Testing and Maintaining Low-Voltage, Bolted Pressure Switches

It seems to happen during every outage. You are brought in to maintain and test medium-voltage electrical distribution equipment. You are rolling along with your scope of work and get a call from the client to assist in resolving a problem with some low-voltage electrical distribution equipment. Most of the time, the problem is associated with the larger, fused-disconnect switches which are being used as mains and feeders for the low-voltage electrical infrastructure. They either will not open or will not close. When you investigate, you find maintenance people huddled around one of the following: a Bolt-Loc switch, a Pringle switch, a Boltswitch, a BP Switch, or a GE THPC switch. All of these devices are commonly referred to as bolted pressure switches and are typically rated from 800 to 4000 ampere. The bolted pressure switches of today are a derivation of the open knife switch prevalent in the 1900s, with improvements having been made for safe and reliable operation. Most of these switches are manually operated, although they can be electrically tripped with the addition of shunt trip capability. Due to their size, they are typically spring-assisted for opening and closing.

These devices are found in many industrial complexes, since they are considered to be cost effective solutions for the industrial plant’s electrical infrastructure needs for circuit protection and electrical system isolation. These devices can provide years of reliable service with appropriate preventive maintenance. Unlike circuit breakers, these devices rely on fuses to provide fault clearing capability; therefore, they do not require a mechanical operation, such as the switch opening, to provide associated circuit protection. Switch operation is typically performed in support of either service and maintenance activities or fuse replacement to ensure adequate electrical circuit isolation. This circumstance can lead to long periods of inactivity where the switch’s mechanical and electrical components never move. Therefore, these switches must be tested and maintained to ensure proper operation when required.

Different Maintenance Strategies

Three basic maintenance strategies are typically applied to bolted pressure switches:

**Corrective Maintenance**—With this strategy, maintenance is performed as the switch fails to operate. Although considered shortsighted by most maintenance professionals, this is a prevalent maintenance philosophy in most medium to small industrials. Justifying the performance of preventive maintenance is a comparative exercise which typically involves comparing short-term savings in maintenance costs to potential repair costs and production losses. The unfortunate result in applying this maintenance strategy is that there may be inoperable switches in the electrical system. The form of corrective maintenance can vary greatly. A common methodology for closing a switch that will not close is to incorporate a hammer and 2X4. This method of corrective maintenance is usually associated with encouragement from the production personnel. It is not recommended, however, due to the long-term effects on the switch in that it probably will not open when required and the contact resistance will not be optimal. The correct
methodology is to follow the manufacturer's recommendations by cleaning and lubricating the switch and adjusting the closing mechanism to accommodate proper closing of the switch.

**Time Interval-Based Maintenance** — With this strategy, maintenance activities are performed at a predetermined frequency regardless of the conditions under which a switch operates. If this method is applied too strictly, however, it may lead to excessive work efforts and costs.

**Condition-Based Maintenance** — With this strategy, the condition of a switch is evaluated through maintenance testing and inspection. The results, supplemented with statistical data and cumulative experience, are then used for maintenance planning. Condition-based maintenance provides excellent opportunities to improve reliability and cut costs, but it requires effective diagnostic methods. Due to the level of current typically associated with bolted pressure switches, the performance of an annual infrared (IR) survey of the switch contacts and cable or bus connections for these switches should be considered mandatory with any condition-based maintenance program. Periodic inspections should include looking for signs of heat discoloration and contamination buildup on contact points and connections.

Periodic testing of the switch should also be performed. ANSI/NETA MTS-2007, Standard for Maintenance Testing Specifications for Electrical Power, Distribution Equipment and Systems, Appendix B, Frequency of Maintenance Tests, could be used as a basis for determining the initial inspection and testing frequency. ANSI/NETA MTS-2007 recommends annual visual/mechanical inspections and testing performed every three (3) years. Recommended inspection and testing intervals should then be refined further as described in the MTS-2007 appendix and also in NFPA 70B-2006, Recommended Practice for Electrical Equipment Maintenance. Both standards give guidance based on operating characteristics, environmental conditions, and maintenance history.

### Suggested Electrical Tests

After installation, most bolted pressure switches remain in use until they are inoperable or are partially destroyed during an electrical event. For those switches that are in service, there are some basic electrical tests that should be performed:

- **Contact resistance** — This test should be performed from line-to-load terminals or the switch contact with the switch closed. The values should be within 50 percent of each other and comparable to similar switches. Resistance values of less than 100 microhms are typical with some manufacturers suggesting values of less than 30 microhms.

- **Insulation resistance** — This test should be performed phase-to-phase and phase-to-ground with the switch closed. Acceptable values should be greater than 100 megohms for 600 volt ac switches and 25 megohms for 240 volt ac switches.

- **Fuse resistance** — This test should be performed across the line-to-load terminals of the fuse. The values should be within 15% of each other and comparable to similar fuses. Resistance values will vary greatly based on type and size of the fuse; therefore, there is no typically expected value.

- **Ground Fault and Shunt Trip Operability** — Where applicable, ground fault and shunt trip circuitry should be verified for operability.

Experience with bolted pressure switches suggests that most problems associated with switch operability are due to the environmental conditions, improper or lack of cleaning, and improper lubrication of the switch. Therefore, cleaning and operability verification should be performed on the same interval as the electrical tests recommended above. Cleaning activities should include complete removal of existing lubricating greases and deposits from moving parts and contact surfaces. Cleaning switch surfaces should not include the use of solvents which may leave residues on surfaces or the use of abrasive cloths (i.e. emery cloths, etc.) due to the potentially harmful effects on the surfaces. In most cases, the electrical contact surfaces of these switches are plated, and using abrasive materials to clean the surfaces may remove or damage that plating. Application of a very thin layer of new lubricant should be provided in accordance with the manufacturer's recommended locations using recommended lubricants. I reiterate that one should apply a "very thin layer of lubricant," since too much grease, particularly on the contact surfaces, can be detrimental to switch operability. Where no lubricant recommendations are specified by the manufacturer, we typically use Mobilgrease 28 on both the contact surfaces and the hinge points of the switch.

Further, blade alignment, blade penetration, and the mechanical open and close operations should be verified. Most manufacturers recommend opening and closing these switches at least three times annually as part of the preventive maintenance activities.
In conclusion, bolted pressure switches are prevalent in the electrical infrastructure of many industrial settings due to their inherent cost effectiveness. These switches can have operability issues if not properly maintained. To ensure switch operability and long service life, appropriate preventive maintenance should be performed on a periodic basis.

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