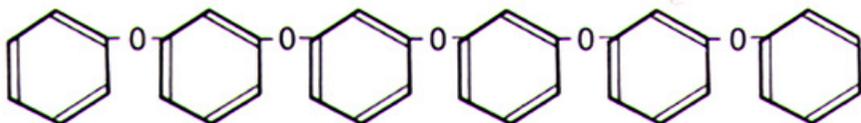


## THE MOLECULE AS A FORTRESS

### Six-Ring Polyphenyl Ether for Electrical Connector Lubrication



For electrical connectors, the need for dependable operation over long years of operating life has intensified the scrutiny given to the lubricants used on such connectors. Lubrication is required for reducing friction and wear during insertion or withdrawal and equally important for protection of the contacting metals and their substrates from airborne pollutants. Another lubricant function would be protection from fretting corrosion in the event of connector vibration over long periods.

The two most important properties of the connector lubricant, therefore, are that it be stable and that it stay where it is applied. For many years, the impressive oxidative stability of the polyphenyl ethers has led to wide use of such fluids as electrical connector lubricants. These oils consist chemically of aromatic rings linked through oxygen atoms, and the fortress-like nature of their molecular structure renders them stable against thermal or oxidative breakdown to temperatures approaching 500°F. Further, their aromatic nature leads to a very high surface tension, such that they possess a degree of "autophobicity", that is, they do not readily wet their own adsorbed film and thus become non-spreading oils. The five-ring polyphenyl ether has been a standard connector lubricant in both the telecommunications and computer industry.

A need for improvement, however, has arisen because of another constraint in keeping a lubricant where it is applied - its volatility. This may come as a bit of a surprise; one might presume that something as oxidatively stable as a high viscosity polyphenyl ether (the 5-ring ether has a viscosity of 363 centistokes at 100°F) wouldn't waft away. However, the very compact nature of the molecule and the fact that electrical connector lubricants are present in extremely thin films with a high surface area to unit volume, can limit the long-term (20 year) dependability of the 5-ring ether to only 50°C maximum continuous operating temperature. This limit is

somewhat dependent on the thickness of the lubricant film; however, to assure usefulness to 100°C or higher over a two decade operating life, a higher molecular weight fluid is required.

The 6-ring polyphenyl ether can be put forward as a less volatile and fully capable alternative. Dr. Morton Antler of AT&T Bell Laboratories describes in detail the testing on connectors of the 6-ring polyphenyl ether in his paper "Electronic Connector Contact Lubricants: The Polyether Fluids", presented at the Thirty Second IEEE Holm Conference in Boston in October, 1986.

We have this 6-ring ether available as our Nye<sup>®</sup> Synthetic Oil 439. This is a higher viscosity fluid than the 5-ring ether; the 100°F reading is 2011 centistokes. Dr. Antler is reported as carrying a sign saying "Viscosity is next to godliness", and this higher viscosity should enhance both protective and stay-in-place capability.

For application in thin film, the oil can be applied from a dilute solution in a fast-evaporating solvent. NyeTact 520 is a 2% (by weight) solution of Nye<sup>®</sup> Synthetic Oil 439 in the fast-evaporating, non-flammable solvent, trichlorotrifluoroethane. Upon application (by brushing or dipping) to a connector surface, the solvent evaporates quickly, leaving behind a thin, protective, oxidatively-stable lubricating film.

Small quantities of the oil and the NyeTact 520 solution are available in dispenser containers as listed below:

**NYE<sup>®</sup> SYNTHETIC OIL 439**  
3 ml dropper dispenser vial  
\$5.00 (min. order, 4 vials)  
22 ml dispenser vial - \$32.00

**NYETACT 520 (2% oil content)**  
4 fluid ounce bottle - \$20.00

For the above products, we will forego our regular \$15.00 small order handling charge for orders of less than \$100.00.

## BURNING-UP VS. SHORTING-OUT

### Synthetic Switch Grease For Use in Arcing Situations

Arcing of electric contacts is always destructive, either of the lubricant present or of the contact metals or both. The temperatures reached in an electric arc are sufficiently high as to thermally degrade any organic molecule. We have traditionally maintained that a lubricant's tendency to degrade in an innocuous manner, to volatiles, will improve switch life by reducing build up of carbonaceous debris during arcing and subsequent shorting out of the switch. A "clean-burning" lubricant is to be desired.

It is still an open question whether the presence of a lubricant on electric switch contacts operating under arcing conditions can actually **suppress** the formation of an arc. Recent work we have done with a new synthetic grease, Nye<sup>®</sup> Rheolube 748, suggests that minimizing the presence of polar compounds in the lubricant both improves dielectric properties and results in improved switch life. The inference would be that a switch lubricant with minimal ability to carry a current on its own serves to inhibit arc creation. Therefore, we are setting a new criterion for formulation of switch lubricants for potential arcing situations: clean-burning tendencies combined with maximum dielectric strength and minimum loss of dielectric properties after repeated arcing.

Nye<sup>®</sup> Rheolube 748 is based on non-polar synthetic hydrocarbon polymers which are "clean-burning". The tendency of these polymers to leave carbon residue when oxidized or thermally degraded is considerably less than that of natural petroleum oils or most synthetic fluids. Careful choice of gellant and additives maintains low polarity within the grease formulation. Operating temperature range, neglecting any arc-induced temperatures, is -20°F to 200°F. Several switch manufacturers have compared Nye<sup>®</sup> Rheolube 748 with traditional switch greases and have achieved significant improvement in switch performance and life using this new grease formulation. Evaluation samples are available on request at no charge, and we welcome all inquiries.

## LUBES BY THE DROP

### Dispenser Containers

Nye has a newly-expanded capability in small-container packaging of lubricants for field service use or for direct use on the production line. We can package either our own products or those of other manufacturers as may be required. Supercleaned containers are also available for lubricants requiring special filtration. A new two-page bulletin describing a variety of plastic and metal dispenser containers for both oils and greases is available.

# Immersion Oils: Temperature and Viscosity

## (1) Temperature

Lubricants, whether oils or greases, are based on "functional fluids". A functional fluid can be loosely defined as any liquid that does a job. Many of the jobs they do require a common pattern of capability, involving wide temperature liquid range, low freezing point, high boiling point, reasonable oxidative

stability and low evaporation rate. These are the requirements for useful lubricants; they are also the requirements for bath oils. Temperature-controlled liquid baths are used for a great variety of testing and control functions in industry. We use them here for viscosity measurement and oxidation stability

testing. They are often required for instrument or thermometer calibration or for processing functions.

We are frequently asked "what bath oil for what temperature?" Our current best recommendations are set forth below.

Bath Temperature	Recommended Oil	Chemical Type	Price, \$/gal. (5-gal. container)
to 200°F	Nye <sup>®</sup> Delicate Machinery Oil 100	Petroleum	8.95
to 250°F	Nye <sup>®</sup> Synthetic Oil 180	Synthetic Hydrocarbon	20.75
to 300°F	Nye <sup>®</sup> Synthetic Oil 181A	Synthetic Hydrocarbon	24.75
to 350°F	Nye <sup>®</sup> Synthetic Oil 622C	Polyol ester	28.75
to 400°F	Dow Corning <sup>®</sup> 510 Fluid, 100 cs.	Phenylmethyl Silicone	190.00*
to 450°F	Dow Corning <sup>®</sup> 550 Fluid	Phenylmethyl Silicone	200.00*
to 500°F	Dow Corning <sup>®</sup> 710 Fluid	Phenylmethyl Silicone	225.00*

\*in 1-gallon pails, discounts available for multiple gallons.

## (2) Viscosity

Usefulness at the above temperatures is a function of time; and longer bath oil life for any particular temperature target can be achieved by going one or more steps up toward the more costly fluids.

Some bath oil uses have minimum or maximum viscosities which can be tolerated for the particular function being performed; in such situations special recommendations are needed. Low temperature bath oil needs can

create such problems of choice. Although a fluid may have a freezing (or pour) point at some very low temperature, its usefulness as a bath oil anywhere near that temperature would probably be seriously compromised by the high viscosities of most functional fluids as they approach their pour points. Thus, specification of a bath oil for low temperatures requires some definition of maximum tolerable viscosity at the target temperature. Also, if the

bath is to be used over a wide temperature range both the low and high targets must be defined.

Selection of the best bath oil for a complicated situation thus might lead us on a merry chase, but we would welcome the challenge and hope you will contact us should you face such needs.

## EFFICIENCY IN PUSH-PULL

### Alternatives for Control Cable Lubrication

No specialty lubricant application presents a wider diversity of successful types of lubricants than that of push-pull cables - essentially a wire sliding in a tube. Control cable designs involve a bewildering array of possible sliding material combinations from metal-on-metal, to metal-on-plastic to plastic-on-plastic. The increasing variety of plastics used as cable liners further complicates the issue as do operating temperature extremes (especially for automotive applications) and the need in many situations for sealant properties as well as friction reduction capability within the lubricant.

The target for the lubricant in most applications, however, is efficiency - defined as the ratio of the force applied at one cable end to the force perceived at the other. The coefficient of friction permitted by the lubricant is the key to its success, and this is often difficult to predict.

Silicone oils of various viscosities, sometimes with polar groups molecularly attached, work with some material combinations; in other designs extremely light (semi-fluid) to relatively tacky greases, often containing polytetrafluoroethylene polymers, provide the needed efficiency.

Nye has two very different greases which have worked out with several different combinations of sliding materials.

**Nye<sup>®</sup> Rheolube 739A** - an extremely soft, lithium soap-gelled grease based on low viscosity synthetic hydrocarbon fluids. A fluorocarbon polymer is incorporated to enhance friction reduction.

**Nye<sup>®</sup> Fluorocarbon Gel 880** - a relatively tacky grease, around which several automotive cable lubricant specifications have been written, based on blended silicone oils gelled with a polytetrafluoroethylene polymer.

Variations on both of the above products are now being tested, and we can modify these and other formulations for your push-pull cable design.

## THE RESISTIVE FILM

### Achieving Electrical Conductivity in Greases

Any rotating component supported by ball bearings is essentially isolated from the rest of the device of which it is a part by the film of lubricant in the bearing raceway. There might be other contacts such as slip rings or commutator brushes; however, if such a component is building up some type of electrical potential or static charge with troublesome implications, it may prove difficult to bleed or dissipate this charge. This problem arises in computer disk drives and in copying machines, among other electrically sensitive devices.

We have frequently been asked for conductive lubricants for ball bearings. Heretofore, our recommendations have involved greases gelled with a conductive carbon with an oil absorption capability. The result is a fine grease, but not one with the best of properties for ball bearing use. Several of the alkali metal soaps - fatty acids reacted with sodium, calcium, lithium or aluminum - provide much better properties for ball bearings.

To make available a more useful conductive ball bearing lubricant, our latest new departure has involved use of special dispersants to permit adding a highly conductive carbon to existing proven ball bearing greases, both of our own and other's manufacture. The resulting greases are relatively stiff, channelling lubricants which have worked well when tested. Conductivity is, of course, short of that provided by metals - the grease has a definite electrical resistance - but a sufficient degree of electrical conductivity is achieved such that static charges are dissipated through the ball bearing lubricant film. Certain adjustments must be accommodated in lubrication of the bearing - a much higher percentage grease fill may be necessary. Also a higher degree of pre-loading may be required.

We stand ready to attempt this novel approach to achieving electrical conductivity for any grease where any of our customers require this unusual quality.

## Salt Water Resistance in a Switch Grease

The technology of the motor car and its manufacture is evolving very rapidly as electronics reaches every part of the automobile, and constant new demands are being placed on the lubricants needed for special automotive devices.

Resistance to salt-water is a lubricant quality likely to be demanded by our local Buzzards Bay boatyards. It was less expected coming from an automotive switch manufacturer, although easily understood when one considers the impact of salt-treated slush and snow if it splashes and percolates into your car's window and door assembly. There are an increasing number of switches and electrically-actuated mechanisms in the modern car door. Many can be sealed from water intrusion; some cannot. For certain applications a defensive lubricant is needed should, say, a switch seal fail.

A grease which may withstand extended immersion in fresh water, even hot, may disintegrate completely if exposed to salty water. Gellants and additives have to be carefully selected. In meeting our switch customer's need, we have developed Nye® Rheolube 732C, based on a wide temperature polyol ester oil with capability from -65°F to 300°F. The best of new generation antioxidants are included, along with corrosion inhibitors and anti-wear additive. The gellant is a special organically modified clay, creating a grease with no melting point and good salt water resistance. Its performance as an electric contact lubricant for non-noble contacts in a door switch mechanism has been impressive.

A bulletin and evaluation sample will be sent on request, should you be facing salt water exposure problems in your application.

## Cerium Fluoride Fortification in Greases

Where there are heavy loads on sliding metals with high friction and significant wear potential, one can expect to find the characteristic gray-black color of molybdenum disulfide as part of any effective lubricant for such conditions. Molybdenum disulfide has a lamellar crystal structure which tends to slide on itself and provides effective load-carrying fortification for greases. Metal-to-metal contact is minimized; the mating surfaces become moly-on-moly. Both friction and wear can be effectively reduced.

There are other compounds with a lattice layer crystal structure which show comparable wear reduction properties. One of the more interesting is **cerium fluoride**, first identified during a NASA search for solid lubricants with 1000°C or higher capabilities for advanced turbojet engines.

Of special interest, however, has been the color of cerium fluoride. It is "off-white", actually a pale buff. Many Nye lubricants are used in color-sensitive situations, such as in personal care appliances, where the black color of molybdenum disulfide is undesirable. Fluorocarbon polymers present a white alternative solid lube type fortifier which can definitely improve lubricity but do not always do the necessary job on wear reduction. A cerium fluoride-fortified grease, however, can provide a solid lubricant's advantages in reducing metal-to-metal contact and resulting wear without inflicting the color black on the application.

Our first product containing this unusual solid lubricant additive is Nye® Rheolube 362CF, a wide-temperature synthetic hydrocarbon-based lithium grease. Write for a no-charge evaluation sample; for comparison purposes we'll also send an evaluation sample of Nye® Rheolube 723-MS, a comparable synthetic hydrocarbon formulation fortified with molybdenum disulfide.

## Response Coupon

Cut along the above line and mail in your company envelope to:

**WILLIAM F. NYE, INC.**  
P.O. Box G-927, New Bedford, MA 02742  
Telephone (617) 996-6721

Send Literature on the Following:

Special Requests or Comments:

Send at no charge or obligation a lubricant sample especially selected to meet the following needs:

Type of Mechanism \_\_\_\_\_

Components to be Lubed \_\_\_\_\_

Materials of Construction \_\_\_\_\_

Ball or Sleeve Bearing (if either)? \_\_\_\_\_ Sintered Metal? \_\_\_\_\_

Preference for Oil \_\_\_\_\_ Grease \_\_\_\_\_ Dry-Film \_\_\_\_\_

Is Oil Creep a Problem? \_\_\_\_\_

Will Lube Touch Plastics? \_\_\_\_\_ Type: \_\_\_\_\_

Elastomers? \_\_\_\_\_ Type: \_\_\_\_\_

Lowest Operating Temperature \_\_\_\_\_ °C/°F. If an electric contact, is arcing expected? \_\_\_\_\_

Highest Operating Temperature \_\_\_\_\_ °C/°F.

Desired Life at High Temperature \_\_\_\_\_

Present Lube \_\_\_\_\_

If unsatisfactory, in what way? \_\_\_\_\_

## A SUPER-SOLUTION FOR SUPER-CLEANING

# Nye<sup>®</sup> Special Cleaning Concentrate

Clean lubricants should be used on clean components. As we have expanded our work in filtration of both oils and greases to achieve increasingly stringent cleanliness levels, we have had the benefit, in cleaning our processing and filtration equipment, of an especially fine proprietary liquid cleaning solution, which we now want to make available to our customers as **NYE<sup>®</sup> SPECIAL CLEANING CONCENTRATE**.

One of the major advantages in using **NYE<sup>®</sup> SPECIAL CLEANING CONCENTRATE** lies in the dangerous cleaners you no longer have to use, such as chromic acid or caustics. The same cleaning efficiency can be obtained with this biodegradable, non-toxic liquid formulation. **NYE<sup>®</sup> SPECIAL CLEANING CONCENTRATE** can be used directly by mixing 2-fluid ounces to a gallon of cold water.

This is a versatile product. It can be used for cold water soak washing (for delicate volumetric apparatus), for ultrasonic cleaning, for hot water washing (95°C for speed cleaning) and automatic machine washing (use a 0.2% solution).

**NYE<sup>®</sup> SPECIAL CLEANING CONCENTRATE** is safe to use with glass, plastic and most metals, although it has some corrosive tendency toward zinc, aluminum and magnesium. It leaves no film on glass.

Whether your cleaning need is in the laboratory or on the production line, **NYE<sup>®</sup> SPECIAL CLEANING CONCENTRATE** offers an attractive alternative. In fact, the cleanest bearing laboratory we've ever seen, one of the best known in the aerospace industry, uses this cleaning solution exclusively.

Order a trial gallon jug for \$35.00 plus shipping. We will forego our regular small order handling charge for any such order. With this gallon of concentrate you can make a drum or more of supercapable cleaning solution. Prices for multiple gallons or larger containers are lower and will be furnished on request.

## A DENSITY OF ONE

# Functional Fluids: Problem-Solving

The man said he needed a silicone oil with a density of one. Not 1.0 plus or minus 5% or even 1%. He needed 1.000 . . . , the number of zeroes being undefined, but as a practical matter limited by the sensitivity of his and our immediately available in-house instrumentation. (Within these terms the target proved to be  $1.0000 \pm 0.0001$ .) This is not an item one can pick out of any handy catalog, but it is also not a request we would readily decline. Being at the whip end of the specialty lubricant business for as long as we have, we have learned that opportunities come in strange guises, and we have developed what amounts to a specialty laboratory service, indeed a kind of lubricant short-order cookery, for unusual requirements, small though they may be. We are prepared to purify, modify, blend, gel, color, clean or dry the range of functional fluids to meet any special customer requirements. Being relatively flexible in our technical staff assignments, pricing for such work can prove more reasonable than might be expected from professional laboratories and scale-up to quantity production can always be considered. The most difficult element to handle is that of time; we welcome special requests; we may have to counsel patience in expecting a full response.

from:

**WILLIAM F. NYE, INC.**

P.O. Box G-927

New Bedford,

Massachusetts 02742-0927

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# NYE<sup>®</sup> LUBEletter

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