-202-A, E-301-A, AND E-302-A IDENTIFY AN ALTERNATE LIGHTNING PROTECTION SYSTEM USING A MAST-TYPE DESIGN INSTEAD OF AN INTEGRAL-TYPE DESIGN. DESIGNER SHALL VERIFY THE CORRECT TYPE OF DESIGN WITH THE CONTRACTING OFFICER AND REMOVE THE SHEETS IDENTIFYING THE NON-APPLICABLE DESIGN FROM THE CONSTRUCTION CONTRACT DOCUMENTS.

(A) - ALTERNATE LIGHTNING PROTECTION DESIGN

US Army Corps of Engineers
Huntsville Center

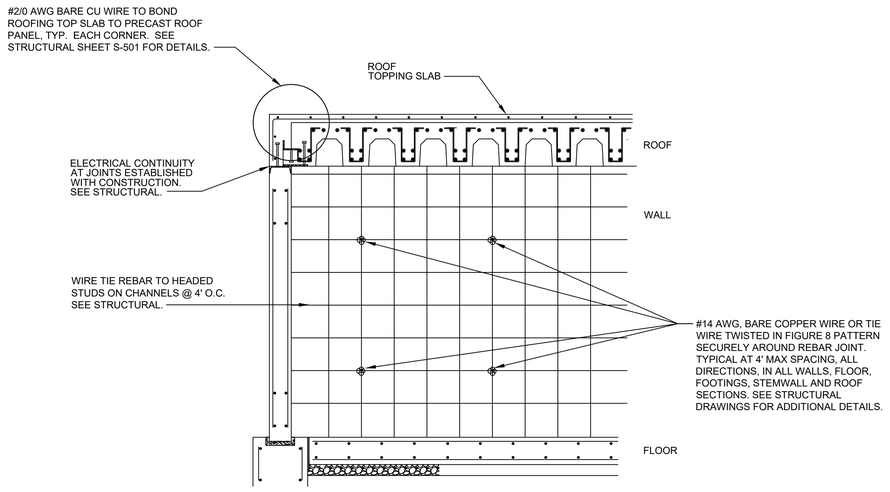
No.	Description	Date	Appr.
1	Electrical Updates. Added E-601 for RSM, and -A' Sheets for Mast-Type LPS Design.	MAY 2023	

Designed by: JRD
Drawn by: JRD
Checked by: JTZ
Project Engineer/Architect: Jeff Coulston
Date: MAY 2023
Scale:
Drawing code:

U. S. ARMY CORPS OF ENGINEERS
ENGINEERING AND SUPPORT CENTER, HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE BOX-TYPE, STD 421-80-08 (REV. 1)
GROUNDING AND LIGHTNING PROTECTION DETAILS

Sheet reference number:
E-201-A
Sheet 26 of 29



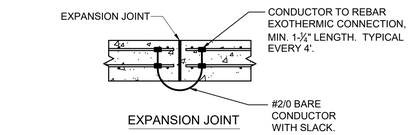
NOTES:

A. "TACK" WELDING MAY BE USED IN LIEU OF TIE WIRE FOR ELECTRICAL CONTINUITY.
B. BONDING AND GROUNDING NOTE: ELECTRICAL BONDING REQUIREMENTS INTERNAL TO PRECAST ROOF AND WALL PANELS SHALL BE PROVIDED BY THE PRECAST MANUFACTURER IN ACCORDANCE WITH THE STRUCTURAL DRAWINGS. ELECTRICAL BONDING REQUIREMENTS EXTERNAL TO PRECAST PANELS AND WITHIN CAST-IN-PLACE CONCRETE SLABS SHALL BE FIELD INSTALLED.
C. PANEL BONDING DETAIL IS GENERIC AND MAY NOT REFLECT EXACT CONSTRUCTION METHODS.
D. INSTALL SAME BONDING METHODS AT WING-WALL PANELS.

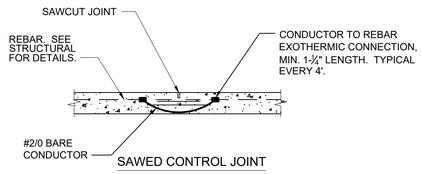
PANEL BONDING DETAILS

SCALE: N.T.S.

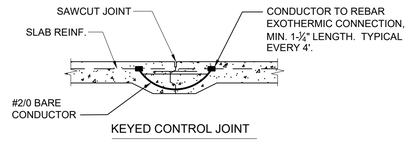
A | E-202-A | E-202-A



EXPANSION JOINT



SAWED CONTROL JOINT



KEYED CONTROL JOINT

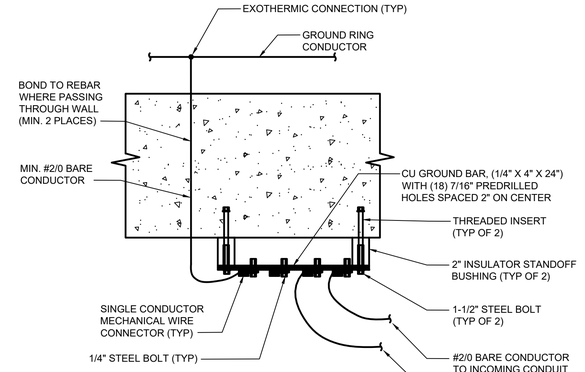
TYPICAL BOND CONNECTION AT VARIOUS CONSTRUCTION JOINTS

SCALE: N.T.S.

B | E-202-A | E-202-A

NOTES:

1. CONDUCTORS SHALL BE COPPER, MINIMUM SIZE #2/0 AWG BARE COPPER, UON.
2. UNLESS OTHERWISE NOTED, BONDING AS SHOWN WITHIN THE DETAILS OF THIS SHEET SHALL BE EVERY 4' MINIMUM IN ALL DIRECTIONS.
3. CABLE-TO-REBAR WELDING REQUIRES MINIMUM 1-¼" WELD LENGTH.
4. SEE GENERAL NOTES ON DRAWING E-101-A.



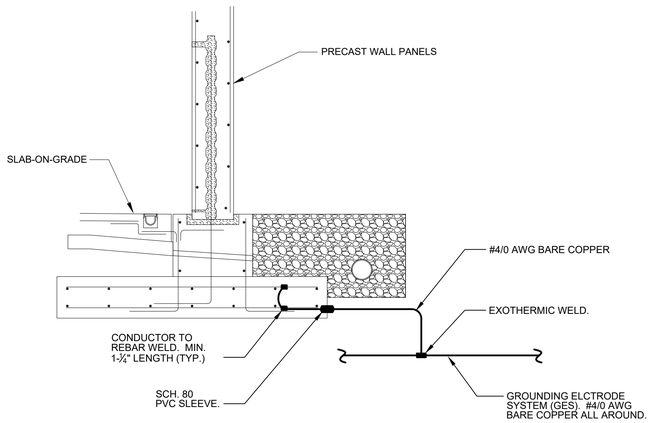
SINGLE POINT GROUND BAR DETAIL

SCALE: N.T.S.

E | E-101-A | E-202-A

NOTES:

A. WHERE POWER IS PROVIDED TO THE MAGAZINE, PROVIDE A SINGLE POINT GROUND BAR AS DETAILED. LOCATE ADJACENT TO POWER PANEL, MIN. 18" ABOVE GRADE. INTERIOR DETAIL SHOWN.



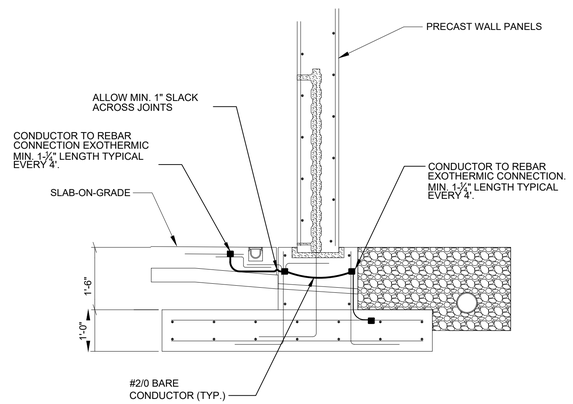
FOUNDATION TO G.E.S.BONDING DETAIL

SCALE: N.T.S.

F | E-101-A | E-202-A

NOTES:

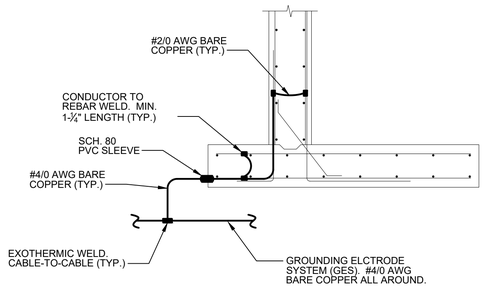
A. TYPICAL FOUNDATION TO G.E.S BONDING DETAIL. PROVIDE AT EACH ECM CORNER AND AT DISTANCES NOT TO EXCEED (NTE) 60'.



FLOOR TO FOUNDATION BONDING DETAIL

SCALE: N.T.S.

C | E-202-A | E-202-A



WING-WALL TO G.E.S. BONDING DETAIL

SCALE: N.T.S.

D | E-101-A | E-202-A

NOTES:

A. BOND WING WALL AS SHOWN A MINIMUM TWO PLACE FOR EACH WING WALL.

DESIGNER NOTE: TO BE REMOVED WHEN PREPARING CONSTRUCTION DRAWINGS FOR SITE ADAPTATION DESIGN

SHEETS E-101-A, E-201-A, E-202-A, E-301-A, AND E-302-A IDENTIFY AN ALTERNATE LIGHTNING PROTECTION SYSTEM USING A MAST-TYPE DESIGN INSTEAD OF AN INTEGRAL-TYPE DESIGN. DESIGNER SHALL VERIFY THE CORRECT TYPE OF DESIGN WITH THE CONTRACTING OFFICER AND REMOVE THE SHEETS IDENTIFYING THE NON-APPLICABLE DESIGN FROM THE CONSTRUCTION CONTRACT DOCUMENTS.

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US Army Corps of Engineers
Huntsville Center

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Drawn by: JRD
Checked by: JTZ
Date: MAY 2023
Scale:
Drawing code:
Project Engineer/Architect: Jeff Coulston
Date:

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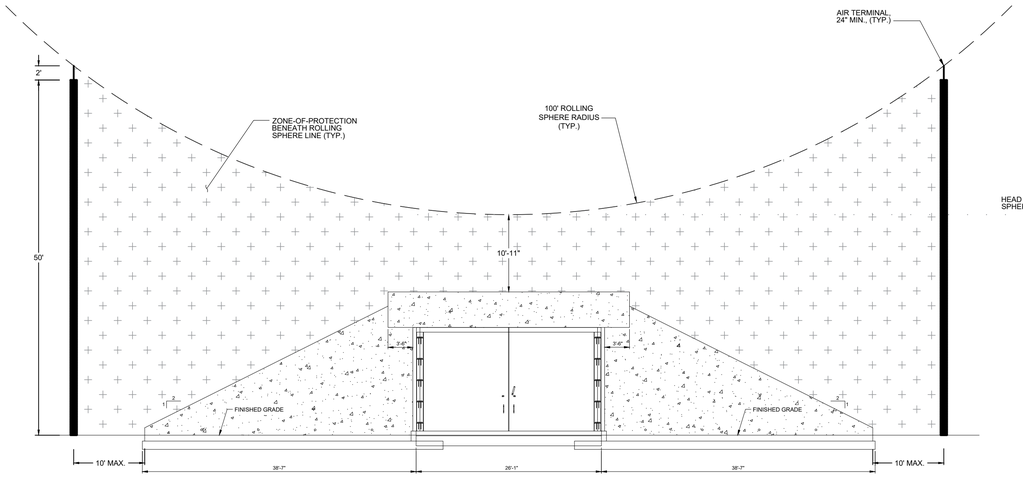
ENGINEERING AND
SUPPORT CENTER,
HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)
GROUNDING AND BONDING
DETAILS

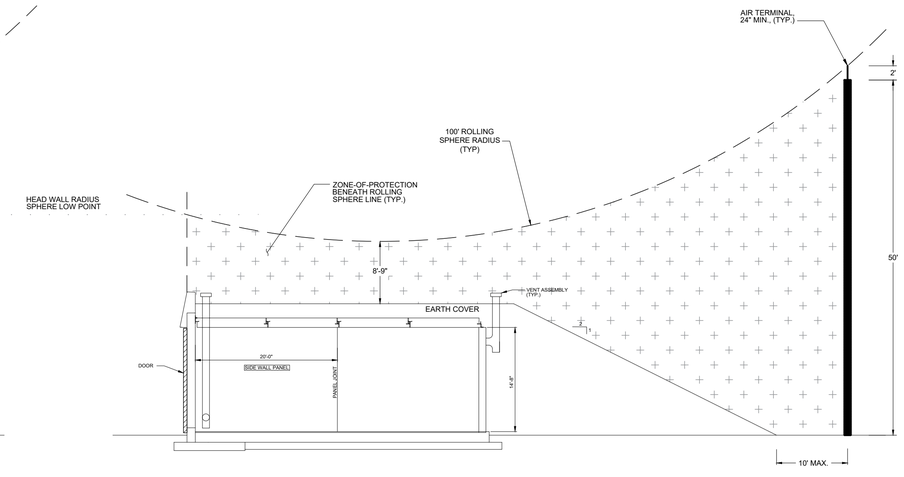
Sheet reference number:
E-202-A
Sheet 27 of 29



ROLLING SPHERE ANALYSIS - HEAD WALL VIEW - 40' ECM

SCALE: N.T.S.

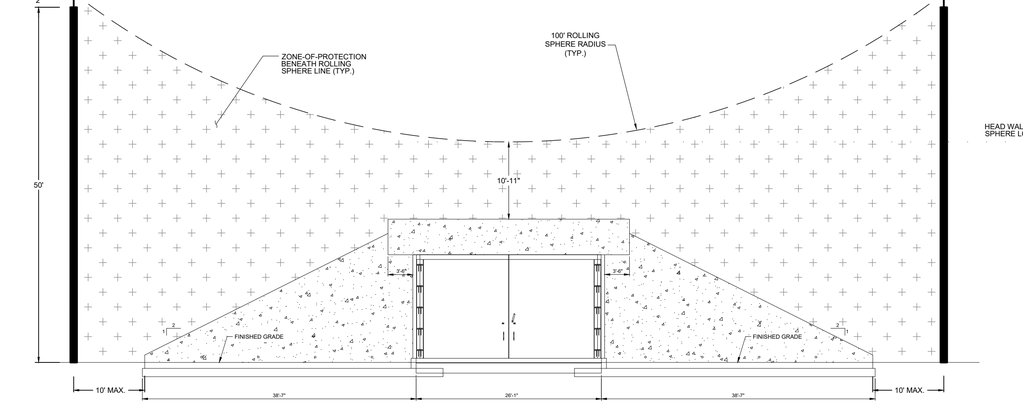
A | E-302-A | E-302-A



ROLLING SPHERE ANALYSIS - CROSS SECTIONAL VIEW - 40' ECM

SCALE: N.T.S.

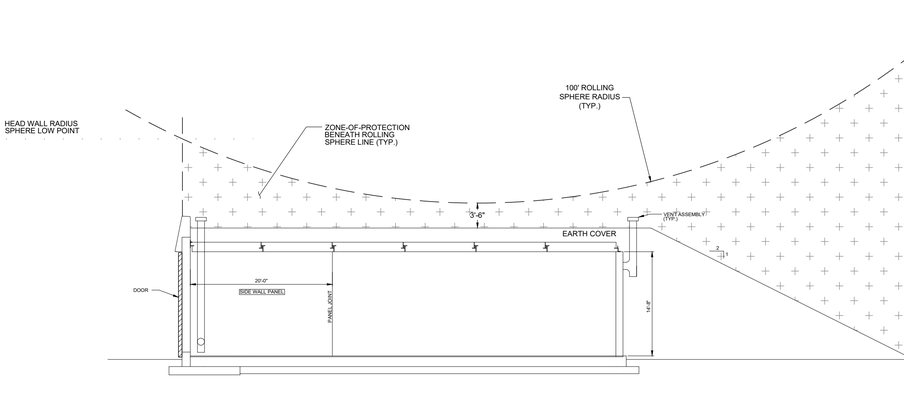
B | E-302-A | E-302-A



ROLLING SPHERE ANALYSIS - HEAD WALL VIEW - 60' ECM

SCALE: N.T.S.

C | E-302-A | E-302-A



ROLLING SPHERE ANALYSIS - CROSS SECTIONAL VIEW - 60' ECM

SCALE: N.T.S.

D | E-302-A | E-302-A

NOTES:

1. ROLLING SPHERE METHOD (RSM) ANALYSIS DEMONSTRATES A ZONE-OF-PROTECTION BASED ON A 100' RADIUS STRIKING DISTANCE FOR THE ECM STRUCTURE AND HEAD WALL ASSEMBLY.
2. MEASURED CLEARANCES AND DIMENSIONS MAY VARY DEPENDING ON FINAL INSTALLATION CONDITIONS AND PRODUCT SELECTIONS.
3. LPS MAST'S HEIGHTS ARE REPRESENTATIVE OF ACCEPTABLE ZONE OF PROTECTIONS FOR THE 421-80-08 ECM AND THE THREE STANDARD LENGTHS. DIFFERENT MAST HEIGHTS OR MAST TYPES MAY BE SELECTED AND USED AS LONG AS THE ZONE OF PROTECTION IS MAINTAINED.
4. SEE SHEET E-302-A FOR THE ANALYSIS ON THE STANDARD 80' ECM.
5. REFER TO STRUCTURAL DRAWINGS FOR COMPLETE DIMENSIONAL INFORMATION.
6. GROUNDING AND BONDING COMPONENTS / SYSTEMS ARE NOT REPRESENTED IN THE RSM ANALYSIS.
7. SEE GENERAL NOTES ON DRAWING E-101-A.

DESIGNER NOTE: TO BE REMOVED WHEN PREPARING CONSTRUCTION DRAWINGS FOR SITE ADAPTATION DESIGN

SHEETS E-101-A, E-201-A, E-202-A, E-301-A, AND E-302-A IDENTIFY AN ALTERNATE LIGHTNING PROTECTION SYSTEM USING A MAST-TYPE DESIGN INSTEAD OF AN INTEGRAL-TYPE DESIGN. DESIGNER SHALL VERIFY THE CORRECT TYPE OF DESIGN WITH THE CONTRACTING OFFICER AND REMOVE THE SHEETS IDENTIFYING THE NON-APPLICABLE DESIGN FROM THE CONSTRUCTION CONTRACT DOCUMENTS.

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US Army Corps of Engineers
Huntsville Center

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ENGINEERING AND
SUPPORT CENTER,
HUNTSVILLE, ALABAMA

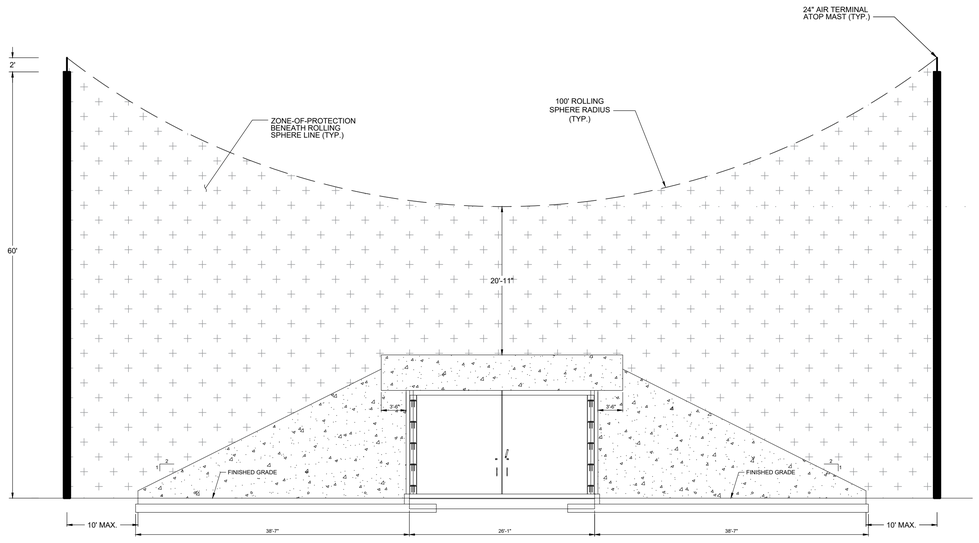
MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

ROLLING SPHERE METHOD
ANALYSIS

Sheet reference number:

E-301-A

Sheet 28 of 29

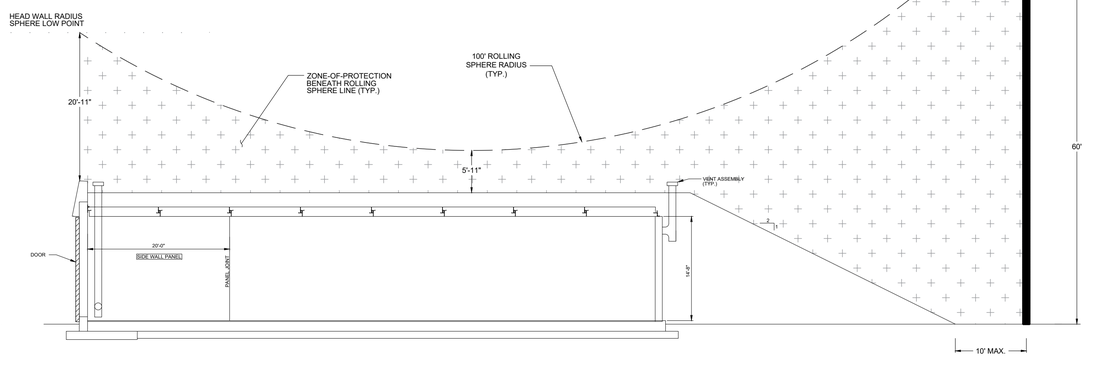


ROLLING SPHERE ANALYSIS - HEAD WALL VIEW - 80' ECM

SCALE: N.T.S.

A

E-301-A E-301-A

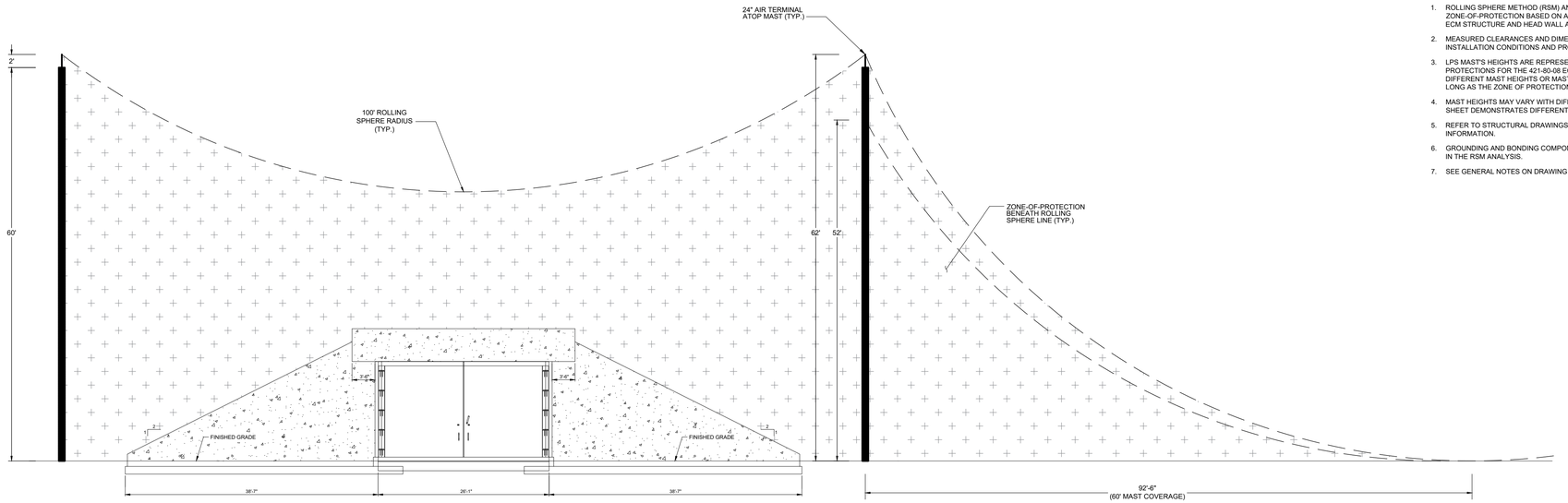


ROLLING SPHERE ANALYSIS - CROSS SECTIONAL VIEW - 80' LENGTH

SCALE: N.T.S.

B

E-301-A E-301-A



ROLLING SPHERE ANALYSIS - EXTENTS VIEW

SCALE: N.T.S.

C

E-301-A E-301-A

NOTES:

1. ROLLING SPHERE METHOD (RSM) ANALYSIS DEMONSTRATES A ZONE-OF-PROTECTION BASED ON A 100' RADIUS STRIKING DISTANCE FOR THE ECM STRUCTURE AND HEAD WALL ASSEMBLY.
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4. MAST HEIGHTS MAY VARY WITH DIFFERENT ECM LENGTHS. DETAIL 'C' THIS SHEET DEMONSTRATES DIFFERENT MAST'S HEIGHTS.
5. REFER TO STRUCTURAL DRAWINGS FOR COMPLETE DIMENSIONAL INFORMATION.
6. GROUNDING AND BONDING COMPONENTS / SYSTEMS ARE NOT REPRESENTED IN THE RSM ANALYSIS.
7. SEE GENERAL NOTES ON DRAWING E-101-A.

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HUNTSVILLE, ALABAMA

MODULAR STORAGE MAGAZINE
BOX-TYPE, STD 421-80-08 (REV. 1)

ROLLING SPHERE METHOD
ANALYSIS

Sheet reference number:

E-302-A

Sheet 29 of 29