

**FIRE-RESISTANT FLUID USAGE IN HYDRAULIC SYSTEMS OF OFF-ROAD WORK MACHINES**

**Foreword**—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. **Scope**—This Information Report is intended to provide reference material for the selection and use of fire-resistant fluids in the hydraulic systems of off-road work machinery with separate hydraulic oil sump.

2. **References**

2.1 **Related Publications**—The following publications are provided for information purposes only and are not a required part of this document.

2.1.1 ANSI PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI/B93.5M 1979—Practice for the Use of Fire-resistant Fluids in Industrial Hydraulic Power Systems

2.1.2 ISO PUBLICATIONS— Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 4404—Hydraulic fluid power—Fire-resistant fluids (Categories A, B, and C)—Determination of anti-corrosive power

ISO 6071—Hydraulic fluid power—Fire-resistant fluids—Classification and designation

ISO 7745—Hydraulic fluid power—Fire-resistant fluids—Guidelines for use

3. **Definition**

3.1 **Fire-Resistant Fluid**—A fluid which, due to physical or chemical properties, is difficult to ignite and shows little tendency to propagate a flame. The fire resistance is obtained either from the presence of water or from chemical compositions which are self-extinguishing.

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#### 4. **Categories Of Fire-Resistant Fluids**

- 4.1 Category HFA - High Water Content Emulsions and Solutions**—These fluids are either oil-in-water emulsions which are dispersions of oil containing additives in a continuous phase of water or solutions which are blends of selected additives in water. The soluble oil content is usually 10% or less of the solution with the water content more than 80%, the balance being selected additives. They have low viscosity, poor lubricity and limited corrosion resistance. The temperature range of +5 – +50 °C (+41 – +122 °F) is due to the high percentage of water in the fluid which will either freeze or vaporize. Because of their vapor pressure, they are subject to cavitation. Certain alloys of aluminum may be subject to rapid corrosion when subjected to this type of fluid.
- 4.2 Category HFB - Water-in-Oil Emulsions**—These fluids contain finely divided water droplets in a continuous phase of mineral oil with special emulsifiers, stabilizers and inhibitors. The water content is approximately 40%. Their viscosity grades and corrosion properties are similar to straight mineral hydraulic oils. They exhibit good lubrication properties. Their viscosity is non-Newtonian and because of their high vapor pressure are subject to cavitation. The temperature range is +5 – +50 °C (+41 – +122 °F). Certain alloys of aluminum may be subject to rapid corrosion when subjected to this type of fluid.
- 4.3 Category HFC - Glycol or Polyglycol Solutions (Water Glycols)**—These fluids are solutions of water and glycol with approximately 45% of the solution being water. They provide reasonable viscosity, corrosive properties and lubricity. Their temperature range is –20 – +50 °C (–4 – +122 °F). They may introduce material incompatibility problems with systems using zinc, cadmium or magnesium alloys. Certain alloys of aluminum may be subject to rapid corrosion.
- 4.4 Category HFD - Synthetic Fluids (Anhydrous)**—These fluids are generally phosphate esters. They exhibit good lubricating and anti-wear properties. They have poor viscosity/temperature relationships. Viscosity index improvers can be added. They are sensitive to the presence of water or humidity. Seals, hoses, packings and accumulator bladders must be manufactured from compatible materials such as fluoroelastomers, PTFE and silicone rubber. The temperature range is between –20 – +70 °C (–4 – +158 °F) although higher temperatures can be permitted. Precautions should be exercised because at higher temperature they may be subject to rapid deterioration and must be frequently checked.

#### 5. **System Requirements**

- 5.1 Fluid Connectors**—Because of the higher relative density of fluids in HFB, HFC and HFD categories and the increased viscosity of HFD fluids at low temperatures, fluid connectors must be sized accordingly or other precautions observed in the use of these fluids in systems designed for mineral oils.
- 5.2 Strainers and Filters**—Because of the higher relative density or high viscosity at low temperature, entailing slow sedimentation of contaminants, filtration area should be as much as three times as large as for systems using mineral oil. Filters made from activated earth or absorbent materials cannot be used.
- 5.3 System Performance**—The overall performance of these fluids in a hydraulic system is inferior to mineral oils. Derating the system may be necessary to avoid unduly reducing the life of components.
- 5.4 Compatibility with Metals**—Certain metals may be sensitive to the corrosion effect of these fluids. Metals which have significant difference in electrolytic potential may result in anodic corrosion.
- 5.5 Compatibility with Coatings**—Coatings used to protect parts of a system during storage or non-use may have to be removed prior to using a fire-resistant fluid. It is possible to treat the surfaces with an oil which is compatible with certain fire-resistant fluids and also those elastomer materials used in the system.

- 5.6 Compatibility with Sealing Devices**—Conventional materials used with mineral oils are generally not compatible with fire-resistant fluids. The following table provides information on suitability:

TABLE 1—

Fluid Category	Suitable Elastomer Types
HFA	NBR, FPM
HFB	NBR, FPM
HFC	NBR, SBR, EPDM, IIR, NR, FPM
HFD	( <sup>1</sup> )FPM, EPDM, IIR

## KEY

NBR - Nitrile rubbers (acrylonitrile butadiene)  
 FPM - Fluorocarbon rubbers  
 SBR - Styrene-butadiene rubber  
 EPDM - Ethylene propylene diene rubbers  
 IIR - Butyl rubbers  
 NR - Natural rubber

1. Compatibility tests may be required depending on the different types of HFD fluids.

## 6. **Converting From Mineral Oil To Fire-Resistant Fluid**

- 6.1** Ensure that each of the components of the system is compatible with the selected fire-resistant fluid and that system performance within the selected fluid limitations is practical.
- 6.2** Completely drain system and clean parts. This may involve flushing or disassembly to remove any traces of the previous fluid depending on the category of fluid to be installed. The flushing fluid should be the intended use fluid or one compatible with the fluid to be used. Pumps, lines, cylinders, all accessible surfaces of valves and tanks, filters, screens and accumulators need to be cleaned. Replace the cartridges and filter elements.
- 6.3** Replace components not compatible with the selected fire-resistant fluid with components which are compatible.
- 6.4** After initial operation, check condition of screens and filters to insure that previous fluid, not completely removed, is not blocking them.

## 7. **Converting From A Fire-Resistant Fluid Of One Category To A Fire-Resistant Fluid Of Different Category**

- 7.1** Ensure that each of the components of the system is compatible with the selected fire-resistant fluid and that system performance within the selected fluid limitations is practical.
- 7.2** Completely drain system and clean parts. This may involve flushing or disassembly to remove any traces of the previous fluid depending on the category of fluid selected. Pumps, lines, cylinders, all accessible surfaces of valves and tanks, filters, screens, strainers, accumulators and rams need to be cleaned.
- 7.3** Replace cartridges, filter elements and all components not compatible with the selected fire-resistant fluid with compatible components.
- 7.4** After initial operation, check condition of screens and filters to ensure that the previous fluid, not completely removed, is not blocking them. Carefully bleed air from the system as necessary and systematically eliminate the water and impurities rising to the surface.

**8. Precautions Taken When Using Fire-Resistant Fluids**

**8.1 High Water Content Emulsions and Solutions (Category HFA)**

- 8.1.1 Ensure that the oil content or the additives remains constant within the specifications.
- 8.1.2 Ensure that any fluid accidentally ejected from a hydraulic system flows away normally and does not accumulate, otherwise the risk of splitting the emulsion exists and the formation of separated oil will be a flammable layer of material.

**8.2 Water-in-Oil Emulsions (Category HFB)**

- 8.2.1 Monitor and maintain the water content of the fluid within specified limits to avoid a reduction in fire resistancy, and to not produce unacceptable changes in fluid viscosity.
- 8.2.2 It may be advisable in some installations to leave the fluid circulating in the hydraulic circuit during extended periods of inoperation to avoid stratification of the two major phases: water and oil.

**8.3 Water Glycol (Category HFC)**

- 8.3.1 Monitor and maintain the water content of the fluid within specified limits to avoid a reduction in fire resistancy and not produce unacceptable changes in the fluid viscosity. Follow specified instructions to determine the quantity of water to be added to the solution to restore water content.

**8.4 Anhydrous Synthetic Fluids (Category HFD)**

- 8.4.1 The same precautions that apply to mineral oils should also be accorded to HFD fluids.
- 8.4.2 The viscosity, acidity and contamination level of the fluid should be checked at regular intervals during use. Suppliers should provide information with regard to checking frequencies.
- 8.4.3 Avoid contamination with mineral oil as far as possible since the addition of such will impair the fire resistancy property.

**8.5** Information provided with regard to storage, handling, preparation, working temperatures, viscosity and installation of the hydraulic circuit for the various types of fire-resistant fluid selected should be followed.

**8.6** Use pure water, such as distilled, steam condensate or deionized water for make-up, to avoid introducing harmful metallic salts, lime, or other contaminants into the system.

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