METALWORKING FLUIDS (MWF) ALL CATEGORIES 5524

DEFINITION: Metal-working fluids CAS: NONE RTECS: NONE

METHOD: 5524, Issue 1 **EVALUATION: PARTIAL** **Issue 1: 15 March 2003**

OSHA : no PEL
NIOSH: 0.4 mg/m^3 as thoracic particulate (0.5 mg/m^3 as total particulate)
ACGIH: no TLV

PROPERTIES: not defined: Fluids contain varying amounts of mineral oil, emulsifiers, water, alkanolamines, polyethoxyethanols, biocides, surfactants, pressure additives and boron compounds.

SYNONYMS: metalworking fluids (MWF), metal removal fluids, machining fluids, mineral oils, straight fluids, soluble fluids, synthetic fluids and semi-synthetic fluids

SAMPLING

SAMPLER: Thoracic particulate: FILTER + CYCLONE (tared 37-mm, 2-µm PTFE filter, + thoracic cyclone).
Total particulate: (tared 37-mm, 2-µm PTFE filter

FLOW RATE: thoracic- 1.6 L/min)
total- 2 L/min

VOL-MIN: 1000 L @ 0.4 mg/m^3 or 0.5 mg/m^3
-MAX: Not determined

SHIPMENT: routine

SAMPLE STABILITY: Refrigerate upon receipt at laboratory; analyze within 2 wks of collection

BLANKS: at least 5 field blanks per set

BULK SAMPLE: one for each fluid at each site for solubility testing

ACCURACY

RANGE STUDIED: 0.05 to 0.9 mg/sample

BIAS: not determined

OVERALL PRECISION ($\hat{S}_{rT}$): total weight 0.06
extracted weight 0.07

ACCURACY (Estimated): total weight 0.12
extracted weight 0.14

MEASUREMENT

TECHNIQUE: GRAVIMETRIC

ANALYTE: airborne metal working fluid

EXTRACTION: ternary Solvent: Dichloromethane: methanol: toluene (1:1:1)
binary Solvent: methanol:water (1:1)

BALANCE: 0.001 mg sensitivity; use same balance before and after sample collection

CALIBRATION: National Institute of Standards and Technology Class S-1.1 weights or ASTM Class 1 weights

RANGE: 0.05 to 2 mg per sample

ESTIMATED LOD: total weight- 0.03 mg per sample [7]
extractable - 0.03 mg per sample weight [7]

PRECISION ($\bar{S}_r$): total weight- 0.04 ($\geq$0.2mg/sample) [1]
extracted - 0.05 ($\geq$0.2mg/sample) weight [1]

APPLICABILITY: The working range is 0.050 to 2 mg/sample for a 1000-L air sample. The total weight procedure permits an estimate of the total particulate aerosol, including nuisance dust, airborne metal particulate and metal working fluid. If the extraction procedure is used, the technique permits an estimate of the total metal working fluid to which the worker is exposed. The method is applicable to all metal working fluids- straight, soluble, synthetic, and semi-synthetic as long as they are soluble in the extraction solvent [1,2]. Only one MWF (Glacier, Solutia Inc.) has thus far been found to be insoluble in the ternary extraction solvent. However, that MWF is soluble in the binary blend. Tests have shown that the binary solvent in combination with the ternary solvent is effective in extracting this fluid. [8].

INTERFERENCES: None identified. However, any material collected on the filter and soluble in the extraction solvents may interfere with the analysis.

OTHER METHODS: This method is similar to Method 0500 for Particulates Not Otherwise Regulated [3]. This method replaces Method 5026 which employs infrared analysis for mineral oil mist [4].

REAGENTS:

1. Dichloromethane, distilled-in-glass.
2. Methanol, distilled-in-glass.
3. Toluene, distilled-in-glass.
4. Water, filtered, double deionized
5. Calcium sulfate, desiccant.
6. Ternary solvent blend*: Mix equal volumes of dichloromethane, methanol, and toluene in a clean dust-free container. Use a bottle with a screw cap (e.g. a clean, empty solvent bottle): Mix the solvents by gentle swirling, not by violent shaking.
7. Binary solvent blend* : Mix equal volumes of methanol, and water in a clean dust-free container. Use a bottle with a screw cap (e.g. a clean, empty solvent bottle): Mix the solvents by gentle swirling, not by violent shaking

* See SPECIAL PRECAUTIONS

EQUIPMENT:

1. Sampler: 37-mm PTFE, 2-µm pore size membrane filter and supporting pad in 37-mm cassette filter holder. Use a 2-piece (closed-face) cassette for sampling total particulate; For sampling thoracic particulate, use a 3-piece cassette with thoracic cyclone (BGI, Inc. Cat. No. GK2.69 or equivalent).
2. Personal sampling pump, 1.6 to 2 L/min, with flexible connecting tubing.
3. Microbalance, capable of weighing to 0.001 mg.
4. Static neutralizer: e.g., ^{210}Po; replace nine months after the production date.
5. Forceps (preferably nylon or chrome-plated steel).
6. Extraction funnel (SKC.,Inc., Cat. No. 225-605 or equivalent).
7. Desiccator.
8. Wash Bottle, PTFE, for containing wash solvent.
9. Vials 20-mL, with leakproof PTFE-lined caps, for transporting bulk fluid samples and solubility testing.
10. Syringe, gas-tight with large bore needle, e.g.16-gauge needle.
11. Graduated cylinder 20 mL
12. Paper towels.
13. Metal screen for drying filters following extraction, approx. 1.5 ft square or other convenient size, (Pre-wash screen with ternary blend solvent and allow to dry.)

SPECIAL PRECAUTIONS: Dichloromethane is a suspect carcinogen. Handle all solvents in a fume hood. Use extreme caution when blending the solvents together. The heat of mixing can cause pressure to develop as the solvents are blended, e.g., blowing a stopper from a glass-stoppered container. Use a clean container sealed with a PTFE-lined screwcap.

PREPARATION OF FILTERS BEFORE SAMPLING:

1. Number the backup pads with a ballpoint pen and place them, numbered side down, in the filter cassette bottom sections.
2. Preweigh the filters by the weighing procedure given in step 3. Record the mean tare weight of sample filters, W_1 and field blanks, B_1 (mg).
3. Weighing procedure:
   a. Equilibrate the filters in an environmentally controlled weighing area or chamber for 1 hour.
   b. Zero the balance before each weighing.
   c. Using forceps, pass each filter over a static neutralizer. Repeat this step if the filter does not release easily from the forceps or attracts the balance pan. Static electricity can cause erroneous weight readings.
   d. Weigh each filter until a constant weight is obtained (two successive weighings within 10 µg). Record the mean of the last two weighings to the nearest microgram.
4. Assemble the filter in the 2- or 3- piece filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter cassette. Place a cellulose shrink band around the filter cassette, allow to dry and mark with the same number as the backup pad.

SAMPLING:

5. For collection of a thoracic sample, insert the cyclone at the inlet to the 3-piece cassette.
6. Calibrate each personal sampling pump with a representative sampler in line.
7. For thoracic measurements, sample at 1.6 L/min for 8-hrs.
   For total particulate measurements, sample at 2 L/min for 8 hrs.
   Do not exceed a total filter loading of approximately 2 mg.
   NOTE: In order to test the extraction step of the analytical procedure, obtain a sample of the pure uncut bulk metal-working fluid (MWF) for solubility testing. Place this sample in a small (10-mL) leakproof container that is sealed with a leakproof PTFE-lined screwcap.
7. Submit at least five blank filter samples as field blanks for each set of samples collected per day. Handle these in the same way as the field samples; i.e., open each in a non-contaminated environment, then close the sampler and ship it to the lab along with the rest of the samples.
9. Refrigerate all samples that are to be stored overnight (or longer) prior to shipment to the laboratory. Ship all samples to the laboratory via overnight express delivery service.
10. Refrigerate the samples immediately upon receipt at the lab until ready for analysis.
11. Analyze the samples within two weeks of receipt at the laboratory.

SAMPLE PREPARATION AND MEASUREMENT:

10. Solubility test of bulk MWF**:**
    a. Shake the container of bulk MWF to assure that a homogeneous sample is obtained.
    b. Place 10-mL of the ternary solvent blend in a 20-mL scintillation vial.
    c. Using a large-bore gas-tight syringe; inject 50 µL of the bulk MWF into the ternary solvent blend. Cap the vial and shake as necessary to dissolve the MWF. The fluid is soluble if the resulting solution is clear and free of precipitates and phase separation.
    d. If the MWF is soluble in the ternary blend, the samples can be extracted with the ternary blend . A list of MWF evaluated for solubility thus far is given as an APPENDIX to this method and also at the NIOSH Manual of Analytical Methods website: (http://www.cdc.gov/niosh/nmam/nmampub.html)
11. Wipe dust from the external surface of each filter cassette (containing either samples or blanks) with a moist paper towel to minimize contamination. Discard the paper towel.
12. Remove the top and bottom plugs from the filter cassette. Equilibrate the filters (in the cassettes) for no more than 2 hrs in a desiccator that employs calcium sulfate.
13. Remove from the desiccator. Equilibrate for 1 hr in the balance room.
14. Remove the cassette band, pry open the cassette, and remove the filter gently to avoid loss of sample.
    NOTE: If the filter adheres to the underside of the cassette top, very gently lift it away by using the dull side of a scalpel blade. This must be done carefully or the filter will tear.
15. Weigh and record (steps 3 b-d)the post-sampling weight of each filter, W_2 (mg) and blanks B_2 (mg). Record anything remarkable about the filter (e.g., overload, leakage, wet, torn, etc.)

CALIBRATION AND QUALITY CONTROL:

16. Zero the microbalance before all weighings. Use the same microbalance for weighing filters before and after sample collection. Maintain and calibrate the balance with National Institute of Standards and Technology Class S-1.1 or ASTM Class 1 weights.
17. Process three tared media blanks through the measurement process for total particulate and the extractables.

EXTRACTION:

18. General guidelines (see NOTE below):
    If the weights of samples exceed the amount expected to be collected at the REL, e.g. 0.4 mg (thoracic) or 0.5 mg (total particulate) for a 1 m^3 air sample, extract the samples and blanks as follows:
    NOTE: Samples weighing < 0.4 to 0.5 mg (for a 1 m^3 sample) may be extracted as desired. The

reason that the cutoffs of 0.4 and 0.5 mg (per 1000 L sample) have been specified is to assure simple compliance with the standard. If the gross sample weight indicates that the standard has not been exceeded, there may be no reason to extract the sample. Otherwise, the usefulness of any extraction data obtained at levels < 0.4 to 0.5 mg per sample is guided by the quantitation limit (LOQ) of the extraction procedure. Extraction data obtained at levels between the LOD and the LOQ of the extraction procedure should be used with appropriate caution.

a. Place each filter (membrane side up) in the filter funnel assembly connected to the vacuum source.
b. Pour one 10-mL aliquot of the ***ternary solvent*** down the inside of the funnel over the filter. Allow solvent to drain by gravity.
c. Pour one 10-mL aliquot of the ***binary solvent*** down the inside of the funnel over the filter. Allow solvent to drain by gravity.
d. Pour a second 10-mL aliquot of the ***ternary solvent*** down the inside of the funnel over the filter. Allow at least 30 seconds of contact time. Remove the solvent under slight vacuum. Wash the inner wall of the filter funnel with 1-2 mL of the ternary blend contained in a PTFE wash bottle. Remove the solvent under slight vacuum.
e. Turn off the vacuum to the filter funnel.
f. Carefully, remove the filter from the filter funnel, place it on the clean metal screen, and allow to dry on the metal screen for 2 hours in a fume hood. Do not remove the filter from the funnel while vacuum is applied or the filter may delaminate.

NOTE: One fluid, Glacier (Solutia Chemical, St Louis), was insoluble in the ternary blend but was soluble in the binary blend. Tests have shown that this fluid is efficiently extracted from the filters using steps 18 a - e.

19. Weigh each filter, including field blanks (using steps 3 a-d). Record the post-extraction weight, W_3 (mg) of the extracted sample filters and B_3 (mg) for the extracted blank filters. Record anything remarkable about the extracted filter (e.g, torn, wet, delamination etc.)

CALCULATIONS:

20. Calculate the concentration of total- or thoracic particulate, C (mg/m^3), in the air volume sampled, V (L):

$$C = \frac{(W_2 - W_1) - (B_2 - B_1) \cdot 10^3 L/m^3}{V}, (mg/m^3)$$

where: W_1 = mean tare weight of filter before sampling (mg)(step 3)
W_2 = mean post-sampling weight of sample-containing filter (mg)(step 15)
B_1 = mean tare weight of blank filters (mg) (step 3)
B_2 = mean post-sampling weight of blank filters (mg) (step 15)

21. Calculate the concentration of extracted MWF aerosol C_{MWF} (mg/m^3), in the air volume sampled, V (L):

$$C_{MWF} = \frac{(W_2 - W_3) - (B_2 - B_3) \cdot 10^3 L/m^3}{V}, (mg/m^3)$$

where: W_2 = mean post-sampling weight (pre-extraction weight) of sample-containing filter (mg)(Step 15)
W_3 = mean post-extraction weight of sample-containing filter (mg) (step 19)
B_2 = mean post-sampling weight of blank filters (mg) (step 15)
B_3 = mean post-extraction weight of blank filters (mg) (step 19)

22. Report the concentration C as total- or thoracic particulate weight; report the concentration C_{MWF} as the weight of the MWF aerosol.

EVALUATION OF METHOD:

The development of the ternary solvent used in this method is described in reference [1]. This method was initially tested with representative samples of straight, soluble, semi-synthetic, and synthetic metalworking fluids (MWF). Samples were spiked onto tared polytetrafluoroethylene (PTFE) membrane filters, stored overnight, and analyzed the following day. The samples were weighed, then the MWF was extracted from the filter with a 1:1:1 blend of dichloromethane:methanol: toluene. The extraction of all fluids from the filters was quantitative over the range 200 µg to 815 µg for the straight fluid, from 223 µg to 878 µg for the soluble fluid, from 51 µg to 189 µg for the semi-synthetic fluid, and from 102 µg to 420 µg for the synthetic fluid. For those weights of all four fluids spiked at levels ≥ 200 µg, the relative standard deviation was estimated to be 4% for the total weight procedure and 5% for the extraction procedure. If the sampling imprecision of 5% is included, these estimates become 6% and 7% respectively for the total weight and extraction procedures. Limits of quantitation, estimated from blanks carried through the entire analytical procedure, were 30 µg for the weighing technique and 60 µg for the extraction technique. No estimate of the bias was available. [2] The filters are dessicated to remove excess water, especially from water-based MWF samples.

In a more rigorous test of the method for a 79-plant survey [7], the average limits of quantitation were estimated to be 0.1 mg for both the total- and extracted- weight procedures. However, there was high variability in these estimates for the sites sampled. The upper 95% confidence limit for the LOQs for both the total weight- and extractable weight- measurements was 0.3 mg. In order to assess the effectiveness of the extraction step, a secondary extraction of the most heavily-loaded filters obtained in this survey was conducted; On average, < 5% of the sample weight was removed during the 2nd extraction, indicating that the majority of extractable material had been removed during the first extraction. Samples were refrigerated upon receipt at the laboratory [6, 7].

The fractions extracted (FE or weight extracted/weight of sample) were studied as a function of the four metalworking fluid types and three main work operations—grinding, milling, and turning. This evaluation indicated that FE generally decreased in the order: straight > semisynthetic or soluble > synthetic; the differences in the fractions extracted for the straight and the synthetic fluids were statistically significant only for the grinding operation at two sample levels tested.

During the 79-plant survey, the stability of quality assurance (QA) samples, spiked separately with a straight, a soluble, a semisynthetic, and a synthetic fluid indicated that the QA samples all lost weight according to simple linear decay equations. These decay equations were used to estimate the amounts expected to be reported for QA filters by the performing laboratory. For storage periods ranging from 17 to 26 days, the total weight of samples recovered for all QA samples were $\geq$80% of those expected from the decay equations. For these QA samples, the fractions extracted of all four fluid types were $\geq$ 0.90.

The binary solvent extraction step has been added to assure complete extraction of MWF components that may be incompletely removed by the ternary blend. In addition, the binary solvent extends the procedure to samples that contain ternary blend-soluble fluids co-mingled with ternary blend-insoluble fluids, e.g. Glacier. Tests of the extraction of five MWF (including Glacier) showed that extraction efficiencies using the ternary blend in combination with the binary blend were comparable to those reported in reference 1 using the ternary blend alone (FE > 90 % ;CV < 0.10) . The binary solvent extractant liquor obtained from the Glacier samples generally contained potassium and phosphorous at levels approximately expected for the mass spiked onto the filters. The binary solvent extracts of the four other test fluids were analyzed for sodium, potassium or boron marker elements. Sodium was present in the extract of the soluble fluid at > background levels. The boron marker was not detected in the extract from the semisynthetic fluid. The potassium marker was not detected in the extract from the synthetic fluid [8].

REFERENCES:

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[8] Glaser RA [2002]. Data Supporting a Provisional American Society for Testing and Materials (ASTM Method for Metalworking Fluids, Part 4: Modification of a Provisional ASTM Method for Metalworking Fluids (PS-42-97) to Enhance Extraction of Insoluble Materials, in preparation for submission to the ASTM,Journal of Testing and Evaluation (2002/3).

METHOD WRITTEN BY:

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APPENDIX

List of Metalworking Fluids that have been found to be soluble in the ternary blend. The individual fluids have been identified by type and manufacturer [6,7].

MANUFACTURER	TRADENAME	TYPE	SOLUBLE
All Power	KOOLMIST 77	Semi-synthetic	Yes
American Lubricants	All Purpose Cutting Oil	Straight	Yes
Americhem Corp	AM Cutting 2506 Oil	Straight	Yes
Angler Industries	Draw LT-1R	Synthetic	Yes
	Angler OIL Cut 121-M straight oil	Straight	Yes
Aqueous Cleaning Tech Inc	ACT 486 Cutting Coolant	Soluble	Yes
	ACT 734 Synthetic Coolant	Synthetic	Yes
Associated Chemists	ACI Templex 5950	Semi-synthetic	Yes
	ACI 4926 Carbide Grinding Fluid	Synthetic	Yes
	ACI 4920 Grinding Fluid	Synthetic	Yes
	ACI Templex 4966	Semi-synthetic	Yes
	ACI Templex 4929 Low Foam Grinding Fluid	Synthetic	Yes
	ACI 4931 Mach and Tap Fluid	Straight	Yes

Blaser Swisslube	BLASOCUT 4000 STRONG	Soluble	Yes
	Blasocut 2000 Universal	Soluble	Yes
Castrol	Castrol Meqqem Cob	Synthetic	Yes
	Clearedge 6519	Semi-synthetic	Yes
	Clearedge 6584	Semi-synthetic	Yes
	Drawfree 811 (Previously Iloform)	Soluble	Yes
	N100 Pale oil (Brass Oil)	Straight	Yes
	Safety Cool 407	Soluble	Yes
	Safety Cool 800	Semi-synthetic	Yes
	Syntilo 9951	Synthetic	Yes
	Syntilo 9954	Synthetic	Yes
Chemtrol Inc	CT-345-J	Semi-synthetic	Yes
Chevron	Chevron Met Working Fluid #503	Straight	Yes
Citgo Petroleum	Citgo Cutting Oil 205	Soluble	Yes
	Citgo Cutting Oil 425	Straight	Yes
	Citicool 22	Synthetic	Yes
	Citcool 33	Synthetic	Yes
CLC Lubricants	CLC Cut PX2 NS	Straight	Yes
	CLC Chem Finish 605	Straight	Yes
	CLC Chem Cut MX-CG	Straight	Yes
	Coolant 2224 Plus	Synthetic	Yes
	Chem Finish 605	Straight	Yes
Commonwealth Oil	Comminac 32 MAX	Straight	Yes
Cutting & Grinding Fluids Inc	CG 650 D	Soluble	Yes
	CG 5352 R	Straight	Yes
	CG 5352 RR	Straight	Yes
	Kool Kut 692	Soluble	Yes
DA Stuart Co	Dascool LN 231-78	Semi-synthetic	Yes
	Dascool 2223	Semi-synthetic	Yes
	Superkool 25 straight	Straight	Yes
	Surgrind 86	Synthetic	Yes
Die-Casting ID Corp	ID DUA Chem 202	Semi-synthetic	Yes
Diversy Corp	LUBRICOOLANT AC	Soluble	Yes
	LUBRICOOLANT 4D	Soluble	Yes
DoALL Co.	DoAll 80	Straight	Yes
	Kool All 940	Semi-synthetic	Yes
	Kool All 948	Semi-synthetic	Yes
ELF Lubricants North America Inc	Elfdraw S 13	Synthetic	Yes
Enterprise Oil Co	Duracut 130	Straight	Yes

ETNA Products	Master Draw B 942/I	Soluble	Yes
Fuchs Lubricants	Fuchs Velvesol 96	Soluble	Yes
	Lus-Co-Cut 570ST	Straight	Yes
	Lus-Co-Cut 514 CMP Straight oil	Straight	Yes
	Lus-Co-Cut 400 Straight oil	Straight	Yes
	Renodraw 419NC	Soluble	Yes
	Renocut 471 straight oil	Straight	Yes
	Shamrock LF	Soluble	Yes
	Ultracool 430	Synthetic	Yes
Hangsterfer's Lab Co	Hangsterfer's Hard Cut # 531	Straight	Yes
Houghton Intl	CUTMAX 570	Straight	Yes
	Cut Max TPO-46	Straight	Yes
	Hocut 787 H	Soluble	Yes
Intercon Enterprises	Jokisch W2-OP	Semi-synthetic	Yes
ITW Fluid Prod Group	Accu-Lube LB-2000	Straight	Yes
	Accu-Lube LB 3000	Straight	Yes
	Rustlick PB-10 Soluble	Soluble	Yes
	Rustlick WS 5050	Soluble	Yes
Lillyblad	DB BROMUS B water souble	Soluble	Yes
	DB Water Soluble oil D	Soluble	Yes
Lyondell Petrochemical	Transkut HD 200	Straight	Yes
Master Chemical	Trim E 190	Soluble	Yes
	Trim CE/CE	Soluble	Yes
	Trim O M287	Straight	Yes
	TRIMSOL	Soluble	Yes
	Trim Microsol 265	Soluble	Yes
	TRIMSOL Silicone Free	Soluble	Yes
Metalworking Lubricants	METKUT 20546-TX-40	Straight	Yes
Milacron	Cimstarr 60-LF	Semi-synthetic	Yes
	Cimstar 3700	Semi-synthetic	Yes
	Cimtech 100	Synthetic	Yes
	Cimstar Qual Star	Semi-synthetic	Yes
	Cimtap II		Yes
	Cimperial 1010	Soluble	Yes
	Cimperial 1011	Soluble	Yes
	Cimstar 55	Semi-synthetic	Yes
	Cimstar 540	Semi-synthetic	Yes
	Cimtech 400	Synthetic	Yes
	C10 TX	Soluble	Yes
Mobil Oil Corp	Mobil Mobilmet Omicron	Straight	Yes
	Mobil Mobilmet Nu oil	Straight	Yes
	Mobil Vascul 18F	Straight	Yes
	Mobilmet Alpha Straight Oil	Straight	Yes

	Mobilmet Omega	Straight	Yes
	Vacmul 281	Straight	Yes
	Mobil Hydraulic AW 68 Straight Oil	Straight	Yes
	Mobilmet Upsilon	Straight	Yes
	Vacmul 3A Honing oil/EDM	Straight	Yes
Monroe Fluid Tech Co	Prime Cut Soluble Oil	Soluble	Yes
Motor Oil Inc	Thredkut 99 cutting oil	Straight	Yes
	Kleercut CF	Straight	Yes
National Oil Products	National Oil Products 3115 cutting oil	Straight	Yes
	National Oil Products Supreme Soluble HD	Soluble	Yes
Oakite Products Inc	Oakite Controlant 650 NS	Synthetic	Yes
Ocean State Oil	Hycut 4 Straight Oil	Straight	Yes
	Neil Cut 570 Cutting straight oil	Straight	Yes
Perkins Products	Perkut 296-H	Straight	Yes
	Perkool 5005- EP	Semi-synthetic	Yes
Relton Corp	Relton A-9 Aluminum Cutting Fluid	Soluble	Yes
Rex Oil & Chemical Co	Titan Cutting Straight Oil	Straight	Yes
	Magic Cutting Oil	Straight	Yes
Richards Apex Prod. formerly G Whitefield Richards Co	Near-a-Lard # 62	Straight	Yes
Rock Valley Oil & Chemical Co	Rockpin Straight Oil	Straight	Yes
Solar Chem Co	Solar Cut	Synthetic	Yes
Solutia	**Glacier**	Synthetic	**No**
Spartan Chem Co.	COOLSPAR	Synthetic	Yes
Steco Corp	TAP Magic Aluminum	Semi-synthetic	Yes
	Tapmagic Extra Cuttng Fluid	Straight	Yes
Stirling Industries Division	Tufcut 316	Straight	Yes
	Raecut A-1	Straight	Yes
	16228 HONING OIL	Straight	Yes
Sunnen Products	Sunnen Honnig Oil MB 30-55	Straight	Yes
Tapmatic Corp	LPS Tapmatic Plus 2	Synthetic	Yes
Texaco	Texaco Sulfur Oil (Sultex)	Straight	Yes
	Texaco SultexF	Straight	Yes
	Texaco 2731 Almag Special	Straight	Yes
	Texaco 01659 rando HD 68 brass st oil	Straight	Yes

Trico Mfg	TriCool	Synthetic	Yes
Union Butterfield	Union Butterfield Tapping & Cutting Oil	Straight	Yes
Unocal Refining	Unocal Kooper Kut 11HD	Straight	Yes
US Oil Co Inc	Blanking Oil 250	Straight	Yes
	Alkut 810	Straight	Yes
	US Drawlube 1517	Straight	Yes
	Vanishing Oil 300	Straight	Yes
	Gem Soluble CP	Soluble	Yes
	US Cut 6040	Straight	Yes
	Spindle Oil ISO 10 Al st oil	Straight	Yes
	321-SS Cutting Straight Oil	Straight	Yes
Valenite Inc	ValCool Turntech	Semi-synthetic	Yes
	Valcool VNT 800	Soluble	Yes
Varoum Chemical	Gauge Sterling Brass Cutting Oil	Straight	Yes
	Metacut MS Steel Cutting Oil	Straight	Yes
	GM 465	Straight	Yes
Viking Chemical Co	Cut Rite 305 CFX	Straight	Yes
Vulcan Oil & Chem	Ultrasol Soluble Oil	Soluble	Yes
	J-Cut 931 Cutting Oil	Straight	Yes
	Poseidon R&O HD	Straight	Yes
WS Dodge Oil Co	Pale oil (all Viscosity grades)	Straight	Yes
	Combo base 82 Additive	Straight	Yes
	Deosol 202	Soluble	Yes
	Pale Straight Oil 55	Straight	Yes
	Superkut Cutting Oil 72/200	Straight	Yes
ZEP Products	ZEP Lubeze 14	Straight	Yes