CERTIFIED
TEST REPORT

Design Tests for the 38.0 kV ELSP Current-limiting Fuse per ANSI/IEEE C37.41-2008

Design Tests for the
38.0 kV ELSP
Current-limiting Fuse
per ANSI/IEEE C37.41-2008

CERTIFICATION

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

James Bukacek 9/18/14
James R. Bukacek
Sr. Design Engineer

James A Wenzel 9/18/14
James A. Wenzel
Specialist Engineer

Alan Yerges 9/18/14
Alan P. Yerges
Sr. Engineering Manager – Assembled Products

Doug H Yute 9/18/14
Doug H. Yute
Director of Engineering - PDD

INTRODUCTION

The 38kV ELSP fuses are designed to be applied as backup type 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 ELSP fuse is typically applied in series with an expulsion device. When applied with an expulsion device or another type of low current interrupting device, the combination provides "full range" protection. The dielectric tests specified by C37.41-2008 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 Eaton's Cooper Power Systems for additional information.

Scope of Testing

Interruption Testing at Line-to-Neutral Rated Voltage

- Series 1 Rated Maximum Interrupting Current
- Series 2 Critical Current
- Series 3 Rated Minimum Interrupting Current

Time Current Characteristics

Thermal Cycle Seal

Radio-Influence Voltage

Temperature Rise

INTERRUPTION TESTING

Requirements

Backup 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 distribution system.

Objective

Verify the interrupting performance of the 38 kV ELSP current-limiting backup fuse according to the requirements specified in ANSI/IEEE C37.41-2008, clause 6.6 and C37.47-2011, clause 4.2.

Procedure

Fuses were assembled by production department personnel using standard methods and procedures. Testing was conducted at ambient temperature for Series 1 and Series 3. For Series 2, testing was performed at the RMAT (140°C) for the maximum current rating of each homogeneous series (65A, 100A, 120A, & 140A) and at ambient temperature for all other ratings (50A & 80A). Peak arc voltages were measured and recorded during all testing.

Series 1 testing was performed at the KEMA Laboratories, Arnhem, Netherlands, in May 2014. All other testing was performed at Powertech Labs in Surrey, BC and the Edison Technical Center in Franksville, WI.

Results

The 38 kV ELSP fuses successfully interrupted each respective test current. The performance parameters are detailed in the Table below.

38.0 kV Ratings						
Base Catalog #	Fuse Rating		Min. Melt I^2t	Total Clear I^2t	Rated Minimum Interrupt Level Amps	Maximum Interrupting Rating (Amps symmetric)
	kV	Amp				
CBUC38050D100	38.0	50	3,870	30,600	450	50,000
CBUC38065D100	38.0	65	7,160	39,300	490	50,000
CBUC38080D100	38.0	80	11,450	60,700	625	50,000
CBUC38100D100	38.0	100	16,100	80,500	635	50,000
CBUC38120D100	38.0	120	21,200	118,000	700	50,000
CBUC38140D100	38.0	140	36,240	163,000	800	50,000

Conclusions

The tested fuses successfully interrupted the required current and voltage, and were within the required peak arc voltage levels as specified in C37.47-2011.

TIME CURRENT CHARACTERISTICS TESTS

Requirements

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

Objective

Establish time-current characteristic curves for the 38 kV ELSP current-limiting fuses per ANSI/IEEE C37.47-2011 requirements.

Procedure

Fuses were assembled by production department personnel using standard methods and procedures.

Minimum-melt and total-clearing time-current characteristic curves were developed using ANSI/IEEE C37.41-2008, Clause 11 requirements as a guideline. Testing was performed by placing the fuses in mineral oil in the horizontal position to simulate actual field application. The fuses were tested by applying current and measuring the time until the fuses opened. The curves were developed by utilizing curve-fitting techniques and applying the appropriate tolerances. 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 38 kV ELSP backup current-limiting fuses were developed using the procedure described above and are detailed in ECPS product literature R240-91-170.

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.

Objective

Verify seal integrity of the 38 kV ELSP fuse per ANSI/IEEE C37.41-2008 requirements.

Procedure

Fuses were assembled by production department personnel using standard methods and procedures. The highest ampere rating of the 38kV ELSP family (140A) was chosen so as to provide the highest thermal stress. Testing was conducted per ANSI/IEEE C37.41-2008, Clause 13 requirements.

The test involved placing five fuses in mineral oil with thermocouples placed at selected locations on the fuses 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 fuses were 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 38kV 140A ELSP fuse assemblies successfully passed the thermal cycle seal test, maintaining seal integrity when cycled per ANSI/IEEE C37.41-2008 requirements.

Conclusion

The 38kV ELSP family of fuses meets the ANSI/IEEE C37.41-2008 requirements for seal integrity.

RIV TESTS

Objective

Determine RIV performance levels for the 38 kV ELSP current-limiting fuse.

Procedure

Fuses were assembled by production department personnel using standard methods and procedures.

Testing was performed as detailed in ANSI/IEEE C37.41-2008, Clause 8. Fuses were secured to a three-phase transformer mounting board (2624086B0305) and tested in an appropriate tank filled with mineral transformer oil. The mounting board assembly provides a clearance of 3.25” to the nearest ground plane, and 5.75” to the nearest adjacent phase (center-to-center).

Three 38kV ELSP fuses were tested. Minimum test voltage was 23.0 kV as required by Table 4 of ANSI/IEEE C37.47-2011. This is based on line-to-line application of the fuses with voltages equal to or less than the rated maximum voltage. Measurements were taken with one fuse energized and the other two grounded. Each configuration (three total) was tested.

Results

The inception voltage for each configuration was less than the 250 μV requirement as specified in ANSI/IEEE C37.47-2011.

Conclusion

All samples tested met RIV levels as required per ANSI/IEEE C37.47-2011 Table 4 requirements.

TEMPERATURE RISE TESTS

Requirements

For applications at ambient temperatures greater than 40°C, ANSI/IEEE C37.47-2011 does not specify temperature rise and total temperature limits. Eaton's Cooper Power Systems requires that under-oil backup fuses achieve temperature stability while carrying rated current continuously in a suitable enclosure filled with oil.

Objective

Determine temperature rise characteristics when tested as specified in ANSI/IEEE C37.41-2008. Verify that temperature stability is achieved.

Procedure

Fuses were assembled by production department personnel using standard methods and procedures.

The fuses under test were mounted in a tank of oil in an appropriate holder to simulate actual field installation. Testing was conducted following ANSI/IEEE C37.41-2008, Clause 10 requirements.

Testing was conducted at room ambient. Current was supplied from a regulated source. Temperature levels of current carrying parts were recorded throughout the test. Final temperature readings were taken at stabilization.

Results and Conclusions

The 38 kV ELSP backup current-limiting fuses reached temperature stability while carrying rated current continuously.

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Cooper Power Systems Business
2300 Badger Drive
Waukesha, WI 53188
United States
Cooperpower.com

Cooper Power Systems
by EATON