Nett Warrior O.C.H. Quick Disconnect Circular Plug and Receptacle Connectors

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity (TE) Nett Warrior O.C.H. Quick Disconnect Circular Plug and Receptacle Connectors to determine their conformance to the requirements of Product Specification 108-32114, Rev A and 108-32114, Rev B.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the TE Connectivity Nett Warrior O.C.H. Quick Disconnect Circular Plug and Receptacle Connectors. Original testing was performed on overmolded test assemblies at the Harrisburg Electrical Components Test Laboratory (HECTL) between 23-February-2015 and 08-May-2015. Test Group 5 environmental and basic functionality testing were performed at E-Labs, Fredericksburg, VA, between 9-April-2015 and 04-May-2015. Testing was performed on non-overmolded test assemblies at HECTL between 03-June-2020 and 07-July-2020. Detailed test data is on file and maintained at the Tyco Electronics Harrisburg Electrical Components Test Laboratory under test files EA20140668T and EA20200212T.

1.3 Conclusion

All overmolded specimens of the TE Connectivity Nett Warrior O.C.H. Quick Disconnect Circular Plug and Receptacle Connectors listed in paragraph 1.5, conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-32114, Rev A. Non-overmolded assemblies listed in paragraph 1.5 conformed to the electrical, mechanical, and environmental performance requirements of Test Groups 2 and 4 in Product Specification 108-32114, Rev B.

1.4 Product Description

Plug and receptacle connectors are quick-disconnect circular electrical connectors.

1.5 Test Specimens

The test specimens were representative of normal production lots, and the following part numbers were used for test:

Table 1 – Test Specimens

Test Group	Qty	Part Number	Description
1	2	2226910-1	Cable mounted plug, overmolded, 6-position assembly
	2	2226920-1	Cable mounted receptacle, overmolded, 6-position assembly
2	2	2226910-1	Cable mounted plug, overmolded, 6-position assembly
	2	2226920-1	Cable mounted receptacle, overmolded, 6-position assembly
	2	2332598-1	Cable mounted plug, non-overmolded, 7-position assembly
	2	2332605-1	Cable mounted receptacle, non-overmolded, 7-position assembly
3	2	2226910-1	Cable mounted plug, overmolded, 6-position assembly
	2	2226920-1	Cable mounted receptacle, overmolded, 6-position assembly
4	2	2226910-1	Cable mounted plug, overmolded, 6-position assembly
	2	2226920-1	Cable mounted receptacle, overmolded, 6-position assembly
	2	2332598-1	Cable mounted plug, non-overmolded, 7-position assembly
	2	2332605-1	Cable mounted receptacle, non-overmolded, 7-position assembly
5	2	2226910-1	Cable mounted plug, overmolded, 6-position assembly
	2	2226920-1	Cable mounted receptacle, overmolded, 6-position assembly

1.6 Qualification Test Sequence

The test specimens referred to in paragraph 1.5 were tested according to the test sequences listed in Table 2.

Table 2 – Test Sequence

Test or Examination	Test Group (a)				
	1	**2**	**3**	4	5
	Test Sequence (b)				
Examination of Product	1, 5	1, 5, 9, 13, 17, 21	1, 5, 9, 13	1, 5, 9, 13,17	1, 5, 9, 13, 17
Voltage Drop @ 1 ADC	2	2, 6, 10, 14, 18, 22	2, 6, 10, 14	2, 6, 10, 14,18	2, 6, 10, 14, 18
Insulation Resistance @ 500 VDC	3	3, 7, 11, 15, 19, 23	3, 7, 11, 15	3, 7, 11, 15,19	3, 7, 11, 15, 19
Breakaway Force	4				
Strength				16	
Altitude – Procedure I		4			
Altitude – Procedure II		8			
Vibration – Procedure I		12			
Shock		16			
Vibration – Procedure II		20			
High Temperature – Procedure II			4		
High Temperature – Procedure I			8		
Low Temperature – Procedure II			12		
Humidity – Induced Storage & Transit				4	
Humidity – Natural Environment Operational				8	
Salt Atmosphere				12	
Rain					4
Snow & Ice					8
Solar Radiation					12
Dust					16

Note: (a) See paragraph 1.5
(b) Numbers indicate sequence which tests were performed.

1.7 Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

Temperature: 15°C to 35°C
Relative Humidity 20% to 80%

2. SUMMARY OF TESTING

2.1 Examination of Product

There was no evidence of physical damage on initial examination or after environmental exposures.

2.2 Voltage Drop

Continuity was verified initially, and after environmental exposure.

2.3 Insulation Resistance

All insulation resistance measurements were greater than the minimum requirement of 100 Megohms.

2.4 Breakaway Force

All breakaway force measurements had a force of 13 ± 3lbf.

2.5 Strength

There was no physical damage to the cable sheath or overmolded connector as a result of the strength test. Non-overmolded connectors showed no physical damage as a result of the strength test.

2.6 Altitude – Procedure I

There was no physical damage to the specimens as a result of procedure I altitude test.

2.7 Altitude – Procedure II

No discontinuities of one microsecond or greater occurred during the procedure II altitude test.

2.8 Vibration – Procedure I

No discontinuities of one microsecond or greater occurred during the procedure I vibration test.

2.9 Shock

There was no physical damage to the specimens as a result of the shock test.

2.10 Vibration - Procedure II

There was no physical damage to the specimens as a result of the procedure II vibration test.

2.11 High Temperature – Procedure II

No discontinuities of one microsecond or greater occurred during the procedure II high temperature test.

2.12 High Temperature – Procedure I

There was no physical damage to the specimens as a result of the procedure I high temperature test.

2.13 Low Temperature – Procedure II

No discontinuities of one microsecond or greater occurred during the procedure II low temperature test.

2.14 Humidity – Induced Storage & Transit

There was no physical damage to the specimens as a result of the induced storage & transit humidity test.

2.15 Humidity – Natural Environmental Operational

No discontinuities of one microsecond or greater occurred during the natural environmental operational humidity test.

2.16 Salt Atmosphere

There was no physical damage to the specimens as a result of the salt atmosphere test.

2.17 Rain

No discontinuities of one microsecond or greater occurred during the rain test.

2.18 Snow & Ice

No discontinuities of one microsecond or greater occurred during the snow & ice test.

2.19 Solar Radiation

There was no physical damage to the specimens as a result of the solar radiation test.

2.20 Dust

There was no physical damage to the specimens as a result of dust exposure.

3. TEST METHODS

3.1. Examination of Product

Visual Examination was performed in accordance with Product Specification 108-32114, Rev. A for overmolded connectors and 108-32114, Rev. B for non-overmolded connectors. Specimens were visually examined to the extent possible, using the unaided eye.

3.2 Voltage Drop

Voltage drop testing was performed in accordance with Product Specification 108-32114, Rev. A for overmolded connectors and 108-32114, Rev. B for non-overmolded connectors. Voltage drop measurements at 1 ADC were made using a four terminal measuring technique.

3.3 Insulation Resistance

Insulation Resistance testing was performed in accordance with Product Specification 108-32114, Rev. A for overmolded connectors and 108-32114, Rev. B for non-overmolded connectors. A voltage of 500 Vdc was applied between the connector positions and the connector shield for a minimum of 1 second, and the insulation resistance measured.

A voltage of 500 VDC was applied between the odd and even circuits for a minimum of 1 second, and the insulation resistance measured.

3.4 Breakaway Force

Breakaway Force testing was performed in accordance with Product Specification 108-32114, Rev. A. Each mating connector pair of an overall assembly was tested individually. The receptacle assembly was secured to a floating x-y-r table on the base of the tensile/compression test system. The plug assembly was secured to the moveable cross-head. An axial force was applied at a rate of 15 inches per minute until the connectors unmated. The maximum force was recorded. Test setup is shown in Figure 1.

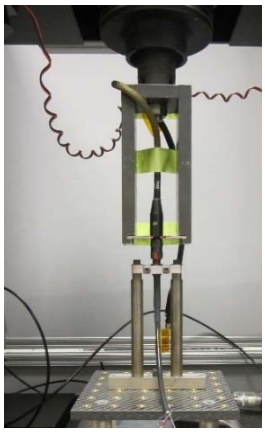

Figure 1 - Breakaway Force

3.5 Strength

Strength testing of overmolded connectors was performed in accordance with Product Specification 108-32114, Rev. A. The connector was secured to the base of the tensile/compression test system using a slotted plate fixture. The cable was secured to the moving cross-head of the system 6 to 12 inches from the connector. A pre-load of 80 lbf was applied using a test speed of 2 inches per minute and then 100 lbf was applied using a test speed of .5 inches per minute. The 100 lbf load was held for 30 seconds. Test setup is shown in Figure 2.

Strength testing of non-overmolded connectors was performed in accordance with Product Specification 108-32114, Rev. B. The connector was secured to the base of the force test system using a plate with a 0.348 inch diameter hole. The cable was secured to the moving cross-head of the system 12 to 16 inches from the connector. A load of 21 lbf was applied using a test speed of .5 inches per minute. The 21 lbf load was held for 30 seconds. Test setup is shown in Figure 3.

Figure 2 – Strength Test, Overmolded Connector

Figure 3 – Strength Test, Non-Overmolded Connector

3.6 Altitude – Procedure I

Storage Altitude testing was performed in accordance with MIL-STD-810G, Method 500.5, Procedure I for overmolded connectors and MIL-STD-810H, Method 500.6, Procedure I for non-overmolded connectors. Mated test specimens were placed in the chamber and the pressure was adjusted to a simulated altitude of 40,000 feet. Specimens were exposed to the simulated altitude for 1 hour.

3.7 Altitude – Procedure II

Operation Altitude testing was performed in accordance with MIL-STD-810G, Method 500.5, Procedure II for overmolded connectors and MIL-STD-810H, Method 500.6, Procedure II for non-overmolded connectors. Mated test specimens were placed in the chamber and the pressure was adjusted to a simulated altitude of 32,000 feet. Specimens were exposed to the simulated altitude for 1 hour. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

3.8 Vibration – Procedure I

The test specimens were subjected to a random vibration test in accordance with specification MIL-STD-810G, Method 514.7, Procedure I for overmolded connectors and MIL-STD-810H, Method 514.8, Annex E, Procedure I for non-overmolded connectors. See Figure 4 and Figure 5 for vibration setup photographs. The parameters of this test condition were specified by a random vibration spectrum with excitation frequency bounds of 20 and 2000 Hertz (Hz). The spectrum was flat at 0.04 G^2/Hz from 20 Hz to 1000 Hz. The spectrum sloped down at 6 dB per octave to a PSD of 0.01 G^2/Hz at the upper bound frequency of 2000 Hz. The root-mean square amplitude of the excitation was 7.7 GRMS. The test specimens were subjected to this test for 1 hour in two perpendicular axes. The longitudinal axis (mating axis) and one of the perpendicular planes to that axis, for a total test time of 2 hours per test specimen. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

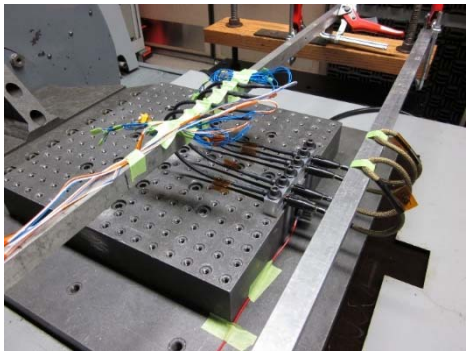

Figure 4 - Vibration - Longitudinal Axis

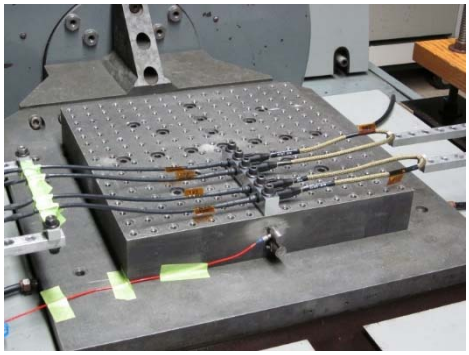

Figure 5 - Vibration - Lateral Axis

3.9 Shock

Transit Drop Shock testing was performed in accordance with MIL-STD-810G, Method 516.6, Procedure IV for overmolded connectors and MIL-STD-810H, Method 516.8, Procedure IV for non-overmolded connectors. Mated test specimens were dropped from a height of 48 inches onto a concrete surface. A total of nine drops were performed on each specimen, re-orienting the assembly approximately 40 degrees from its previous orientation with each drop.

3.10 Vibration – Procedure II

Loose cargo vibration testing was performed in accordance with MIL-STD-810G, Method 514.6, Category 5, Procedure II for overmolded connectors and MIL-STD-810H, Method 514.8, Category 5, Procedure II for non-overmolded connectors. Testing was performed using a package tester setup as shown in Figure 6. The length of each side was approximately 22.5 inches (based on a specimen length of approximately 20 inches and a connector diameter of approximately 0.5 inches and using Equation (3) of MIL-STD-810G, Method 514.6, Annex C, Paragraph 2.2.c) and MIL-STD-810H, Method 514.8, Annex C, Paragraph 2.2.c). The movement of the package tester bed was a 1.0 inch diameter orbital path at 5 Hz. Unmated double-ended production test specimens were placed in the test area in a non-uniform manner and subjected to the prescribed motion for a period of 20 minutes.

Figure 6 - Loose Cargo Vibration

3.11 High Temperature – Procedure II

Operation High Temperature testing was performed in accordance with MIL-STD-810G, Method 501.5, Procedure II. Mated test specimens were placed in the test chamber as shown in Figure 7 and subjected to three cycles of the temperature profile defined in Table 3. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

Table 3– Operation High Temperature Profile

Hour	Temperature (Deg. C)	Hour	Temperature (Deg. C)
1	36	13	48
2	40	14	46
3	44	15	44
4	48	16	42
5	52	17	40
6	55	18	38
7	55	19	36
8	55	20	34
9	55	21	32
10	55	22	30
11	52	23	30
12	50	24	33

Figure 7 - Specimens in Chamber

3.12 High Temperature – Procedure I

Storage High Temperature testing was performed in accordance with MIL-STD-810G, Method 501.5, Procedure I. Mated test specimens were placed in the test chamber as shown in Figure 7 and subjected to seven cycles of the temperature profile defined in Table 4.

Table 4 – Storage High Temperature Profile

Hour	Temperature (Deg. C)	Hour	Temperature (Deg. C)
1	42	13	58
2	48	14	54
3	54	15	50
4	59	16	46
5	64	17	43
6	68	18	40
7	71	19	37
8	71	20	34
9	69	21	32
10	67	22	30
11	64	23	33
12	61	24	37

3.13 Low Temperature – Procedure II

Operation Low Temperature testing was performed in accordance with MIL-STD-810G, Method 502.5, Procedure II. Mated test specimens were placed in the test chamber as shown in Figure 7 and subjected to a temperature of -18°C for a period of 6 hours. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

3.14 Humidity – Induced Storage and Transit

Induced Storage and Transit Humidity testing was performed in accordance with MIL-STD-810G, Method 507.5, Procedure I for overmolded connectors and MIL-STD-810H, Method 507.6, Procedure I for non-overmolded connectors. Mated specimens were placed in the chamber and subjected to three cycles of the Induced Storage and Transit temperature/humidity profile defined in Column B2 of Figure 8.

	Natural[1]									Induced (Storage and Transit)								
	High Humidity																	
	Constant Temp. (Cycle B1)			Cyclic High RH (Cycle B2)			Hot Humid (Cycle B3)			Constant Temp. (Cycle B1)			Cyclic High RH (Cycle B2)			Hot Humid (Cycle B3)		
	Temp		RH	Temp		RH	Temp		RH	Temp		RH	Temp		RH	Temp		RH
Time	°C	°F	%	°C	°F	%	°C	°F	%	°C	°F	%	°C	°F	%	°C	°F	%
0100	Nearly constant at 24°C (75°F) throughout the 24 hours		100[2]	27	80	100	31	88	88	Nearly constant at 27°C (80°F) throughout the 24 hours		100	33	91	69	35	95	67
0200			100	26	79	100	31	88	88			100	32	90	70	34	94	72
0300			100	26	79	100	31	88	88			100	32	90	71	34	94	75
0400			100	26	79	100	31	88	88			100	31	88	72	34	93	77
0500			100	26	78	100	31	88	88			100	30	86	74	33	92	79
0600			100	29	78	100	32	90	85			100	31	88	75	33	91	80
0700			98	27	81	94	34	93	80			98	34	93	64	36	97	70
0800			97	29	84	88	36	96	76			97	38	101	54	40	104	54
0900			95	31	87	82	37	98	73			95	42	107	43	44	111	42
1000			95	32	89	79	38	100	69			95	45	113	36	51	124	31
1100			95	33	92	77	39	102	65			95	51	124	29	57	135	24
1200			95	34	94	75	40	104	62			95	57	134	22	62	144	17
1300			95	34	94	74	41	105	59			95	61	142	21	66	151	16
1400			95	35	95	74	41	105	59			95	63	145	20	69	156	15
1500			95	35	95	74	41	105	59			95	63	145	19	71	160	14
1600			95	34	93	76	41	105	59			95	62	144	20	69	156	16
1700			95	33	92	79	39	102	65			95	60	140	21	66	151	18
1800			95	32	90	82	37	99	69			95	57	134	22	63	145	21
1900			97	31	88	86	36	97	73			97	50	122	32	58	136	29
2000			98	29	85	91	34	94	79			98	44	111	43	50	122	41
2100			100	28	83	95	33	91	85			100	38	101	54	41	105	53
2200			100	28	82	96	32	90	85			100	35	95	59	39	103	58
2300			100	27	81	100	32	89	88			100	34	93	63	37	99	62
2400			100	27	80	100	31	88	88			100	33	91	68	35	95	63

Figure 8 – Humidity Induced Storage and Transit Test Profile

3.15 Humidity – Natural Environment Operational

Natural Humidity testing was performed in accordance with MIL-STD-810G, Method 507.5, Procedure I for overmolded connectors and MIL-STD-810H, Method 507.6, Procedure I for non-overmolded connectors. Mated specimens were placed in the chamber and subjected to three cycles of the Natural temperature/humidity profile defined in Column B2 of Figure 9. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

	Natural[1]									Induced (Storage and Transit)								
	High Humidity																	
	Constant Temp. (Cycle B1)			Cyclic High RH (Cycle B2)			Hot Humid (Cycle B3)			Constant Temp. (Cycle B1)			Cyclic High RH (Cycle B2)			Hot Humid (Cycle B3)		
	Temp		RH	Temp		RH	Temp		RH	Temp		RH	Temp		RH	Temp		RH
Time	°C	°F	%	°C	°F	%	°C	°F	%	°C	°F	%	°C	°F	%	°C	°F	%
0100	Nearly constant at 24°C (75°F) throughout the 24 hours		100[2]	27	80	100	31	88	88	Nearly constant at 27°C (80°F) throughout the 24 hours		100	33	91	69	35	95	67
0200			100	26	79	100	31	88	88			100	32	90	70	34	94	72
0300			100	26	79	100	31	88	88			100	32	90	71	34	94	75
0400			100	26	79	100	31	88	88			100	31	88	72	34	93	77
0500			100	26	78	100	31	88	88			100	30	86	74	33	92	79
0600			100	29	78	100	32	90	85			100	31	88	75	33	91	80
0700			98	27	81	94	34	93	80			98	34	93	64	36	97	70
0800			97	29	84	88	36	96	76			97	38	101	54	40	104	54
0900			95	31	87	82	37	98	73			95	42	107	43	44	111	42
1000			95	32	89	79	38	100	69			95	45	113	36	51	124	31
1100			95	33	92	77	39	102	65			95	51	124	29	57	135	24
1200			95	34	94	75	40	104	62			95	57	134	22	62	144	17
1300			95	34	94	74	41	105	59			95	61	142	21	66	151	16
1400			95	35	95	74	41	105	59			95	63	145	20	69	156	15
1500			95	35	95	74	41	105	59			95	63	145	19	71	160	14
1600			95	34	93	76	41	105	59			95	62	144	20	69	156	16
1700			95	33	92	79	39	102	65			95	60	140	21	66	151	18
1800			95	32	90	82	37	99	69			95	57	134	22	63	145	21
1900			97	31	88	86	36	97	73			97	50	122	32	58	136	29
2000			98	29	85	91	34	94	79			98	44	111	43	50	122	41
2100			100	28	83	95	33	91	85			100	38	101	54	41	105	53
2200			100	28	82	96	32	90	85			100	35	95	59	39	103	58
2300			100	27	81	100	32	89	88			100	34	93	63	37	99	62
2400			100	27	80	100	31	88	88			100	33	91	68	35	95	63

[1] Temperature and humidity values are for ambient air.

[2] For chamber control purpose, 100 percent RH implies as close to 100 percent RH as possible, but not less than 95 percent.

Figure 9 – Humidity Natural Environment Test Profile

3.16 Salt Atmosphere

Salt atmosphere testing was performed in accordance with MIL-STD-810G, Method 509.5 for overmolded connectors and MIL-STD-810H, Method 509.7 for non-overmolded connectors. Unmated test specimens were placed in the chamber as shown in Figure 10. Specimens were exposed to the standard salt spray conditions of 5% salt concentration at 35°C for 24 hours. Specimens were removed from the chamber and allowed to dry at ambient conditions for a period of 24 hours. Specimens were then exposed the standard salt spray conditions for another 24 hours after which they were removed from the chamber and allowed to dry at ambient conditions for a period of 24 hours.

Figure 10 - Salt Atmosphere

3.17 Rain

Rain testing was performed in accordance with MIL-STD-810G, Method 506.5, Procedure II (Exaggerated). Mated specimens were subjected to a water spray pattern having a droplet size predominately in the 0.45 to 0.50 mm range travelling at approximately 64 km/h (40 mph) at approximately 276 kPa (40 psig). The spray was applied to all exposed surfaces of the test specimens for 40 minutes. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

3.18 Snow & Ice

Snow & Ice testing was performed in accordance with MIL-STD-810G, Method 521.3 (Glaze Ice Procedure for 6 mm Ice Thickness). Mated specimens were placed in the test chamber, and the air temperature was adjusted to 0°C (-0/+2°C) and maintained for a minimum period of 1 hour to allow the test specimens to stabilize at temperature. The specimens were then subjected to a uniform, pre-cooled (0 to 3°C) water spray at a rate of approximately 25 mm/hour for 1 hour to allow water penetration into the test specimen crevices and openings. The chamber air temperature was then adjusted to -10°C, and the water spray rate maintained until 6 millimeters of ice had accumulated on the surface of the test specimens. At that point, the chamber air temperature was maintained for a minimum period of 4 hours to allow ice to harden. The specimens were then manually unmated and mated, using only standard items available in the field. Immediately following the mating cycle, voltage drop and insulation resistance were measured in accordance with Paragraphs 3.2 and 3.3 respectively. The chamber air temperature was then adjusted to standard ambient conditions.

3.19 Solar Radiation

Solar Radiation testing was performed in accordance with MIL-STD-810G, Method 505.5, Procedure I, Cycle A1, for three continuous cycles. Mated specimens were placed in the test chamber, and exposed to three continuous 24-hour cycles of controlled simulated radiation and dry-bub temperature as indicated for Cycle A1 of Figure 11.

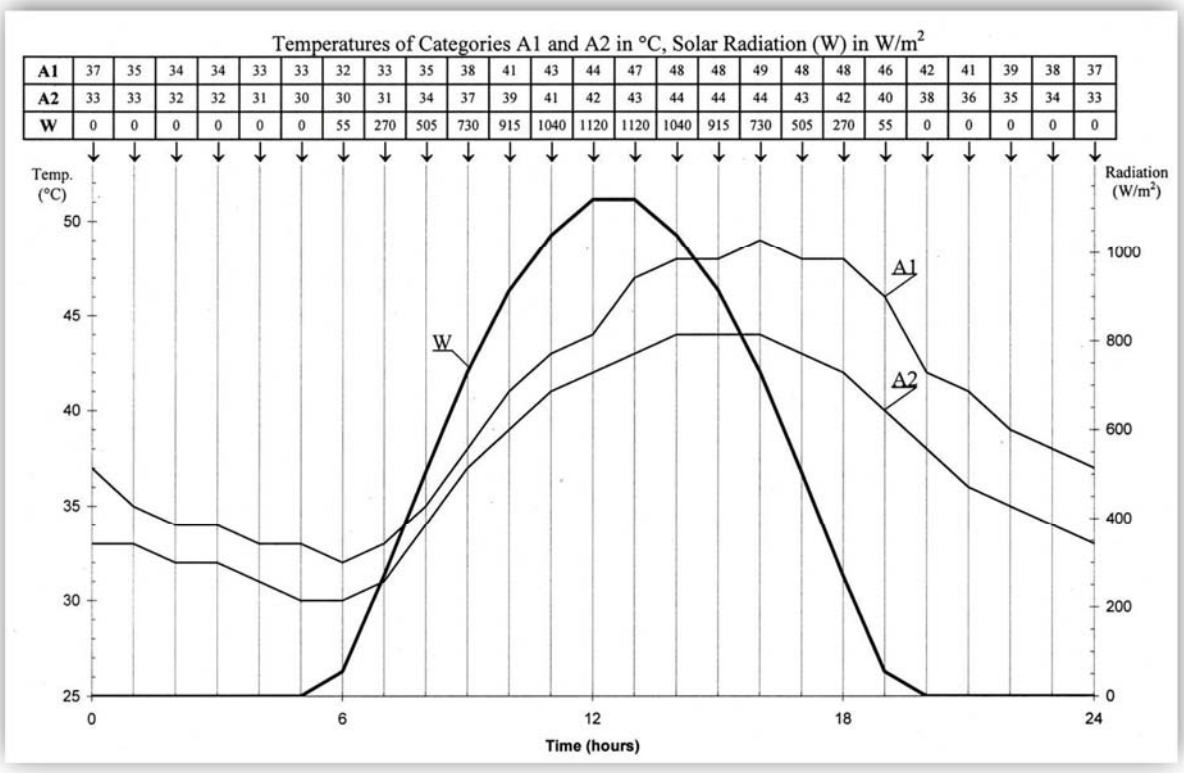

Figure 11 - Solar Radiation Exposure Curve

3.20 Dust

Dust testing was performed in accordance with MIL-STD-810G, Method 510.5, Procedure I. Mated specimens were placed in the test chamber, and stabilized at a temperature of 55°C. The air velocity was then adjusted to 8.9 m/sec, and the dust feed control adjusted to a dust concentration of 10.6 +/- 7 g/m^3. These conditions were maintained for a period of 6 hours. The dust feed was then stopped, and the air velocity was reduced to 1.5 +/- 1 m/sec while the chamber was maintained at a temperature of 55°C. These conditions were maintained for a period of 1 hour. The air velocity was then adjusted to 8.9 m/sec, and the dust feed control adjusted to a dust concentration of 10.6 +/- 7 g/m^3. These conditions were maintained for another period of 6 hours. The dust feed was then stopped, the test chamber was allowed to return to room ambient conditions, the air flow was stopped, and the dust was allowed to settle. Accumulated dust was removed from the test specimens by shaking and brushing prior to post-test measurements.