NAVSEA
NAVAL SEA SYSTEMS COMMAND

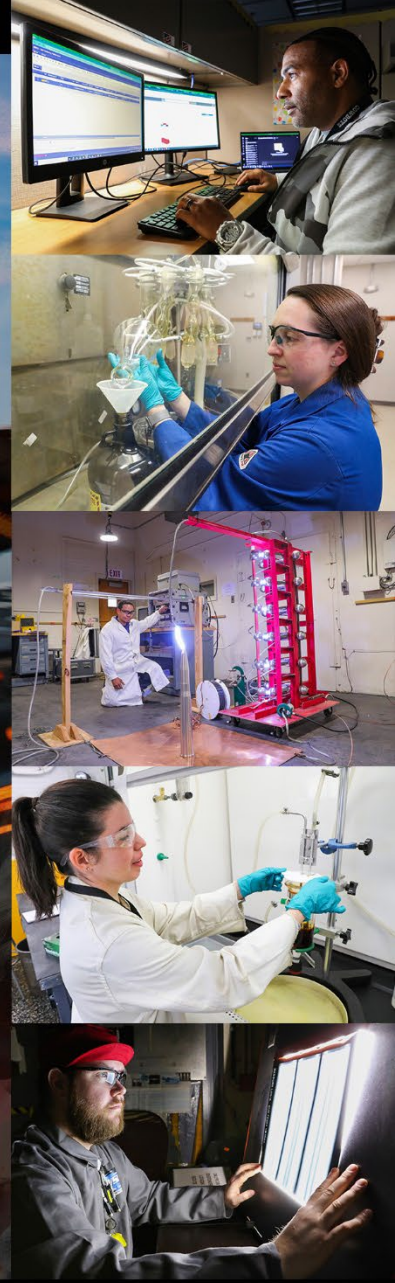
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

6 May 2026

Plastic/Composite Pallets for Domesitic Unit Load Use

2026 NIPHLE Training Event

Samuel Kouretas
Senior Development Engineer
NSWC IHD DET PICA, CODE W6
Samuel.k.kouretas.civ@us.navy.mil
973-724-7897



NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Agenda

- Background
- Pallet Description
- Test Development
- Unit Load Description
- Detailed Test Description
- Test Results
- Test Results Summary and Conclusion
- Future Efforts

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Background

- **Currently used pallets:** Navy ordnance domestic unit loads typically use wooden pallets, commonly, MIL-DTL-15011, Class 1, style 1. (40”x48”)

- **Opportunity for improvement:** High-Density Polyethelyene (HDPE) plastic pallets present significant potential benefits.

  - **Cost Savings:** Reduces procurement and lifecycle costs.
  - **Weight Savings:** Lower tare weight, easier handling, and potential for reduced transportation costs.
  - **Durability and Reusability:** Resistant to moisture, pests (no need to heat treat), and rot leading to longer service life.

- **Project Objective:** to test and validate the performance of a commercial HDPE pallet against the requirements of MIL-STD-1660B for level B domestic Unit Loads.

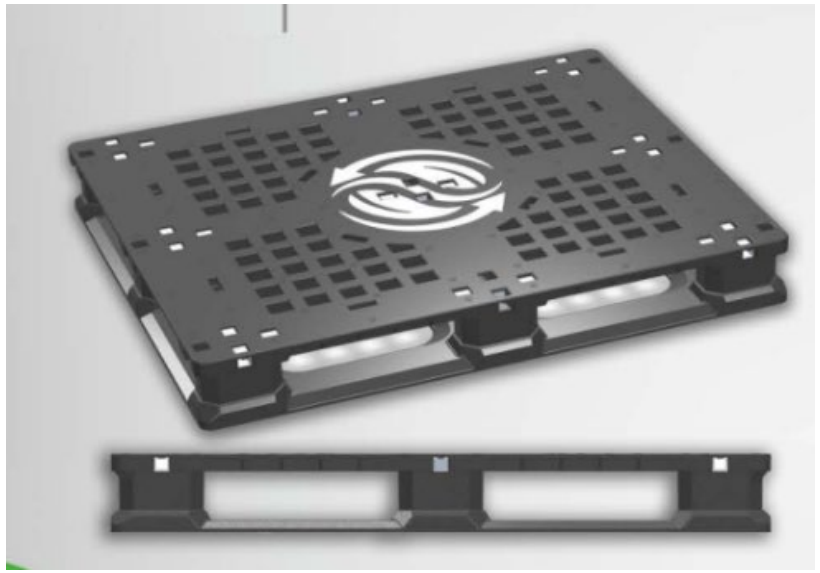
NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Green Current Solutions Pallet

Green Current Solutions Pallet

- Plastic 100% Recycled HDPE
- 40” x 48” x 5 ¾”
- 48 lbs



Traditional MIL-STD-15011 Pallet Class 1, type 1

- Wood - Group IV of ASTM D6199 and from Group III only Red Maple (Acer rubrum).
- 40” x 48” x 5”
- 80 lbs

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

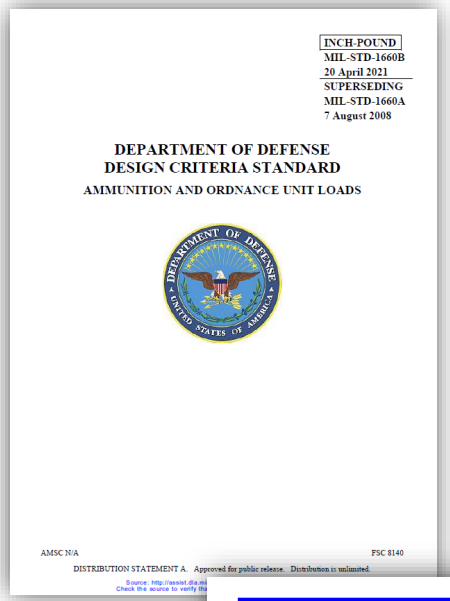
Test Development

- **Standard:** The governing standard for our testing is MIL-STD-1660B, Department of Defense Design Criteria Standard, Ammunition and Ordnance Unit Loads

- **Approach:** It was decided to take an incremental approach to determine performance limits.
  - **Phase 1:** 2,500 lb unit load
  - **Phase 2:** 4,000 lb unit load

- **Test series at ambient temperature:** Stacking Test, Repetitive Shock Test (stacked), Drop Tests (Edgewise Rotational Drops), Impact Test, Forklifting Test, Pushing Test, Towing Test, Pallet Truck Test, Sling Compatibility, Dissassembly Test

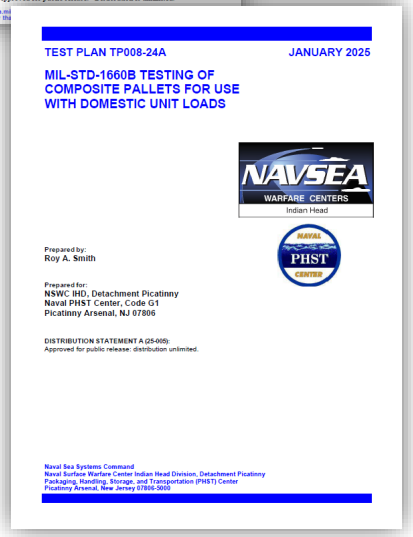
- **Temperature Extremes:** Non metallic or wood material requires testing at high and low temperatures. Repetitive shock test (not stacked) and drop tests were repeated at these extremes, with temperature pre-conditioning immediately before each test
  - **Hot Extreme:** 160°± 5° F, conditioned at 4 hours
  - **Cold Extreme:** -40°± 5°F and -65°± 5° F, conditioned at 4 hours


INCH-POUND
MIL-STD-1660B
20 April 2021
SUPERSEDING
MIL-STD-1660A
7 August 2008

DEPARTMENT OF DEFENSE
DESIGN CRITERIA STANDARD
AMMUNITION AND ORDNANCE UNIT LOADS

AMSC N/A FSC 8140

DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited.


TEST PLAN TP008-24A JANUARY 2025

MIL-STD-1660B TESTING OF COMPOSITE PALLETS FOR USE WITH DOMESTIC UNIT LOADS

NAVSEA WARFARE CENTERS
Indian Head

PHST

Prepared by:
Roy A. Smith

Prepared for:
NSWC IHD, Detachment Picatinny
Naval PHST Center, Code G1
Picatinny Arsenal, NJ 07806

DISTRIBUTION STATEMENT A (25-005):
Approved for public release: distribution unlimited.

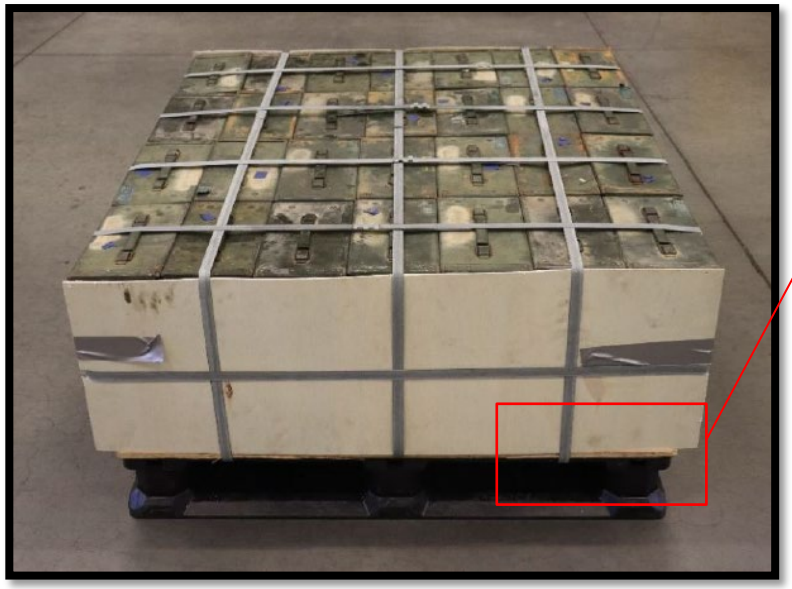
Naval Sea Systems Command
Naval Surface Warfare Center Indian Head Division, Detachment Picatinny
Packaging, Handling, Storage, and Transportation (PHST) Center
Picatinny Arsenal, New Jersey 07806-5000

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Unit Loads

- **4,000 lb Unit Load:** Based on AMC Drawing 19-48-4116/15C-20PA1002
- **2,500 lb Unit Load:** Based on NAVSEA Drawing 6214536 Rev D



2500 lb Unit Load

*** Note: Both unit loads utilized a sheet of plywood between the ammo cans and pallet**

4000 lb Unit Load

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Stacking Test:** IAW MIL-STD-1660B 5.4.1
- **Test Duration:** 1 Hour
- **Load:** Representing a stack of unit loads up to 16 ft high for 1 hour
  - 20,000 lbs for the 2,500 lb unit load
  - 16,000 lbs for the 4,000 lb unit load
- **Equipment:** CHANT 9638-1 Compression Tester, 50,000 lb capacity, 180”L x 60”W x 84”H

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Repetitive Shock Test (Stacked):** IAW MIL-STD-1660B 5.4.2.1 and appendix A
- **Test Duration:** 1 Hour
- **Load:** Superimposed load on top to simulate a 2 high stack.
- **Equipment:** CHANT 8760 Loose-Cargo Simulator, 1 inch double amplitude, vertical linear motion, 10,000 lb capacity, 96” x 144” surface

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Drop Tests (Edgewise Rotational Drops):** IAW MIL-STD-1660B 5.4.3 and appendix B
- **Drop Height:** 4,000 lbs: 9 in, 2500 lbs: 12 in (see table)
- **Number of Drops**: 4, 1 drop on each bottom edge
- **Equipment:** Overhead Crane, Drop Hook, Impact Surface

TABLE B-I. Height of rotational drops for unit loads of various sizes and weights. 1/

Gross weight (within range limits)	Dimensions of any edge, height, or width (within range limits)	Height of drops on edges	
Pounds	Inches	Level A (inches)	Level B (inches)
150 – 250	60 – 66	36	27
251 – 400	67 – 72	32	24
401 – 600	73 – 80	28	21
601 – 1,000	81 – 95	24	18
1,001 – 1,500	96 – 114	20	16
1,501 – 2,000	115 – 144	17	14
2,001 – 3,000	Above 145 – No limit	15	12
Above – 3,000		12	9

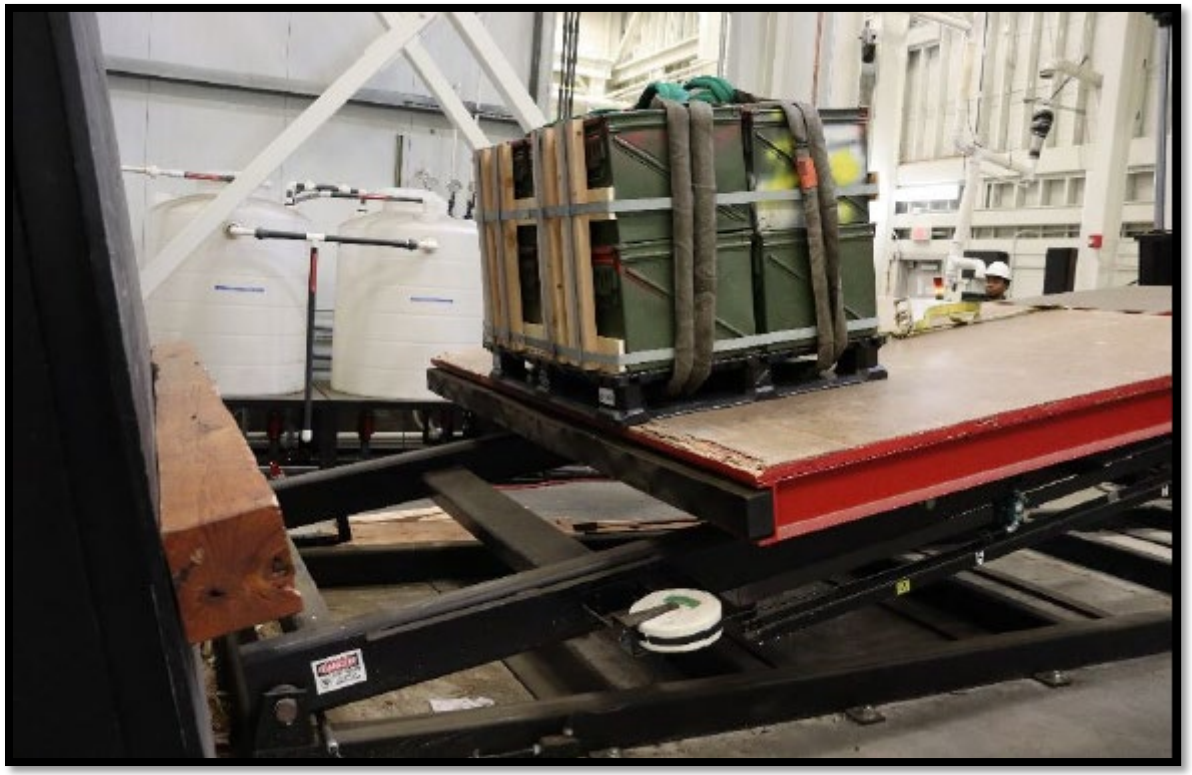
NOTE:
1/ Use the lowest drop height indicated by either gross weight or dimension. For example, a unit load having a gross weight of 440 pounds and a maximum edge dimension of 95⅝ inches, shall be dropped 20 inches for level A tests or 16 inches for level B tests.

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Impact Test:** IAW MIL-STD-1660B 5.4.5 and appendix D
- **Impact Velocity:** 5 ft/s for level B
- **Number of Impacts**: 4, 1 impact on each side
- **Equipment:** LAB 901009 Incline Impact Machine (10 degree incline, 10,000 lb capacity, steel wall impact surface with optional Hardwood Timber)

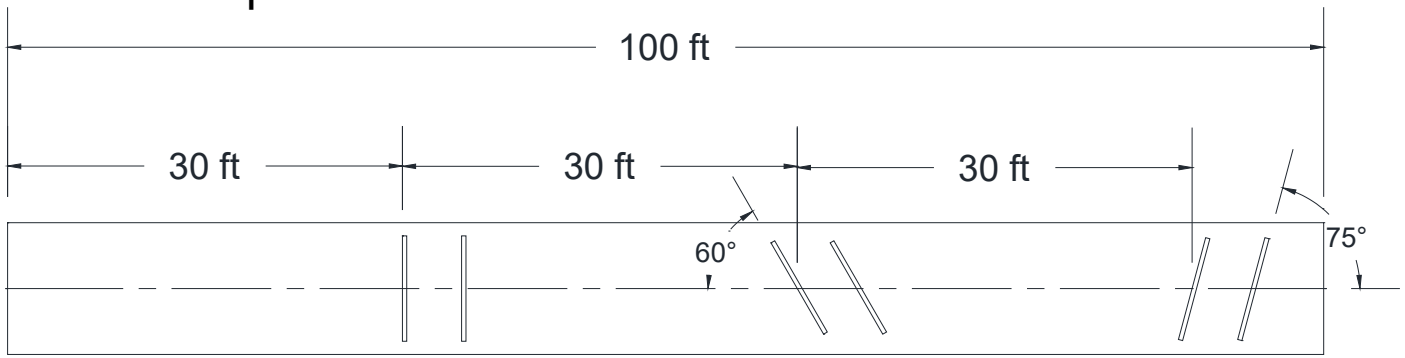


NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Forklifting Test:** IAW MIL-STD-1660B 5.4.6 and appendix G 5.2
- **Orientation:** Tested twice, from one end and one side
- **Equipment:** 6K Hard tire Forklift, 3 pairs of 1-inch-high parallel boards for course
- **Course Description:**
  - Length: 100 Ft
  - Speed: approximately 23 seconds
  - Surface: Hard Dry Pavement
  - 3 pairs of parallel 1 inch boards, second board in each pair spaced 54 in from 1st board



NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Pushing Test Test:** IAW MIL-STD-1660B 5.4.6 and appendix G 5.5
- **Orientation**: Tested twice, from one end and one side
- **Equipment:** 6K Hard tire Forklift
- **Course Description:**
  - Length: 35 Ft
  - Speed: approximately 85 seconds
  - Surface: Hard Dry Pavement

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Towing Test Test:** IAW MIL-STD-1660B 5.4.6 and appendix G 5.6
- **Orientation**: Tested twice, from one end and one side
- **Equipment:** 6K Hard tire Forklift
- **Course Description:**
  - Length: 100 Ft
  - Speed: approximately 23 seconds
  - Surface: Hard Dry Pavement

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Pallet Truck Test:** IAW MIL-STD-1660B 5.4.7
  - **Equipment:** Pallet Truck
  - **Procedure:** Lift the unit load clear off the ground, transport it 50 ft, and lower the unit load.

- **Sling Compatibility Test:** IAW MIL-STD-1660B 5.4.8
  - **Equipment:** Mk 93 Mod 0 Pallet Sling
  - **Procedure:** Lift the unit load, swing, lower, and otherwise handle as necessary.
    - Note: this pallet was not compatible with the Navy's MK 93 Mod 0 Pallet Sling. Test not performed

- **Dissassembly Test:** IAW MIL-STD-1660B 5.4.9
  - **Procedure:** Following all test, cut and remove the strapping. The unit load shall retain its unity and any damage noted.

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Description

- **Temperature Extremes:** Non metallic or wood material requires testing at high and low temperatures. Repetitive shock test (not stacked) and drop tests were repeated at these extremes, with temperature pre-conditioning immediately before each test
  - **Hot Extreme:** 160°± 5° F, conditioned at 4 hours
  - **Cold Extreme:** -40°± 5°F and -65°± 5° F, conditioned at 4 hours

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Results

- **Standard Pallet – 2,500 lbs (PHST Test Report 25002)**

Ambient Testing	
Stacking Test	☑
Repetitive Shock Test (Stacked)	☑
Drop Test (Edgewise Rotational)	☑
Impact Test	☑
Forklifting Test	☑
Pushing Test	☑
Towing Test	☑
Pallet Truck Test	☑
Sling Compatibility Test	Not Performed
Disassembly Test	☑

Temperature Tests	
Hot Extreme (160° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑
Cold Extreme (-40° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	✗
Cold Extreme (-65° F)	
Repetitive Shock Test (not stacked)	Not Performed
Drop Test (Edgewise Rotational)	Not Performed

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Results

- **Cold Additive "A" modification to Pallet – 2,500 lbs (PHST Test Report 26004)**

Ambient Testing	
Stacking Test	☑
Repetitive Shock Test (Stacked)	☑
Drop Test (Edgewise Rotational)	☑
Impact Test	☑
Forklifting Test	☑
Pushing Test	☑
Towing Test	☑
Pallet Truck Test	☑
Sling Compatibility Test	Not Performed
Disassembly Test	☑

Temperature Tests	
Cold Extreme (-40° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑
Cold Extreme (-65° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑
Hot Extreme (160° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Results

- **Cold Additive "B" modification to Pallet – 2,500 lbs (PHST Test Report 25043)**

Ambient Testing	
Stacking Test	☑
Repetitive Shock Test (Stacked)	☑
Drop Test (Edgewise Rotational)	☑
Impact Test	☑
Forklifting Test	☑
Pushing Test	☑
Towing Test	☑
Pallet Truck Test	☑
Sling Compatibility Test	Not Performed
Disassembly Test	☑

Temperature Tests	
Cold Extreme (-40° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑
Cold Extreme (-65° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑
Hot Extreme (160° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Results

- **Cold Additive "A" modification to Pallet – 4000 lbs (PHST Test Report 26003)**

Ambient Testing	
Stacking Test	☑
Repetitive Shock Test (Stacked)	☑
Drop Test (Edgewise Rotational)	☑
Impact Test	☑
Forklifting Test	☑
Pushing Test	☑
Towing Test	☑
Pallet Truck Test	☑
Sling Compatibility Test	Not Performed
Disassembly Test	☑

Temperature Tests	
Hot Extreme (160° F)	
Repetitive Shock Test (not stacked)	✗
Drop Test (Edgewise Rotational)	Not Performed
Cold Extreme (-40° F)	
Repetitive Shock Test (not stacked)	Not Performed
Drop Test (Edgewise Rotational)	Not Performed
Cold Extreme (-65° F)	
Repetitive Shock Test (not stacked)	Not Performed
Drop Test (Edgewise Rotational)	Not Performed

Damage after Hot Repetitive Shock

Note: Pallet used for 4000 pound testing had already gone thru 2500 pound testing

NAVSEA
NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION

Test Results

- **Cold Additive "B" modification to Pallet – 4,000 lbs (PHST Test Report 26003)**

Ambient Testing	
Stacking Test	☑
Repetitive Shock Test (Stacked)	☑
Drop Test (Edgewise Rotational)	☑
Impact Test	☑
Forklifting Test	☑
Pushing Test	☑
Towing Test	☑
Pallet Truck Test	☑
Sling Compatibility Test	Not Performed
Disassembly Test	☑

Temperature Tests	
Cold Extreme (-40° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑
Cold Extreme (-65° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑
Hot Extreme (160° F)	
Repetitive Shock Test (not stacked)	☑
Drop Test (Edgewise Rotational)	☑

Visible Sagging after 4000 Hot Temperature Edgewise Drops

Test Results Summary and Conclusion

- A standard commercially available HDPE pallet by Green Current Solutions was tested for MIL-STD-1660B level B, with a test load of 2,500 pounds.
  - Cold performance issues were identified on the standard pallet and the formula was modified.

- Two modified formula pallets were submitted for retesting.
  - Modification A and B both performed with no issues at 2,500 pounds.
  - At 4,000 pounds, modification A did not meet the hot temperature requirements.
  - At 4,000 pounds, modification B did meet all requirements.

- Based on this testing, specific HDPE pallets can be cost effective and weight saving alternatives to traditional wooden pallets for domestic Navy ordnance shipments

Future Efforts

- Retest Modification “A”
  - A fresh pallet at 4,000 pounds
  - GCS thinks tweaking the modification may help
- Re-evaluate pallets after UV exposure testing
- Explore possibility of Level A testing
- Possibly incorporate galvanized supports to reduce “sagging”
- Explore other lightweight, low-cost materials for naval packaging


NAVSEA
NAVAL SEA SYSTEMS COMMAND
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD DIVISION