

IEEE Standards Interpretations for IEEE Std 18™-2002 IEEE Standard for Shunt Power Capacitors

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May 2005

Interpretation Request #1

Can capacitors manufactured to this standard be applied with continuous operating voltages at 110% or below of the rated nameplate nominal voltage when this rms operating voltage contains harmonics and the capacitors are installed in a normal transmission substation shunt harmonic capacitor bank configuration for VAR support and the conditions of item a) and c) in section 5.2.3 of IEEE Standard 18-1992 are not exceeded?

Reason for Request:

Subclause 8.3.1 of IEEE Std 18-1992 again states that the capacitor should be able to operate continuously at 110% rated rms voltage including harmonics. Subclause 3.1.2.3 in the ratings section of IEEE Std 1036-1992, IEEE Application Guide also repeats what is stated in 5.2.3 of IEEE Std 18-1992. Subclause 5.5.1 of IEEE Std 1036-1992 states:

"... IEEE Std 18-1992 gives limitations on voltage ... which can be used to determine the maximum allowable harmonic limits. IEEE Std 18-1992 indicates that the capacitor can be applied continuously within the following limitations, including harmonic currents:

a) 110% of rated rms voltage b) 120% of rated peak voltage..."However, 6.1 of IEEE Std 1036-1992 on Harmonic Filters states:

"The allowable overload limits of capacitors based on IEEE Std 18-1992 are as follows:

a) Kilovar - 135% b) RMS voltage - 110% C) Sum of peak voltages - 120% D) RMS current - 180%

These overload capabilities are to be used for contingency conditions while normal duty

is to be within the capacitor rating. All of these parameters should be checked when applying capacitors in a harmonic environment, especially if the capacitors are part of a filter. ...”

The last two sentences of this quote from 6.1 of IEEE Application Guide (IEEE Std 1036-1992) appears to contradict the ratings section of IEEE Std 18-1992 that states the capacitors should be able to continuously operate at 110% of the rated rms voltage which includes harmonics.

If the answer to this question is yes, then the last two sentences from IEEE Std 1036-1992 quoted in this interpretation request should be changed to reflect the ability of the capacitors to operate continuously at 110% RMS voltage including harmonics based on their ratings. This is the first mention of contingency conditions.

If the answer to this question is no, then the last two statements quoted from IEEE Std 1036-1992 are correct. This would then mean the other sections quoted for the ratings in both IEEE Standards 18-1992 and IEEE Std 1036-1992, as well as other sections, should all be changed to reflect that the ratings are only temporary ratings for contingencies.

Interpretation Response

When a unit, or an element in a unit, fails the voltage will increase on the remaining units (elements). The 110% maximum continuous overvoltage capability is provided to allow the bank (units) to stay in service for the failure of at least one unit (element) in an effort to keep the bank in service as long as possible. An informal survey of the capacitor subcommittee several years ago showed that the majority of users designed their capacitor banks to operate the units at or below the rated voltage of the unit. For the loss of units (elements) in the bank the relaying was typically set to alarm at 105% rated voltage and trip on unbalance when the voltage exceeded 110% rated voltage. This is typically how the 110% continuous voltage capability is utilized. Since the units are designed to operate and remain in service continuously for this contingency bank condition this is not referred to as an abnormal service condition.

The standard has always defined the limits for the maximum continuous voltage, current and kvar, but it came to the attention of the Capacitor Subcommittee that banks were at times being designed and expected to operate at these limits on a nominal design basis. The maximum continuous voltage limit (110% of rated voltage) was always intended for contingencies and not intended to be used for a nominal design basis. Language was added in IEEE 18-2002 to clarify that capacitors are designed to be operated at or below their rated voltage, and be capable of continuous operation under contingency system and bank conditions provided that none of the following limitations are exceeded:

- 1) 110% of rated rms voltage
- 2) 120% of rated peak voltage, including harmonics
- 3) 135% of nominal rms current
- 4) 135% of rated kvar

Note that the continuous current capability for contingencies was changed from 180% in previous versions to 135% in the current standard. It came to the attention of the Subcommittee that users were applying the 180% rating in design of harmonic filters. The Subcommittee did not foresee the 180% overcurrent rating being applied in this manner, and noted that previous units may have had this capability but allowing 180% continuous current through a capacitor was not a desirable situation as it may cause the rated kvar output to exceed the 135% limit. Therefore the maximum overcurrent capability was changed to be in agreement with the maximum allowable kvar output.

Mr. Field kept referring back and forth between IEEE 18 and IEEE 1036 on how the rated voltage was discussed. One point of clarification is that IEEE 18 is a standard for the units only, and IEEE 1036 contains guidelines for the application of capacitor units in a capacitor bank. Also, there is now an application guide for harmonic filters, IEEE 1531, which addresses the selection of components, protection and control of harmonic filters. Guidelines for protection of shunt capacitor banks can be found in IEEE C37.99.

Capacitor banks are not intended to be applied where the maximum operating voltage exceeds the nominal voltage rating of the capacitor bank. If a power system operates at higher than nominal system voltage then the user should take that into consideration when designing the bank and choose an appropriate unit voltage rating to assure the units operate within 100% of rated voltage. The user of course can choose to operate the units at 110% of rated for the nominal design basis if they are willing to take the risk of losing the capacitor bank for the failure of one unit (element). If the user chooses to do so they may want to consult the manufacturer for recommendations on protection for failures in the bank.

There was also a question about the normal service conditions section, 4.1. Section 4.1 c) states "The voltage applied between terminals does not exceed the rated voltage by more than the tolerance specified 5.3" and section 4.1 e) states "the applied voltage including harmonics does not exceed the limit specified in 5.3." The Subcommittee agrees this is confusing and thanks you for pointing this out. Only 4.1 e) should be stated and it applies to the unit. We will remove 4.1 c) in the next revision.

There was also a question of section 6.7.2.1 and 7.9.2.3 mentioning operation at 110% rated voltage for fuses and thermal stability test. Since the units are expected to stay in service for bank contingencies up to 110% rated voltage the fuses should be rated to withstand this overvoltage as well. And the thermal stability test would need to reflect this as well.