INTRODUCTION

A lack of lubrication continues to be a major factor in circuit breaker failures, according to a recently completed study from the Nuclear Regulatory Commission [US NRC Information Notices, No. 98-38]. Choosing and applying the correct lubricant to circuit breakers, while often overlooked, plays a key role in the proper maintenance of electrical distribution equipment. It's a task made more difficult for plant engineers trying to maintain aging equipment with recommended lubricants that have become obsolete. Trying to find suitable replacements for discontinued lubricants can be time consuming, and carrying too many lubricants in stock can be costly.

Circuit breakers are sophisticated electromechanical devices. They are comprised of a complex combination of sliding and rotating parts, with various loads, mating surfaces and conductive and isolating materials. Circuit breakers are often required to operate in difficult environments, and are subject to a wide range of temperatures, moisture, dust, particulate, abrasive materials and corrosive atmospheric components. Ironically, a breaker that is in service is in a static condition. Only when an overcurrent situation arises is a circuit breaker's moving parts required to move.

These unique conditions make specifying the proper lubricant for circuit breakers a difficult task. Adding to the complexity is the growing demand to extend maintenance periods up to 15 or more years. This increases the importance of a systematic approach to maintenance and lubrication procedures.

LUBRICATION BASICS

The function of a lubricant is simple - reduce friction between moving metal surfaces. A lubricant coats surfaces and resists being displaced by pressure, keeping the metal parts separated. Lubricants also prevent corrosion, block contaminants and can serve as a coolant. A good lubricant flows easily under pressure and remains in contact with moving surfaces. It does not leak out from gravitational or centrifugal forces, nor does it stiffen in cold temperatures.

There are several types of lubricants:

- **Oils** cover a broad class of fluid lubricants, each of which has particular physical properties and characteristics. Petroleum oils (mineral oils) are made from naphthenic or paraffinic oils. Naphthenic oils contain little wax and their low pour point makes them good lubricants for most applications. Paraffinic oils, on the other hand, are very waxy, which makes them useful for hydraulic equipment and other machinery.

- **Ideal for lubricating bearings, gaskets, seals and other moving parts,** **greases** consist of an oil or synthetic fluid (~80%), a thickening agent (~10%) and additives (~10%). The consistency of greases is usually ranked by their relative hardness on a scale set by the National Lubricating Grease Institute (NLGI). The softest greases are rated at 000 (which is a flowing liquid) with higher numbers indicating harder grease. Most grease falls in the range between 1 and 4.

- **Solid lubricants** are usually fine powders, such as Molybdenum Disulfide (Moly), graphite and Teflon® (PTFE). They can be used alone,
or as additives in grease or dispersions, or as dry film bonded lubricants. Lubricating solids can last longer than unfortified oils and greases because of their ability to form burnished films on surfaces.

**Synthetic lubricants** cover a broad category of oils, greases, and pastes of varied properties. Synthetic lubricants are more inert, generate less waste, are capable of a wider range of temperatures and have a longer life than petroleum materials. Certain classifications are friendlier to elastomers, seals and O-rings that might come in contact with the lubricant.

- Synthetic oils are used to lubricate instrument bearings, hydraulics, air compressors, gas and steam turbines and other applications. They generally have excellent viscosity-temperature characteristics, good resistance to oxidation and an extremely wide operating temperature range.
- Synthetic greases can last a lifetime, making them very cost-effective. They are chemically inert, and their high thermal stability makes them useful for aerospace, electrical, automotive and other high-tech or industrial applications. Some of these lubricants keep their viscosity in temperatures ranging as high as 550° F and are nonflammable up to 1,200° F.

**Silicones** are very stable and very inert lubricants, which provide a wider range of operating temperatures than non-silicone synthetic lubricants. Other advantages include water repulsion and electrical insulation. Fluorosilicones have a higher resistance to harsh environments and the ability to carry bearing loads.

Lubricant manufacturers can provide technical data sheets on their products to advise you on the best applications of each type of lubricant.

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**LUBRICATING CIRCUIT BREAKERS**

Circuit breaker lubrication recommendations should include three specifications: 1) the location of lubrication points, 2) the products to use for specific locations, and 3) terms of maintenance and overhaul. An equipment manufacturer's lubrication specifications, usually found in the maintenance section of the equipment operator's manual, should be followed without exception. However, you may find that the recommended lubricant is no longer available. In this case, the specific application should guide the selection of a substitute lubricant.

When choosing a substitute lubricant for circuit breakers, consider all the primary elements that go into the making of the product - the liquid lubricant (petroleum or synthetic fluid, and type of synthetic oil), the thickening agent and additives. The chosen lubricant must be heavy enough to provide the right film strength, yet be light enough to flow well in cold temperatures.

Working temperature range is another important consideration. Because petroleum oils cannot handle temperature extremes, synthetic lubricants must be given preference where extreme temperature could be a factor of operation. Synthetic lubricants last longer, which is an advantage over petroleum lubricants, particularly with today's requirements for extended service without maintenance.
TROUBLESHOOTING AND TIPS TO REMEMBER

If a piece of equipment fails, it’s possible that the failure could have been caused by insufficient or improper selection of circuit breaker lubrication. To determine if lubrication problems contributed to the failure, look for symptoms such as excessive leakage, overheating wear, or scoring. Examine the properties of the lubrication product used in previous maintenance to be sure it is correct for your application. You may also need to review your lubrication and maintenance procedures.

When re-lubricating equipment, be aware that the new lubricant may not be compatible with the old lubricant. If new grease is applied that is incompatible with the old grease, a chemical reaction between thickeners can cause the mixture to liquefy and leak out. Non-soap greases (like organic clay-based Mobilgrease 28 from Mobil or poliurea-based SRI grease from Chevron) are incompatible with soap greases. Lithium soap grease can be incompatible with sodium soap grease. Silicone lubricants should not be applied to silicone rubber, fluorosilicone lubricants to fluorosilicone rubber and petroleum lubricants to rubber.

To eliminate issues of compatibility, be sure to remove all traces of the old lubricant before you apply a new lubricant product for the first time. Use a commercial cleaner - kerosene, mineral spirits, etc. If possible, soak the part in the solvent and use a soft-bristled brush to loosen the old lubricant. After cleaning, parts should be dried carefully and re-lubricated as soon as possible.

While penetrating oils are useful for loosening stuck parts, they should not be used as a lubricant in electrical equipment because they attack, dissolve and wash out factory-installed lubricants, hastening equipment failure. Also, penetrating oils are flammable and should not be applied in areas where sparks or arcing may occur.

One final caution. Electrical contacts should not be lubricated with metal-filled lubricants unless tested and proved to be effective long term. Many metal-filled lubricants can accelerate corrosion, create conductive paths and eventually cause failure. It is better to avoid graphite and Molybdenum Disulfide containing lubricants for electrical contacts, because it could cause a resistance rise after multiple operations. For switches that operate infrequently, keeping the contact just clean and dry with no lubricant might be a viable option.
GLOSSARY OF TERMS

**Viscosity** is a measure of “flowability.” It is the resistance to flow, caused by internal friction between the lubricant molecules. This characteristic helps to determine load-carrying capacity, thickness of the lubricating film and operating temperature. In selecting a lubricant for a particular application, it is critical to define the required levels of viscosity at both start up and during operation. Viscosity can be expressed as the number of seconds required for a measured volume of oil to flow through a specified orifice at a standard condition. In the United States, viscosity is usually measured and specified between 100° and 210° F.

**Viscosity Index** indicates how viscosity varies with temperature, which can be an important consideration in applications where operating temperatures vary widely.

**Pour Point** is the lowest temperature at which oil will pour or flow and is most critical in low temperature applications.

**Flash Point** is the temperature at which oil gives off ignitable vapors. The flash point is not necessarily a safe upper limit for oil because some decomposition takes place below the flash point.

**Fire Point** is the temperature at which oil will burn if ignited.

**Lubrication Additives** define many of the physical properties of various oils and greases. Types of additives include oxidation inhibitors, defoamers, rust inhibitors, pour point depressants and Extreme Pressure (EP) additives. EP additives react with metal to form anti-weld compounds that help reduce wear, prevent scoring, ridging and seizure.

GETTING HELP

The Services division of Square D / Schneider Electric has developed a lubrication manual that provides recommendations for the majority of low and medium voltage circuit breakers made by most major manufacturers over the past 50 years. A comprehensive guide, the lubrication manual includes specs for most lubricants used in the electrical industry and recommendations for lubricating electrical equipment. It also provides OEM’s specifications for over 1,500 models of circuit breakers, switches and switchgear from most major national and international manufacturers. Further, it provides a guide to interchangeable lubricants and a cross reference for substitute lubricants.

A training course on the basics of lubrication for engineering staff and technicians is also available. For more information on the manual, training, or consulting call Square D Services at 513-777-4445 and ask for the Engineering department.