Energy Capability of Ohio Brass® PVN Arresters

HUBBELL® POWER SYSTEMS, INC.

OHIO BRASS®

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Ohio Brass catalogs the energy capability for all arresters in terms of kJ/kV or MCOV. Most other manufacturers publish energy capabilities in similar terms. Occasionally the capability may be indicated in terms of kJ/kV of arrester rating (or duty cycle rating). What do these numbers mean, and how can numbers from different manufacturers be compared to assess the relative capabilities of their products? What is enough energy for a particular application?

General Considerations

The first point to consider is that there are presently no standardized procedures for determining arrester energy capability. The expression of an energy capability in terms of kJ/kV merely states that, under some particular set of operating conditions, the arrester can absorb a certain number of kilojoules of energy without suffering damage. The number of kilojoules that a particular arrester can so absorb is determined by multiplying the kJ/kV value by the kilovolt rating of the arrester in question. In doing this, one must pay particular attention to whether the kV rating used is ***maximum continuous operating voltage (MCOV) rating or duty cycle voltage rating***. Because there are no standard procedures for determining the energy capability, the "particular set of operating conditions" are not defined and can vary from manufacturer to manufacturer. Likewise, "without suffering damage" is undefined. It is generally understood to mean that, while operating at MCOV and at the upper ambient temperature limit of usual service conditions, the arrester is able to absorb the published amount of energy without any physical damage to any of the arrester components and then thermally recover back to its original operating conditions. ("Usual service conditions" are defined. For example, ANSI Standard C62.11 specifies the upper limit of ambient temperature under usual service conditions is 40°C for outdoor arresters. It should be pointed out again, however, that the manner in which the energy is applied to the arrester is ***not*** defined by standards).

The second point to consider is the statistical nature of the energy capability of metal oxide varistor blocks. The varistor blocks are manufactured by means of a complex process which involves a large number of individual process steps, each one of which has some degree of variability, albeit slight, that will play a part in determining the ultimate electrical performance of the blocks. When varistor block production is monitored over a long period of time (e.g. months), an essentially Gaussian distribution of energy absorbing capability is observed. Both the mean value and the range of the distribution will depend on the specific manner in which the energy is introduced into the blocks.

Purchasers of arresters should be aware of the above points, and should request information from manufacturers on how stated energy ratings are established, to allow a more informed comparison of the manufacturers' products.

Energy Capabilities of Ohio Brass PVN Arresters

Rated Energy

Ohio Brass PVN arresters are rated at 4.9 kJ/kV of MCOV. This rating applies for energy resulting from switching surges of an essentially "square wave" waveform of magnitudes up to 1,000 A and for durations in the order of 1-3 ms. Square wave current impulses have an essentially constant current throughout the duration of the impulse and are typical of arrester switching surge discharges. This is illustrated in Figure 1 which shows oscillo-

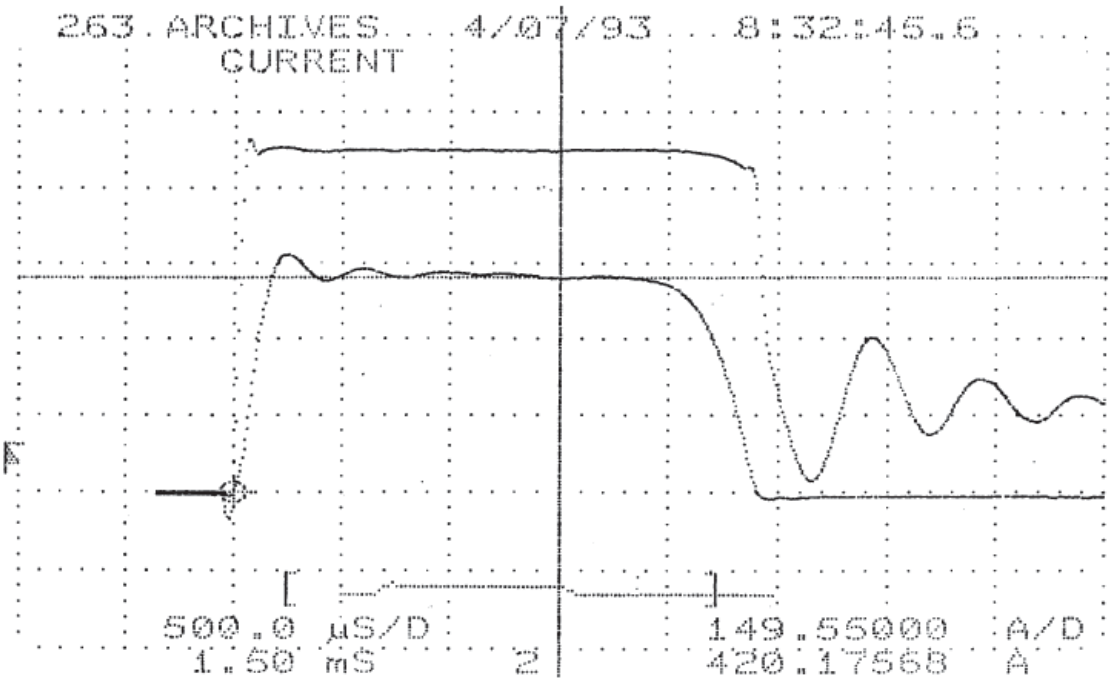

Figure 1

grams of a transmission line discharge test on MOV blocks used in PVN arresters. The energy rating of 4.9 kJ/kV of MCOV represents the minimum energy that such arresters can safely absorb in one discharge. "Safely" means without physical damage to the MOV blocks and without any diminishing of the arrester capability following thermal recovery from the increased temperature caused by the energy absorption.

To provide assurance of this capability, **every MOV block** used in a PVN arrester is subjected to a two-discharge test, in which the first discharge is at 100% rated energy (square wave of approximately 1000A and 2 ms duration) and the second discharge is at 80% rated energy (same duration as first discharge except at approximately 80% of the current magnitude).

Ultimate Energy Capability of MOV Blocks

In addition to the routine tests on every MOV block, samples from each manufacturing batch of MOV blocks are subjected to an ultimate capability test in which square wave discharges of 3 ms duration are applied at increasing current magnitudes until electrical failure occurs (i.e. block puncture or flashover). Historical data shows the average ultimate energy capability as measured by this test is about 1.7 times the rated energy of 4.9 kJ/kV of MCOV.

Functional Capability of PVN Arresters

Rated energy is the "single shot" rating of MOV blocks. After a short period (30 seconds to 1 minute) to allow for thermal stabilization within the body of the MOV block, the block can absorb another rated energy discharge without damage. The limit for number of successive rated energy discharges is established not by the MOV block itself, but the ability of the arrester to thermally recover at MCOV from the elevated temperature caused by the discharges.

A rated energy discharge of 4.9 kJ/kV of MCOV results in an essentially instantaneous

temperature rise in the MOV blocks of about 50°C. PVN arresters can thermally recover at MCOV from block temperatures above 180°C. Thus, starting from a normal temperature of 30°C, at least 3 rated energy discharges could be absorbed, with 30 seconds to 1 minute between successive discharges, before a concern for thermal runaway was reached.

In practical applications, even one rated energy discharge would represent a very significant (and unlikely) event or series of events. For example, a PVN with an MCOV of 84 kV, typical of what is used on 138 kV systems, would be subjected to only 1.21 kJ/kV of MCOV if called upon to discharge a 2.6 pu switching overvoltage on a 200 mile 138 kV line. This one discharge, already quite significant, represents only 25% of the rated energy of the arrester. The arrester could handle four such discharges in rapid succession without exceeding its rated energy capability. After 30 seconds to 1 minute, it could handle such a series of discharges again. Following another 30 seconds to 1 minute "rest period", it could handle another sequence of discharges and still be able to thermally recover.

It should be quite evident that the energy handling capability of PVN arresters is more than sufficient for any practical switching surge protection application.

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