

**FINAL REPORT  
DECEMBER 2006**

**REPORT NO. 05-27**



**TRANSPORTABILITY TESTING  
OF THE COUPLED  
BOH FPU 8 AND FPU 12 INTERMODAL SHIPPING  
CONTAINERS WITH PLS INTERFACE  
TP-94-01,  
“TRANSPORTABILITY TESTING PROCEDURES”**

Prepared for:

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BOH Environmental, LLC  
4116 C Walney Rd  
Chantilly, VA 20151

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**DEFENSE AMMUNITION CENTER  
VALIDATION ENGINEERING DIVISION  
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**REPORT NO. 05-27  
TRANSPORTABILITY TESTING OF THE  
COUPLED BOH FPU 8 AND FPU 12  
INTERMODAL CONTAINERS WITH PLS INTERFACE  
TP-94-01, REV. 2, JUNE 2004, "TRANSPORTABILITY TESTING  
PROCEDURES"**

**DECEMBER 2006**

**ABSTRACT**

The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMAC-DEV), was tasked by BOH Environmental, LLC to conduct transportability testing with ammunition on the Coupled Field Pack-Up (FPU) 8 and FPU 12 Intermodal Containers with the PLS Interface. The testing was conducted in accordance with TP-94-01, Revision 2, June 2004 "Transportability Testing Procedures."

The objective of the testing was to evaluate the Coupled FPU 8 and FPU 12 Intermodal Containers with the PLS Interface when transportability tested in accordance with TP-94-01, Revision 2, June 2004.

The following observations resulted from the testing of containers:

1. The interior design of the containers makes it difficult to load the payload in the containers. For example, the door locking provisions on the container floor interfere when loading the payload.
2. The interior geometry requires that a large amount of dunnage be used to secure the payload. Proper fitting of the dunnage is very difficult due to the non-uniformity of the FPU container.
3. The container floors have numerous holes for mounting hardware inside the container. The holes could allow for sparks to enter the container.
4. The containers have lighting and electrical provisions.

5. During testing on the FPU 8, the door locking provisions on the container floor damaged the base of the 155MM Separate Loading Projectile (SLP) pallet.

6. The floor in the FPU 8 was deformed 0.25 inches following completion of the testing. The deformation was from contact of the base of 155MM SLP pallet on the floor.

The following conclusions resulted from the testing of the containers:

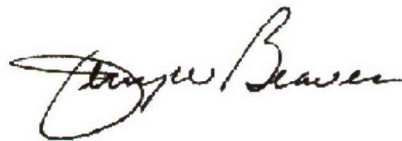
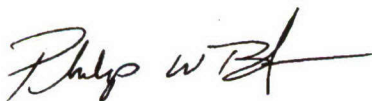
1. Ammunition **shall not** be transported in the BOH FPU 8 and FPU 12 with PLS interface that are equipped with electrical components.

2. Ammunition **shall not** be transported in the BOH FPU 8 and FPU 12 with PLS interface that have open holes in the floor of the container.

3. The Coupled BOH FPU 8 and FPU 12 successfully completed the transportability testing.

Prepared by:

Reviewed by:



PHILIP W. BARICKMAN  
Lead Validation Engineer

JERRY W. BEAVER  
Chief, Validation Engineering Division



**U.S. ARMY DEFENSE AMMUNITION CENTER**

VALIDATION ENGINEERING DIVISION  
MCALESTER, OK 74501-9053

**REPORT NO. 05-27**

**Transportability Testing of the Coupled BOH FPU 8 and FPU 12  
Intermodal Containers with PLS Interface  
TP-94-01, Revision 2, June 2004 "Transportability Testing Procedures"**

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## **PART 1 – INTRODUCTION**

**A. BACKGROUND.** The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMAG-DEV), was tasked by BOH Environmental, LLC to conduct transportability testing with ammunition on the Coupled Field Pack-Up (FPU) 8 and FPU 12 Intermodal Containers with the PLS Interface. The testing was conducted in accordance with TP-94-01, Revision 2, June 2004 “Transportability Testing Procedures.”

**B. AUTHORITY.** This test was conducted IAW mission responsibilities delegated by the U.S. Army Joint Munitions Command (JMC), Rock Island, IL. Reference is made to the following:

1. AR 740-1, 15 June 2001, Storage and Supply Activity Operation.
2. OSC-R, 10-23, Mission and Major Functions of U.S. Army Defense Ammunition Center (DAC) 21 Nov 2000.

**C. OBJECTIVE.** The objective of the testing was to evaluate the Coupled BOH FPU 8 and FPU 12 Intermodal Shipping Containers with the PLS Interface when transportability tested in accordance with TP-94-01, Revision 2, June 2004.

**D. OBSERVATIONS.**

1. The interior design of the container makes it difficult to load the payload in the containers. For example, the door locking provisions on the container floor interfere when loading the payload.

2. The interior geometry requires that a large amount of dunnage be used to secure the payload. Proper fitting of the dunnage is very difficult due to the non-uniformity of the FPU interior.

3. The container floors have numerous holes for mounting hardware inside the container. The holes could allow for sparks to enter the container.

4. The containers have lighting and electrical provisions.

5. During testing on the FPU 8, the door locking provisions on the container floor damaged the base of the 155MM Separate Loading Projectile (SLP) pallet.

6. The floor in the FPU 8 was deformed 0.25 inches following completion of the testing. The deformation was from contact of the base of 155MM SLP pallet on the floor.

#### **E. CONCLUSIONS.**

1. Ammunition **shall not** be transported in the BOH FPU 8 and FPU 12 with PLS interface that are equipped with electrical components.

2. Ammunition **shall not** be transported in the BOH FPU 8 and FPU 12 with PLS interface that have open holes in the floor of the container.

3. The coupled BOH FPU 8 and FPU 12 with PLS interface successfully completed the transportability testing.



## **PART 2 - ATTENDEES**

### **ATTENDEE**

Philip Barickman  
DSN 956-8992  
(918) 420-8992

Michael S. Bartosiak  
DSN 956-8083  
(918) 420-8083

### **MAILING ADDRESS**

Director  
U.S. Army Defense Ammunition Center  
ATTN: SJMAC-DEV  
1 C Tree Road, Bldg. 35  
McAlester, OK 74501-9053

Director  
U.S. Army Defense Ammunition Center  
ATTN: SJMAC-DET  
1 C Tree Road, Bldg. 35  
McAlester, OK 74501-9053

### **PART 3 - TEST EQUIPMENT**

1. Coupled BOH FPU 8 and FPU 12 Intermodal Containers with PLS Interface  
Manufactured by BOH Environmental LLC  
Tare Weight: 10,420 pounds
  
2. Palletized Load System Truck  
Model #: M1074  
Manufactured by Oshkosh Truck Corporation, Oshkosh, WI  
ID #: 10T2P1NH6N1044011  
NSN: 2320-01-304-2277  
Serial #: 44011  
Curb Weight: 55,000 pounds
  
3. Truck, Tractor, MTV, M1088 A1  
ID #: J0229  
NSN: 232001-447-3893  
VSN: NL1FSC  
MFG Serial #: T-018488EFJM  
Weight: 19,340 pounds
  
4. Semitrailer, flatbed, breakbulk/container transporter, 34 ton  
Model #: M872A1  
Manufactured by Heller Truck Body Corporation, Hillsdale, NJ  
ID #: 11-1505 NX05NZ  
NSN: 2330 01 109 8006  
Weight: 19,240 pounds

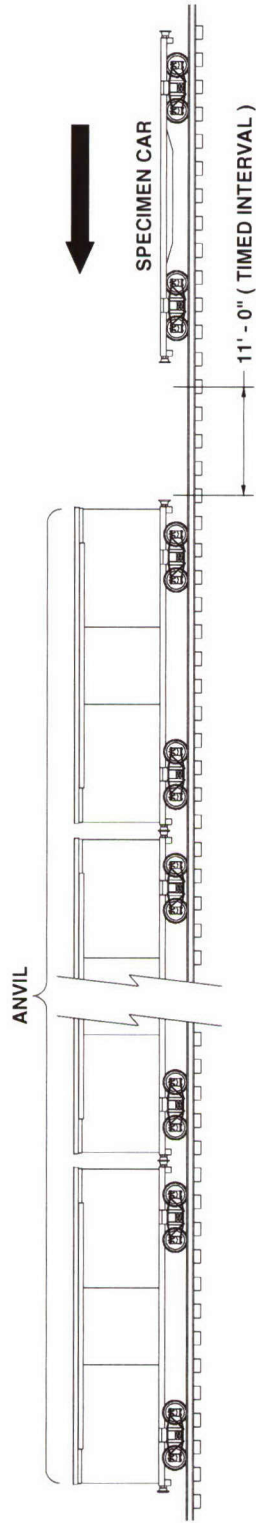
## **PART 4 - TEST PROCEDURES**

The test procedures outlined in this section were extracted from TP-94-01, "Transportability Testing Procedures," Revision 2, June 2004, for validating tactical vehicles and outloading procedures used for shipping munitions by tactical truck, railcar, and ocean-going vessel.

The rail impact will be conducted with the loaded intermodal container secured directly to the railcar. Inert (non-explosive) items were used to build the load. The test loads were prepared using the blocking and bracing procedures proposed for use with munitions (**see Part 6 – Drawings for procedures**). The weight and physical characteristics (weights, physical dimensions, center of gravity, etc.) of the test loads were similar to live (explosive) ammunition.

**A. RAIL TEST. RAIL IMPACT TEST METHOD.** The test load or vehicle will be secured to a flatcar. The equipment needed to perform the test will include the specimen (hammer) car, four empty railroad cars connected together to serve as the anvil, and a railroad locomotive. The anvil cars will be positioned on a level section of track with air and hand brakes set and with draft gears compressed. The locomotive unit will push the specimen car toward the anvil at a predetermined speed, then disconnect from the specimen car approximately 50 yards away from the anvil cars allowing the specimen car to roll freely along the track until it strikes the anvil. This will constitute an impact. Impacting will be accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the reverse direction. The tolerance for the speeds is plus 0.5 mph, minus 0.5 mph for the 4 mph and 6 mph impacts, and plus 0.5 mph, minus 0 mph for the 8.1 mph impacts. The impact speeds will be determined by using an electronic counter to measure the time for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars (see Figure 1).

**ASSOCIATION OF AMERICAN RAILROADS (AAR)  
STANDARD TEST PLAN**



**4 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:**

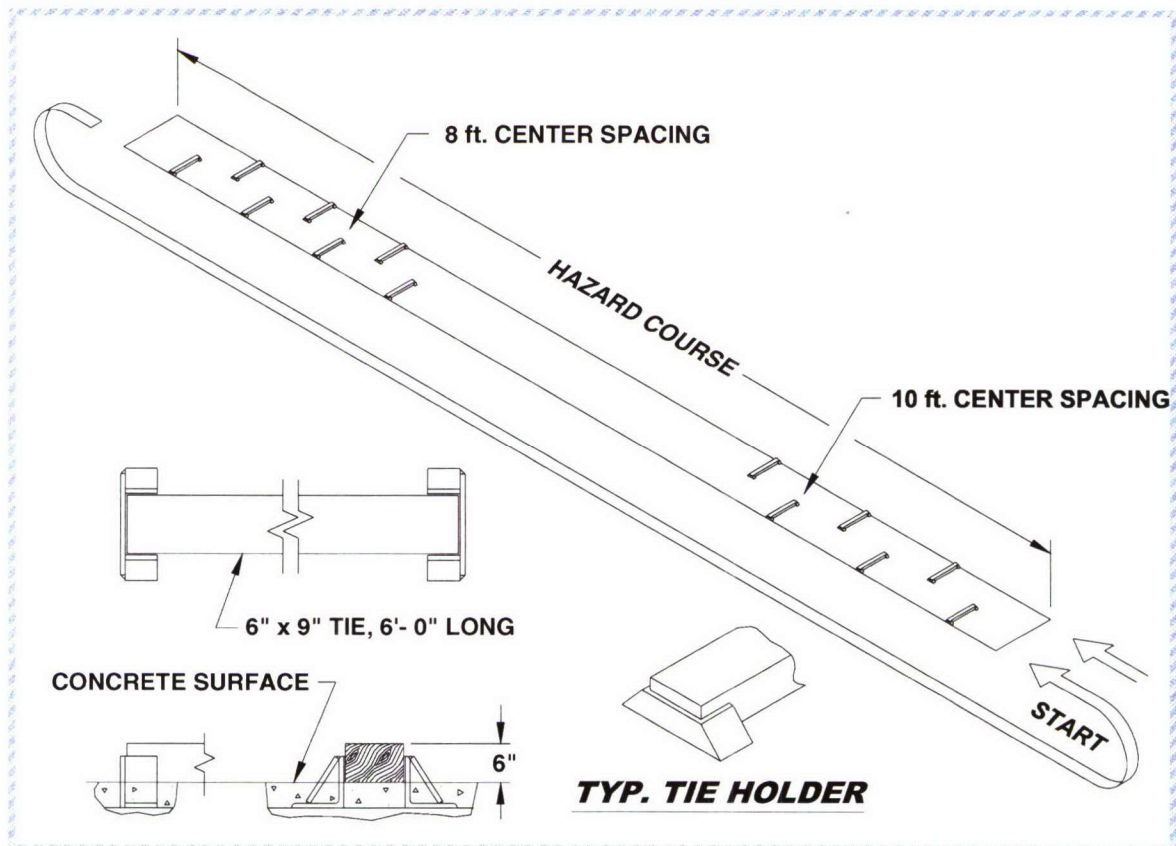
**IMPACT NO. 4 @ 8.1 MPH**

**Figure 1. Rail Impact Sketch**



**B. ON/OFF ROAD TEST.**

**1. HAZARD COURSE.** The test load or vehicle will be transported over the 200-foot-long segment of concrete-paved road consisting of two series of railroad ties projecting 6 inches above the level of the road surface. The hazard course will be traversed two times (see Figure 2).



**Figure 2. Hazard Course Sketch**

- a. The first series of 6 ties are spaced on 10-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.
- b. Following the first series of ties, a paved roadway of 75 feet separates the first and second series of railroad ties.

c. The second series of 7 ties are spaced on 8-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 48 feet.

d. The test load is driven across the hazard course at speeds that will produce the most violent vertical and side-to-side rolling reaction obtainable in traversing the hazard course (approximately 5 mph).

**2. ROAD TRIP.** The test load or vehicle will be transported for a distance of 30 miles over a combination of roads surfaced with gravel, concrete, and asphalt. The test route will include curves, corners, railroad crossings and stops and starts. The test load or vehicle will travel at the maximum speed for the particular road being traversed, except as limited by legal restrictions.

**3. PANIC STOPS.** During the road trip, the test load or vehicle will be subjected to three (3) 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 approximately 5 mph. This testing will not be required if the Rail Impact Test is performed.

**4. WASHBOARD COURSE.** The test load or vehicle will be driven over the washboard course at a speed that produces the most violent response in the vertical direction.

**C. OCEAN-GOING VESSEL TEST. Shipboard Transportation Simulator (Test Method 5).** The Shipboard Transportation Simulator (STS) is used for testing loads in 8-foot-wide by 20-foot-long intermodal freight containers. The specimen shall be positioned onto the STS and securely locked in place using the cam lock at each corner. Using the procedure detailed in the operating instructions, the STS shall begin oscillating at an angle of 30 degrees, plus or minus 2 degrees, either side of vertical center and a frequency of 2 cycles-per-

minute (30 seconds, plus or minus 2 seconds) for a duration of two (2) hours. This frequency shall 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 or minus one second per cycle) and the apparatus operated for two (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 or minus one second per cycle), and the apparatus operated for four (4) hours. The operation does not necessarily have to be continuous; however, no changes 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.

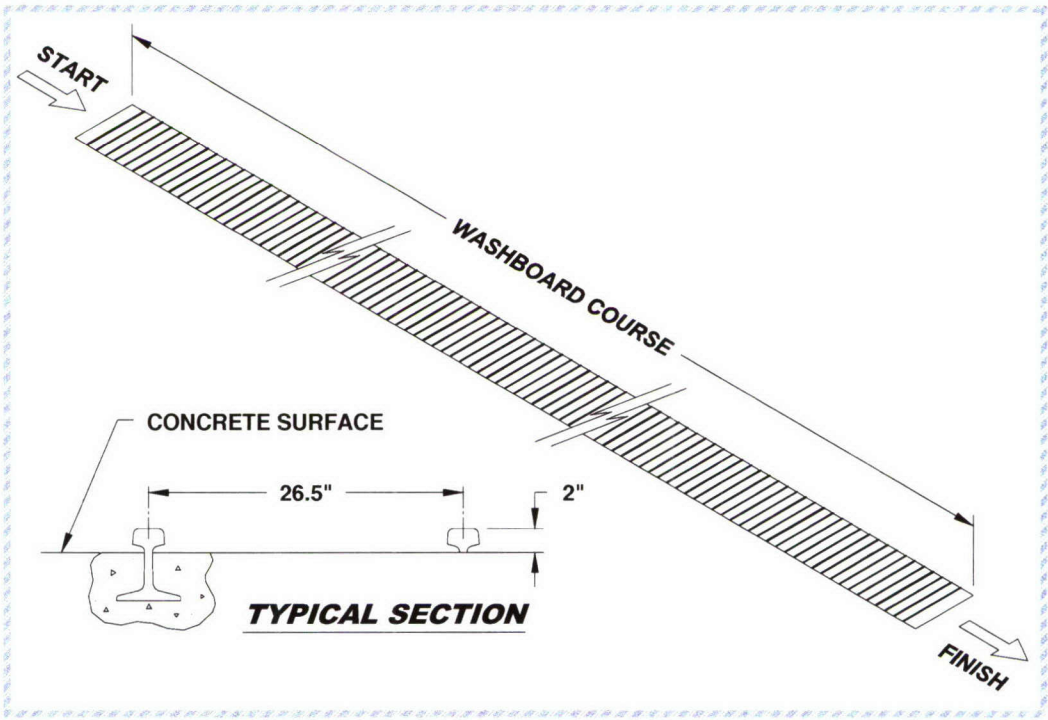


Figure 3. Washboard Course Sketch



## **PART 5 - TEST RESULTS**

### **5.1**

Test Specimen: Coupled BOH FPU 8 and FPU 12 Intermodal Shipping Containers with PLS Interface.

Testing Date: 11-12 October 2006

Payload: 1. FPU 8 with 155MM Separate Loading Projectile (SLP) Pallet  
2. FPU 12 with wood pallets of 40MM Linked.

Gross Weight: 30,700 pounds (Including FPU 8 and FPU 12, dunnage and payload).



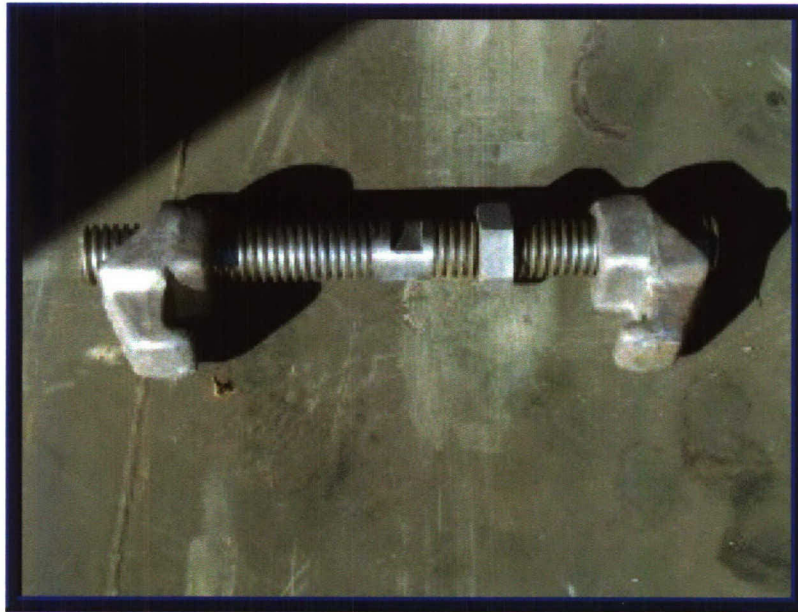
**Photo 1. FPU 8 with 155MM SLPs.**





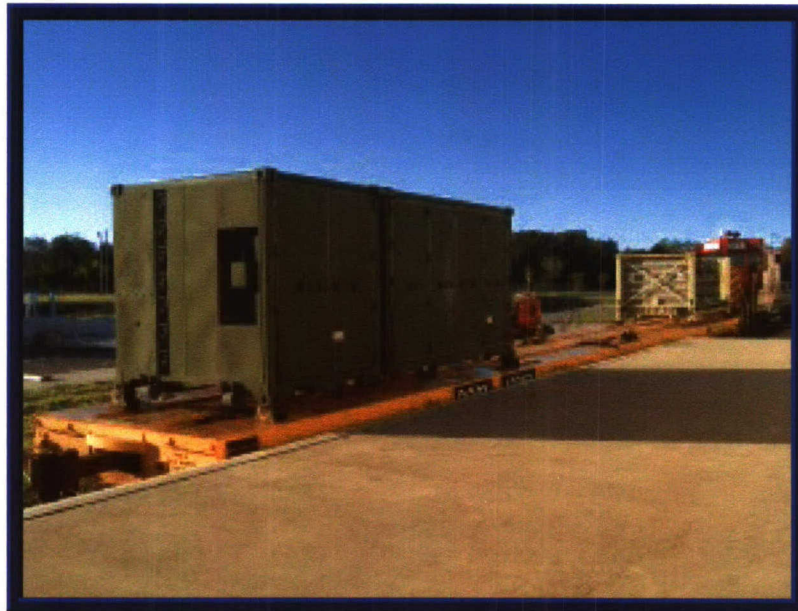
**Photo 2. FPU 12 with 40MM Linked.**

Note: Prior to the start of testing, the top coupler between containers was removed. The coupled containers also could not be picked up using the Rough Terrain Container Handler when the coupler was in place. The container manufacturer stated that the coupler was not required when transporting the coupled containers.



**Photo 3. Coupler which was removed for testing.**

**A. RAIL TEST.**



**Photo 4. Rail Impact Testing of the Coupled BOH Containers  
(Prior to Testing)**

Description	Weight
Flatcar Number: DODX 42353	85,000 lbs.
Coupled BOH FPU 8 and FPU 12	30,700 lbs.
M1 Flatrack with MLRS Pods	28,265 lbs.
Total Specimen Wt.	143,965 lbs.
Buffer Car (four cars)	257,900 lbs.

**Figure 4.**

**Remarks:** Figure 4 lists the test components and weights of the items used during the Rail Impact Tests.

Impact Number	Avg. Velocity (mph)
1	5.0
2	6.3
3	8.4
4	8.2

Figure 5.

**Remarks:**

1. Figure 5 lists the average speeds of the specimen car immediately prior to impact with the anvil. Impact #5 is the reverse impact.
2. Following Impact #1, the payload in each of the FPU containers moved in the direction of impact 0.25 inches.
3. Following Impact #2, the payload in FPU 8 moved an additional 0.125 inches in the direction of impact.
4. Following Impact #3, the payload in FPU 8 moved an additional 0.125 inches in the direction of impact.
5. Following Impact #4, the payload in FPU 8 moved 1 inch in the direction of impact.

**B. ON/OFF ROAD TESTS.**

**1. HAZARD COURSE.**





**Photo 5. Hazard Course Testing of the Coupled BOH Containers**

Pass No.	Elapsed Time	Avg. Velocity (mph)
1	20 Seconds	8
2	25 Seconds	6

**Figure 6.**

**Remarks:**

1. Figure 6 lists the average speeds of the test load through the Hazard Course.
2. Inspection following Pass #1 revealed that the payload in FPU 8 moved back 0.5 inches to the original starting position.
3. Inspection following Pass #2 revealed that the payload in FPU 12 moved 0.125 inches toward the passenger side.
4. Inspection did not reveal any damage to the BOH FPU 8 or FPU 12.

**2. ROAD TRIP:**

**Remarks:**

1. The Road Trip was conducted between the Road Hazard Course Passes #2 and #3.
2. Inspection did not reveal any damage to the BOH FPU 8 or FPU 12.



3. **PANIC STOPS:** Testing was not required since the load was rail impact tested.

4. **HAZARD COURSE:**

Pass No.	Elapsed Time	Avg. Velocity (mph)
3	24 Seconds	6
4	24 Seconds	6

Figure 7.

**Remarks:**

1. Figure 7 lists the average speeds of the test load through the Hazard Course.
2. Inspection following Pass #4 revealed that the payload in FPU 12 moved 0.25 inches toward the rear.

5. **WASHBOARD COURSE:**

**Remarks:**

1. Inspection following the Washboard Course revealed no damage to the FPU 8 or FPU 12.
2. Inspection following the Washboard Course revealed damage to the base of the 155MM SLP pallet due to impact with the door locking mechanisms.



**Photo 6. Washboard Course Testing of the Coupled BOH Containers.**



**Photo 7. Damage to 155MM SLP Pallet.**

**C. SHIPBOARD TRANSPORTATION SIMULATION (STS).**

**Remarks:** Final inspection following the completion of the STS did not reveal any damage to the BOH FPU 8 or FPU 12.

**D. ON/OFF ROAD TESTS.**

**1. HAZARD COURSE.**



**Photo 8. Hazard Course Testing of the Coupled BOH Containers on the PLS Vehicle.**

<b>Pass No.</b>	<b>Elapsed Time</b>	<b>Avg. Velocity (mph)</b>
<b>1</b>	<b>No Time</b>	<b>---</b>
<b>2</b>	<b>21 Seconds</b>	<b>7</b>

**Figure 8.**

**Remarks:**

1. Figure 8 lists the average speeds of the test load through the Hazard Course.
2. Inspection following Pass #2 revealed damage to the top boards in FPU 8.
3. Inspection following Passes #1 and #2 did not reveal any damage to the BOH FPU 8 or FPU 12.





Photo 9. Damage to Top Board

2. ROAD TRIP:

Remarks:

1. The Road Trip was conducted between the Road Hazard Course Passes #2 and #3.
2. Inspection did not reveal any damage to the BOH FPU 8 or FPU 12.

3. PANIC STOPS: Testing was not required since the load was eail impact tested.

4. HAZARD COURSE:

Pass No.	Elapsed Time	Avg. Velocity (mph)
3	20 Seconds	7
4	19 Seconds	7

Figure 9.



**Remarks:**

1. Figure 9 lists the average speeds of the test load through the Hazard Course.
2. Inspection following Passes #3 and #4 did not reveal any damage to the BOH FPU 8 or FPU 12.

**5. WASHBOARD COURSE:**

**Remarks:** Inspection following the Washboard Course revealed no damage to the FPU 8 or FPU 12.



**Photo 10. Washboard Course Testing of the Coupled BOH Containers on the PLS Vehicle.**

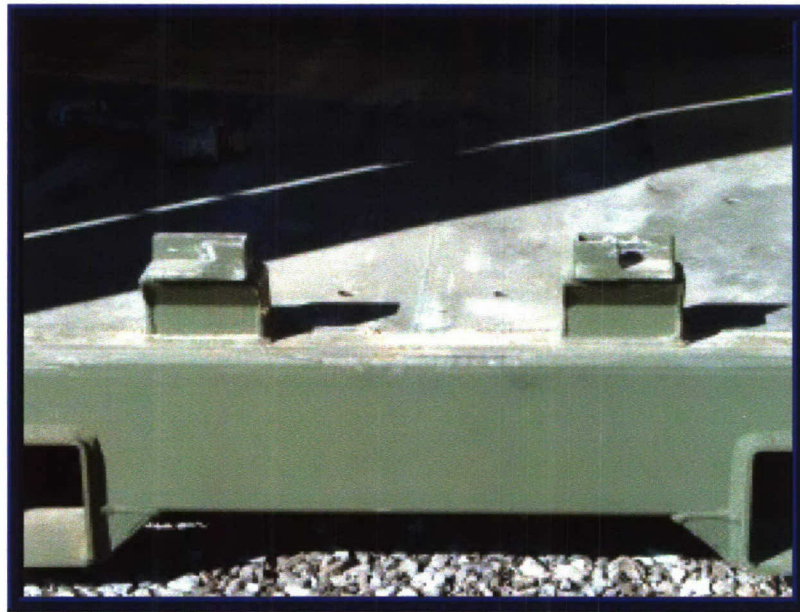
**E. OBSERVATIONS:**

1. The interior design of the container makes it difficult to load the payload in the containers. For example, the door locking provisions on the container floor interfere when loading the payload.
2. The interior geometry requires that a large amount of dunnage be used to secure the payload. Proper fitting of the dunnage is very difficult due to the non-uniformity of the FPU interior.

3. The container floors have numerous holes for mounting hardware inside the containers. The holes could allow for sparks to enter the container.

4. The containers have lighting and electrical provisions.

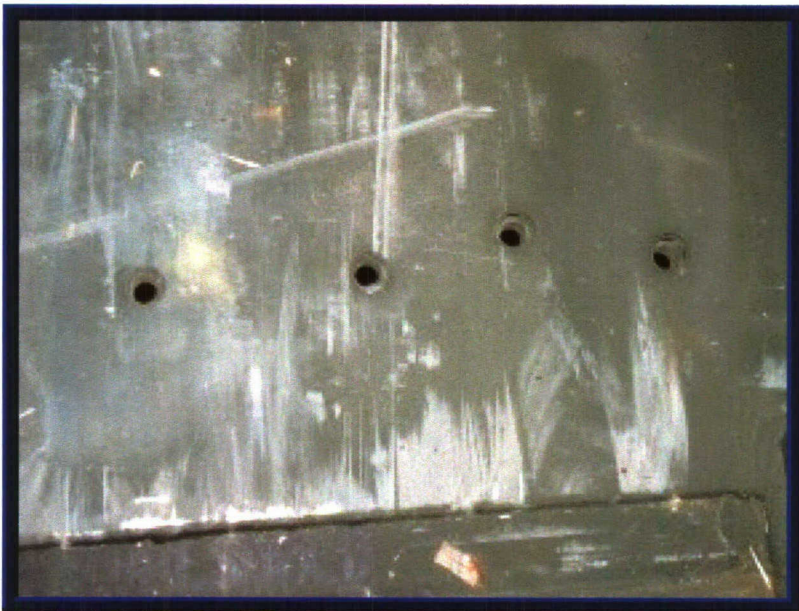
5. Final Inspection revealed that the floor in FPU 8 was deformed 0.25 inches during testing. The deformation was from contact of the base of the 155MM SLP pallet on the floor.



**Photo 11. Door Locking Provisions.**

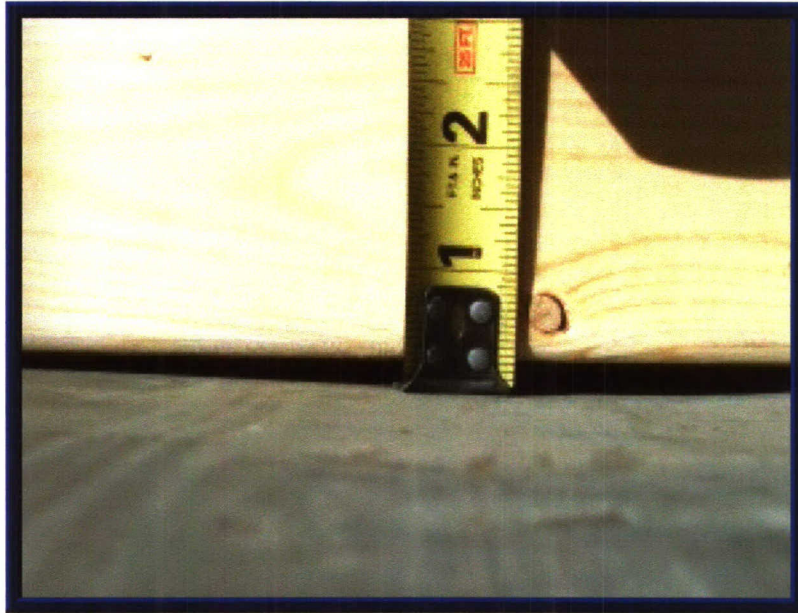


**Photo 12. Dunnage Required to Secure Payload.**



**Photo 13. Holes in the Floor of the FPU Containers.**





**Photo 14. Floor Deformation.**

**F. CONCLUSIONS:**

1. Ammunition **shall not** be transported in the BOH FPU 8 and FPU 12 with PLS interface that are equipped with electrical components.
2. Ammunition **shall not** be transported in the BOH FPU 8 and FPU 12 with PLS interface that have open holes in the floor of the containers.
3. The coupled BOH FPU 8 and FPU 12 successfully completed the transportability testing.



## **PART 6 – DRAWINGS**

The following drawing represents the load configuration that was subjected to the test criteria.

# TEST SKETCH

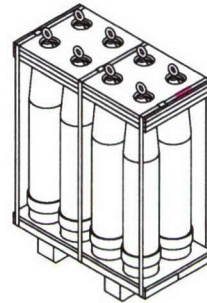
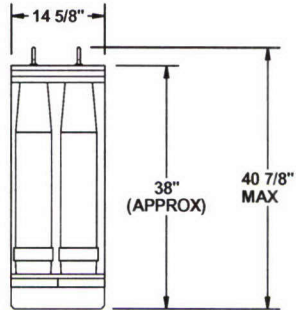
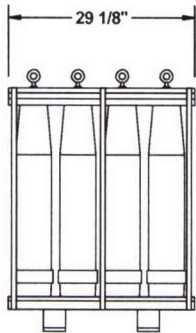
## **LOADING AND BRACING OF FIELD PACK UP (FPU) 8 UNIT AND FPU 12 UNIT INTERMODAL SHIPPING CON- TAINERS**

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**THIS TWELVE PAGE DOCUMENT DEPICTS PALLET  
UNITS OF 40MM LINKED IN METAL BOXES AND  
155MM PROJECTILES FOR TRANSPORTABILITY  
TESTING OF THE BOH 20 FT EQUIVALENT UNIT**

PREPARED DURING AUGUST 2006 BY:  
U.S. ARMY DEFENSE AMMUNITION CENTER  
ATTN: SJMAC-DET  
POC: MICHAEL BARTOSIAK  
DSN 956-8083  
COMM (918) 420-8083  
FAX (918) 420-8811  
E-MAIL: MICHAEL.BARTOSIAK@US.ARMY.MIL

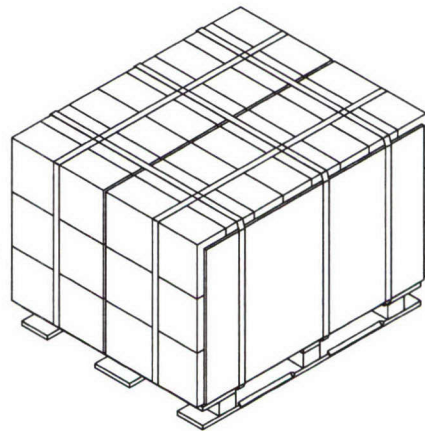
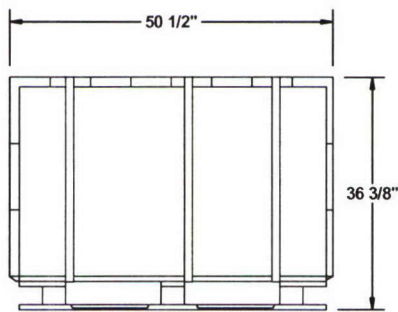
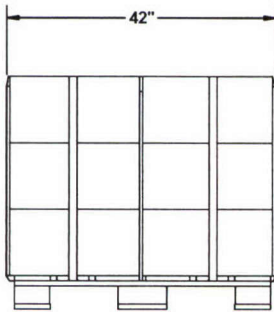
LAURAA. FIEFFER  
CHIEF, TRANSPORTATION ENGINEERING DIVISION



**155MM SLP, 8/LARGE WOODEN PALLET**

UNIT WEIGHT ----- 874 LBS (APPROX)  
 CUBE ----- 9.7 CU FT

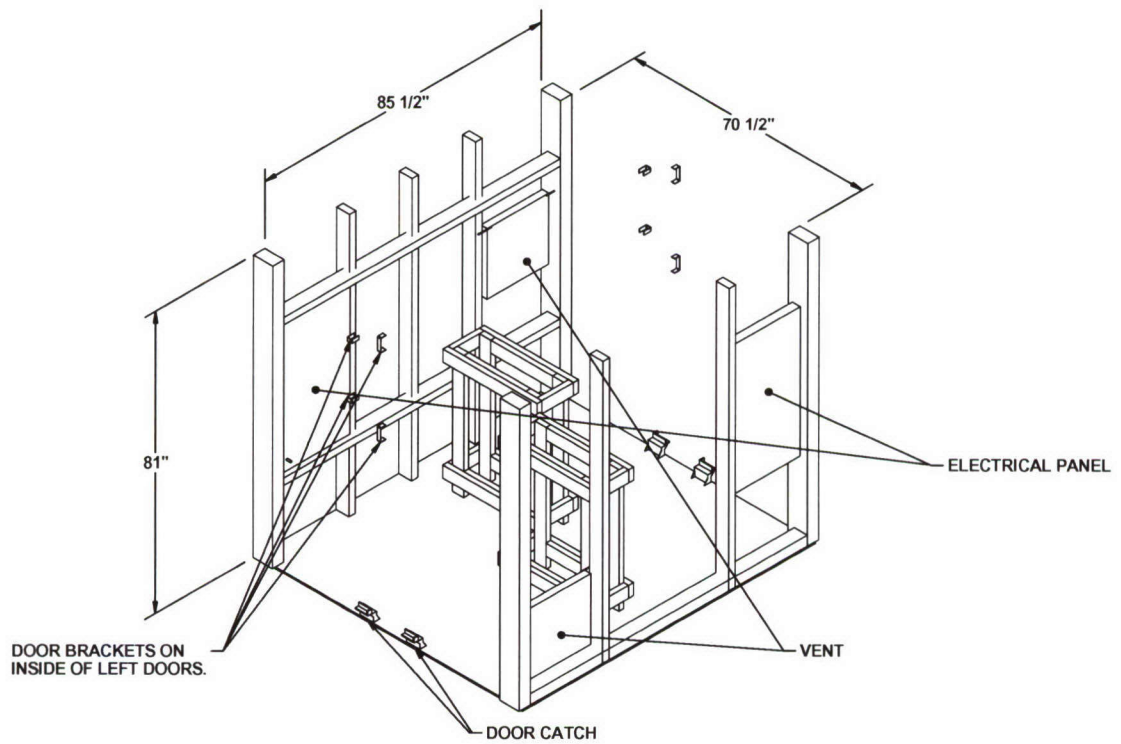
REFER TO LOAD ON PAGE 4



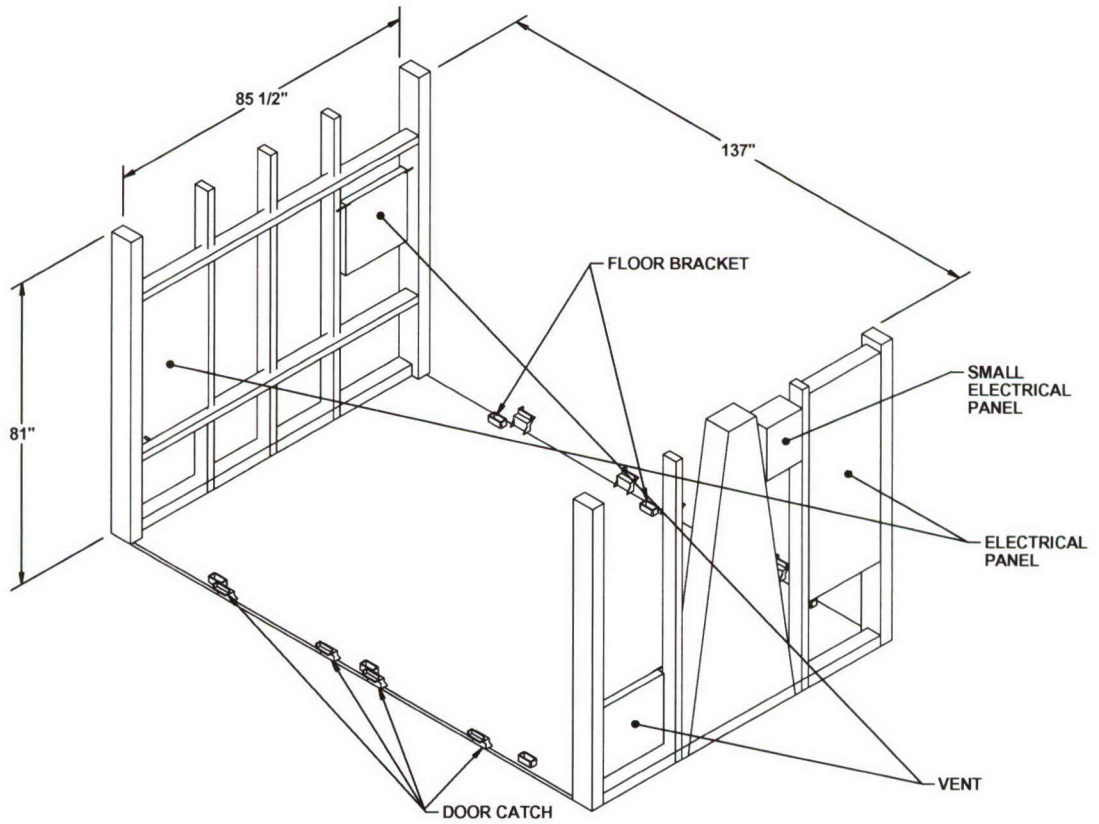
**40MM LINKED METAL BOX UNITIZATION**

UNIT WEIGHT ----- 2,575 LBS (APPROX)  
 CUBE ----- 44.7 CU FT

REFER TO LOAD ON PAGE 7



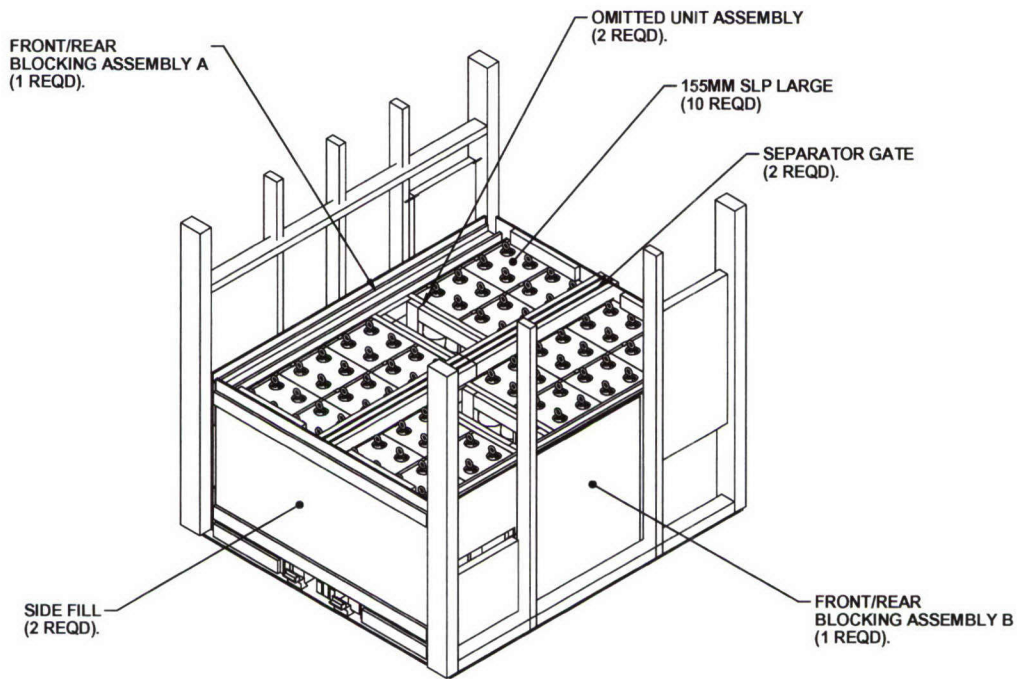
INSIDE OF 8 FT BOH CONTAINER



INSIDE OF 12 FT BOH CONTAINER

INTERIOR OF 8 FT AND 12 FT BOH CONTAINERS





**ISOMETRIC VIEW**

**BILL OF MATERIAL**

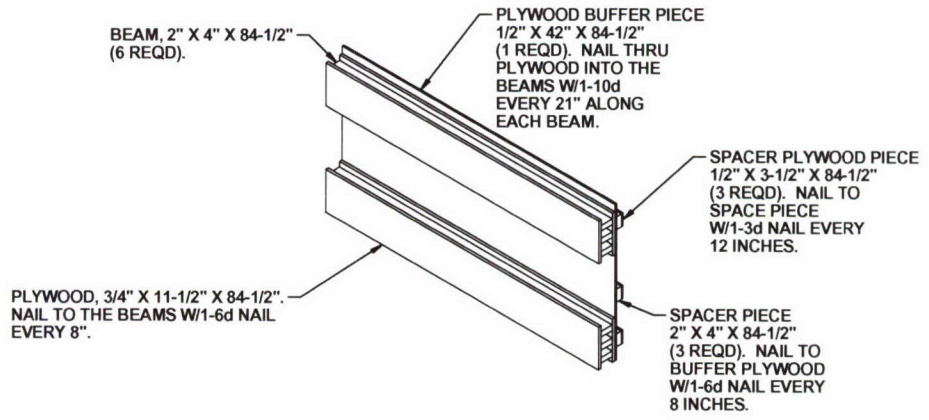
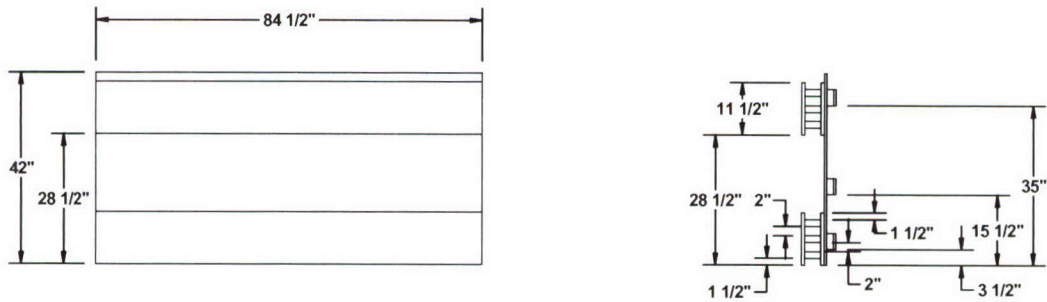
LUMBER	LINEAR FEET	BOARD FEET
1" x 4"	29	10
2" x 4"	239	160
NAILS	NO. REQD	POUNDS
3d (1-1/4")	29	1/16
6d (2")	326	2
10d (3")	144	2-3/16
1/2 PLYWOOD	156 SQ FT	215 LBS
3/4 PLYWOOD	54 SQ FT	112 LBS

**LOAD AS SHOWN**

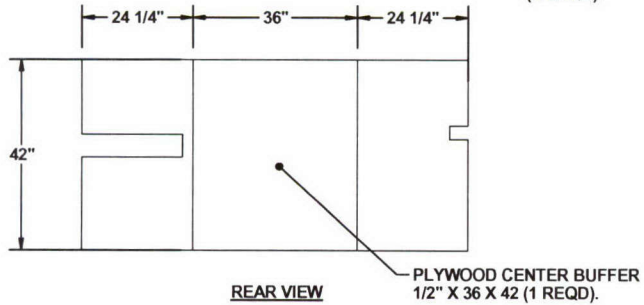
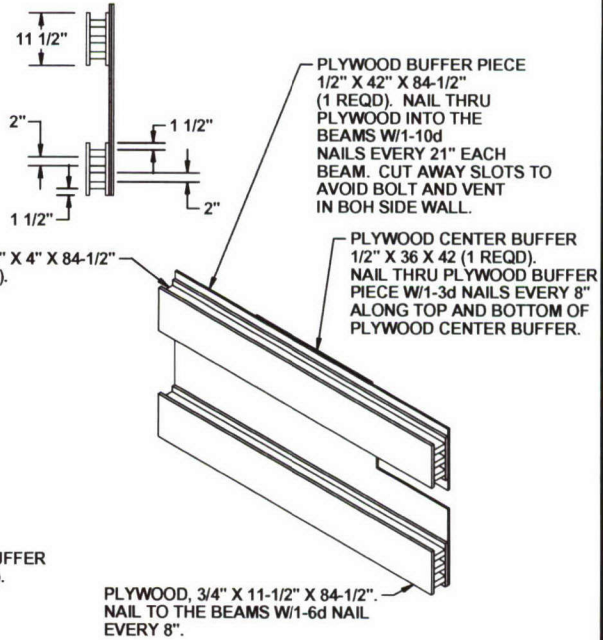
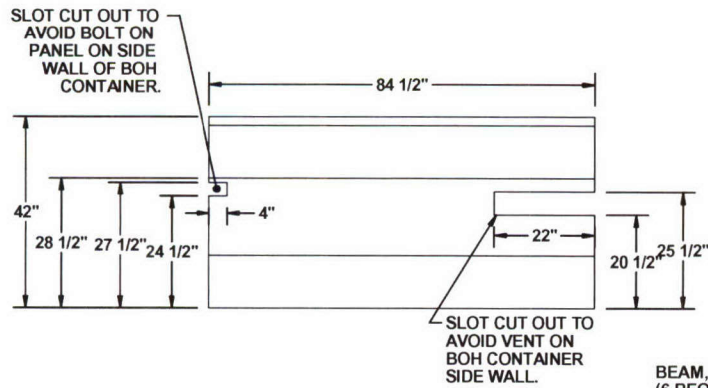
ITEM	QUANTITY	WEIGHT (APPROX)
155MM SLP LARGE	10	8,740 LBS
DUNNAGE		672 LBS
BOH 8 FT CONTAINER		3,655 LBS

TOTAL WEIGHT - - - - - 13,067 LBS (APPROX)

**8 FT BOH CONTAINER LOAD**



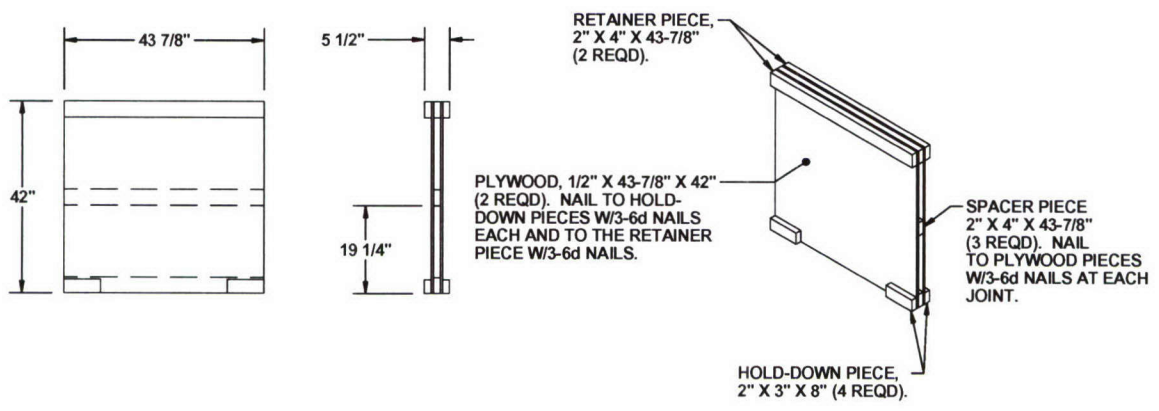
**FRONT/REAR ASSEMBLY A**  
(1 REQD)



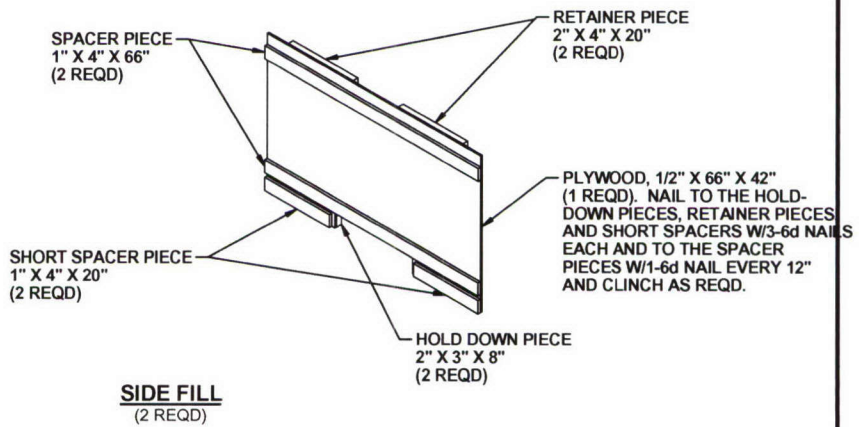
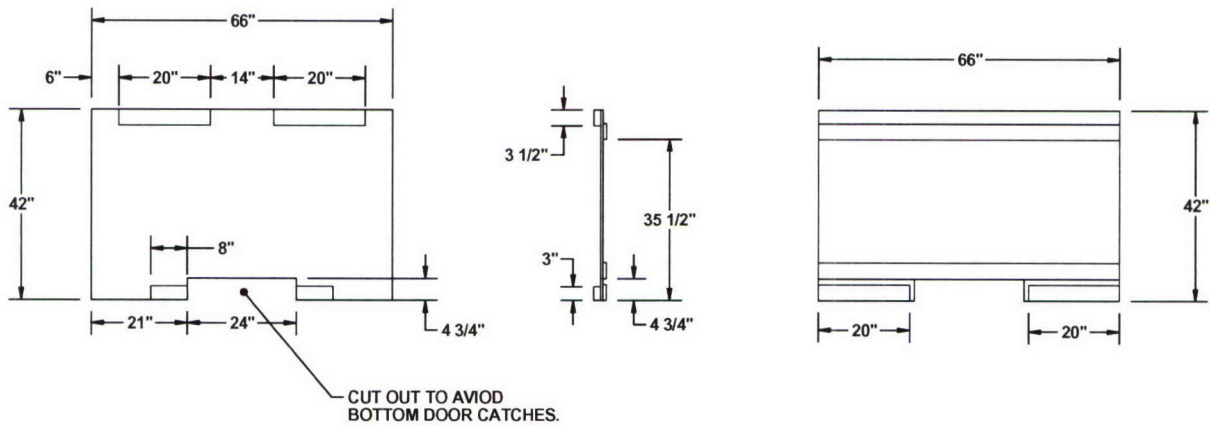
**REAR VIEW** PLYWOOD CENTER BUFFER 1/2" X 36 X 42 (1 REQD).

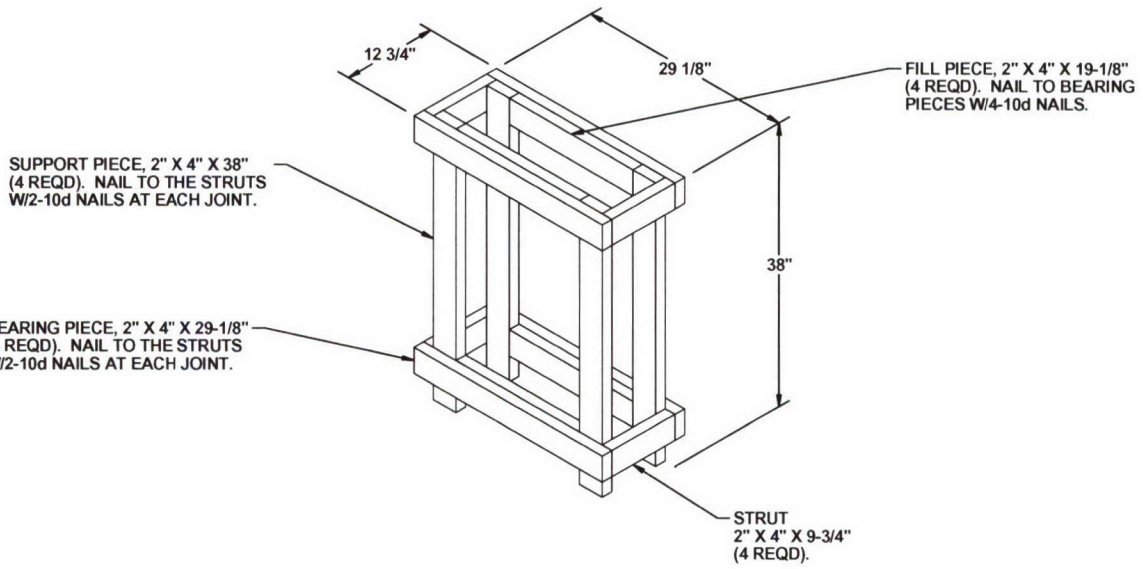
**FRONT/REAR ASSEMBLY B**  
(1 REQD)

**DETAILS OF 8 FT BOH CONTAINER LOAD**



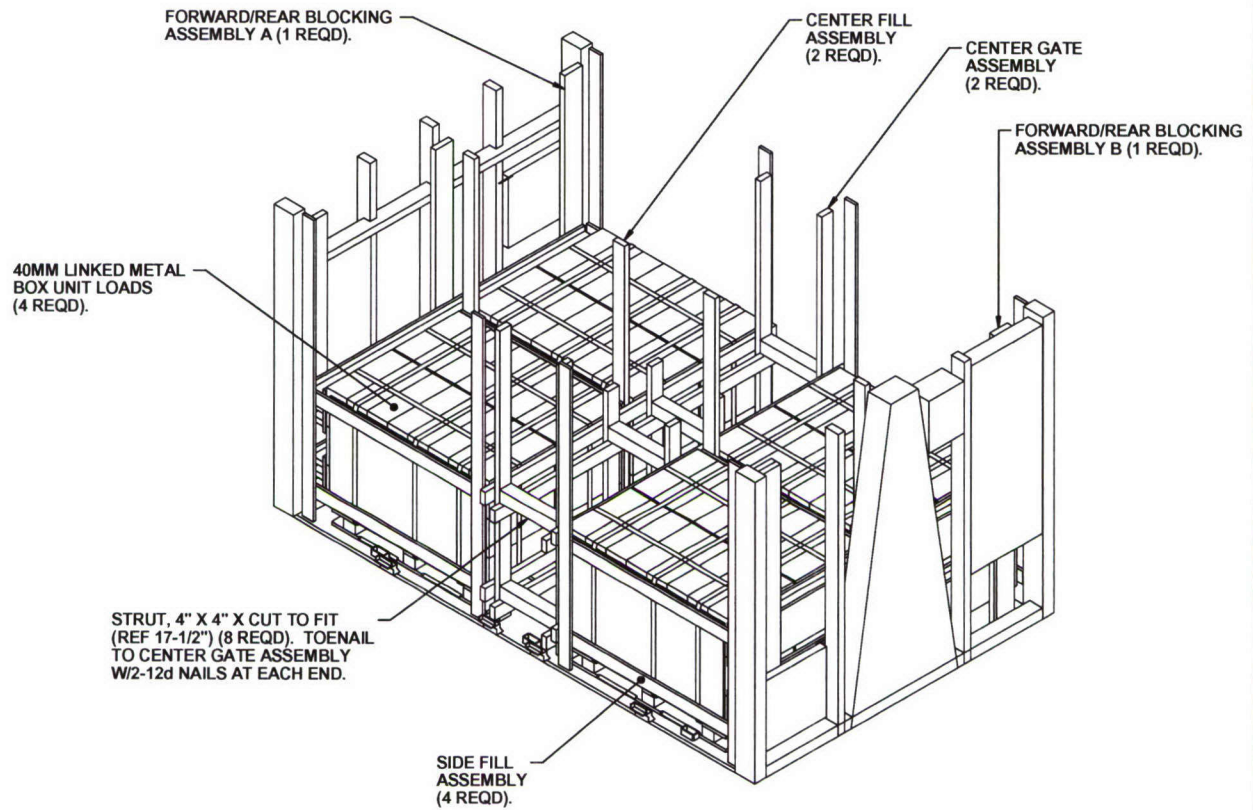
**SEPARATOR GATE**  
(2 REQD)





**OMITTED UNIT ASSEMBLY**  
(2 REQD)





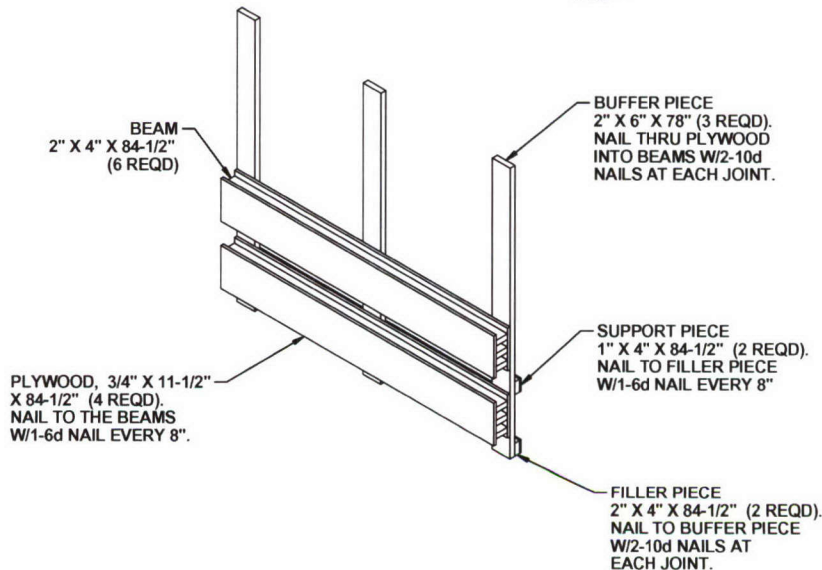
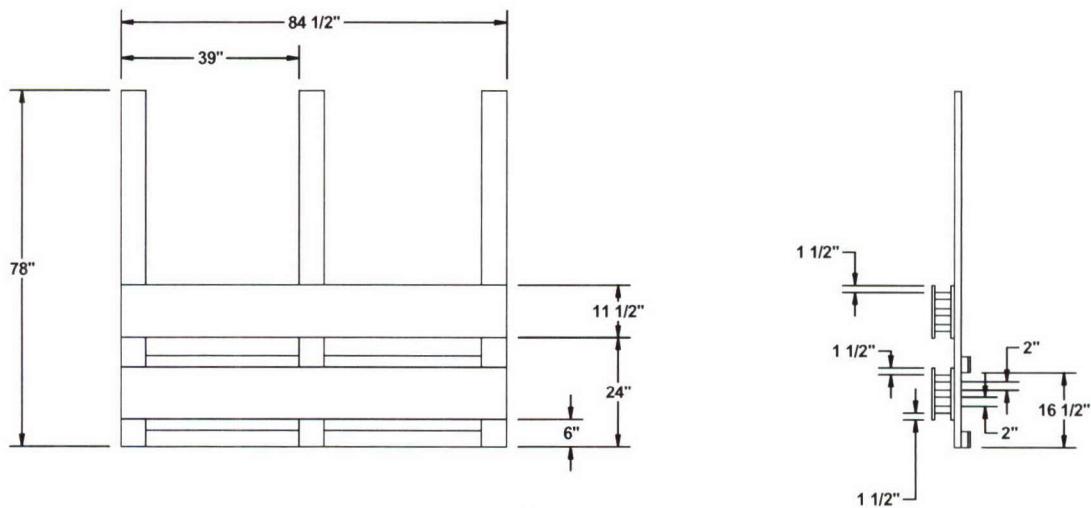
**ISOMETRIC VIEW**

**BILL OF MATERIAL**

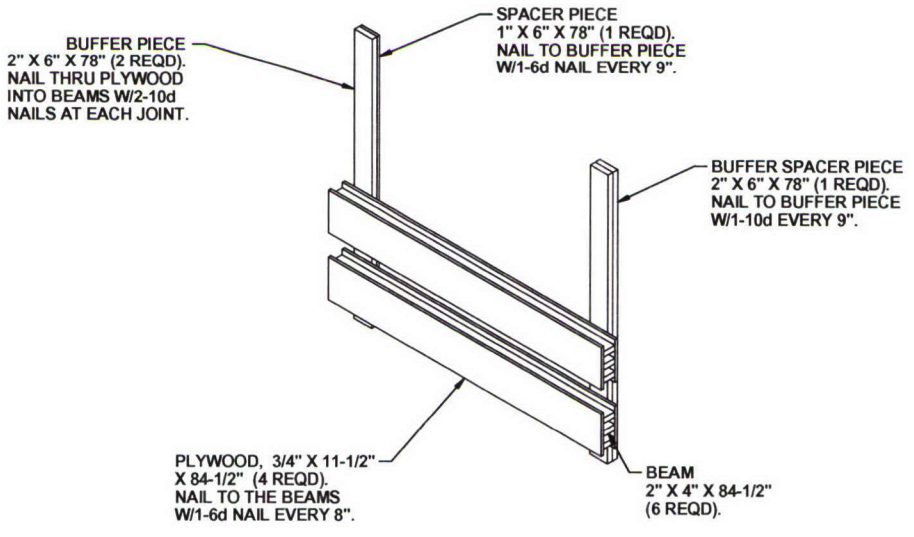
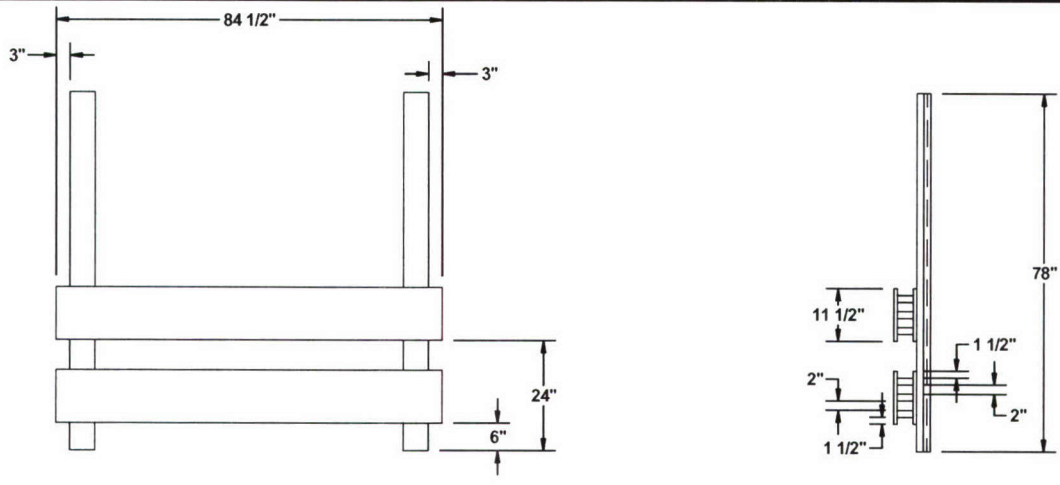
LUMBER	LINEAR FEET	BOARD FEET
1" X 4"	78	26
1" X 6"	7	4
2" X 4"	269	180
2" X 6"	39	39
NAILS	NO. REQD	POUNDS
6d (2")	316	2
10d (3")	128	2
3/4 PLYWOOD	54 SQ FT	112 LBS

**LOAD AS SHOWN**

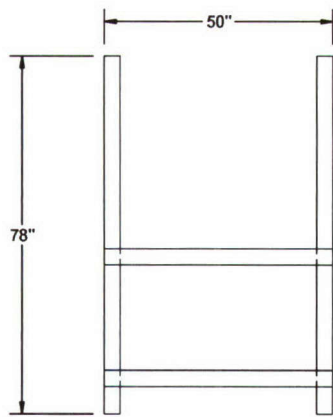
ITEM	QUANTITY	WEIGHT (APPROX)
40MM LINKED PALLETS	4	10,300 LBS
DUNNAGE		614 LBS
BOH 12 FT CONTAINER		5,000 LBS
<b>TOTAL WEIGHT</b>		<b>15,914 LBS (APPROX)</b>



**FORWARD/REAR BLOCKING ASSEMBLY A**  
(1 REQD)

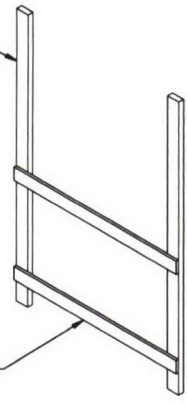


**FORWARD/REAR BLOCKING ASSEMBLY B**  
(1 REQD)

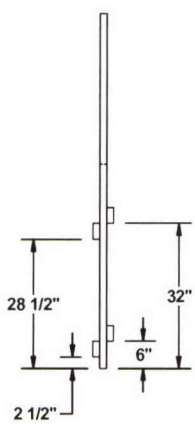
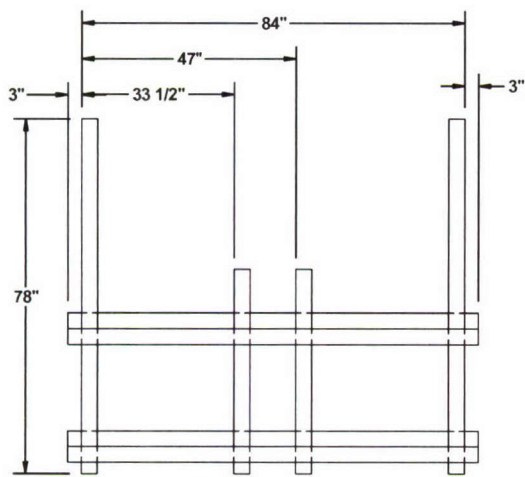


VERTICAL PIECE  
1" X 4" X 78" (2 REQD).

SPACER PIECE  
2" X 4" X 50" (2 REQD).  
NAIL TO VERTICAL  
PIECES W/2-6d AT  
EACH JOINT.



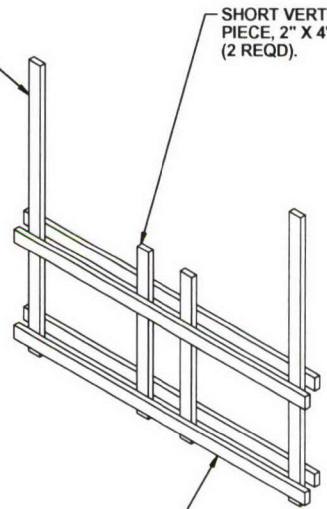
**CENTER FILL ASSEMBLY**  
(2 REQD)



VERTICAL PIECE,  
2" X 4" X 78"  
(2 REQD).

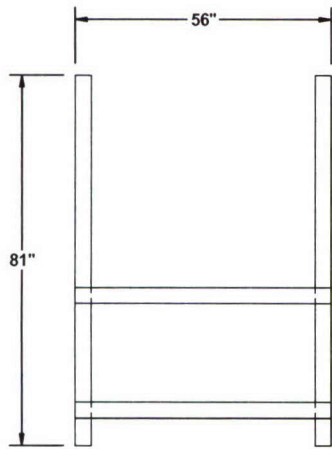
SHORT VERTICAL  
PIECE, 2" X 4" X 45"  
(2 REQD).

BUFFER PIECE  
2" X 4" X 90"  
(4 REQD). NAIL  
TO VERTICAL PIECES  
AND SHORT VERTICAL  
PIECES W/2-10d NAILS  
AT EACH JOINT.



**CENTER GATE ASSEMBLY**  
(2 REQD)





**SIDE FILL ASSEMBLY**  
(4 REQD)

