



TEST REPORT

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ThermaRex™ Wire Qualification Test Report (Ref. QTP-850)

Revision	Description of Changes	Date	Author
1	Initial Release	6/3/2020	Micah Summers

1. Scope

This test report summarizes the qualification test results of ThermaRex™ wire. All tests were performed according to AS4373 Revision E and QTP-850.

2. Test Specimens

The part number and full description of the ThermaRex™ wire tested is listed in Table I.

Table I

Part Number	Description
960-2371-N-C-9-5-A	20 AWG ThermaRex™ Wire Twisted Shielded Pair with ArmorLite™ CF and ThermaRex™ Jacket

960-2371

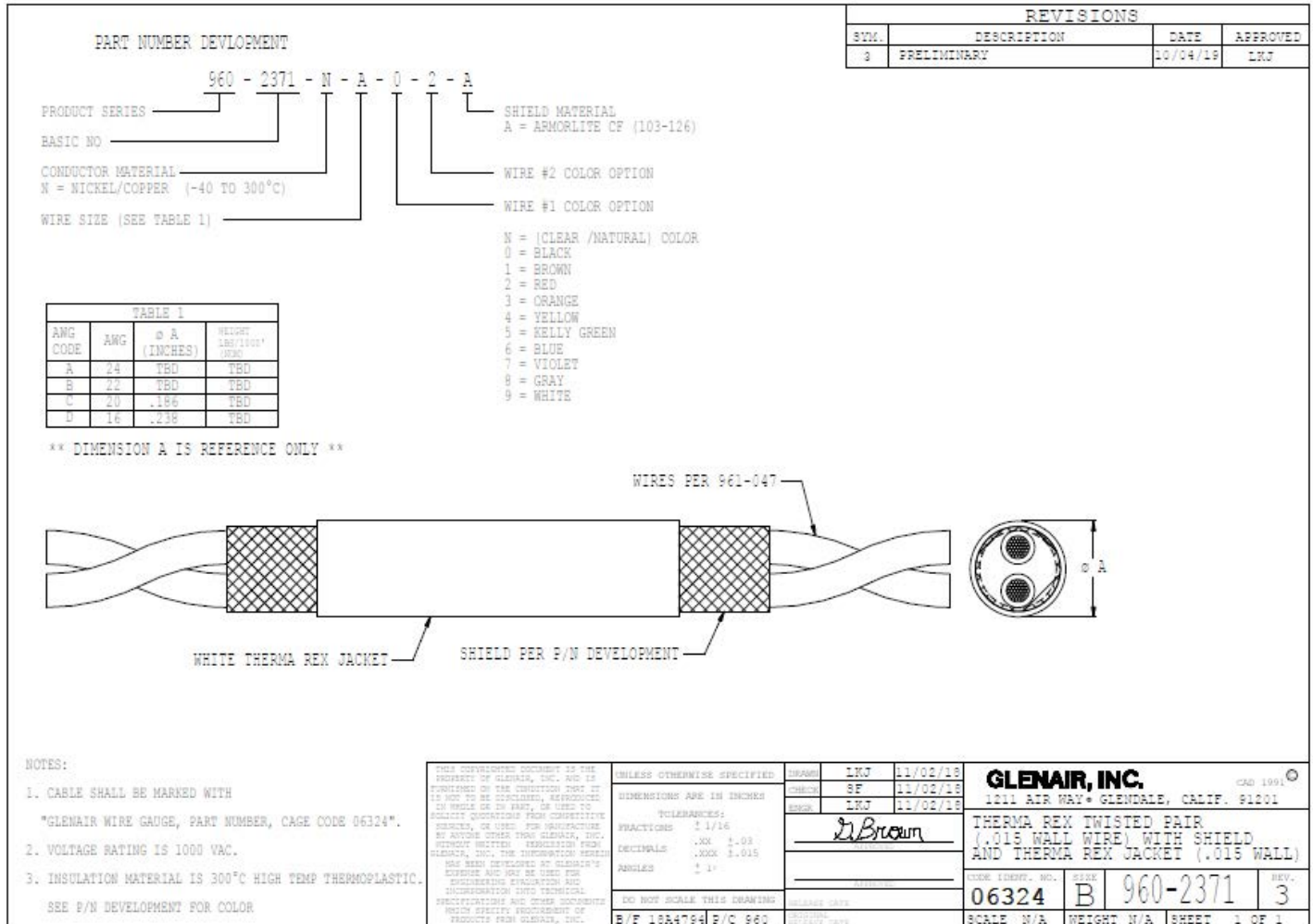


Figure 1: Glenair ThermaRex™ Twisted Pair with ArmorLite™ CF Shield and ThermaRex™ Jacket drawing 960-2371



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3. Summary of Results

The results of the tests are summarized in Table II.

Table II

Test	Specification	Test Conditions	Results
Multi-Day Heat Aging (Life Cycle)	AS4373E, Method 807	300°C for 120 Hours DWV 2500 VDC 60 seconds	Pass
Wrapback	AS4373E, Method 708	300°C for 6 Hours DWV 2500 VDC 60 seconds	Pass
Cold Bend	AS4373E, Method 702	-65°C for 4 Hours DWV 2500 VDC 60 seconds	Pass
Thermal Shock Resistance	AS4373E, Method 805	-55°C to 300°C	Pass
Humidity Resistance	AS4373E, Method 603	95% Humidity for 360 Hours	Pass
60-Degree Burn	FAR 25.853	See test report	Pass
Wet Arc Propagation Resistance	AS4373E, Method 509	See test report	Pass
Forced Hydrolysis (Unconditioned Wire)	AS4373E, Method 602	70°C for 672 Hours DWV 2500 VDC 60 seconds	Pass
Bend Test	AS4373E, Method 712	23°C	Pass
Insulation Shrinkage/Expansion	AS4373E, Method 104	300°C for 6 Hours	Pass
Dynamic Cut-Through	AS4373E, Method 703	23°C and 300°C	Pass
Fluid Immersion	AS4373E, Method 601	See test report	Pass

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QTP-850 ThermaRex Wire Testing

5 May 2020

Version 1

Prepared By: Lawrence Quinto
Test Engineer

Reviewed By: Brian Morales
Test Engineer

Approved By: Kane Liang
Quality Manager



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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1 Identification

One spool of ThermaRex Wire (Twisted Pair with ArmorLite CF Shield and ThermaRex Jacket, Part Number 960-2371-N-C-9-5-A) was submitted for testing per the battery provided in QTP-850, “ThermaRex Wire”, dated 11 July 2019. Specimens were created for the tests as provided in the table below:

Test Group	Test Method	QTP-850 Requirement Section	Specimen Labels
1	Multi-Day Heat Aging (Life Cycle)	8.1.1	001 / 002 / 003
2	Wrapback	8.1.2	004 / 005 / 006
3	Cold Bend	8.1.3	007 / 008 / 009
4	Thermal Shock Resistance	8.1.4	010 / 011 / 012
5	Humidity Resistance	8.1.5	013 / 014 / 015
6	Flame Resistance	8.1.6	016 / 017 / 018
7	Wet Arc Propagation Resistance	8.1.7	101
8	Forced Hydrolysis	8.1.8	022 / 023 / 024
9	Bend Test	7.1.5	025 / 026 / 027
10	Insulation Shrinkage/Expansion	8.1.9	028 / 029 / 030
11	Dynamic Cut-Through	8.1.10	031 / 032 / 033
12	Fluid Immersion	8.1.11	019 / 020 / 021
13	60 Degree Wire Burn	-	N1157

Table 1: Specimen Identification

2 References

1. SAE AS4373 Rev. E, *Test Methods for Insulated Electric Wire*.
2. Lectromechanical Design Company, LLC (Lectromec) Report N1061-R001 Rev A, dated 14 December 2019
3. Lectromechanical Design Company, LLC (Lectromec) Report N1157-R001, dated 30 March 2020



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3 Test Summary

3.1 Multi-Day Heat Aging

Three samples, each 14 inches long, were cut from a spool of ThermaRex Wire. The samples were examined to verify their lengths were within the requirements for the Multi-day heat aging test and to see that there were no visible flaws on the wire jacket. The wires were hung over a PTFE coated stainless steel mandrel so that the jacket was compressed and the insulator was under stress. The wires were placed in an air circulating oven for 120 hours at 300°C. After the Multi-Day Heat Aging test, the samples were subjected to the Bend Test and Voltage Withstand Test. All samples passed as they did not crack during the bend test and passed the voltage withstand test.

Test results are compiled in Section 3.1. Test details are provided in data sheet 19218D1SPV1, located in the Appendix of this report.

3.2 Wrapback

Three samples of ThermaRex wire, each 12 inches in length, were cut from a large spool of wire supplied by the customer. After initial visual examination, they were then bent about the midpoint such that the radius of the bend was greater than the radius of the wire with one side wrapping 4 full turns around the other following the procedure in AS4373 Revision E 4.7.8.4.1. The samples were placed in an air circulating oven at 300°C for 6 hours and then removed and subjected to voltage withstand testing. The samples passed as they did not crack or suffer damage during the wrapback test and passed the voltage withstand testing.

Test results are compiled in Section 3.2. Test details are provided in data sheet 19218D2SPV1, located in the Appendix of this report.

3.3 Cold Bend

Three 36.5 inch wire segments were cut from a large spool of ThermaRex Wire. The samples were tested per QTP-850 ThermaRex Wire Testing section 8.1.3, section 7.1.3 and AS4373 revision E. section 4.7.2. The purpose of this test was to test the cold weather durability of the ThermaRex wire jacket. The samples were placed one at a time inside a thermal chamber and cooled to -65°C attached to a PTFE coated mandrel on one end and a weight at the other. After soaking at -65°C for 4 hours, the PTFE rod was rotated at 1 rpm manually using a timer until the entire length of the cable was coiled around the mandrel while inside the chamber. The sample was removed from the chamber and mandrel while maintaining its coiled configuration and checked for cracks and damage. The samples were then subjected to voltage withstand testing. The samples passed as there was no damage after Cold Bend testing and all samples passed the voltage withstand testing.

Test results are compiled in Section 3.3. Test details are provided in data sheet 19218D3SPV1, located in the Appendix of this report.



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3.4 Thermal Shock Resistance

Three samples, each 14 inches in length, were cut from a spool of ThermaRex Wire supplied by the customer. The samples were subjected to thermal shock resistance testing to test the durability of the ThermaRex jacket. The wires were soaked in a preheated oven at 300°C and a precooled chamber at -55°C for 30 minutes each and manually shuttled between the chambers within two minutes. This process was repeated 4 times. Insulation resistance testing was performed on all samples before and after thermal shock resistance testing to detect any deteriorations. The samples passed all tests as there was no flaring of any layer of insulation after the thermal shock resistance test.

Test results are compiled in Section 3.4. Test details are provided in data sheet 19218D4SPV1, located in the Appendix of this report.

3.5 Humidity Resistance

Three wires, each 52' long were cut from a spool of ThermaRex Wire supplied from the customer. The samples were subjected to insulation resistance testing before and after humidity resistance testing per QTP-850 ThermaRex Wire Testing in accordance with AS4373 Revision E, Section 4.5.10 and Section 4.6.3. The purpose of the testing was to determine the durability of the ThermaRex jacket after exposure to 95% humidity and thermal cycling for 360 hours. The samples passed testing as the jacket suffered no damages that interfered with the performance of the wires.

Test results are compiled in Section 3.5. Test details are provided in data sheet 19218D5SPV1, located in the Appendix of this report.

3.6 Wet Arc Propagation Resistance

Two (2) groups of fifteen (15) seven-wire specimen bundles were created from the green and white conductors of a length of customer supplied ThermaRex wire. These bundles were then submitted to Lectromec for wet arc propagation resistance testing per QTP-850 Section 8.1.7 in accordance with AS4373 Revision E, Section 4.5.9.

Test results are compiled in Section 3.6. Test details are provided in Lectromec Report N1061-R001 Section 2.2, located in the Appendix of this report.

3.7 Forced Hydrolysis

Three segments of ThermaRex Wire, each 30 inch in length, were cut from the customer-supplied spool of cable and were tested according to QTP-850 ThermaRex Wire Testing, section 8.1.8 Forced Hydrolysis (Unconditioned Wire). The samples were wrapped ten times around a 6X PTFE coated steel mandrel and immersed in a 5% saline solution held at 70°C for 672 hours. After the immersion the samples were visually inspected and subjected to voltage withstand (wet dielectric) testing. The samples



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passed as they did not degrade in the long term saline solution immersion such that the performance of the wires was affected.

Test results are compiled in Section 3.7. Test details are provided in data sheet 19218D8SPV1, located in the Appendix of this report.

3.8 Bend Test

Three segments of ThermaRex wire were cut to 24 inches from a large spool supplied by the customer. The samples were subjected to insulation resistance testing before and after Bend Testing per AS 4373 Rev. E 4.7.12. All samples passed as they did not crack or suffer damages during the bend test.

Test results are compiled in Section 3.8. Test details are provided in data sheet 19218D9SPV1, located in the Appendix of this report.

3.9 Insulation Shrinkage/Expansion

Three segments of ThermaRex wire, each of length 13 inches, were cut from a spool of cable and were tested for Insulation Shrinkage/Expansion according to QTP-850 ThermaRex Wire Testing, section 8.1.9. An insulation resistance test was performed before the insulation shrinkage and expansion test per QTP-850 Table 4 according to section 7.1.4. The wires had 1/2 inch of insulation stripped from each end and measured. Afterwards the samples were placed on a wire oven rack inside an air circulating oven and exposed to 300°C for 6 hours. The lengths of the exposed conductors of each sample were measured after heating the wires. All samples passed as no samples exhibited a change in insulation length greater than 0.125 inches.

Test results are compiled in Section 3.9. Test details are provided in data sheet 19218D10SPV1, located in the Appendix of this report.

3.10 Dynamic Cut-Through

Six ThermaRex cable segments, each 18 inches long, were cut from the customer supplied spool and submitted to Lectromec for dynamic cut-through testing per QTP-850 Section 8.1.10, in accordance with AS4373 Method 703. The test was conducted three times at ambient conditions and three times at 300°C.

Test results are compiled in Section 3.10. Test details are provided in Lectromec Report N1061-R001 Section 3.2, located in the Appendix of this report.

3.11 Fluid Immersion

Twelve ThermaRex wire segments, each 24" long, were cut from a large spool of wire. All samples were subjected to insulation resistance testing before and after the fluid immersion. Three samples were immersed into a bath of MIL-H-5606 Hydraulic Fluid, Isopropyl Alcohol, MIL-DTL-5624 JP-4 Turbine Fuel, and MIL-L-7808 Lubricating Oil each. Testing was conducted according to AS 4373 4.6.1



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specifications. All samples passed as they showed no signs of damage or deformation such that the performance of the wire was affected.

Test results are compiled in Section 3.11. Test details are provided in data sheet 19218D11SPV1, located in the Appendix of this report.

3.12 60° Wire Burn Test

One ThermaRex wire sample of length 157 inches was cut from the customer supplied spool. The entire continuous sample length was first subjected to insulation resistance testing before its submission to Lectromec for 60° Bunsen Burner Testing per 14 CFR 25 Appendix F Part I, Paragraph (b)(7). The sample was divided into four specimens and subjected to a Bunsen Burner flame at 60° inclination for 30 seconds.

All samples met the acceptance criteria of 14 CFR 25 Appendix F Part I, Paragraph (a)(3).

Test results are compiled in Section 3.12. Test details are provided in 19218D13LQV1 and Lectromec Report N1157-R001, located in the Appendix of this report.



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4 Results Summary

4.1 Multi-Day Heat Aging

Multi-Day Heat Aging Test Report					
Mandrel	Length	24"	Oven temperature	300°C	
	Diameter	1/4"			
	Weight	5.3 oz			
Load Weight	Sample No.	Weight (lbs)	Post Test Assesment	Sample No.	Cracking
	001	5		001	None
	002	5		002	None
	003	5		003	None

Bend Test Data		
Mandrel	Length	12"
	Diameter	1 5/8"
	Weight	102.45 oz
Post Test Assesment	Sample No.	Cracking
	001	None
	002	None
	003	None

Voltage Withstand Test Data			
Description	A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	Effective Length	22"
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
001	2500	60	Pass
002	2500	60	Pass
003	2500	60	Pass

4.2 Wrapback

Wrapback Test Data		
Post Test Assesment	Sample No.	Cracking
	004	None
	005	None
	006	None

Voltage Withstand Test Data			
Description	A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	Effective Length	10"
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
004	2500	60	Pass
005	2500	60	Pass
006	2500	60	Pass



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4.3 Cold Bend

Cold Bend Test Data		
	Sample No.	Cracking
Post Test Assessment	007	None
	008	None
	009	None

Voltage Withstand Test Data			
Description	A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	Effective Length	35.5"
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
007	2500	60	Pass
008	2500	60	Pass
009	2500	60	Pass

4.4 Thermal Shock Resistance

Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	12	Applied Voltage (DC)	500	Electrification Time (s)	60

Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)
010	Before	255.03	3.06	413.70	4.96
	After	957.33	11.50	1898.00	22.80
011	Before	222.86	2.67	504.83	6.06
	After	>2,000	24.00	1460.00	17.50
012	Before	75.80	0.91	149.63	1.80
	After	>2000	24.00	1762.00	21.20



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3.4 Thermal Shock Resistance (continued)

Thermal Shock Test Data: Exposed Conductor Length (inches)						
Sample No.	-	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Net Change
010	White (L)	0.9715	0.9715	0.995	0.989	0.0175
	Green (L)	0.965	0.996	0.9795	0.9835	0.0185
	White (R)	1.0065	0.996	0.9636	1.016	0.0095
	Green (R)	1.042	1.034	1.0525	1.0325	-0.0095
011	White (L)	1.0655	1.0565	1.0675	1.037	-0.0285
	Green (L)	0.9885	1.0065	1.008	1.016	0.0275
	White (R)	1.022	1.0365	0.9495	1.043	0.021
	Green (R)	0.998	0.9935	1.016	1.0485	0.0505
012	White (L)	0.9785	0.982	0.988	0.996	0.0175
	Green (L)	0.956	1.008	1.0035	0.9635	0.0075
	White (R)	0.9925	1.083	1.018	1.0195	0.027
	Green (R)	0.979	0.967	0.977	1.023	0.044

4.5 Humidity Resistance

Humidity Resistance - Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorldite shielding and ThermaRex Jacket	Immersed Length (ft)	51.5	Applied Voltage (DC)	500	Electrification Time (s)	60

Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)
010	Before	>2000	104.0	>2000	104.0
	After	>2000	104.0	706.0	36.7
011	Before	1679.0	87.3	>2000	104.0
	After	>2000	104.0	>2000	104.0
012	Before	309.6	16.1	86.7	4.5
	After	>2000	104.0	>2000	104.0



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4.6 Wet Arc Propagation Resistance

Table 3: Wet arc test results for test N1061-01, green wire sample.

Test ID	In-Line Resistance (ohms)	CBs Tripped	Length of Damage (mm)								Post-test Dielectric Voltage Withstand (Pass/Fail)					Four or more wires fail
			A 1	B 1	C 1	A 2	B 2	D 1	D 2	C1	A2	B2	D1	D2		
N1061-01-01	0	none	4	9	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-02	0	none	3	6	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-03	0	none	3	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-04	0.5	none	4	6	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-05	0.5	none	7	8	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-06	0.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-07	1	none	3	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-08	1	none	3	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-09	1	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-10	1.5	none	6	9	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-11	1.5	none	3	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-12	1.5	none	4	4	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-13	2	none	4	5	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-14	2	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-01-15	2	none	5	5	0	0	0	0	0	P	P	P	P	P	N	

Table 4: Wet arc test results for test N1061-02, white wire sample.

Test ID	In-Line Resistance (ohms)	CBs Tripped	Length of Damage (mm)								Post-test Dielectric Voltage Withstand (Pass/Fail)					Four or more wires fail
			A 1	B 1	C 1	A 2	B 2	D 1	D 2	C 1	A 2	B 2	D 1	D 2		
N1061-02-01	0	none	3	4	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-02	0	none	1	4	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-03	0	none	2	6	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-04	0.5	none	2	8	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-05	0.5	none	6	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-06	0.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-07	1	none	8	7	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-08	1	none	3	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-09	1	none	6	7	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-10	1.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-11	1.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-12	1.5	none	2	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-13	2	none	7	9	6	0	1	0	0	F	P	F	P	P	N	
N1061-02-14	2	none	4	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-15	2	B1 x2	11	8	1	0	0	0	0	F	P	P	P	P	N	



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4.7 Forced Hydrolysis

Post-Exposure Voltage Withstand (Wet Dielectric) Test Data			
Description	A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	Effective Length	28"
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
031	2500	60	Pass
032	2500	60	Pass
033	2500	60	Pass

4.8 Bend Test

Post Exposure Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	22	Applied Voltage (DC)	500	Electrification Time (s)	60

Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)
010	Before	1876.0	22.5	>2000	24.0
	After	>2000	24.0	>2000	24.0
011	Before	1960.0	23.6	1260.0	15.1
	After	>2000	24.0	1300.0	15.6
012	Before	1980.0	23.7	>2000	24.0
	After	>2000	24.0	>2000	24.0

3.8 Bend Test (Continued)

Bend Test Data		
Mandrel	Length	12"



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	Diameter	1 5/8"
	Weight	102.45 oz
Post Test Assessment	Sample No.	Cracking
	034	None
	035	None
	036	None

4.9 Insulation Shrinkage/Expansion

Humidity Resistance - Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	12	Applied Voltage (DC)	500	Electrification Time (s)	60

Sample No.	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)
037	1069.7	0.09	1296.0	0.11
038	1312.0	0.11	1187.3	0.10
039	1440.6	0.12	1140.0	0.10



Job No: 19218
Date: 2020-05-05

Document No: 19218R1LQV1
Version: 1

3.9 Insulation Shrinkage/Expansion (continued)

Insulation Shrinkage and Expansion						
Sample			Before	After	Difference	Percent Change (%)
037	White	Right	0.5665	0.5935	0.0270	4.77
		Left	0.5705	0.5910	0.0205	3.59
	Green	Right	0.5430	0.5950	0.0520	9.58
		Left	0.5270	0.5575	0.0305	5.79
038	White	Right	0.5070	0.5070	0.0000	0.00
		Left	0.5135	0.5435	0.0300	5.84
	Green	Right	0.5375	0.5425	0.0050	0.93
		Left	0.5120	0.5280	0.0160	3.13
039	White	Right	0.5365	0.5550	0.0185	3.45
		Left	0.5200	0.5405	0.0205	3.94
	Green	Right	0.5140	0.5240	0.0100	1.95
		Left	0.4965	0.5370	0.0405	8.16

4.10 Dynamic Cut-Through

Results of the dynamic cut-through tests are found in Table 6. Result values are the force applied until cut-through in ft-lbs.

Table 6: Dynamic cut-through test results.

Sample ID	Temp. (°C)	Trial Number								Analysis			
		#1	#2	#3	#4	#5	#6	#7	#8	Min	Max	Average	Std. Dev
S01	23	72.94	72.86	78.66	79.22	77.20	79.86	81.92	86.14	72.86	86.14	78.60	4.4
S02	23	68.58	80.04	83.52	83.70	68.52	72.28	72.40	73.34	68.52	83.7	75.30	6.2
S03	23	76.92	82.38	80.34	69.74	76.30	68.82	73.68	77.18	68.82	82.38	75.67	4.7
S04	300	22.92	19.20	23.02	9.94	9.52	6.38	8.10	16.54	6.38	23.02	14.45	6.8
S05	300	21.52	21.16	7.68	16.60	21.06	5.14	4.62	18.90	4.62	21.52	14.59	7.5
S06	300	20.92	21.70	12.74	17.24	13.70	12.70	11.94	15.16	11.94	21.70	15.76	3.8



Job No: 19218
Date: 2020-05-05

Document No: 19218R1LQV1
Version: 1

4.11 Fluid Immersion

Humidity Resistance - Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	12	Applied Voltage (DC)	500	Electrification Time (s)	60

Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)
019	Before	1458.0	2.7	1285.0	2.4
	After	>2000	3.7	>2000	3.7
020	Before	1984.0	3.6	1976.0	3.6
	After	880.0	1.6	>2000	3.7
021	Before	>2000	3.7	940.0	1.7
	After	>2000	3.7	>2000	3.7
022	Before	>2000	3.7	>2000	3.7
	After	>2000	3.7	>2000	3.7
023	Before	1252.0	2.3	>2000	3.7
	After	>2000	3.7	1015.0	1.9
024	Before	>2000	3.7	>2000	3.7
	After	683.0	1.3	>2000	3.7
025	Before	>2000	3.7	>2000	3.7
	After	706.0	1.3	1140.0	2.1
026	Before	>2000	3.7	>2000	3.7
	After	1493.0	2.7	1800.0	3.3
027	Before	>2000	3.7	>2000	3.7
	After	1200.0	2.2	>2000	3.7
028	Before	>2000	3.7	>2000	3.7
	After	913.0	1.7	>2000	3.7
029	Before	>2000	3.7	>2000	3.7
	After	730.0	1.3	>2000	3.7
030	Before	>2000	3.7	>2000	3.7
	After	>2000	3.7	737.0	1.4



Job No: 19218
Date: 2020-05-05

Document No: 19218R1LQV1
Version: 1

3.11 Fluid Immersion (continued)

Fluid Immersion Test Data: Fluids and Immersion			
Sample No.	Test Fluid	Temperature (°C)	Immersion Time (hrs)
19, 20, 21	Aviation Hydraulic Fluid per MIL-PRF-5606	49	20
22, 23, 24	TT-I-735 75% Isopropyl Alcohol	21.7	168
25, 26, 27	JP-4 per MIL-DTL-5624	21.7	168
28, 29, 30	Eastman Turbo Oil 2389 per MIL-L-7808	120	30

Fluid Immersion Test Data: Wire Diameter				
Sample No.	-	Before Immersion (in)	After Immersion (in)	Difference (in)
019	Thin side of Twist	0.1390	0.1315	-0.0075
	Thick side of Twist	0.1820	0.1800	-0.0020
020	Thin side of Twist	0.1410	0.1350	-0.0060
	Thick side of Twist	0.1790	0.1810	0.0020
021	Thin side of Twist	0.1295	0.1375	0.0080
	Thick side of Twist	0.1680	0.1825	0.0145
022	Thin side of Twist	0.1470	0.1540	0.0070
	Thick side of Twist	0.1705	0.1890	0.0185
023	Thin side of Twist	0.1350	0.1335	-0.0015
	Thick side of Twist	0.1860	0.1810	-0.0050
024	Thin side of Twist	0.1440	0.1340	-0.0100
	Thick side of Twist	0.1815	0.1825	0.0010
025	Thin side of Twist	0.1290	0.1285	-0.0005
	Thick side of Twist	0.1645	0.1820	0.0175
026	Thin side of Twist	0.1460	0.1340	-0.0120
	Thick side of Twist	0.1785	0.1780	-0.0005
027	Thin side of Twist	0.1275	0.1315	0.0040
	Thick side of Twist	0.1825	0.1860	0.0035
028	Thin side of Twist	0.1390	0.1310	-0.0080
	Thick side of Twist	0.1820	0.1810	-0.0010
029	Thin side of Twist	0.1305	0.1420	0.0115
	Thick side of Twist	0.1810	0.1810	0.0000
030	Thin side of Twist	0.1360	0.1400	0.0040
	Thick side of Twist	0.1660	0.1700	0.0040



Job No: 19218
Date: 2020-05-05

Document No: 19218R1LQV1
Version: 1

4.12 60° Wire Burn Test

60° Bunsen Burner Test – Pretest Insulation Resistance Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	157	Applied Voltage (DC)	500	Electrification Time (s)	60

Sample No.	Sample Resistance (GΩ)	Insulation Resistance Ω-1000ft (GΩ)
N1157-S01	>2000	24.56

60° Bunsen Burner Test Data				
Test Sample	Damage Length (in.)	Burning Duration After Flame Removal (s)	Incendiary Drops Y/N	Burn Time of Incendiary Particles (s)
N1157-S01-1	1.5	0	N	N/A
N1157-S01-2	1.5	0	N	N/A
N1157-S01-3	1.5	0	N	N/A
N1157-S01-4	1.5	0	N	N/A

Post Burn Specimen Resistance Test Data				
Specimen	Total Length (inches)	Length Positive To Burn (inches)	Length Negative To Burn (inches)	Measured Resistance (kΩ)
N1157-S01-1	29.25	22.625	6.625	45
N1157-S01-2	30	6.75	23.25	46
N1157-S01-3	30	6.75	23.25	51
N1157-S01-4	29.875	5.375	24.5	46



Job No: 19218
Date: 2020-05-05

Document No: 19218R1LQV1
Version: 1

Appendix: Data Sheets

Multi-Day Heat Aging Test Data

19218 QTP-850 ThermaRex Wire

19218D1SPV1

Version 1

10/25/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Mehrdad Mostoufi</u> Test Engineer	<u>10/22/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/25/2019</u> Date



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/25/2019	Initial Release	Sunjay Patten	Mehrdad Mostoufi	Kane Liang



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
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Sheet Name	Test Deviations
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Deviation No.	Test Name	Description
19218DV2SPV1	8.1.1 Multi-Day Heat Aging	High-temp cloth bags used for load weights failed early into test. Test weights were replaced and test was restarted.



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Summary		

Job Name	QTP-850 ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	001, 002, 003
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Multi-Day Heat Aging	001, 002, 003	10/2/2019	10/7/2019	X	-	-
Bend Test		10/8/2019	10/8/2019	X	-	-
Voltage Withstand (Wet Dielectric)		10/8/2019	10/8/2019	X	-	-

Test Summary

Three, 14 inch long samples were cut from a spool of ThermaRex Wire. The samples were examined to verify their lengths were within the requirements for the Multi-day heat aging test and to see that there were no visible flaws on the wire jacket. The wires were hung over a PTFE coated stainless steel mandrel so that the jacket was compressed and the insulator was under stress. The wires were placed in an air circulating oven for 120 hours at 300°C. After the Multi-Day Heat Aging test, the samples were subjected to the Bend Test and Voltage Withstand Test. All samples passed as they did not crack during the bend test and passed the voltage withstand test.



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
CE040	Convection Oven	Blue M Electric	DC-256-8-MP350	-	-
TC00001	Digital Thermometer	Fluke	51 II	11/21/2019	11/30/2019
EM029	15kv Megohmmeter	AEMC Instruments	Model 6555	7/19/2019	7/31/2020
-	6X PTFE coated mandrel	Alert Plating	-	-	-
DM002	Steel Ruler 36"	Starrett	C604R	9/05/2019	9/30/2020
EM024	AC/DC/IR Hipot Tester	QuadTech	Sentry 30	10/17/2019	10/31/2020



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions

The samples were examined to verify their lengths were within the requirements for the multi-day heat aging test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	001
			002
			003



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
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Sheet Name	Test Sequence
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Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Multi-Day Heat Aging	QTP-850 section 8.1.1	1	001, 002, 003
2	Bend Test	QTP-850 section 7.1.5		
3	Voltage Withstand (Wet Dielectric)	QTP-850 section 7.1.3		



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Multi-Day Heat Aging
Specification	QTP-850 ThermaRex Wire Testing
Method / Procedure	AS4373 Rev. E Section 4.8.7
Figure / Table	-

Test Requirements

Three, 24 inch samples of ThermaRex Wire shall be cut from a spool of cable. The samples shall be bent along the midpoint and hung over a 1/4" inch diameter PTFE coated steel mandrel. A load weight of 5 pounds shall be attached to the ends of the wires such that the sample conductor is under tension and the insulation is under compression. The wires and the weights shall be placed in an air circulation oven and exposed to 300°C for 120 hours. At the completion of 120 hours, the samples shall be cooled to 20°C within 1 hour. The samples shall be subjected to Bend Testing per AS4373 Rev E. 4.7.12 and Voltage Withstand testing per AS4373 Rev. E 4.5.10.



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
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Sheet Name	Test Parameters
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Test Name	Bend Test
Specification	QTP-850 ThermaRex Wire Testing
Method / Procedure	AS4373 Rev. E 4.7.12
Figure / Table	-

Test Requirements

Three samples of 24 inch lengths of ThermaRex Wire shall be cut from a spool of cable. One end of the wire shall be attached to a stainless steel PTFE coated mandrel of nominal diameter 50 times greater than that of the conductor. The other end of the wire shall have a load weight of 1 pound attached. The mandrel shall be rotated till the entire length of the cable is wrapped around the mandrel. The mandrel shall then be rotated the other direction till the wire is fully wrapped around the mandrel. The wire shall undergo two cycles of wrapping back and forth. The outer surface shall be observed for any cracking of the insulation.



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Voltage Withstand (Wet Dielectric)
Specification	QTP-850 ThermaRex Wire Testing
Method / Procedure	AS4373 Rev. E Section 4.5.10
Figure / Table	-

Test Requirements
<p>A solution of 5% NaCl and 0.05% to 0.10% wetting agent (Triton X-100) shall be prepared. Each sample shall have 1 inch of insulation stripped from both side and placed in the solution to soak for 4 hours. The samples shall be checked for gross flaws by applying 500VDC to the wire and verifying that the resistance is greater than $1 \times 10^6 \Omega$. After this, the wire shall be tested at 2500VDC for one minute with a ramp up and ramp down rate of 500 volts per second.</p>



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
9/12/2019	21.6°C	10:19 AM	Samples were cut from spool of ThermaRex Wire and measured to verify lengths.
	55.2% RH		
9/12/2019	21.0°C	11:04 AM	Samples were in process of reaching test temperature, when load weigh bags experienced failure. Test was halted.
	55.3% RH		
10/2/2019	22.2°C	8:25 AM	Multi-day heat aging test was restarted with the same samples and new weight baskets with greater heat resistance.
	40.3% RH		
10/7/2019	21.9°C	8:45 AM	Multi-day heat aging test completed after 120 hours at 300°C. Samples were removed from the oven and visually inspected for damage.
	41.6% RH		
10/7/2019	23.4°C	11:41 AM	Bend Test was performed.
	31.3% RH		
10/8/2019	22.4°C	8:06 AM	Samples were placed in saline solution to begin 4 hour soak for Voltage Withstand (Wet Dielectric) Test.
	43.6% RH		
10/8/2019	22.5°C	12:15 PM	Voltage Withstand (Wet Dielectric) was performed.
	39.0% RH		

Test Operator	Sunjay Pattem
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Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Data		

Multi-Day Heat Aging Test Report		
Mandrel	Length	24"
	Diameter	1/4"
	Weight	5.3 oz
Load Weight	Sample No.	Weight (lbs)
	001	5
	002	5
	003	5
Oven temperature	300°C	
Post Test Assesment	Sample No.	Cracking
	001	None
	002	None
	003	None

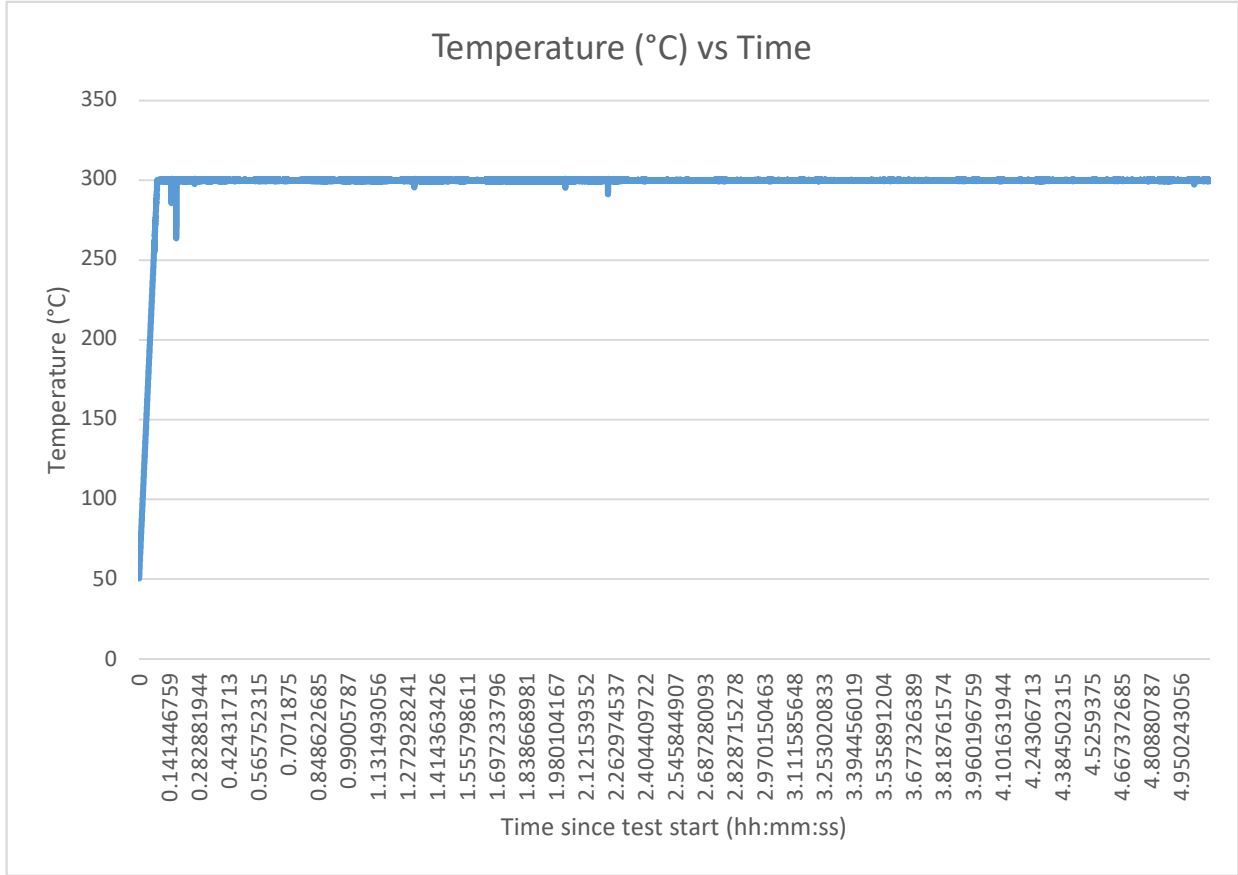
Bend Test Data		
Mandrel	Length	12"
	Diameter	1 5/8"
	Weight	102.45 oz
Post Test Assesment	Sample No.	Cracking
	001	None
	002	None
	003	None

Voltage Withstand Test Data			
Description	A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	Effective Length	22"
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
001	2500	60	Pass
002	2500	60	Pass
003	2500	60	Pass



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Plots		

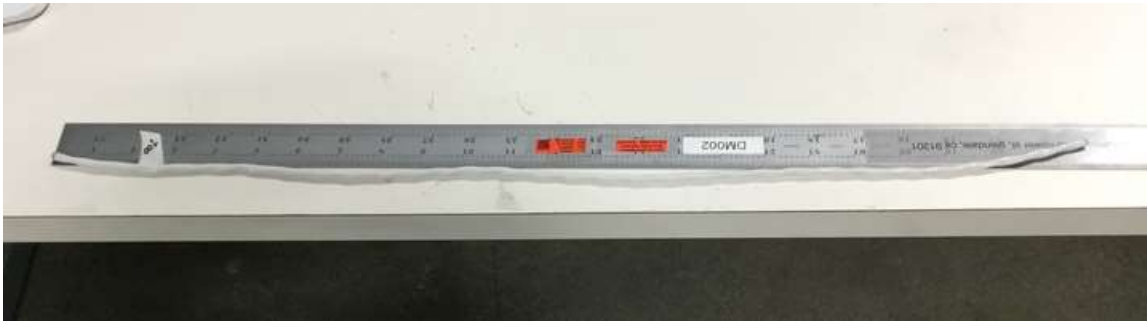


Description	120hrs, 300°C. Temperature drops were from chamber door opening
Test Name	Multi-Day Heat Aging
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	001, 002, 003



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample pretest photo. Verifying sample length.
Test Name	Multi-Day Heat Aging
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	See test sample identification sheet.



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Photos		



Description	Test set up in oven
Test Name	Multi-Day Heat Aging
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	001, 002, 003



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples after multi-day heat aging test.
Test Name	Multi-Day Heat Aging
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	001, 002, 003



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples after multi-day heat aging test
Test Name	Multi-Day Heat Aging
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	001, 002, 003



Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Photos		



Description	Performing Bend Test
Test Name	Bend Test
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	001, 002, 003





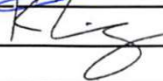
Multi-Day Heat Aging Test Data

Doc. No.	19218D1SPV1	Version	1
Sheet Name	Test Photos		



Description	Performing Voltage Withstand (Wet Dielectric) Test
Test Name	Voltage Withstand (Wet Dielectric)
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	001, 002, 003

Appendix

		Test Deviation Form		
		Doc. No.	19218DV2SPV1	Version
		Test Type	Multi-Day Heat Aging	
Test Name	QTP-850 ThermaRex Wire			
Part Name	ThermaRex Wire			
Part No.	#001, #002, #003			
Serial No.	#001, #002, #003			
Test Requirements				
<p>The samples are to be bent over a 1/4" PTFE coated mandrel with weights attached such that the insulation is compressed and the conductor is under tension. The samples are to be exposed for 120 hours at 300°C</p>				
Specification	QTP-850 ThermaRex Wire			
Method / Procedure	8.1.1 Mutli-Day Heat Aging			
Test Deviation Description				
<p>High temperature polyurathane bags were utilized for the test with a manufacturer's rating of 325°C. The bags failed at 300°C 2 hours into the test during the temperature ramp up phase, before the 120 hour soak began.</p>				
Test Operator	Sunjay Patten	Deviation Date	9/13/2019	
Reported To	Micah Summers	Date	9/13/2019	
Resolution				
<p>Customer stated to restart test with original samples.</p>				
Approval				
Client Name	Micah Summers			
Client Signature		Date	9/17/19	
Quality Manager		Date	9/16/2019	

QMS708-F4 v3.1

End of Test Data Sheet

Wrapback Test Data Sheet

19218 QTP-850 ThermaRex Wire

19218D2SPV1

Version 1

10/25/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Mehrdad Mostoufi</u> Test Engineer	<u>10/22/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/25/2019</u> Date



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/25/2019	Initial Release	Sunjay Patten	Mehrdad Mostoufi	Kane Liang



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Summary		

Job Name	ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	004, 005, 006
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Wrapback	004, 005, 006	9/4/2019	9/5/2019	X	-	-
Voltage Withstand		9/5/2019	9/5/2019	X	-	-

Test Summary

Three samples of ThermaRex Wire of 12 inches in length were cut from a large spool of wire supplied by the customer. The wires were visually examined before any testing began, They were then bent about the midpoint such that the radius of the bend was greater than the radius of the wire with one side wrapping 4 full turns around the other following the procedure in AS4373 Revision E 4.7.8.4.1. The samples were placed in an air circulating oven at 300°C for 6 hours and then removed and subjected to voltage withstand testing. The samples passed as they did not crack or suffer damage during the wrapback test and passed the voltage withstand testing.



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
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Sheet Name	Test Equipment List
-------------------	---------------------

ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
CE040	Convection Oven	Blue M Electric	DC-256-8-MP350	-	-
EM00024	AC/CD/IR Hipot Tester	Quadtech	Sentry 30	10/12/2018	10/31/2019
TC00001	Digital Thermometer	Fluke	51 II	11/21/2019	11/30/2019
DM002	Steel Ruler 36"	Starrett	C604R	9/05/2019	9/30/2020



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions
<p>The samples were examined to verify that their lengths were within the requirements for the wrapback test and that the jacket had no cracks or defects.</p>


Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	004
			005
			006



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Sequence		

Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Wrapback	QTP-850 section 8.1.2	1	004, 005.
2	Voltage Withstand	QTP-850 section 7.1.3		006

	Wrapback Test Data Sheet			
	Doc. No.	19218D2SPV1	Version	1
	Sheet Name	Test Parameters		

Test Name	Wrapback
Specification	QTP-850 ThermaRex Wire Testing section 8.1.2
Method / Procedure	AS4373 Revision E. section 4.7.8.4.1
Figure / Table	-

Test Requirements
<p>Each sample shall be bent about its midpoint such that the radius of the bend does not fall beneath the radius of the wire. One side of the wire shall be wound tightly around the other side a total of 4 full turns and secured to hold the wires in that position. The wires shall then be placed in an air circulating oven and exposed to 300°C for 6 hours. The samples shall then be inspected for any cracking of the insulation.</p>



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Voltage Withstand
Specification	QTP-850 ThermaRex Wire Testing section 7.1.3
Method / Procedure	AS4373 Revision E section 4.5.10
Figure / Table	-

Test Requirements
<p>Each sample shall have 1 inch of insulation stripped from each end be twisted together. Each samples shall then be immersed in a solution of 5% NaCl and 0.05% to 0.10% wetting agent (Triton-X 100), to within 2 inches of the stripped ends of the wire. The sample shall be connected to a hipot tester and the resistance measured between the wire and solution with the use of a grounding electrode. The test voltage shall be 2500VDC with an electrification rate of 500V/s and a dwell time of one minute.</p>



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
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Sheet Name	Engineering Notes
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Date	Ambient	Time	Notes
9/4/2019	21.1°C	7:00 AM	Samples were visually examined and photographed before testing.
	54.5% RH		
9/4/2019	21.9°C	9:00 AM	Samples were placed into the oven and the wrapback test was initiated.
	53.6% RH		
9/4/2019	22.9°C	3:00 PM	Samples completed wrapback test.
	53.6% RH		
9/5/2019	22.3°C	7:30 AM	Samples were examined for any cracking after heat exposure. There was no cracking along the jacket of each sample.
	51.9% RH		
9/5/2019	22.4°C	11:35 AM	Voltage Withstand test was performed on all samples.
	55.6% RH		

Test Operator	Sunjay Pattem
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Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
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Sheet Name	Test Data
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Wrapback Test Data

	Sample No.	Cracking
Post Test Assessment	004	None
	005	None
	006	None

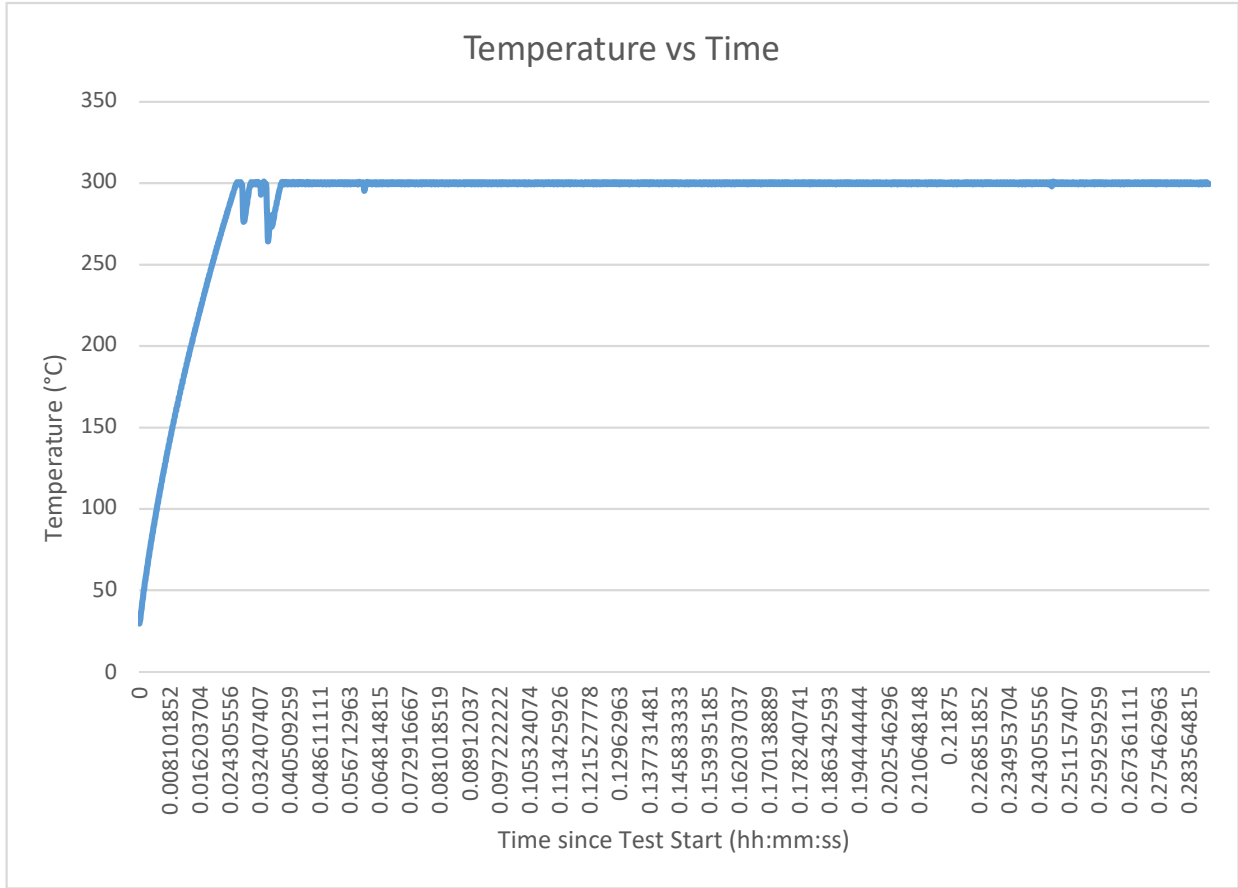
Voltage Withstand Test Data

Description	Effective Length		
A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	10"		
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
004	2500	60	Pass
005	2500	60	Pass
006	2500	60	Pass



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Plots		



Description	6 hours, 300°C. Temperature drops were from chamber door opening.
Test Name	Wrapback
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	004, 005, 006



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples before testing in wrapback configuration.
Test Name	Wrapback Test
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	004, 005, 006



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Photos		

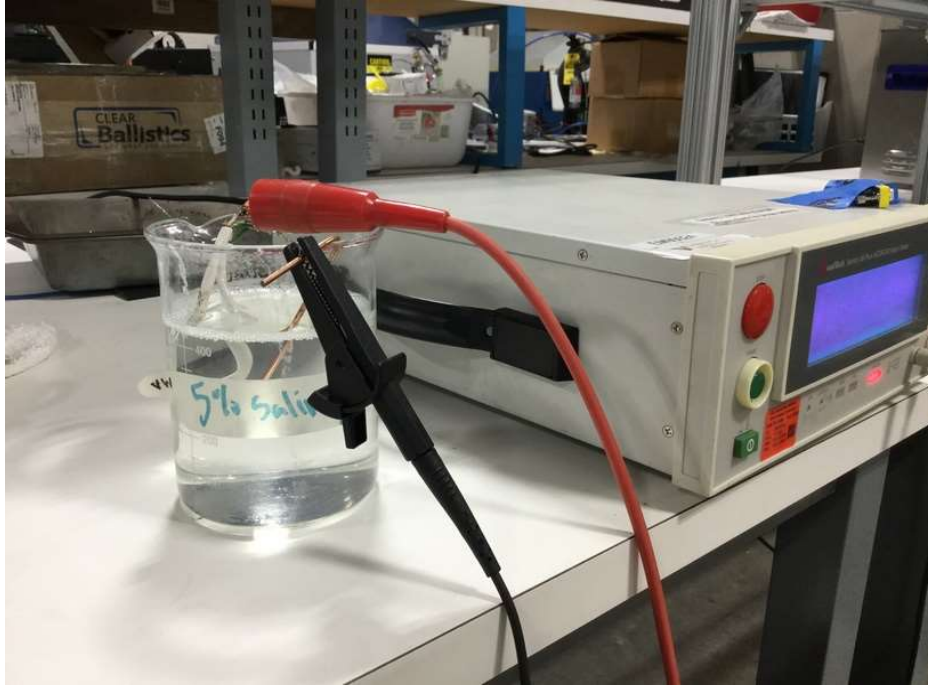


Description	Samples after exposure to 300°C for 6 hours.
Test Name	Wrapback Test
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	004, 005, 006



Wrapback Test Data Sheet

Doc. No.	19218D2SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample in saline solution connected to hipot testing machine.
Test Name	Voltage Withstand
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	004, 005, 006

End of Test Data Sheet

Cold Bend Test Data

QTP-850 ThermaRex Wire Testing
19218D3SPV1
Version 1
10/25/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Mehrdad Mostoufi</u> Test Engineer	<u>10/23/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/25/2019</u> Date



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/25/2019	Initial Release	Sunjay Patten	Mehrdad Mostoufi	K. Liang



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Summary		

Job Name	ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	007, 008, 009
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Cold Bend	007, 008, 009	10/14/2019	10/18/2019	X	-	-
Voltage Withstand		10/21/2019	10/21/2019	X	-	-

Test Summary

Three, 36.5 inch wire segments were cut from a large spool of ThermaRex Wire. The samples were tested per QTP-850 ThermaRex Wire Testing section 8.1.3, section 7.1.3 and AS4373 revision E. section 4.7.2. The purpose of this test was to test the cold weather durability of the ThermaRex wire jacket. The samples were placed one at a time inside a thermal chamber and cooled to -65°C attached to a PTFE coated mandrel on one end and a weight at the other. After soaking at 65°C for 4 hours, the PTFE rod was rotated at 1 rpm manually using a timer until the entire length of the cable was coiled around the mandrel while inside the chamber. The sample was removed from the chamber and mandrel while maintaining its coiled configuration and checked for cracks and damage. The samples were then subjected to voltage withstand testing. The samples passed as there was no damage after Cold Bend testing and all samples passed the voltage withstand testing.



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
CE00005	Environmental Chamber	Tenney	TJR	12/12/208	12/31/2019
EM024	AC/DC/IR Hipot Tester	QuadTech	Sentry30	10/17/2019	10/31/2020
DM002	Steel Ruler 36"	Starrett	C604R	9/05/219	9/30/2020



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions

The samples were examined to verify their lengths were within the requirements for the cold bend test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	007
			008
			009



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Sequence		

Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Cold Bend	QTP-850 section 8.1.3	1	007, 008, 009
2	Voltage Withstand	QTP-850 section 7.1.3		



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Cold Bend
Specification	QTP-850 ThermaRex Wire Testing
Method / Procedure	AS4373 Revision E. Section 4.7.2
Figure / Table	-

Test Requirements	
<p>Three, 36.5 inch wire segments shall be cut from a spool of ThermaRex wire. Each sample shall be placed inside an environmental chamber with one end attached to a PTFE mandrel and the other attached to a test weight. The sample and fixture shall be ramped down to -65°C and allowed to soak for at least 4 hours. After the soak is complete the mandrel shall be rotated from outside the chamber at a steady rate of 1 rpm until the entire length of wire is coiled around the mandrel. The sample shall then be removed from the chamber and mandrel without straightening and allowed to return to room temperature. The sample shall be examined for cracks or deformation of the ThermaRex jacket.</p>	



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Voltage Withstand
Specification	QTP-850 ThermaRex Wire Testing
Method / Procedure	AS4373 Revision E. section 4.5.10
Figure / Table	-

Test Requirements	
<p>The samples shall be placed inside a solution of 5% NaCl with 0.05% to 0.10% wetting agent (Triton-X 100) one at a time and attached to a hipot test machine, measuring the leakage current between the wire and the solution. The wires shall be energized to 2500V for one minute with a ramp rate of 500 V/s. The electrification voltage, time, and time of failure if it occurs shall be reported. The samples shall pass if there is no leakage detected.</p>	



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
10/14/2019	23.7°C	10:00 AM	Sample lengths were checked and visually inspected. Test fixture was set up in chamber.
	43.8% RH		
10/14/2019	23.6°C	11:44 AM	Sample 007 was placed in chamber and the Cold Bend test was started.
	42.3% RH		
10/14/2019	22.7°C	3:50 PM	Cold Bend test was performed and sample was removed from chamber and mandrel.
	46.9% RH		
10/15/2019	22.4°C	1:40 PM	Cold Bend test was performed on sample 008.
	40.8% RH		
10/18/2019	22.6°C	1:43 PM	Cold Bend test was performed on sample 009.
	43.5% RH		
10/21/2019	23.0°C	8:30 AM	Voltage Withstand testing was performed on all samples.
	30.2% RH		

Test Operator	Sunjay Pattem
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Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
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Sheet Name	Test Data
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Cold Bend Test Data		
	Sample No.	Cracking
Post Test Assesment	007	None
	008	None
	009	None

Voltage Withstand Test Data			
Description	A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	Effective Length	35.5"
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
007	2500	60	Pass
008	2500	60	Pass
009	2500	60	Pass



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Photos		



Description	Pre-test visual examination
Test Name	Cold Bend
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	007, 008, 009



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Photos		



Description	Test fixture set up with sample.
Test Name	Cold Bend
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	007, 008, 009



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample at -65°C after rotated onto mandrel
Test Name	Cold Bend
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	007, 008, 009



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample undergoing voltage withstand testing
Test Name	Voltage Withstand
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	007, 008, 009



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Photos		

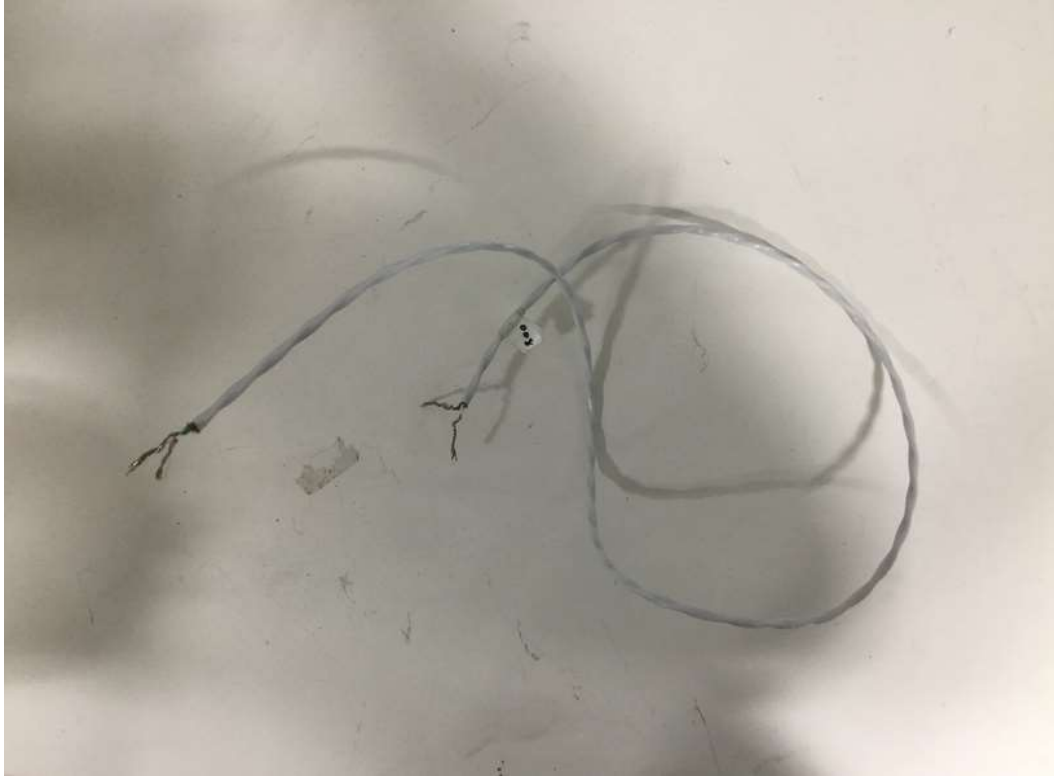


Description	Sample post-testing
Test Name	-
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	007



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample post-testing
Test Name	-
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	008



Cold Bend Test Data

Doc. No.	19218D3SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample post-testing
Test Name	-
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	009

End of Test Data Sheet

Thermal Shock Resistance Test Data

19218 ThermaRex Wire Testing
19218D4SPV1
Version 1
10/28/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Brian Morales</u> Test Engineer	<u>10/23/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/25/2019</u> Date



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/28/2019	Initial Release	Sunjay Patten	Brian Morales	Kane Liang



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Summary		

Job Name	QTP-850 ThermaRex Wire Testing
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Insulation Resistance	010, 011, 012	9/19/2019	9/19/2019	-	-	X
Thermal Shock Resistance		10/1/2019	10/1/2019	X	-	-
Insulation Resistance		10/2/2019	10/2/2019	-	-	X

Test Summary

Three samples, 14 inches in length were cut from a spool of ThermaRex Wire supplied by the customer. The samples were subjected to thermal shock resistance testing to test the durability of the ThermaRex jacket. The wires were soaked in a preheated oven at 300°C and a precooled chamber at -55°C for 30 minutes each and manually shuttled between the chambers within two minutes. This process was repeated 4 times. Insulation resistance testing was performed on all samples before and after thermal shock resistance testing to detect any deteriorations. The samples passed all tests as there was no flaring of any layer of insulation after the thermal shock resistance test.



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
EM029	15kV Megohmmeter	AEMC	Model 6555	7/19/2019	7/31/2020
CE007	Environmental Chamber	Sun Electronic Systems	EC01	1/17/2019	1/31/2020
CE040	Convection Oven	Blue M Electric	DC-256-8-MP350	-	-
TC00001	Digital Thermometer	Fluke	51 II	11/21/2018	11/30/2019
DM002	Steel Rule 36"	Starrett	C604R	9/05/2019	9/30/2020



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions

The samples were examined to verify their lengths were within the requirements for the thermal shock resistance test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	010
			011
			012



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Sequence		

Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Insulation Resistance	QTP-850 section 7.1.4	1	010, 011, 012
2	Thermal Shock Resistance	QTP-850 section 8.1.4		
3	Insulation Resistance	QTP-850 section 7.1.4		



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Insulation Resistance
Specification	QTP-850 ThermaRex Wire Section 7.1.4
Method / Procedure	AS4373 Revision E Section 4.5.4
Figure / Table	-

Test Requirements
<p>The wire segments shall be immersed in a solution of water and 0.05% to 0.10% Triton-X 100, and left to soak in the solution for 4 hours. The ends of the wire shall be twisted together and the resistance measured between the conductor and the solution after the 4 hour soak. The measurement shall be made at 500VDC over an electrification time of 1 minutes. The Ω-1000ft shall be reported as a function of the measured resistance and the immersed length.</p>



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Thermal Shock Resistance
Specification	QTP-850 ThernaRex Wire Testing Section 8.1.4
Method / Procedure	AS4373 Revision E Section 4.8.5
Figure / Table	-

Test Requirements
<p>Three segments of 14 inches shall be cut from a spool of ThernaRex cable. The cables shall have 1 inch of insulation removed from each end and the exposed conductor shall be measured to 0.0010 inches. The samples shall be placed in an air circulating oven at 300°C for 30 minutes. After this time the samples shall be transferred to a chamber at -55°C within two minutes, and allowed to soak for 30 minutes. The samples shall then be removed and left to return to room temperature and the lengths of the exposed conductors remeasured. This process shall be repeated a total of four times.</p>



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
9/19/2019	22.3°C	8:00 AM	The samples were placed in solution to start 4 hour soak for insulation resistance test.
	55.3% RH		
	22.8°C	11:00 AM	The samples were subjected to insulation resistance testing. All samples passed.
	51.5% RH		
10/1/2019	22.1°C	8:45 AM	Exposed conductor lengths were measured. Samples were placed in 300°C convection oven to start cycle 1.
	35.4% RH		
	23.0°C	9:16 AM	Samples were removed from oven and placed in chamber at -55°C.
	35.3% RH		
	23.7°C	9:46 AM	Samples were removed from chamber, allowed to return to room temperature and exposed conductor lengths were remeasured.
	35.5% RH		
	22.8°C	10:23 AM	Samples were placed in oven to start cycle 2.
	38.7% RH		
	23.6°C	10:54 AM	Samples were moved to cold chamber.
	35.4% RH		
	21.8°C	11:24 AM	Samples were removed from cold chamber, allowed to return to room temperature and exposed conductors were remeasured.
	40.4% RH		
	22.4°C	12:05 PM	Samples were placed in oven to start cycle 3.
	38.3% RH		
	22.7°C	12:36 PM	Samples were moved to cold chamber.
	38.3% RH		
	22.6°C	1:06 PM	Samples were removed from cold chamber, allowed to return to room temperature and exposed conductors were remeasured.
	40.1% RH		
22.5°C	1:26 PM	Samples were placed in oven to start cycle 4	
40.3% RH			
22.4°C	1:57 PM	Samples were moved to cold chamber.	
40.2% RH			
22.2°C	2:27 PM	Samples were removed from cold chamber, allowed to return to room temperature and exposed conductors were remeasured.	
42.8% RH			

Test Operator

Sunjay Pattem



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Data		

Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	12	Applied Voltage (DC)	500	Electrification Time (s)	60
Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)		
010	Before	255.03	3.06	413.70	4.96		
	After	957.33	11.50	1898.00	22.80		
011	Before	222.86	2.67	504.83	6.06		
	After	>2,000	24.00	1460.00	17.50		
012	Before	75.80	0.91	149.63	1.80		
	After	>2000	24.00	1762.00	21.20		

Thermal Shock Test Data: Exposed Conductor Length (inches)						
Sample No.	-	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Net Change
010	White (L)	0.9715	0.9715	0.995	0.989	0.0175
	Green (L)	0.965	0.996	0.9795	0.9835	0.0185
	White (R)	1.0065	0.996	0.9636	1.016	0.0095
	Green (R)	1.042	1.034	1.0525	1.0325	-0.0095
011	White (L)	1.0655	1.0565	1.0675	1.037	-0.0285
	Green (L)	0.9885	1.0065	1.008	1.016	0.0275
	White (R)	1.022	1.0365	0.9495	1.043	0.021
	Green (R)	0.998	0.9935	1.016	1.0485	0.0505
012	White (L)	0.9785	0.982	0.988	0.996	0.0175
	Green (L)	0.956	1.008	1.0035	0.9635	0.0075
	White (R)	0.9925	1.083	1.018	1.0195	0.027
	Green (R)	0.979	0.967	0.977	1.023	0.044



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample undergoing insulation resistance testing.
Test Name	Thermal Shock Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Photos		



Description	Examination of the wire length.
Test Name	Thermal Shock Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples inside of the convection oven.
Test Name	Thermal Shock Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Photos		

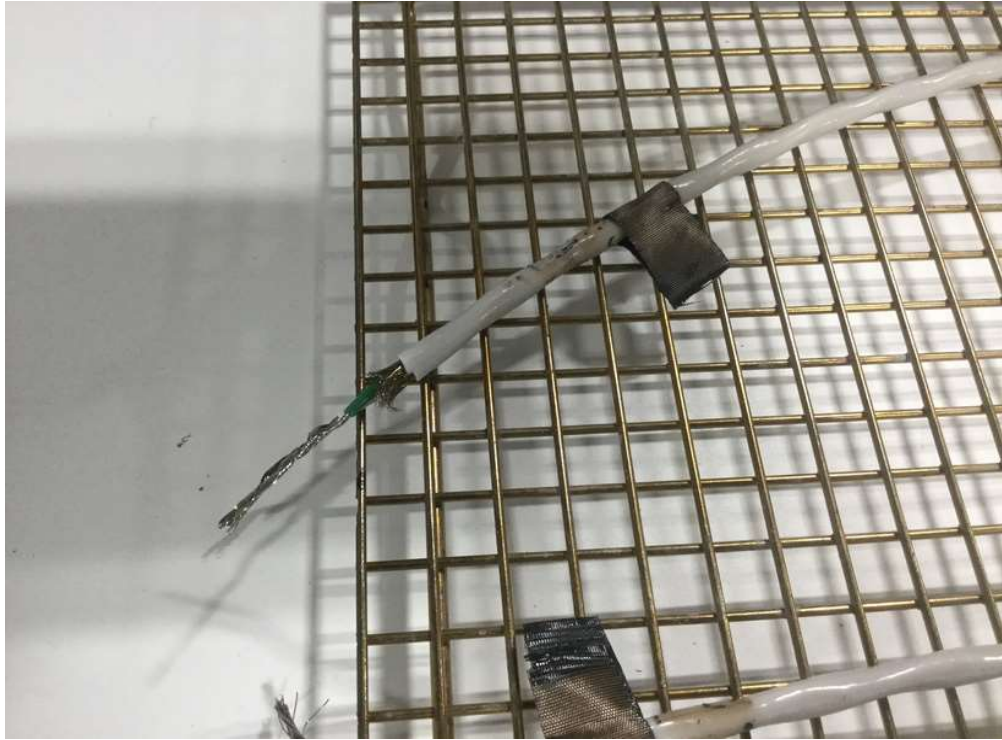


Description	Samples inside of the cold chamber.
Test Name	Thermal Shock Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample and exposed conductor after 1st thermal shock cycle.
Test Name	Thermal Shock Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Photos		

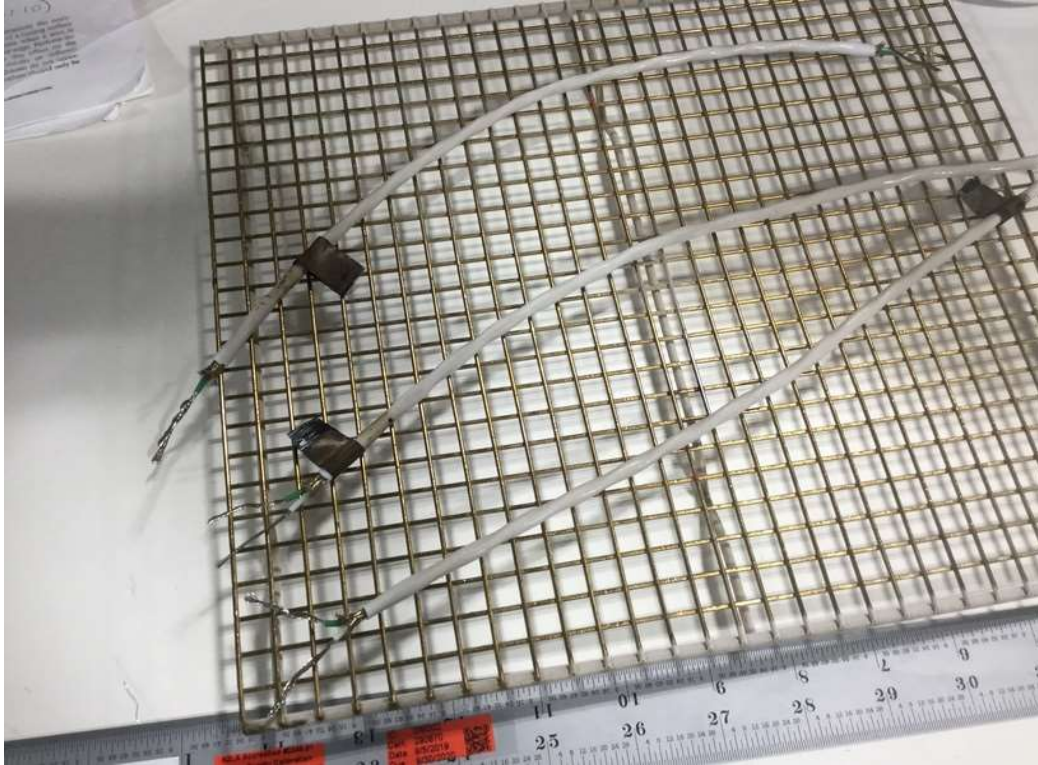


Description	Samples after the third thermal cycle.
Test Name	Thermal Shock Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012



Thermal Shock Resistance Test Data

Doc. No.	19218D4SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples after the final thermal cycle.
Test Name	Thermal Shock Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	010, 011, 012

End of Test Data Sheet

Humidity Resistance Test Data

19218 ThermaRex Wire Testing
19218D5SPV1
Version 1
10/28/2019

Prepared By:	Sunjay Pattem Test Technician	
Reviewed By:	Brian Morales Test Engineer	10/23/2019 Date
Approved By:	Kane Liang Quality Manager	10/21/2019 Date



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com



A2LA Certificate No: 4993.01

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Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/28/2019	Initial Release	Sunjay Patten	Brian Morales	Kane Liang



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Summary		

Job Name	ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	013, 014, 015
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Insulation Resistance	013, 014, 015	9/23/2019	9/23/2019	-	-	X
Humidity Resistance		9/24/2019	10/9/2019	X	-	-
Insulation Resistance		10/9/2019	10/9/2019	-	-	X

Test Summary

Three wires, 52' long were cut from a spool of ThermaRex Wire supplied from the customer. The samples were subjected to insulation resistance testing before and after humidity resistance testing per QTP-850 ThermaRex Wire Testing in accordance with AS4373 Revision E. Section 4.5.10 and Section 4.6.3. The purpose of the testing was to determine the durability of the ThermaRex jacket after exposure to 95% humidity and thermal cycling for 360 hours. The samples passed testing as the jacket suffered no damages that interfered with the performance of the wires.



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
DM002	Steel Rule 36"	Starrett	C604R	9/05/2019	9/30/2020
EM029	15kV Megohmmeter	AEMC	6555	7/19/2019	7/31/2020
CE00027	Temperature and Humidity Chamber	Test Equity	100H	11/08/2018	11/30/2019



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions

The samples were examined to verify their lengths were within the requirements for the humidity resistance test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	013
			014
			015



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Sequence		

Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Insulation Resistance	QTP-850 section 7.1.4	1	013, 014, 015
2	Humidity Resistance	QTP-850 8.1.5		
3	Insulation Resistance	QTP-850 section 7.1.4		



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Insulation Resistance
Specification	QTP-850 ThermaRex Wire Testing Section 7.1.4
Method / Procedure	AS4373 Revision E. Section 4.5.4
Figure / Table	-

Test Requirements
<p>The wire segments shall be immersed in a solution of water and 0.05% to 0.10% Triton-X 100, and left to soak in the solution for 4 hours. The ends of the wire shall be twisted together and the resistance measured between the conductor and the solution after the 4 hour soak. The measurement shall be made at 500VDC over an electrification time of 1 minutes. The Ω-1000ft shall be reported as a function of the measured resistance and the immersed length.</p>



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Humidity Resistance
Specification	QTP-850 ThermaRex Wire Testing Section 8.1.5
Method / Procedure	AS4373 Revision E. Section 4.6.3
Figure / Table	-

Test Requirements
<p>All samples shall be placed inside of a humidity chamber with the exposed ends of the wire passed through a chamber port and the port plugged with a rubber stopper. The chamber shall be programmed to raise the humidity to 95% in two hours and hold that condition for the duration of the test. The temperature shall rise from room temperature to 70°C in two hours, dwell for 6 hours, and cool to 38°C over 16 hours and then repeat. This temperature cycle of 2 hours heating to 70°C, dwell for 6 hours, and cool for 16 hours shall be repeated 15 times for a total of 360 hours of testing. The samples shall be subjected to insulation resistance testing within 2 hours of the test completion.</p>



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
9/23/2019	21.0°C	9:15 AM	Samples were immered in solution to begin 4 hour soak for IR test.
	53.7% RH		
9/23/2019	22.8°C	1:15 PM	Performed Insulation Resistance test on all samples.
	53.0% RH		
9/24/2019	21.3°C	9:30 AM	Samples were placed into humidity chamber and test was started.
	55.3% RH		
10/9/2019	22.6°C	9:30 AM	Test completed after 360 hours. Samples were removed from chamber and inspected.
	50.0% RH		
10/9/2019	22.4°C	10:00 AM	Samples were immersed in solution to begin 4 hour soak for IR test.
	50.6% RH		
10/9/2019	23.0°C	2:00 PM	Performed Insulation resistance test on all samples.
	47.1% RH		

Test Operator	Sunjay Pattem
----------------------	---------------



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Data		

Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (ft)	51.5	Applied Voltage (DC)	500	Electrification Time (s)	60
Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)		
013	Before	>2000	104.0	>2000	104.0		
	After	>2000	104.0	706.0	36.7		
014	Before	1679.0	87.3	>2000	104.0		
	After	>2000	104.0	>2000	104.0		
015	Before	309.6	16.1	86.7	4.5		
	After	>2000	104.0	>2000	104.0		



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples subjected to IR testing before Humidity Resistance.
Test Name	Insulation Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	013, 014, 015



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples inside of humidity chamber.
Test Name	Humidity Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	013, 014, 015



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Photos		



Description	Exposed conductors outside of the chamber.
Test Name	Humidity Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	013, 014, 015



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples post Humidity Resistance Testing.
Test Name	Humidity Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	013, 014, 015



Humidity Resistance Test Data

Doc. No.	19218D5SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples subjected to IR testing after Humidity Resistance.
Test Name	Insulation Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	013, 014, 015

End of Test Data Sheet



4230-K Lafayette Centre Drive
Chantilly, VA 20151

DRAFT Test Report
of One (1) Cable Specification

Prepared for

Vertical Labs
1805 Flower St
Glendale, CA 91201

Report Number
N1061-R001 Rev A

By

Lectromechanical Design Company, LLC.
4230-K Lafayette Center Drive
Chantilly, VA 20151 USA

Report Date: December 4, 2019
Revision Date: December 14, 2019

Prepared by: Laura Wishart

Reviewed by: Michael Traskos

• Accredited to ISO/IEC 17025:2005 •

Revision History

Revision	Date	Edited by	Comments
Original	12/4/2019	Laura Wishart	
A	12/14/2019	M. Traskos	Editorial Corrections

Lectromec Accreditation Information

Standard to which Accredited: ISO 17025:2005
Evaluating Body: PJLA
Accreditation ID: L17-210
Field: Testing

Contents

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2	Wet Arc Track Propagation Resistance	5
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3	Dynamic Cut-Through	9
3.1	Test Objective	9
3.2	Test Information	9
3.3	Test Results	10

1 Summary

Several tests were performed on cable specimen provided to Lectromec by Vertical Labs. Table 1 provides the list of tests performed in this effort.

Table 1: Summary of tests performed in this effort.

Test #	Test Name	Test Spec	Method
1	Wet Arc Propagation Resistance	AS4373	509
2	Dynamic Cut-Through	AS4373	703

The specimens provided to Lectromec by Vertical Labs are listed in Table 2.

Table 2: Specimens tested in this effort.

Test ID	Lectromec Sample Tracking ID	Vertical Labs ID
Wet Arc Testing	N1061-01-(01-15)	101G-115G
	N1061-02-(01-15)	101W-115W
Dynamic Cut-Through	N1061-S01	040A
	N1061-S02	041A
	N1061-S03	042A
	N1061-S04	040T
	N1061-S05	041T
	N1061-S06	042T

2 Wet Arc Track Propagation Resistance

2.1 Test Information

Testing was performed to the following specifications and parameters.

Test Specification:	AS4373-Rev E
Method:	509
Additional Notes/Special Conditions:	None

2.2 Equipment and Description

The wet arc propagation resistance test assesses the ability of insulation to prevent damage during an electrical arcing event. Arc-propagation resistance is defined as the length of arc propagation damage along the wires and the extent of damage to the wire insulation of wires that were not pre-damaged. This test also evaluates the insulation's ability to prevent further arc-propagation when the wires are re-energized following an arcing event.

The testing follows the procedures outlined in AS4373 Method 509 (wet arc track resistance test). In this test, two of seven wires in the test bundle are initially damaged exposing a short section of the conductor. The test bundle is placed in a fixture under a saline drip and connected to three phase power. As the drops create a low resistance path between the damage sites, electrical activity can occur and, in some cases, an arcing event will occur. The test objective is to determine the damage caused to the five initially undamaged wires in the bundle.

The control system used is Lectromec's LEC1001 test unit. Photos of the equipment are shown in Figure 1. The control cabinet provides automatic handling of the test circuit. The power to the test sample follows the AS4373 requirements shown in Figure 2. A 20kVA power supply operating at 400Hz was used for the tests.

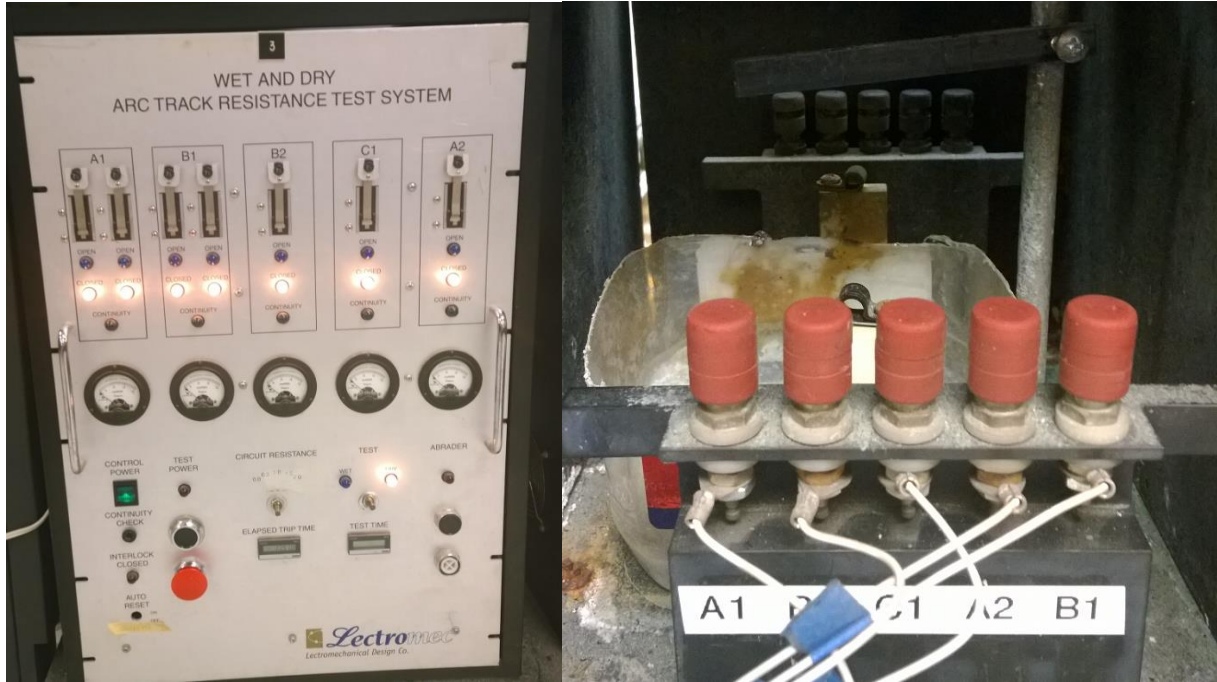


Figure 1: Lectromec wet arc track resistance test equipment control cabinet [left] and wet arc resistance test stand [right].

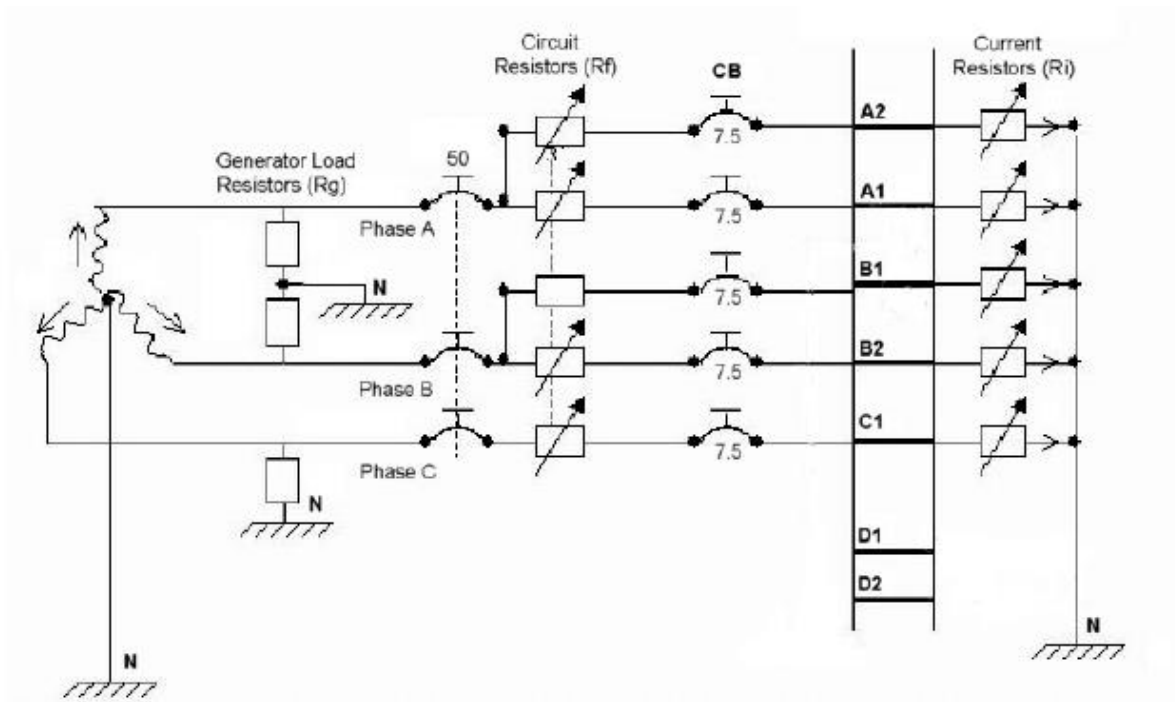


Figure 2: Power circuit for wet arc track resistance test system (source AS4373).

Additional information about arc track resistance testing can be found here:

- [What do Arc Track Resistance Test Results Mean](http://www.lectromec.com) (www.lectromec.com)

2.3 Test Results

Table 3 and Table 4 show the results of both wet arc tests performed on each of the internal wires of the sample cable provided. Test N1061-01 (Table 3) refers to the tests performed on the green wire, and N1061-02 (Table 4) refers to the tests performed on the white wire. Fifteen (15) tests were performed on each wire type at five (5) resistance levels (0.0, 0.5, 1.0, 1.5, 2.0 Ω).

Table 3: Wet arc test results for test N1061-01, green wire sample.

Test ID	In-Line Resistance (ohms)	CBs Tripped	Length of Damage (mm)							Post-test Dielectric Voltage Withstand (Pass/Fail)					
			A 1	B 1	C 1	A 2	B 2	D 1	D 2	C1	A2	B2	D1	D2	Four or more wires fail
N1061-01-01	0	none	4	9	0	0	0	0	0	P	P	P	P	P	N
N1061-01-02	0	none	3	6	0	0	0	0	0	P	P	P	P	P	N
N1061-01-03	0	none	3	3	0	0	0	0	0	P	P	P	P	P	N
N1061-01-04	0.5	none	4	6	0	0	0	0	0	P	P	P	P	P	N
N1061-01-05	0.5	none	7	8	0	0	0	0	0	P	P	P	P	P	N
N1061-01-06	0.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N
N1061-01-07	1	none	3	3	0	0	0	0	0	P	P	P	P	P	N
N1061-01-08	1	none	3	3	0	0	0	0	0	P	P	P	P	P	N
N1061-01-09	1	none	2	2	0	0	0	0	0	P	P	P	P	P	N
N1061-01-10	1.5	none	6	9	0	0	0	0	0	P	P	P	P	P	N
N1061-01-11	1.5	none	3	3	0	0	0	0	0	P	P	P	P	P	N
N1061-01-12	1.5	none	4	4	0	0	0	0	0	P	P	P	P	P	N
N1061-01-13	2	none	4	5	0	0	0	0	0	P	P	P	P	P	N
N1061-01-14	2	none	2	2	0	0	0	0	0	P	P	P	P	P	N
N1061-01-15	2	none	5	5	0	0	0	0	0	P	P	P	P	P	N

Table 4: Wet arc test results for test N1061-02, white wire sample.

Test ID	In-Line Resistance (ohms)	CBs Tripped	Length of Damage (mm)								Post-test Dielectric Voltage Withstand (Pass/Fail)					Four or more wires fail
			A 1	B 1	C 1	A 2	B 2	D 1	D 2	C 1	A 2	B 2	D 1	D 2		
N1061-02-01	0	none	3	4	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-02	0	none	1	4	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-03	0	none	2	6	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-04	0.5	none	2	8	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-05	0.5	none	6	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-06	0.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-07	1	none	8	7	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-08	1	none	3	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-09	1	none	6	7	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-10	1.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-11	1.5	none	2	2	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-12	1.5	none	2	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-13	2	none	7	9	6	0	1	0	0	F	P	F	P	P	N	
N1061-02-14	2	none	4	3	0	0	0	0	0	P	P	P	P	P	N	
N1061-02-15	2	B1 x2	11	8	1	0	0	0	0	F	P	P	P	P	N	

3 Dynamic Cut-Through

3.1 Test Objective

One of the most common means for damage to wire/cable on an aircraft is when the wire/cable is crushed. This may happen by a misaligned LRU, accidental contact by maintenance, or any other way a wire/cable may be pinched when in-service. A wire/cable's ability to withstand compression damage, particularly at elevated temperatures, will likely correspond to a fewer physical damage related issues.

The dynamic cut-through test is designed to assess the cut-through force of a wire/cable specimen. The wire/cable specimen is compressed under the fine edge of a jig until contact is made between the wire/cable conductor and the test jig. The pass/fail criteria for this test is based on the wire/cable's specification.

3.2 Test Information

Test Specification: AS4373-D
Method: 703
Additional Notes/Special Conditions: Needle Used in Cut-Through Jig: 20 mil diameter

Table 5: Test properties.

Property	Measured Value	Accuracy
Measurement	0.00" – 5.00"	± 0.005
Ambient Test Temperature (if applicable)	20°C	± 3°C
Elevated Test Temperature (if applicable)	20°C – 300°C	± 3°C
Applied Force	0 – 2500N	± 0.05N

In this test, the sample is placed under a compression force tester as shown in Figure 3. Either the insulation of the primary wire or all wires and the shield are connected to a detection circuit to identify when contact is made between the sample and the cut through jig.

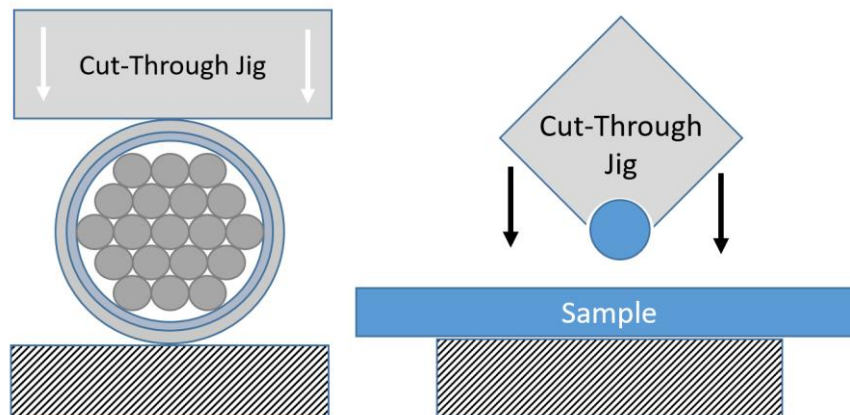


Figure 3: [Left] the cross-section of the wire is shown with the clean jig applying force perpendicular to the lodging to the direction of the sample. [Right] the cut through jig with the steel needle is shown.

One item to note is that when this test is performed on cables for complicated harnesses, the results can have a wide distribution. The test does require that the sample is rotated 90° between each test. As such the cut through jig will apply force at different orientations of the cable/harness.

3.3 Test Results

The results of the dynamic cut-through tests are found in Table 6. Result values are the force applied until cut-through in ft lbs.

Table 6: Dynamic cut-through test results.

Sample ID	Temp. (°C)	Trial Number								Analysis			
		#1	#2	#3	#4	#5	#6	#7	#8	Min	Max	Average	Std. Dev
S01	23	72.94	72.86	78.66	79.22	77.20	79.86	81.92	86.14	72.86	86.14	78.60	4.4
S02	23	68.58	80.04	83.52	83.70	68.52	72.28	72.40	73.34	68.52	83.7	75.30	6.2
S03	23	76.92	82.38	80.34	69.74	76.30	68.82	73.68	77.18	68.82	82.38	75.67	4.7
S04	300	22.92	19.20	23.02	9.94	9.52	6.38	8.10	16.54	6.38	23.02	14.45	6.8
S05	300	21.52	21.16	7.68	16.60	21.06	5.14	4.62	18.90	4.62	21.52	14.59	7.5
S06	300	20.92	21.70	12.74	17.24	13.70	12.70	11.94	15.16	11.94	21.70	15.76	3.8

Forced Hydrolysis Test Data

19218 ThermaRex Wire Testing

19218D8SPV1

Version 1

10/28/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Brian Morales</u> Test Engineer	<u>10/23/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/21/2019</u> Date



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/28/2019	Initial Release	Sunjay Patten	Brian Morales	Kane Liang



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Summary		

Job Name	ThermaRex Wire Testing
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	031, 032, 033
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Forced Hydrolysis (Unconditioned Wire)	031, 032, 033	9/16/2019	10/14/2019	X	-	-
Voltage Withstand (Wet Dielectric)		10/14/2019	10/14/2019	X	-	-

Test Summary

Three, 30 inch segments of ThermaRex Wire were cut from a spool of cable and were tested according to QTP-850 ThermaRex Wire Testing, section 8.1.8 Forced Hydrolysis (Unconditioned Wire). The samples were wrapped ten times around a 6X PTFE coated steel mandrel and immersed in a 5% saline solution held at 70°C for 672 hours. After the immersion the samples were visually inspected and subjected to voltage withstand (wet dielectric) testing. The samples passed as they did not degrade in the long term saline solution immersion such that the performance of the wires was affected.



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
HP02	Hot Plate	Thermo Fisher Scientific	Cimarec	-	-
TC00001	Thermometer	Fluke	51 II	11/21/2018	11/31/2019
EM029	15kV Megohmmeter	AEMC Instruments	Model 6555	7/19/2019	7/31/2019
-	Digital Calipers	Husky	-	-	-
DM002	Steel Rule 36"	Starrett	C604R	9/05/2019	9/30/2019



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions

The samples were examined to verify their lengths were within the requirements for the forced hydrolysis test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	031
			032
			033



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Sequence		

Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Forced Hydrolysis (Unconditioned Wire)	QTP-850 section 8.1.8	1	031, 032, 033
2	Voltage Withstand (Wet Dielectric)	QTP-850 section 7.1.6		



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Forced Hydrolysis (Unconditioned Wire)
Specification	QTP-850 ThermaRex Wire Testing Section 8.1.8
Method / Procedure	AS4373 Revision E. Section 4.6.2.4.2
Figure / Table	-

Test Requirements
<p>Three wire segments of 30 inches shall be cut from a spool of ThermaRex Wire. The samples shall be tightly wound around a 1/4" PTFE coated stainless steel mandrel such that the central portion of the wire is in constant contact with the mandrel. The wires and the mandrel shall be submerged into a 70°C saline solution for 672 hours leaving at least 6 inches of wire above the solution.</p>



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Voltage Withstand (Wet Dielectric)
Specification	QTP-850 ThermaRex Wire Testing Section 7.1.6
Method / Procedure	AS4373 Revision E, Section 4.8.7
Figure / Table	-

Test Requirements
<p>The samples shall be left to soak for 4 hours in a solution containing 5% NaCl and 0.05% to 0.10% wetting agent, Triton X-100. After the soak the samples shall be tested with an hipot tester to 2500 VDC with a ramp up rate of 500 V/s and a electrification time of 1 minute. The electrification time, voltage, and time of failure if one occurs shall be reported.</p>



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
9/16/2019	22.6°C	8:00 AM	The samples were visually inspected and wrapped around the 6X PTFE coated stainless steel mandrel. Saline solution was prepared and brought to temperature on a hot plate.
	57.2% RH		
9/16/2019	23.3°C	8:30 AM	Samples were placed in saline solution and sealed to soak for 672 hours.
	55.3% RH		
10/14/2019	22.2°C	8:30 AM	Samples finished 672 hour immersion and were removed from the saline solution and left to air dry at room temperature.
	45.8% RH		
10/14/2019	23.3°C	12:00 PM	Samples were completed 4 hour soak in saline solution and were subjected to voltage withstand (wet dielectric) testing.
	42.7% RH		

Test Operator	Sunjay Pattem
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Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Data		

Voltage Withstand (Wet Dielectric) Test Data			
Description	A twisted pair of 20 awg wire with ArmorLite Shield and ThermaRex Jacket	Effective Length	28"
Sample No.	Test Voltage (VDC)	Electrification Time (s)	Result
031	2500	60	Pass
032	2500	60	Pass
033	2500	60	Pass



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Photos		

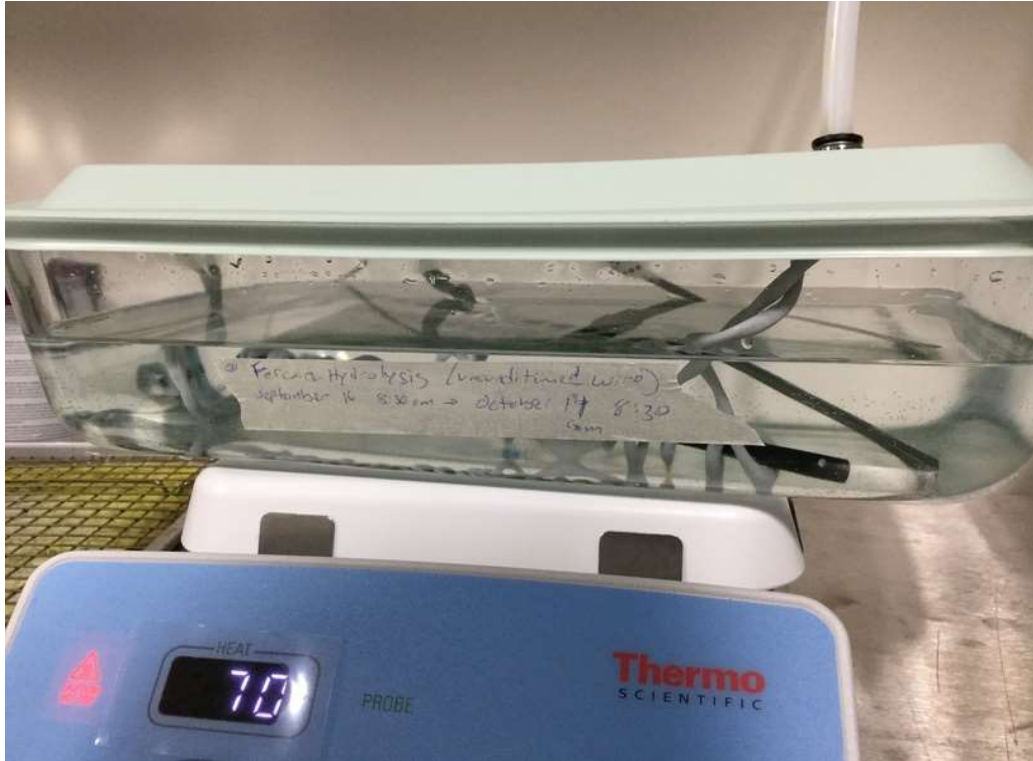


Description	All three samples wrapped 10 times around a 6X PTFE mandrel.
Test Name	Forced Hydrolysis
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	031, 032, 033



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Photos		



Description	The samples immersed in the fluid at temperature.
Test Name	Forced Hydrolysis
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	031, 032, 033



Forced Hydrolysis Test Data

Doc. No.	19218D8SPV1	Version	1
Sheet Name	Test Photos		



Description	All three samples post immersion and voltage withstand testing.
Test Name	Forced Hydrolysis
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	031, 032, 033

End of Test Data Sheet

Bend Test Data Sheet

19218 QTP-850 ThermRex Wire

19218D9SPV1

Version 1

10/28/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Mehrdad Mostoufi</u> Test Engineer	<u>10/24/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/25/2019</u> Date



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1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/28/2019	Initial Release	Sunjay Patten	Mehrdad Mostoufi	Kane Liang



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Summary		

Job Name	QTP-850 ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-C
Serial No.	034, 035, 036
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Insulation Resistance	034, 035, 036	9/13/2019	9/13/2019	-	-	X
Bend Test		9/13/2019	9/13/2019	X	-	-
Insulation Resistance		9/13/2019	9/13/2019	-	-	X

Test Summary
<p>Three segments of ThermaRex wire were cut to 24 inches from a large spool supplied by the customer. The samples were subjected to insulation resistance testing before and after Bend Testing per AS 4373 Rev. E 4.7.12. All samples passed as they did not crack or suffer damages during the bend test.</p>



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Equipment List		

ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
-	6X PTFE coated mandrel	Alert Plating	-	-	-
EM029	15kv Megohmmeter	AEMC Instruments	Model 6555	7/19/2019	7/31/2019
DM002	Steel Ruler 36"	Starrett	C604R	9/05/2019	9/30/2020



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions

The samples were examined to verify their lengths were within the requirements for the bend test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	034
			035
			036



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
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Sheet Name	Test Sequence
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Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Insulation Resistance	AS4373 Rev. E 4.5.4	1	034, 035, 036
2	Bend Test	AS4373 Rev. E 4.7.12	1	
3	Insulation Resistance	AS4373 Rev. E 4.5.4	1	



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Insulation Resistance
Specification	QTP-850 ThermaRex Wire Testing section 7.1.4
Method / Procedure	AS4373 Rev. E 4.5.4
Figure / Table	-

Test Requirements
<p>The wire segments shall be immersed in a solution of water and 0.05% to 0.10% Triton-X 100 wetting agent and left to soak in the solution for 4 hours. The ends of the wire shall be twisted together and the resistance measured between the conductor and the solution. The measurement shall be made at 500VDC over an electrification time of 1 minutes. The Ω-1000ft shall be reported as a function of the measured resistance and the immersed length.</p>



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Bend Test
Specification	QTP-850 ThermaRex Wire Testing section 7.1.5
Method / Procedure	AS4373 Rev. E 4.7.12
Figure / Table	-

Test Requirements
<p>Three, 24 inch samples of ThermaRex Wire shall be cut from a spool of cable. One end of the wire shall be attached to a stainless steel PTFE coated mandrel of nominal diameter 50 times greater than that of the conductor. The other end of the wire shall have a load weight of 1 pound attached. The mandrel shall be rotated till the entire length of the cable is wrapped around the mandrel. The mandrel shall then be rotated the other direction till the wire is fully wrapped around the mandrel. The wire shall undergo two cycles of wrapping back and forth. The outer surface shall be observed for any cracking of the insulation.</p>



Bend Test Data Sheet

Doc. No.

19218D9SPV1

Version

1

Sheet Name

Engineering Notes

Date	Ambient	Time	Notes
9/13/2019	21.7°C	7:00 AM	Took Initial photos of samples.
	60.0% RH		
9/13/2019	21.7°C	7:00 AM	Started 4 hour soak for IR testing.
	60.0% RH		
9/13/2019	21.3°C	11:00 AM	Performed IR Test on all samples.
	47.8% RH		
9/13/2019	21.4°C	11:15AM	Performed Bend Test on all samples.
	48.0% RH		
9/13/2019	21.6°C	11:30 AM	Placed all samples in solution for 4 hour soak.
	48.8% RH		
9/13/2019	23.4°C	3:30 PM	Performed IR Test on all samples.
	44.9% RH		

Test Operator

Sunjay Pattem



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Data		

Insulation Resistance Test Data

Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	22	Applied Voltage (DC)	500	Electrification Time (s)	60
Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)		
034	Before	1876.0	22.5	>2000	24.0		
	After	>2000	24.0	>2000	24.0		
035	Before	1960.0	23.6	1260.0	15.1		
	After	>2000	24.0	1300.0	15.6		
036	Before	1980.0	23.7	>2000	24.0		
	After	>2000	24.0	>2000	24.0		

Bend Test Data

Mandrel	Length	12"
	Diameter	1 5/8"
	Weight	102.45 oz
Post Test Assesment	Sample No.	Cracking
	034	None
	035	None
	036	None



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Photos		



Description	Sample undergoing insulation resistance test.
Test Name	Insulation Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	All samples



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Photos		

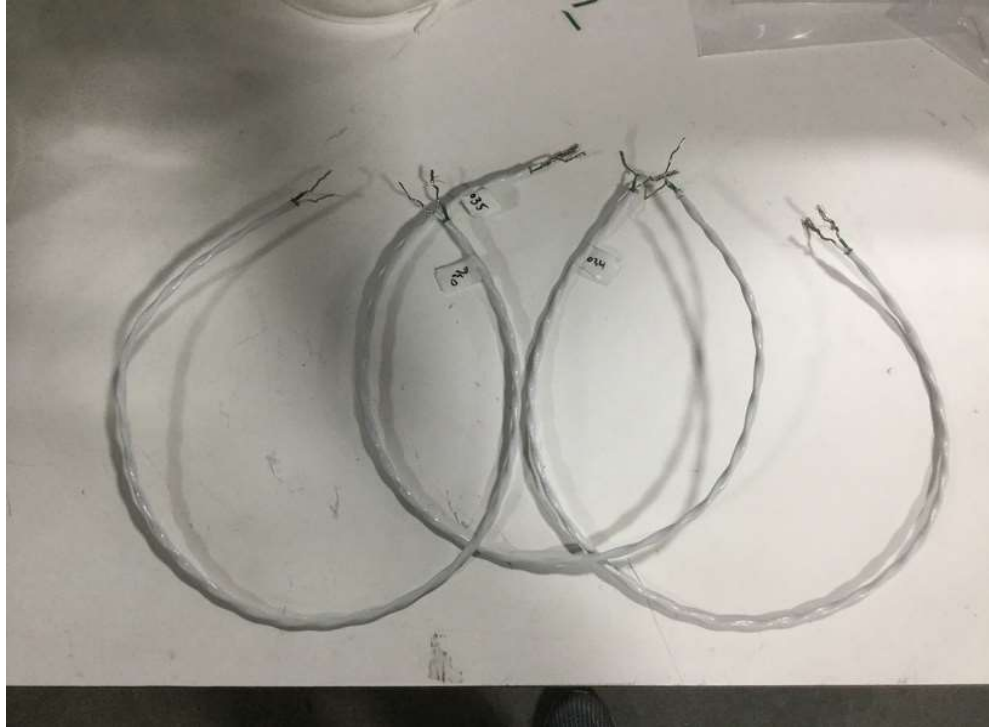


Description	Sample wound around the 50X PTFE mandrel.
Test Name	Bend Test
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	All samples



Bend Test Data Sheet

Doc. No.	19218D9SPV1	Version	1
Sheet Name	Test Photos		



Description	Final visual inspection of samples.
Test Name	Visual Inspection
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	034, 035, 036

End of Test Data Sheet

Insulation Shrinkage & Expansion Test Data

19218 ThermaRex Wire
19218D10SPV1
Version 1
10/28/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Mehrdad Mostoufi</u> Test Engineer	<u>10/24/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/24/2019</u> Date



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1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
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Sheet Name	Version History
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Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/28/2019	Initial Release	Sunjay Patten	Mehrdad Mostoufi	Kane Liang



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
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Sheet Name	Test Deviations
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Deviation No.	Test Name	Description
19218DV1SPV1	Insulation Shrinkage and Expansion	Samples were overtested to 330°C. Test was restarted with news samples.



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Summary		

Job Name	ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	037, 038, 038
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Insulation Resistance	037, 038,	9/10/2019	9/10/2019	-	-	X
Insulation Shrinkage/Expansion	038	9/11/2019	9/11/2019	X	-	-

Test Summary

Three, 13 inch long segments of ThermaRex wire were cut from a spool of cable and were tested according to QTP-850 ThermaRex Wire Testing, section 8.1.9 Insulation Shrinkage/Expansion. An insulation resistance test was performed before the insulation shrinkage and expansion test per QTP-850 Table 4 according to section 7.1.4. The wires had 1/2 inch of insulation stripped from each end and measured. Afterwards the samples were placed on a wire oven rack inside an air circulating oven and exposed to 300°C for 6 hours. The lengths of the exposed conductors of each sample were measured after heating the wires. All samples passed as no samples exhibited a change in insulation length greater than 0.125 inches.



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
CE040	Convection Oven	Blue M Electric	DC-256-8-MP350G	-	-
TC00001	Digital Thermometer	Fluke	51 II	11/21/2019	11/30/2019
EM029	15kV Megohmmeter	AEMC Instruments	Model 6555	7/19/2019	7/31/2019
DM002	Steel Ruler 36"	Starrett	C604R	9/5/2019	9/30/2020



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions

The samples were examined to verify their lengths were within the requirements for the insulation shrinkage and expansion test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	037
			038
			039



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Sequence		

Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Insulation Resistance	QTP-850 Section 7.1.4	1	037, 038, 039
2	Insulation Shrinkage/Expansion	QTP-850 Section 8.1.9		



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Insulation Resistance
Specification	QTP-850 ThermaRex Wire Testing Section 7.1.4
Method / Procedure	AS4373 Revision E Section 4.5.4
Figure / Table	-

Test Requirements	
<p>The wire segments shall be immersed in a solution of water and 0.05% to 0.10% Triton-X 100 wetting agent and be left to soak in the solution for 4 hours. The ends of the wire shall be twisted together and the resistance measured between the conductor and the solution. The measurement shall be made at 500 VDC over an electrification time of 1 minutes. The Ω-1000ft shall be reported as a function of the measured resistance and the immersed length.</p>	



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Insulation Shrinkage and Expansion
Specification	QTP-850 ThermaRex Wire Testing Section 8.1.9
Method / Procedure	AS4373 Revision E Section 4.1.4
Figure / Table	-

Test Requirements	
<p>Each sample shall be 13 inches in length and have 1/2 inches of insulation removed from each end of the wire. The lengths of the exposed conductor shall be measured and recorded. The samples shall then be placed in an air circulating oven to be exposed to 300°C for 6 hours. Once the samples have cooled to room temperature the exposed lengths of the conductor shall be measured again. The difference from the pre-test and post-test lengths shall not exceed 0.125 inches.</p>	



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
9/9/2019	22.3°C	11:30 AM	Performed IR test on samples. Placed parts in oven but overtested to 330°C.
	55.1% RH		
9/10/2019	22.2°C	9:00 AM	Performed IR test on replacement samples and measured stripped ends of samples.
	62.6% RH		
9/11/2019	22.0°C	7:00 AM	Placed samples in oven to heat to 300°C for 6 hours.
	61.5% RH		
9/12/2019	22.2°C	7:00 AM	Measured exposed conductor lengths and visually inspected jacket for damage.
	62.3% RH		

Test Operator	Sunjay Pattem
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Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Data		

Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	12	Applied Voltage (DC)	500	Electrification Time (s)	60
Sample No.	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)			
037	1069.7	0.09	1296.0	0.11			
038	1312.0	0.11	1187.3	0.10			
039	1440.6	0.12	1140.0	0.10			

Insulation Shrinkage and Expansion						
Sample			Before	After	Difference	Percent Change (%)
037	White	Right	0.5665	0.5935	0.0270	4.77
		Left	0.5705	0.5910	0.0205	3.59
	Green	Right	0.5430	0.5950	0.0520	9.58
		Left	0.5270	0.5575	0.0305	5.79
038	White	Right	0.5070	0.5070	0.0000	0.00
		Left	0.5135	0.5435	0.0300	5.84
	Green	Right	0.5375	0.5425	0.0050	0.93
		Left	0.5120	0.5280	0.0160	3.13
039	White	Right	0.5365	0.5550	0.0185	3.45
		Left	0.5200	0.5405	0.0205	3.94
	Green	Right	0.5140	0.5240	0.0100	1.95
		Left	0.4965	0.5370	0.0405	8.16



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Photos		



Description	Pretest photo of sample to verify dimensions and check condition.
Test Name	Examination of Product, Examination of Dimensions
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	037, 038, 039



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Photos		



Description	Performing insulation resistance test on sample.
Test Name	Insulation Resistance
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	037, 038, 039



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Photos		

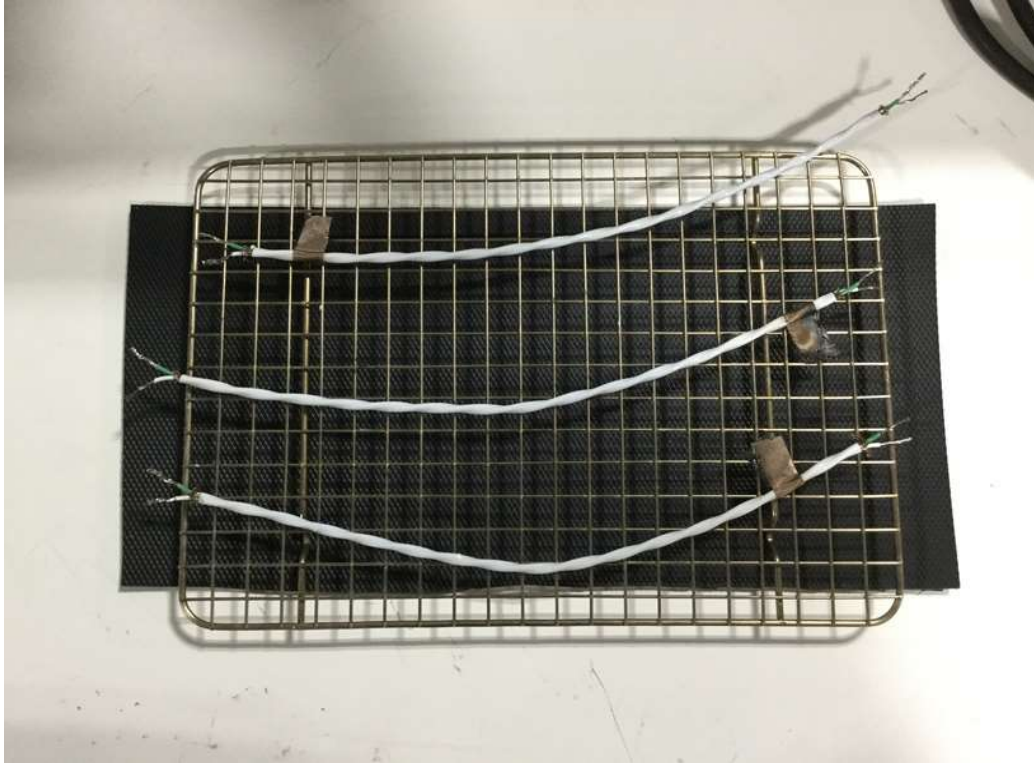


Description	Samples on rack before heat exposure.
Test Name	Insulation shrinkage and expansion
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	037, 038, 039



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Photos		

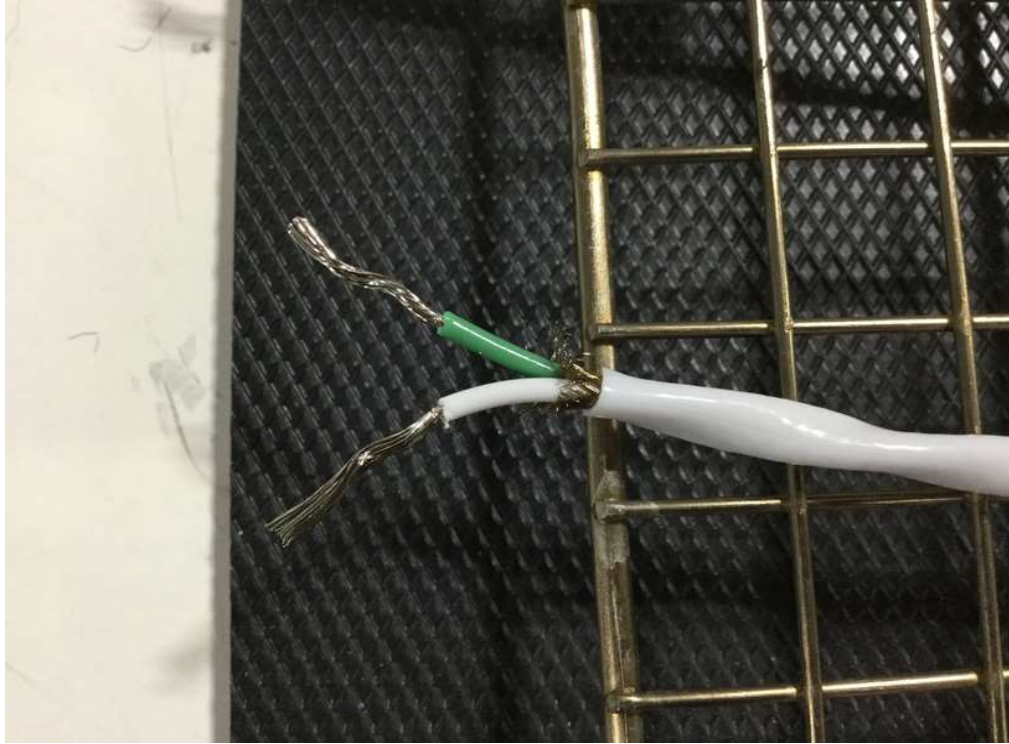


Description	Samples after heat exposure.
Test Name	Insulation shrinkage and expansion
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	037, 038, 039



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Photos		



Description	Close up of stripped end after heat exposure.
Test Name	Insulation shrinkage and expansion
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	037, 038, 039



Insulation Shrinkage & Expansion Test Data

Doc. No.	19218D10SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples after heat exposure.
Test Name	Insulation shrinkage and expansion
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	037, 038, 039



Test Deviation Form

Doc. No.	19218DV1SPV1	Version	1
Test Type	Insulation Shrinkage and Expansion		

Test Name	QTP-850 ThermaRex Wire
Part Name	ThermaRex Wire
Part No.	#37, #38, #39
Serial No.	#37, #38, #39

Test Requirements

The samples are to under go a preliminary insulation resistance test, and then exposed for 6 hours at 300°C

Specification	QTP-850 ThermaRex Wire
Method / Procedure	8.1.9 Insulation Shrinkage/Expansion

Test Deviation Description


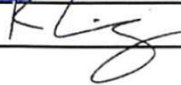
The samples were exposed for 6 hours at 330°C instead of 300°C, which resulted in overtesting. Original temperature profile had been incorrectly selected.

Test Operator	Sunjay Patten	Deviation Date	9/10/2019
Reported To	Micah Summers	Date	9/10/2019

Resolution

New samples were cut from a spool of ThermaRex Wire and the test was restarted.

Approval

Client Name	Micah Summers		
Client Signature		Date	9/17/19
Quality Manager		Date	9/16/2019

End of Test Data Sheet

Fluid Immersion Test Data Sheet

19218 QTP-850 ThermaRex Wire Testing
19218D11SPV1
Version 1
10/28/2019

Prepared By:	<u>Sunjay Pattem</u> Test Technician	
Reviewed By:	<u>Mehrdad Mostoufi</u> Test Engineer	<u>10/24/2019</u> Date
Approved By:	<u>Kane Liang</u> Quality Manager	<u>10/24/2019</u> Date



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1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	10/28/2019	Initial Release	Sunjay Patten	Mehrdad Mostoufi	Kane Liang



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
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Sheet Name	Test Summary
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Job Name	QTP-850 ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	019, 020, 021, 022, 023, 024, 025, 026, 027, 028, 029, 030
Controlling Document	QTP--850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Insulation Resistance	019 - 030	9/11/2019	9/11/2019	-	-	X
Fluid Immersion		9/12/2019	9/19/2019	X	-	-
Insulation Resistance		9/20/2019	9/20/2019	-	-	X

Test Summary

Twelve thermaRex wire segments of 24" long were cut from a large spool of wire. All samples were subjected to insulation resistance testing before and after the fluid immersion. Three samples were immersed into a bath of MIL-H-5606 Hydraulic Fluid, Isopropyl Alcohol, MIL-DTL-5624 JP-4 Turbine Fuel, and MIL-L-7808 Lubricating Oil each. Testing was conducted according to AS 4373 4.6.1 specifications. All samples passed as they showed no signs of damage or deformation such that the performance of the wire was affected.



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
HP02	Hot Plate	Thermo Scientific	Cimarec	-	-
HP03	Hot Plate	Thermo Scientific	Cimarec	-	-
TC00001	Thermometer	Fluke	51 II	11/21/2018	11/30/2019
EM029	15kV Megohmmeter	AEMC Instruments	Model 6555	7/19/2019	7/31/2019



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Sample Identification		

Date Received	7/31/2019
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Pre-test sample conditions
The samples were examined to verify their lengths were within the requirements for the fluid immersion test and to see that there were no visible flaws on the wire jacket.

Part Name	Test Group	Part No.	Serial No.
ThermaRex Wire	1	960-2371-N-C-9-5-A	019
			020
			021
	2		022
			023
			024
	3		025
			026
			027
	4		028
			029
			030



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
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Sheet Name	Test Sequence
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Test Sequence	Test Name	Specification	Test Group	Serial No.
1	Insulation Resistance	QTP-850 Section 7.1.4	1- 4	019 - 030
2	Fluid Immersion	QTP-850 Section 8.1.11		
3	Insulation Resistance	QTP-850 Section 7.1.4		



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	7.1.4 Insulation Resistance
Specification	QTP-850 ThermaRex Wire Testing Section 7.1.4
Method / Procedure	AS 4373 Rev E. 4.5.4
Figure / Table	-

Test Requirements
<p>The wire segments shall be immersed in a solution of water and 0.05% to 0.10% Triton-X 100 wetting agent. The samples shall be left to soak in the solution for 4 hours. The ends of the wire shall be twisted together and the resistance measured between the conductor and the solution. The measurement shall be made at 500VDC over an electrification time of 1 minutes. The Ω-1000ft shall be reported as a function of the measured resistance and the immersed length.</p>



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Parameters		

Test Name	Fluid Immersion
Specification	QTP-850 ThermaRex Wire Testing
Method / Procedure	AS 4373 Rev. E 4.6.1
Figure / Table	Table 2 / Table 5

Test Requirements

Three samples are to be immersed in each of the four test fluids for one cycle at the temperature and for the durations listed in Table 5 of QTP-850. Test fluid 1 shall be Philips 66 X/C Aviation Hydraulic Fluid per MIL-PRF-5606. Test fluid 2 shall be 75% Isopropyl Alcohol. Test fluid 3 shall be JP-4 shall be per MIL-DTL-5624. Test fluid 4 shall be Eastman Turbo Oil 2389 per MIL-L-7808. Immersions with test fluids 1 and 4 shall be conducted on a hot plate with controlled to a remote probe with the temperature verified by a calibrated thermometer. Immersions 2 and 3 were conducted at ambient conditions. The diameter of the wires before and after the immersions shall be recorded.



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
9/11/2019	21.4°C	9:30AM	Samples dimensions were measured and recorded, Insulation resistance test was initiated. Samples left to soak in solution for 4 hours.
	54.3% RH		
9/11/2019	21.9°C	1:30 PM	Insulation resistance test conducted on all samples.
	52.0% RH		
9/12/2019	22.3°C	7:30 AM	Samples 022, 023, 024 were immersed in Isopropyl Alcohol at ambient conditions.
	61.1% RH		
9/12/2019	22.3°C	7:30 AM	Samples 025, 026, and 027 were immersed in MIL-DTL-5624 at ambient conditions.
	61.1% RH		
9/12/2019	21.4°C	8:30AM	Samples 028, 029, and 030 were immersed in MIL-L-7808 at 120°C.
	55.4% RH		
9/12/2019	22.5°C	12:30PM	Samples 019, 020, and 021 were immersed in MIL-H-5606 at 49°C.
	54.2% RH		
9/13/2019	20.4°C	8:30 AM	Samples 019, 020, and 021 completed 20 hours of immersion, were removed from the fluid and left to air dry.
	53.1% RH		
9/13/2019	26.6°C	2:30 PM	Samples 028, 029, and 030 completed 30 hours of immersion, were removed from the fluid and left to air dry.
	39.6% RH		
9/19/2019	21.9°C	7:30 AM	Samples 022, 023, and 024 completed 168 hours of immersion, were removed from the fluid, and left to air dry.
	55.1% RH		
9/19/2019	21.9°C	7:30 AM	Samples 025, 026, and 027 completed 168 hours of immersion, were removed from the fluid and left to air dry.
	55.1% RH		
9/20/2019	21.5°C	1:30 PM	Post Immersion test insulation resistance testing was performed. Sample dimensions were measured and recorded.
	48.65% RH		

Test Operator	Sunjay Pattem
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Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Data		

Insulation Resistance Test Data							
Description:	20 awg twisted pair with Armorlite shielding and ThermaRex Jacket	Immersed Length (in)	22	Applied Voltage (DC)	500	Electrification Time (s)	60
Sample No.	-	Average Resistance: White Conductor (GΩ)	Ω-1000ft: White Conductor (GΩ)	Average Resistance: Green Conductor (GΩ)	Ω-1000ft: Green Conductor (GΩ)		
019	Before	1458.0	2.7	1285.0	2.4		
	After	>2000	3.7	>2000	3.7		
020	Before	1984.0	3.6	1976.0	3.6		
	After	880.0	1.6	>2000	3.7		
021	Before	>2000	3.7	940.0	1.7		
	After	>2000	3.7	>2000	3.7		
022	Before	>2000	3.7	>2000	3.7		
	After	>2000	3.7	>2000	3.7		
023	Before	1252.0	2.3	>2000	3.7		
	After	>2000	3.7	1015.0	1.9		
024	Before	>2000	3.7	>2000	3.7		
	After	683.0	1.3	>2000	3.7		
025	Before	>2000	3.7	>2000	3.7		
	After	706.0	1.3	1140.0	2.1		
026	Before	>2000	3.7	>2000	3.7		
	After	1493.0	2.7	1800.0	3.3		
027	Before	>2000	3.7	>2000	3.7		
	After	1200.0	2.2	>2000	3.7		
028	Before	>2000	3.7	>2000	3.7		
	After	913.0	1.7	>2000	3.7		
029	Before	>2000	3.7	>2000	3.7		
	After	730.0	1.3	>2000	3.7		
030	Before	>2000	3.7	>2000	3.7		
	After	>2000	3.7	737.0	1.4		



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
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Sheet Name	Test Data
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Fluid Immersion Test Data: Fluids and Immersion

Sample No.	Test Fluid	Temperature (°C)	Immersion Time (hrs)
019	Philips X/C Aviation Hydraulic Fluid per MIL-PRF- 5606	49	20
020			
021			
022	TT-I-735 75% Isopropyl Alcohol	21.7	168
023			
024			
025	Petro Star Inc. JP-4 per MIL- DTL-5624	21.7	168
026			
027			
028	Eastman Turbo Oil 2389 per MIL-L-7808	120	30
029			
030			



Fluid Immersion Test Data Sheet

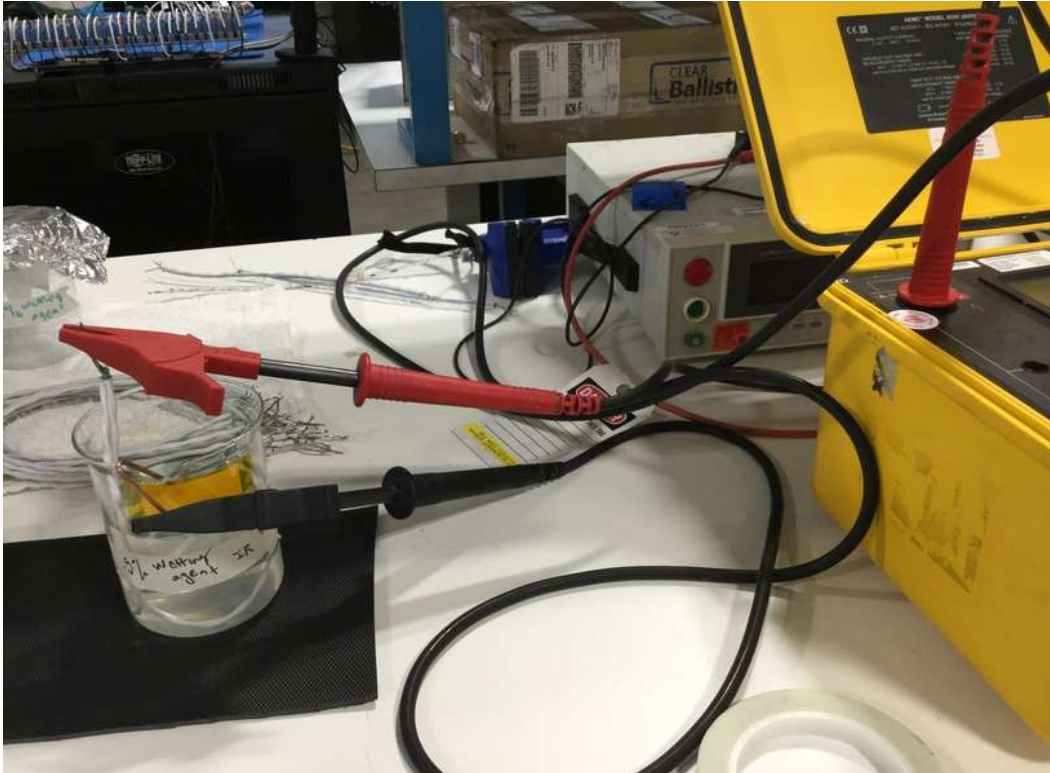
Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Data		

Fluid Immersion Test Data: Wire Diameter				
Sample No.	-	Before Immersion (in)	After Immersion (in)	Difference (in)
019	Thin side of Twist	0.1390	0.1315	-0.0075
	Thick side of Twist	0.1820	0.1800	-0.0020
020	Thin side of Twist	0.1410	0.1350	-0.0060
	Thick side of Twist	0.1790	0.1810	0.0020
021	Thin side of Twist	0.1295	0.1375	0.0080
	Thick side of Twist	0.1680	0.1825	0.0145
022	Thin side of Twist	0.1470	0.1540	0.0070
	Thick side of Twist	0.1705	0.1890	0.0185
023	Thin side of Twist	0.1350	0.1335	-0.0015
	Thick side of Twist	0.1860	0.1810	-0.0050
024	Thin side of Twist	0.1440	0.1340	-0.0100
	Thick side of Twist	0.1815	0.1825	0.0010
025	Thin side of Twist	0.1290	0.1285	-0.0005
	Thick side of Twist	0.1645	0.1820	0.0175
026	Thin side of Twist	0.1460	0.1340	-0.0120
	Thick side of Twist	0.1785	0.1780	-0.0005
027	Thin side of Twist	0.1275	0.1315	0.0040
	Thick side of Twist	0.1825	0.1860	0.0035
028	Thin side of Twist	0.1390	0.1310	-0.0080
	Thick side of Twist	0.1820	0.1810	-0.0010
029	Thin side of Twist	0.1305	0.1420	0.0115
	Thick side of Twist	0.1810	0.1810	0.0000
030	Thin side of Twist	0.1360	0.1400	0.0040
	Thick side of Twist	0.1660	0.1700	0.0040



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		

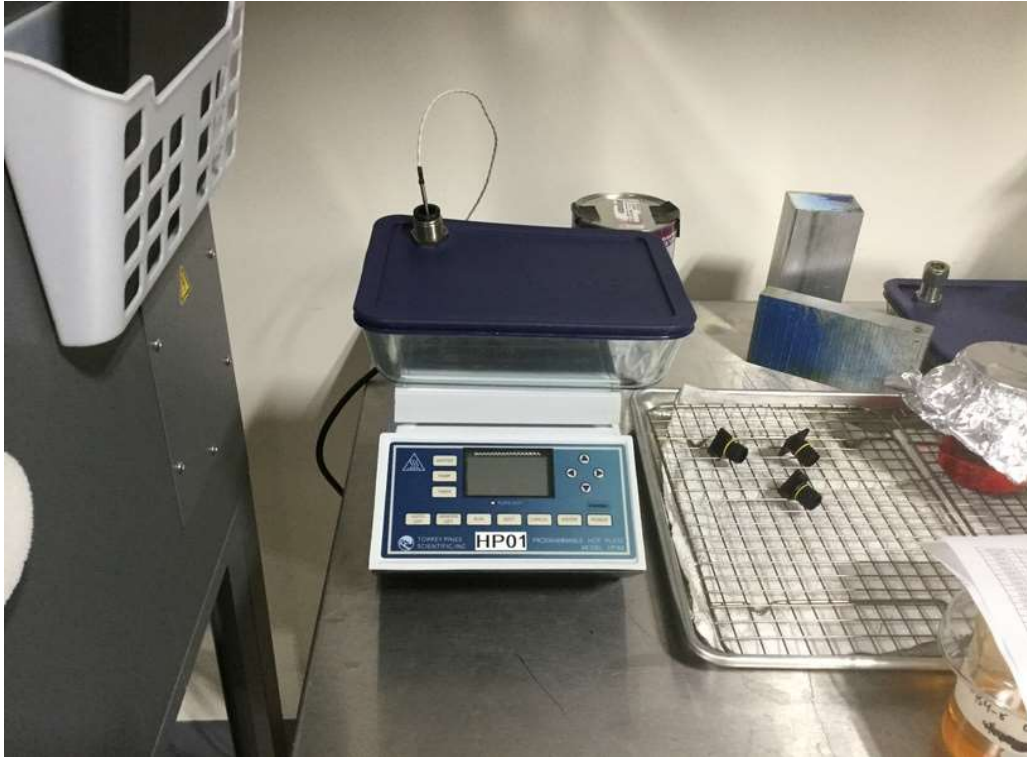


Description	Insulation resistance testing before fluid immersion
Test Name	Insulation Resistance Test
Part Name	ThermaRex Wire
Test Group	All groups
Part No.	960-2371-N-C-9-5-A
Serial No.	All samples



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		

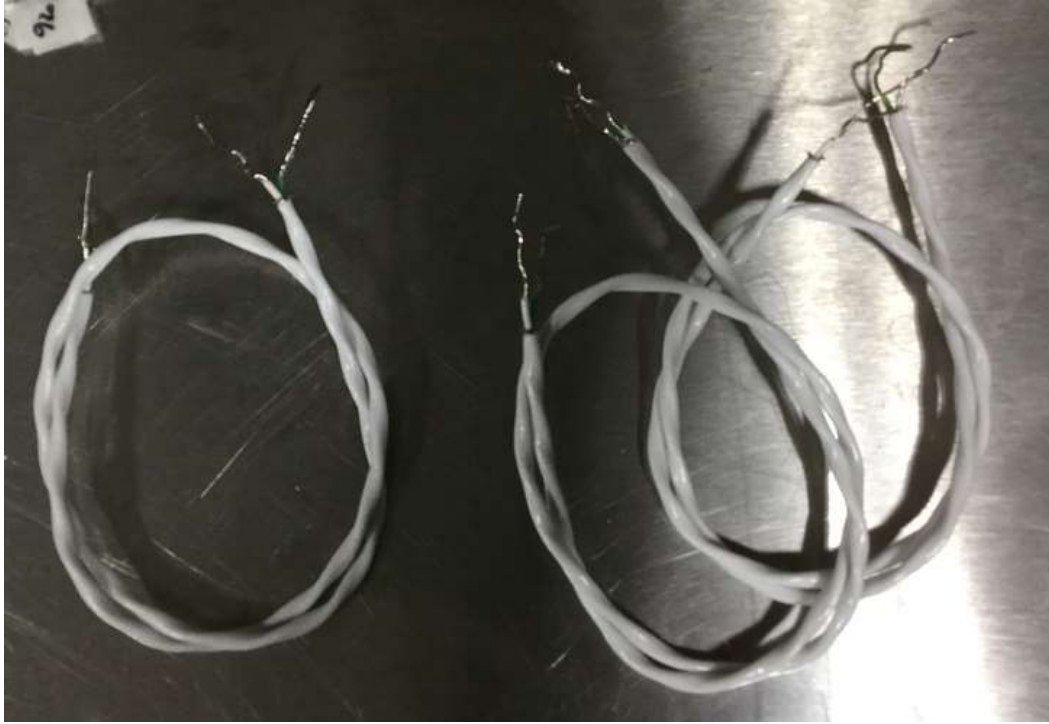


Description	Test set up for fluid immersion at temperature.
Test Name	Fluid Immersion
Part Name	ThermaRex Wire
Test Group	1 and 4
Part No.	960-2371-N-C-9-5-A
Serial No.	019-021 and 028-030



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		



Description	Wire samples before immersion
Test Name	Fluid Immersion
Part Name	ThermaRex Wire
Test Group	All groups
Part No.	960-2371-N-C-9-5-A
Serial No.	All samples



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		



Description	Wire samples 019, 020, and 021 after 20 hours immersion in fluid 1
Test Name	Fluid Immersion
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	019, 020, 021



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples immersed in fluid 2 for 168 hours
Test Name	Fluid Immersion
Part Name	ThermRex Wire
Test Group	2
Part No.	960-2371-N-C-9-5-A
Serial No.	022, 023, 024



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		

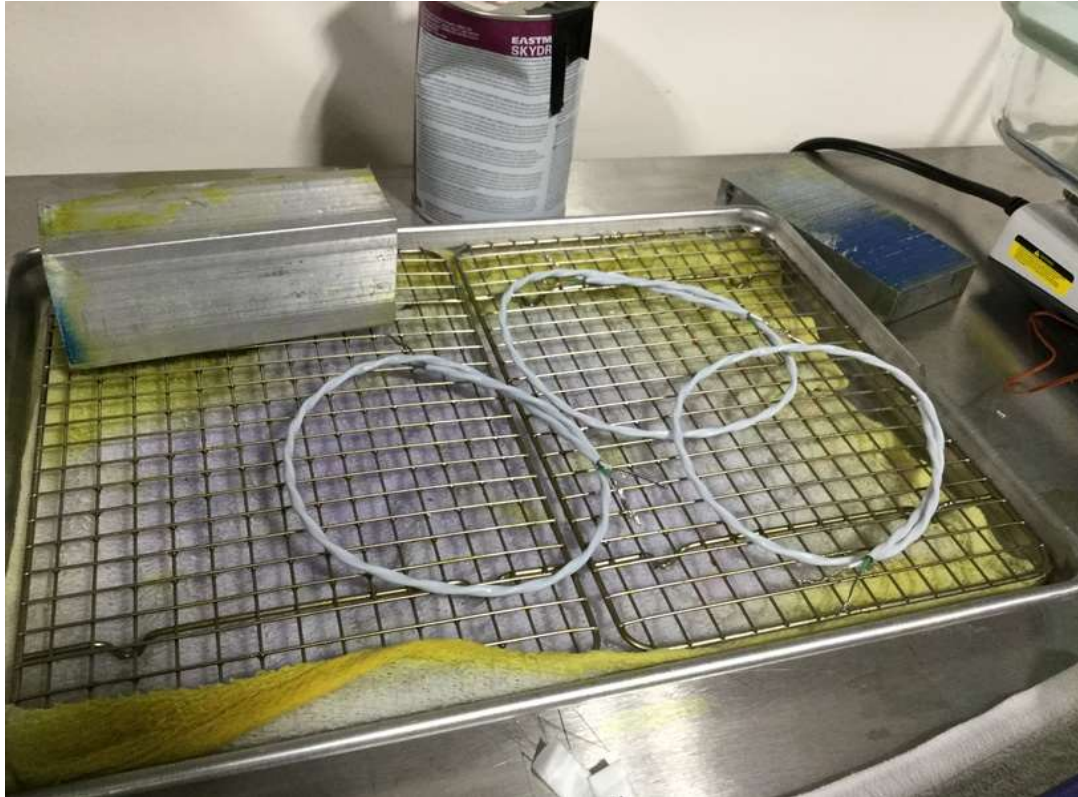


Description	Samples immersed in fluid 3 for 168 hours
Test Name	Fluid Immersion
Part Name	ThermaRex Wire
Test Group	3
Part No.	960-2371-N-C-9-5-A
Serial No.	025, 026, 027



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		



Description	Samples air drying after fluid immersion in fluid 4
Test Name	Fluid Immersion
Part Name	ThermaRex Wire
Test Group	4
Part No.	960-2371-N-C-9-5-A
Serial No.	028, 029, 30



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		



Description	Final photos of fluid 1 samples
Test Name	Visual Inspection
Part Name	ThermaRex Wire
Test Group	1
Part No.	960-2371-N-C-9-5-A
Serial No.	019, 020, 021



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		



Description	Final photo of fluid 2 samples
Test Name	Visual Inspection
Part Name	ThermaRex Wire
Test Group	2
Part No.	960-2371-N-C-9-5-A
Serial No.	022, 023, 024



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		

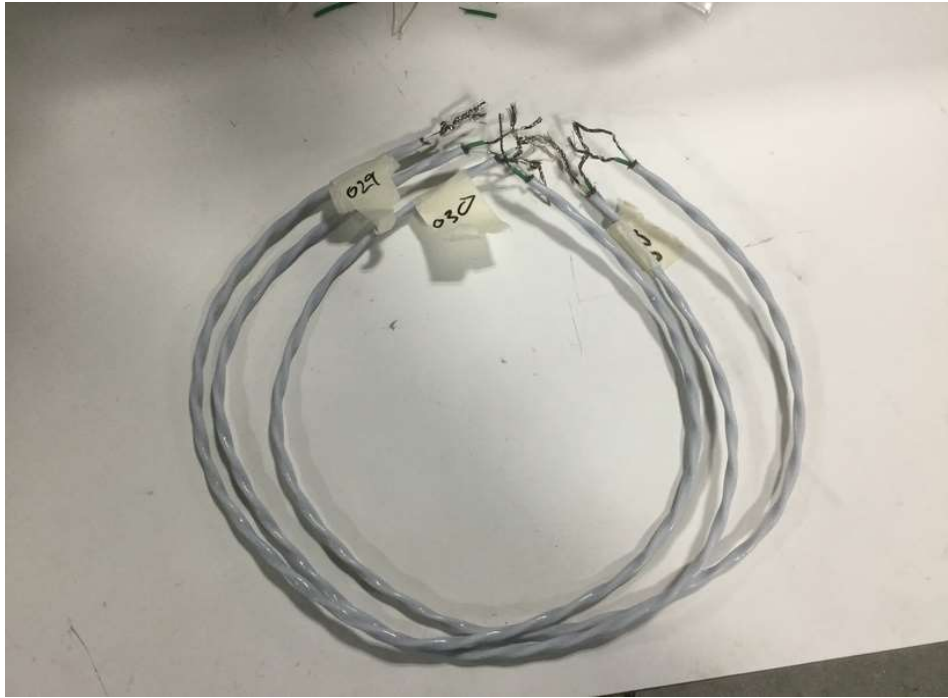


Description	Final photo of fluid 3 samples
Test Name	Visual Inspection
Part Name	ThermaRex Wire
Test Group	3
Part No.	960-2371-N-C-9-5-A
Serial No.	025, 026, 027



Fluid Immersion Test Data Sheet

Doc. No.	19218D11SPV1	Version	1
Sheet Name	Test Photos		



Description	Final photo of fluid 4 samples
Test Name	Visual Inspection
Part Name	ThermaRex Wire
Test Group	4
Part No.	960-2371-N-C-9-5-A
Serial No.	028, 029, 030

End of Test Data Sheet

60 Degree Wire Burn Test Data

19218 QTP-850 ThermaRex Wire

19218D13LQV1

Version 1

5/4/2020

Prepared By:	Lawrence Quinto Test Engineer	
Reviewed By:	Sam Malanoski Test Engineer	5/4/2020 Date
Approved By:	Kane Liang Quality Manager	5/4/2020 Date



Vertical Laboratories LLC
1805 Flower St | Glendale, CA | 91201
818-858-1982
www.verticallaboratories.com

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60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Version History		

Version	Date	Comments	Prepared By	Reviewed By	Approved By
1	5/4/2020	Initial Release	L. Quinto	S. Malanoski	K. Liang



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Summary		

Job Name	QTP-850 ThermaRex Wire
Job No.	19218
Client	Glenair
Contact Name	Micah Summers
Telephone No.	818-247-6000
Email	msummers@glenair.com
Part Name	ThermaRex Wire
Part No.	960-2371-N-C-9-5-A
Serial No.	-
Controlling Document	QTP-850 ThermaRex Wire Testing Version C

Test Name	Serial No.	Start Date	End Date	Pass	Fail	Record
Pre-burn Insulation Resistance (Wet Dielectric)	-	1/28/2020	1/28/2020	-	-	>29 gigaohm (1000 ft)
60° Wire Burn Testing	-	1/28/2020	1/28/2020	Pass	-	-
Post-burn Insulation Resistance (Jacket and Conductor)	-	1/28/2020	1/28/2020	-	-	47 kiloohm

Test Summary

One sample, 15 feet in length, was cut from a spool of ThermaRex Wire and subjected to insulation resistance testing per ASTM D3032-16. The following properties were recorded:

- * Measured Resistance: >2 teraohm
- * Immersed Length: 147.38 inch
- * Insulation Resistance: >29 gigaohm (1000 ft)

The sample was then sent to Lectromec, where it was divided into four specimens and subjected to 60° wire burn testing per FAR 25.853. The wire did not burn after flame removal, nor were any drips detected.

The burned specimens were then returned to Vertical Labs. Upon return, the specimens were photographed and measured for insulation resistance between jacket and conductors for reference only.



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
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Sheet Name	Test Equipment List
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ID No.	Equipment Name	Manufacturer	Model No.	Cal. Date	Cal. Due
EM029	Megaohmmeter	AEMC	6555	11/05/2019	11/30/2020
MA019	Weight Scale 0-5000	Ohaus	CL5000	6/10/2019	6/30/2020
TC002	Thermometer	Fluke	51 II	9/5/2019	9/30/2020



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Parameters		

Test Name	Insulation Resistance
Specification	QTP-850 ThermaRex Wire Testing
Method / Procedure	ASTM D3032-16 Section 6 (ref. by AS4373 Rev. E Section 4.5.4)
Figure / Table	-

Test Requirements

One inch from each end of the sample shall be stripped, and their wires twisted together. The specimen shall then be immersed to within 6 inches of a saline water bath of temperature $23 \pm 5^{\circ}\text{C}$ for four hours. Sample resistance measurements shall be taken at the start of immersion and after 4 hours of immersion.

The sample insulation resistance shall be calculated using the equation $\Omega_{(1000\text{ft})} = RL/1000$, where R is the measured specimen resistance in ohms and L is the specimen length in feet.

After burn testing, the resistance between the conductor and the shield shall be measured for reference only.



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Data		

Pre-Burn Insulation Resistance Test Data	
Mass of container	493 g
Mass of water and container	2604 g
Water mass	2111
Salt added	106 g
Wetting Agent added	1 mL
Solution Specific Gravity	1.04 @ 21.3°C
Initial Immersion Time	2020-03-03 10:30AM
Initial Water Bath Temp	19.8°C
Initial Electrification Time	2020-03-03 10:36AM
Initial Electrification Duration	1 minute
Initial Electrification Voltage	499 V
Initial Electrification Measured Current	201 pA
Initial Electrification Resistance (Displayed)	> 2.000 Tohm
Initial Electrification Resistance (Calculated)	2.48 Tohm
Final Water Bath Temp	19.8°C
Final Electrification Time	2020-03-03 2:49PM
Final Electrification Duration	1 min
Final Electrification Voltage	501 V
Final Electrification Measured Current	200 pA
Final Electrification Resistance (Displayed)	> 2.000 Tohm
Final Electrification Resistance (Calculated)	2.51 Tohm
Specimen Length	160.25 inch (13.35 ft)
Immersed Length	147.38 inch (12.28 ft)
Insulation Resistance (from displayed)	> 24.56 Gohm
Insulation Resistance (from final calc)	30.8 Gohm



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
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Sheet Name	Test Data
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Post Burn Specimen Resistance Test Data

Specimen	Total Length (inches)	Length Positive To Burn (inches)	Length Negative To Burn (inches)	Measured Resistance (kohm)
19218-BRN60-1	29.25	22.625	6.625	45
19218-BRN60-2	30	6.75	23.25	46
19218-BRN60-3	30	6.75	23.25	51
19218-BRN60-4	29.875	5.375	24.5	46
			Average	47



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Engineering Notes		

Date	Ambient	Time	Notes
03/03/2020	Lab Ambient	10:30 AM	Initial pretest insulation resistance measured.
		2:49 PM	Final pretest insulation resistance measured.
03/04/2020	-	5:04 PM	Specimen submitted to Lectromec for wire burn testing.
04/10/2020	-	11:50 AM	Specimen returned to Vertical Labs.
04/22/2020	Lab Ambient	4:36 PM	Post-burn insulation resistance measured.

Test Operator	Lawrence Quinto
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60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Photos		



Description	Sample pretest photo with minimum immersion depth mark. Ruler for reference only.
Test Name	Insulation Resistance
Part Name	ThermaRex Wire
Test Group	-
Part No.	960-2371-N-C-9-5-A
Serial No.	-



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Photos		



Description	Insulation resistance setup.
Test Name	Pre-burn insulation resistance testing.
Part Name	ThermaRex Wire
Test Group	-
Part No.	960-2371-N-C-9-5-A
Serial No.	-



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Photos		



Description	Post-test insulation resistance setup. Positive lead attached to conductors. Negative lead attached to shield.
Test Name	Post-burn insulation resistance.
Part Name	ThermaRex Wire
Test Group	-
Part No.	960-2371-N-C-9-5-A
Serial No.	-



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Photos		



Description	Close-up of burned area.
Test Name	Post-burn insulation resistance.
Part Name	ThermaRex Wire
Test Group	-
Part No.	960-2371-N-C-9-5-A
Serial No.	19218-BRN60-1



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Photos		



Description	Close-up of burned area.
Test Name	Post-burn insulation resistance.
Part Name	ThermaRex Wire
Test Group	-
Part No.	960-2371-N-C-9-5-A
Serial No.	19218-BRN60-2



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Photos		



Description	Close-up of burned area.
Test Name	Post-burn insulation resistance.
Part Name	ThermaRex Wire
Test Group	-
Part No.	960-2371-N-C-9-5-A
Serial No.	19218-BRN60-3



60 Degree Wire Burn Test Data

Doc. No.	19218D13LQV1	Version	1
Sheet Name	Test Photos		



Description	Close-up of burned area.
Test Name	Post-burn insulation resistance.
Part Name	ThermaRex Wire
Test Group	-
Part No.	960-2371-N-C-9-5-A
Serial No.	19218-BRN60-4

End of Test Data Sheet



4230-K Lafayette Centre Drive
Chantilly, VA 20151

Final Test Report
of One (1) Cable Specification

Prepared for

Vertical Labs
1805 Flower Street
Glendale CA 91201

Report Number
N1157-R001

By

Lectromechanical Design Company, LLC.
4230-K Lafayette Center Drive
Chantilly, VA 20151 USA

Report Date: March 31, 2020

Prepared by: Devon Gonteski

Reviewed by: Michael Traskos

• Accredited to ISO/IEC 17025:2005 •

Revision History

Revision	Date	Edited by	Comments
Original	03/30/2020	D. Gonteski	

Lectromec Accreditation Information

Standard to which Accredited: ISO 17025:2017
Evaluating Body: PJLA
Accreditation ID: L19-637
Field: Testing

Contents

1	Summary	4
2	Flammability.....	4
2.1	Test Objective	4
2.2	Test Information	4
2.3	Equipment and Description	4
2.4	Test Results	5

1 Summary

One test was performed on one (1) cable specimen provided to Lectromec by Vertical Labs. Table 1 provides the list of tests performed in this effort.

Table 1: Summary of tests performed in this effort.

Test #	Test Name	Test Spec	Method
1	Flammability	FAR	25.853

The specimens provided to Lectromec by Vertical Labs is listed in Table 2.

Table 2: Specimens tested in this effort.

Lectromec Sample Tracking ID	Vertical Labs Identification
N1157-S01	Part Number: 960-2371-N-C-9-5-A Sample ID: 19218-BRN60

2 Flammability

2.1 Test Objective

This test is used to measure the burn length of wire and cable insulation, measure the additional flame perpetuation time, and to measure the occurrence of molten cable drippings.

2.2 Test Information

Test Specification: FAR

Method: 25.853

Additional Notes/Special Conditions: Pass Criteria: Extinguish time 3s, burn travel 3" max

2.3 Equipment and Description

The test apparatus is configured such that the lower end of the specimen is rigidly secured, and the upper end falls over a pulley and is held taut with an attached weight (the weight used is specimen dependent). The specimen is held at a 60-degree angle from horizontal and the incident flame source is perpendicular to the sample. The incident flame source is also not directly under the specimen, but at a 30-degree angle to vertical (see Figure 1).

The flame source is a propane torch with a nominal 3/8" bore. The gas flow is adjusted to produce a 3-inch flame with a 1-inch inner cone. The sample position is adjusted to be 1.0 inch from the torch flame source (at the tip of the inner flame cone). A mark is made on the sample at this location.

The flame is applied for 30 seconds. Once the flame has been extinguished, the time that the specimen remains afire and the time that any dripped materials continue to burn is recorded; dripped materials that

are specifically on fire when they drip are included in the reporting. The burn length is measured and recorded.

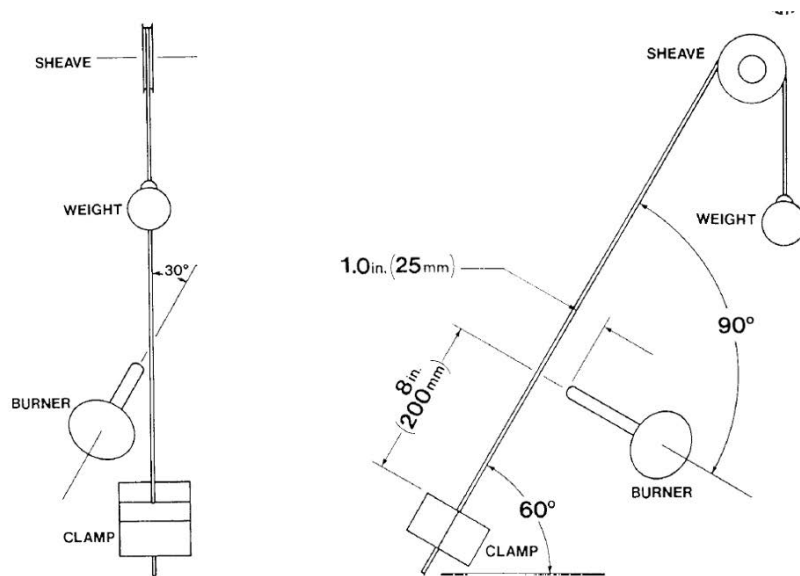


Figure 1: Setup as viewed from the left side of the enclosure (Left) and as viewed from the front of the enclosure (Right). Source: ASTM 3032.

Table 3: Equipment used in this test.

Equipment Name	Series Number (Lectromec ID)	Last Calibration Date	Calibration Due
Burner	LEC183	2019/03/01	2021/03/01
Test Fixture	LEC184	N/A	N/A

2.4 Test Results

The flame test results are shown Table 4.

Table 4: Flammability test results.

Test Sample	Damage Length (in.)	Burning Duration After Flame Removal (s)	Incendiary Drops Y/N	Burn Time of Incendiary Particles (s)
N1157-S01-1	1.5	0	N	N/A
N1157-S01-2	1.5	0	N	N/A
N1157-S01-3	1.5	0	N	N/A
N1157-S01-4	1.5	0	N	N/A



Job No: 19218
Date: 2020-05-05

Document No: 19218R1LQV1
Version: 1

End of Test Report