



**HUBBELL**<sup>®</sup>  
Power Systems

**SEISMIC QUALIFICATION OF EVP SURGE ARRESTERS  
TO MODERATE PERFORMANCE LEVEL  
OF IEEE 693-2005**



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## CONFORMANCE STATEMENT

### IEEE693 SEISMIC QUALIFICATION TEST FOR THE HUBBELL POWER SYSTEMS TYPE EVP, 115kV COMPOSITE SURGE ARRESTER

The test performed on the Hubbell Power Systems Type EVP 115kV Composite Surge Arrester, described herein conforms to the seismic test requirements set forth in the IEEE 693-2005 Test Standard entitled "IEEE Recommended Practice for Seismic Design of Substations", Moderate Seismic Qualification Level (Annex "K"). All deviations from these requirements are listed below and have been approved by the responsible Hubbell Power Systems representative witnessing the test.

Hubbell Power Systems Representative Albert J. Molnar P.E. 5/30/12  
Clark Testing Laboratory Manager John R. Chuteanu 5/29/12  
Clark Testing Laboratory Q.A. Representative Gary Blitt 5/29/12

#### **DEVIATIONS FROM TEST PROCEDURE:**

##### **Seismic**

None





### **INTRODUCTION**

The industry standard to which Hubbell Power Systems - Ohio Brass qualifies the seismic capability of its arresters is IEEE 693-2005. This report qualifies that standard Ohio Brass EVP series arresters up to a certain size (i.e. length and mass) meet the "MODERATE PERFORMANCE LEVEL" as demonstrated by a shake table test on a test stand.

IEEE 693-2005 allows seismic qualification based on the concept of "qualifying equipment by group." This permits product of different voltage ratings, but of similar physical structure (such as surge arresters) to be combined into groups for qualification purposes, with the most seismically vulnerable piece of equipment of each group being analyzed or tested. Key parameters affecting the seismic capability are: diameter and thickness of the fiberglass filament wound internal support structure; the type of end fitting used; and the overall mass and center of gravity of the arrester. We use this concept of "qualifying by group" to use the results of one shake table test to qualify many arresters.

### **STATIC LOAD AND SNAPBACK TESTING**

Seismic tests in accordance with IEEE 693 have been performed on arrester model number EVP011500-3001. The arrester had a mass of 82.1 lb (37.2 kg) and a center of gravity of 31.8 in (808 mm) from the base (includes weight of grading ring). An additional 15 lb (6.8 kg) was added to simulate the line terminal per the standard. This assembly was mounted to a 4' x 4' x 2" steel plate. A horizontal load of ½ of ultimate strength of the arrester was applied and then the load was dropped and released at 75% of said load. Full details and results of the pre- and post-Static Load and Snapback Testing are contained in sections 3.2, 4.5 and 5.0 of the attached Clark Test Lab report, number EL: 10111 (Annex of this report).

### **SEISMIC TESTING**

Seismic tests in accordance with IEEE 693 have been performed on arrester model number EVP011500-3001. The above mentioned assembly of the arrester, simulated line terminal mass and steel mounting plate were, in turn, mounted to the shake-table platform.

The shake table portion of the test was performed on March 12-13, 2012 at Clark Testing Laboratory in Jefferson Hills, PA. Details of the seismic test set up and test measurements are given in the Clark Test Lab report, number EL: 10111, Annex. Results of post-seismic electrical tests are presented in Table 1 below.

The arrester was subjected to a shake table test with a response spectrum that was at least twice the moderate required response spectrum of Figure A.2 of IEEE 693-2005. The actual test spectra used for horizontal and vertical accelerations are shown on pages IV-2 through IV-4 of report EL: 10111. Post-seismic resonance search tests met the evaluation requirements of IEEE 693.



To be qualified to the moderate seismic performance level, IEEE 693-2005 requires that an arrester tested to the 0.5g ZPA level survives the shake-table test with no structural damage, and that it remains functional, as demonstrated by successfully passing routine production tests after the shake-table test. These tests consist of measurement of reference voltage, partial discharge and watts loss. Table 1 shows the results of electrical tests performed before and after all the mechanical testing mentioned above. All values remained within factory acceptance limits.

Table 1: Electrical Testing Results

Test Measurement	Factory Limits	Before	After
Reference Voltage (kV pk) at 9.5 mA	146.6 – 153.9	147.2	147.7
Watts loss (W) at 1.2 x MCOV	114.6 Max	90.45	84.41
Partial Discharge (pC) at 1.05 x MCOV	10 Max	5.8	8.35

To be qualified to the moderate seismic performance level, IEEE 693-2005 requires that the arrester also pass the Composite Polymer Shed Seal Test. Fushin dye was applied to the bottom seal of the arrester while the arrester was placed under maximum deflection as measured from the seismic shake table test using a static load. The seal area was disassembled to demonstrate there was no dye penetration past any sealing element. Further detail of this testing, along with pictures are contained in section 4.7 of the Annexed EL: 10111 report.

### **QUALIFICATION BY PRODUCT GROUPING OF OTHER ARRESTERS**

IEEE 693-2005 provides for “qualification by product grouping”, whereby all members of a “group” are considered to be qualified to the same level as the most seismically vulnerable member of the group. All Hubbell Power Systems - Ohio Brass EVP arresters having an MCOV of 115 kV and less, share the same diameter and thickness of the fiberglass filament wound internal support structure, the same type of end fittings, are equal to or lower in height and the overall mass and center of gravity are lower than that of the 115 kV arrester. For seismic analysis purposes, according to provisions in IEEE 693-2005, they can be considered to all be part of a “group”, since the 115 kV size arrester is the most seismically vulnerable member of this group.

### **SUMMARY**

The above results provides information necessary to qualify all standard Hubbell Power Systems - Ohio Brass EVP arresters of 115 kV MCOV or lower, to the moderate performance level of IEEE 693-2005, provided that the mass, total height and height of center of gravity of those arresters do not exceed the corresponding characteristics of arrester model EVP011500-3001. That is, EVP arresters are qualified to the moderate seismic performance level of IEEE 693-2005 if

Mass  $\leq$  82.1 lb (37.2 kg)  
Center of Gravity  $\leq$  31.8 in (808 mm) from base



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**ANNEX**

**DETAILED SHAKE TABLE TEST REPORT AVAILABLE UPON REQUEST.**

**PLEASE CONTACT YOUR HUBBELL REPRESENTATIVE**