



IEEE Recommended Practice for Seismic Design of Substations

Amendment 1: Alterations of Transformers and Select Appendages, Surge Arresters, Response Spectra, Time Histories, and Their Qualification Methodologies

IEEE Power and Energy Society

Developed by the
Substation Design Criteria Committee

IEEE Std 693a™-2024
Amendment to IEEE Std 693™-2018

STANDARDS

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Approved 26 September 2024

IEEE SA Standards Board

Abstract: Seismic design recommendations for substations, including qualification of different equipment types are discussed in this amendment. Design recommendations consist of seismic criteria, qualification methods and levels, structural capacities, performance requirements for equipment operation, installation methods, and documentation.

Keywords: anchorage, conductor, damping, dynamic analysis, electrical equipment, IEEE 693™, loads, projected performance, required response spectrum, seismic protective devices, seismic qualification, shake table, static coefficient analysis, support structure, suspended equipment, time history

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Introduction

This introduction is not part of IEEE Std 693a-2024, IEEE Recommended Practice for Seismic Design of Substations—Amendment 1: Alterations of Transformers and Select Appendages, Surge Arresters, Response Spectra, Time Histories, and Their Qualification Methodologies.

The amendment alters recommendations for the seismic design and qualification of transformers and select appendages attached to transformers and surge arresters. The amendment alters recommendations for response spectra, time histories, and qualification methodologies associated with them.

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Amendment 1: Alterations of Transformers and Select Appendages, Surge Arresters, Response Spectra, Time Histories, and Their Qualification Methodologies

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

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3. Definitions, acronyms and abbreviations

3.2 Acronyms and abbreviations

Delete the text in 3.2 as shown:

DCV ~~————— duty cycle voltage (rating)~~

Insert the text in 3.2 as shown:

MCOV maximum continuous operating voltage

4. Instructions

4.5 Acceptance of previously qualified electrical equipment

4.5.2 Acceptance of previous versions of IEEE Std 693

Change the text in 4.5.2 as shown:

Surge arresters ~~90 kV DCV~~ 70 kV MCOV and above with conductor load effects (by A.1.6).

4.6 Optional qualification methods

4.6.2 Option to static analysis

Change the text in 4.6.2 as shown:

When static analysis is specified, the manufacturer has the option of substituting it with linear dynamic analysis, time history analysis, or time history testing (design or performance level), provided all other requirements are met.

4.6.4 Option to dynamic analysis (time history analysis or testing)

Change the text in 4.6.4 as shown:

When dynamic analysis is specified, the manufacturer has the option of substituting it by ~~the~~ linear time history analysis or time history testing (design or performance level) and their ~~its~~ associated acceptance criteria in lieu of the analytical method, provided all other requirements are met.

4.6.5 Option to static coefficient analysis

Change the text in 4.6.5 as follows:

When the static coefficient analysis is specified, the manufacturer has the option of substituting it with linear dynamic analysis, time history analysis, or time history testing (design or performance level) as an alternative method of analysis, provided all other requirements are met.

4.6.8 Option to design level test

Replace the text in 4.6.8 with the following:

When design level testing (refer to 5.4.2) is specified, the manufacturer has the option of testing at the performance level (refer to 5.4.1) with consideration of 5.4.1.3. In the recommended practice, there are three instances of design level testing: circuit breakers greater than 550 kV (refer to Annex C.4.1), circuit switchers greater than 550 kV (refer to Annex H.4.1), and cable terminators greater than 500 kV (refer to Annex N.4.1).

4.6.10 Option to ~~test to the design~~ test to the design performance level test

Replace the text in 4.6.10 with the following:

For some equipment types and configurations, testing at the performance level may be limited by the size and capacity of shake table facilities, the unique configuration of the equipment to be tested, and the hazard involved with testing such equipment to high levels. For these types of equipment, it is permissible to conduct time history testing to the design level in lieu of testing to the performance level. The equipment types and configurations for which this option is allowed are restricted to those described in V.3.2.6 and W.3.3.3.

5. Seismic criteria for qualification of electrical substation equipment

5.3 Seismic qualification approaches

5.3.4 Performance level seismic qualification approach

5.3.4.3 Performance level analysis

Change the text in 5.3.4.3 as follows:

The complexities of performing an analytical qualification of equipment at the performance level are not addressed in this document. While a performance level analysis may be needed to properly evaluate some types of highly non-linear systems (e.g., suspended equipment or equipment with seismic protective devices ~~base isolated equipment~~ that are beyond the scope of Annex I and Annex W) this recommended practice does not provide acceptance criteria for analytically qualifying equipment at the performance level. ~~For such cases, the acceptance criteria used for the analytical qualification shall be adherent to the seismic~~

~~qualification objective, consistent with industry practice and agreed upon by the end user prior to proceeding with the analysis.~~

5.4 Seismic qualification methods with respect to test qualifications

5.4.3 Specification of performance level testing or design level testing

Replace the text in 5.4.3 with the following:

The applicability of performance level testing or design level testing shall be as specified in each equipment annex (refer to 5.3.1).

Equipment that is specified to be qualified by performance level testing may be qualified by design level testing as described in 4.6.10.

For equipment that is required to be qualified by design level testing, the manufacturer may elect to exercise the option to conduct a performance level test (refer to 4.6.8).

5.6 Damping with respect to seismic qualification methods

5.6.4 Damping associated with time histories ~~matching the required response spectra~~

Replace the text in 5.6.4 with the following:

Prescribed time histories to be used for qualification by either testing or analysis have been time-domain spectrally matched to envelop the applicable required response spectrum at a specific level of damping. The levels of damping associated with the time history sets are as follows:

- b) Time histories for performance level testing have been developed to envelop the 5% damped required response spectra. This is applicable to the time history sets specified in Table A.2, Table A.3, and Table A.4.
- c) Time histories for design level testing have been developed to envelop the 2% damped required response spectra. This is applicable to the time history set specified in Table A.5.
- d) Time histories for performance level and nonlinear analysis have been developed to envelop the 5% damped required response spectra. This is applicable to the time history sets specified in Table A.1.
- e) Time histories for linear design level analysis have been developed to envelop the 2% damped required response spectra. This is applicable to the time history set specified in A.1.1.10.3.2 item a).