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NESC Arc Assessment Compliance

Bonita Martin, PE

As most of us are aware, the National Electrical Safety Code (NESC) has mandated an Arc Flash Hazard Assessment to be completed by January 1, 2009. Over the remaining 9 months, the assessment, along with implementation and personnel training, should be completed.

On April 22, 2008, Patterson & Dewar Engineers will conduct a seminar entitled "NESC Arc Assessment Compliance." In the seminar, we will provide methods for completing the Arc Flash Hazard Assessment. You can sign up by going to www.pd-engineers.com and clicking on NESC Arc Assessment Compliance Seminar. In the meantime, in this article, we'll share with you a few of our thoughts on this new requirement.

Here is what NESC Section 41, Rule 410A3 requires:

Effective as of January 1, 2009, the employer shall ensure that an assessment is performed to determine potential exposure to an electric arc for employees who work on or near energized parts or equipment. ™

The first step in this process is to determine system locations or tasks where employees are exposed to energized parts or equipment. The list of those locations is very long. An example of a task with possible exposure to energized parts is substation switching.

The next step is to determine for those locations the level of incident energy (expressed in cal/cm^2) to which an employee may be exposed. To aid in this task, Section 41 also provides Tables 410-1 and 410-2. To use Tables 410-1 and 410-2 the fault current and maximum clearing time must be known for each location of interest. Maximum clearing time is not always straightforward. For example, maximum clearing time for relay-operated breakers would be the relay trip time AND breaker operating time.

When using Tables 410-1 and 410-2, it is advisable to conduct the detailed Arc Flash calculations for several locations within the system and ensure the results fall within the ranges of data found in Tables 410-1 and 410-2. These tables are conservative and lower arc flash personal protective equipment (PPE) requirements may be possible upon conducting a thorough system assessment.

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Checking Distribution Capacitor Banks for Failed Units

by Gary Grubbs, PE

Introduction †

This article provides background information on capacitance testing of medium voltage double bushing capacitors (see Figure 1) commonly used in capacitor banks and harmonic filter banks with rated line voltages greater than 2.4kV. Due to their relatively low capacitance (0.20uF to 100.00uF), testing of the capacitors can be conducted with many standard digital multi-meters (DMM's). Meters such as the Fluke 110, 170, and 180 series can provide the required data necessary to determine the presence of a failed capacitor. Although other test methods are available, such as live testing, this article is centered on **testing capacitors in their de-energized state.**

Medium Voltage Capacitors can be internally fused or externally fused. External fuse operation (as evidenced by a blown fuse indicator for current limiting fuses, or a "dropped out" fuse link for expulsion style fuses) may indicate a failed capacitor. The fuse operation, however, does not guarantee a failed capacitor as the fuse may have opened due to a faulty fuse or from surges due to lightning or switching operations. It is therefore recommended that externally fused capacitors be tested before replacement in situations where the external fuse has blown. For internally fused capacitors, testing is required as the fuse is not visible.

Test Procedure ‡

The following test procedure requires the capacitor or harmonic filter bank to be disconnected and grounded. **Normal high voltage disconnect, grounding, and test procedures should be followed and should only be conducted by individuals that are qualified in the operation and maintenance of medium and high voltage harmonic filter banks and capacitor banks.** A suggested procedure, but not a necessarily all inclusive procedure is as follows:

1. De-energize the capacitor bank per the recommendations of the capacitor bank manufacturer. NOTE: All necessary safety procedures must be followed.
2. Isolate the capacitor bank (i.e. provide a visible disconnect) from the medium or high voltage system.
3. Wait at least five minutes to allow the voltage to “drain” off after de-energization before proceeding to the next step.
4. Ground the capacitor bank. It is important that each phase as well as the neutral (for ungrounded banks) be grounded. For banks equipped with vacuum switches, phase bus grounding should take place on the load side of the vacuum switches.
5. In addition to the phase bus grounding and before coming into contact with an individual capacitor, each capacitor should be individually grounded by touching its terminals with a grounded tip at the end of a high voltage stick.
6. Disconnect the line-side terminal of the capacitor to be tested. This may involve the removal of a fuse link for externally fused capacitors.
7. After bank grounding, proceed to the appropriate section below for the type of capacitor.

Externally Fused Capacitor Bank Testing

IEEE Std. 18 (IEEE Standard for Shunt Power Capacitors) specifies the standard ratings of capacitors designed for shunt connection to alternating current transmission and distribution systems should have a capacitance rating of 0 to +10% of its nominal nameplate value. In reality, most manufactures produce capacitors in the 0 to +2% of its nominal nameplate rating. It is desirable to detect, remove, and replace open capacitors, shorted capacitors, and partially failed capacitors. Each of these conditions can be detected with a DMM as follows:

(Continued on page 4)

Business Continuity Plan

by Gary Hasty

Organizations need to have a Business Continuity Plan (BCP) to ensure that all critical services and products are delivered during a major disaster or disruption. A BCP is the result of a proactive planning process identifying the necessary resources required to continue the operation of your business and the development of a plan to respond effectively and efficiently when a major disruptive event occurs.

One of the things that September 11, 2001 taught us was that high impact, low probability events do occur and that recovery is possible. Those businesses with good continuity plans survived and reduced the negative impacts to their clients. While terrorist attacks may not happen to most businesses, equally damaging results can and do occur as the result of natural disasters such as tornadoes, floods, earthquakes and fires.

An effective BCP normally includes four major parts:

1. A governance structure must be established for control after a major disruption. This is most often a senior level team to implement the plan, coordinate activities and guide the recovery process.
2. A vulnerability and risk assessment must be part of the BCP to identify the organization's critical services and products, the impacts of a disruption and the most significant threats.
3. A set of detailed plans must be included to identify the critical resources needed, locations of temporary operations and individual responsibilities during the recovery process.
4. A BCP must be updated routinely and procedures developed to assure that the plan is tested and continually improved.

Having a BCP can not only greatly improve your ability to recover after a major emergency but can also enhance your organization's image with employees, share holders and customers. If P&D can assist you in any way with your BCP, please call us.

NESC Arc Assessment Compliance *(cont'd)*

(Continued from page 1)

Tables 410-1 and 410-2 are valid only for systems 1000V and greater. For system voltages less than 1000V, we recommend a detailed Arc Flash Analysis be performed. Why? Our company has performed numerous Arc Flash Analyses for systems below 1000V and we often find the calculated incident energy to be greater than the 4 cal/cm^2 noted in Rule 410A3, Exception 2.

While the NESC requirements give a bit of an "out" (see Section 41, Rule 410A4), an Arc Flash Assessment must still be completed in order to determine if this "temporary modification of the rules" is justified.

While there is no NESC requirement for Arc Flash Hazard labeling as is required in the National Electrical Code (NEC) for non-utility facilities, accurate and concise documentation of the required Arc Flash Assessment is vital to meeting the requirement. In the unfortunate event of an Arc Flash incident, precise documentation will be needed. It is also our belief that the worst thing an employer can do is ignore this NESC rule and hope that you never have to address it. There are several documented cases in the industrial and commercial arena where OSHA imposed hefty fines, much worse in cases where the employer had not addressed such issues. Organizing the tasks or locations to be addressed and pulling together the required data for those locations will likely prove to be a more time-consuming process than originally estimated and so an early start is the best way to avoid the last minute rush.

(Continued from page 2)

- ✓ **Shorted Capacitors -** Typically the DMM will show "over-load" or "O.L." for a completely shorted capacitor.
- ✓ **Open Capacitors ~** Typically the DMM will show a "disc" or a very low capacitance reading (capacitance reading below 1 nF).
- ✓ **Partially Failed Capacitors ~** Typically the DMM will show a capacitance reading that is more than 10% greater than the capacitors nominal value as shown in Table 1.

The values listed in Table 1 are for industry standard shunt capacitors. For double bushing capacitors not listed in Table 1, the following formula can be used to calculate the nominal capacitance value based on nameplate data:

$$C = \frac{10^6}{(2\pi f)\,X_c} = \frac{k\text{var} \times 1000}{(2\pi f)(kv)^2}$$

kv ~ *Capacitor Voltage Rating*

kvar ~ *Capacitor KVAR Rating*

f ~ *Capacitor Frequency Rating*

C ~ *Calculated Capacitance in Micro-Farads*

In almost all cases, capacitors utilized in externally fused capacitor banks and fuse-less capacitor banks will fail in the partially failed condition or the shorted condition as noted above.

Figure 1‡

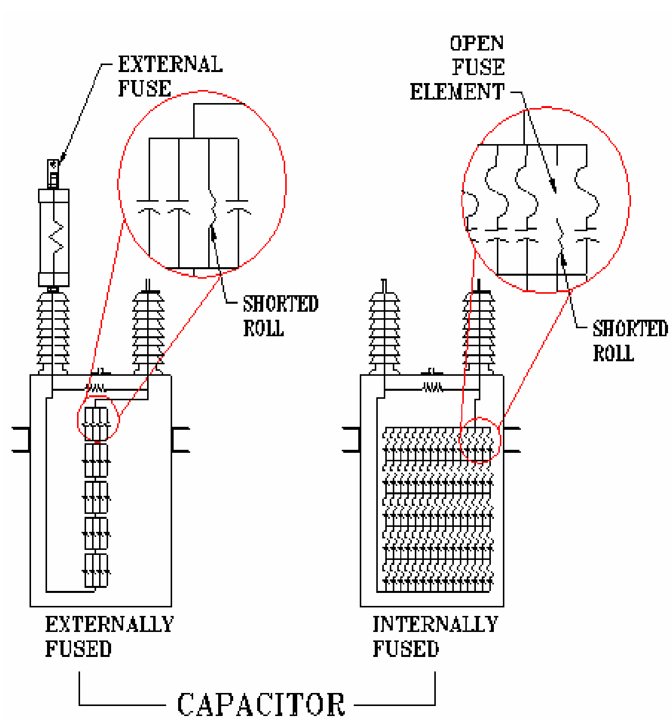

Table 1‡

7200 Volt Capacitors

KVAR	Voltage (Volts)	Reactance (Ohms)	Capacitance (uF)	Rated Amps
50	7200	1036.800	2.559	6.9
100	7200	518.400	5.117	13.9
150	7200	345.600	7.676	20.8
200	7200	259.200	10.234	27.8
300	7200	172.800	15.351	41.7
400	7200	129.600	20.468	55.6
500	7200	103.680	25.585	69.4
600	7200	86.400	30.702	83.3

7620 Volt Capacitors

KVAR	Voltage (Volts)	Reactance (Ohms)	Capacitance (uF)	Rated Amps
50	7620	1161.288	2.284	6.6
100	7620	580.644	4.568	13.1
150	7620	387.096	6.853	19.7
200	7620	290.322	9.137	26.2
300	7620	193.548	13.705	39.4
400	7620	145.161	18.274	52.5
500	7620	116.129	22.842	65.6
600	7620	96.774	27.411	78.7

† *All company safety rules and work procedures must be followed.*

‡ *Info supplied by Northeast Power Systems, Inc.*