

A Research Report
On
The Use of Fire Resistant Fluids in Underground Mining Equipment



By
Amritpal Singh Gosal
MASc. Student (Mechanical Eng.)
BASc. Mining and Mineral Process Engineering
Rm. 517 – 6350 Stores Road
University of British Columbia
Vancouver, BC
V6T 1Z4
Email: gosal@mech.ubc.ca

TABLE OF CONTENTS

1.0	INTRODUCTION	1
2.0	EXISTING REGULATIONS.....	3
2.1	British Columbia.....	4
2.2	Alberta.....	4
2.3	Saskatchewan.....	4
2.4	Manitoba.....	5
2.5	Ontario.....	5
2.6	Nova Scotia.....	5
2.7	Yukon Territories.....	6
2.8	Northwest Territories and Nunavut.....	6
2.9	The United States of America.....	7
2.10	Australia.....	7
2.10.1	New South Wales (Australia).....	7
2.10.2	Queensland.....	7
2.11	South Africa.....	8
3.0	DISCUSSION.....	9
4.0	SUMMARY.....	11
	Appendix A.....	12
	References.....	26
	Contacts.....	27

List of Tables

Table 1: Fire Resistant Hydraulic Fluids Comparative Performance Characteristics	1
Table 2: A Summary of Fire-Resistant Fluid requirements.....	3
Table 3: A comparison of cost (provided by Vic Castleton)	10

1.0 INTRODUCTION

Hydraulic equipment has a widespread use in underground mining. Mineral oil is generally used in hydraulic equipment as a medium for power transmission. The energized hydraulic fluid is under extreme pressure and, in case of a hose failure, can spray onto a hot surface, such as the exhaust piping, and result in a fire. In order to alleviate the risk of fire from hydraulic fluids in underground equipment, the British Columbia legislation requires that all hydraulic systems with a capacity greater than 10L use fire-resistant fluids (*HS&RC*, 4-26).

Loudon (1981) gives a good overview of the fire resistant hydraulic fluids used in Australia in the early 1980's, and serves as a general background. There were six types listed in descending order with water-glycol fluids giving the best fire resistance:- **Water-glycol; Phosphate Ester; Water-in-Oil Emulsion; Oil - Synthetic Blends (dependent on the phosphate content); Synthetic Fatty Acid Esters; and Mineral Oil.** For convenience Table 1 lists the various fire resistant hydraulic fluids outlining comparative performance characteristics; however, it must be pointed out that these are broad generalisations.

TYPE OF HYRDAULIC FLUID	PET. HYD. OIL	WATER-GLYCOL	PHOS. ESTER	OIL SYN. BLEND	OIL IN WATER EMULSION	SYN. FATTY ACID ESTER
Property or Performance Characteristics						
Fire Resistance:	P	E	G	F	F	F to P
Viscosity - Temp. Properties	G	E	F	F to G	G	E
Seal Compatibility:	G	E	F	F	G	G
Lubricating Quality:	E	F to G	E	E	F to G	G
Temp. Range °C Max.:	65	50	65	65	50	65
Relative Cost:	1	2.5-3.0	5	3.0-4.0	1.5-2.0	3.0-4.0
KEY: E – Excellent; G – Good; F- Fair; P – Poor						

Table 1: Fire Resistant Hydraulic Fluids Comparative Performance Characteristics

This report examines the regulatory requirements of various legislations from around the world, governing the use of hydraulic fluids and fire-suppression methods, and concludes with a discussion based on site visits at two BC mining operations: Myra Falls and Quinsam Coal..

2.0 EXISTING REGULATIONS

Several Canadian and international regulations are shown below in Table 1. Most of the following information was obtained from the Internet. The links to the specific web-locations are also listed in the following sections.

Table 2: A Summary of Fire-Resistant Fluid requirements

Country	Province/State	U/G Coal Mines	U/G Non-Coal Mines
Canada	BC	Yes	Yes
Canada	AB	Yes <i>Presently, no operating u/g coal mines in AB</i>	-
Canada	SK	-	Yes unless <i>fire-suppression deemed safe by inspector is used</i>
Canada	MB	-	No <i>With Fire-suppression on equipment with >100L fluid capacity</i>
Canada	ON	-	No <i>With Fire-suppression on equipment with >100L fluid capacity</i>
Canada	NS	<i>No</i> <i>With Fire-suppression on equipment with >100L fluid capacity</i>	No <i>Fire-suppression on equipment with >100L fluid capacity</i>
Canada	YT	-	No <i>If fire suppression is used</i>
Canada	NT and NU	-	No <i>If fire suppression is used</i>
USA	Federal	Yes on unattended equipment & No <i>If fire-suppression is used on attended equip.</i>	No
Australia	Queensland	No but require risk assessment to ensure suitability for use	-
Australia	NSW	Yes	-
South Africa	-	?	No

2.1 **British Columbia**

The regulation is entitled “Fire-resistant Fluids” and can be found in section 4.8.3 of *Health, Safety and Reclamation Code for Mines in British Columbia*. It states that all underground equipment with hydraulic systems of a capacity greater than 10L must use fire-resistant hydraulic fluids (FRF’s) that meet the requirements of CSA Standard CAN/CSA-M423-M87, Category 1 or 2. Engine hydraulic systems such as hydraulic valve-lifters, hydraulic cooling fan drivers, lubricating systems, fuel-injection systems, torque converters, transmissions, axles and braking systems with enclosed friction elements immersed in a liquid coolant and with hydraulic systems independent of other hydraulic systems are exempt from the rule (4-26).

2.2 **Alberta**

Under ground coal mining regulations of Alberta require all equipment to use FRF’s that meet the CAN/CSA-M423-8M87 standards. The regulation explicitly states *underground coal mines*, but there is no reference made to non-coal underground mines.

42(f) equipment that is brought into an underground coal mine after March 31, 1999 except for axles, fluid couplings and brake systems, use fire resistant hydraulic fluids that conform to CAN/CSA - M423-8M87

The regulation is available at: http://www.qp.gov.ab.ca/documents/regs/1995_292.cfm.

In underground coal mines, no flammable liquid in excess of 700-litres may be stored in a mine except in a fireproof chamber (42(a)).

2.3 **Saskatchewan**

Saskatchewan requires that all equipment operating underground shall use FRF’s.

However, if approved by the chief inspector, *an integrated fire-suppression system* may be used instead, if it provides an equal *degree of protection*.

416.24(1) The employer at a mine shall ensure that ...all hydraulic fluids shall be of a fire-resistant type acceptable to the chief inspector and where this is not reasonable practicable, the chief inspector may approve the use of an integrated fire-suppression system that would give an equivalent degree of protection to workers.

<http://www.qp.gov.sk.ca/documents/English/Regulations/Regulations/SR284-78.pdf>

Flammable fluids (other than fuel) not exceeding seven-days of consumption can be stored underground in Saskatchewan (416.22(1)(c)).

2.4 Manitoba

Similar to Ontario, the Manitoba regulations allow the use of flammable hydraulic fluids in underground mines provided the equipment is fitted with a fire-suppression system.

The regulations state:

“49(2) An employer shall provide and maintain a fire suppression system consisting of sprinklers, foam or other means of suppressing a fire on each piece of equipment containing more than 100 litres of flammable hydraulic fluids;”

<http://web2.gov.mb.ca/laws/regs/pdf/w210-228.94.pdf>

Manitoba permits storage of no more than seven days of supply of lubricating or hydraulic oils underground (section 50(3) (b)).

2.5 Ontario

Although the exact regulations about the use of hydraulic fluids in underground equipment were not found, an inference may be made that Ontario does not require that only fire-resistant fluids be used underground. The regulation states:

“28(2)(a)(i) A fire suppression system consisting of sprinklers, foam or other suitable means of suppressing fire shall be provided,

(a) in an underground mine,

(i) on equipment containing more than 100 litres of flammable hydraulic fluids,....”

http://192.75.156.68/DBLaws/Regs/English/900854_e.htm

Any area where more than 500-litres of flammables are stored, must have a fire suppression system (28(2)(a)(ii)).

2.6 Nova Scotia

The following excerpts were provided by Mr. Pleman G. Woodland, and are taken from a draft of the proposed new legislation of Nova Scotia.

102(1) An employer shall ensure that flammable material

(a) when being used underground are transported and stored in metal containers or plastic containers for petroleum fuels as specified in CSA standard B376-M1980, "Portable Containers for Gasoline and Other Petroleum Fuels"; and

- (b) are kept in a storage area in a quantity no greater than,
 - (i) in the case of a flammable liquid with a flashpoint below 52° C, enough for the current day's work,
 - (ii) in the case of fuel oil, enough for seven days work, and
 - (iii) in the case of other flammable liquids with a flashpoint of 52° C or above, enough for 30 days work.

And regarding the use of hydraulic fluids underground, the rules are similar to the legislation of Ontario:

- 100(4)** An employer shall provide an adequate fire suppression system
- (a) at the places referred to in clauses (c) and (d);
 - (b) at a shop and service garage that are
 - (i) located underground, and
 - (ii) not constructed of non-combustible material;
 - (c) fuelling station, fuel oil transfer system and battery charging station that are located underground;
 - (d) on a main fan, where the main fan is located underground;
 - (e) a booster fan; and
 - (f) on equipment underground containing more than 100 l of flammable fluids.

2.7 Yukon Territories

The mining regulation of YT exempts underground equipment with an approved fire-suppression system from requirement to use FRF's. All other equipment with a capacity exceeding 11-litres must use FRF's (Section 155). The web-address for the regulations is: <http://wcb.yk.ca/acts/ohsregs/mining.pdf>.

2.8 Northwest Territories and Nunavut

There is no reference made to fire-resistant fluids in the regulations of NT and Nunavut, which can be found at:

<http://www.wcb.nt.ca/Legislation/MineAct/PDFdocuments/NWT%20Mine%20Health%20and%20Safety%20Regs.pdf>

However, in the fire suppression section of the Mine Act, "mining equipment that could present a fire hazard" is required to have a multi nozzle fire suppression system installed.

“10.42. (1) Mining equipment, that could present a fire hazard, shall be fitted with a multi-nozzle fire suppression system in the fire hazard area of the equipment.”

A supply of up to seven days of combustible fluids is allowed to be stored underground (section 12.05.(b)).

2.9 The United States of America

This information was provided by Mr. Thomas Brady and Mr. Floyd Varley, who work for the Center for Disease Control (CDC). In the United States, any hydraulic fluid can be used in non-coal mines. For equipment used in underground coal mines, the rules require the use of fire-resistant fluids on all unattended equipment and attended equipment without an approved fire suppression system (<http://www.msha.gov/regdata/msha/75.1107-1.htm>). All of the mining regulations can be accessed from <http://www.msha.gov/REGDATA/MSHA/0.0.HTM>. A list of the approved FRF's may be located in Appendix A and at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydflld.pdf>.

2.10 Australia

2.10.1 New South Wales (Australia)

Coal Mines (Underground) Regulations 1999

125 A mine mechanical engineer must ensure that all hydraulic oil or fluid used underground at the mine for the following purposes is of a fire resistant type:

- (a) hydraulic braking systems of vehicles where the friction surfaces are designed to operate in a dry state,
- (b) fluid couplings and hydraulic torque converters except where designed to operate integrally with an oil gearbox,
- (c) hydraulic self-advancing roof supports used in connection with longwall or shortwall faces,
- (d) any other specified purpose

This regulation can be accessed via the following link:

<http://www.legislation.nsw.gov.au/fragview/inforce/subordleg+433+1999+pt.7-div.2-sec.125+0+N>.

Other regulations are available through a “Browse A-Z” listing at:

<http://www.legislation.nsw.gov.au/maintop/scanact/inforce/NONE/0>.

2.10.2 Queensland

The Coal Mining Safety & Health Regulations 2001 under the Coal Mining Safety & Health Act of 1999 does not appear to specifically mention use of hydraulic fluids but in

use of vehicles (Part 8, Division 4, Section 260) it requires a risk assessment to be made prior to use to ensure suitability of use of the vehicle underground. This could be construed to include consideration of any hazards from the use of hydraulic fluids.

This can be accessed through www.ugcoal.ca (secure site).

2.11 South Africa

The regulations were not found for South Africa, but a source at EJC Loaders (Burlington) assures that there is no requirement for the use of FRF's in underground mines in SA. EJC is a manufacturer of underground equipment and is producing units for the South African market. Mr. Patrick Murphy, who is the R&D engineer at EJC Loaders, provided this information.

3.0 DISCUSSION

Fire safety is a great concern in underground mining, where because of an enclosed environment, toxic gases, as a by-product of a fire, can lead to disastrous consequences. All equipment utilizing hydraulic fluids may add to the hazard if adequate preventative measures are not made available.

After talking to the personnel at the two aforementioned BC mines and with Mr. Vic Castleton (*Manager- Sales and Engineering at Fuchs Lubricants*), certain practical facts about the fire-resistant fluids were discovered. Quinsam Coal uses *Aquacent Light*, which is an invert-emulsion. The primary advantage of using this and similar fluids is the apparent fire-resistive properties because of water being the base ingredient. The disadvantages, according to the mine personnel, are significantly shortened life of hydraulic components resulting from a poor lubricating ability and increased cost incurred in purchasing such fluids and maintaining the equipment. Myra Falls uses *Glycent 46*, a water-solution. Although *Glycent 46* has better lubricating qualities than *Aquacent Light*, it is still not as good a lubricant as mineral oil. Therefore, the result of using it in hydraulic equipment is again reduced component life and increased cost incurred in downtime and maintaining the equipment. The cost to purchase *Glycent 46* is significant: on average, *Glycent 46* costs over twice that of mineral oil. Furthermore, it has to be disposed of separately at waste disposal facilities that accept such fluids. It cannot be mixed with other lubricating or hydraulic mineral oils at disposal, all of which translates to a higher cost of handling and disposing. Most importantly, *Glycent 46* is not compatible with the hydraulic seals installed by the equipment manufacturers. Before *Glycent 46* can be used in a piece of equipment, the machine has to be refitted with new seals, which also demands a significant cost in terms of new materials and maintenance man-hours. Approximate cost of mineral oil, *Aquacent Light* and *Glycent 46*, as suggested by *Fuchs Lubricants Canada*, is tabulated in Table 2. Note that the aforementioned operations obtain their hydraulic fluids from *Fuchs Lubricants*.

Table 3: A comparison of cost (provided by Vic Castleton)

Fluid Type	Mineral Oil	Aquacent Light	Glycent 46
Cost: \$/L	\$1.50	\$1.56	\$3.26

A meeting was held with Mr. Vic Castleton to obtain additional information about FRF's. He believes that an invert-emulsion fluid, like Aquacent Light, is a good replacement for mineral oil, as it can provide similar protection from wear. He suggests that if diligent maintenance practices are established, there will be no loss of component life even when FRF's are used. According to a study conducted by him, when he compared two BC mines using FRF's, the mine practising fluid changes every 1000-hours had a significantly lower maintenance cost than the other mine with no real maintenance system in place. As these FRF's have non-Newtonian viscosities, they do not behave well with extreme temperature fluctuations. A reliable temperature range of operation of these fluids is about -10°C to 60°C, varying again with the type of FRF. According to Mr. Castleton, a well maintained hydraulic system in an underground environment should operate below 55°C, a point with which the mine maintenance people would disagree.

BC has prescribed the use of fire-resistant fluids in all underground mines since 1975. This was a result of the aftermath of a mining fire disaster in Kellogg, Idaho on May 02, 1972, where 91 lives were lost. By removing *flammables* from underground, it was thought that such an incident could be prevented from occurring in BC mines. Since 1975, significant changes promoting fire-safety have been introduced in the design of mining equipment – the most significant of which is the advent of fire-suppression systems. The legislation has been also changed to further render the equipment fire-safe by requiring all electrical wiring to be shielded (Section 4.9.26).

Since that time other legislative jurisdictions have developed in this regard such that now USA, Saskatchewan, Manitoba, Ontario and more recently, Nova Scotia and Queensland have moved away from mandatory use of fire-resistant hydraulic fluids. In part this reflects evolving industry practices such as routing all hydraulic piping in such a way that in case of a rupture, the fluid would not spray directly onto a hot exhaust component or the engine or such.

4.0 SUMMARY

As was found in the research for this report, most regulatory bodies from around the world deem the use of fire-suppression systems sufficiently safe to negate the use of fire-resistant fluids. In the United States, where the incident that brought about the changes to the BC hydraulic fluid requirements took place, non-coal mines are not required to use fire-resistant fluids. The mining regulations of the United States require that fire-resistant fluids must be used only on unattended equipment in coal mines, whereas attended equipment with an approved fire-suppression system is allowed to use the conventional, mineral-hydraulic fluid. In order to allow the mines in BC to operate profitably and to stay competitive in the global industry of mining, and to rejuvenate the industry in this province, the mine-personnel at the aforementioned operations feel that Part 4.8.3 of the Health, Safety and Reclamation Code should be removed.

It is concluded that based on the fact that other Canadian and international jurisdictions have moved away from mandatory use of fire-resistant hydraulic fluids to reflect improving industry practice and in favour of mandatory fire suppression systems where flammable hydraulic fluids are used, then British Columbia could benefit in similar ways by adopting such a change.

Appendix A

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>.

United States Department of Labor
M S H A
Mine Safety and Health Administration

COMMERCIALLY AVAILABLE FIRE-RESISTANT HYDRAULIC FLUIDS
APPROVED BY MSHA UNDER CODE OF FEDERAL REGULATIONS
TITLE 30, PART 35

ORINATION OFFICE:

Mine Safety and Health Administration
Approval and Certification Center
Materials and Explosion Testing Branch
Box 251, Industrial Park Road
Triadelphia, West Virginia 26059

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
Amoco Oil Company 200 East Randolph Chicago, IL 60680	30-12-1 Amoco FR Fluid WO Date Approved: 4/2/71 Invert Emulsion
BASF Wyandotte Corporation P.O. Box 181 Parsippany, NJ 07054	30-42-1 WGF 200D Date Approved: 2/7/74 Water-glycol
	30-42-2 WGF 200E Date Approved: 5/22/75 Water-glycol
	30-42-3 Plurasafe P-1000 Date Approved: 7/18/84 HWBF Concentrate
	30-42-4 Plurasafe P-1000 Date Approved: 7/16/84 HWBF Concentrate
	30-42-5 Plurasafe P-1200 Date Approved: 7/18/84 HWBF Concentrate
	30-42-6 Plurasafe P1200/P1400 Date Approved: 7/18/84 HWBF Concentrate
	30-42-7 Plurasafe P1210 Date Approved: 3/13/85 HWBF Concentrate
Century Lubricants Co. 2140 South 88th Street Kansas City, KS 66111-8701	30-4-1 Hulsafe 600 Date Approved: 6/6/72 Invert Emulsion
	30-4-2

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
	Soluble Oil 40 Date Approved: 6/28/79 HWBF Concentrate
Century Lubricants Co. 2140 South 88th Street Kansas City, KS 66111-8701 (Continued)	30-4-3 Aquacent Heavy Hydraulic Fluid Date Approved: 5/28/80 Invert Emulsion
	30-4-4 Phosphate Ester NTP Hydraulic Fluid Date Approved: 5/28/80
	30-4-5 Solcenic 2 Hydraulic Fluid Date Approved: 5/28/80 HWBF Concentrate
	30-4-6 Solcenic 3-A Hydraulic Fluid Date Approved: 5/28/80 HWBF Concentrate
	30-4-7 Solcenic 4 Hydraulic Fluid Date Approved: 6/9/80 HWBF Concentrate
	30-4-8 Solcenic 7 Hydraulic Fluid Date Approved: 5/28/80 HWBF Concentrate
	30-4-9 Solcenic 3B Longwall Fluid Date Approved: 3/3/89 HWBF Concentrate
	30-4-11

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
	Solcenic 2B Date Approved: 3/5/90 HWBF Concentrate
	30-4-12 Solcenic 2B-W Date Approved: 4/24/91 HWBF Concentrate
Century Lubricants Co. 2140 South 88th Street Kansas City, KS 66111-8701 (Continued)	30-4-13 Solcenic 801E Storage Fluid Date Approved: 1/22/92
	30-4-14 Solcenic HL Date Approved: 5/5/92 HWBF Concentrate
	30-4-15 Solcenic Ecosyn 2001 Date Approved: 10/18/94 HWBF Concentrate
	30-4-16 Solcenic Ecosyn 2002 Date Approved: 10/18/94 HWBF Concentrate
	30-4-17 Solcenic Ecosyn 2003 Date Approved: 10/18/94 HWBF Concentrate
	30-4-18 Solcenic Ecosyn 3002 Date Approved 10/18/94 HWBF Concentrate
	30-4-19 Solcenic Ecosyn 3010 Date Approved: 3/21/95 HWBF Concentrate
	30-4-20 Solcenic 2B-DF Date Approved: 4/14/95

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
	HWBF Concentrate
	30-4-21 Solcenic 3B-DF Date Approved: 4/14/95 HWBF Concentrate
	30-4-22 Ecosyn 2001-DF Date Approved: 4/14/95 HWBF Concentrate
Century Lubricants Co. 2140 South 88th Street Kansas City, KS 66111-8701 (Continued)	30-4-23 Solcenic Ecosyn 3050 Date Approved: 4/23/96 HWBF
	30-4-24 Solcenic Ecosyn 3060 Date Approved: 4/25/96 HWBF Concentrate
	30-4-25 Solcenic Ecosyn 2000 M Date Approved: 9/2/97 HWBF Concentrate
	30-4-27 Solcenic 2012 Date Approved: 11/20/98 HWBF Concentrate
Chempet Corporation 1750 Armitage Court Addison, IL 60101	30-52-1 Chempet FRF 3300 Date Approved: 9/3/81 Invert Emulsion
Chrysler Corporation 5437 West Jefferson Avenue Trenton, MI 48183	30-46-1 L-799 Date Approved: 2/28/75 Invert Emulsion
Cincinnati-Vulcan Company, Inc. 5353-5363 Spring Grove Avenue Cincinnati, OH 45217	30-39-1 Vulcan FR Fluid Date Approved: 11/29/72 Invert Emulsion

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
Cities Service Tech. & Computer Center 4500 South 129 East Avenue Tulsa, OK 74102	30-16-1 Citgo Glycol FR 40XD Date Approved: 1/16/73 Water-glycol
Conoco, Inc. P.O. Box 2197 Houston, TX 77001	30-32-2 Conoco Hy-Chock Oil Date Approved: 4/26/78 HWBF Concentrate
	30-32-3 Conoco FR Hydraulic Fluid Date Approved: 8/12/80 Invert Emulsion
D.A. Stuart Oil Company of America 7575 Plaza Court Willowbrook, IL 60521	30-13-1 Stuart's Dasco IFR Hydraulic Fluid Date Approved: 10/2/61 Invert Emulsion
	30-13-2 Stuart's Dasco IFR Hydraulic Fluid Base Date Approved: 10/2/61 Invert Emulsion Base
D.A. Stuart Oil Co. Of America 7575 Plaza Court Willowbrook, IL 60521 (Continued)	30-13-3 Isosynth VX 110 BF2 Date Approved: 6/4/93 HWBF
	30-13-4 Hydraulid Fluid Concentra Isosynth VX 110 BF5 Date Approved: 7/28/98
	30-13-5 Hydraulic Fluid Concentrate Isosynth VX 110 BF5 Date Approved: 05/04/00

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

Company

Houghton International Inc.
Madison and Van Buren Avenues
Valley Forge, PA 19482

Product

30-21-3
Houghto-Safe 5046W
Date Approved: 10/16/73
Invert Emulsion

30-21-5
Cosmolubric HF-130
Date Approved: 12/14/83
Synthetic Ester

30-21-6
Hydrolubric 141-M
Date Approved: 12/14/83
HWBF Concentrate

30-21-7
Hydrolubric 120-M
Date Approved: 12/14/83
HWBF Concentrate

30-21-8
Hydrolubric 120-B
Date Approved: 12/14/83
HWBF Concentrate

30-21-9
Cosmolubric B-230
Date Approved: 12/17/96
Natural Ester

30-21-10
Hydrolubric 123-M
Date Approved: 09/28/00
HWBF Concentrate

E/M Lubricants Inc.
P.O. Box 2200
Highway 52 North West
West Lafayette, IN 47906

30-47-1
RFR-150
Date Approved: 9/10/75
Invert Emulsion

Exxon Company USA
P.O. Box 2180
Houston, TX 77001

30-10-2
Firexx I
Date Approved: 11/27/72
Invert Emulsion

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydflid.pdf>

<u>Company</u>	<u>Product</u>
	30-10-3 Firexx 95/5 Date Approved: 9/15/81 HWBF Concentrate
Exxon company USA P.O. Box 2180 Houston, TX 77001 (Continued)	30-10-4 Firexx M 95/5 Date Approved: 2/10/88 HWBF Concentrate
Far Best Inc. 1401 Greenleaf Avenue Elk Grove Village, IL 60007	30-51-1 FR 40 M Date Approved: 11/20/79 Invert Emulsion
Gulf Research and Development Company P.O. Drawer 2038 Pittsburgh, PA 15230	30-7-7 Gulf FR Fluid LS 6914 Date Approved: 11/12/75 Invert Emulsion
Keenan Oil Company 2350 Seymour Avenue Cincinnati, OH 45212	30-38-1 KFR-R1 Date Approved: 6/16/72 Invert Emulsion
	30-38-2 KFR-RZ Date Approved: 11/15/72 Invert Emulsion
	30-38-3 KFR-RA Date Approved: 11/15/72 Invert Emulsion
Lubrication Engineers, Inc. P.O. Box 16447 Wichita, KS 67216	30-44-2 6455 Monolec Date Approved: 4/21/77 Invert Emulsion
Lubrizol Corp. 29400 Lakeland Blvd. Wickliffe, Ohio 44092	30-54-2 Lubrizol 5662A, 5662B Date Approved: 6/23/87 HWBF Concentrate
	30-54-4 Microzol T30 Date Approved: 3/6/87

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
	HWB Fluid
	30-54-5 Microzol T46 Date Approved: 3/6/87 HWB Fluid
Lubrizol Corp. 29400 Lakeland Blvd. Wickliffe, Ohio 44092 (Continued)	30-54-6 Microzol T70 Date Approved: 3/6/87 HWB Fluid
	30-54-7 Longwall Concentrate 5665 Date Approved: 11/25/88
Lyondell Petrochemical Co. Div. of Atlantic-Richfield Co. 12000 Lawndale P.O. Box 2451 Houston, Texas 77252-2451	30-32-3 Arco Duro FR-HD Date Approved: 12/12/69 Invert Emulsion
	30-5-2 Emulsiplex Date Approved: 5/8/86 HWBF Concentrate
Mason Oil Company, Inc. Box 8343 Pittsburgh, PA 15218	30-24-1 Masol FR Mine Fluid Date Approved: 10/9/64 Invert Emulsion
Metalworking Lubricants Company 6785 Telegraph Road Suite 200 Birmingham, MI 48010	30-48-1 Metsafe IFR-100 Date Approved: 9/10/75 Invert Emulsion
Mobil Oil Corporation 3225 Gallows Road Fairfax, VA 22037	30-3-2 Mobilmet S-122 Date Approved: 1/21/81 HWBF Concentrate
	30-3-3 Mobilmet S-127 Date Approved: 1/21/81 HWBF Concentrate

The following list may be found at:
<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
	30-3-4 Pyrogard D Date Approved: 3/17/83 Invert Emulsion
	30-3-5 Hydrasol LW 18 Date Approved: 7/7/89 HWBF Concentrate
Nalco Chemical Company Metal Industries, Chemical 9165 Harbor Avenue Chicago, IL 60617	30-27-1 Fyre-Safe W/O Date Approved: 4/18/65 Invert Emulsion
Pennzoil Company-Industrial Department Reno Building P.O. Box 808 21 Seneca Street Oil City, PA 16301	30-19-2 Maxzol Soluble Date Approved: 7/79 HWBF Concentrate
	30-19-3 Maxmul FRP Date Approved: 6/5/86 Invert Emulsion
Piedmont Chemical Company P.O. Box 382 Bridgeville, PA 15017	30-45-1 Fire Resistant Hydraulic Fluid 300 Date Approved: 2/14/75 Invert Emulsion
National Petroleum Products North Urania Avenue Greensburg, PA 15601	30-55-1 NPP Date Approved: 4/21/87 Invert Emulsion
Quaker Chemical Corporation Conshohocken, PA 19428	30-20-1 Quintolubric 958-50 Date Approved: 12/17/63 Invert Emulsion
Quaker Chemical Corporation (continued)	30-20-2 Quintolubric 958-30 Date Approved: 11/19/65

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
	Invert Emulsion
	30-20-3 Quintolubric 822-450 Date Approved: 12/23/71 Synthetic
	30-20-4 Quintolubric 19-LWM Date Approved: 1/16/91 HWBF
	30-20-5 Quintolubric 814-01 Date Approved: 7/17/96 HWBF
Singer and Hersch P.O. Box 19 Sasolburg 9570 South Africa	30-53-1 Senfluid HF7 Date Approved: 6/16/83 HWBF Concentrate
Southwest Grease and Oil Company 1400 South Harrison Olathe, KS 66061	30-35-1 Code 18306 Date Approved: 3/13/72 Invert Emulsion
	30-35-2 Fire Resistant Hydraulic Fluid Code 8X120 Date Approved: 9/29/80 Invert Emulsion
Suntech, Inc. P.O. Box 1135 Marcus Hook, PA 19061	30-8-8 Sun Sol (X996-216) Date Approved: 8/6/81 HWBF Concentrate
	30-8-9 Sunsafe F (X196-143) Date Approved: 10/28/81 Invert Emulsion
Standard Oil Co. 200 Public Square Cleveland, Ohio 44114-2375	30-54-3 Staysol 19 Date Approved: 11/21/86 HWBF Concentrate

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
Texaco, Inc. Research and Technical Department P.O. Box 509 Beacon, NY 12508	30-9-2 1670 LWM/786 Sol. Oil D Date Approved: 12/4/86 HWBF Concentrate
	30-9-3 1666 LWM Date Approved: 6/26/89 Aquashield 18
	30-9-4 LMW Shield Storage Date Approved: 6/6/96
	30-54-2 LWM Concentrate 19 Date Approved: 6/23/87 HWBF Concentrate
Texas Refinery Corporation One Refinery Place Fort Worth, TX 76101	30-34-1 TRC Fire Resistant HD Date Approved: 7/13/71 Invert Emulsion
Tower Oil and Tech. Company 4300 Tripp Avenue Chicago, IL 60632	30-50-1 Safoil No. 22 Date Approved: 10/22/79 Invert Emulsion
	30-50-2 Safoil No. 33 Date Approved: 10/22/79 Invert Emulsion
Union Carbide Corporation Technical Center Saw Mill River Road Route 100C Tarrytown, NY 10591	30-15-1 UCON Hydrolube CC-732 Date Approved: 12/18/61 Water-glycol
	30-15-2 UCON Hydrolube CC-760 Date Approved: 12/18/61 Water-glycol
Union Oil Company of California	30-14-1

The following list may be found at:

<http://www.msha.gov/TECHSUPP/ACC/lists/35hydfld.pdf>

<u>Company</u>	<u>Product</u>
1650 E. Golf Road Schaumburg, IL 60196	Union FR Fluid Date Approved: 6/8/71 Invert Emulsion
Unocal Refining & Marketing Division Unocal Corporation 1650 East Golf Road Schaumburg, IL 60196-1088	30-10-3 Soluble Oil MS Date Approved: 9/15/81 HWBF Concentrate

References

Hiestad, R., *Fire Resistant Hydraulic Fluids, Rationale for Recommending Removal of Part 4.8.3, HS&R Code*, July 17, 2002

Castleton, V.W., *Practical Considerations for Fire-Resistant Fluids, Lubrication Engineer*, Vol. 54, No. 2, February 1998

Loudon B.J., *Fire Resistant Hydraulic Fluids in Industry Today*, ON Technical Manager, Paykel Oils and Chemicals (N.S.W.) Pty Ltd

Die Casting Bulletin, Issue No. 36, October, 1981

Contacts

Pleman Woodland

Mining Engineer
Nova Scotia Department of Environment and Labour
Occupational Health and Safety Division
P.O. Box 697, Halifax, NS
B3J 2T8
Ph: (902) 424-0451, Fax: (902) 424-5640
E-mail: woodlapg@gov.ns.ca

Vic Castleton

Manager – Sales and Engineering
19829 – 99A Avenue
Langley, BC
V1M 3G4
Ph: (604) 888-1552, Fax: (604) 888-1145
E-mail: vcastleton@fuchs.ca

Kresho Galovich, P.Eng., C.Eng.

Principal Geotechnical Engineer
Director, Technical Services & Safety
Quinsam Coal Corporation
P.O. Box 5000
Campbell River, BC
V9W 5C5
Ph: (250) 286-3224 Ext. 238, Fax: (250) 286-9727
E-mail: qcc4@island.net