

MODULAR STORAGE MAGAZINE BOX-TYPE STD 421-80-08

Background:

The DDESB approved the Munitions Storage Magazine (14 foot ceiling height) at Hill AFB in 2002 as a 7-Bar ECM with an allowable Net Explosives Weight (NEW) of 500,000 lbs HD 1.1 explosives. The MSM at Hill AFB was basically a larger version of the MSM Standard 421-80-06 (modified) with an optional 14 feet clear door height. This optional door height was evaluated and determined to provide “at least equivalent in strength” to the field tested standard door clear height of 10’-4” in terms of dynamic response.

Purpose:

The MSM Standard 421-80-08 replaces the previous Munitions Storage Magazine (14 feet ceiling height) as designed for Hill AFB. The new series updates the drawings to meet current AEC CAD standards, and features improved plan readability, constructability, and corrects omissions within the construction drawings. Another key element performed during the revision was the incorporation of lessons learned (see Appendix A) from previous MSM projects at various user organizations. In addition to the drawings, a conventional structural load analysis was performed to identify some key loading limits, which will assist the designer during the site-adaptation process. Many upgrades were made to the drawing package to improve the drawings in an effort to enhance new construction of this type.

The following is a condensed list of some notable changes from the MSM design for Hill AFB that were incorporated into the new MSM Standard 421-80-08 drawings:

- Lightning protection system and grounding design was revised to include the rolling ball analysis method
- Doors were revised to provide both high security hasps and internal locking devices
- Revised thrust bearing plates to allow for grease fittings
- Added grease fittings to hinge pins to improve the operation of the doors
- Provided depth gauges on the precast roof panels to improve the earth cover inspection process
- Precast wall thickness was changed from 8” to 12” for increase flexural and shear resistance in the wall due to lateral earth pressures (earth cover) resulting from earthquake motions.
- Added stirrups in the precast walls at the top to increase the anchorage capacity of the headed studs in the precast concrete wall.
- Revised the connection of the precast wall to foundation by removing the embed plates with headed studs and replacing them with rebar dowels that are grouted solid inside a

corrugated steel conduit. This was changed to increase the shear resistance at the wall-to-foundation interface and to provide a failure mode where the steel would yield to enhance the ductility of the structure during seismic events.

- Added seismic hooks at the ends of the horizontal reinforcement in the precast walls.
- Increased the precast roof panel bearing length 8 inches to facilitate the 12" wall thickness
- Additional stirrups were added at each end of the precast roof panel so that the stirrup spacing would remain unchanged due to the increased panel length.
- Raised top of floor slab on inside of door frame to allow for a smoother transition over the door frame
- Added door handles to both doors
- Changed weld of skin plates to door frame from skip weld to continuous weld to provide a better seal against water infiltration
- Modified passive ventilators by removing mesh screen, fusible link, butterfly valve, indicator flag assembly, and weighted damper to simplify the ventilator system in both, construction, operation and maintenance.
- Vertical reinforcement in the precast side wall panels were changed from #7's at 12" o.c. to #8's at 12" o.c. for increased flexural resistance against lateral earth pressures.
- Foundation dimensions and reinforcement (size and spacing) was revised so that the allowable soil bearing pressure wasn't exceeded.
- Changed L6x4x1/2 to L6x6x1/2 at precast roof-to-back wall connection to accommodate the increased wall thickness
- Revised the weld of the door's interior skin plate to crossing bars by replacing the 1/2" diameter plug weld with a 1/4" fillet weld by using slotted holes in the skin plate

APPENDIX A-LESSONS LEARNED

Item	Commenter	Component	Lesson Learned	Status	Action Taken
1	Integrated Systems Analysts, Inc James S. Wassenberg 850-862-7321	Electrical - Interior lighting and conduit	Recess the interior lights to be flush with the bottom of the roof panels and move ceiling conduit to either side to keep from being impacted with fork-lift.	For Information Only	The fixture is only 7" wide and the interior rib cavity dimension is 10" side-to-side. However, there will only be 1.5" inches on either side (if center mounted) of the light fixture for hand clearance to operate the latch to remove/re-attach the lens. I don't recommend this because of the tight clearance and potential maintenance hardship. However, the fixture can be mounted inside the panel ribs with only the lens portion extending below the rib cavity. The total fixture depth is 5.188", and the lens depth is 2.125". So, this method of installation will raise the fixture height about 3 more inches, not counting the gains by having the mounting hardware now inside the rib cavity. Still required to center mount the fixture within the panel ribs.
2	Integrated Systems Analysts, Inc James S. Wassenberg 850-862-7321	Serviceability - Door Seal	Add a weather seal around the doors in order to keep rain, snow, sand, etc out .	Accepted	Added a note on Detail A/S701 for the contractor to provide proper weather sealing around door. Final weather sealing will depend upon the location, therefore is intended to be a site-adapt issue.
3	Integrated Systems Analysts, Inc James S. Wassenberg 850-862-7321	Physical Security	Update hasps/locks to meet physical security requirements for explosives facilities.	Accepted	Drawings were updated to show details of ILD and security hasps. Refer to Sheet S705.
4	Integrated Systems Analysts, Inc James S. Wassenberg 850-862-7321	Serviceability - Door Stop	Add a door catch to hold each door open. A slight gust of wind could close the door while personnel are working and cause injury.	Accepted	Added a hook on the site cast concrete walls and doors to retain the doors from closing shut. Refer to revised drawings sheet S201 for details.
5	Integrated Systems Analysts, Inc James S. Wassenberg 850-862-7321	Accessibility	Need ramps to allow forklifts to get over bottom lip on the door.	Accepted	Added a note on sheet S302 of the revised drawings to provide ramps to safely transport munitions over door sill.

6	Integrated Systems Analysts, Inc James S. Wassenberg 850-862-7321	Usability	Insure the tops of the floor and the front lip at the bottom of the door are flush. Otherwise, it acts as a speed bump for a forklift causing the loss of storage in the front portion of the ECM to get the forks out from under a pallet.	Accepted	Revised drawings to show the inside face of the door tube at the bottom flush with the finish floor. Refer to revised drawings detail A/S302.
7	Integrated Systems Analysts, Inc James S. Wassenberg 850-862-7321	Serviceability - Drainage	Insure adequate drainage (slope) away from the door for the pad in front of the ECM.	Not Accepted	This is considered a site-adapt issue and not part of the scope for the standard design/drawings of the ECM.
8	CESPK-CO-UR Tim Willard _ 801-586-3219 Hill AFB Resident Engineer	Waterproofing	We had some leakage issues due to the protruding bolts on the head wall. As the earth cover put pressure on the waterproofing fabric, it caused the membrane to tear. We had to go back in and repair.	Accepted	Revised the size of cant strip to 3x3 (min.) to ensure bolt head at headwall would be adequately recessed to prevent leakage.
9	CESPK-CO-UR Tim Willard _ 801-586-3219 Hill AFB Resident Engineer	Serviceability - Floor Slab	The cutting of the concrete joints created us a problem. At the front of the igloo the slab is thickened. There was no joint shown running parallel to the thickened edge. This caused a crack in the floor slab, so we added a joint there. The spacing of the joints pushed the limits, and we experienced some random cracking. Therefore, we added some joints, and it solved the cracking problems.	Accepted	Added control joints on slab-on-grade per the guidelines of PCA. Refer to revised drawings sheet S101.
10	CESPK-CO-UR Tim Willard _ 801-586-3219 Hill AFB Resident Engineer	Door Design	We found the weight of the door exceeded the capacity of the tack weld causing the door to sag. Hinge pin required tack-welding of the pin on two sides. We revised the detail to weld all around the hinge pin head and this took care of the problem.	Accepted	Refer to Detail A/S702 of revised drawings which shows an "weld all around" for the hinge pin to hinge plate. Also, note that the original drawings showed a "weld all around" on detail 8/S-10.
11	CESPK-CO-UR Tim Willard _ 801-586-3219 Hill AFB Resident Engineer	Accessibility	We dropped the entrance apron approximately one inch to assist door swing.	Accepted	An 1" clearance between the bottom of the doors and top of door footing was provided in the revised drawings. Refer to Detail A/S302.

12	CESPK-CO-UR Tim Willard _ 801-586-3219 Hill AFB Resident Engineer	Door Design	The door bumpers were inadequate. In strong winds, the door banged the door stop. We had to beef up the door stop. Also requires heavy duty industrial door bumpers. Added a retain chain to keep the door from blowing shut.	Accepted	Revised drawings show bollards (optional) with industrial bumpers (see S101 and S201) Also, added a D-ring anchor at the CIP concrete retaining wall for a door catch if the bollard option isn't chosen.
13	CESPK-CO-UR Tim Willard _ 801-586-3219 Hill AFB Resident Engineer	Door Design	Added a closure plate along the mating edges of the doors. Design showed a plate on one side , but the user requested one of both sides of the door.	Accepted	Revised drawings show a closure plate on both sides of the door. Refer to Door Elevations A/S702 and B/S702.
14	CESPK-CO-UR Tim Willard _ 801-586-3219 Hill AFB Resident Engineer	Serviceability - Weatherproofing	Commercial grade door seals are required on the inside edge of the door to prohibit blowing sand, rain and snow.	Accepted	Added a note on Detail A/S701 for the contractor to provide proper weather sealing around door. Final weather sealing will depend upon the location, therefore is intended to be a site-adapt issue.
15	CENWK-CD-MW James Rudy _ 660-563-2311 Whiteman AFB Resident Eng.	Serviceability	Provide overburden gauges to the roof. The current probing method leads to damaged waterproofing and water leakage.	Accepted	Depth gauges were added to the top of the roof panels. See A/S301, A/S302, and F/S501 of the revised drawings.
16	CENWK-CD-MW James Rudy _ 660-563-2311 Whiteman AFB Resident Eng.	Wall Panel Design	Wall panels need to be designed for any soil type, not just well draining materials and not just after construction but during construction. If certain fill types are not allowed, this should be stated. Best solution is to design to allow native material so material close to site can be used.	Accepted	Note has been revised on S301 and S302 of revised standard drawings to indicate allowable earth fill per DOD 6055.09-M.
17	CENWK-CD-MW James Rudy _ 660-563-2311 Whiteman AFB Resident Eng.	Utilization	Floor thickness needs to be increased appropriately for greatest number of possible munitions and munitions trailers. Installations use magazines as needed even if it means waivers, de-rating magazine or underutilizing magazine capacity. Thicker floors are a simple way to add to versatility to a magazine.	Accepted	Floor thickness and/or slab-on-grade design needs to be looked at on a case-by-case basis, thus is not considered as part of this standard design.

18	CENWK-CD-MW James Rudy _ 660-563-2311 Whiteman AFB Resident Eng.	Serviceability	Latching system shown (S11 and S12) needs hold open device. When operating doors latch can fall and drag and get pinned between the door and frame, both causing damage.	Accepted	In order to allow the latch to stay in the "unlock" position during operation of the door, the upper lock bar was weighted slightly heavier than the lower lock bar to keep the latch from falling back in the "lock" position. See detail 5/S704 of the revised drawings.
19	CENWK-CD-MW James Rudy _ 660-563-2311 Whiteman AFB Resident Eng.	Accessibility	Make the floor lip and the entrance as small as possible. Munitions safety would like it to be under 0.25 inches.	Accepted	Revised drawings to show the inside face of the door tube at the bottom flush with the finish floor. Refer to revised drawings detail A/S302. A lip on the outside of the door frame is required to allow door bearing as required under a blast load.
20	CENWK-CD-MW James Rudy _ 660-563-2311 Whiteman AFB Resident Eng.	Serviceability	Slope of overburden needs to be easy to mow.	Not Accepted	The overburden slope is shown at 2 MIN:1 per DOD 6055.09-M. A Milder slope (i.e., 3 to 1, etc) is acceptable.
21	CENWK-CD-MW James Rudy _ 660-563-2311 Whiteman AFB Resident Eng.		Interior space for a security panel needs to be provided.	For Information Only	Interior space is available on interior face of wall panels. Any penetrations need to be coordinated with precast manufacturer.
22	Professional Engineering Consultants Dennis Cook		What are the dimensions giving the size and location of the gravel and sand backfill at the weep hole? Is the depth of the gravel backfill to align with the centerline of the weep hole?	For Information Only	This issue is not critical to the structural designation of the ECM. However, some guidance is given in the NOTES on Detail A/S303 of the revised drawings. This is part of the site adapt design and site adapt engineer should ensure water does not build up behind the wing walls.
23	Professional Engineering Consultants Dennis Cook		Detail 3 on Sheet S-5 "Detail" – Are there any notes required at the trough formed by the embedded angle in the roof panel?	Accepted	Added high strength non-shrink grout over the embedded angles to ease waterproofing application. See revised drawings Detail A/S302.