



# TEST REPORT

January 19, 2018
GT-17-261
Revision 2
Page 1 of 54

# GT-17-261

## Qualification of ThermaRex 300°C Helical Polymer Conduit

Revision	Description of Changes	Date	Author
1	Initial Release	12/11/2017	Sam Farhat
2	Revised report from NTS showing corrected number of flex cycles	1/19/2018	Sam Farhat



# TEST REPORT

January 19, 2018
GT-17-261
Revision 2
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## 1. Scope

This test report summarizes the results of qualification testing on 120-159-1-1-16C ThermaRex helical polymer conduit at temperatures up to 300°C. The polymer conduit was tested without braid or jacketing. Testing was modeled after AS81914/9B and modified to include higher temperature testing of the unique ThermaRex conduit material.

## 2. Summary of Results

Test	Description	AS81914 Test Section	Results	
Examination of Product	Wall thickness	4.6.1	.018 inch	Pass
Stress in PSI @ 10% Strain	250 to 900 psi	4.7.2	323 psi	Pass
Crush Resistance, Horizontal	10 pounds minimum	4.7.4	23.83 lbs.	Pass
Low Temperature Flex at -54°C	Report number of cycles to break, 15 cycles per minute, 360° per cycle	4.7.5	750 cycles	Pass
Low Temperature Flex at -54°C After 216 Hours at 300°C	Report number of cycles to break, 15 cycles per minute, 360° per cycle	4.7.5	1,250 cycles	Pass
Minimum Bend Radius	1.25 inch minimum bend radius, less than 3 lbs force	4.7.1.3	1.95 lbs.	Pass
Heat Shock	300°C ± 3°C for 4 hours, 15% max longitudinal change	4.7.6	3.13%	Pass
Heat Aging	96 hours at 300°C ± 3°C, Stress in PSI @ 10% strain, 80% of initial value	4.7.7	352 psi	Pass
Dielectric Breakdown	DWV, 12 kv DC minimum	4.7.11	12.5 kV DC	Pass

## 3. Conclusion

ThermaRex helical polymer conduit shows outstanding resistance to high temperatures up to 300°C while maintaining mechanical strength and dielectric properties.



National Technical Systems  
1536 East Valencia Drive  
Fullerton, California 92831

Main: 714-879-6110  
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**REVISION 1**

January 17, 2018

Glenair Inc  
1333 Air Way  
Glendale, California 91201

**Purchase Order Number: P172615**

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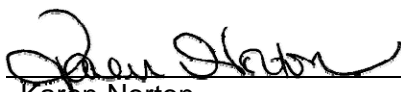
- A. TESTS: Tensile Strain Properties, Crush Resistance, Minimum Bend Radius, Heat Aging, Heat Shock, Dielectric Breakdown, and Low Temperature Flex
- B. TEST ITEMS: 26 Helical Convoluted Tubing Samples  
See Page 3 for Test Item Identification
- C. SPECIFICATIONS:
1. Glenair QTP-646, Revision 1, Paragraph 4
  2. SAE Aerospace Document No. AS81914, Issued 2011-01, Paragraphs 4.7.1.3, 4.7.2, 4.7.4, 4.7.5, 4.7.6, 4.7.7, and 4.7.11
  3. Glenair e-mail dated 10/6/17
  4. ANSI NCSL Z540-1
  5. ISO 17025:2005

D. RESULTS:

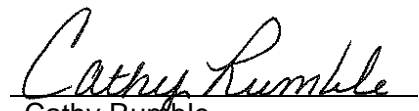
This is to certify that the Helical Convoluted Tubing Samples were subjected to the tests listed on Page 3 according to the above specifications.

See Page 4 for a Summary of Test Results. The Helical Convoluted Tubing Samples were returned to Glenair for post tests and final evaluation.

Test data, equipment lists, and photographs are attached.

  
Karen Norton,  
Preparer

  
Marty McCormick,  
Program Manager

  
Cathy Rumble,  
Quality Coordinator



**REVISIONS**

<b>Revision</b>	<b>Reason for Revision</b>	<b>Date</b>
NR	Initial Release	9/28/2017
1	<p>Page 1: Item B – Changed quantity of test items to 26. Item C – Added Glenair e-mail dated 10/6/17</p> <p>Page 3: Added Part Number 120-159-1-1-16C, Serial Numbers NTS-23 through NTS-26 for Low Temperature Flex.</p> <p>Page 4: Added test results for second Low Temperature Flex Test.</p> <p>Pages 37 – 42: Added test data and equipment for second Low Temperature Flex Test.</p> <p>Note: At the request of Glenair, two reports (TR No. PR066282 and PR066282-1, Revision 1) were merged into one report, herein.</p>	



**TEST ITEM IDENTIFICATION**

<b>Quantity</b>	<b>Part Number</b>	<b>Serial Number</b>	<b>Test Performed</b>
10	120-159-1-1-16C	NTS 1 through NTS 10	Tensile Strain Properties
6	120-159-1-1-16C	NTS 11 through NTS 16	Heat Aging
1	120-159-1-1-16C	NTS 19	Dielectric Breakdown
1	120-159-1-1-16C	NTS 17	Heat Shock
1	120-159-1-1-16C	NTS 22	Crush Resistance
2	120-159-1-1-16C	NTS 20 and NTS 21	Low Temperature Flex
1	120-159-1-1-16C	NTS 18	Minimum Bend Radius
4	120-159-1-1-16C	NTS-23 through NTS-26	Low Temperature Flex

The test item description and part number were taken from Glenair QTP-646, Revision 1. Serial numbers were assigned by NTS.



## **SUMMARY OF TEST RESULTS**

### **Tensile Strain Properties**

The Average Tensile Strength for the 10 samples was 9.48 lbs which met the requirements of the test.

### **Crush Resistance**

A max load of 23.83 lbs @ 75% displacement was reached as a result of the test.

### **Minimum Bend Radius**

The force measured to pull the slug through the tube was 1.95 lbs, which met the requirements of the test.

### **Heat Aging**

The distance between the fittings of the three specimens (NTS 11 through NTS 13) were prepared to the incorrect size (see NOD MECH 3). New samples were cut (NTS 14 through NTS 16) and the test was repeated using the new samples. The post test Tensile Strain Properties Test was performed and the Average Tensile Strength for the 3 samples was 10.32 lbs which met the requirements of the test.

### **Heat Shock**

There was no evidence of dripping, flowing, or cracking as a result of the test. The percent of change was 3.13% which met the requirements of the test.

### **Dielectric Shock**

No evidence of Dielectric Breakdown was recorded as a result of the test.

### **Low Temperature Flex**

During cycling, the chamber had a compressor fault after 24 hours. As a result the chamber did not hold temperature at -54°C and returned to ambient temperature. Cycles were continued at ambient temperature over the weekend. The sample (NTS 20) was broken right above the horizontal plane, between two mandrels (see NOD MECH-1). The test was repeated with a new sample (NTS 21). After 750 cycles the chamber was opened for inspection and it was noted that the sample had broken and fell out of the fixture. The failure was noted (see NOD MECH-2).

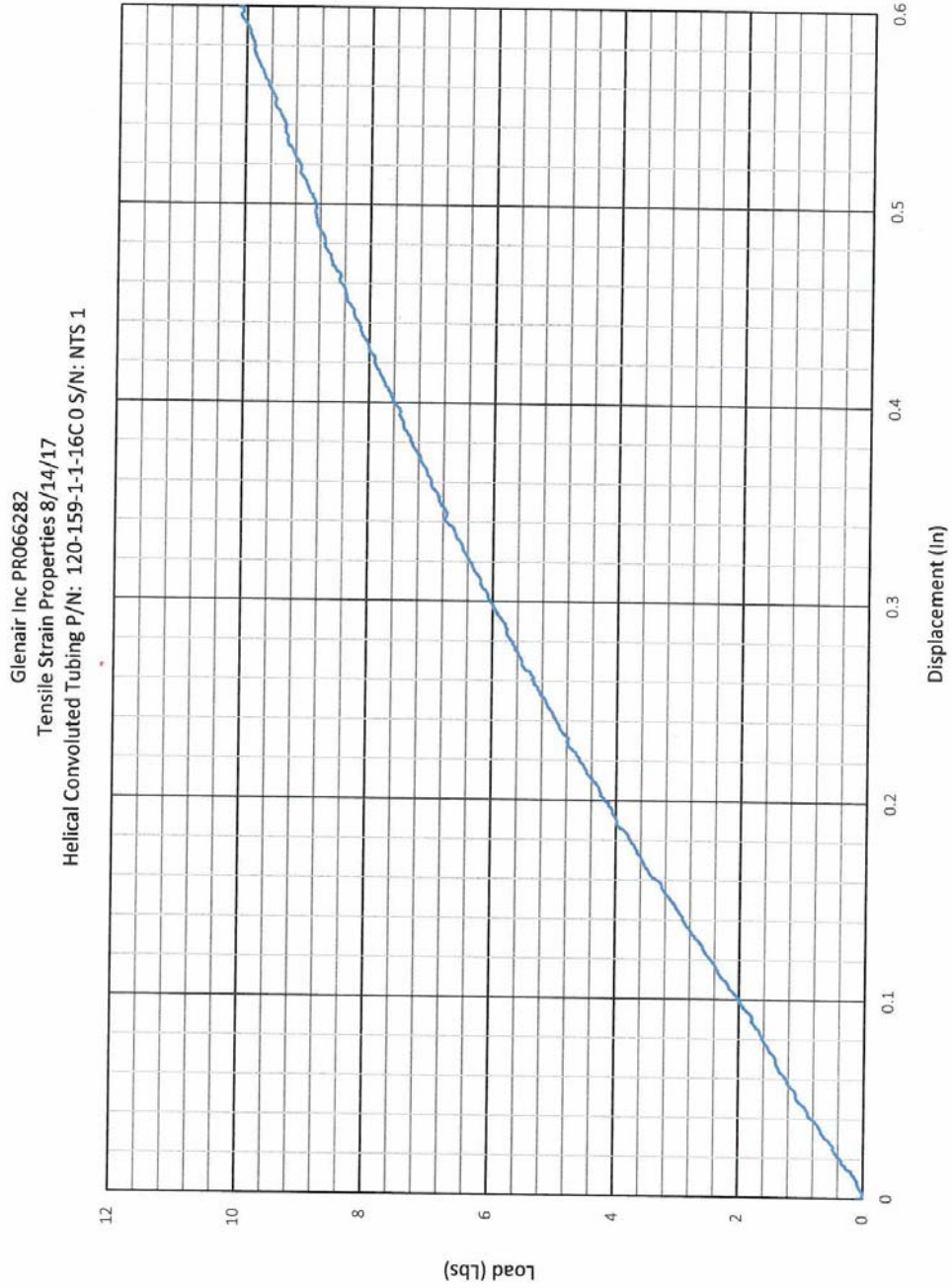
Four (4) additional Tubing Samples were provided for testing. The Tubing Samples were subjected to a 300°C environment for 216 hours. Serial Number NTS-23 was subjected to Low Temperature Flexibility and broke between 1,001 and 1,250 flex cycles (see NOD MECH-3). The temperature chamber utilized for testing went out of calibration during the test (see NOD MECH-4). Glenair requested that testing be stopped and the Helical Convolved Tubing Samples were returned to Glenair for post tests and final evaluation.



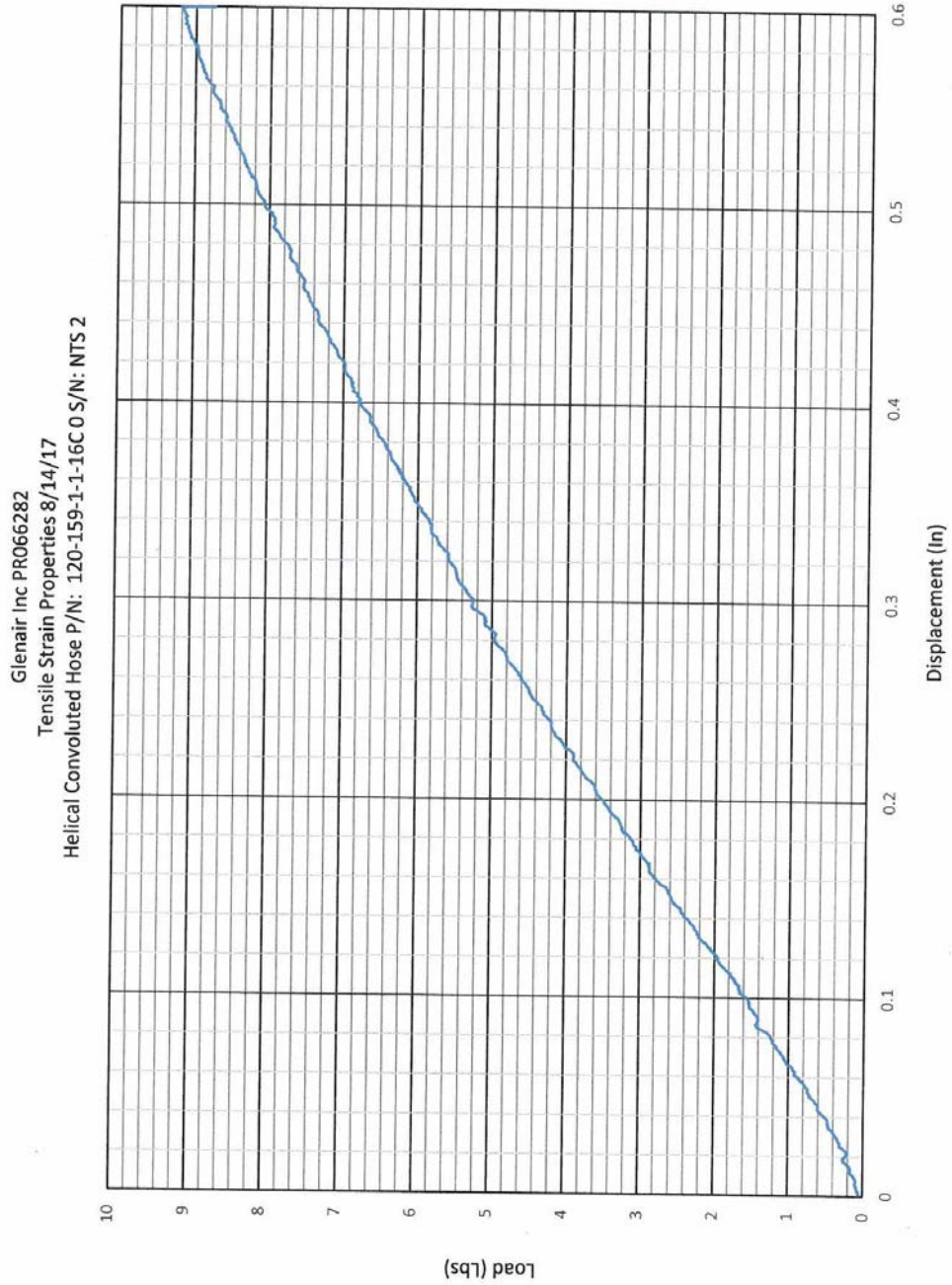
**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair Inc.	<b>MJO:</b>	PR066282
<b>TEST:</b>	Stress in PSI @ 10% Strain (Tensile Strain Properties) & Crush Resistance	<b>DATE:</b>	8/14/2017
<b>TEST ITEM:</b>	Helical Convoluted Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS 1 - NTS 10 and NTS 22
<b>SPECIFICATION:</b>	QTP-646 (Ref. SAE AS81914 Pg 10 of 17)	<b>PARA:</b>	4, 4.7.2 & 4.7.4
<b>TECHNICIAN:</b>	Alex Jarboe	<b>TEMP:</b>	73°F
		<b>RH:</b>	65%
<b>Program Manager:</b>	Marty McCormick	<b>DEVIATION:</b>	NO <input checked="" type="checkbox"/> YES <input type="checkbox"/>
<b>TECHNICAL REVIEW:</b>	<i>[Signature]</i>	<b>TECHNICAL REVIEW DATE:</b>	8/22/17

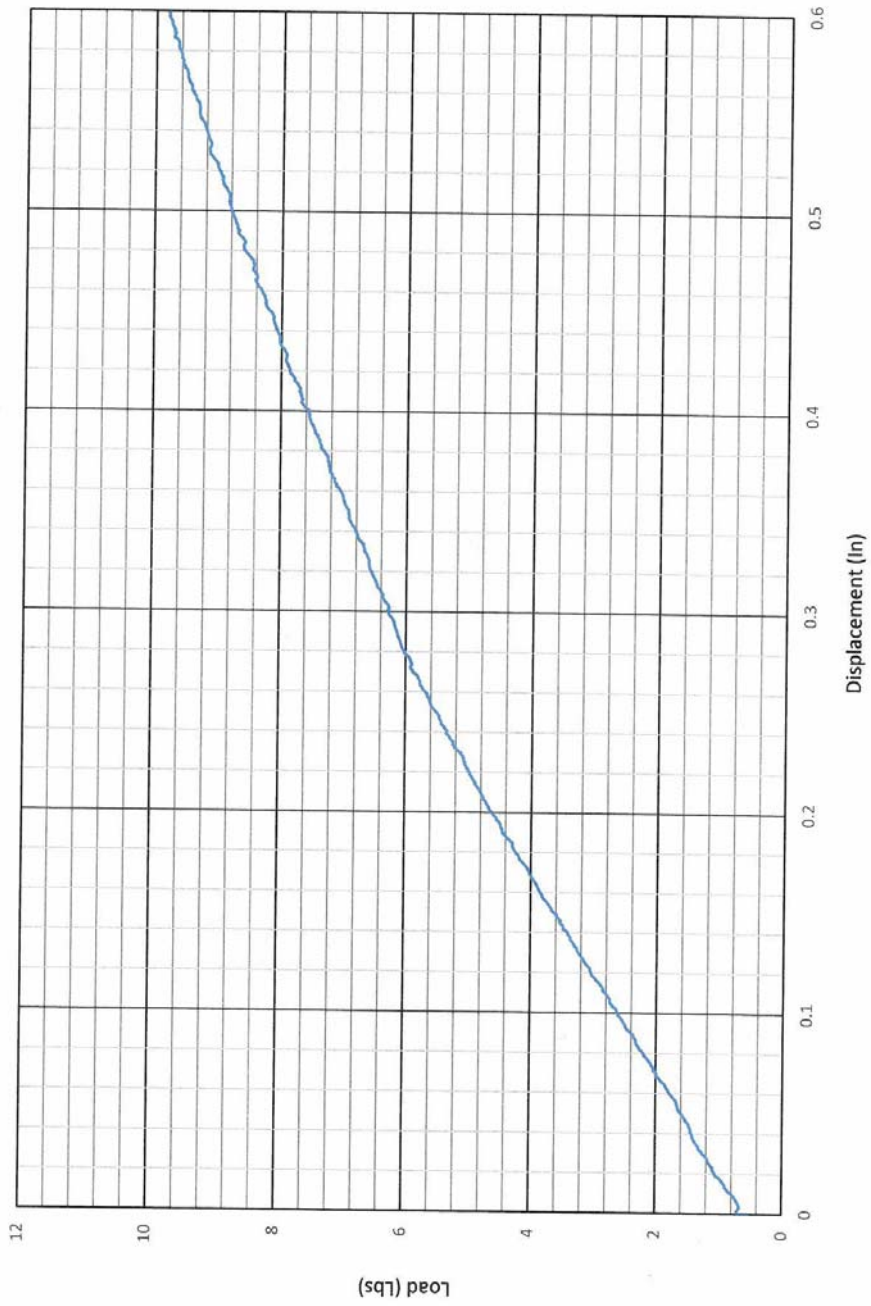
Date	Time	Test Description		
8/14/17	8:00	Setup for tubing between suitable fittings that prevent slippage while being loaded. Distance between the fittings shall be 6±.13inch. Specimen shall be extended .6 inches using Instron Loading Machine. 10 samples will be averaged and no individual sample shall deviate ±10% from the average of the combined samples. Begin Tensile Strain Properties Test 4.7.2.		
		<b>Serial Number</b>	<b>Max Load (lbs.)</b>	<b>Average (lbs.)</b>
	16:37	NTS 1	10.13	9.48
	16:40	NTS 2	9.19	
	16:44	NTS 3	9.85	
	16:47	NTS 4	9.41	
8/18/17	6:43	NTS 5	9.18	
	6:46	NTS 6	9.43	
	6:49	NTS 7	8.94	
	6:51	NTS 8	9.67	
	6:54	NTS 9	9.37	
	6:57	NTS 10	9.61	
		Combined average of all test units is 9.48lbs. NTS 1 through NTS 10 Tensile Strain Properties Test loads do not deviate from the ±10% (.94lbs) range of the 9.48 average load.		
	11:00	Setup NTS 22 sample for Crush Resistance Testing. Sample is cut to 1inch ±.063inch. Test item outside diameter is measured at .639 inches. Test item to be loaded horizontally by 75% of the diameter at a rate of .5 inches per minute.		
	11:21	Begin loading. Max load: 23.83 lbs. @ 75% displacement (.479inches)		
		5%=2.9lbs, 10%=5.8lbs. 15%=7.0lbs .20%=9.4lbs. 25%=11.4lbs. 30%=13.0lbs. 35%=14.5lbs. 40%=15.8lbs 45%=17.0lbs 50%=18.1lbs 55%=19.1lbs. 60%=19.9lbs 65%=20.9lbs. 70%=22.2lbs 75% = 23.8lbs		
		Test Complete.		



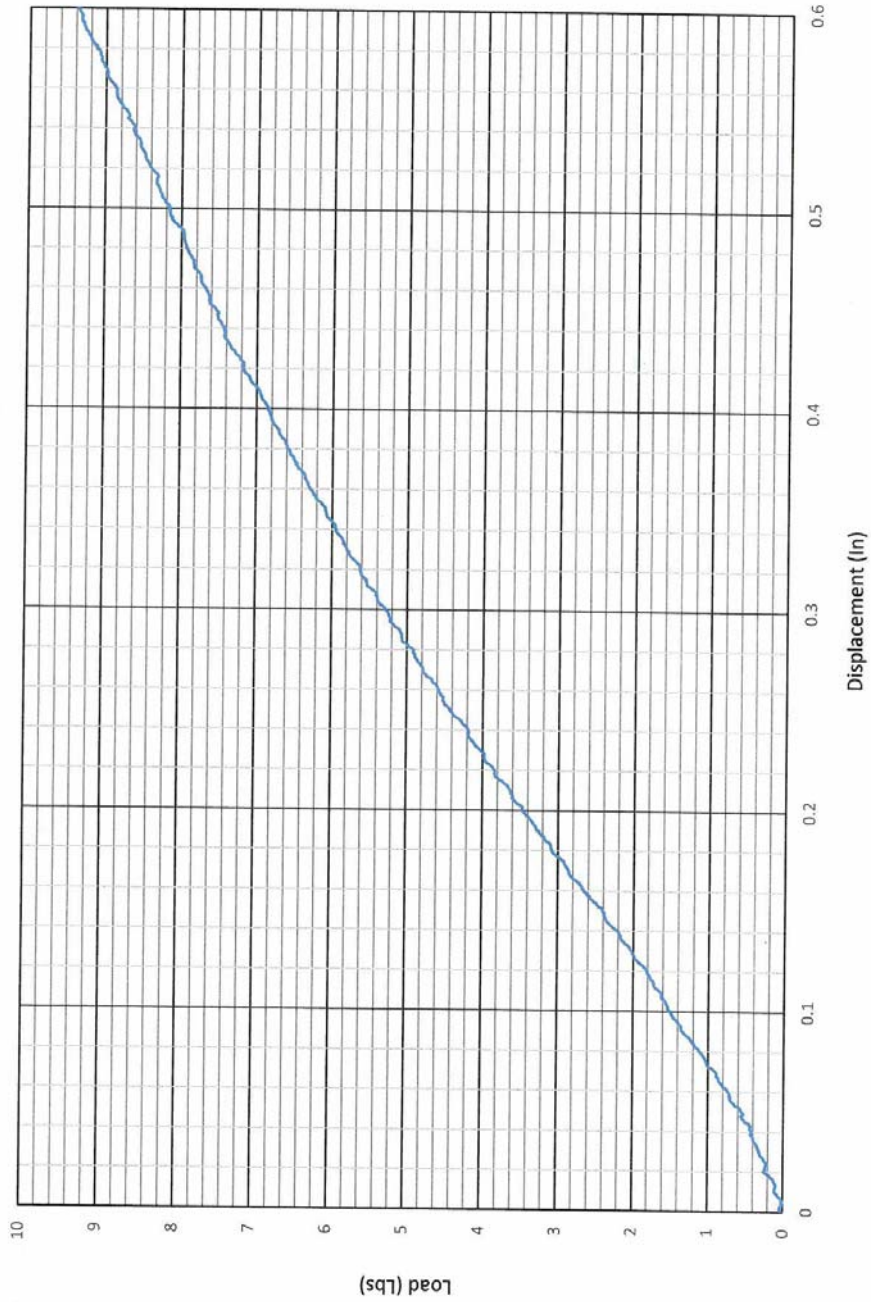


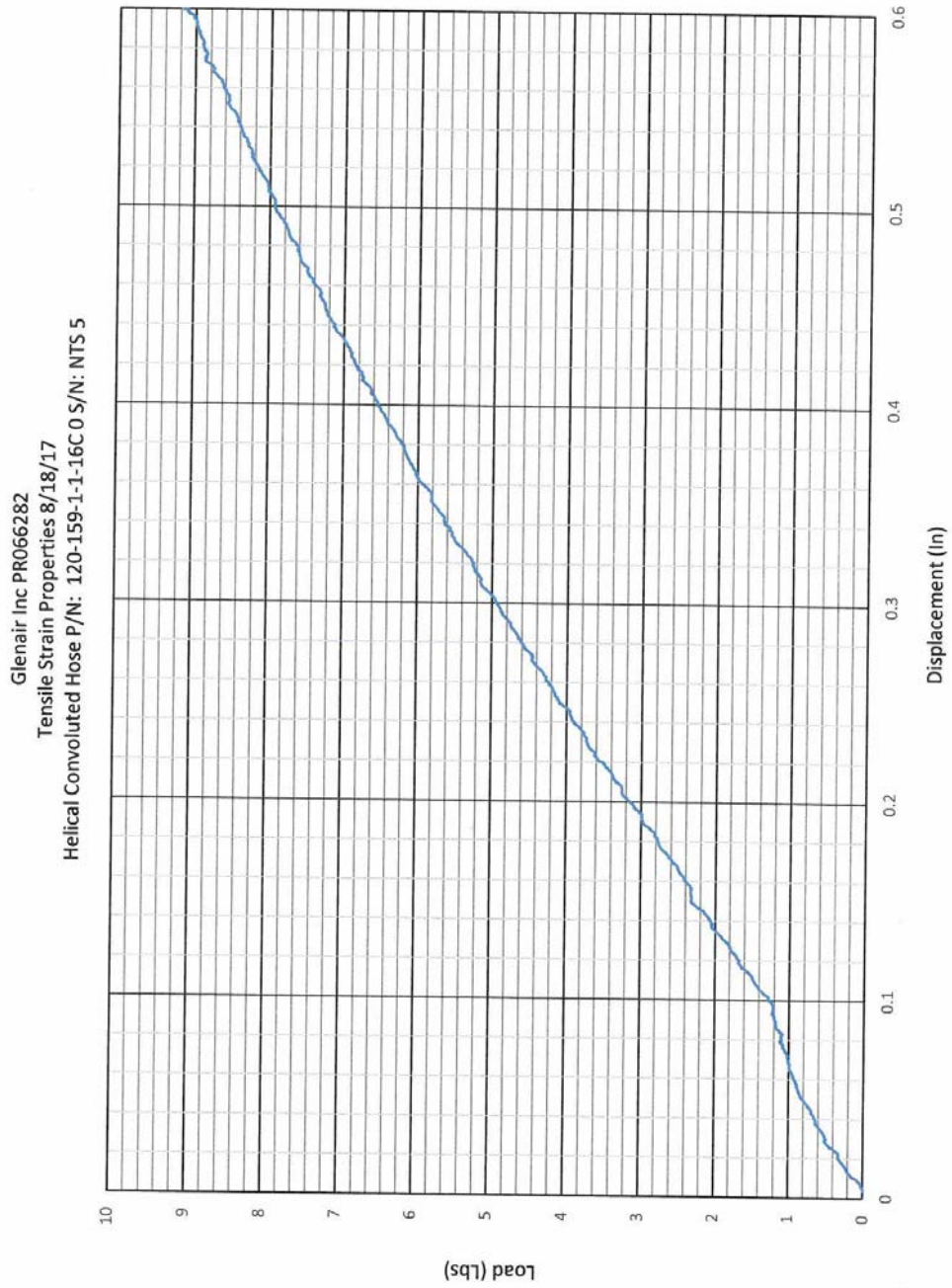


Glenair Inc PR066282  
Tensile Strain Properties 8/14/17  
Helical Convoluted Hose P/N: 120-159-1-1-16C 0 S/N: NTS 3

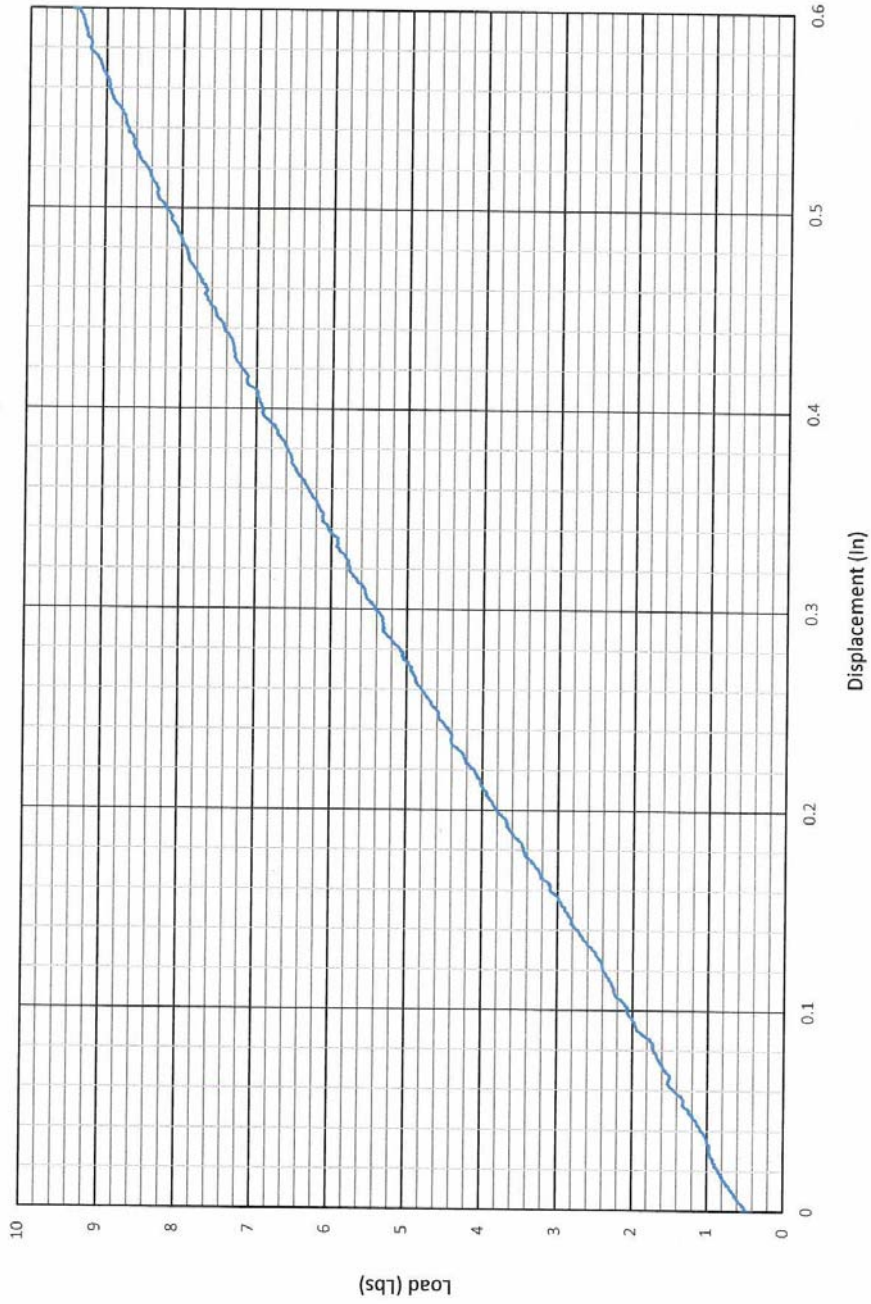


Glenair Inc PR066282  
 Tensile Strain Properties 8/14/17  
 Helical Convoluted Hose P/N: 120-159-1-1-16C 0 S/N: NTS 4

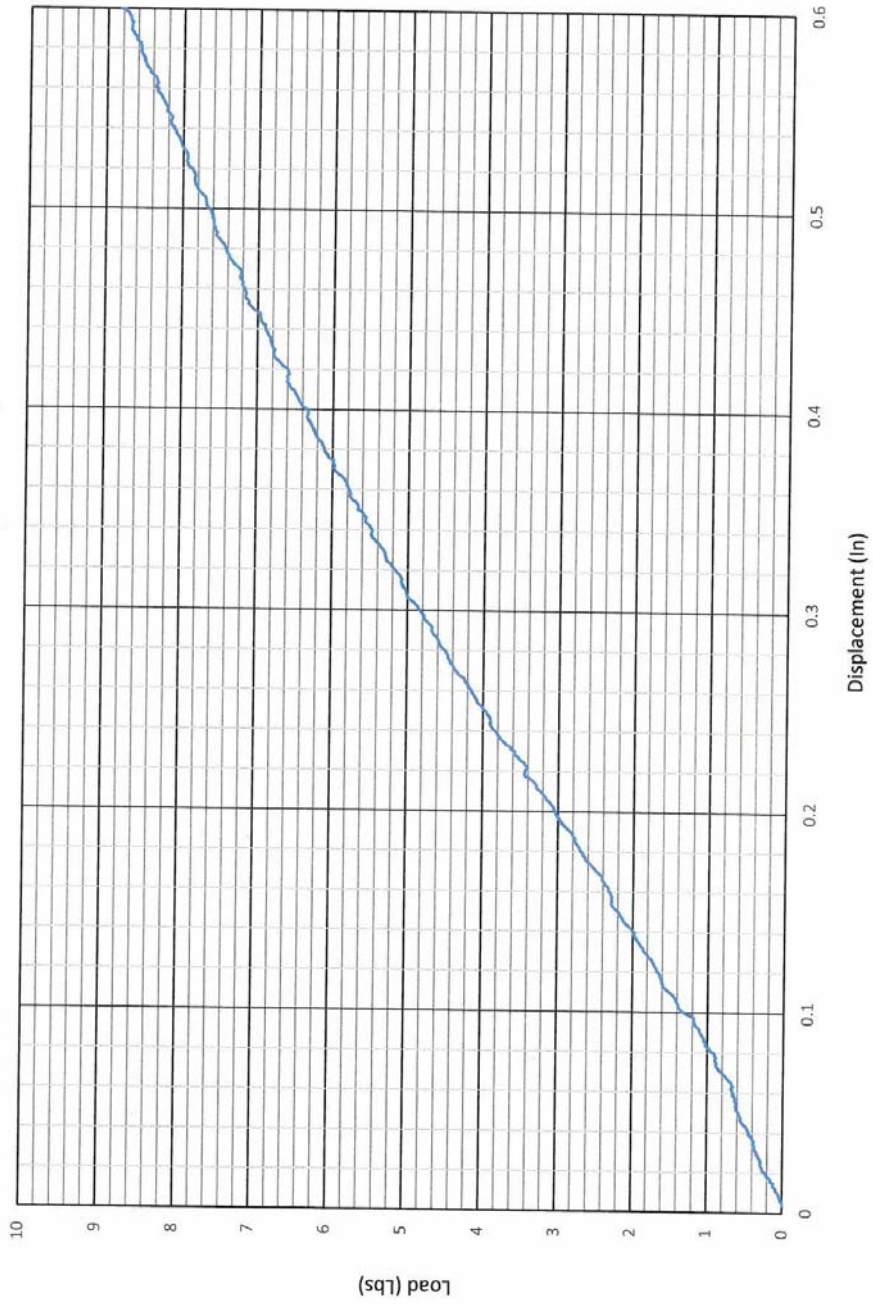




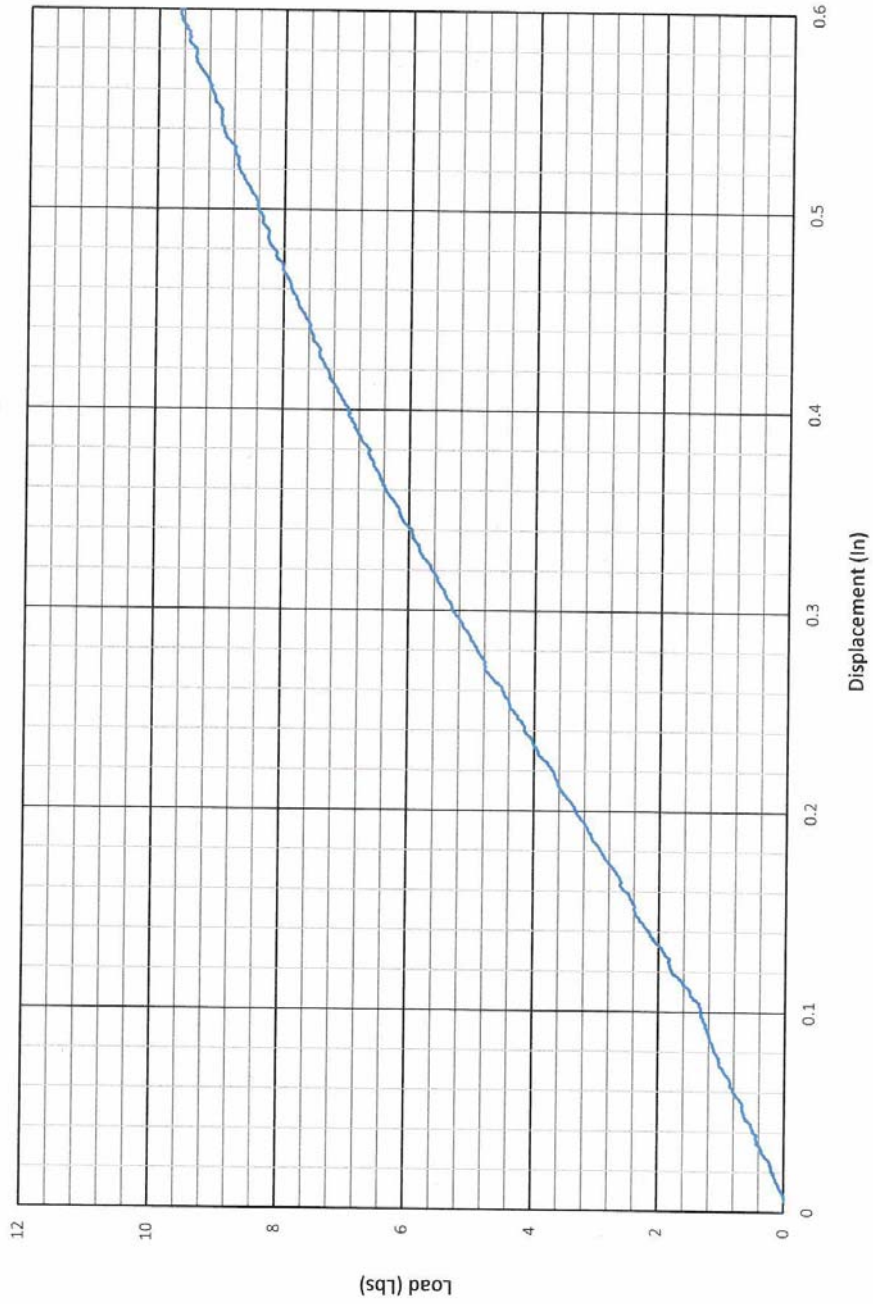
Glenair Inc PR066282  
Tensile Strain Properties 8/18/17  
Helical Convoluted Hose P/N: 120-159-1-1-16C O S/N: NTS 6

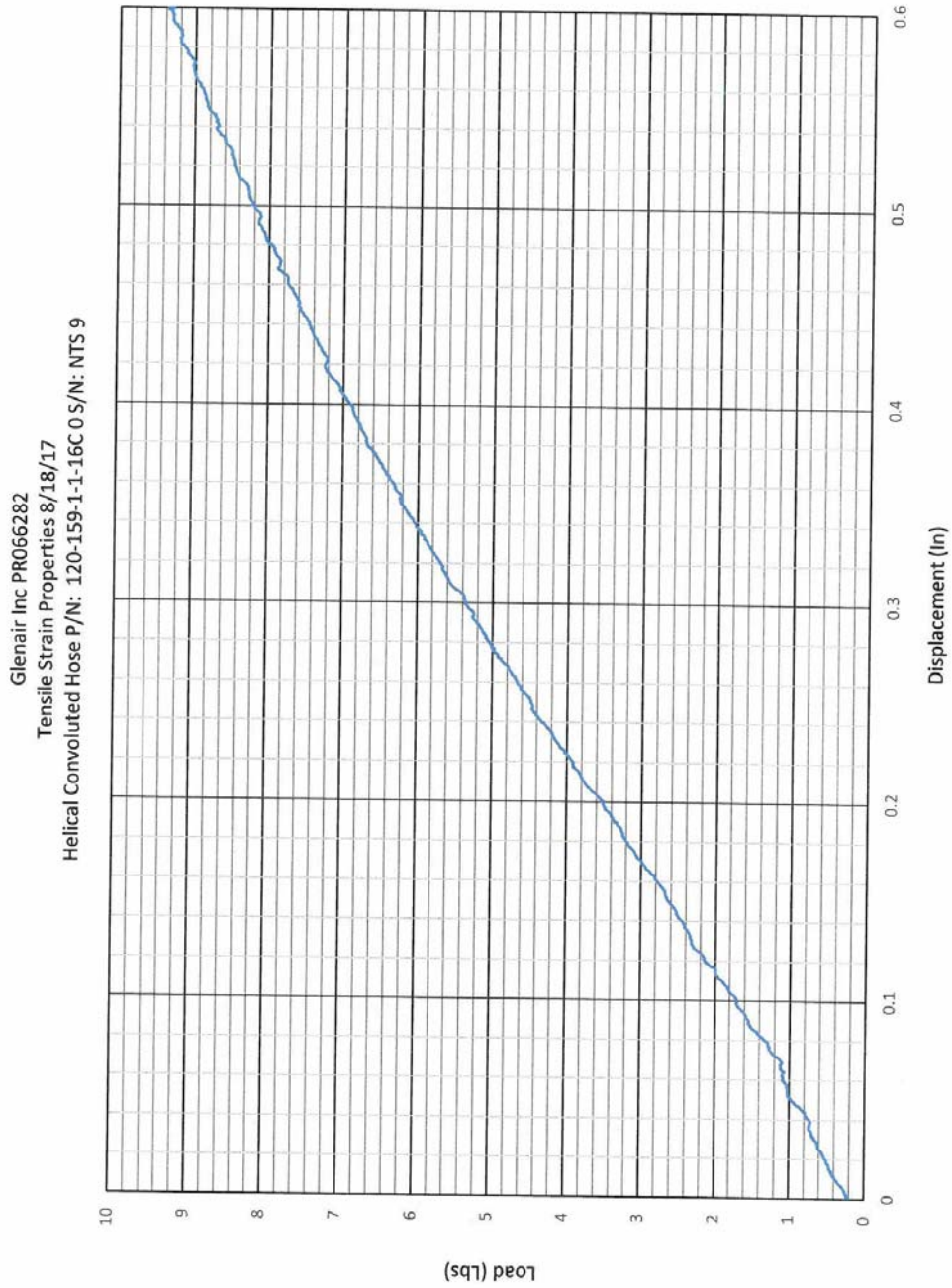


Glenair Inc PR066282  
 Tensile Strain Properties 8/18/17  
 Helical Convoluted Hose P/N: 120-159-1-1-16C 0 S/N: NTS 7

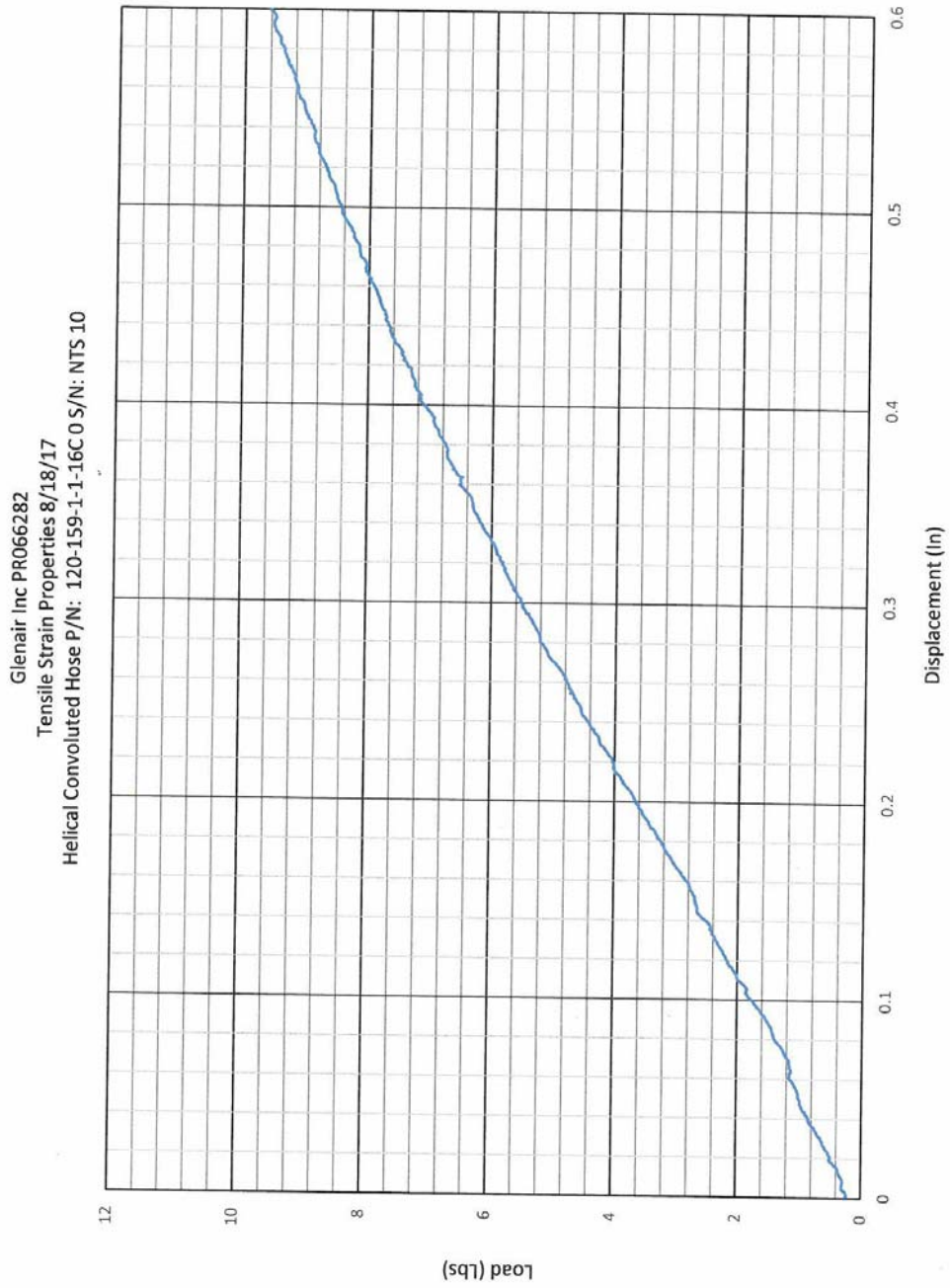


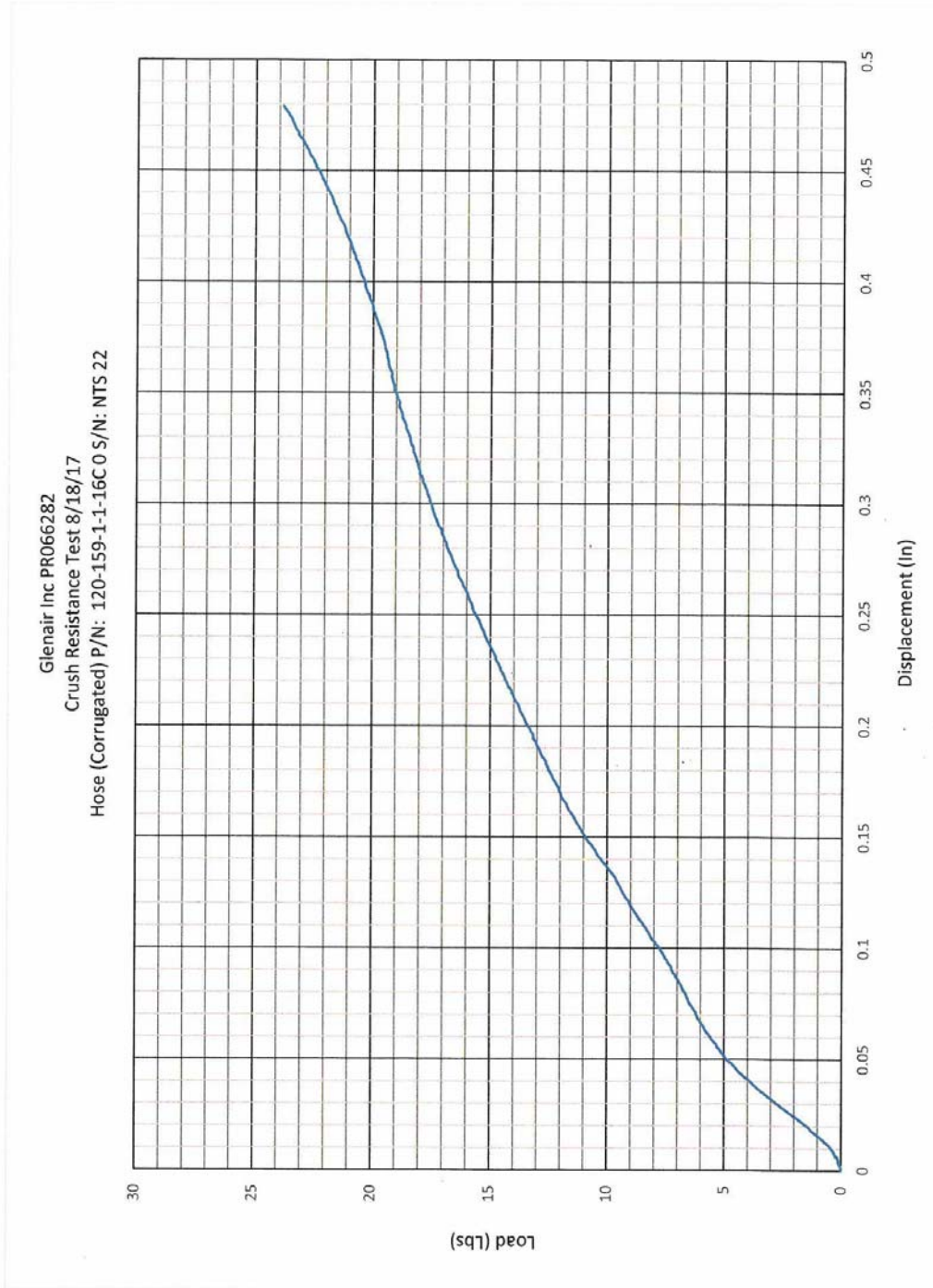
Glenair Inc PR066282  
Tensile Strain Properties 8/18/17  
Helical Convoluted Hose P/N: 120-159-1-1-16C 0 S/N: NTS 8













**Tensile Strain & Crush Resistance EQUIPMENT LIST**

Client: Glenair Inc PR No.: pr066282 Start Date: 8/14/2017 End Date: 8/18/2017

Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL1390	Load Cell (Tension/Compression)	Instron	2511-301	1794	± 1% FS	0 to 1000 lbs.	12 Months	10/10/2017
FL2600	Machine (Test)	Instron	4204	3167	± 1% FS	0 to 10,000 lbs	12 Months	10/10/2017
FL5516	Data Acquisition (Board/Card)	National Instruments	USB-6259	1481388	± 0.05%	N/A	24 Months	1/6/2018
FL5191	Recorder (Data)	National Instruments	194710D-04L	13F8B5F	± 0.06%	N/A	24 Months	6/29/2018
FL4605	Measurement Tools (Calliper)	Tesa Technology	599-579-4	2Y372501	± 0.001 in.	0 to 6 in.	12 Months	6/6/2018
FL7195	Meter (Hygrometer)	Cole-Parmer	03313-86	80272435	± 2° F/ 4% RH	32 to 122 °F/ 25 to 95% RH	24 Months	1/30/2019



**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair, Inc	<b>MJO:</b>	PR066282
<b>TEST:</b>	Minimum Bend Radius	<b>DATE:</b>	8/21/2017
<b>TEST ITEM:</b>	Helical Covoluted Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS 18
<b>SPECIFICATION:</b>	QTP-646 Rev 1, (Ref. SAE AS81914)	<b>PARA:</b>	4 & 4.7.1.3
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	75°F <b>RH:</b> 51%
<b>ENGINEER:</b>	Marty McCormick	<b>DEVIATION:</b>	NO <input checked="" type="checkbox"/> YES <input type="checkbox"/>
<b>TECHNICAL REVIEW:</b>	<i>M.A.</i>	<b>TECHNICAL REVIEW DATE:</b>	9/25/17

Date	Time	Test Description
		A metal slug has been made out of aluminum meeting the dimension in 4.7.1.3. It has a hole drilled through the center so that a string can be run through the slug and be used to pull it through the tube being tested. A mandrel that meets the minimum bend radius will have the tube wrapped around it once and held so that the tube maintains contact with the mandrel. The string attached to the slug will be threaded through the tube and secured to a 10 Lbs load cell. The load cell will be zeroed prior to testing and set to record the peak force achieved while pulling the slug through the tube.
8/21/17	15:20	A string has been secured to the load cell and the aluminum slug after threading it through the tube being tested. The tube sample is 10 inches in length. The load cell has been zeroed and set to record peak force.
	15:25	The force measured to pull the slug through the tube is 1.95 Lbs. The requirement is less than 3 Lbs.
		Test sample met the requirements of the test.
		Photo's taken and moved to the MJO folder.



### MINIMUM BEND RADIUS EQUIPMENT LIST

Client: Glenair, Inc PR No.: PR066282 Start Date: 8/21/2017 End Date: 8/21/2017

Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL4681	Gauge (Force)	Chatillon	DFGS10	NONE	± 0.15% FS + 1 LSD	0 to 10 lbs	12 Months	8/29/2017



**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair, Inc.	<b>MJO:</b>	PR066282
<b>TEST:</b>	Heat Aging	<b>DATE:</b>	8/22/2017
<b>TEST ITEM:</b>	Convoluted Conduit Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS-11 thru NTS-16
<b>SPECIFICATION:</b>	QTP -646 Rev. 1 (Ref. SAE AS81914)	<b>PARA:</b>	4 & 4.7.7
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	75°F
<b>ENGINEER:</b>	Marty McCormick	<b>RH:</b>	52%
<b>TECHNICAL REVIEW:</b>	<i>Mak</i>	<b>DEVIATION:</b>	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
		<b>TECHNICAL REVIEW DATE:</b>	<i>9/25/17</i>

Date	Time	Test Description
8/22/17	8:15	Three (3) six (6) inch sample has been cut from the supplied tubing sample (NTS 11-13). Each of the three (3) samples will have a 1/4" mandrel placed through their center and will be supported by the mandrel. The mandrel will be placed on metal spacers to keep them above the chamber floor for good air circulation. The chamber will be at the test temperature (300° C +/- 3° C) prior to placing the units into the chamber. The units will be placed roughly in the center of the chamber and will be left to condition for ninety-six (96) hours. Once the samples have completed their conditioning, they units will be tested per section 4.7.2.
8/22/17	10:25	Chamber is at 300° C, door open and sample placed into chamber and door secured.
	17:15	Chamber at 300° C.
8/23/17	10:25	Chamber at 300° C. 24 hours total
	17:10	Chamber at 300° C.
8/24/17	10:30	Chamber at 300° C. 48 hours total
	16:50	Chamber at 300° C.
8/25/17	10:30	Chamber at 300° C. 72 hours total
		Chamber at 300° C.
8/26/17	10:25	Chamber at 300° C. 96 hours total. Chamber turned off and door opened. Test articles will be left inside chamber to cool. All three test samples will be removed from the chamber and the mandrel will be removed. Each of the samples will have the supplied connectors secured to each end. The test articles will then be tested in accordance with section 4.7.2
		The above samples were cut without the connector measurement factor. (Ref. NOD MECH3)
		Three (3) new parts (NTS 14-NTS 16) were cut from the supplied sample and fittings were added. The span between the fittings was measured and adjusted to six (6) inches. The samples were then placed into a chamber that had been pre-heated to the 300° C temperature. The fitting were placed on aluminum channels which suspended the test items one (1) inch above the floor of the chamber.
9/7/2017	8:30	Chamber at 300° C, aluminum channels spaced to support fittings, each of the samples have been placed in the chamber, metal spaces have been placed between the fittings to keep them from rolling.
9/7/2017	8:30	Chamber door sealed, 96 hour dwell started.
9/11/2017	9:00	Chamber turned off and door opened. Devices will be allowed to cool to ambient conditions before being removed from the chamber.
	13:10	The test units have been removed from chamber and tagged with NTS-14, NTS-15 and NTS-16.



**NOTICE OF DEVIATION**

CLIENT:	Glenair	MJO:	PR066282	NOD NO.:	MECH 3
P.O. NO.:	P172615	DATE OF DEVIATION:	8/22/2017	CPAR NO.:	

NOTIFICATION MADE TO: <small>(CLIENT CONTACT)</small>	Sam Farat	NOTIFICATION MADE BY:	Marty McCormick
NOTIFICATION DATE:	9/5/2017	VIA:	email
IF NOTIFICATION NOT MADE, PROVIDE JUSTIFICATION:			

TEST NAME:	Heat Aging	TEST ITEM:	Convolved Conduit Tubing
SPECIFICATION:	QTP -646 Rev. 1 (Ref. SAE AS81914)	MODEL/PART NO.	120-159-1-1-16C
REVISION/DATE:	Rev. 1	PARA:	4 & 4.7.7
		SERIAL NO.	NTS-11 thru NTS-13

**REQUIREMENT:** *(Reference paragraph or section of specification)*  
 Perform Heat aging test according to AS81914, 96 hours at 300°C, +/- 3°C, Stress in PSI @ 10% strain, 80% of the initial value. Three 6 Inch lengths of tubing shall be positioned as shown in SAE AS81914 Sec. 4.7.6. The tubing shall be conditioned for the time and temperature specified in the applicable specification sheet. The distance between the fittings shall be 6 in (+/- 0.13 in.)

**DESCRIPTION OF DEVIATION:**  
 The distance between the fittings of the three specimens were prepared to the incorrect size. (actual 4.75 inches). The length of the fittings was not factored into the size.

**DISPOSITIONS / COMMENTS / RECOMMENDATIONS:** *(to be completed by client)*  
 Prepare 3 new samples (NTS 14 thru NTS 16) to the correct lengths.

Per customer, dispositioned 9/5/17 <i>E-MAIL</i>	<i>Cathy Rumble</i> 9/28/17
CLIENT TEST WITNESS (if applicable) _____ DATE	NTS QUALITY REPRESENTATIVE _____ DATE
<i>Marty McCormick</i> 9/28/17	_____ DATE
NTS PROJECT MANAGER _____ DATE	GOVERNMENT QAR (if applicable) _____ DATE

NOTE: IT IS THE CLIENT'S RESPONSIBILITY TO ANALYZE AND DISPOSITION DEVIATIONS ON CLIENT TEST PROGRAMS.

FOR NTS QA USE: Tracking Code:  1. Employee Error     2. Test Equipment Problem     3. Customer Item Problem     4. Weather     5. Power Failure     6. Equipment Limitations     7. Other



**Heat Aging EQUIPMENT LIST**

Client: Glenair, Inc PR No.: PR066282 Start Date: 8/22/2017 End Date: 9/11/2017

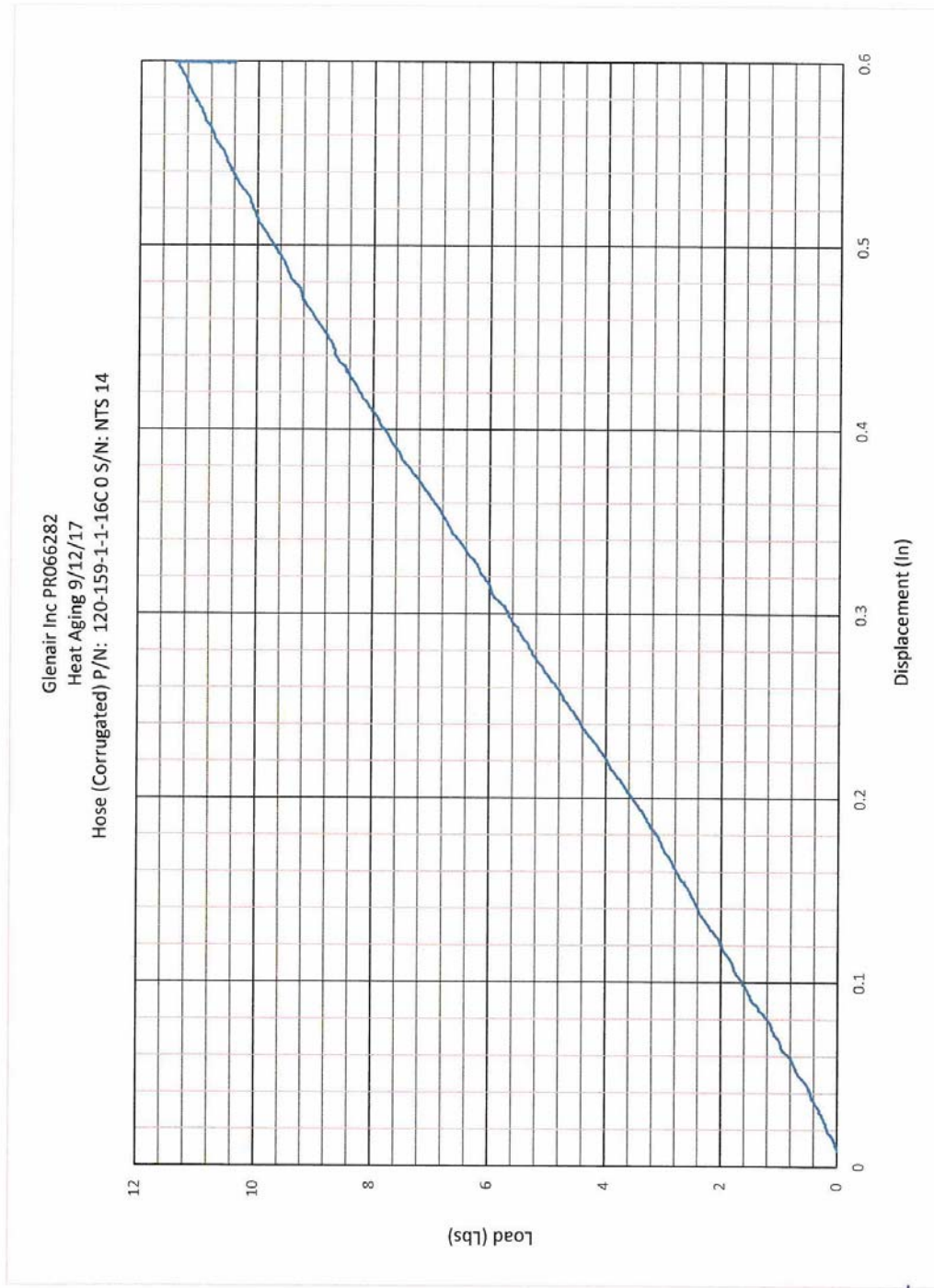
Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL7180	Measurement Tools (Tape Measure)	Lufkin	QR1425	NONE	± 0.06 in.	0 to 25 ft.	24 Months	12/9/2018
FL1456	Chamber (High Temperature)	Blue M	DC 256 F HP	DC 6339	MFG	N/A	No Calibration Required	N/A
FL5316	Controller (Process)	Watlow	F4DH	014869	± .14% FS + 1 LSD	-100 to 400°C	12 Months	3/27/2018

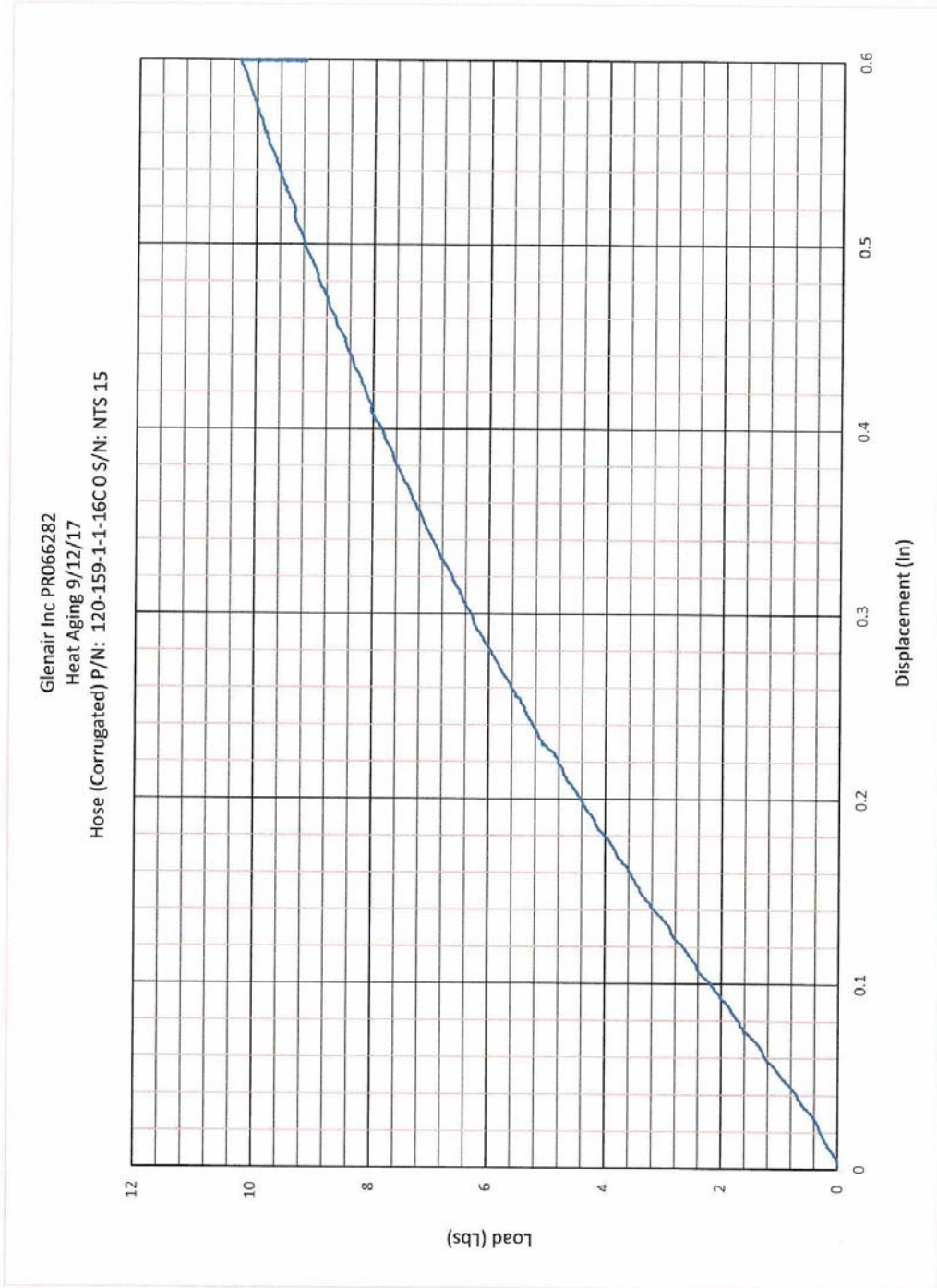


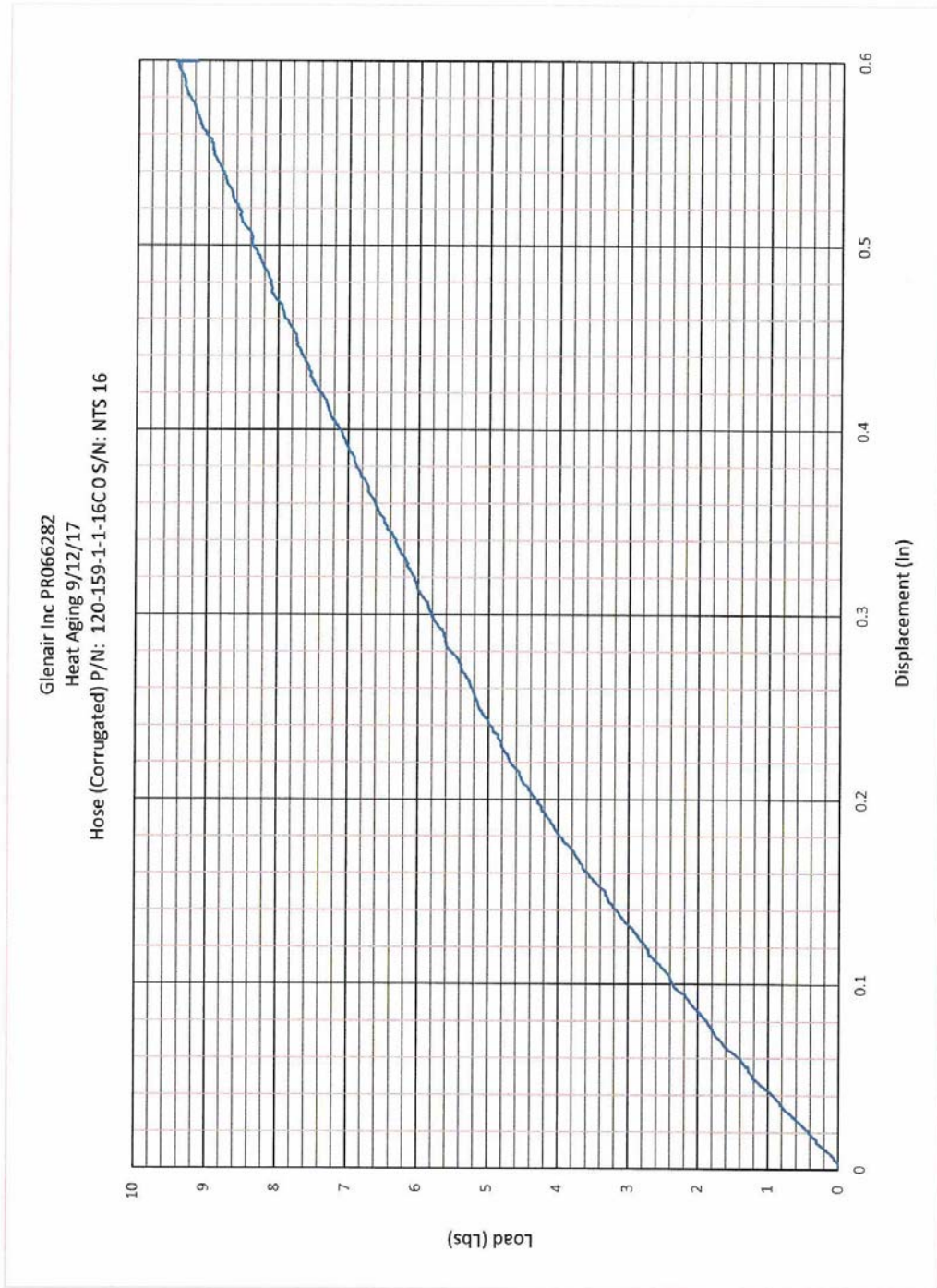
**NTS****GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair Inc.	<b>MJO:</b>	PR066282
<b>TEST:</b>	Heat Aging	<b>DATE:</b>	9/12/2017
<b>TEST ITEM:</b>	Helical Convuluted Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS 14 through NTS 16
<b>SPECIFICATION:</b>	QTP-646 Rev 1/ SAE AS81914 Pg. 10 of 17	<b>PARA:</b>	4, 4.7.2 & 4.7.7
<b>TECHNICIAN:</b>	Alex Jarboe	<b>TEMP:</b>	70°F
		<b>RH:</b>	25%
<b>Program Manager:</b>	Marty McCormick	<b>DEVIATION:</b>	NO <input checked="" type="checkbox"/> YES <input type="checkbox"/>
<b>TECHNICAL REVIEW:</b>	<i>[Signature]</i>	<b>TECHNICAL REVIEW DATE:</b>	9/25/17

Date	Time	Test Description		
9/12/17	5:30	Post Heat aging tensile test.		
		Setup for tubing between suitable fittings that prevent slippage while being loaded. Distance between the fittings shall be 6±.13inch. Specimen shall be extended .6 inches using Instron Loading Machine. All 3 samples loads will be averaged and no individual sample shall deviate ±10% from the average of the combined samples. Begin Tensile Strain Properties Test 4.7.2.		
		<b>Serial Number</b>	<b>Max Load (lbs.)</b>	<b>Average (lbs.)</b>
	6:14	NTS 14	11.03	10.32
	6:27	NTS 15	10.37	
	6:31	NTS 16	9.55	
		Combined average of all test units is 10.32lbs. NTS 14 through NTS 16 Tensile Strain Properties Test loads do not deviate from the ±10% (1.03lbs) range of the 10.32 average load.		









### HEAT AGING EQUIPMENT LIST

Client: Glenair, Inc PR No.: PR066282 Start Date: 8/22/2017 End Date: 9/11/2017

Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL7180	Measurement Tools (Tape Measure)	Lufkin	QR1425	NONE	± 0.06 in.	0 to 25 ft.	24 Months	12/9/2018
FL1456	Chamber (High Temperature)	Blue M	DC 256 F HP	DC 6339	MFG	N/A	No Calibration Required	N/A
FL5316	Controller (Process)	Watlow	F4DH	014869	± .14% FS + 1 LSD	-100 to 400°C	12 Months	3/27/2018



**GENERAL DATA SHEET**

CUSTOMER:	Glenair, Inc	MJO:	PR066282
TEST:	Heat Shock	DATE:	8/22/2017
TEST ITEM:	Convolute Conduit Tubing		
PART NUMBER:	120-159-1-1-16C	S/N:	NTS 17
SPECIFICATION:	QTP-646 Rev. 1, (Ref. SAE AS81914)	PARA:	4.7.6
TECHNICIAN:	John A. Smith	TEMP:	75°F RH: 52%
ENGINEER:	<i>Handwritten signature</i>	DEVIATION:	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
TECHNICAL REVIEW:	<i>M.A.</i>	TECHNICAL REVIEW DATE:	<i>9/22/17</i>

Date	Time	Test Description
8/22/17	8:15	One six (6) inch sample has been cut from the supplied tubing sample. Two marks have been made with four (4) inch space between them. The chamber that will be used has been brought up to temperature (300° C +/-3° C). The sample will be placed on a 1/4" mandrel and placed on metal supports to keep it off the chamber floor and allow for good air circulation around the sample. The sample will be conditioned for four (4) hours and then removed from the chamber and allowed to return to laboratory ambient conditions before measuring any change.
8/23/17	14:25	Chamber is at 300° C, door open and sample placed into chamber and door secured.
	18:25	Chamber door opened and test sample removed.
8/24/17	8:10	Sample will be allowed to cool to room ambient prior to measurements
		% change = $12-11 / 11 \times 10$
		1 1            4.000
		1 2            3.875
		1 2 - 1 1      -0.125
		12 - 11/11    -0.031
		*100          3.13%      Percentage of Change
		At the end of the test there was no evidence of Dripping, Flowing or Cracking.
		The percent of change is less than 15%, actual value 3.13%
		Convolute tubing met the requirements of the specification



### Heat Shock EQUIPMENT LIST

Client: Glenair, Inc PR No.: PR066282 Start Date: 8/22/2017 End Date: 8/24/2017

Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL7180	Measurement Tools (Tape Measure)	Lufkin	QR1425	NONE	± 0.06 in.	0 to 25 ft.	24 Months	12/9/2018
FL1456	Chamber (High Temperature)	Blue M	DC 256 F HP	DC 6339	MFG	N/A	No Calibration Required	N/A
FL5316	Controller (Process)	Watlow	F4DH	014869	± .14% FS + 1 LSD	-100 to 400°C	12 Months	3/27/2018



**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair, Inc.	<b>MJO:</b>	PR066282	
<b>TEST:</b>	Dielectric Breakdown	<b>DATE:</b>	9/7/2017	
<b>TEST ITEM:</b>	Helical Convolutud Tubing			
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS 19	
<b>SPECIFICATION:</b>	QTP 646 Rev. 1,(Ref. AS81914)	<b>PARA:</b>	4 & 4.7.11	
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	75°F	<b>RH:</b> 51%
<b>ENGINEER:</b>	Marty McCormick	<b>DEVIATION:</b>	NO <input checked="checked" type="checkbox"/> YES <input type="checkbox"/>	
<b>TECHNICAL REVIEW:</b>	<i>M.A.</i>	<b>TECHNICAL REVIEW DATE:</b>	<i>9/25/17</i>	

Date	Time	Test Description
9/17/17 <i>7</i> <i>M.A.</i> <i>9/17/17</i>	14:00	A 24" AWG 12 solid copper piece of wire has been stripped of its insulation and will be placed inside the test piece NTS-1. The 24" sample was cut from the supplied spool of material, and tagged NTS-1
		The copper conductor was placed inside the test piece and bent into a "U" shape. A solution of 1% aqueous sodium chloride solution has been made and verified using FL7763 Salometer. A glass beaker will be used to hold the test sample and the aqueous solution. The tube will be filled within 6" of the top of the tubing after placing it into the beaker. A piece of capton tape is being used to mark the location to fill the beaker with the aqueous solution. A length of AWG 12 copper will be bent and inserted into the beaker as the negative conductor. Voltage will be applied across the two copper conductors. The voltage will be increased from 0 to the required potential within 30 seconds and then and held for 60 seconds.. The voltage needed to meet the specification is 12,000v DC.
9/7/17	10:30	The positive output has been connected to the conductor inside the tube. The negative output has been connected to the conductor in the beaker. Water levels checked, ready to test.
	10:35	The voltage was adjusted up to 12,500 Volts DC over a 30 second period and held for 60 seconds. No evidence of Dielectric Breakdown was recorded.
		Sample meets the specification.





**Dielectric Breakdown EQUIPMENT LIST**

Client: Glenair, Inc PR No.: PR066282 Start Date: ~~8/25/2017~~ <sup>9/2/17</sup> End Date: <sup>7</sup> 9/30/2017  
*Adj. 9/28/17*

Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL7180	Measurement Tools (Tape Measure)	Lufkin	QR1425	NONE	± 0.06 in.	0 to 25 ft.	24 Months	12/9/2018
FL7763	Meter (Salometer)	H-B Instrument Co.	08299-05	1342729	± 0.5%	0 to 26%	60 Months	7/1/2019
FL1027	Hipot	Associated Research	3570D	091437	± 2% + 5 V	5kVAC/ 6kVDC	12 Months	2/14/2018
FL0745	Hipot	Hipotronics	100	1400-1200	± 2% FS	25 kV/5 mA	12 Months	9/5/2018



**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair	<b>MJO:</b>	PR066282
<b>TEST:</b>	Low Temperature Flex	<b>DATE:</b>	9/8/2017
<b>TEST ITEM:</b>	Convolutted Conduit Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS 20 & NTS 21
<b>SPECIFICATION:</b>	QTP-646 Rev 1 (Ref. SAE AS81914)	<b>PARA:</b>	4 and 4.7.5
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	82°F
<b>ENGINEER:</b>	Marty McCormick	<b>RH:</b>	54%
<b>TECHNICAL REVIEW:</b>	<i>M.A.</i>	<b>DEVIATION:</b>	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
		<b>TECHNICAL REVIEW DATE:</b>	9/25/17

Date	Time	Test Description
		<b>4.7.5 Low Temperature Flexibility</b> - A length of tubing shall be secured to the apparatus shown in Figure 3. The apparatus shall be placed in a cold chamber at -54 +/-1 °C (-65 +/-2 °F) and the tubing flexed over the mandrels at the rate of 15 +/- 2 cycles per minute. A cycle shall consist of one flex over each mandrel. The number of cycles for each convoluted tubing shall be as specified in the applicable specification sheet. The tubing shall be examined for cracking.
		A fixture was made that used two mandrels with a diameter of 1.25" (minimum bend radius). The mandrels were separated with enough clearance that the tube would not touch either side in the starting position ( 0°). A arm was used that would allow for a piece of Teflon to act as the "slip sleeve" from figure 3. A hole was 13/16"drilled through the Teflon and the corners de-burred. The tube was secured in one of the supplied fittings. The fitting was secured to the base of the fixture and allows the tube to pass freely through the center of the mandrels and through the Teflon "slip sleeve". A stepper motor and controller will be used to control the speed and angle that the arm will travel. With a scrap piece of tubing in the fixture, the motor controller was programmed so that the arm would travel from 0° in the clockwise direction until the tubing was bent over the mandrel 90° (+90°). The motor was then programmed to move in the counterclockwise direction until the tubing was bent over the mandrel 90° (-90°) and return to 0°. This will be considered one cycle and will be timed to complete 15 cycles per minute. The fixture will be placed into a chamber and the temperature lowered to -54°C. The chamber will dwell for a minimum of one hour to stabilize part and fixture prior to starting the cycles. 10,000 cycles will be run in total. Once all the cycles have been completed the chamber will be ramped back to ambient conditions and the test item inspected for cracks.
9/8/2017	13:45	The test item NTS 20 has been secured in the fixture and the fixture moved to the chamber. The motor controller program has been verified and is ready to run. Chamber door closed ready to start test. Should take 41 hours to complete 10,000 cycle (10,000(cycles * 4(cycles per minute) = 2500 minutes or 41.45 hours.
9/8/2017	15:50	Chamber started, ramping down to -54°C.
	16:20	Chamber at test temperature
	17:25	One hour dwell period completed, cycles starting.



**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair	<b>MJO:</b>	PR066282
<b>TEST:</b>	Low Temperature Flex	<b>DATE:</b>	9/8/2017
<b>TEST ITEM:</b>	Convolutd Conduit Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS 20 & NTS 21
<b>SPECIFICATION:</b>	QTP-646 Rev 1 (Ref. SAE AS81914)	<b>PARA:</b>	4 and 4.7.5
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	82°F
		<b>RH:</b>	54%
<b>ENGINEER:</b>	Marty McCormick	<b>DEVIATION:</b>	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
<b>TECHNICAL REVIEW:</b>	M.M.	<b>TECHNICAL REVIEW DATE:</b>	9/25/17

Date	Time	Test Description
	18:00	Chamber operational, cycles running normally.
9/11/2017	7:10	Cycles have been completed, door is open, test item inspected.
		Test item has fracture and broken into two pieces, right above the center line of the mandrels. There are wear marks on the mandrels. The mandrels still spin freely, no binding of mandrels evident.
		See NOD MECH - 1
9/18/2017	8:00	A new sample has been placed into the fixture and the chamber temperature set to -54°C.
	8:05	Chamber running with NTS 21 in the fixture ready for testing.
	8:25	Chamber at -54° C, one hour dwell started
	9:30	The motor controller will be programmed to run 250 cycles and stop for inspection.
	9:30	250 cycle started
	10:15	250 cycles completed - no failure
	10:17	250 cycle started
	10:44	500 cycles completed - no failure
	10:45	250 cycle started
	11:07	750 cycles completed - Door was opened to inspect tubing and it's broken in half.
		Chamber door was left open to allow the samples to return to room ambient. Test item was removed photographed.
		See NOD MECH-2



**NOTICE OF DEVIATION**

CLIENT:	Glenair	MJO:	PR066282	NOD NO.:	Mech-1
P.O. NO.:	P172615	DATE OF DEVIATION:	9/11/2017	CPAR NO.:	

NOTIFICATION MADE TO: <small>(CLIENT CONTACT)</small>	Sam Farhat	NOTIFICATION MADE BY:	Marty McCormick
NOTIFICATION DATE:	9/11/2017	VIA:	E-Mail
IF NOTIFICATION NOT MADE, PROVIDE JUSTIFICATION:			

TEST NAME:	Low Temperature Flexibility	TEST ITEM:	Convoluted Helical Tubing
SPECIFICATION:	QTP-646 & AS81914	MODEL/PART NO.	120-159-1-1-16C
REVISION/DATE:	Rev. 1	PARA:	4 & 4.7.5
		SERIAL NO.	NTS 20

**REQUIREMENT:** *(Reference paragraph or section of specification)*  
 The test item will be cycled 10,000 times from 0° to +90° to -90° to 0° at a rate of 15 +/-2 cycles per minute at -54° C. Tubing will be inspected at the end of test cycles for cracking.

**DESCRIPTION OF DEVIATION:**  
 During the cycling the chamber after 24 hours had a compressor fault. The fault resulted in the chamber not holding the -54°C temperature and drifted uncontrolled back to the ambient temperature in the lab. The Motor Controller is not integrated with the chamber so the cycles continued at chamber temperature during its drift back to ambient and the remaining cycles were completed at laboratory ambient temperature. Upon arrival Monday morning, the chamber door had been opened by one of the environmental technicians after the fault that they could not reset. The sample being tested was in the fixture and the cycles had stopped. The sample was broken in half right above the horizontal plane between the two mandrels. The mandrels show some witness marks, and were inspected to ensure they continue to roll freely.

**DISPOSITIONS / COMMENTS / RECOMMENDATIONS: (to be completed by client)**  
 Per email from Glenair; Proceed with retest using the new slip plate

Per email from Glenair dated 9/12/17  
 CLIENT TEST WITNESS (if applicable) \_\_\_\_\_ DATE

*Cathy Rumble* \_\_\_\_\_ *9/28/17*  
 NTS QUALITY REPRESENTATIVE DATE

Marty McCormick *M.M.* \_\_\_\_\_ 9/12/2017  
 NTS PROJECT MANAGER DATE

GOVERNMENT QAR (if applicable) \_\_\_\_\_ DATE

NOTE: IT IS THE CLIENT'S RESPONSIBILITY TO ANALYZE AND DISPOSITION DEVIATIONS ON CLIENT TEST PROGRAMS.

FOR NTS QA USE: Tracking Code: 3 & 2 1. Employee Error 3. Customer Item Problem 5. Power Failure 7. Other  
 2. Test Equipment Problem 4. Weather 6. Equipment Limitations



**NOTICE OF DEVIATION**

CLIENT:	Glenair	MJO:	PR066282	NOD NO.:	Mech-2
P.O. NO.:	P172615	DATE OF DEVIATION:	9/5/2017	CPAR NO.:	

NOTIFICATION MADE TO: <small>(CLIENT CONTACT)</small>	Sam Farhat	NOTIFICATION MADE BY:	Marty McCormick
NOTIFICATION DATE:	9/18/2017	VIA:	E-Mail
IF NOTIFICATION NOT MADE, PROVIDE JUSTIFICATION:			

TEST NAME:	Low Temperature Flexability	TEST ITEM:	Convolutd Helical Tubing
SPECIFICATION:	QTP-646 & AS81914	MODEL/PART NO.	120-159-1-1-16C
REVISION/DATE:	Rev. 1	PARA:	4 & 4.7.5
		SERIAL NO.	NTS 21

**REQUIREMENT:** *(Reference paragraph or section of specification)*  
 The test item will be cycled 10,000 times from 0° to +90° to -90° to 0° at a rate of 15 +/-2 cycles per minute at -54° C. Tubing will be inspected at the end of test cycles for cracking.

**DESCRIPTION OF DEVIATION:**  
 A new Sample NTS 21 was placed in the fixture after modifying the slip joint. The chamber was set to -54° C and once it reached temperature it was allowed to dwell for one hour prior to starting the cycles. The motor controller was set to only run 250 cycles at a time to narrow down the cycles before failure. Two 250 cycles set were completed there didn't appear to be any cracks in the sample at this point. At the end of the third set of 250 cycles the chamber door was opened for inspection and the upper portion of the sample being flexed had broken and fallen out of the slip joint of the fixture. The chamber was turned off and allowed to come back to laboratory ambient conditions.

**DISPOSITIONS / COMMENTS / RECOMMENDATIONS: (to be completed by client)**  
 Dispositions noted in email from GlenAir dated 9/18/17. Test failure to be documented in report.

Dispositioned per email dated 9/18/7		<i>Craig Rumble</i>	9/28/17
CLIENT TEST WITNESS (if applicable)	DATE	NTS QUALITY REPRESENTATIVE	DATE
<i>Marty McCormick</i>	9/28/17		
NTS PROJECT MANAGER	DATE	GOVERNMENT QAR (if applicable)	DATE

NOTE: IT IS THE CLIENT'S RESPONSIBILITY TO ANALYZE AND DISPOSITION DEVIATIONS ON CLIENT TEST PROGRAMS.

FOR NTS QA USE: Tracking Code:  1. Employee Error 3. Customer Item Problem 5. Power Failure 7. Other  
 2. Test Equipment Problem 4. Weather 6. Equipment Limitations



**Low Temperature Flex EQUIPMENT LIST**

Client: Glenair PR No.: PR066282 Start Date: 9/8/2017 End Date: 9/18/2017

Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL0906	Chamber (Temperature/Humidity)	Theratron	SR-1200-3-3	27907	± 2.5° C/2.5% RH	-68 to 177° C/0 to 100% RH	6 Months	10/24/2017
FL5428	Motor (Stepper)	Applied Motion Products	HT34-490	NONE	MFG	N/A	No Calibration Required	N/A
FL7878	Controller (Servo Motor)	Applied Motion Products	STAC6-SI	255622	MFG	N/A	No Calibration Required	N/A
FL5170	Controller (Process)	Applied Motion Products	HUB 444	617151	MFG	0	No Calibration Required	N/A



**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair	<b>MJO:</b>	PR066282
<b>TEST:</b>	Low Temperature Flex	<b>DATE:</b>	10/6/2017
<b>TEST ITEM:</b>	Convuluted Conduit Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS-23 thru NTS-27
<b>SPECIFICATION:</b>	QTP-646 Rev 1 (Ref. SAE AS81914), Email dated 10/6/17		
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	82°F
<b>ENGINEER:</b>	Marty McCormick	<b>RH:</b>	54%
<b>TECHNICAL REVIEW:</b>	<i>M. McC</i>	<b>DEVIATION:</b>	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
		<b>TECHNICAL REVIEW DATE:</b>	11/13/17

Date	Time	Test Description
		<b>4.7.5 Low Temperature Flexibility</b> - A length of tubing shall be secured to the apparatus shown in Figure 3. The apparatus shall be placed in a cold chamber at -54 +/-1 °C (-65 +/-2 °F) and the tubing flexed over the mandrels at the rate of 15 +/- 2 cycles per minute. A cycle shall consist of one flex over each mandrel. The number of cycles for each convuluted tubing shall be as specified in the applicable specification sheet. The tubing shall be examined for cracking.
		A fixture consisting of two mandrels with a diameter of 1.25" (minimum bend radius) was utilized for setup. The mandrels were separated with enough clearance that the tube would not touch either side in the starting position ( 0°). A arm was used that would allow for a piece of Teflon to act as the "slip sleeve" from figure 3. A hole was 13/16"drilled through the Teflon and the corners de-burred. The tube was secured in one of the supplied fittings. The fitting was secured to the base of the fixture and allows the tube to pass freely through the center of the mandrels and through the Teflon "slip sleeve". A stepper motor and controller will be used to control the speed and angle that the arm will travel. With a scrap piece of tubing in the fixture, the motor controller was programmed so that the arm would travel from 0° in the clockwise direction until the tubing was bent over the mandrel 90° (+90°). The motor was then programmed to move in the counterclockwise direction until the tubing was bent over the mandrel 90° (-90°) and return to 0°. This will be considered one cycle and will be timed to complete 15 cycles per minute. The fixture will be placed into a chamber and the temperature lowered to -54°C. The chamber will dwell for a minimum of one hour to stabilize part and fixture prior to starting the cycles. 10,000 cycles will be run in total. Once all the cycles have been completed the chamber will be ramped back to ambient conditions and the test item inspected for cracks.
10/6/17	11:00	Four additional samples have been cut and will be placed in an oven at 350°C for 10 days to condition the samples per e-mail dated 10-6-17 @ 7:08am.
10/6/17	11:15	Chamber turned on and coming up to temperature prior to having samples placed inside.
10/6/17	15:00	Four samples placed in chamber at 300° C. Photo taken.
10/6/17	17:00	Chamber at 300°C
10/9/17	8:30	Chamber at 300°C
10/9/17	17:00	Chamber at 300°C



**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair	<b>MJO:</b>	PR066282
<b>TEST:</b>	Low Temperature Flex	<b>DATE:</b>	10/6/2017
<b>TEST ITEM:</b>	Convolutd Conduit Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS-23 thru NTS-27
<b>SPECIFICATION:</b>	QTP-646 Rev 1 (Ref. SAE AS81914), Email dated 10/6/17		<b>PARA:</b> 4 and 4.7.5
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	82°F <b>RH:</b> 54%
<b>ENGINEER:</b>	Marty McCormick	<b>DEVIATION:</b>	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
<b>TECHNICAL REVIEW:</b>	<i>M-M</i>	<b>TECHNICAL REVIEW DATE:</b>	11/13/17

Date	Time	Test Description
10/10/17	8:30	Chamber at 300°C
10/10/17	17:00	Chamber at 300°C
10/11/17	8:00	Chamber at 300°C
10/11/17	17:00	Chamber at 300°C
10/12/17	8:00	Chamber at 300°C
10/12/17	17:00	Chamber at 300°C
10/13/17	10:45	Chamber at 300°C
10/13/17	17:00	Chamber at 300°C
10/16/17	8:00	Chamber at 300°C
10/17/17	8:00	Chamber at 300°C
10/18/17	8:00	Chamber at 300°C
10/19/17	8:00	Chamber at 300°C
10/20/17	9:00	Samples removed from chamber, total time in chamber at 300°C is 216 hours.
10/30/17	15:12	One of the four aged samples has been placed into the test fixture (NTS-23). The motor controller will be programmed to cycle the unit 250 step increments to determine when and if a failure occurs.
10/31/17	8:00	Chamber running down to -54°C.
	9:30	Chamber at -54° C, for one hour to stabilize.
	9:35	First 250 cycles started
	10:45	First 250 cycles completed, no damage noted.
	10:46	Second 250 cycles started
	11:02	500 cycles completed, no damage noted.
	11:03	Third 250 cycles started
	11:28	750 cycles completed, no damage noted.
	11:30	Fourth 250 cycles started
	11:57	1,000 cycles completed, no damage noted.
	11:58	Fifth 250 cycles started
	13:30	Upon completion of the above 250 cycles the DUT being tested was found broken. The DUT was not checked during the cycles so an exact number of cycles cannot be determined. So cycles





**GENERAL DATA SHEET**

<b>CUSTOMER:</b>	Glenair	<b>MJO:</b>	PR066282
<b>TEST:</b>	Low Temperature Flex	<b>DATE:</b>	10/6/2017
<b>TEST ITEM:</b>	Convoluted Conduit Tubing		
<b>PART NUMBER:</b>	120-159-1-1-16C	<b>S/N:</b>	NTS-23 thru NTS-27
<b>SPECIFICATION:</b>	QTP-646 Rev 1 (Ref. SAE AS81914), Email dated 10/6/17		
<b>TECHNICIAN:</b>	John A. Smith	<b>TEMP:</b>	82°F <b>RH:</b> 54%
<b>ENGINEER:</b>	Marty McCormick	<b>DEVIATION:</b>	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
<b>TECHNICAL REVIEW:</b>	M.M.	<b>TECHNICAL REVIEW DATE:</b>	11/13/17

Date	Time	Test Description
10/31/17		count would have been from 1,001 to 1,250.
		The chamber has been turned off. PM notified.
		Sample NTS-23 failed to meet the requirements of the specification. Ref. NOD Mech-3



**NOTICE OF DEVIATION**

CLIENT:	Glenair	MJO:	PR066282	NOD NO.:	Mech-3 Rev. 1
P.O. NO.:	P172615	DATE OF DEVIATION:	10/30/2017	CPAR NO.:	

NOTIFICATION MADE TO: <small>(CLIENT CONTACT)</small>	Sam Farhat	NOTIFICATION MADE BY:	John Smith
NOTIFICATION DATE:	12/12/2017	VIA:	E-Mail
IF NOTIFICATION NOT MADE, PROVIDE JUSTIFICATION:			

TEST NAME:	Low Temperature Flexability	TEST ITEM:	Convolutd Helical Tubing
SPECIFICATION:	QTP-646 & AS81914 & Email dated 10/6/17	MODEL/PART NO.	120-159-1-1-16C
REVISION/DATE:	Rev. 1	PARA:	4 & 4.7.5
		SERIAL NO.	NTS-23

**REQUIREMENT:** *(Reference paragraph or section of specification)*  
 Bake test samples to 300°C for 10 days (240 hours ± 1). The test item shall then be be cycled 10,000 times from 0° to +90° o -90° to 0° at a rate of 15 +/-2 cycles per minute at -54° C. Tubing will be inspected at the end of test cycles for cracking.

**DESCRIPTION OF DEVIATION:**  
 The test item broke between 1,001 and 1,250 cycles. Note: notification to client and documented in initial release or test report indicated the test sample broke between 750- 1000 cycles. Test data and test report to be revised to reflect correct account of events.

**DISPOSITIONS / COMMENTS / RECOMMENDATIONS: (to be completed by client)**  
 Proceed with test report.

Approved by customer via email dated 12/18/2017		<i>Cathy Reumble</i>	12/18/17
CLIENT TEST WITNESS (if applicable)	DATE	NTS-QUALITY REPRESENTATIVE	DATE
Marty McCormick <i>M.A.</i>	12/18/17		
NTS PROJECT MANAGER	DATE	GOVERNMENT QAR (if applicable)	DATE

NOTE: IT IS THE CLIENT'S RESPONSIBILITY TO ANALYZE AND DISPOSITION DEVIATIONS ON CLIENT TEST PROGRAMS.

FOR NTS QA USE: Tracking Code:  1. Employee Error 3. Customer Item Problem 5. Power Failure 7. Other  
 2. Test Equipment Problem 4. Weather 6. Equipment Limitations



**LOW TEMPERATURE FLEX EQUIPMENT LIST**

Client: Glenair PR No.: PR066282 Start Date: 10/6/2017 End Date: 10/31/2017

Control No.	Equipment	Manufacturer	Model No.	Serial No.	Accuracy	Range	Calibration	
							Cycle	Cal. Due
FL0993	Chamber (High Temperature)	Blue M	CW-6680F	CW-633	± 2.2° C	0	No Calibration Required	N/A
FL0995	Controller (Process)	Watlow	942A-1BB2-A000	NONE	± 2° C	0 to 600°C	12 Months	3/27/2018
FL0906	Chamber (Temperature/Humidity)	Thermotron	SR-1200-3-3	27907	± 2.5° C/2.5% RH	-68 to 177° C/0 to 100% RH	12 Months	10/24/2017*
FL5428	Motor (Stepper)	Applied Motion Products	HT34-490	NONE	MFG	N/A	No Calibration Required	N/A
FL7878	Controller (Servo Motor)	Applied Motion Products	STAC6-SI	255622	MFG	N/A	No Calibration Required	N/A
FL5170	Controller (Process)	Applied Motion Products	HUB 444	617151	MFG	0	No Calibration Required	N/A

\* The temperature chamber went out of calibration during the test. Post test calibration of the chamber indicated that the chamber remained in tolerance (see NOD MECH-4).



**NOTICE OF DEVIATION**

CLIENT:	Glenair	MJO:	PR066282	NOD NO.:	Mech-4
P.O. NO.:	P172615	DATE OF DEVIATION:	10/30/2017	CPAR NO.:	

NOTIFICATION MADE TO: <small>(CLIENT CONTACT)</small>	Sam Farhat	NOTIFICATION MADE BY:	Marty McCormick
NOTIFICATION DATE:	11/27/2017	VIA:	E-Mail
IF NOTIFICATION NOT MADE, PROVIDE JUSTIFICATION:			

TEST NAME:	Low Temperature Flexability	TEST ITEM:	Convolutd Helical Tubing
SPECIFICATION:	QTP-646 & AS81914 & Email dated 10/6/17	MODEL/PART NO.	120-159-1-1-16C
REVISION/DATE:	Rev. 1	PARA:	4 & 4.7.5
		SERIAL NO.	NTS-23

**REQUIREMENT:** *(Reference paragraph or section of specification)*  
 Bake test samples to 300°C for 10 days (240 hours ± 1). The test item shall then be be cycled 10,000 times from 0° to +90° o -90° to 0° at a rate of 15 +/-2 cycles per minute at -54° C. Tubing will be inspected at the end of test cycles for cracking.

**DESCRIPTION OF DEVIATION:**  
 Temperature chamber that was used for Low Temperature Flexability testing was not in calibration during use. Calibration was due on 10/24/17. Test date was 10/30/17. Chamber was recalibrated on 11/8/17 and found to be in tolerance with no adjustments required. NTS Asset no. FL0906

**DISPOSITIONS / COMMENTS / RECOMMENDATIONS:** *(to be completed by client)*  
 Proceed with finalizing test report.

Customer approved NOD via email dated 11/27/17		<i>Cary Rumble</i>	11-28-17
CLIENT TEST WITNESS <small>(if applicable)</small>	DATE	NTS QUALITY REPRESENTATIVE	DATE
Marty McCormick <i>M.M.</i>	11/27/2017		
NTS PROJECT MANAGER	DATE	GOVERNMENT QAR <small>(if applicable)</small>	DATE

**NOTE: IT IS THE CLIENT'S RESPONSIBILITY TO ANALYZE AND DISPOSITION DEVIATIONS ON CLIENT TEST PROGRAMS.**

FOR NTS QA USE: Tracking Code:  1. Employee Error 2. Test Equipment Problem 3. Customer Item Problem 4. Weather 5. Power Failure 6. Equipment Limitations 7. Other



**Test Item Identification (Typical)**



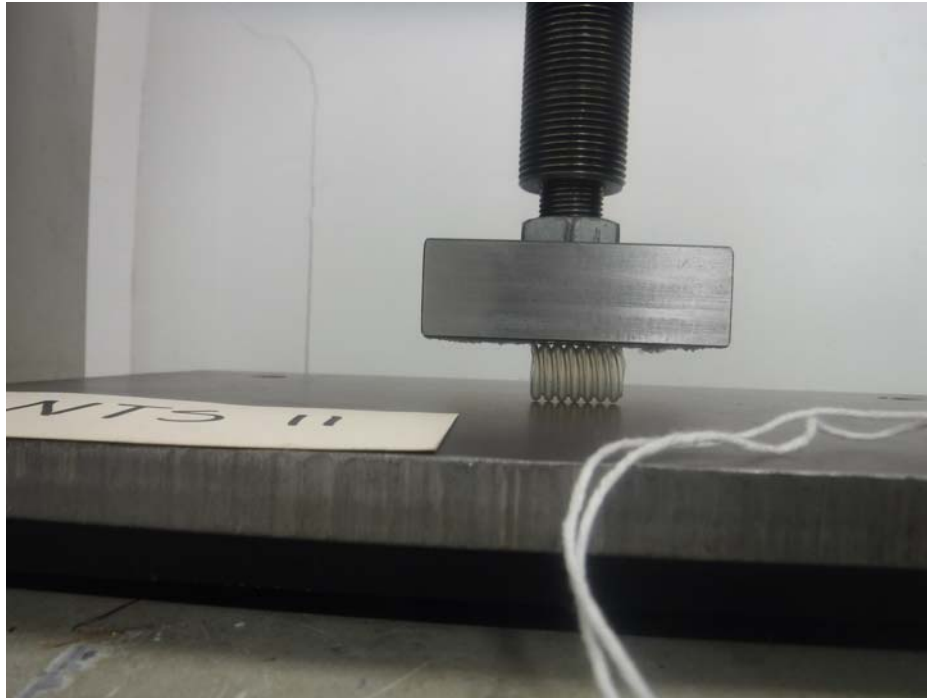
**Tensile Strength Properties Test Setup**



**Tensile Strength Properties Test Height**



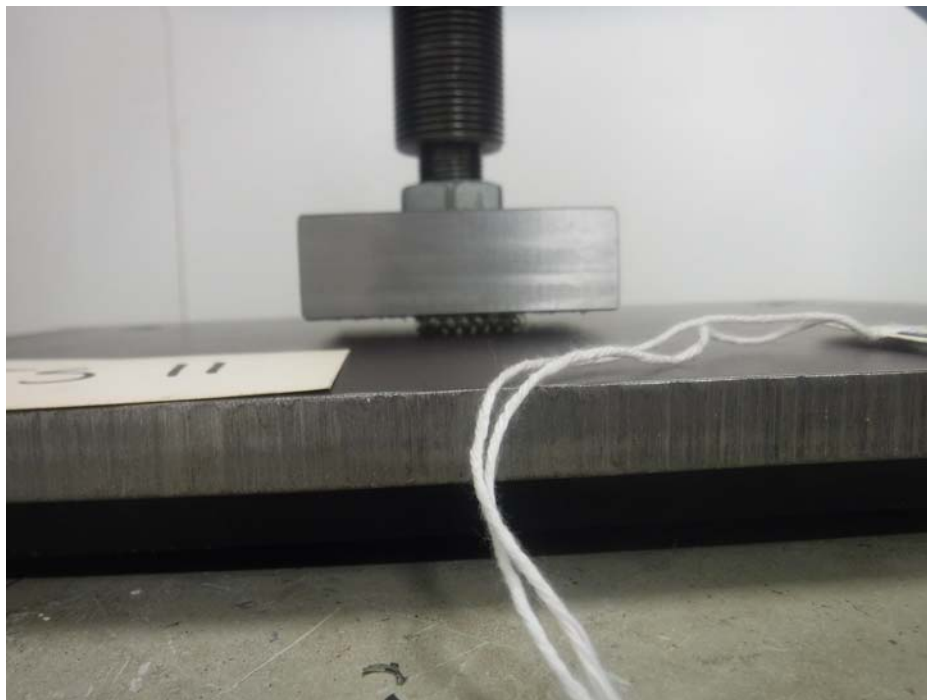
**Tensile Strength Properties Pull Height**



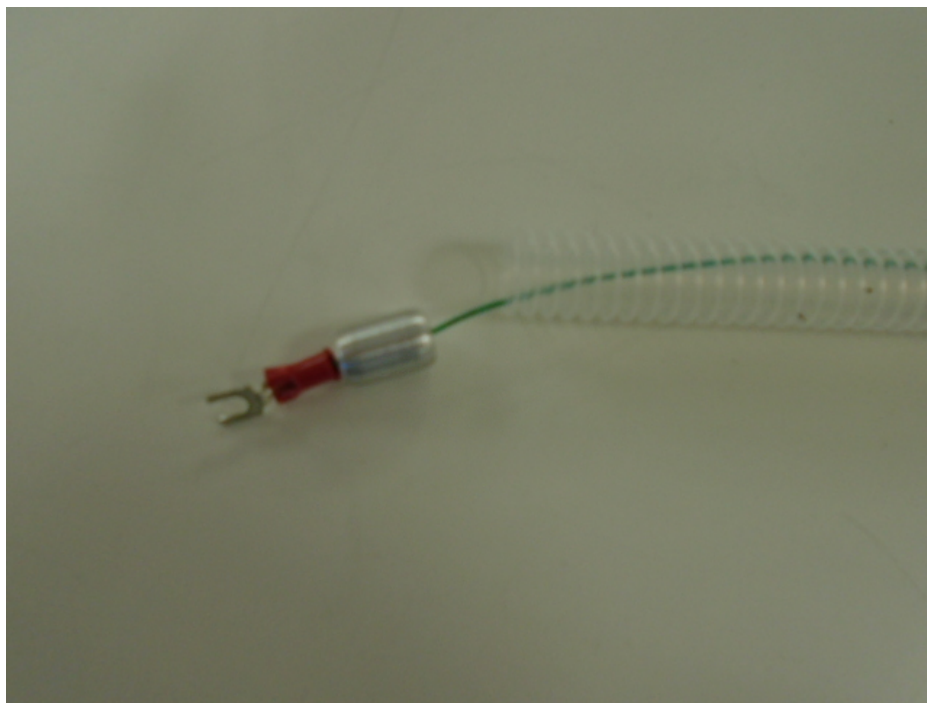
**Crush Resistance Test Setup**



**Crush Resistance - Outer Dimensions**

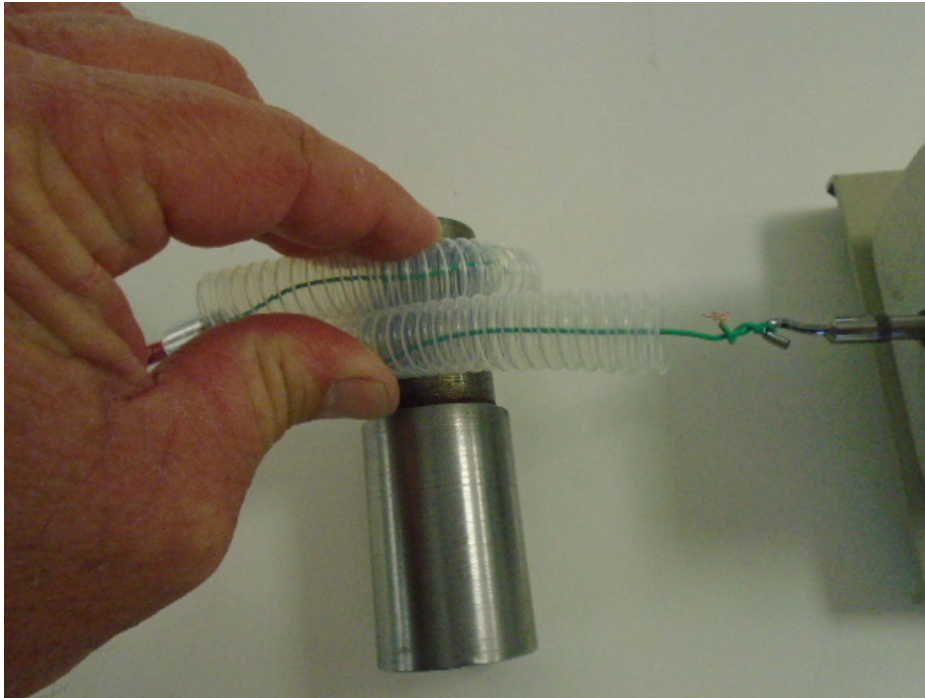


**Crush Resistance at 75%**

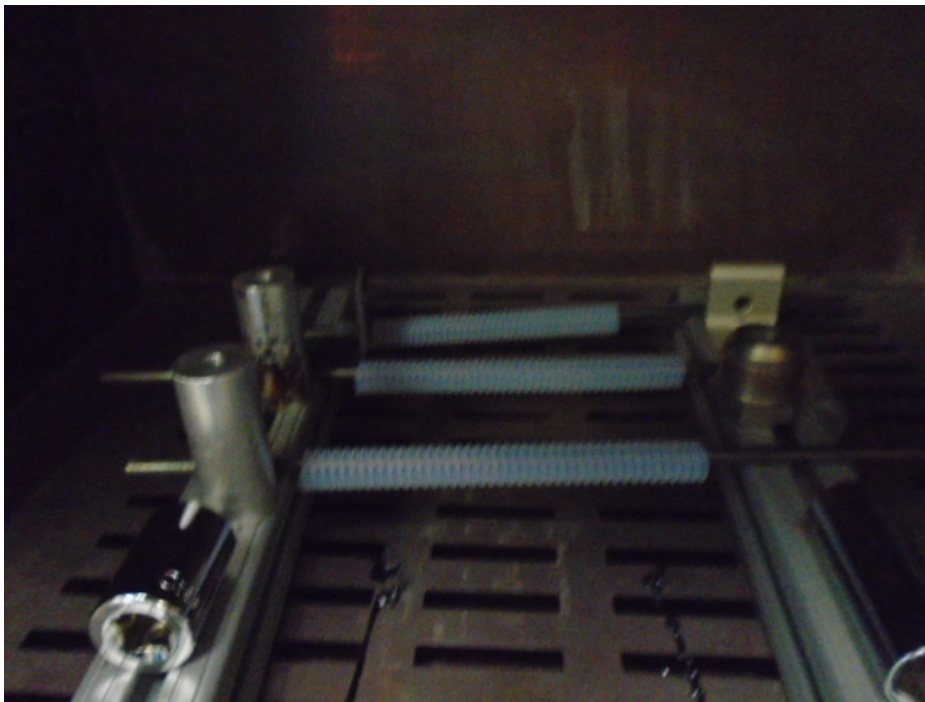


**Minimum Bend Radius – Slug**





**Minimum Bend Radius – Test Setup**



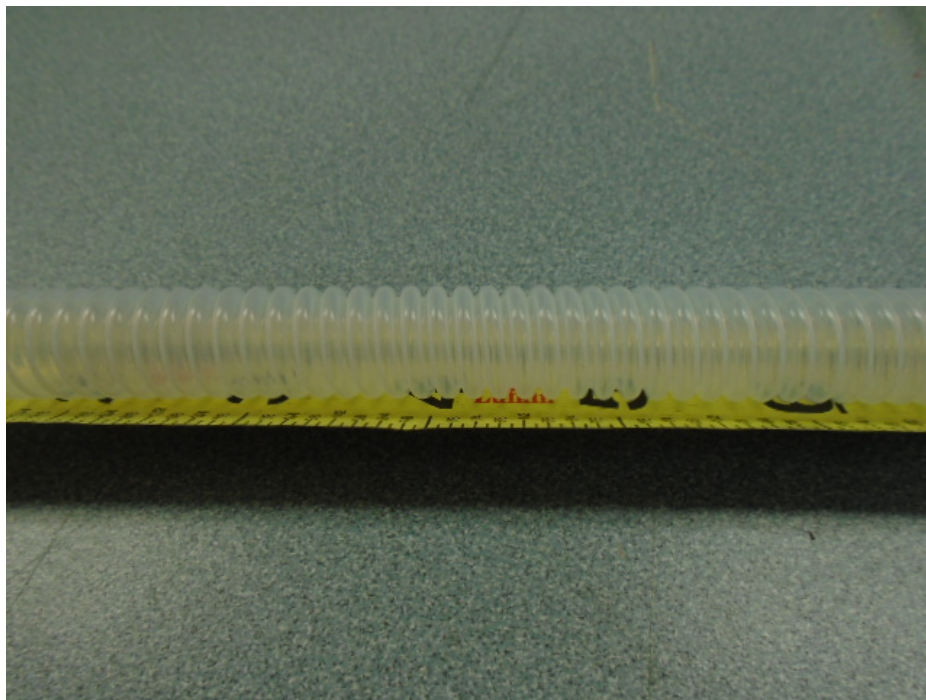
**Heat Aging Test Setup**



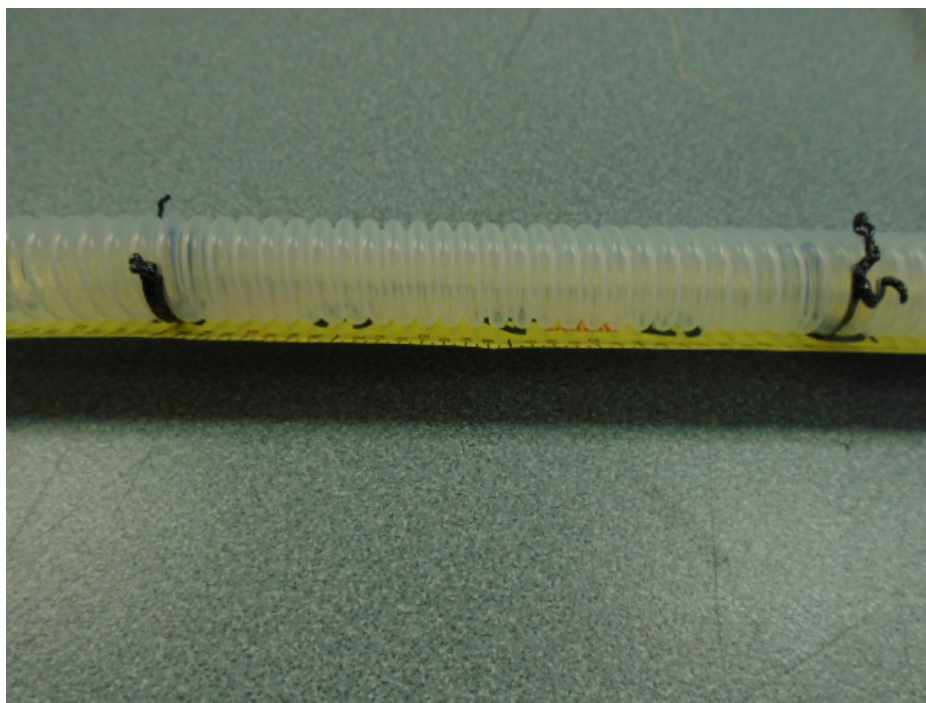
**Heat Aging Test**



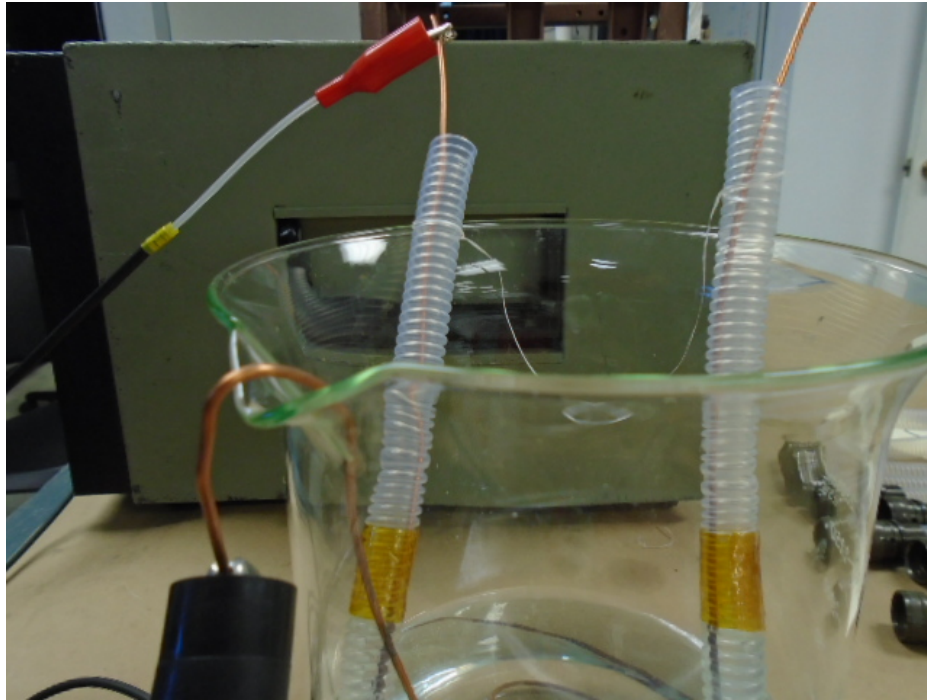
**Heat Aging Test**



**Heat Shock Pre-Test**



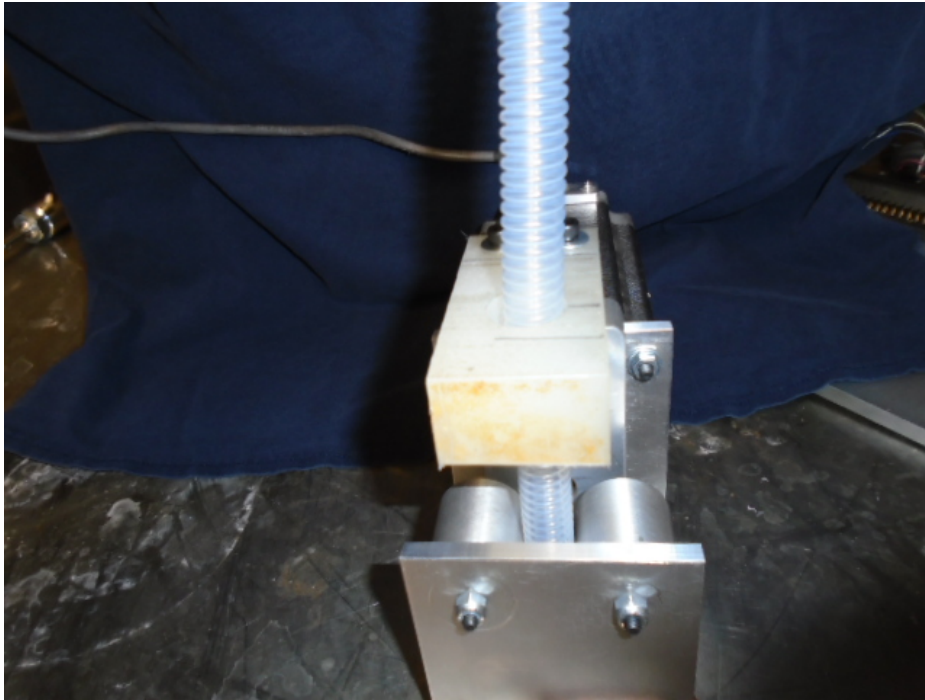
**Heat Shock Post Test**



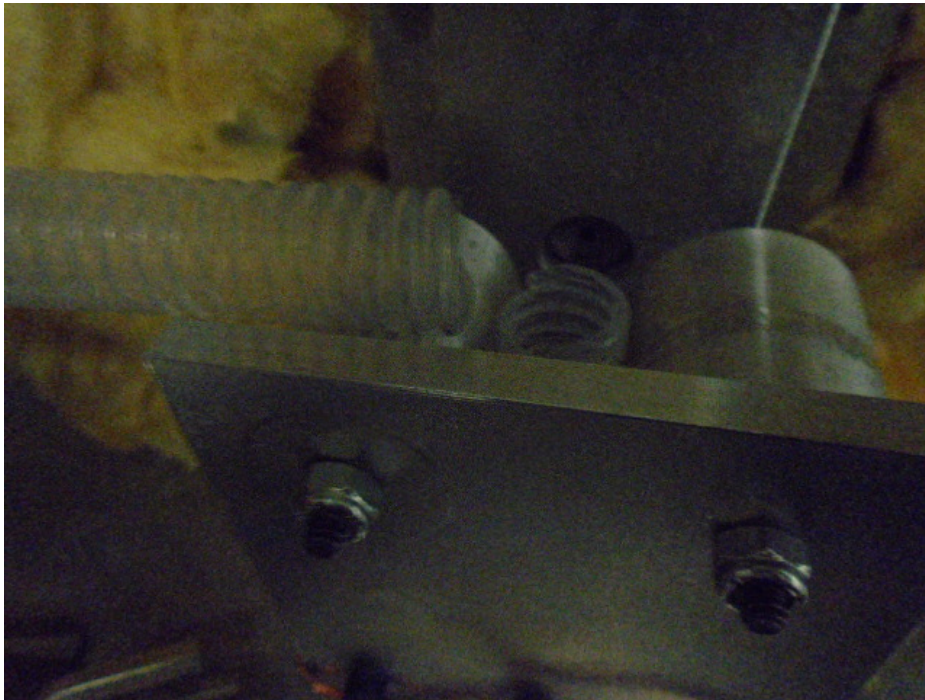
**Dielectric Breakdown Test Setup**



**Dielectric Breakdown Test Setup**



**Low Temperature Flex Test Setup (Typical)**



**Low Temperature Flex Post Test**



**Low Temperature Flex Post Test**