

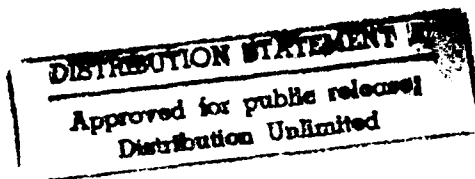
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FINAL REPORT
JUNE 1991

REPORT NO. EVT 13-90

MIL-STD-1660 TESTS
OF
DS2 CONTAINERS



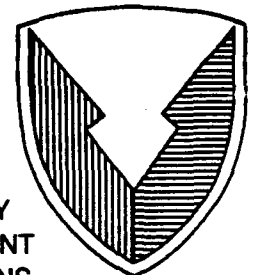
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VALIDATION ENGINEERING DIVISION
SAVANNA, ILLINOIS 61074-9639

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FIELD	GROUP	SUB-GROUP				
19. ABSTRACT <i>(Continue on reverse if necessary and identify by block number)</i> The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, Rock Island, IL to test the DS2 container. This report contains the procedures, results, and recommendations from the tests conducted. As tested, the DS2 container passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads.						
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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to test the DS2 container.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of this test was to assess the ability of the DS2 container to remain damage free during transportation.

PART 2

ATTENDEES

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PART 3

TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is considered to be acceptable. The four tests that were conducted on the test specimen are synopsized below.

1. SUPERIMPOSED LOAD TEST. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high for a period of one hour, as specified in Method 5016, Federal Standard 101. This stacking load is simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner. The unit load weight is multiplied by 192 minus the unit height in inches, divided by the unit height in inches, then multiplied by a safety factor of two. The resulting number is the equivalent compressive force of a 16-foot-high load.

2. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles-per-second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves $1 \pm 0.1G$. Midway into the testing period, the specimen shall be rotated 90 degrees, and the test continued for the duration. Unless failure occurs, the total time of vibration shall be two hours if the specimen is tested in one position; and, if tested in more than one position, the total time shall be three hours.

3. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise rotational drop test is as follows: The specimen shall be placed on its skids with one end of the pallet supported on a beam 4 1/2-inches high. The height of the beam shall be increased, if necessary, to ensure that there will be no support for the skids between the ends of the pallet when dropping takes place, but should not be high enough to cause the pallet to slide on the supports when the dropped end is raised for the drops. The unsupported end of the pallet shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
POUNDS	INCHES	INCHES
600 lbs.	72	36
3,000 lbs.	no limit	24
no limit	no limit	12

4. INCLINE-IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the incline-impact test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least two inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4- by 4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage

and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet-per-second.

PART 4

TEST EQUIPMENT

1. TEST PALLET NO. 1.

- a. Unitization: 4 containers long by 3 containers wide by 2 containers high
- b. Width: 35 3/4-inches (90.8cm)
- c. Length: 47 inches (119.4cm)
- d. Height: 33 1/4-inches (84.5cm)
- e. Weight: 1,247 pounds (566kg)

2. TEST PALLET NO. 2.

- a. Unitization: 4 containers long by 3 containers wide by 2 containers high
- b. Width: 35 3/4-inches (90.8cm)
- c. Length: 47 inches (119.4cm)
- d. Height: 35 inches (88.9cm)
- e. Weight: 1,338 pounds (607kg)

3. COMPRESSION TESTER.

- a. Manufacturer: Ormond Manufacturing
- b. Platform: 60 inches by 60 inches
- c. Compression Limit: 50,000 pounds
- d. Tension Limit: 50,000 pounds

4. TRANSPORTATION SIMULATOR.

- a. Manufacturer: Gaynes Laboratory
- b. Capacity: 6,000-pound pallet
- c. Displacement: 1/2-inch Amplitude
- d. Speed: 50 to 400 rpm
- e. Platform: 5-foot by 8-foot

5. INCLINED RAMP.

- a. Manufacturer: Conbur Incline
- b. Type: Impact Tester
- c. Grade: 10 percent Incline
- d. Length: 12-foot Incline

PART 5

TEST RESULTS

MIL-STD-1660 TESTS

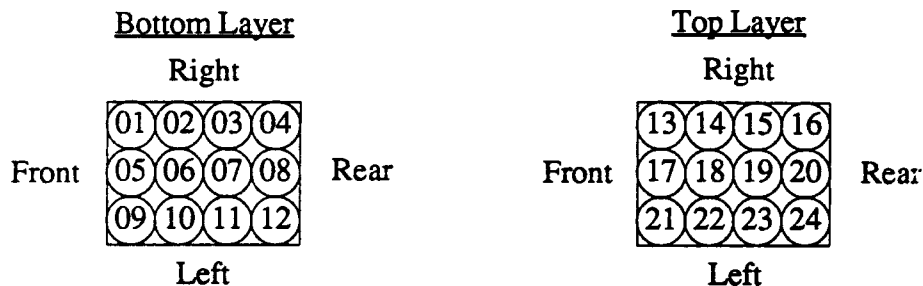
PALLET NO. 1:

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 6,250 pounds compression for a period of one hour. The safety factor of two was decreased for less hazardous shipments, level B packing (test no. 2 uses a safety factor of two). Periodic adjustments were made to maintain the desired stacking weight of 6,250 pounds. At the end of one hour, no noticeable deformation of the pallet or containers was noted.
2. REPETITIVE SHOCK TEST. The test pallet successfully passed the lateral portion of the transportation simulation. During the longitudinal portion of the test, the containers rotated causing the paint to rub off. Also, containers nos. 20 and 23 leaked around the lid, and containers nos. 6 and 7 were suspected of leaking. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the required 1/16-inch minimum clearance between the pallet and the transportation simulator bed, the equipment was operated at 210 revolutions per minute (rpm) for the longitudinal orientation and 195 rpm for the lateral orientation.
3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4 1/2-inches above the floor. The first drop was longitudinal to the skids and dropped from a height of 24 inches per MIL-STD-1660 specifications. This process was repeated in a clockwise direction until all four sides of the pallet had been tested. No noticeable deformation of the pallet or containers was noted during this test.

4. **INCLINE-IMPACT TEST.** The incline plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. After each impact all of the outer containers were dented.

5. **END OF TEST INSPECTION.** During final inspection of the pallet and containers, the tops of containers nos. 3, 4, 5, 6, 9, 20, and 23 were wet. The outer containers were dented and paint was scraped off, which exposed the bare metal surface.

DS2 CONTAINER NUMBERING/ORIENTATION FOR ALL PALLETS



PALLET NO. 2 (WITH INTERMEDIATE ADAPTER):

1. **SUPERIMPOSED LOAD TEST.** The test pallet was loaded to 13,400 pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 13,400 pounds. At the end of one hour, no noticeable deformation of the pallet or containers was noted.

2. **REPETITIVE SHOCK TEST.**

a. The test pallet successfully passed the lateral portion of the transportation simulation. During the longitudinal portion of the test, the top layer of containers shifted forward 2 1/4-inches.

b. The test pallet was reunitized with two longitudinal load straps added. MIL-STD-1660 testing resumed after reunition of the pallet. During the longitudinal portion of the test, containers nos. 3 and 22 rotated 90 degrees in a counterclockwise direction; containers nos. 10, 11, 14, and 15 rotated in a counterclockwise direction between 2 and 3 inches; and container no. 23 rotated 3 inches in a clockwise direction. During the lateral portion of the test, containers nos. 15 and 22 rotated another 3 inches in a counterclockwise direction. In order to achieve the required 1/16-inch clearance between the pallet and the transportation simulator bed, the equipment was operated at 205 rpm for the longitudinal orientation and 195 rpm for the lateral orientation.

3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4 1/2 inches above the floor. The first drop was longitudinal to the skids, dropped from a height of 24 inches per MIL-STD-1660 specifications. This process was repeated in a clockwise direction until all four sides of the pallet had been tested. When the third drop (the front portion, longitudinal to the skids) of the test pallet occurred, the top layer of containers shifted forward 1 inch. No other noticeable deformation was noted to the pallet or containers.

4. INCLINE-IMPACT TEST. The incline plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. After each impact some containers were dented. There was a 2-inch gap between the pallet assemblies and containers on both layers.

5. END OF TEST INSPECTION. During final inspection of the pallet and containers, most containers were dented approximately 3 inches across on the top portion of the container on at least one face, and some were dented on both the top and bottom portion of the container. There was paint scraped off to expose the bare metal on some containers.

ENGINEERING TESTS

After MIL-STD-1660 testing was completed, a 25-foot stacking test was conducted. This test was similar to the superimposed load test, except that a height of 25 feet was used instead of 16 feet in calculating the equivalent compressive force. The test was conducted for a period of 96 hours instead of a period of 1 hour. The test pallet was loaded to 11,250-pounds compression for a period of 96 hours. Periodic adjustments were made to maintain the desired stacking weight of 11,250 pounds. At the end of the 96 hours, no noticeable deformation of the pallet or containers was noted.

PART 6

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. As tested, the DS2 pallet design passed MIL-STD-1660 testing and can be used for one transportation cycle. The DS2 containers are susceptible to corrosion from the DS2. The combination of corrosion and rotation of the DS2 containers can wear holes through the metal. The revised design successfully minimized rotation of the DS2 containers; however, the revised design doesn't allow the successive layers of containers to nest on top of each other, and they are susceptible to denting as with the initial design. The increased strength of containers from 24 gage to 22 gage helped decrease denting; therefore, this pallet design is acceptable for "like new" containers only.

2. RECOMMENDATIONS:

a. Inspect the pallet load after each transportation cycle to verify sound structure for transportability. If any damage has occurred to the pallet, reunite the containers on new pallets before transporting. If any damage has occurred to the containers, repackage the DS2 in new containers.

b. For long-term storage, the containers should be replaced with containers made from material that will not corrode upon contact with the DS2, such as stainless steel, galvanized steel, or other rustproofing.

PART 7

PHOTOGRAPHS



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. AO317-SPN-91-121-1038. This photo shows the initial pallet unitization design.



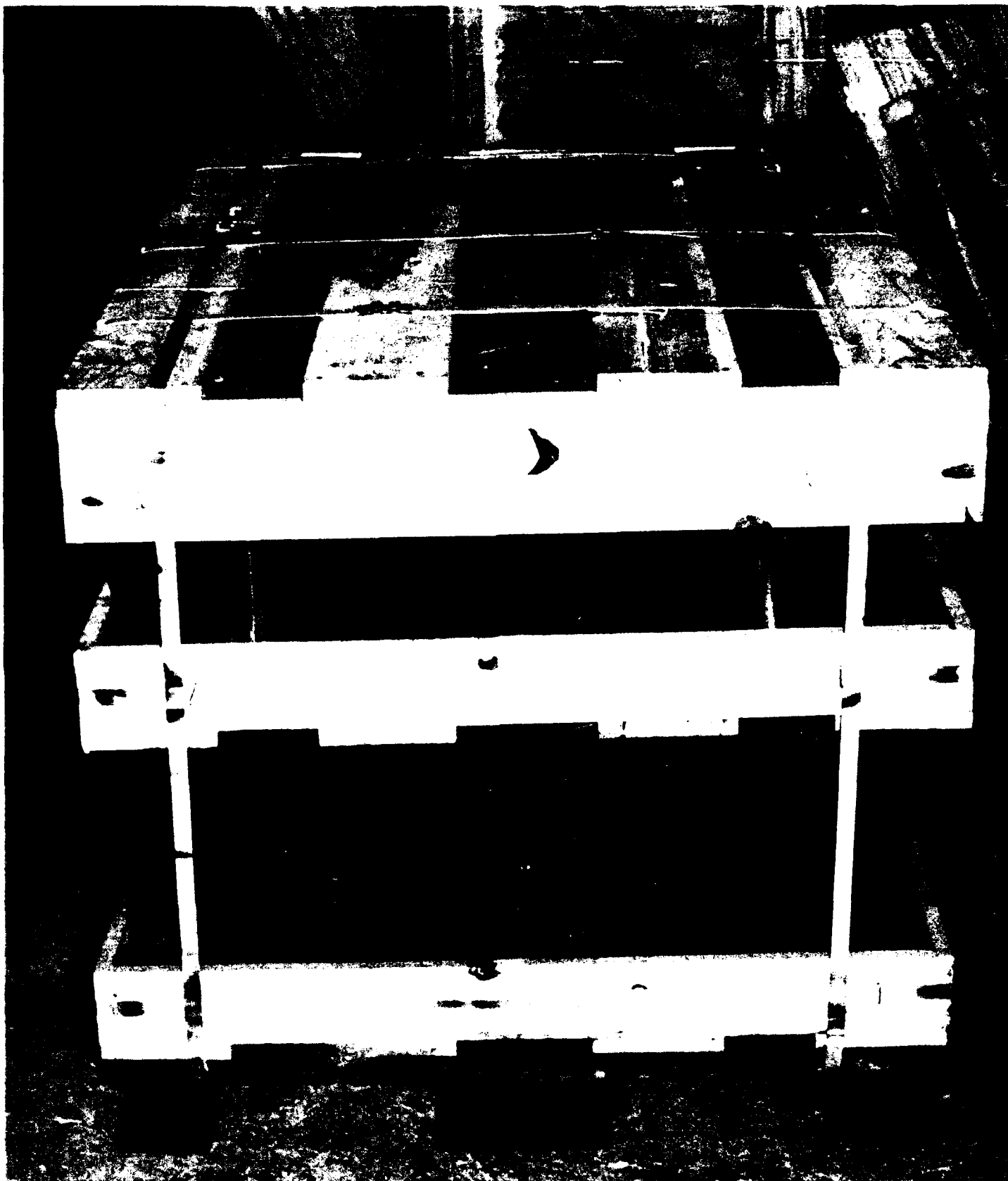
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Photo No. AO317-SPN-91-201-2346-91. This photo shows the revised pallet unitization design with the intermediate adapter.



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Photo No. AO317-SPN-91-201-2345-91. This photo shows the amount of shifting that occurred to the top layer of the pallet during vibration, before two longitudinal bands were added.



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Photo No. AO317-SPN-91-200-3190. This photo shows the final pallet unitization design using longitudinal bands.		
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Photo No. AO317-SPN-91-200-3195. This photo shows the damage (denting) to the
canisters following testing.