Final Report
JUNE 1989

HALF-HIGH INTERMODAL SHIPPING CONTAINER (ISC) TRANSPORTABILITY TEST

Prepared For:
U.S. Marine Corps
7th MEB
Twentynine Palms, CA 92278

Distribution Unlimited

US ARMY ARMAMENT MUNITIONS CHEMICAL COMMAND
US ARMY DEFENSE AMMUNITION CENTER AND SCHOOL

EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639
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Half-High Intermodal Shipping Container (ISC) Transportability Test

The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division, SMCAC-DEV, was tasked by the U.S. Marine Corps, 7th Marine Expeditionary Brigade, FMF, to perform validation of the half-high (4 feet by 4 feet by 20 inches) Intermodal Shipping Container (ISC) for transportability, storage of ammunition aboard Maritime Prepositioned Ships (MPS). A sample container was supplied and tested with an inert load of 155MM M548 projectiles. Blocking and bracing procedures supplied by the Storage and Outloading Division (SMCAC-DEV) provided for 36 pallets of inert ammunition. The loaded container was subjected to Rail, Road Hazard, 30-Mile Road Trip, Panic Stops, Washboard and Shipboard Transportation Simulator (STS) tests. The half-high ISC satisfied all test requirements.

Two problem areas were identified as a result of testing this container. The first problem area was the requirement for load baffling to prevent damage to the container roof bows. As a result, the payload was decreased by six ammunition pallets. The second problem was the angle of the loading ramp available to USADACS. When extended for loading, the ramp
presented a step to the loading forklift that prevented driving onto the container floor. To overcome this problem, an access ramp was placed at the end of the container loading ramp that provided easy forklift access.
U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL  
Evaluation Division  
Savanna, IL 61074-9639

REPORT NO. EVT 27-89  
HALF-HIGH INTERMODAL SHIPPING CONTAINER TRANSPORTABILITY TEST

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV) was tasked by the U.S. Marine Corps, 7th Marine Expeditionary Brigade, FMF, to validate half-high (4 feet by 4 feet by 20 inches) ISC for transportability, storage of ammunition aboard Maritime Prepositioned Ships (MPS). A sample container was supplied for testing with an inert load of 155MM M548 projectiles. Blocking and bracing procedures supplied by the Storage and Outloading Division (SMCAC-DEO) provided for 36 pallets of inert ammunition. The loaded container was subjected to Rail, Road Hazard, 30 Mile Road Trip, Panic Stops, Washboard and STS tests. The half-high ISC satisfied all test requirements.

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. Reference is made to Change 4, 4 October 1974, to AR 740-1, 23 April 1971, Storage and Supply Operations; AMCCOM R 10-17, 13 January 1986, Mission and Major Functions of USADACS.

C. OBJECTIVE. The objective of these tests was to determine if the Marine Corps half-high ISC would be suitable to road, ship and rail transportation environment.

D. CONCLUSIONS. The half-high ISC safely retained the inert load of 155MM M548 projectiles when subjected to Rail, Road and STS tests. Difficulties were observed in forklift access into the container during loading and unloading. Positioning of the roof bow mounts prevented testing with a full capacity load of projectiles.
E. **RECOMMENDATIONS.** It is recommended that the roof bow mounts be mounted to the top side rail so that more cube is available for loading. Consideration should be given to modifying the loading ramp design for easier access of the smaller forklifts (4,000 pounds).

E. **APPROVAL.** The Marine Corps half-high ISC is approved for the transportation of ammunition.
PART 2

ATTENDEES

Mr. A. C. McIntosh
Test Engineer
AV 585-8989
815-273-8989

Mr. Quinn Hartman
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Savanna, Illinois 61074-9639

Commander
U.S. Marine Corps
7th MEB
Twentynine Palms, CA 92278
PART 3
TEST PROCEDURES

A. RAIL IMPACT TEST. The test load or vehicle should be positioned in/on a railcar. For containers, the loaded container shall be positioned on a container chassis and securely locked in place using the twist locks at each corner. The container chassis shall be secured to a railcar. Equipment needed to perform the test includes the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. These anvil cars are positioned on a level section of track with air and hand brakes set and with the draft gear compressed. The locomotive unit pulls the specimen car several hundred yards away from the anvil cars and, then, pushes the specimen car toward the anvil at a predetermined speed, disconnects from the specimen car about 50 yards away from the anvil cars, and allows the specimen car to roll freely along the track until it strikes the anvil. This constitutes an impact. Impacting is accomplished at speeds of 4, 6, and 8 mph in one direction and at a speed of 8 mph in the opposite direction. The 4 and 6 mph impact speeds are approximate; the 8 mph speed is a minimum. Impact speeds are to be determined by using an electronic counter to measure the time required for the specimen car to traverse an 11 foot distance immediately prior to contact with the anvil cars.

B. HAZARD COURSE. The specimen being tested will be subjected to the road hazard course. Using a suitable truck/tractor or tactical vehicle, the vehicle/specimen of test method No. 1 shall be towed/drawn over a hazard course two times at a speed of approximately 5 mph. The speed may be increased or decreased, as appropriate, to produce the most violent load response.
C. 30 MILE ROAD TRIP. Using a suitable truck/tractor and trailer, or tactical vehicle, the tactical vehicle/specimen load shall be driven/towed for a total distance of at least 30 miles over a combination of roads surfaced with gravel, concrete, and asphalt. Test route shall include curves, corners, railroad crossings, cattle guards, stops, and starts. The test vehicle shall travel at the maximum speed suitable for the particular road being traversed, except as limited by legal restrictions. This step provides for the tactical vehicle/specimen load to be subjected to three full airbrake stops while traveling in the forward direction and one in the reverse direction while traveling down a 7 percent grade. The first three stops are at 5, 10, and 15 mph, while the stop in the reverse direction is of approximately 5 mph.

D. WASHBOARD COURSE. Using a suitable truck/tractor, and/or tactical vehicle, the specimen shall be towed/driven over the washboard course at a speed which produces the most violent response in the particular test load as indicated by the resonant frequency of the suspension system beneath the load.

E. SHIPBOARD TRANSPORTATION SIMULATOR. The test load/specimen shall be positioned onto the STS and securely locked in place using the ram lock at each corner. Using the procedure detailed in the operating instructions, the STS shall be started oscillating at an amplitude of 30 inches plus 2 inches, either side of center and a frequency of 2 cycles-per-minute (30 seconds plus 2 seconds total roll period). This frequency shall be maintained for at least 15 minutes during which time the load will be observed for apparent defects that could cause a safety hazard. The frequency of oscillation shall then be increased to 4 cycles-per-minute (15 seconds plus 1 second roll period) and the apparatus operated for 2 hours. If an inspection of the load does not indicate an impending failure, the frequency of oscillation shall be further increased to 5 cycles-per-minute (12 seconds plus 1 second cycle time).
and the apparatus operated for 4 hours. The 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. After once being set in place, the test load (specimen) shall not be removed from the apparatus until the test has been completed or is terminated.
US ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
TRANSPORTABILITY ROAD COURSE

START
HAZARD COURSE
HAZARD COURSE
30 MILE ROAD TRIP

WASHBOARD COURSE (IF REQUIRED)

PANIC STOPS (IF REQUIRED)

FINISH
PART 4

TEST RESULTS
RAIL IMPACT DATA

DATE: 23 MAY 1989

TEST NO. 1

TEST SPECIMEN: TOFC with Half-High ISO container.

TEST CAR NO. TTX 153621 LT. WT. 74,800 pounds

LADING AND DUNNAGE WT. 37,570 pounds

TOTAL SPECIMEN WT. 112,370 pounds

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

<table>
<thead>
<tr>
<th>IMPACT NO.</th>
<th>END STRUCK</th>
<th>VELOCITY (MPH)</th>
<th>IMPACT FORCE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>forward</td>
<td>3.81</td>
<td>120,860</td>
<td>Pallet tops chipping at rear of container.</td>
</tr>
<tr>
<td>2</td>
<td>forward</td>
<td>6.59</td>
<td>133,067</td>
<td>Container slipped 2 inches on chassis. Load shifted 5/8 inch to rear.</td>
</tr>
<tr>
<td>3</td>
<td>forward</td>
<td>8.65</td>
<td>238,007</td>
<td>Cracked forward end gate. Bulk of loading on gate center beam (2 by 5). Deflection caused upper beam to crack.</td>
</tr>
<tr>
<td>4</td>
<td>reverse</td>
<td>8.81</td>
<td>259,400</td>
<td>Cracked rear end gate beam. Identical damage cited in Impact 3.</td>
</tr>
</tbody>
</table>
### RESULTS FROM THE RAIL IMPACT TEST OF THE MARINE CORPS HALF-HEIGHT CONTAINER
**DATE:** 23 MAY 1989

**TAPE CHANNEL 6 : RAIL COUPLER FORCE**

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED (MPH)</th>
<th>PEAK VALUE (POUNDS)</th>
<th>DURATION (MILLISECONDS)</th>
<th>AREA (POUNDS-SECONDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>3.81</td>
<td>120860.24</td>
<td>59.53</td>
<td>4685.15</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.59</td>
<td>133067.28</td>
<td>78.68</td>
<td>7518.17</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.65</td>
<td>238007.36</td>
<td>36.41</td>
<td>5675.70</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.81</td>
<td>259400.14</td>
<td>36.21</td>
<td>6181.03</td>
</tr>
</tbody>
</table>
RAIL IMPACT TEST OF MARINE CORPS HALF-HEIGHT CONTAINER

IMPACT 1: 3.81 MPH, DATE: 23 MAY 1989

Time in Seconds
X 1.00

RAIL COUPLER FORCE
IN POUNDS X 1000.00
RAIL IMPACT TEST OF MARINE CORPS HALF-HEIGHT CONTAINER

IMPACT 2: 6.51 MPH, DATE: 23 MAY 1989

TIME IN SECONDS

IN POUNDS X 1000000.00

RAIL COUPLER FORCE

4-5
RAIL IMPACT TEST OF MARINE CORPS HALF-HEIGHT CONTAINER
IMPACT 3: 8.65 MPH, DATE: 23 MAY 1989

Time in Seconds
X 1.00
RAIL IMPACT TEST OF MARINE CORPS HALF-HEIGHT CONTAINER
IMPACT 4: 8.81 MPH, DATE: 23 MAY 1989

Time in Seconds
X 1.00
ROAD TEST DATA

TEST NO. 2

DATE: 23 MAY 1989

TEST SPECIMEN: Half-High ISO Container

PASS 1-A OVER FIRST SERIES OF TIES: 0.10 MIN 5.68 MPH

PASS 1-B OVER SECOND SERIES OF TIES: 0.10 MIN 5.68 MPH

REMARKS: No movement or damage to load

PASS 2-A OVER FIRST SERIES OF TIES: 0.10 MIN 5.59 MPH

PASS 2-B OVER SECOND SERIES OF TIES: 0.10 MIN 5.68 MPH

REMARKS: No movement or damage to load.

30 MILE ROAD TEST: No damage to load.

PANIC STOP TEST: No damage or load movement.

PASS 3-A OVER FIRST SERIES OF TIES: 0.10 MIN 5.58 MPH

PASS 3-B OVER SECOND SERIES OF TIES: 0.11 MIN 5.16 MPH

REMARKS: No damage to load.

PASS 4-A OVER FIRST SERIES OF TIES: 0.10 MIN 5.68 MPH

PASS 4-B OVER SECOND SERIES OF TIES: 0.095 MIN 6.00 MPH

REMARKS: No damage to load.

WASHBOARD COURSE: No damage to load.

SHIPBOARD TRANSPORTATION SIMULATOR: No damage to load or container.
PART 5

TEST PLANS
PROPOSED LOADING AND BRACING PROCEDURES FOR 155MM SEPARATE LOADING PROJECTILES (TALL UNIT) IN MARINE CORPS HALF HIGH OPEN TOP INTERMODAL FREIGHT CONTAINER

INDEX

ITEM

GENERAL NOTES, AND MATERIAL SPECIFICATIONS ------------------ 2
PALLET UNIT DETAILS ------------------------------------------ 3
TYPICAL FULL LOAD PROCEDURES ---------------------------------- 4-5
GENERAL DETAILS ------------------------------------------ 6-8

NOTE: This 8 page document delineates proposed outloading procedures to be used for the shipment of palletized units of 155MM separate loading projectiles (tall unit) in a Marine Corps half high open top container. The procedures as delineated are to be verified by rail impact, road transportability, and shipboard simulation tests prior to their approval for actual shipment.

Prepared during May 1989 by:

U.S. Army Defense Ammunition Center and School
ATTN: SMCAC-DEO
Savanna, IL 61074-9639
KEY NUMBERS

1. FORWARD BLOCKING ASSEMBLY (1 REQD). SEE THE "FORWARD BLOCKING ASSEMBLY" DETAIL ON PAGE 6.


3. LOWER SIDE FILL ASSEMBLY (6 REQD). SEE THE "LOWER SIDE FILL ASSEMBLY" DETAIL ON PAGE 7.

4. SPACER ASSEMBLY (5 REQD). SEE THE "SPACER ASSEMBLY" DETAIL ON PAGE 8.

5. REAR BLOCKING ASSEMBLY (1 REQD). SEE THE "REAR BLOCKING ASSEMBLY" DETAIL ON PAGE 6.

6. FILLER PIECE, 2" x 6" x 40" (AS REQD). LAMINATE THE FIRST PIECE TO THE VERTICAL PIECE OF THE REAR BLOCKING ASSEMBLY W/4-10d NAILS. LAMINATE EACH ADDITIONAL PIECE TO THE PREVIOUS IN A LIKE MANNER.

7. DOOR POST VERTICAL, 4" x 4" x 40" (2 REQD).

8. SPANNER PIECE, 4" x 4" BY CUT-TO-FIT (REF: 76-1/8") (2 REQD). TOENAIL EACH END TO THE DOOR POST VERTICAL W/2-12d NAILS.

9. SUPPORT PIECE, 2" x 4" x 30" (2 REQD). NAIL TO THE DOOR POST VERTICAL W/4-10d NAILS.
# BILL OF MATERIAL

<table>
<thead>
<tr>
<th>LUMBER</th>
<th>LINEAR FEET</th>
<th>BOARD FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>2' X 2'</td>
<td>154</td>
<td>52</td>
</tr>
<tr>
<td>2' X 3'</td>
<td>56</td>
<td>28</td>
</tr>
<tr>
<td>2' X 4'</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>2' X 6'</td>
<td>163</td>
<td>163</td>
</tr>
<tr>
<td>2' X 8'</td>
<td>138</td>
<td>184</td>
</tr>
<tr>
<td>4' X 4'</td>
<td>19</td>
<td>26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NAILS</th>
<th>NO. REQD</th>
<th>POUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6d (2&quot;)</td>
<td>180</td>
<td>1</td>
</tr>
<tr>
<td>10d (3&quot;)</td>
<td>588</td>
<td>9</td>
</tr>
<tr>
<td>12d (3-1/4&quot;)</td>
<td>8</td>
<td>1/4</td>
</tr>
</tbody>
</table>

1/2" PLYWOOD: 46.6 SQ FT ---- 64.1 LBS

## LOAD AS SHOWN

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>WEIGHT (APPROX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PALLET UNITS</td>
<td>36 @ 871 LBS</td>
<td>31,356 LBS</td>
</tr>
<tr>
<td>DUNNAGE</td>
<td></td>
<td>989 LBS</td>
</tr>
<tr>
<td>CONTAINER</td>
<td></td>
<td>4,760 LBS</td>
</tr>
</tbody>
</table>

TOTAL WEIGHT: 37,105 LBS
Beam, 2''x6''x82-1/2'' (6 reqd).

Plywood 3/4'' thick by 7-1/2'' wide by 82-1/2'' long (4 reqd). Nail to the beam 1/2''-wed nails every 6''.

Bearing piece, plywood 3'' thick by 5-1/8'' wide by 40'' long (2 reqd). Nail the plywood into beam, 1/2''-wed nails per joint.

Support piece, 2''x6''x23'' (3 reqd). Tremendous end to the beam 1/2''-wed nails.

FORWARD BLOCKING ASSEMBLY

Beam, 2''x6''x82-1/2'' (6 reqd).

Plywood 3/4'' thick by 7-1/2'' wide by 82-1/2'' long (4 reqd). Nail to the beam 1/2''-wed nails every 6''.

Plywood 5'' thick by 2-1/2'' wide by 82-1/2'' long (4 reqd). Nail to the beam 1/2''-wed nails every 6''.

REAR BLOCKING ASSEMBLY
Upper Side Fill Assembly

Retention piece, 2"x2"x32" (2 each). Nail to 2x6 bearing piece w/1/8"-1 1/4" nails.

Bearing piece, 2"x8"x32" (1 each).

Lower Side Fill Assembly

Retention piece, 2"x3" (actual) x 16' (1 each). Nail to the bearing piece w/1/8"-1 1/4" nails.

Bearing piece, 2"x8"x16' (1 each).
Upper bearing piece
1-1/16" x 7-1/2" (2 Naga).
Nail to the spacer piece w/1/16d nails at each joint.

Lower bearing piece
2" x 8" x 7-1/2" (2 Naga).
Nail to the spacer piece w/1/16d nails at each joint.

Upper return piece,
2-3/8" x 7-1/2" (2 Naga).
Nail to the upper bearing piece w/8-10d nails.

Lower return piece
3/4" x 3" (actual) x 8" (6 Naga).
Nail to the lower bearing piece w/8-10d nails.

SPACER ASSEMBLY
CARGO CONTAINER
PRODUCTION CERTIFICATE

Design Type Number: AB/080/88

Certificate No. 88 LS 164-X

Date 29th July, 1988

THIS IS TO CERTIFY that Thirty (30) Open Top with Tarp Containers built by METALSINES-COMPANHIA DE VAGÕES DE SINES, SA - PORTUGAL for MARTEC INTERNATIONAL TRADING CORPORATION, U.S.A. have been thoroughly inspected at each stage of manufacture by the attending Surveyor and the prototype of which has serial number MO2-2P-S1-001 was tested on 13 March 88 and 24 Jun 88, and subsequent dates: and that the details of design, materials, construction and workmanship of the containers conform to the applicable specifications and to the American Bureau of Shipping Rules For Certification of Cargo Containers.

The container(s) are constructed in accordance with prints reviewed on 7th April, 1988: reference T-3/9264; under general arrangement drawing 1-605-00-000; the prototype of which has serial number MO2-2P-S1-001; was tested on 13 March 88 and 24 Jun 88, and subsequent dates: and that the details of design, materials, construction and workmanship of the containers conform to the applicable specifications and to the American Bureau of Shipping Rules For Certification of Cargo Containers.

Size 20' X 8' X 4'3" Model OPEN TOP WITH TIR TARPALIN AND RAMP

Max. Gross Wt. 20 320 kg Tare Wt. 2 160 kg Payload 18 160 kg
44 797 lb 4 762 lb 40 035 lb

Manufacturers serial numbers: MO2-2P-S1-085 through MO2-2P-S1-114

Operating numbers: US MC 000 962-0 US MC 000 974-4 US MC 000 976-5
(with alpha prefix) through through through US MC 000973-9 US MC 000992-9

The undersigned has visited the plant of METALSINES located at SINES, PORTUGAL and carried out quality control surveillance as indicated in the Rules For Certification of Cargo Containers.

A. SALGADO, Surveyor American Bureau of Shipping

This certificate evidences compliance with the applicable rules of the American Bureau of Shipping and is issued solely for the use of the Bureau, its committees, its clients or other authorized entities. No certificate is a representation only that the container(s) have met the applicable rules of the American Bureau of Shipping. The validity, applicability and interpretation of this certificate is governed by the Rules and standards of the American Bureau of Shipping. Nothing contained in this certificate or in any report issued in contemplation of this certificate shall be deemed to relieve any designer, builder, owner, manufacturer, seller, supplier, repairer, operator or other party of any warranty express or implied.
INTERNATIONAL CONVENTION FOR SAFE CONTAINERS (CSC)

THIS IS TO CERTIFY that the Containers identified on the obverse of this certificate meet the requirements of the International Convention for Safe Containers and the regulations promulgated by the United States Department of Transportation. The containers are hereby approved and the applicant may affix, to every container noted herein, a Safety Approval Plate with Approval number:

USA/AB— 080 / 88

A. SALGADO Surveyor

The containers identified on the obverse of this certificate carry an International Convention for Safe Container approval plate bearing the number

CUSTOMS CERTIFICATION (TIR)

THIS IS TO CERTIFY that the undersigned has visited the plant of the manufacturer to examine random containers from the group identified on the obverse of this certificate for adherence to the certificate of approval by design type for transport of goods under customs seal and found such containers in compliance.

Design Type Approval Certificate Number: USA/AB/

Surveyor

THIS IS TO CERTIFY that each of the containers identified on the obverse of this certificate have been manufactured in full compliance with the applicable certificate of approval by design type.

Quality Control Superintendent

The containers identified on the obverse of this certificate carry a Customs approval plate bearing the number P/DGV-019/88

INTERNATIONAL UNION OF RAILWAYS (UIC)

THIS IS TO CERTIFY that the containers identified on the obverse of this certificate have been constructed in accordance with approved drawings and are in compliance with UIC Code 592-1 OR.

The containers conform to the prototype of the design series; were tested to UIC Requirements; and are as represented on prints. These containers are to be registered with and bear the participating railway code number

Surveyor

The containers identified on the obverse of this certificate are marked with UIC railway code number IC 94

WOOD TREATMENT

The exposed timber of the containers identified on the obverse of this certificate has been treated in accordance with the Australian Department of Health Regulations as set forth in "Cargo Containers and Unit Loads — Quarantine Aspects and Procedures."

Quality Control Superintendent