CERTIFIED
TEST REPORT

8.3kV, 9.9kV, 15.5kV, 17.2kV and 23kV Cooper ELSP Backup Fuses Testing per C37.41-2008

8.3kV, 9.9kV, 15.5kV 17.2kV and 23kV ELSP Backup Fuses Testing per C37.41-2008

CERTIFICATION

Statements made and data shown, to the best of our knowledge and belief, are correct and within the usual limits of commercial testing practice.

5/3/2011
Nicole Horst
Advanced Design Engineer

5/3/11
Gary Goedde
Staff Engineer

5/3/2011
Alan Yerges
Technical Manager – Assembled Products

5/3/11
Frank Muench
Program Manager - Technology

5/4/11
Doug Yute
Director of Engineering – LIPE

Overview

Cooper Power Systems (CPS) ELSP 8.3kV – 23kV fuses are designed to be applied as backup current limiting fuses. In this application, the ELSP fuse provides protection against high current faults and limits the peak current and the amount of let-through energy to the protected equipment. The CPS ELSP fuse is typically applied in series with an expulsion fuse. When applied in series with an expulsion or another type of low current interrupting device, the combination provides "full range" protection. RIV, dielectric, and temperature rise tests are a function of the fuse mounting and enclosure rather than of the particular fuse design. Therefore this report does not include these tests. Contact CPS for additional information.

Certification Tests as required by IEEE Std C37.41-2008

1. Interruption Tests at Line-to-Neutral Rated Voltage

- Series 1 Rated Maximum Interrupting Current
- Series 2 Critical Current (at RMAT)
- Series 3 Rated Minimum Interrupting Current (at RMAT)

2. Thermal Cycle Seal Tests

3. Time Current Characteristic Tests

INTERRUPTION TESTS

Requirements

Back-up current-limiting fuses are required to operate on high available fault currents and limit the fault current magnitude and energy. They must interrupt these fault currents so that the other pieces of connected equipment are isolated from the electrical distribution system.

Objective

The objective of these tests is to verify the interrupting performance of the ELSP backup fuse for applications at the respective voltage rating by testing according to the requirements specified in ANSI/IEEE C37.41-2008, clause 6.6 and C37.47-2000.

Procedures

These tests were run on production fuses which were assembled using standard methods and procedures. The testing was conducted at ambient temperature for Series 1 and 140°C for Series 2 and Series 3 test shots. During the interruption testing peak arc voltages were measured and recorded.

Test Results

The 8.3kV – 23kV ELSP fuses successfully interrupted each respective test current. The performance parameters are detailed in tables as follows:

Table 1 - 8.3 kV ratings

Base Catalog #	Fuse Rating		Minimum Melt I^2t	Total Clear I^2t	Max. Interrupting Rating (Amps symmetric) at 8.3kV
	kV	Amp			
CBUC08030C1	8.3	30	1,800	9,410	50,000
CBUC08040C1	8.3	40	2,900	14,000	50,000
CBUC08050C1	8.3	50	6,300	30,000	50,000
CBUC08065C1	8.3	65	9,300	33,000	50,000
CBUC08080C1	8.3	80*	11,600	56,000	50,000
CBUC08100C1	8.3	100*	20,600	76,000	50,000
CBUC08125C1	8.3	125	32,100	120,000	50,000
CBUC08150D1	8.3	150	58,500	290,000	50,000
CBUC08165D1	8.3	165	82,200	395,000	50,000
CBUC08180D1	8.3	180	103,100	485,000	50,000
CBUC08250D1	8.3	250	148,500	690,000	50,000
CBUC08150D1x2	8.3	300	234,200	1,280,000	50,000
CBUC08165D1x2	8.3	330	328,900	1,700,000	50,000
CBUC08180D1x2	8.3	360	412,500	2,100,000	50,000
CBUC08250D1x2	8.3	500	594,000	2,500,000	50,000

*Have been tested successfully at 9.9kV per IEEE C37.41-2008

Table 2 - 9.9 kV ratings

Base Catalog #	Fuse Rating		Minimum Melt I^2t	Total Clear I^2t	Max. Interrupting Rating (Amps symmetric) at 9.9kV
	kV	Amp			
CBUC09030C1	9.9	30	1,800	9,500	50,000
CBUC09040C1	9.9	40	2,900	14,000	50,000
CBUC09050C1	9.9	50	6,300	30,000	50,000
CBUC09065C1	9.9	65	9,300	34,000	50,000

Table 3 - 15.5 kV ratings

Base Catalog #	Fuse Rating		Minimum Melt I^2t	Total Clear I^2t	Max. Interrupting Rating (Amps symmetric) at 15.5kV
	kV	Amp			
CBUC15030C1	15.5	30	1,800	10,000	50,000
CBUC15040C1	15.5	40	2,900	19,000	50,000
CBUC15050C1	15.5	50	6,300	33,000	50,000
CBUC15065C1	15.5	65	9,300	40,000	50,000
CBUC15080C1	15.5	80**	11,600	62,000	50,000
CBUC15100C1	15.5	100**	20,600	116,000	50,000
CBUC15125C1	15.5	125**	32,100	150,000	50,000
CBUC15150D1	15.5	150	58,500	260,000	50,000
CBUC15165D1	15.5	165	82,200	365,000	50,000
CBUC15180D1	15.5	180	103,100	445,000	50,000
CBUC15125C1x2	15.5	250	128,500	500,000	50,000
CBUC15150D1x2	15.5	300	234,200	1,300,000	20,000

** Have been successfully tested at 17.2kV per IEEE C37.41-2008

Table 4 – 17.2 kV ratings

Base Catalog #	Fuse Rating		Minimum Melt I^2t	Total Clear I^2t	Max. Interrupting Rating (Amps symmetric) at 17.2kV
	kV	Amp			
CBUC17030C1	17.2	30	1,800	10,000	43,000
CBUC17040C1	17.2	40	2,900	19,500	43,000
CBUC17050C1	17.2	50	6,300	34,000	43,000
CBUC17065C1	17.2	65	9,300	42,000	43,000

Table 5 – 23 kV ratings

Base Catalog #	Fuse Rating		Minimum Melt I^2t	Total Clear I^2t	Max. Interrupting Rating (Amps symmetric) at 23kV
	kV	Amp			
CBUC23030C1	23	30	1,800	12,000	31,000
CBUC23040C1	23	40	2,900	20,000	31,000
CBUC23050C1	23	50	6,300	39,000	31,000
CBUC23065C1	23	65	9,300	44,000	31,000
CBUC23080C1	23	80	11,600	70,000	31,000
CBUC23100C1	23	100	20,600	120,000	31,000
CBUC23125D1	23	125	32,100	180,000	31,000
CBUC23150D1	23	150	58,500	320,000	50,000*
CBUC23165D1	23	165	82,200	430,000	31,000
CBUC23125D1x2	23	250	128,500	650,000	12,000
CBUC23150D1x2	23	300	234,200	1,300,000	31,000
CBUC23165D1x2	23	330	328,900	1,700,000	31,000

* Series 1 testing for the 23kV 150A ELSP fuse was performed at IPH, Berlin, Germany, in April 2010.

All other Series 1 tests were performed at Powertech Labs in Surrey, BC and Edison Technical Center in Franksville, WI.

Conclusions

The tested fuses successfully interrupted the required current and voltage and were with the required peak arc voltage levels as specified in the standards IEEE C37.46 and C37.47.

THERMAL CYCLE SEAL EVALUATION

Requirements

Oil leaking into the sand fuse can adversely affect fuse operation. It is essential, therefore, to verify seal integrity of the fuse design. Testing per ANSI/IEEE standards was performed as detailed below.

Object

Verify seal integrity of the ELSP fuse families per ANSI C37.48-1987 requirements.

Procedure

The highest ampere rated designs were chosen because they provide the highest thermal stress. The nominal 2 inch diameter 15.5kV 125A fuse was selected because it is in between the 8.3kV and 23kV voltage classes both of which are nominal 3 inch diameter fuses. The test involved placing the fuses in oil with thermocouples placed at various key locations on the fuse and within the surrounding oil medium to monitor temperatures. Ten cycles were run from room ambient (25°C) to a maximum temperature of 140°C. Current was passed through each fuse sample for two hours after the oil reached 140°C. The fuse was then allowed to cool down to room ambient, completing one cycle. Following the conclusion of the ten cycles, the fuses were dissected and examined for any oil ingress.

Results

The 8.3 kV 250A, 15.5kV 125A and 23kV 165A ELSP fuse assemblies successfully passed the thermal cycle seal test, maintaining seal integrity when cycled per ANSI C37.48-1987 requirements.

Conclusion

The 8.3 kV 250A, 15.5kV 125A and 23kV 165A ELSP fuses met ANSI C37.48-1987 requirements for seal integrity.

TIME-CURRENT CHARACTERISTICS TESTS

Requirements

Time-current characteristic curves are primarily for application, selection and system coordination studies. The minimum-melt and total-clearing curves detail the performance data of a particular fuse design.

Objective

Establish time-current characteristic curves for the 8.3kV – 23kV ELSP fuses per ANSI/IEEE C37.47-2000 requirements.

Procedure

Testing was performed on production fuses which were assembled using established methods and procedures.

Minimum-melt and total-clearing time-current characteristic curves were developed using ANSI/IEEE C37.41-2008, Clause, 12 requirements as a guideline. The curves reflect the typical industry tolerances ± 10% of the average melting current. An allowance for arcing time is also added to the total-clearing curve to determine the fuse's total clearing characteristics. Testing was performed at ambient temperatures.

Results and Conclusions

The minimum-melt and total-clearing TCC curves for the 8.3kV – 23kV ELSP backup current limiting fuses were developed using the procedure described above and are detailed in CPS product literature R240-91-167, R240-91-168 and R240-91-169.

COOPER Power Systems

Quality from
Cooper Industries
P.O. Box 1640, Waukesha, WI 53187