

Circuit Breaker Lubrication in the Field



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"The majority of all circuit breaker failures below 38 kV are avoidable with proper lubrication. Proper lubrication will prevent most mechanical failures that lead to faults or arc flash."

Finley Ledbetter, CBS Group

"We continue to hear or read about circuit breakers that failed to operate properly because of dried grease or lack of lubrication."

Institute of Nuclear Power Operations

Introduction

There have been many circuit breaker failures attributed to lack of lubrication or improper lubrication. Many of these failures have led to arc-flash incidents that have damaged equipment or injured personnel. The formula for calculating the incident energy in calories per centimeter squared, cal/cm², is dependent on arc duration, arc-fault current, and distance from the source. The clearing time and operation of the circuit breaker is strongly dependent on the quality of its lubrication.

Most published articles on lubrication offer two strong recommendations - "follow manufacturer's instructions" and "don't mix lubricants." This sounds easy and one would think it is common sense. It is *not* easy or simple, and sometimes common sense does not apply.

Almost all engineering specifications, maintenance books, training seminars, NFPA and IEEE documents, etc., fall back on the recommendation of "follow manufacturer's instructions." The problem is, it is usually impossible. The original maintenance manual that came with most equipment is usually unavailable or outdated.

A few hours of searching on the Internet can reveal a lot of helpful information and it can add to the confusion. Calling on your peer group can also add to your confusion, as there are many different opinions. Some manufacturers are helpful (now and then) in publishing updates, but others seem to regard any maintenance information as proprietary. To compound this, if you ever do

manage to get in contact with a tech support person, most do not know much about this issue. My personal favorite is a Westinghouse DHP Maintenance Manual that recommends "an extremely light coat of oil on the arcing and main contacts." Most wisdom on this is never put oil on a circuit breaker arcing contact. What constitutes an "extremely light coat" is a qualitative issue that is a large problem with all lubrication issues. Remember, a little goes a long way.

"Don't mix lubricants." Is this common sense? The old thought was that you could rejuvenate old grease with a few drops of oil. After all, we know that grease is a thickening agent with the purpose of suspending the oil. The oil is what provides the lubrication. In the 1960's when oil was made of oil, an oil squirt can and a can of grease provided most maintenance lubrication. Manufacturer and type were whatever was available. Maintenance was performed frequently and thoroughly. The equipment was robust and worked well. Along came the 1970's - 1980's. The spray can started to show up everywhere. Maintenance frequency and time allowed per unit were reduced. Circuit breaker maintenance started

to become dust it off and spray whatever lubricant you had (including WD40) into whatever area you could reach. Circuit breakers still continued to work. The old equipment could take a lot of abuse, for a while. What the spray can brought to the party was a simple and efficient way to wash all the grease out of bearing and roller interfaces that could not be relubricated without complete teardown.

Time marches on. The circuit breakers are getting older. Chemists are busy in their laboratories creating a large variety of products and their sales departments are busy. Customers want lubricants that do not attract dirt, last forever, and are impervious to temperature. The promise is made to provide this and even more. Overwhelmed maintenance managers and technicians take the bait. A free-for-all is created. Everybody has an opinion (or a can of spray in their hand) as to what works. The result is, who knows what lubrication is in your breaker, and how those lubricants have combined? That is, if the breakers have had any maintenance at all. The real problem with mixing lubricants is that the fillers can be incompatible as well as the lubricating suspended material. This can cause chemical reactions that will create everything from heat to cement.

The only practical way to replace old lubrication from large tight interfaces is by disassembly. No amount of spray or brush applied grease will replace it. The best way to restore an old circuit breaker is to send it to a qualified breaker shop for a complete inspection and tear down. If the circuit breaker is in good or fair condition, limited lubrication and disassembly can be performed in the field. This can be done provided a proper work area with adequate time, lighting, and ventilation is present.

Issues and Problems

What can we learn from the manufacturer's maintenance manuals, the Internet, our fellow technicians, local and national circuit breaker repair shops, and our own field experience? In the past 12 years, our technicians have attended four different, nationally recognized training seminars on circuit breaker maintenance. All were excellent classes where the technicians gained valuable skills. All of these have used the same basic lubrication chart. All of these charts are outdated.

Most GE greases can be replaced with Mobil 28. Several other manufacturers, such as ABB and Cutler-Hammer, list Mobile 28 as a viable substitute for some applications. Here is a pleasant surprise! Mobil 28 is easily available and inexpensive. Some circuit breaker repair shops use Mobil 28 for all lubrication on all manufacturers' circuit breakers. At the recent PowerTest Conference held by NETA in Denver there were two panel sessions on circuit breaker maintenance. A question was posed to the approximately 100 participants. What lubricant do you use on all manufacturers' circuit breakers? The great majority replied, "Mobil 28."

This article is not a blanket recommendation for Mobil 28. It is an excellent, long tested lubricant. When applied correctly it will provide years of good service. But there are other factors. The first to consider is what does the manufacturer recommend. The second is more than one type of lubricant may be required in a circuit breaker. There are the main stabs, the pivot point of the main current carrying path, and the operating mechanism.

Note: Using Mobil 28 in some applications may cause a circuit breaker to operate too fast. Some of the excellent lubrications, such as Anderol, Siemens, Magnalube, etc., are sticky. By replacing these with a lighter viscosity lubricant such as Mobil 28 on moving parts, the latch may not have time to operate, or the opening and closing times could be reduced. These are not common problems, but, as in all situations where changes are being made, attention to detail and worst case scenario must be examined. One manufacturer has a modified latch kit to address this problem.

Another substitution tip, several manufacturers suggest replacing their Molykote (Molybdenum Disulfide, a silicone base) with Magnalube (a Teflon base). In 1991, Westinghouse made this change on some circuit breakers. Cutler-Hammer followed in 1996. Magnalube is an excellent replacement for the sticky greases and is also easy to purchase. The issue of lubricant compatibility and substitution can become very technical and time consuming. See the attached chart for locations to purchase some lubricants.

A lot can be said regarding grease that "attracts" dirt. The older types of grease would absorb and encapsulate any dirt that landed upon it. In a dirty area, after a time, the lubrication quality is reduced. The best solution is today's enclosed and environmentally conditioned substation. However, we are maintenance people and work with what we have. The next idea is to use lubricant that does not encapsulate dirt. This, of course, is graphite or one of the sticky, nonviscous greases, such as Anderol or Magnalube. The main reason the sticky greases are used is they do not leak out; they stick to where you put them.

If you use Scotch-Brite pads for cleaning silver-plated surfaces, be very careful. Too much scrubbing will remove the silver. There is a great variety of pads. Some have additives, some are too rough, while others fall apart. Scotch-Brite pads are available in many different types. Pick the least aggressive. Experiment and find which is best for your job. Old hardened grease and old no-ox are virtually impossible to remove with Scotch-Brite pads. Some contain soaps and other abrasives that leave behind unneeded residue. Use a wire brush and solvent, starting with the least aggressive and working your way up. What is very important is to remove all the old lubrication prior to adding a different type of lubrication.

The best liquid to use in removing old lubrication is a difficult choice with many options and many problems. Alcohol, kerosene, and others recommended in the past are flammable. This introduces an unacceptable hazard in some substations. The nonflammable chlorinated products

(trichloroethylene and its variations) were a welcome solution, especially around electrical equipment. However, these have environmental and noxious issues that eliminate their use in some areas. The citrus cleaners are a good solution to the noxious problem. They have a pleasant odor and are environmentally friendly, but a residue is left to be cleaned off. The biggest problem with this residue is it may be conductive. Do not allow citrus cleaner to come into contact with the breaker insulation. Whatever liquid you use, remember to have the MSDS sheet easily available *at the location being used*. Also, be wary of purchasing a large container of any liquid to distribute into smaller containers for job site use. This could lead to serious labeling problems and might result in the wrong liquid being applied, with disastrous results. Another issue with chemicals is compatibility with plastics.

Avoid the use of spray cans of any type. Many spray cans of cleaners and lubricants have flammable propellants. Even if they are not flammable, what chemical is it? What are the environmental consequences of that chemical and its propellant? Having knowledge of these hazards, make a decision as to what is safe and appropriate for the circuit breaker on the floor. Would you use these same sprays and chemicals in a cubicle? The cubicle has the additional hazards of possible energized space heaters and a worker's head or body inside a small space. The reality is whatever is available at that site will probably get used in the cubicle.

Spray solvents and lubricants have a strong chance of washing out any good grease that was present. What remains when using a spray lubricant is whatever could be propelled through a very small nozzle. This may work great (if it is compatible) to get the circuit breaker to work. This thin lubrication you deposited will last only a short time. Not good. Also remember WD-40 and other liquid penetrants do not act as lubricants. They act as solvents and will only temporarily free up sticky interfaces.

If you find oil or grease spots on the bottom of the cubicle, the source needs to be discovered. It could be due to chemical reaction, excessive lubrication, or overheating. Another issue in the cubicle is what grease is on the stabs. It is important to have the same grease on the cubicle stationary stabs and on the circuit breaker stabs. One very important lubrication task you can accomplish is the stabs. Many an arc-flash incident has occurred by trying to force a circuit breaker onto dry stabs. If a cluster of fingers is part of the stab assembly some of the fingers may get pushed back. This leads to a poor connection.

Maintenance jobs can be divided into two categories. In the first, the equipment is available for enough time that proper procedures may be performed. In the second, there is not sufficient time to do testing and maintenance procedures. For example, a section of equipment is only to be de-energized for 6 to 12 hours and 50 large circuit breakers are to be serviced. In this situation what kind of lubrication will you perform? In some situations the best lubrication may be no lubrication. You could cause more problems by

applying the wrong lubrication. Sometimes the primary lubrication you perform is exercising the circuit breaker to spread the existing grease or oil around.

The original goal of this article was to provide a chart of the proper lubrication for each type of circuit breaker and the different points in a breaker. After extended hours of research of many manufacturers' circuit breaker maintenance books, we realized this could not be done in a reasonable time and space. This task is beyond the scope of a short article. It would be a large chapter in a book.

Other issues became obvious in this investigation. I am aware of no field service company (including the manufacturer's field services) that possesses even a small portion of the large number of lubricants manufacturers recommend. Attempting to follow these recommendations can lead to frustration. One older manual stated, "There is no need for maintenance lubrication." Some manuals are very vague regarding the lubrication points. Adequate information is not given.

This brings us back to "follow the manufacturer's instructions." The manufacturer has to conform to many regulations and design criteria to achieve product listing. The field service company has a different mandate; make it work and keep it working until the next maintenance cycle. It is unrealistic to have a circuit breaker test form with a box to check "perform lubrication" and allow the technician only a few minutes to perform this critical task. More information should be documented, including, if appropriate, "no time to properly lubricate."

Part 3 Solutions

Now that we have examined some of the issues, what can we do at a specific job site?

1. Obtain the manufacturer's maintenance manuals.
2. Take your time and read carefully what lubrication is recommended and where to apply it.
3. Research what lubrication is currently available and recommended today.
4. Make a plan for the specific job site considering the age of the equipment and its problems. When was maintenance last performed, and what is the time between maintenance? What are the operating conditions, including temperature, dirt, and number of operations.
5. Meet with the owners of the equipment, explaining what you have found and your suggestions for maintenance. Make a joint plan on how to proceed.
6. Develop a written procedure, documenting what lubrication is to be used and where it will be applied. One problem to address here is lubrication on the stabs. Is the cubicle energized and what kind of grease is on the cubicle stabs? Can you insure that the circuit breaker stabs and the cubicle stabs are going to have the same kind of grease?

LUBRICANT Manufacture	CONTACT INFORMATION
Lubriplate AERO Fiske Bros Refining Co, Lubriplate Div	HQ: 129 Lockwood Street Newark, NJ 07105 973-589-9150 Tel 973-589-4432 Fax Company website: www.lubriplate.com/ Distributors: www.lubriplate.com/Products/DistributorsMap.htm
Mobilgrease 28 ExxonMobil Products	Exxon Mobil Corporation 3225 Gallows Road Fairfax, VA 22037-0001 For additional technical information or to identify the nearest U.S. ExxonMobil supply source, call 1800 662-4525. www.exxonmobil.com
NO-OX-ID Grade A-Special electrical Sanchem, Inc.	Sanchem Inc. · 1600 S. Canal Street Chicago, IL · 60616 312-733-6100 · 800-621-1603 www.sanchem.com/aSpecialE.html
Anderol 757 Anderol Inc.	Anderol Inc. 215 Merry Lane PO Box 518 East Hanover, NJ 07936 Phone: 1 (973) 887 7410 Fax: 1 (973) 887 6930 Toll Free: 1 888 263 3765 Email: info@anderol.com www.anderol.com
Fomblin M-30 Ausimont USA, Inc.	Ausimont USA, Inc. 10 Leonards Lane Thorofare, New Jersey 08086 UNITED STATES Phone: 856-853-8119 Fax: 856-853-6405 (no website available)
DC Z Moly-Powder, Molykote Grease, and Molykote 3451 Dow Corning	Distribution by: APPLIED INDUSTRIAL TECHNOLOGIES 2886 E BLUE STAR ST ANAHEIM CALIFORNIA 92806-2507 TEL: +1 714 666 8623 web.applied.com/ Product information from manufacturer: www.dowcorning.com/applications/search/default.aspx?country=USA&R=30EN
Electrical Contact Lubricant Part No. 15-171-370-002 Siemens	Siemens Energy & Automation in Cypress 10833 Valley View St. Suite 350 Cypress, CA 90630 714-763-3400 Fax: 713-763-3405 Check site below to find closest sales office. Reference part number 15-171-370-002 www.sea.siemens.com/sales/default.html
Magnalube	Saunders Enterprises, Inc. 11-51 44th Road Long Island City, New York 11101 Phone: 718.729.1000 Fax: 718.729.2690 www.magnalube.com

7. The test form being used to document all work being performed needs to have detailed lubrication information. What was found? What was done? How was it left?
8. Install a sticker on the circuit breaker after maintenance describing what lubrication (if any) was used on the different locations. The stabs, the pivot point, and the mechanism should all be documented.

We know that paying attention to the above eight items would result in a much better job. We also know that some jobs will just not allow for that kind of detailed work. Our goal is to educate the owner, customer, and technicians performing the work on how important and time consuming proper lubrication is.

(See chart at left of the common lubricants and where you may obtain them) 

Tony Demaria worked for the Los Angeles Department of Water and Power in substation maintenance prior to starting his own company. He has owned and operated Tony Demaria Electric for over 25 years, specializing in maintenance and testing of switchgear and large motors for industrial facilities. Tony Demaria Electric is a NETA Accredited Company, and Tony serves on the NETA Safety Committee.