REPORT NO. EVT 22-90

TRANSPORTABILITY TESTING OF 2,000-POUND BOMBS IN A SIDE OPENING COMMERCIAL CONTAINER

Prepared for:
U.S. Army Defense Ammunition
Center and School
ATTN: SMAC-C-DET
Savanna, IL 61074-9639

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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
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THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.
The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to verify the procedure, Loading and Bracing With Wooden Dunnage in Side Opening Commercial Containers of 2,000-Pound Bombs, MK84, and MODs, Unitized, Two Bombs Per Metal Pallet, MK79 MOD O, would meet the transportation requirements of Transportability Testing Procedures, EVT-TP-1-86. The test configuration was subjected to rail, road hazard, road trip, washboard, and shipboard transportation simulation tests. The loading and bracing procedure successfully passed all tests and was approved.
REPORT NO. EVT 90-22
TRANSPORTABILITY TESTING OF 2,000-POUND BOMBS
IN A SIDE OPENING COMMERCIAL CONTAINER

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PART 1

GENERAL

A. INTRODUCTION. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to test a loading and bracing procedure for 2,000-pound bombs using wooden dunnage in a side opening commercial container. The test load consisted of inert MK84 bombs, unitized, two to a MK79 MOD 0 pallet. A total of eight pallets were used to load the side opening container to a gross weight of 40,215 pounds. Transportability tests are in agreement with the procedures outlined in part 4.

B. AUTHORITY. Testing was accomplished in accordance with mission responsibilities delegated by U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL. Reference is made to Change 4, 4 October 1974, to AR-740-1, 23 April 1971, Storage and Supply Operations; and, AMCCOM-R 10-17, 13 January 1986, Mission and Major Functions of USADACS.

C. OBJECTIVE. The objective of these tests is to determine if the proposed loading and bracing procedure using wooden dunnage in side opening commercial containers of 2,000-pound bombs will satisfy road, rail, and ship transportation environments.

D. CONCLUSIONS. The proposed loading and bracing with wooden dunnage in side opening commercial containers of 2,000-pound bombs, MK84, and MODs, unitized, two bombs per metal pallet, MK79 MOD 0, passed the rail transportation, road hazard, road, washboard, and shipboard transportation simulation tests.
E. RECOMMENDATIONS. It is recommended that the loading procedure be accepted for the transportation of 2,000-pound bombs in a side opening commercial container.
## PART 2

TRANSPORTABILITY TEST OF 2,000-POUND BOMBS IN A SIDE OPENING COMMERCIAL CONTAINER

AUGUST 1990

### TEST ATTENDEES

<table>
<thead>
<tr>
<th>NAME AND PHONE NUMBER</th>
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<td>ATTN: SMCAC-DEV</td>
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<tr>
<td>Quinn Hartman</td>
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<td>Richard Haynes</td>
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</tr>
</tbody>
</table>
Dan Healy
Senior Inspector
708-392-6846
202-828-1999

Association of American Railroads/
Bureau of Explosives
309 N. Douglas
Arlington Heights, IL 60004
PART 3

TEST PROCEDURES

A. RAIL IMPACT TEST. The commercial side opening container with the inert load of 2,000-pound bombs was positioned on a container chassis and securely locked in place using the twist locks at each corner. The chassis, with the mounted container, was secured to a Trailer-on-flatcar (TOFC) type railcar, equipped with friction draft gear. Equipment needed to accomplish the test included the specimen (hammer) car, five empty railroad cars to serve as the anvil (total weight of the railroad cars is 250,000 pounds), and a railroad locomotive. The anvil cars were positioned on a level section of track with the draft gear compressed, and the air and hand brakes set. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars, then pushed the specimen car toward the anvil at a predetermined speed, disconnected the specimen car approximately 50 yards away from the anvil cars, and allowed the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting is accomplished at speeds of 4, 6, and 8 miles per hour (mph) in one direction and at a speed of 8 mph in the opposite direction. The 4 mph and 6 mph impact speeds are approximate, the 8 mph speed is a minimum. Impact speeds are determined by using an electronic counter to measure the time required for the specimen car to traverse an 11-foot distance immediately before contact with the anvil cars.

B. ROAD HAZARD COURSE. The commercial side opening container, with the inert load of 2,000-pound bombs, was positioned on a container chassis and securely locked in place using the twist locks at each corner. The chassis was towed over the road hazard course with a tractor twice at a speed of approximately 5 mph. The speed was increased or decreased, as appropriate, to produce the most violent load response.
C. **ROAD TRIP TEST.** Using a suitable tractor, the chassis with commercial side opening container, inertly loaded with 2,000-pound bombs, was towed a total distance of at least 30 miles over a combination of roads surfaced with gravel, concrete, and asphalt. The test route included curves, corners, railroad crossings, cattle guards, stops, and starts. The test vehicle traveled at the maximum speed suitable for the particular road being traversed, except as limited by legal restrictions. The road test usually concludes with three full airbrake stops while traveling in the forward direction, and one in the reverse direction while traveling down a 7 degree grade. For this test, the panic stops were omitted as the test specimen sustained greater longitudinal shock forces in the rail impact test than would be realized in the panic stops.

D. **POST ROAD TRIP HAZARD COURSE.** After completion of the road trip test, the chassis with container was towed over the road hazard course with a tractor twice at a speed of approximately 5 mph. The speed was increased or decreased, as appropriate, to produce the most violent load response.

E. **WASHBOARD COURSE.** The chassis with commercial side opening container, inertly loaded with 2,000-pound bombs, was towed over the washboard course at a speed which produced the most violent response in the particular test load (as indicated by the resonant frequency of the suspension system beneath the load).

F. **SHIPBOARD TRANSPORTATION SIMULATION.** The commercial side opening container, with the inert load of 2,000-pound bombs, was positioned onto the Shipboard Transportation Simulator (STS) and securely locked into place using the cam lock at each corner. The STS began oscillating at an amplitude of 30 degrees +/- 2 degrees, either side, at a frequency of 2 cycles-per-minute (30 seconds +/- 2 seconds total per roll period). This frequency was maintained for at least 15 minutes during which time the load was observed for apparent defects which could have caused a safety hazard. The frequency of oscillation was then
increased to 4 cycles-per-minute (15 seconds +/- 1 second roll period) and was maintained for two hours. When an inspection of the load did not show any impending failure, the frequency of oscillation was increased to 5 cycles-per-minute (12 seconds +/- 1 second cycle time), and the equipment was operated for four more hours. This operation does not necessarily have to be continuous; however, no change or adjustments to the load or load restraints shall be permitted at any time during the test. The test load (specimen) shall not be removed from the apparatus, once positioned in place, until the test is completed or stopped.
PART 4

TEST RESULTS

A. RAIL IMPACT TEST

TEST SPECIMEN: TRANSPORTABILITY TEST OF 2,000-POUND BOMBS
IN A SIDE OPENING COMMERCIAL CONTAINER

TEST TOFC NO: TTX 151044
TEST SPECIMEN WT.: 124,765 pounds

CHASSIS NO: 5394
CHASSIS WT.: 4,000 pounds

SIDE OPENING MILVAN: USAF 0010598
SIDE OPENING WT.: 6,050 pounds

LADING & DUNNAGE
LADING & DUNNAGE WT.: 41,315 pounds

TOTAL SPECIMEN
TOTAL SPECIMEN WT.: 124,765 pounds

BUFFER CAR (5 CARS)
BUFFER CAR (5 CARS) WT.: 250,000 pounds

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<th>REMARKS</th>
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<td>1</td>
<td>Forward</td>
<td>4.36</td>
<td>No Load Movement</td>
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<td>2</td>
<td>Forward</td>
<td>6.28</td>
<td>No Load Movement</td>
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<td>3</td>
<td>Forward</td>
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<td>4</td>
<td>Reverse</td>
<td>8.49</td>
<td>No Load Movement</td>
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ROAD TEST DATA

TEST NO. 2

DATE 27 June 1990

TEST SPECIMEN: TRANSPORTABILITY TEST OF 2,000 POUND BOMBS IN A SIDE OPENING COMMERCIAL CONTAINER

PASS 1-A OVER FIRST SERIES OF TIES 0.11 MIN 5.16 MPH
PASS 1-B OVER SECOND SERIES OF TIES 0.10 MIN 5.68 MPH

REMARKS: No visible damage to the load of Side Opening Container.

PASS 2-A OVER FIRST SERIES OF TIES 0.10 MIN 5.68 MPH
PASS 2-B OVER SECOND SERIES OF TIES 0.12 MIN 4.73 MPH

REMARKS: No visible damage to the load of Side Opening Container.

30-MILE ROAD TRIP: No load movement or damage to the Side Opening Container.

PASS 3-A OVER FIRST SERIES OF TIES 0.11 MIN 5.16 MPH
PASS 3-B OVER SECOND SERIES OF TIES 0.09 MIN 6.31 MPH

REMARKS: No visible damage to the load of Side Opening Container.

PASS 4-A OVER FIRST SERIES OF TIES 0.10 MIN 5.68 MPH
PASS 4-B OVER SECOND SERIES OF TIES 0.11 MIN 5.16 MPH

REMARKS: No visible damage to the load of Side Opening Container.

WASHBOARD COURSE: No damage or load movement.

STS: No lateral load movement or damage to load, dunnage, or container.
PART 5

TIEDOWN PROCEDURES
LOADING AND BRACING WITH WOODEN DUNNAGE IN SIDE OPENING COMMERCIAL CONTAINERS OF 2000-POUND BOMB, MK84 AND MODS, UNITIZED 2 BOMBS PER METAL PALLET, MK79 MOD 0

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<th>ITEM</th>
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<td>PALLET UNIT DETAIL</td>
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<td>8-UNIT LOAD</td>
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<td>4.5</td>
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<td>DETAILS</td>
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LOADING AND BRACING SPECIFICATIONS SET FORTH WITHIN THIS DRAWING ARE APPLICABLE TO LOADS THAT ARE TO BE SHIPPED BY TRAILER/CONTAINER-ON-FLAT-CAR (T/COFC) RAIL CARRIER SERVICE. THESE SPECIFICATIONS MAY ALSO BE USED FOR LOADS THAT ARE TO BE MOVED BY MOTOR OR WATER CARRIERS. SEE GENERAL NOTE "J" ON PAGE 2.

REVISIONS

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<th>7127</th>
<th>SPI5PB</th>
<th>1007</th>
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DO NOT SCALE
GENERAL NOTES

A. THIS DOCUMENT HAS BEEN PREPARED AND ISSUED IN ACCORDANCE WITH AS 400-1 AND AMENDMENTS IN 743-2001 (CHAPTER 5).

B. THE SPECIFIED OUTLOADING PROCEDURES ARE APPLICABLE TO THE 2000 POUND DUNNAGE MATERIAL, UNLESS SPECIFIED OTHERWISE.

C. CALIBRATION OF THE 34x27 PLAIN WOOD WIRE LUMBER. EQUALS THE SPECIFIED GRADE AND MILL SPECIFICATIONS.

D. WHEN LAMINATING WHEN LOVE IN THE PANEL ASSEMBLIES, THE FOLLOWING SPECIFICATIONS APPLY:
   1. A 8" X 8" MATERIAL IS ACTUALLY 3/4" THICK BY 3-1/2" WIDE.
   2. A 4" X 4" MATERIAL IS ACTUALLY 1-1/2" THICK BY 3-1/2" WIDE.

E. A STAGGERED NAILING PATTERN WILL BE USED WHENEVER POSSIBLE.

F. WHEN LAMINATING DUNNAGE, THE PATTERN WILL BE ADJUSTED AS REQUIRED TO PRECLUDE Voids AND TO ALLOW ADJUSTMENT OF THE LOAD TO ACHIEVE A TIGHT LOAD.

G. THE LOAD AS SHOWN IS BASED ON A 6,050 POUND LOAD ON A 12'-0" WIDE BY 8'-0" HIGH SIDE OPENING INTERMODAL COMMERCIAL CONTAINER WITH INSIDE DIMENSIONS OF 12'-0" LONG BY 20'-0" WIDE BY 8'-0" HIGH.


I. The load is designed for trailer/container-on-flat-car (T/COFC) shipment. However, the load design can also be moved by other surface modes of transport. Notice: Other containers of the same design configuration can be used.

J. WHEN LOADING THE DESIGNATED UNITS, THEY ARE TO BE POSITIONED SO AS TO ACHIEVE A TIGHT LOAD (TIGHT AGAINST THE END AND SIDE DUNNAGE ASSEMBLIES). LATERAL Voids WILL NOT BE ALLOWED.

K. THE LOAD IS DESIGNED FOR TRAILER/CONTAINER-ON-FLAT-CAR (T/COFC) SHIPMENT. HOWEVER, THE LOAD AS DESIGNED CAN ALSO BE MOVED BY OTHER SURFACE MODES OF TRANSPORT. NOTICE: OTHER CONTAINERS OF THE SAME DESIGN CONFIGURATION CAN BE USED.

L. CAUTION: DO NOT NAIL DUNNAGE MATERIAL TO THE CONTAINER WALLS OR FLOOR. ALL NAILING WILL BE WITHIN THE DUNNAGE.

M. PORTIONS OF THE CONTAINER DEPICTED WITHIN THIS DRAWING, SUCH AS THE SIDE DOORS, HAVE NOT BEEN SHOWN IN THE LOAD VIEWS FOR CLARITY PURPOSES.

N. REQUIREMENTS CITED WITHIN THE BUREAU OF EXPLOSIVES PARCEL OR APPLIES WHEN THE SHIPMENT MOVES BY TRAILER/CONTAINER-ON-FLAT-CAR (T/COFC). SPECIAL T/COFC NOTES FOLLOW:
   1. A LOADED CONTAINER MUST BE ON A CHASSIS EQUIPPED WITH TWO BASIC ASSEMBLIES WHEN BEING MOVED IN T/COFC SERVICE.
   2. THE LOAD LIMIT OF A T/COFC RAILCAR MUST NOT BE EXCEEDED, NOR WILL A CAR BE LOADED SO THAT THE TRUCK UNDER ONE END OF THE CAR CARRIES MORE THAN ONE-HALF OF THE LOAD LIMIT FOR THAT CAR.

O. DURING INTRASTATE AND/OR INTERSTATE MOVES BY MOTOR CARRIER, A PROPER CHASSIS OR MODIFIED FLAT BED TRAILER MUST BE USED TO PRECLUDE VIOLATION OF ONE OR MORE WEIGHT LAWS APPLICABLE TO THE STATE OR STATES INVOLVED.

P. CONVERSION TO EQUIVALENTS: DIMENSIONS WITHIN THIS DOCUMENT ARE EXPRESSED IN INCHES AND WEIGHTS ARE EXPRESSED IN POUNDS. WHEN NECESSARY, THE METRIC EQUIVALENTS MAY BE COMPUTED ON THE BASIS OF ONE INCH EQUALS 25.4MM AND ONE POUND EQUALS 0.45360.

MATERIAL SPECIFICATIONS


NAILS -------: COMMON. FED SPEC FF-N-105.

WIRE -------: ANNEALED. BLACK. FED SPEC QQ-W-461.

PLYWOOD -------: FED SPEC MH-P-530; GROUP B, CONSTRUCTION AND INDUSTRIAL. PLYWOOD. INTERIOR WITH EXTERIOR GLUE, GRADE C-D. IF SPECIFIED GRADE IS NOT AVAILABLE, A BETTER INTERIOR OR EXTERIOR GRADE MAY BE SUBSTITUTED.

PAGE 2
PALLLET UNIT

GROSS WEIGHT ———— 4,133 POUNDS (APPROX)
CUBE———–———–——— 52.8 CUBIC FEET
SPECIAL NOTES:
1. An 8-UNIT, 2-LAYER LOAD IS SHOWN IN A SIDE OPENING INTER-
   MODAL ISO COMMERCIAL FREIGHT CONTAINER.
2. A 4-UNIT, 1-LAYER LOAD CAN BE SHIPPED BY REDUCING THE
   WEIGHT OF THE DURABLE ASSEMBLIES AS SPECIFIED IN THE
   DETAILS.

BILL OF MATERIAL

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<td>100 (3.1/2&quot;)</td>
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PLYWOOD, 3/4"

192 SQ FT

396 LBS

LOAD AS SHOWN

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<td>1.101 LBS</td>
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<td>SIDE OPENING CONTAINER</td>
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<td>6.050 LBS</td>
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<td>TOTAL WEIGHT</td>
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8-UNIT LOAD
END WALL GATE
SEE NOTE AT RIGHT

NOTE: FOR A 4-UNIT, 1-LAYER LOAD, REDUCE THE HEIGHT OF THE GATE TO 24'. OMIT TWO WALL BEARING PIECES.

3/4" PLYWOOD (1 REQD).
NAIL TO HOLD-DOWN CLEATS W/3-60 NAILS.

SIDE WALL/DOOR PANEL GATE
(3 REQD, RIGHT HAND)
(2 REQD, LEFT HAND)
SEE NOTE AT RIGHT

NOTE: FOR A 4-UNIT, 1-LAYER LOAD, REDUCE THE HEIGHT OF THE GATE TO 24'.
POSITION THIS END OF ASSEMBLY TOWARD BASE END OF BOMB PALLET UNIT.

TIE PIECE/STRUT LEDGER, 2" x 6" x 48" (12 REQD). NAIL TO VERTICALS W/3-10D NAILS AT EACH JOINT.

CRIB FILL ASSEMBLY
SEE NOTE AT RIGHT.

LOAD BEARING PIECE, 2" x 6" x 10' (2 REQD). NAIL TO VERTICAL STRUT BEARING PIECES W/3-10D NAILS AT EACH JOINT.

HOLD DOWN CLEAT, 2" x 8" x 30" (DOUBLES) (2 REQD). NAIL THE FIRST PIECE TO THE VERTICAL PIECES W/3-10D NAILS AT EACH JOINT. NAIL THE SECOND PIECE TO THE FIRST W/7-10D NAILS.

NOTE: FOR A 4-UNIT, 1-LAYER LOAD, ONLY TWO TIE PIECES/STRUT LEDGERS AND FOUR STRUTS. REDUCE THE VERTICAL PIECES TO 24". REDUCE THE 24-1/2" HEIGHT FOR THE SECOND LAYER STRUTS TO 21-1/2".

VERTICAL PIECE, 2" x 6" x 48" (8 REQD). NAIL TO STRUT PIECES W/3-10D NAILS AT EACH JOINT.

NOTE: FOR A 4-UNIT, 1-LAYER LOAD ONLY ONE LOAD BEARING PIECE AND ONE STRUT LEDGER. REDUCE THE GATE HEIGHT TO 18".

CENTER GATE
SEE NOTE AT RIGHT.

DETAILS
PROJECT SP 176-30
PAGE 7
PART 6

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

Photo No. AO317-SPN-90-289-5177. This photo shows two commercial side opening containers after a rail impact. The open container was loaded with inert 2,000-pound bombs. The load was being inspected for excessive shifting and broken dunnage. None was found.
Photo No. AO317-SPN-90-289-5175. This photo shows the test engineer and BOE Senior Inspector viewing the 2,000-pound bomb dunnage after a rail impact.
Photo No. AO317-SPN-90-289-5186. This photo shows the test load of 2,000-pound bombs being towed over the road hazard course. No damage or excessive load shift occurred during this test.
Photo No. AO317-SPN-90-289-5192. This photo shows the test engineer measuring the dunnage movement as a result of a rail impact.
Photo No. AO317-SPN-90-289-5176. This photo shows the test engineer inspecting the test load in a side opening container loaded with inert 2,000-pound bombs. Upon completion of rail impact testing, load movement, was less than one inch.
Photo No. AO317-SPN-90-289-5194. This photo shows the side opening container with an inert load of 2,000-pound bombs.
Photo No. AO317-SPN-90-289-5193. This photo shows the side opening container with a door panel open. The load is about to be inspected after a rail impact.
Photo No. AO317-SPN-90-289-5196. This photo shows two side opening containers on a TOFC. The side opening container on the left contains an inert load of 30mm ammunition. The side opening container on the right contains eight pallets of inert 2,000-pound bombs.