REPORT NO. 92-03

RAIL IMPACT TESTS OF MINIMUM DUNNAGE FOR 120MM PALLETS IN 20-FOOT MILITARY VANS (MILVANS)

92-31017

Prepared for:
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The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Logistics Engineering Office (SMCAC-DE), to verify rail transportation of 120mm tank ammunition in MILVANs. Tests were conducted following dunnage failure during rail movement of an untested blocking and bracing procedure authorized by the Transportation Engineering Division (SMCAC-DET). These failures occurred during blocking and bracing against the MILVAN doors on ammunition returning from Saudi Arabia (SA). Two blocking and bracing procedures were tested, with both procedures failing during testing. As such, blocking and bracing against MILVAN doors was deemed unsuitable for safe railroad transportation of 120mm ammunition. This report contains details of the tests conducted.
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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 USADACS, Logistics Engineering Office (SMCAC-DE), to verify rail transportation of 120mm tank ammunition in Military Vans (MILVANs). Tests were conducted following dunnage failures during rail movement of an untested blocking and bracing procedure authorized by the Transportation Engineering Division (SMCAC-DET). These failures occurred during blocking and bracing against the MILVAN doors on ammunition returning from Saudi Arabia (SA).

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

C. OBJECTIVE. The objective of this test is to verify if blocking and bracing procedures with authorized deviations to normal procedures are acceptable for the safe transportation of retrograde 120mm tank ammunition from SA.

D. CONCLUSION. The two blocking and bracing procedures tested with loading against the MILVAN doors failed prior to completing the tests. One design was loaded horizontally across the doors and at the center, with the other design loading vertically on the door edges opposite the hinges. As tested, the MILVAN doors and component parts were not strong enough to retain the load without MILVAN damage. Therefore, these procedures are not adequate for safe railroad shipment of 120mm tank ammunition in MILVANs.

E. RECOMMENDATION. Current procedures for reduced dunnage and loading against the MILVAN doors be terminated.
PART 2

22-23 OCTOBER 1991

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PART 3

TEST PROCEDURES

The test procedures outlined herein were extracted from TP-91-01, Transportability Testing Procedures, July 1991.

A. MILVAN Load Preparation. The MILVAN was loaded with 10 metal pallets of 120mm tank ammunition and blocked and braced in the same manner as authorized deviations to normal blocking and bracing procedures. The weight and physical characteristics of the load configuration were identical to the live (explosive) ammunition provided for in the outloading procedure; i.e., weights, physical dimensions, center of gravity, materials, etc. The ammunition packages used duplicated that of the live ammunition. When failures occurred during any part of testing, modifications were made to the load and/or blocking and bracing procedures and were entirely retested.

B. Rail Impact Test. The MILVAN was loaded onto a Trailer-on-flatcar (TOFC) and twist locked at each corner to the railcar. Equipment needed to perform the test included the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. These anvil cars were positioned on a level section of track with air and hand brakes set and with the draft gear compressed. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars and, then, pushed the specimen car toward the anvil at a predetermined speed, then disconnected from the specimen car approximately 50 yards away from the anvil cars, which allowed the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting was accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the opposite direction. The 4 and 6 mph impact speeds were approximate; the 8.1 mph speed was a minimum. Impact speeds were determined by using an electronic counter to measure the time required for the specimen
traverse an 11-foot distance immediately prior to contact with the anvil cars (see figure 1). At the discretion of the test engineer, additional impacts at higher or lower speeds may be conducted on the specimen car for engineering test data after the conclusion of the four rail impacts have been conducted.

C. **Data Collection.** The specimen car was instrumented with accelerometers at the following locations as a minimum:

1. On the sill of the railcar.
2. At the top of the test load on one pallet.
3. At the bottom of the test load on one pallet.

After each rail impact, the recorded accelerations were downloaded to determine stresses, movement, forces, velocities, and accelerations during each impact. Data collected were suitable for use in investigating causes for failure and as a criteria for design when developing new procedures, if required.

D. **Failure Criteria.** At the conclusion of each impact, the load was examined for excessive shifting of contents, loosening or breaking of load restraints or blocking and bracing, or any visible damage to the items in the load or their packaging. Normally, testing will be stopped when it becomes apparent that the load will fail; however, the test may be continued until complete failure if the test engineer determines usable data will be developed and safety of personnel and equipment integrity are not violated.
ASSOCIATION OF AMERICAN RAILROADS (AAR)
STANDARD TEST PLAN

5 BUFFER CARS (ANVIL) WITH DRAFT GEAR
COMPRESSED AND AIR BRAKES IN A SET
POSITION
ANVIL CAR TOTAL WT 250,000 LBS (APPROX)

SPECIMEN CAR
IS RELEASED BY
SWITCH ENGINE TO
ATTAIN: IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8.1 MPH
THEN THE CAR IS REVERSED AND
RELEASED BY SWITCH ENGINE TO
ATTAIN: IMPACT NO 4. @ 8.1 MPH

FIGURE 1
PART 4

TEST EQUIPMENT

A. 120mm Palletized Ammunition
   (Test Samples)
   1. Drawing Number: 19-48-4231/48-20PM1006
   2. Width: 40 1/8-inches
   3. Length: 44 1/2-inches
   4. Height: 51 3/4-inches
   5. Weight Empty: 2,444 pounds

B. MILVAN
   1. Width: 8 feet
   2. Length: 20 feet
   3. Height: 8 feet
   4. Weight: 5,785 pounds

C. Railcar
   1. Car Number: TTWX 981502
   2. Car Type: TOFC
   3. Length: 89 feet 4 inches
   4. Weight: 10 feet (approximately)
   5. Draft Gear: Friction

D. Data Acquisition Equipment
   1. Manufacturer: Pacific Scientific
   2. Number of channels: 3
PART 5

TEST RESULTS

Two separate blocking and bracing procedures were tested during this series of tests, with both procedures loaded against the MILVAN doors.

Procedure No. 1. The load was blocked and braced horizontally across and vertically at the center of the MILVAN doors (see drawing no. 1 for details). The first impact was at 4.46 mph with no damage occurring. The second impact at 6.41 mph caused the doors to bow outward at the center approximately 1 inch (see photos nos. 1 and 2). This test was terminated to avoid permanent deformation to the MILVAN. Accelerations experienced during this test are in part 7 of this report.

Procedure No. 2. The load was blocked and braced using a box beam across the palletized load which transmitted all load forces vertically to the MILVAN door hinges (see drawing no. 2 for details). Impact no. 1 was conducted at 4.6 mph with slight deformation to the doors at the bottom corners, below the hinges. After this impact, the door corners were shifted outward approximately 1 inch. Impact no. 2 was conducted at 6.41 mph with the door bottom corners now shifted outward approximately 2 inches. After this impact clear permanent deformation was apparent to the lower door corners and hinges. This damage was in line with the lower box beam. The upper beam appeared to have no adverse effect on the middle of the door or hinges. This test was also terminated prior to any additional deformation to the MILVAN (see photos nos. 3 - 6). Accelerations experienced during this test can be found in part 7 of this report.
RAIL TEST OF 120MM PALLETS IN 20-FOOT END-OPENING MILVAN

PLACEMENT OF ACCELEROMETER #3 ON SILL OF THE RAILCAR.

BLOCKING & BRACING AGAINST MILVAN DOOR.

PLACEMENT OF ACCELEROMETER #1 TOP OF PALLET 6 INCHES FROM AFT END.

PLACEMENT OF ACCELEROMETER #2 ON PALLET SKID AFT END SIDE.

NOTES:
1. RAILCAR 89'-4" LONG BY 9'-2" WIDE

FOR INFORMATION ONLY

92-003-0-T00049
RAIL TEST OF 120MM PALLETS IN 20-FOOT END-OPENING MILVAN

PLACEMENT OF ACCELEROMETER #3 ON SILL OF THE RAILCAR.

BLOCKING & BRACING AGAINST MILVAN DOOR.

PLACEMENT OF ACCELEROMETER #1 TOP OF PALLET 6 INCHES FROM AFT END.

PLACEMENT OF ACCELEROMETER #2 ON PALLET SKID AFT END SIDE.

NOTES:
1. RAILCAR 89'-4" LONG BY 9'-2" WIDE

FOR INFORMATION ONLY

TITLE
TEST #2 ALTERNATIVE PROPOSED BLOCKING PROCEDURE

92-003-0-T00050

VALIDATION ENGINEERING DIVISION SHEET
PART 6

PHOTOGRAPHS
Photo No. AO317-SPN-92-18-524. This photo shows blocking and bracing procedure no. 1 after the second rail impact test. Note, center of doors bowed outward.
This photo shows blocking and bracing procedure no. 1. Note, the top of the doors bowed out after the second rail impact test.
Photo No. AO317-SPN-92-18-538. This photo shows blocking and bracing procedure no. 2, the overall view of MILVAN doors after the second rail impact test. Note, permanent deformation to the corner of the doors and hinges.
Photo No. AO317-SPN-92-18-534. This photo shows blocking and bracing procedure no. 2. Shown is a closeup view of permanent deformation to the corner of the door and hinges.
Photo No. AO317-SPN-92-40-554. This photo shows blocking and bracing procedure no. 2. Shown is permanent deformation to the door. Note, exposure of wooden dunnage.
Photo No. AO317-SPN-92-40-557. This photo shows blocking and bracing procedure no. 2. Note, wooden dunnage extending beyond the door's threshold as well as permanent deformation of the door around the lower hinge.

Time of Sample
Seconds X 1.0000

Long. Accel. Bottom of Pallet
Gs X 1.0000

Time of Sample
Seconds X 1.0000

Center Still
Long. Accel.

Time of Sample
Seconds X 1.0000
PART 8

DRAWING
APPENDIX 48

UNITIZATION PROCEDURES FOR AMMUNITION AND COMPONENTS PACKED IN CYLINDRICAL METAL OR PLASTIC CONTAINERS ON 4-WAY ENTRY METAL PALLETS

CARTRIDGE, 120MM, PACKED 1 PER PAI16 CYLINDRICAL METAL CONTAINER, UNITIZED 30 PER 44" X 40" PALLET; APPROX CONTAINER SIZE 44½ L X 7¾ W X 7¾ H

<table>
<thead>
<tr>
<th>ITEMS INCLUDED</th>
<th>HAZARD CLASSIFICATION</th>
<th>WEIGHT</th>
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<tbody>
<tr>
<td>NSN</td>
<td>DODIC</td>
<td>DOT</td>
</tr>
<tr>
<td>1315-</td>
<td>01-264-2256</td>
<td>C380</td>
</tr>
<tr>
<td>01-226-7418</td>
<td>C786</td>
<td>B II-B</td>
</tr>
<tr>
<td>01-232-4638</td>
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NOTICE: THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-2231-20PM 1006.

HAZARD CLASSIFICATION DATA CONTAINED IN THE ABOVE CHART IS FOR GUIDANCE AND INFORMATIONAL PURPOSES ONLY. VERIFICATION OF THE SPECIFIED DATA SHOULD BE MADE BY CONSULTING THE MOST RECENT JOINT HAZARD CLASSIFICATION SYSTEM LISTING OR OTHER APPROVED LISTING(S).
GENERAL NOTES

A. This Appendix cannot stand alone but must be used in conjunction with the Basic Unitization Procedures Drawing 19-48-4237-2004 and the Basic Drawing 19-48-4231-200A. To produce an approved unit load, all pertinent procedures, specifications, and criteria set forth within the Basic Drawing will apply to the procedures delineated in this Appendix. Any exceptions to the Basic Procedures are specified in this Appendix.

B. Dimensions, cube and weight of a pallet unit will vary slightly depending upon the actual dimensions of the container and the weight of the specific item being unitized.

C. Bundling straps must be tensioned and sealed prior to the application of the unitizing straps. Install bundling straps as close to the outer container rings as possible to avoid damage to the containers.

D. Although the containers depicted in the unit load at left are constructed with interlocking devices, the interlocks will not function properly unless the containers are positioned so that the “pins” of the interlocks are facing upward. This orientation will aid in the prevention of container movement, both laterally and longitudinally, during shipment of the unit load.

E. The following AMC (DARCOM) Drawings are applicable for outloading and storage of the items covered by this Appendix.

F. For method of securing a strap cutter to the pallet unit, see DARCOM Drawing 19-48-4272-209100.

G. If items covered herein are unitized prior to issuance of this Appendix, the containers need not be reunitized solely to conform to this Appendix.

H. For details of the pallet adapter and top lift assembly, see Military Specification MIL-A-7075A.

I. The unitization procedures depicted herein may also be used for unitizing 120MM cartridges when identified by different National Stock Numbers. NSN 1540-01-226-7418 should not be used for explosive items. The explosive classification of other items may differ from that shown.

J. The containers need not be reunitized except as necessary to prevent movement of the container during shipment. This applies only to those items which are to be omitted. Containers to be omitted are marked with “OMITTED” on the title page and the container pack. The containers on the right side of the pallet will be marked with “OMITTED” on the title page and the container pack.

K. Empty or reject containers will be omitted one full layer of containers will be omitted when (empty) filler containers are used in place of filled containers to complete a layer on a pallet. They will be marked as specified within MIL-STD-129.

L. For more information, refer to the AMC (DARCOM) Drawings 19-48-4244-15PM1007, 19-48-4245-14PM1006, and 19-48-4246-5PM1006.