

# **S2933 - One Sided Deck Tie-Down Welding and Inspection**

## ***Jan 2023 – March 2025***

***Jonathan Roberts– Ingalls Shipbuilding***

***NSRP All Panel Meeting***

***Welding Technology Panel***

***February 25, 2025***

# Issue Description



**Aircraft secured to the flight deck of LHA-6 USS America**

Source: <https://www.dvidshub.net/image/4062198/uss-america-aircraft-chained-down-flight-deck>



**Flight deck aircraft tie-downs**

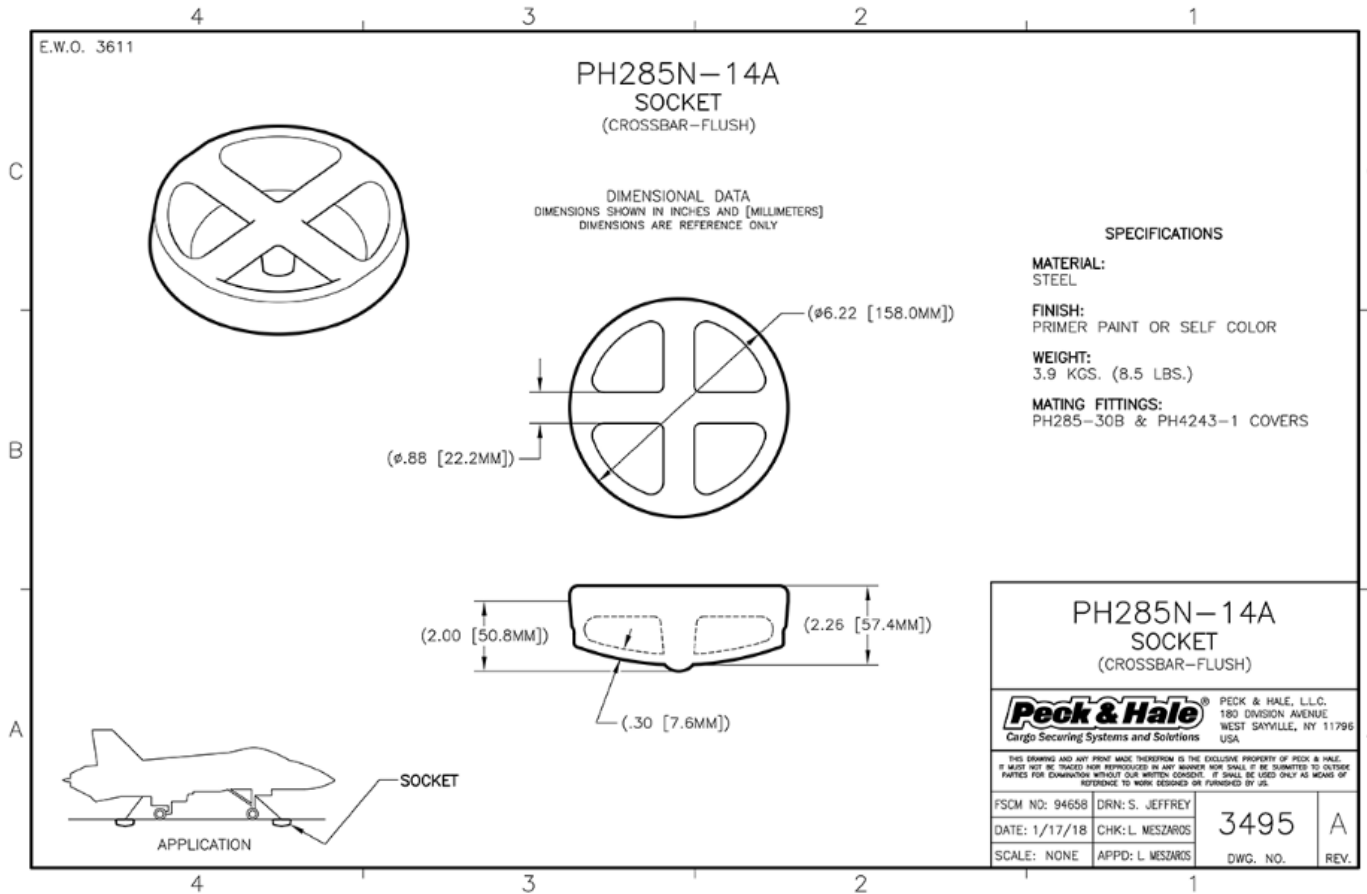
Source: <https://www.peckhale.com/gallery>



**Vehicle Lashing tie-downs**

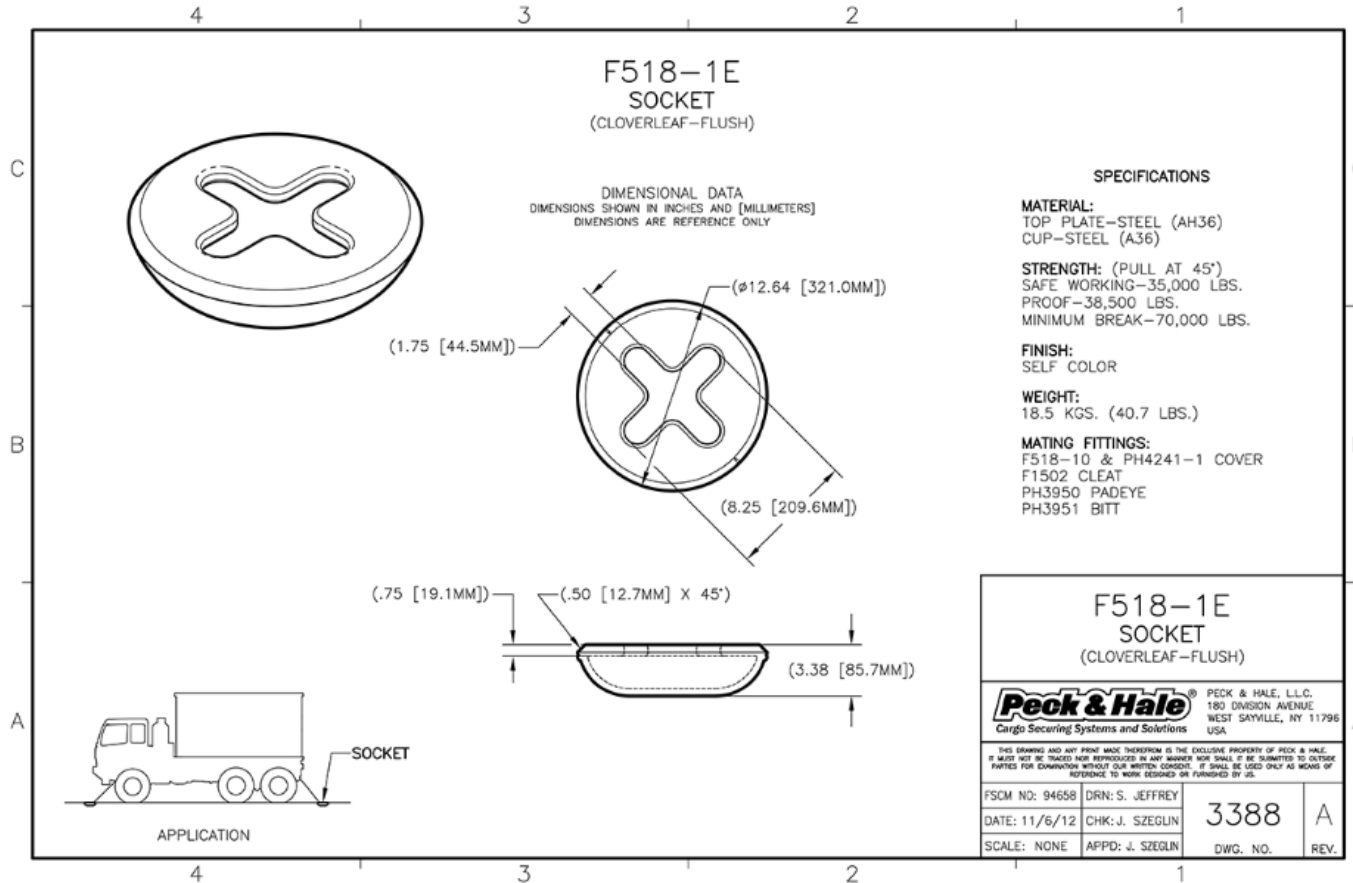
Source: <https://www.peckhale.com/gallery>

# Issue Description



**Example: Peck & Hale Aircraft Deck Socket**

# Issue Description



**Example: Peck & Hale Vehicle Lashing Deck Socket**

# Issue Description / Project Objective



- **Issue Description**

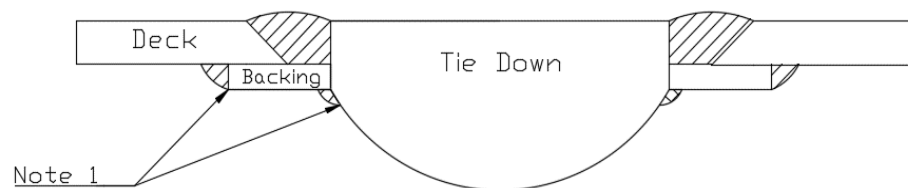
- All Navy ships currently built at Ingalls require the installation of aircraft tie-downs on the deck.
- The process begins with holes for the tie-downs cut utilizing CNC machines. The plate orientation starts out in the ship shape position where the aircraft tie-down is welded per Ingalls defined weld sequence.
- The plate is then flipped to the inverted position, back gouged to sound metal with a visual inspection performed followed by welding the back side to complete the 100% welded penetration.
- The panel is flipped to ship shape where magnetic particle inspection (MT) is performed, and the panel is flipped again to the inverted position to perform MT of the weld and allow for stiffener and/or bulkhead assembly.
- This is a labor-intensive process and if defects are found during the process the panel may have to be flipped several additional times for re-work and re-inspection.



# Issue Description / Project Objective

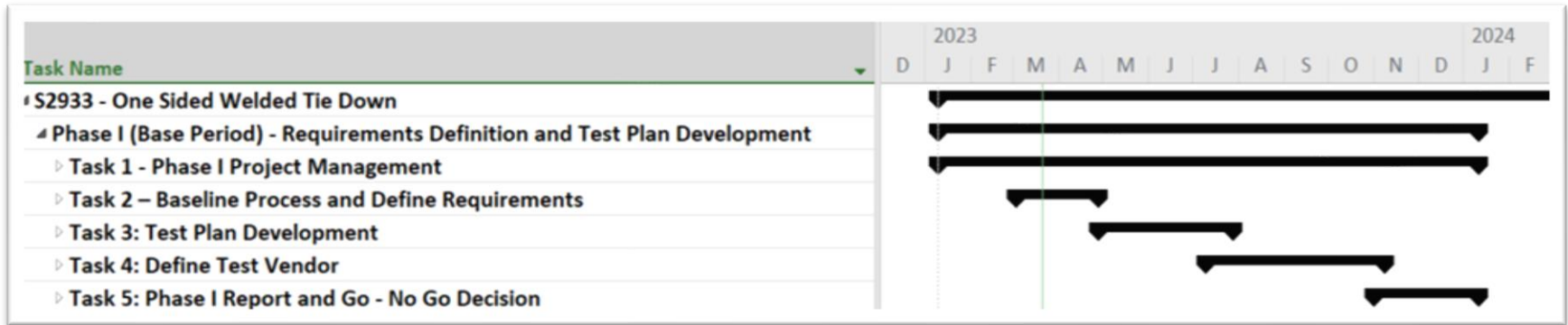
## • Project Objective

- The objective of this project is to increase efficiencies in the aircraft tie-down and vehicle lashing tie-down installation process by structurally welding the tie-downs from one side on DDG, LHA and LPD versus the current process of structurally welding the tie-downs from both sides.
  - The detail below shows the one-sided structural weld with a backing bar which will require a continuous fillet seal weld on the back side. This still alleviates the need to back gouge the weld on the opposite side of the tie-down as well as eliminate re-welding and MT inspection on the back side and flipping the panel.
- This project will focus on performing the required testing and obtaining NAVSEA tech warrant approval to weld and inspect aircraft and vehicle lashing tie-downs from one side with the use of a permanent backing bar.



Note 1  
Welds shall be in accordance with  
MIL-STD-22D Figure 1 and  
MIL-STD-1689A Paragraph 11.1

# High Level Schedule (Phase I) - Complete



- **Period of performance: 1/10/2023 – 1/10/2024 (12 Months)**
- **Latest Rev 9.0 on CNM SharePoint Site**

# Project Status / Issues



Task No.	Description	Last Presentation 8/15/24	This Presentation 2/27/25
1	Phase I Project Management	Complete	Complete
2	Baseline Process and Define Requirements	Complete	Complete
3	Test Plan Development	Complete	Complete
4	Define Test Vendor	Complete	Complete
5	Phase I Report and Go-No Go Decision	Complete	Complete
6	Phase II Project Management	In Process	In Process
7	Tie-Down Testing	In Process	In Process
8	Analyze Results		In Process
9	Final Reporting and Implementation Plan		



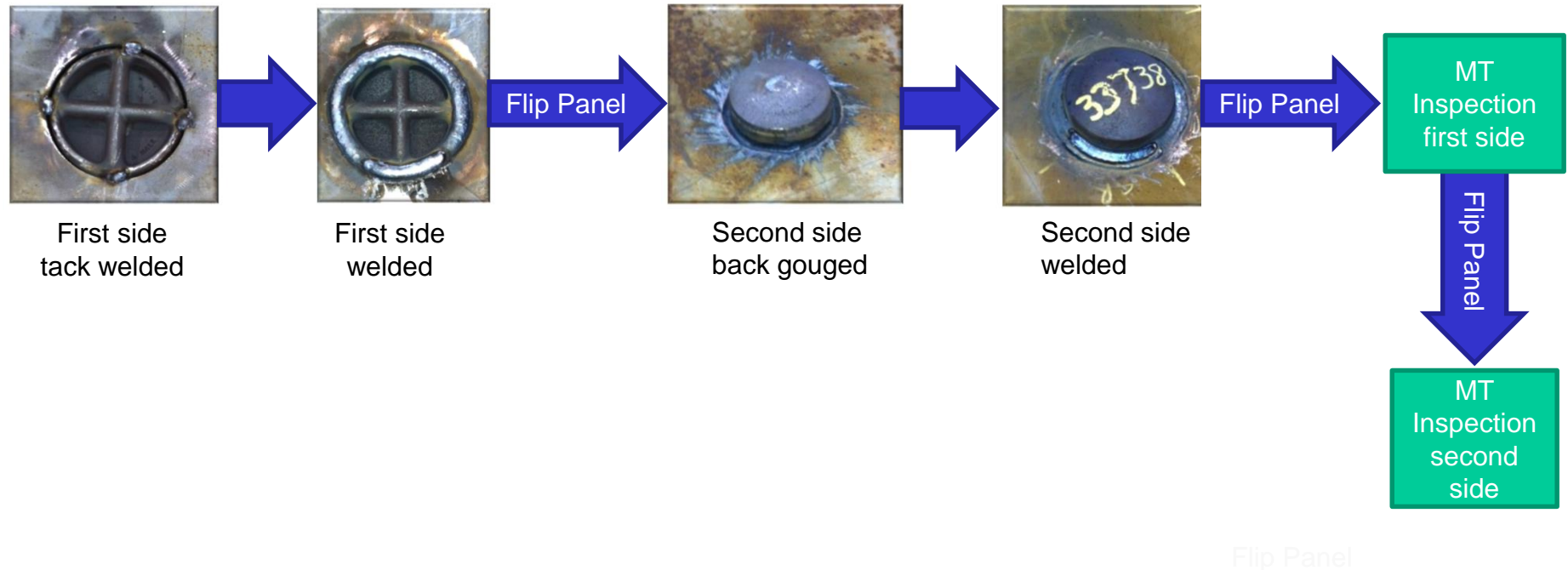
# Task 2 – Baseline Process and Define Requirements - Complete



- Subtask 2.1 – Baseline and Map Current Processes
  - Ingalls shall conduct a study of existing processes.
- Subtask 2.2 - Defined Technical Requirements
  - The procedural requirements were derived from the following documents:
  - NAVSEA Technical Publication 248, “Requirements for Welding and Brazing Procedure and Performance Qualification”
  - MIL-STD-1689A, “Department of Defense Manufacturing Process Standard: Fabrication, Welding, and Inspection of Ships Structures”
  - LHA Ship Specification Section 588
  - DDG Ship Specification Section 588
  - LPD Ship Specification Section 588
  - NAVSEA Drawing 803-1916300
  - Aircraft Securing System Static Load Test (Test no. 58821-2-002)

# Issue Description / Project Objective

## Tie-down Process (current)

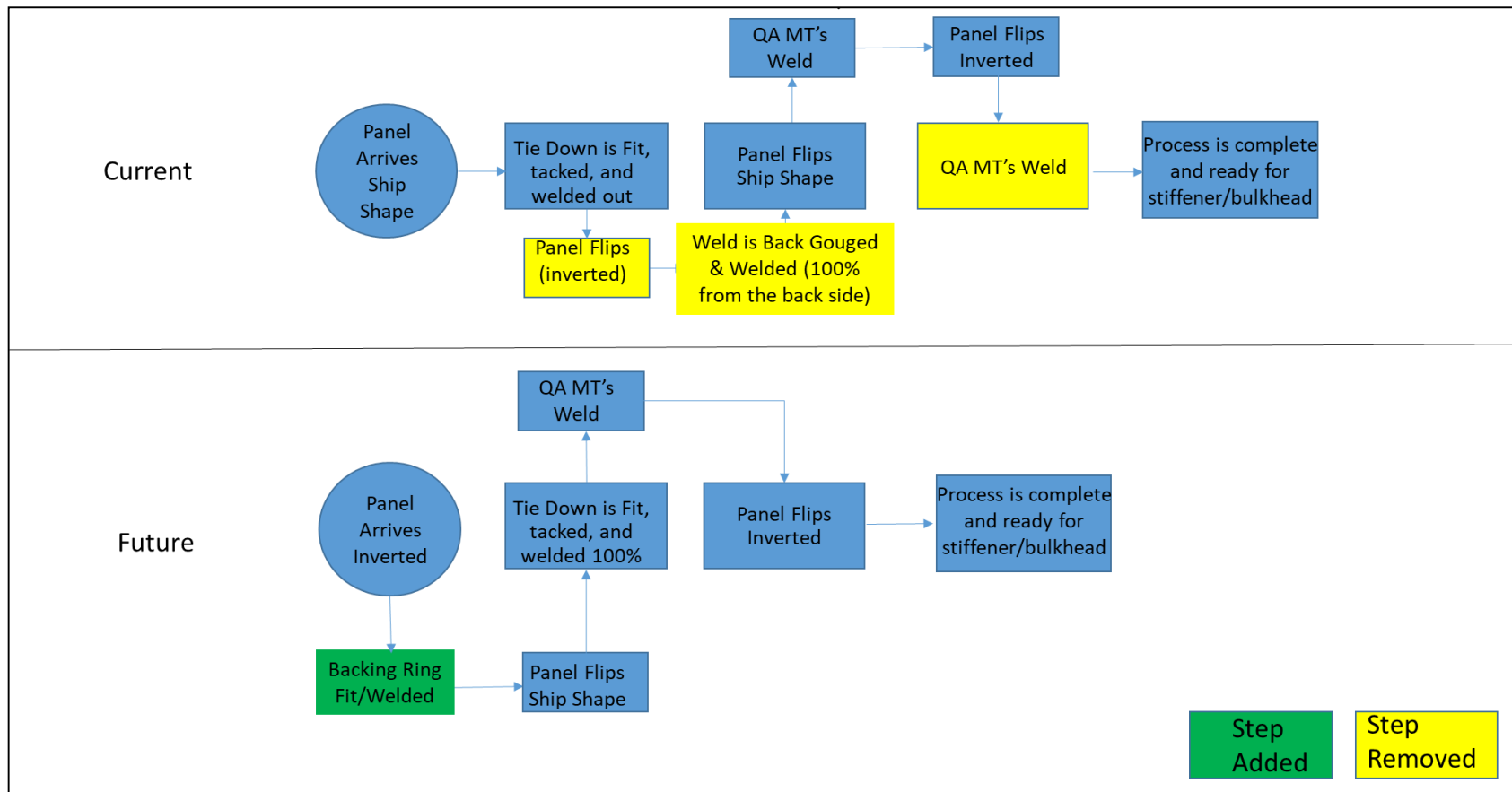


Flip Panel

# Task 2 – Baseline Process and Define Requirements - Complete



## Current / Future State Maps



# Task 2 – Baseline Process and Define Requirements - Complete



## Material Type and Weld Requirements

Material Requirements	
Material Type	S-1 and S-11 Steel
Material Size	1/4" to 1" thick
Fitting Requirements	
Cutting Type	Plasma or Oxy fuel
Joint Design	Weld B2(S) V.2 (Figure 2) (or alternatively C2V.2 as baseline and C1V.5 for modified joint with backing) shall be utilized for weld preparation
Welding Requirements	
Weld Type	FCAW, Weld B2V(S).2 (Figure 1) shall be utilized, with a permanent backing ring/ Full penetration, 100% efficient joints are required.
Filler Material	MIL-71T-1-HYD conforming to MIL-DTL-24403/1F shall be used
Inspection Requirements	
Weld Quality Criteria	Visual and MT inspection in accordance with Class III of MIL-STD-2035(A)

# Task 3 – Test Plan Development - Complete

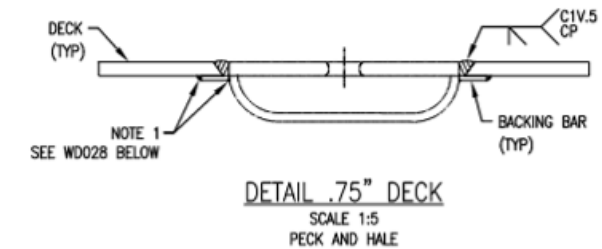
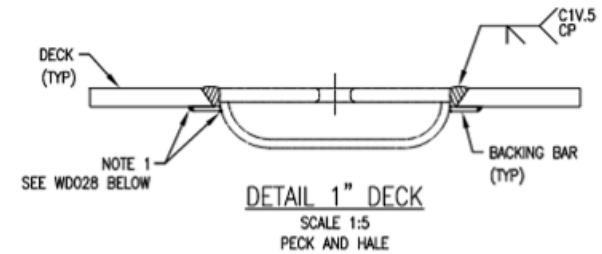
- Initial discussions with Tech Warrants provided draft test approach:
  - NSWCCD developed draft Modeling and Simulation plan for completing 2-D configurations of test matrix. (See chart). FEA work consisted of 2D runs of the Type XIV (with and without a backing bar and with different weld fusion lines assumed) to look at the information that would be seen out of the completed analysis and make sure it provided what was needed for the entire test matrix.
- A small quantity was down selected for 3D solid models to support decisions for physical testing and distribute plan to all stakeholders and TWHs for agreement on FEA plan. Was able to go directly to 3-D based on some initial 2D results
- Pull tests and inspection will be performed by Ingalls on all test articles fabricated
- Macrographs of the installation weld on the backing bar is required to document the root conditions that were typically present for of all the test series

Finite Element Analysis Matrix						
ID	Fitting Type	Configuration	Plate Thickness	Backing Fillet	Backing Fillet Size	
1	Aircraft Securing Fitting	Type XIV	Current	Min	N/A	N/A
2			Max	N/A	N/A	
3		Type XIV A	Current	Min	N/A	N/A
4				Max	N/A	N/A
5			Proposed	Min	No	N/A
6					Yes	Min
7					Yes	Max
8				Max	No	N/A
9					Yes	Min
10					Yes	Max
11	Vehicle Lashing Socket	Ingalls Fab	Current	Min	N/A	N/A
12				Max	N/A	N/A
13		Proposed	Min	No	N/A	
14				Yes	Min	
15				Yes	Max	
16			Max	No	N/A	
17				Yes	Min	
18				Yes	Max	
19		Vendor Fab	Current	Min	N/A	N/A
20				Max	N/A	N/A
21			Proposed	Min	No	N/A
22					Yes	Min
23	Yes				Max	
24	Max			No	N/A	
25				Yes	Min	
26				Yes	Max	

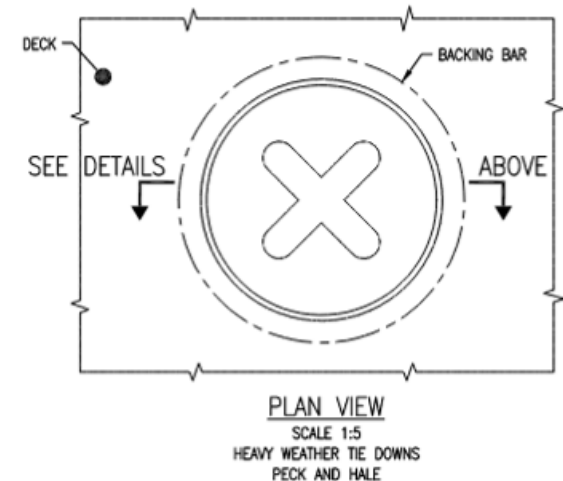
Table 1. Analysis Matrix

# Task 3 – Test Plan Development - Complete

- Ingalls/Tech Warrants/ NSWCCD reviewed feasibility of cutting the tie down cloverleaf in the deck and only welding the bowl in certain deck thicknesses/locations on vehicle lashing tie downs. This is done on T-AKE vehicle stowage tie-downs
- Reviewed feasibility with O5Z fitting Tech Warrants on range of acceptable HSLA-65 deck plating thicknesses from LPD and LHA where Ingalls could cut the fittings in the deck plate and eliminate those thicknesses from the backing bar matrix



Ingalls cut vehicle lashing tie down in 1" plate



# Task 3 – Test Plan Development - Complete



- Aircraft tie-down matrix – FEA determined what materials, thicknesses and quantities require physical testing

Aircraft Tie Downs								
Hull	Thickness	Material	Manufacturer	Tie Down Type	Weld Process	Filler Material	*Angle of Tie Down	Quantity
DDG	0.375"	HSLA 80	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	143
DDG	0.5"	HSLA 80	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	9
DDG	0.75"	HSLA 80	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	9
DDG	0.375"	HY 80	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	33
LPD	0.5"	HSLA 65	Peck and Hale	XIVA	FCAW	71T-1	longitudinal inline	708
LPD	.75"	HSLA 65	Peck and Hale	XIVA	FCAW	71T-1	longitudinal inline	104
LPD	1"	HSLA 65	Peck and Hale	XIVA	FCAW	71T-1	longitudinal inline	54
LPD	0.75"	HSLA 80	Peck and Hale	XIVA	FCAW	71T-1	longitudinal inline	64
LHA	0.25"	HSLA 65	PECK AND HALE	XIVA	FCAW	71T-1	longitudinal inline	28
LHA	0.28125"	HSLA 65	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	19
LHA	0.375"	HSLA 65	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	15
LHA	.5"	HSLA 65	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	713
LHA	0.75"	HSLA 65	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	1
LHA	0.25"	HSLA 100	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	20
LHA	0.375"	HSLA 100	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	182
LHA	.5625"	HSLA 100	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	1956
LHA	.75"	HSLA 100	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	456
LHA	.875"	HSLA 100	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	6
LHA	1"	HSLA 100	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	35
LHA	1.25"	HSLA 100	PEMCO	XIVA	FCAW	71T-1	longitudinal inline	2
<b>Total Quantity</b>								<b>4557</b>

\*Orientation with respect to ship longitudinal axis



# Task 3 – Test Plan Development - Complete



- Vehicle Lashing Tie-Down matrix – FEA determined what materials, thicknesses and quantities require physical testing

Vehicle Lashing Tie Downs								
Hull	Thickness	Material	Manufacturer	Tie Down Type	Weld Process	Filler Material	*Angle of Tie Down	Quantity
LHA	.5"	HSLA 65	FAB IN HOUSE	In Accordance with 0900-LP-000-100	FCAW	71T-1	45° to longitudinal	1217
LHA	.563"	HSLA 65	FAB IN HOUSE		FCAW	71T-1	45° to longitudinal	16
LHA	0.625	HSLA 65	FAB IN HOUSE		FCAW	71T-1	45° to longitudinal	18
LHA	.75"	HSLA 65	FAB IN HOUSE		FCAW	71T-1	45° to longitudinal	29
LHA	1"	HSLA 65	FAB IN HOUSE		FCAW	71T-1	45° to longitudinal	82
LPD	.3125"	HSLA 65	PECK AND HALE	F518-1 ABS_- _LR_GR-EH36	FCAW	71T-1	45° to longitudinal	427
LPD	.375"	HSLA 65	PECK AND HALE	F518-1 ABS_- _LR_GR-EH36	FCAW	71T-1	45° to longitudinal	404
LPD	.4375"	HSLA 65	PECK AND HALE	F518-1 ABS_- _LR_GR-EH36	FCAW	71T-1	45° to longitudinal	53
LPD	.5"	HSLA 65	PECK AND HALE	F518-1 ABS_- _LR_GR-EH36	FCAW	71T-1	45° to longitudinal	49
LPD	.5625"	HSLA 65	PECK AND HALE	F518-1 ABS_- _LR_GR-EH36	FCAW	71T-1	45° to longitudinal	53
LPD	0.625	HSLA 65	PECK AND HALE	F518-1 ABS_- _LR_GR-EH36	FCAW	71T-1	45° to longitudinal	3
LPD	1"	HSLA 65	PECK AND HALE	F518-1 ABS_- _LR_GR-EH36	FCAW	71T-1	45° to longitudinal	12
<b>Total Quantity</b>								<b>2363</b>

\*Orientation with respect to ship longitudinal axis

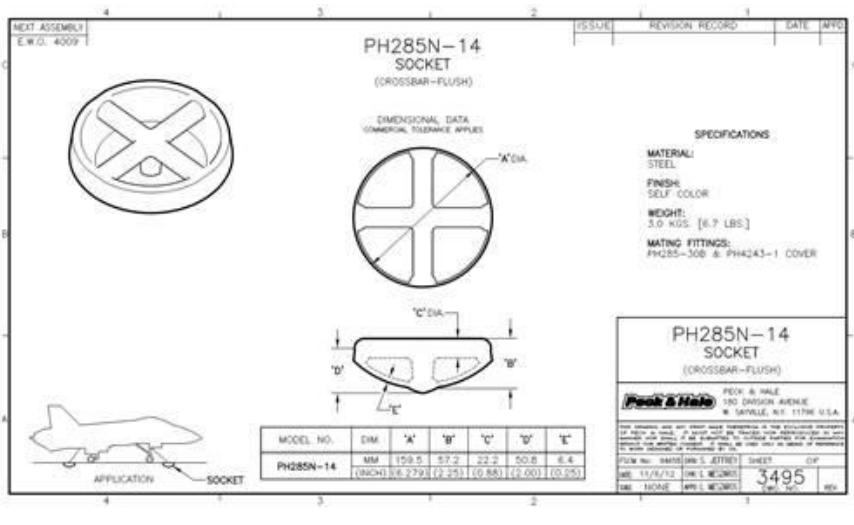




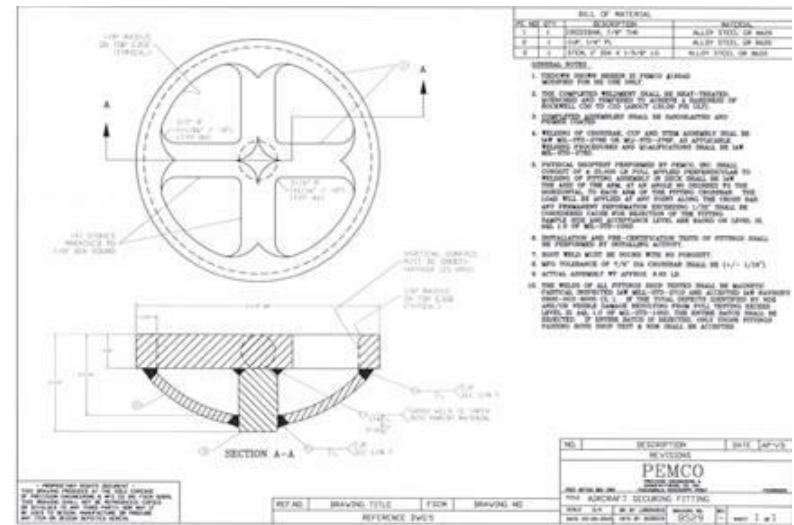
# Task 3 Test Plan Development - Complete



- Aircraft Tie-Down Testing
  - For the aircraft securing fitting pull tests the Test Plan has finalized the following aircraft fitting types
  - Type XIVA (PEMCO 8529) and XIVA (P&H 3495)



LPD Peck & Hale Dwg 3495



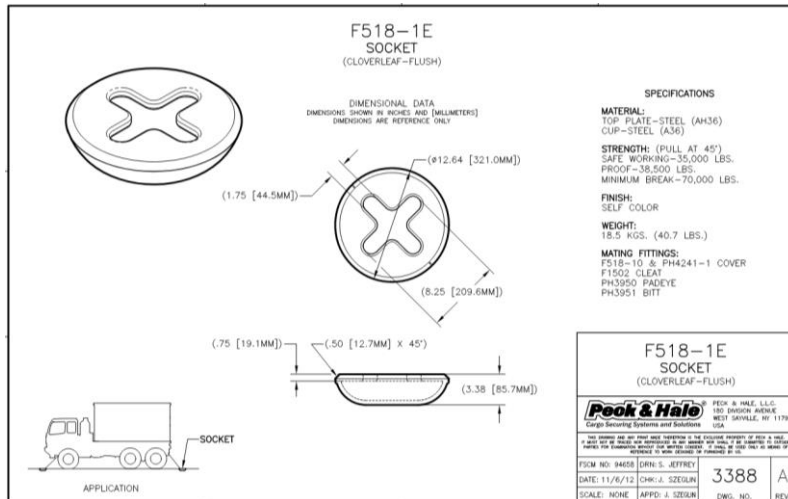
LHA PEMCO Dwg 8529



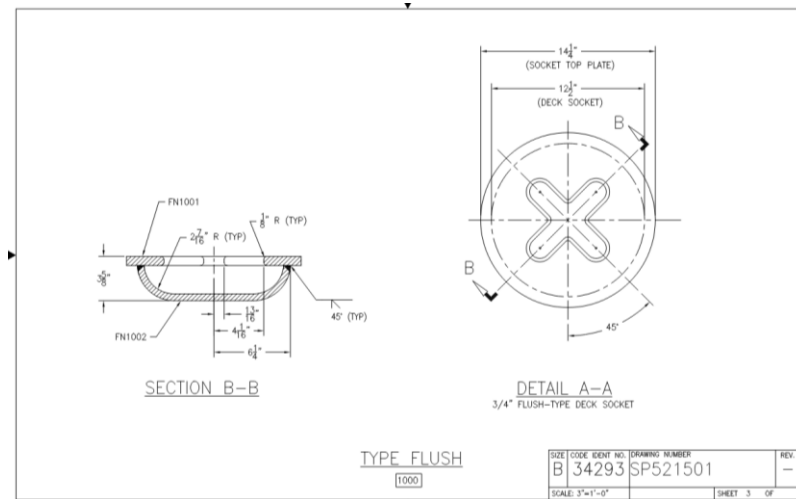
# Task 3 Test Plan Development - Complete



- Vehicle Lashing Tie-Downs for Testing
  - For the vehicle lashing fitting pull tests the Test Plan has finalized the following fitting types
  - Peck & Hale (3388) and Ingalls fabricated (SP521501)



LPD Peck & Hale



LHA Ingalls Fab



# Task 3 Test Plan Development - Complete



- Aircraft & Vehicle Lashing Tie-Down Strength Testing
  - Matrix of Pull Testing for Fittings with One-Sided Welds
    - The following test matrix provides the fitting type and quantity to be inspected with all applicable NDT and pull tests in accordance with NAVSEA Drawing 803-1916300 “Aircraft Securing and Engine Run-Up Fittings” and NAVSEA Drawing 804-1213717 “Vehicle Lashing Sockets”.
    - The intent of these tests are to show that use of the one-sided installation weld has no adverse impact on strength of the fitting that would prevent it from meeting the required load levels for qualification or installation test.

# Task 3 Test Plan Development - Complete



Table 1: Matrix of Pull Testing for Fittings with One-Sided Welds

Fitting Type	Qty	Deck Thickness	Deck Material	Test Type	Post Test Analysis
Type XIVA (PEMCO 8529 – LHA)	2	1/4”	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Type XIV (P&H 3495 – LPD)	2	1/4”	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Type XIVA (PEMCO 8529 – LHA)	2	1/4”	HSLA-100	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Type XIV (P&H 3495 – LPD)	2	1/4”	HSLA-100	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Vehicle Lashing (3/4”) – (P&H)	2	5/16”	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Vehicle Lashing (3/4”) – (Ingalls Fab)	2	5/16”	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)

# Task 3 Test Plan Development - Complete



- Vehicle Lashing Tie-Down Strength Testing
  - Matrix of Pull Testing for Vehicle Lashing Sockets Cut in Deck Plating
    - The following test matrix is intended to provide information on the testing to evaluate fit of the applicable vehicle securing chain assembly and the actual vehicle socket opening cut into the deck plate.
    - Additionally, for those thicknesses less than or equal to the  $\frac{3}{4}$ " (DH-36 or EH-36 material grade) standard socket thickness a pull test is planned to provide information on establishing the equivalent (lowest) thickness HSLA-65 material that could be considered to allow cutting of the fittings within the deck in lieu of inserting the standard fittings that use  $\frac{3}{4}$ " 51-ksi yield strength DH-36 plate.

# Task 3 Test Plan Development - Complete



Table 2: Matrix of Pull Testing for Vehicle Lashing Sockets Cut in Deck Plating

Fitting Type	Qty	Deck Thickness	Deck Material	Test Type	Post Test Analysis
Vehicle Lashing (HSLA-65 Deck)	2	1"	HSLA-65	Includes fitting check for tie-down interface, given increased deck plate thickness (+1/4") over standard	Includes fitting check for tie-down interface, given increased deck plate thickness (+1/4") over standard
Vehicle Lashing (HSLA-65 Deck)	2	0.75"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 3)	Validates 3/4" HSLA-65 as equal or better than 3/4" DH-36 of Standard Drawing
Vehicle Lashing (HSLA-65 Deck)	2	0.625"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 3)	Includes fitting check for tie-down interface, given reduced deck plate thickness (-1/8") below standard
Vehicle Lashing (HSLA-65 Deck)	2	0.5"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 3)	Includes fitting check for tie-down interface, given reduced deck plate thickness (-1/4") below standard

# Task 3 Test Plan Development - Complete



- Task 3: Fatigue Testing
  - To determine the fatigue strength of the one-sided installation weld of the fittings, uni-axial constant amplitude fatigue testing using fully reversed loading ( $R=-1$ ) and tested to specimen failure or until axial compliance of the specimen doubles, will be performed per the following test matrix for 16 specimens comprised of the aircraft securing fitting Type XIVA of reference “PEMCO Drawing 8529 – Type XIVA Aircraft Securing Fitting” welded to the deck plate from one side only.
  - The permanent backing bar will be fillet welded to provide a complete seal and to provide a flush extension of the backing bar to fitting.

# Task 3 Test Plan Development - Complete



Table 3: Matrix of Fatigue Testing for Fittings with One-Sided Welds

<b>Fitting Type</b>	<b>Qty</b>	<b>Deck Thickness</b>	<b>Deck Material</b>	<b>Test Type</b>	<b>Post Test Analysis</b>
Type XIVA (PEMCO 8529 – LHA)	16	9/16"	HSLA-65	NDT per Standard Drawing Fatigue Testing - In-plane loads	Macro of backing bar weld - Quarter points* - 2 of 16

\* If specific fatigue cracking initiation sites warrant detailed review after testing, macros may be shifted accordingly.



# Task 4 Define Test Vendor - Complete



- Ingalls submitted RFP to potential vendors
  - The University of Texas at Austin was selected as the vendor to perform fatigue testing
    - The University of Texas has performed and is currently performing structural testing on another ManTech project with Ingalls

# Task 5 Phase I Report and Go/No-Go Decision - Complete



- Subtask 5.1: Business Case Analysis
  - The Interim Business Case Analysis D#7 was submitted on 12/6/23
- Subtask 5.2: Go/No-Go Assessment
  - The Go/No-Go Assessment D#8 was held on 12/14/23, with a Go decision made to proceed to Phase II
- Subtask 5.3: Phase I Report
  - The Phase I Report D#9 was submitted 12/18/23
- Subtask 5.4: Phase I Review
  - Phase I Review was held on 12/14/23

# High Level Schedule (Phase II)



Task Name	% Compl	Duration	Start	Finish	2024					2025				
					N	J	M	M	J	S	N	J	M	M
▲ Phase II: One Sided Welded Tie Down Testing and Functionality Demonstration	66%	308d	Thu 1/11/24	Mon 3/17/25	[Gantt bar spanning from Jan 11, 2024 to Mar 17, 2025]									
▷ Task 6: Phase II Project Management	86%	140d	Thu 1/11/24	Wed 7/24/24	[Gantt bar spanning from Jan 11, 2024 to Jul 24, 2024]									
▲ Task 7: Tie Down Testing	81%	208d	Thu 1/11/24	Mon 10/28/24	[Gantt bar spanning from Jan 11, 2024 to Oct 28, 2024]									
▷ Subtask 7.1: Test Article Design	100%	10d	Thu 1/11/24	Wed 1/24/24	[Gantt bar spanning from Jan 11, 2024 to Jan 24, 2024]									
▷ Subtask 7.2: Build Test Articles	100%	100d	Thu 1/25/24	Wed 6/12/24	[Gantt bar spanning from Jan 25, 2024 to Jun 12, 2024]									
▷ Subtask 7.3: Testing	63%	107d	Fri 5/31/24	Mon 10/28/24	[Gantt bar spanning from May 31, 2024 to Oct 28, 2024]									
▲ Task 8: Analyze Results	0%	26d	Tue 10/29/24	Tue 12/3/24	[Gantt bar spanning from Oct 29, 2024 to Dec 3, 2024]									
▷ Subtask 8.1: Post Test Analysis	0%	15d	Tue 10/29/24	Mon 11/18/24	[Gantt bar spanning from Oct 29, 2024 to Nov 18, 2024]									
▷ Subtask 8.2: Final Test Report	0%	11d	Tue 11/19/24	Tue 12/3/24	[Gantt bar spanning from Nov 19, 2024 to Dec 3, 2024]									
▲ Task 9: Final Reporting and Implementation Plan	0%	100d	Tue 10/29/24	Mon 3/17/25	[Gantt bar spanning from Oct 29, 2024 to Mar 17, 2025]									
▷ Subtask 9.1: Final Business Case	0%	20d	Tue 10/29/24	Mon 11/25/24	[Gantt bar spanning from Oct 29, 2024 to Nov 25, 2024]									
▷ Subtask 9.2: Implementation plan	0%	25d	Tue 11/26/24	Mon 12/30/24	[Gantt bar spanning from Nov 26, 2024 to Dec 30, 2024]									
▷ Subtask 9.3: Final report	0%	55d	Tue 12/31/24	Mon 3/17/25	[Gantt bar spanning from Dec 31, 2024 to Mar 17, 2025]									
▷ Subtask 9.4: Final review	0%	26d	Tue 12/31/24	Tue 2/4/25	[Gantt bar spanning from Dec 31, 2024 to Feb 4, 2025]									
▷ Subtask 9.5: Deliver and Disposition Custom Equipment	0%	6d	Wed 12/4/24	Wed 12/11/24	[Gantt bar spanning from Dec 4, 2024 to Dec 11, 2024]									

**Period of performance: 1/11/2024 – 3/10/2025 (14 Months)\***

\* A no-cost extension has been requested through 11/3/25 to allow the team time to complete analysis of the test data and develop final recommendations and reporting.



# Task 7 Tie-Down Testing

- Task 7.1: Test Article Design - Complete
- Task 7.2 Build Test Articles – Complete
  - 16 Fatigue specimens completed fabrication and were shipped to U of TX
  - 12 Aircraft and Vehicle lashing tie downs completed fabrication
  - 8 Vehicle lashing tie downs cut in deck plate completed fabrication



# Task 7 Tie-Down Testing – Complete

- Task 7.3: Testing

- Table 1: Matrix of Pull Testing for Fittings with One-Sided Welds

Fitting Type	Qty	Deck Thickness	Deck Material	Test Type	Post Test Analysis
Type XIVA* (PEMCO 8529 – LHA)	2	1/4"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Type XIVA* (P&H 3495 – LPD)	2	1/4"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Type XIVA* (PEMCO 8529 – LHA)	2	1/4"	HSLA-100	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Type XIVA* (P&H 3495 – LPD)	2	1/4"	HSLA-100	Pull Test and NDT per Standard Drawing (Test Note 6 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Vehicle Lashing * * (3/4") – (P&H)	2	5/16"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)
Vehicle Lashing * * (3/4") – (Ingalls Fab)	2	5/16"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 2)	Macro of backing bar weld - Quarter points – All (Post Pull Test and NDT)

\* Using test hook, apply a vertical pull of 32KIPS equally divided between two non-adjacent crossbar arms

- First pull. 1min to stabilize test rig.
- Second pull. 3min and release. No permanent deformation greater than 0.03"
- Repeat first and second pull on remaining crossbars.

\*\* Using a lashing bulb hook, apply a 45-degree pull to each cavity of the fitting.

- First pull. 35KIPS 1min to stabilize test rig. No cracking or permanent deformation greater than 0.015"
- Second pull. 70KIPS 5min. Fitting shall not crack, and the bulb shall not pull out of cavity. Permanent deformation is permitted.
- Repeat first and second pull on remaining deck socket cavities.

# Task 7 Tie-Down Testing – In Work

- Task 7.3: Testing
  - Pull Testing of Aircraft & Vehicle Lashing Tie Downs Complete

Fitting Type	Deck Thickness	Deck Mat.	Part #	MT Test	Pull Test	MT Test	Macro.
Type XIVA* (PEMCO 8529 – LHA)	1/4"	HSLA-65	1	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Type XIVA* (PEMCO 8529 – LHA)	1/4"	HSLA-65	2	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Type XIV* (P&H 3495 – LPD)	1/4"	HSLA-65	1	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Type XIV* (P&H 3495 – LPD)	1/4"	HSLA-65	2	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Type XIVA* (PEMCO 8529 – LHA)	1/4"	HSLA-100	1	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Type XIVA* (PEMCO 8529 – LHA)	1/4"	HSLA-100	2	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Type XIV* (P&H 3495 – LPD)	1/4"	HSLA-100	1	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Type XIV* (P&H 3495 – LPD)	1/4"	HSLA-100	2	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Vehicle Lashing **(3/4") – (P&H)	5/16"	HSLA-65	1	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Vehicle Lashing **(3/4") – (P&H)	5/16"	HSLA-65	2	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Vehicle Lashing **(3/4") – (Ingalls Fab)	5/16"	HSLA-65	1	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail
Vehicle Lashing **(3/4") – (Ingalls Fab)	5/16"	HSLA-65	2	Pass	Pass	Pass	Pass
				Fail	Fail	Fail	Fail

# Task 7 Tie-Down Testing – Complete



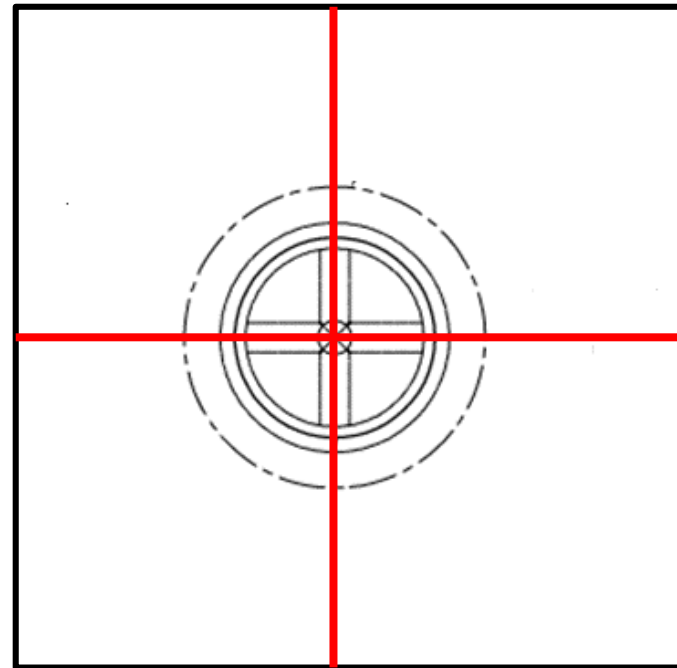
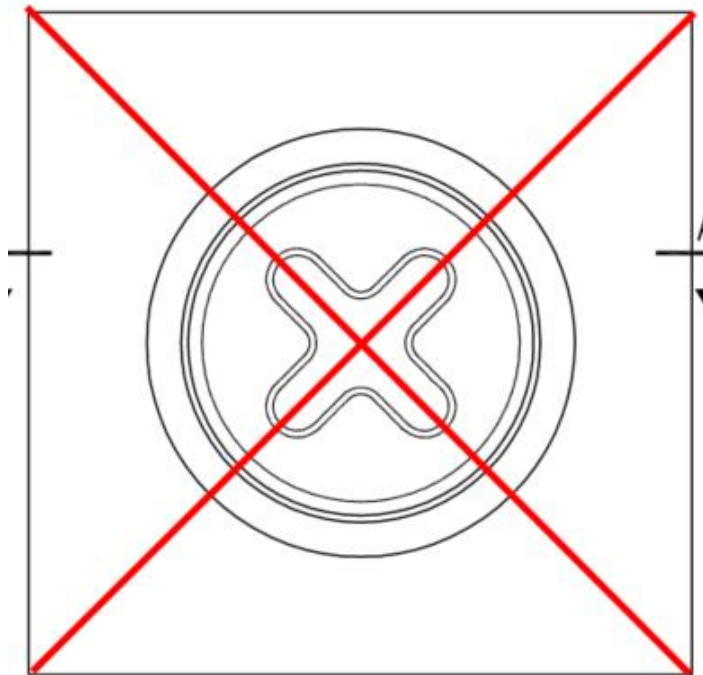
- Task 7.3: Testing
  - Pull Testing of Aircraft & Vehicle Lashing Tie- Down Deflection Data after pull test
  - Max deflection of Type XIVA Aircraft Tie-Downs was 0.003” (max allowable from test plan is 0.03”)
  - Max deflection of Vehicle Lashing Tie Downs was 0.013” (max allowable from test plan is 0.015”)

Table 1. Matrix of Pull Testing			
Fittings with One-Sided Welds			
Type	Thickness	Material	Deflection
Pemco LHA	1/4"	HSLA-65	0.0003"
Pemco LHA	1/4"	HSLA-65	0.0000"
P&H LPD	1/4"	HSLA-65	0.0000"
P&H LPD	1/4"	HSLA-65	0.0000"
Pemco LHA	1/4"	HSLA-100	0.0000"
Pemco LHA	1/4"	HSLA-100	0.0000"
P&H LPD	1/4"	HSLA-100	0.0000"
P&H LPD	1/4"	HSLA-100	0.0000"
Ingalls Vehicle Lashing Socket			
Tie Down	Cavity	Material	Deflection
1	1	5/16" HSLA 65	0.013"
	2		0.003"
	3		0.002"
	4		0.005"
2	1	5/16" HSLA 65	0.003"
	2		0.003"
	3		0.005"
	4		0.009"
Peck and Hale Vehicle Lashing Socket			
Tie Down	Cavity	Material	Deflection
1	1	5/16" HSLA 65	0.002"
	2		0.007"
	3		0.003"
	4		0.004"
2	1	5/16" HSLA 65	0.000"
	2		0.005"
	3		0.000"
	4		0.001"



# Task 7 Tie-Down Testing – Complete

- Task 7.3: Testing
  - The tie-down specimens have been cut as shown below to provide macros that show the full extent of the backing bar, the seal welds of the backing and the entire thickness of the weldment. Documentation of macros are in work.





# Task 7 Tie-Down Testing – Complete

- Task 7.3: Testing

- Table 2: Matrix of Pull Testing for Vehicle Lashing Sockets Cut in Deck Plating

Fitting Type	Qty	Deck Thickness	Deck Material	Test Type	Post Test Analysis
Vehicle Lashing (HSLA-65 Deck) *	2	1"	HSLA-65	Includes fitting check for tie down interface, given increased deck plate thickness (+1/4") over standard	Includes fitting check for tie down interface, given increased deck plate thickness (+1/4") over standard
Vehicle Lashing (HSLA-65 Deck) *	2	0.75"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 3)	Validates 3/4" HSLA-65 as equal or better than 3/4" DH-36 of Standard Drawing
Vehicle Lashing (HSLA-65 Deck) *	2	0.625"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 3)	Includes fitting check for tie down interface, given reduced deck plate thickness (-1/8") below standard
Vehicle Lashing (HSLA-65 Deck) **	2	0.5"	HSLA-65	Pull Test and NDT per Standard Drawing (Test Note 1 – Figure 3)	Includes fitting check for tie down interface, given reduced deck plate thickness (-1/4") below standard
<p>* Using a lashing bulb hook, apply a 45-degree pull to each cavity of the fitting.</p> <ul style="list-style-type: none"> <li>– First pull. 35KIPS 1min to stabilize test rig. No cracking or permanent deformation greater than 0.015"</li> <li>– Second pull. 70KIPS 5min. Fitting shall not crack, and the bulb shall not pull out of cavity. Permanent deformation is permitted.</li> <li>– Repeat first and second pull on remaining deck socket cavities.</li> </ul>					



# Task 7 Tie-Down Testing – Complete



- Task 7.3: Testing
  - Test Status of Pull Testing for Vehicle Lashing Tie Downs Cut in Deck

Fitting Type	Deck Thickness	Deck&B Mat.	Part #	VT Test		Pull Test		VT Test	
Vehicle Lashing	1"	HSLA-65	1	Pass	Fail	Pass	Fail	Pass	Fail
Vehicle Lashing	1"	HSLA-65	2	Pass	Fail	Pass	Fail	Pass	Fail
Vehicle Lashing	0.75"	HSLA-65	1	Pass	Fail	Pass	Fail	Pass	Fail
Vehicle Lashing	0.75"	HSLA-65	2	Pass	Fail	Pass	Fail	Pass	Fail
Vehicle Lashing	0.625"	HSLA-65	1	Pass	Fail	Pass	Fail	Pass	Fail
Vehicle Lashing	0.625"	HSLA-65	2	Pass	Fail	Pass	Fail	Pass	Fail
Vehicle Lashing	0.5"	HSLA-65	1	Pass	Fail	Pass	Fail	Pass	Fail
Vehicle Lashing	0.5"	HSLA-65	2	Pass	Fail	Pass	Fail	Pass	Fail

# Task 7 Tie-Down Testing – Complete



- Task 7.3: Testing
  - Pull Testing of Vehicle Lashing Tie Downs Cut in Deck Deflection Data after pull test
  - Max deflection of Vehicle Lashing Tie Downs cut in deck was 0.002” (max allowable from test plan is 0.015”)
  - Max deflection of Vehicle Lashing Tie Downs cut in 1/2” thick deck was 0.128” (max allowable from test plan is 0.015”)

Vehicle Lashing Cut in Deck			
Thickness	Tie Down	Cavity	Deflection
1" HSLA-65	1	1	0.000"
		2	0.000"
		3	0.000"
		4	0.000"
	2	1	0.000"
		2	0.000"
		3	0.001"
		4	0.001"
3/4" HSLA-65	1	1	0.000"
		2	0.001"
		3	0.000"
		4	0.000"
	2	1	0.000"
		2	0.000"
		3	0.000"
		4	0.000"
5/8" HSLA-65	1	1	0.000"
		2	0.001"
		3	0.000"
		4	0.000"
	2	1	0.000"
		2	0.000"
		3	0.001"
		4	0.001"
1/2" HSLA 65	1	1	0.044"
		2	0.050"
		3	0.051"
		4	0.044"
	2	1	0.080"
		2	0.048"
		3	0.128"
		4	0.044"



# Task 7 Tie-Down Testing – Complete



- Task 7.3: Testing
  - Table 3: Matrix of Fatigue Testing for Fittings with One-Sided Welds

<b>Fitting Type</b>	<b>Qty</b>	<b>Deck Thickness</b>	<b>Deck Material</b>	<b>Test Type</b>	<b>Post Test Analysis</b>
Type XIVA (PEMCO 8529 – LHA)	16	9/16"	HSLA-65	NDT per Standard Drawing Fatigue Testing - In-plane loads	Macro of backing bar weld - Quarter points* - 2 of 16

# Task 7 Tie-Down Testing – Complete

- Task 7.3: Testing
  - Fatigue Testing for Fittings with One-Sided Welds

Test Loads				
Area (9/16" x 12")	Stress Range (ksi)	Stress Amplitude (ksi)	Load Range (x1000 lbs)	Load Amplitude (x1000 lbs)
6.75	25.00	12.50	168.75	84.38
6.75	35.00	17.50	236.25	118.13
6.75	45.00	22.50	303.75	151.88
6.75	60.00	30.00	405.00	202.50



# Task 7 Tie-Down Testing – Complete

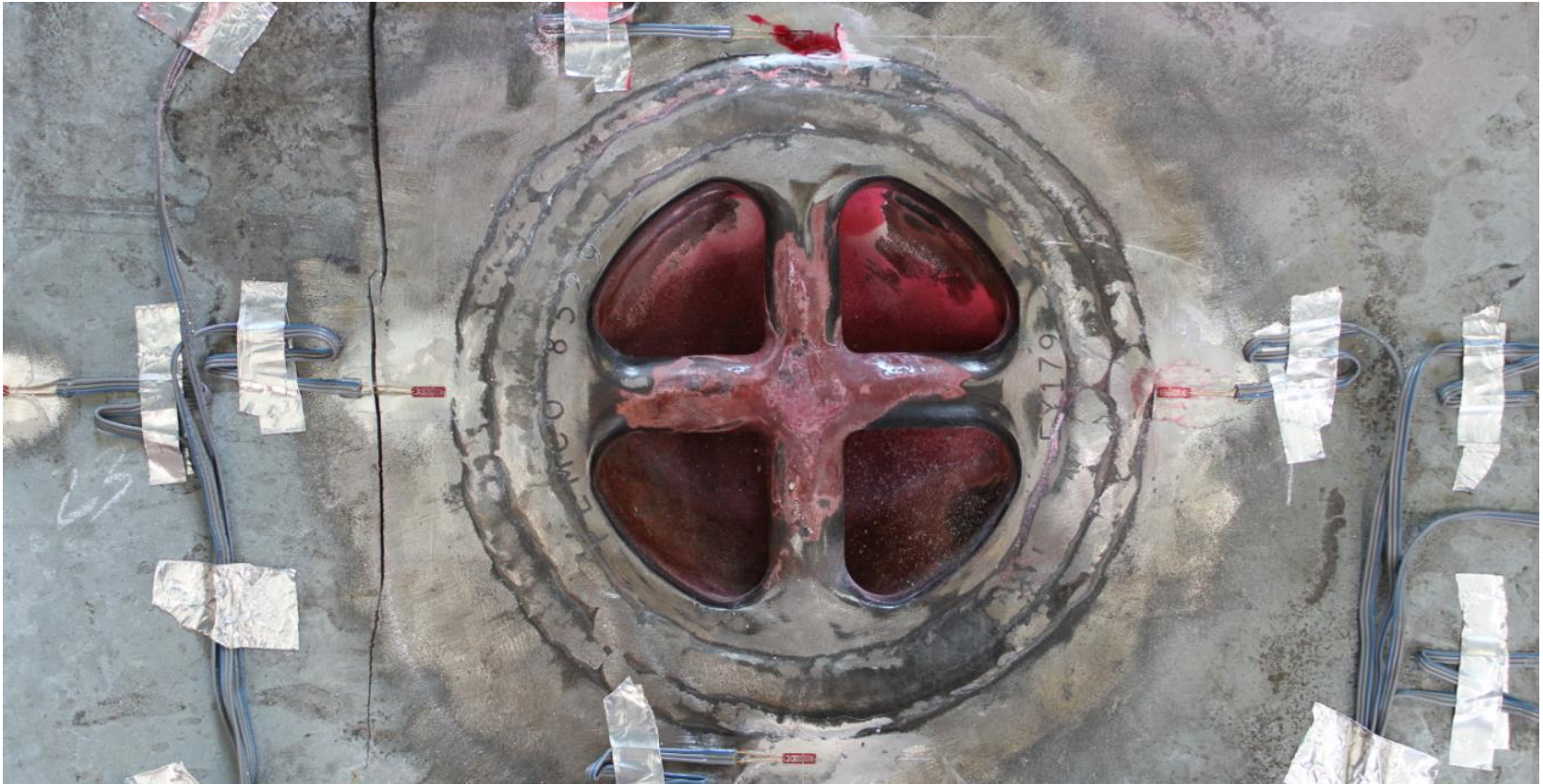


- Task 7.3: Testing
  - Fatigue Testing Status at the University of Texas

Specimen	Cycles at Failure	Fracture Location
25KSI_1	724772	Tie Down
25KSI_2	626516	BB Weld Toe
25KSI_3	787453	BB Weld Toe
25KSI_4	1477374	Plate Edge and Tie Down
35KSI_1	107674	Tie Down
35KSI_2	318818	Tie Down
35KSI_3	331808	Tie Down
35KSI_4	118213	Tie Down
45KSI_1	34047	Tie Down
45KSI_2	33667	Tie Down
45KSI_3	40204	Tie Down
45KSI_4	54779	Tie Down
60KSI_1	10560	BB Weld Toe
60KSI_2	15485	Tie Down
60KSI_3	25524	BB Weld Toe
60KSI_4	25281	BB Weld Toe

# Task 7 Tie-Down Testing – Complete

TEST#2 – 25KSI STRESS RANGE  
626,516 Total Cycles



# Task 7 Tie-Down Testing – Complete

TEST#4 – 25KSI STRESS RANGE  
1,477,374 Total Cycles





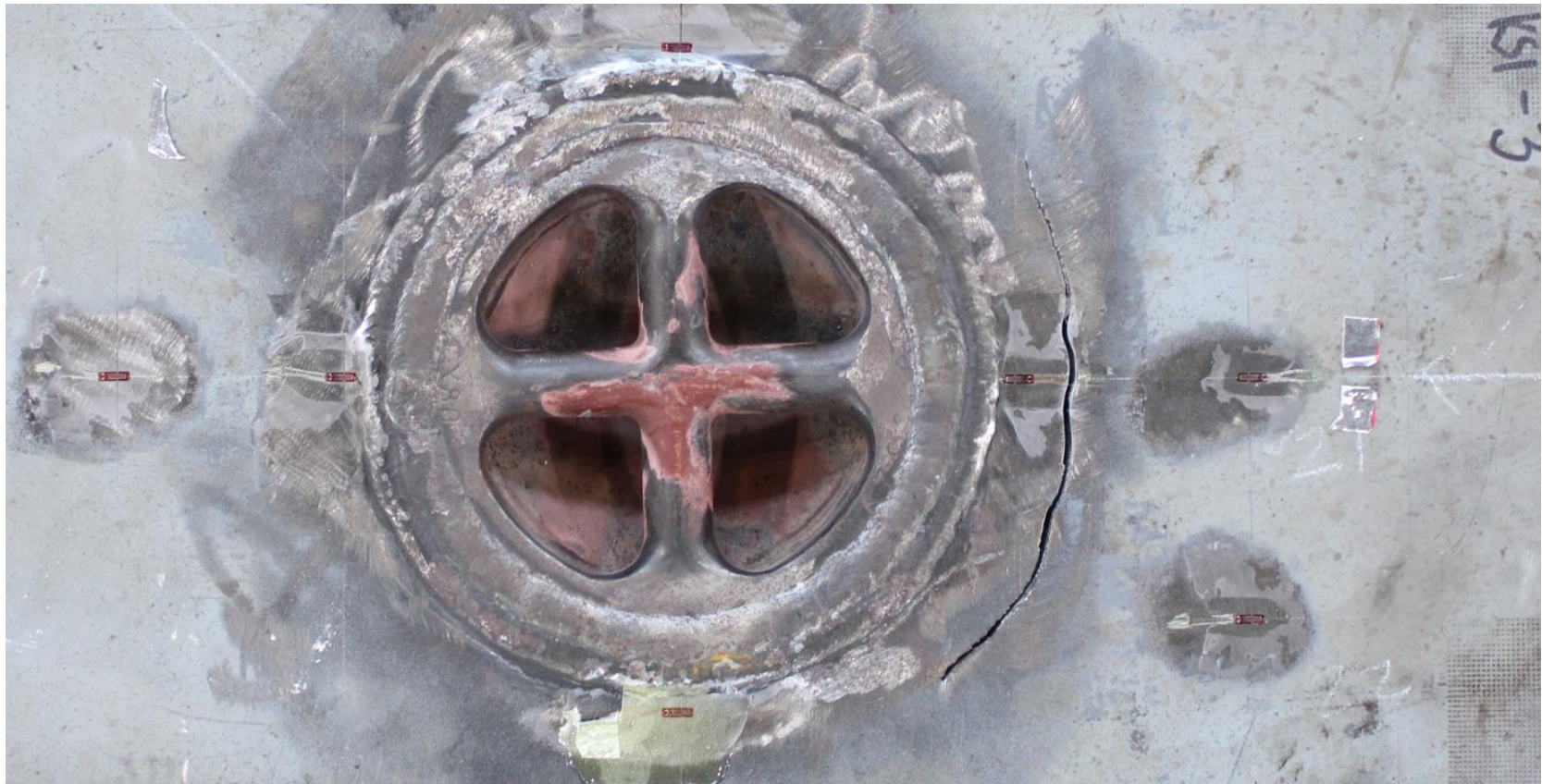
# Task 7 Tie-Down Testing – Complete

TEST#3 – 35KSI STRESS RANGE  
331,808 Total Cycles



# Task 7 Tie-Down Testing – Complete

TEST#1 – 60KSI STRESS RANGE  
10,560 Total Cycles



# Near-Term Activities



- Near-Term Milestones to be Addressed
  - Complete pull test and inspection of 9/16” plate for vehicle lashing tie-downs cut in deck plate
  - Update engineering product to reflect new installation methods
- Technical Progress to be Accomplished
  - Analyze fatigue test data and review macros of tie down pull tests with Navy Tech Warrants