Raychem

Electrical Products Division Report

EDR-5190

Performance Test of
Raychem Nuclear Motor
Connection Kit - NMCK-8

Revision A

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I. OBJECTIVE

To evaluate the performance of Raychem NMCK 8 Non-Shielded Stub Type Motor Connection Kit, by testing it to a modified sequence of IEEE-404 1986, the standard for shielded power cable joints.

II. SUMMARY

A total of three NMCK 8-4V samples were evaluated. Each sample was subjected to a series of voltage withstand tests, followed by load cycling in air, with a long term overvoltage test. Test results are summarized in Table I.

III. CONCLUSION

This report establishes the performance capability of the NMCK 8 Non-Shielded Stub Type Motor Connection Kit. It also establishes the satisfactory performance of the connection when the cap is in intimate contact with ground.

IV. SAMPLE PREPARATION

The following cables and accessories were used in the construction of the samples.

Motor lead:	#6 AWG glass reinforced silicone rubber insulated, 8kV, stranded copper conductor cable.
Feeder cable:	#2 AWG EPR-NEO 5kV, 133% insulation, metal tape shield stranded copper conductor cable.
Lugs:	Copper compression, single hole.

A standard HVT-80 kit was used to terminate the feeder cable. The lugs were bolted together to form a stub connection. The NMCK 8-4V kit was assembled in accordance with the standard installation instruction PII-57425-0, as provided in the kit. Three such assemblies were constructed.

V. TESTING

All three samples were subjected to a modified sequence of tests listed in IEEE-404 1986. The tests included AC and DC voltage withstands, impulse withstand, current cycling in air, long term overvoltage followed by AC voltage withstand test.

A ground plane was constructed around the stub by wrapping a copper gauze over the cap. This was to simulate a worst case field condition where the stub connection could be in intimate contact with a grounded enclosure. All tests were conducted with the intimate ground plane on the exterior surface.

VI. TEST RESULTS

6.1 AC VOLTAGE WITHSTAND

A 23kV (rms) 60Hz voltage was applied for one minute between conductor and the external copper gauze ground plane.
Result: All samples passed with no breakdown or flashover.

6.2 DC VOLTAGE WITHSTAND

A 45 kV DC voltage was applied for 15 minutes between conductor and the external copper gauze ground plane. Result: All samples passed with no breakdown or flashover.

6.3 IMPULSE VOLTAGE WITHSTAND

A nominal 1.2 x 50 μs wave of 55 kV crest was applied between conductor and the external copper gauze ground plane. The samples were subjected to 10 consecutive positive and 10 consecutive negative shots.
Result: All samples passed with no breakdown or flashover.

6 4 LOAD CYCLING IN AIR

The samples were connected in a loop and an induced current of 185A, corresponding to the ampacity required to raise the temperature of a #6 AWG copper conductor to 130°C while in air, was passed through them.

The current flow was maintained for a period of eight hours and switched off for the next 16 hours. Samples were continuously energized to 13.8kV. The samples were subjected to 32 such cycles.
Result: All samples passed with no breakdown or flashover.

6.5 LONG TERM OVER VOLTAGE

A 17.3kV (rms) 60Hz voltage was applied for 32 days between the conductor and the external copper gauze ground plane.
See Appendix I.
Result: All samples passed with no breakdown or flashover.

6.6 VOLTAGE WITHSTAND

Following the long term overvoltage test, the samples were subjected to a 23kV (rms) 60Hz voltage for a period of 5 hours.
Result: All samples passed with no breakdown or flashover.

TABLE I

SUMMARY OF TEST RESULTS

TEST TEST	REQUIREMENT	RESULTS
1. AC voltage withstand	23kV (rms) 60Hz for 1 minute	Passed
2. DC voltage withstand	45kV DC for 15 minutes	Passed
3. Impulse withstand	1.2 x 50 μ, 55kV crest 10 positive, 10 negative shots	Passed
4. Load cycling in air	8 hours on, 16 hours off, 32 cycles, impressed voltage 13.8kV (rms)	Passed
5. Long term overvoltage	17.3kV (rms) 60 Hz, for 32 days	Passed
6. AC voltage withstand	23kV (rms) 60 Hz, for 5 hours	Passed

APPENDIX I

The accepted industry equation for life prediction by overvoltage testing is:

predicted life = test time (test voltage/rated voltage)^n
where ^{n} = a constant usually of the order of 5-6
rated voltage = rated ground to line voltage.

The applied voltage of 17.3kV represents 3.5 times rated line to ground voltage. Substituting the data into the equation with ^{n} =5 (a very conservative acceleration factor).

predicted life = 32 days $(3.5)^5$

= 32 days x $\frac{1 \text{ year}}{365 \text{ days}}$ $(3.5)^5$

= 0.088 years (525.2)

= 46 years

This implies that the accelerated overvoltage testing performed extrapolates to an equivalent service life of over 40 years.

Addendum 1

Applicability of EDR-5190
to
NMCK8 Stub Kits Using
Molded End Caps

The NMCK8-4V (NS) and the NMCK8-5V (NS) were assembled using NMCK-1000 and NMCK-1500 bonded caps. These caps were made from WCSF tubing and coated with S1119 sealant. Because the bonding process is obsolete, it is necessary to convert to molded caps manufactured with the nuclear grade compound designated -52. The molded caps that the NMCK8-4V (NS) and the NMCK8-5V (NS) will utilize are 101A140-52/144 and 101A150-52/144. All other components remain the same.

Table 1 below shows the comparison of wall thickness, length, and electrical properties of the two materials. This comparison shows that EDR-5190 is applicable to the NMCK8 stub kits using the molded cap without further testing. The NMCK bonded cap dimensional requirements are listed in SCD-37002 and the electrical properties are listed in Raychem Materials Specification PPS 3010/7. The dimensional requirements for the 101A140-52/144 and 101A150 are listed in SCD-48062 and the electrical properties are listed in Raychem Materials Specification PPS 3011/8.

Table 1

	NMCK-1000 Bonded	101A140-52/144	NMCK-1500 Bonded	101A150-52/144
Recovered wall thickness	0.170”	0.170”	0.170”	0.170”
Length	10”	10”	13”	13”
Dielectric Strength, V/mil (see note)	350@ 0.06” 200@ 0.10”	200	350@ 0.06” 200@ 0.10”	200
Volume Resistivity (see note)	1 x 10↑13 ohm cm	1 x 10↑13 ohm cm	1 x 10↑13 ohm-cm	1 x 10↑13 ohm-cm

Note: The electrical properties apply to all sizes of caps.