Monsanto development department

MCS 153

Transfer to Marketing

And Recommended Product Strategy

O D No 1400

R E Hatton

June 29, 1964

ORGANIC CHEMICALS DIVISION

MONS 021105

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## INTRODUCTION

Fire-resistant turbine lubricants have been under development by Monsanto for many years Both good and bad results have been experienced and it was recently decided that further research is required (O. D Report 1398) Part of the good experience has been with MCS 153 and OS-81 in gas turbine-natural gas compressors operated by Texas Eastern Transmission Corporation To satisfy this customer's requirements while the research program is underway, MCS 153 is being transferred to Marketing This report will summarize the technical and commercial experience with MCS 153 and present a recommended product strategy



MONS 021108

## SUMMARY AND CONCLUSIONS

Monsanto's fire-resistant turbine lubricant project was reviewed and reassessed in a recent Development Department Report (O D 1398) It was concluded that Monsanto muet continue to supply MCS 153 to Texas Eastern Transmission Corporation--our sole customer who is well satisfied with product performance -while the Research Department re-examines

Texas Eastern has selected MCS 153 (a lower pour point version of OS-81) as their sole fire-resistant turbine lubricant and plans to use it in all new gas turbine installations MCS 153 and OS-81 have accumulated over 70,000 successful operating hours in a total of nine gas turbines and natural gas compressors Counter balancing this experience has been a number of failures and problems which have prevented acceptance of the lubricants by turbine manufacturers and caused a complete technical reassessment

A real economic opportunity exists to sell fire-resistant turbine lubricants Work to explain the phenomena involved, to develop new fluids, to serve our current customer and to become more familiar with the marketing problems appears worthwhile



MONS 021109

## RECOMMENDATIONS

1. It is recommended that MCS 153 be accepted by Marketing.

2. It is recommended that Marketing not promote MCS 153 beyond our present customer, Texas Eastern Transmission Corporation, except on specific request.

3. It is recommended that the product strategy and 1964 market plans outlined be accepted by Marketing.



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## DEVELOPMENT ACTIVITY

### A History

The background to the development of MCS 153 as a fire-resistant gas turbine lubricant is covered in detail in a recent Development Department Report (O.D. 1398). MCS 153 was devised early in 1961 as a lower pour point version of OS-81 specifically for Texas Eastern Transmission Corporation and has now been adopted as their standard fire-resistant lubricant for gas turbine-natural gas compressors

Although some problems were experienced by Texas Eastern during the early introductory phases of MCS 153, mechanical changes and defoamer addition to the fluid resulted in satisfactory performance MCS 153 lubricates the gas turbine and the natural gas compressor and also serves as the compressor seal oil A routine sampling program (about bi-monthly) has functioned since the start of our work with Texas Eastern and should be continued. Samples are sent directly to the J F. Queeny Plant Laboratory.

Relations with Texas Eastern have been very pleasant and mutually profitable Mr O. M. Fletcher originally directed their program, and Mr. Walter Woods now is our prime contact for lubricant problems. Monsanto has agreed to stock a reasonable supply (5,000 gallons) of MCS 153 since loss of lubricant can result in shut-down of a compressor and reduction in gas supply. Each unit has storage capacity equal to one full lubricant charge Further reserves must be with Monsanto.

Although rework and recovery of used lubricant is not recommended, it should be mentioned that Monsanto dehydrated and filtered about 2,000 gallons of MCS 153 in August, 1962, which had been stored outside unprotected over the winter Satisfactory product resulted.

Texas Eastern is firmly committed to the use of fire-resistant lubricants for all new gas turbines and MCS 153 is the product of choice Monsanto should continue to supply their needs.



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B Development Sales

All sales of MCS 153 have been to Texas Eastern. These amounted to about $33,000 in 1962 and $39,000 in 1963 and are predicted to be around $50,000 in 1964

MCS 153 has not been sampled broadly since most development effort was around OS-81 It is felt that performance data for OS-81 are also applicable to MCS 153 A number of samples of MCS 153 were given to Texas Eastern component suppliers for compatibility tests.

C Commercial Use

The Texas Eastern use of OS-81 and MCS 153 has been well publicized The following articles are of interest

O. M. Fletcher 'Synthetic Lube Reduces Fire Hazard at Turbine Stations', Pipe Line Industry, p 38, June, 1960

O M Fletcher "Gas Turbines and Fire-Resistant Lubrication', Lubrication Engineering, p 111, March, 1962.

H C Bozeman, 'At Texas Eastern, Aircraft Gas Turbine Moves Outdoors", The Oil and Gas Journal, p. 92, January 14, 1963

E Sterrett, Low Cost Horsepower from Outdoor Turbine", Diesel and Gas Engine Progress, p. 45, February, 1963

Anon, "New Concepts in Automated Pipelines", Automation, p 61, March, 1963.

E Sterrett, "Texas Eastern's Packaged Gas Turbines", Diesel and Gas Engine Progress, p. 53, March, 1963

Anon, "Fire-Resistant Turbine Fluid", Gas Turbine, p. S-15, January-February, 1964 (See Appendix I).



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## TECHNICAL AND MARKETING DATA

### A Product Data

Since MCS 153 was developed as a follow-on to OS-81 and is similar to and compatible with OS-81 much of the technical data on OS-81 was not redetermined for MCS 153 This is particularly true with compatibility gas solubility, corrosion etc

Because of limited distribution no technical bulletins were prepared for MCS 153 Normally a listing of properties comparing MCS 153 and OS-81 and an OS-81 bulletin were supplied to answer inquiries Copies are given in Appendix II

Variation of viscosity specific gravity specific heat and thermal conductivity with temperature have been determined The curves are given in Appendix III

The fire-resistant characteristics of MCS 153 were shown to be similar to those of OS 81 Data are given in Appendix IV No fire problems have been experienced in the field with either product

During introduction of MCS 153 some questions were raised concerning electrostatic corrosion of bearings Therefore electrical properties were determined Data are given in Appendix V Later work showed that dirt and misalignment had caused the problem

MCS 153 has proven to be a satisfactory lubricant in bench tests and in Texas Eastern gas turbines The formulation contains FH 139 viscosity index improver It should be noted that Diesel Injector Shear Tests indicate MCS 153 to be relatively shear stable Pump tests show greater shear but less than with other VI improvers

Rust tests (ASTM D-665) show that MCS 153 is comparable to an uninhibited petroleum oil Emulsion tests (ASTM D-1401) indicate some emulsion forming tendency with MCS 153 although the amount is not objectionable MCS 153 contains a defoamer and tests (ASTM D-892) confirm its low foaming tendencies

B *Pricing*

The development price of MCS 153 has been established as follows

$3 35 per gallon - tankcar and tanktruck
$3 55 per gallon - carload drums
$3 65 per gallon - LCL drums

All prices are f o b St Louis

The product code is 5124-000-11 01

MCS 153 is packaged in 55-gallon drums and 5-gallon cans It is similar to the Pydraul fluids in handling characteristics and materials compatibility Since it is high in Aroclor content its label should show the usual precautionary statements

C. *Specifications*

Tentative specifications have been established for MCS 153 as follows

| Property | Specifications |
|---|---|
| Viscosity at 210°F | 3 15-3 35 cs |
| at 100°F | 21 5-23 5 cs |
| at 40°F | 455-480 cs |
| at 20°F | 3600-3800 cs |
| Pour Point | 0°F maximum |
| Flash Point | 350°F minimum |
| Fire Point | 550°F minimum |
| AIT | 1120°F minimum |
| Emulsification | Report |
| Foam Test | Report |
| Four-Ball Wear | Report |
| Timken Test | Report |
| Shear Stability | Report |
| Oxidation and Corrosion at 250°F | Report |
| Stability at 300°F | Report |



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D. Patent Situation

Patent applications are being prepared on the use of the FH-139 viscosity index improver in a number of base stocks. This would then cover MCS 153. Simple mixtures of Aroclor and tricresyl phosphate are not patentable. The probability of obtaining patents on FH-139 has not been defined, but appears to be only mediocre.

E. Toxicity

The Medical Department has agreed that MCS 153, based on composition data and tests on FH-139, presents no more hazards than our Pydraul 50 or OS-81. The toxicity statement for OS-81 has therefore been used in our handling of MCS 153. A copy is given in Appendix VI.



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## THE MARKET SITUATION

### A. Potential

Petroleum lubricants are normally used in gas and steam turbines The high temperatures involved and the location of such equipment in hazardous areas can result in fires One way of preventing fires is to use fire-resistant turbine lubricants Monsanto has endeavored to introduce such fluids for the past ten years. This project has recently been reviewed in detail and a future program outlined in Development Department O.D. Report 1398 This program envisions work by the Research Department to overcome technical problems and transfer to the Marketing Department of MCS 153

The total potential market for fire-resistant turbine lubricants for new installations has been estimated to be around $4 million per year for a $3.00 per gallon product (O.D. 1398). However, this market cannot be approached until we have resolved the problems with our present lubricants or have developed new products Meanwhile we must continue to supply MCS 153 to Texas Eastern Transmission Corporation. It is estimated that Monsanto sales could reach $2 million in 1971 if a satisfactory proprietary product is available and equipment manufacturers' approvals are obtained during 1965

### B MCS 153 Sales Growth

Texas Eastern plans steady expansion in the use of gas turbines Thus, sales of MCS 153 should slowly increase from the $39,000 in 1963. Further, MCS 153 will replace the OS-81 now used in their earlier installations being added as make-up. It is predicted that sales of MCS 153 might reach $50,000 in 1964 and $70,000 in 1965 Predictions beyond this time cannot be made since MCS 153 will either be replaced by a new product or its performance parameters will be sufficiently defined to introduce to other customers In the interim period, MCS 153 should not be broadly promoted and should be given to others than Texas Eastern and its component suppliers only on a request basis.

Many of our Pydraul distributors are interested in our fire-resistant turbine lubricant program and have requested permission to market our products. MCS 153 should not be given to this group during the interim period mentioned above.

C. Forces Acting on the Market

1. For MCS 153

The major reason for using MCS 153 is safety. In gas turbines hot combustion gases heat many surfaces which can serve as sources of fire. The trend in steam turbines is toward higher temperatures and steam pressures. Piping containing this hot steam is a source of ignition. The increasing use of high pressure electrohydraulic control systems can give rise to a spray of flammable fluid. Further, turbines may be located in hazardous areas presenting further complications. Unattended, remotely operated systems containing turbines are increasing in number. All these factors make fire-resistant lubricants more desirable and even necessary.

However, to sell a fire-resistant turbine lubricant, performance must be essentially trouble-free and approval must be given by the turbine manufacturer. Further, it must be economically feasible to the turbine user. The advantages of fire resistance to the turbine user are general safety in his operation, freedom from outages due to fires, and a reduction in the amount of fire protection equipment needed or in insurance rates because of the use of such a lubricant.

Satisfactory use in Texas Eastern installations is a real force acting for MCS 153.

2. Against MCS 153

Cost is a major factor against MCS 153 when compared to petroleum lubricants. However, the price of MCS 153 is competitive to other synthetic fire-resistant products and should be no problem if the customer wants the safety involved.

Chlorine-containing lubricants are currently in some disrepute as steam turbine bearing lubricants. This includes EP additives in petroleum lubricants and our products This, combined with our technical problems on OS-81, works against the widespread use of MCS 153. The problems include rust formation, poor bearing lubrication, and servovalve sticking and erosion. New and improved products or a complete understanding of the phenomena involved will be required before MCS 153 can be actively promoted

Current industry complacency works against fire-resistant turbine lubricants A series of serious fires caused by flammable turbine lubricants would change this attitude overnight.

D Competition

Petroleum-based turbine lubricants represent the major competition to MCS 153 where safety is not a factor

Two classes of lubricants presently compete for the fire-resistant turbine lubricant market Monsanto's formulations (OS-81 and MCS 153) are the first class and their status has been described

The second class is the triaryl phosphate ester fluids These are finding use in gas turbine lubrication and in electrohydraulic control systems It is felt these products offer serious competition to our future progr. m on turbine lubricants.

Water-base fire-resistant fluids have been tried but are not considered usable as turbine lubricants



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## LONG-RANGE OBJECTIVES

A Capture a significant share of the market for fire-resistant turbine lubricants with a proprietary product

B Maintain and increase sales of MCS 153 to Texas Eastern until the product becomes obsolescent

C Stay knowledgeable in the field so that introduction of new lubricants can be accomplished with a minimum of effort.



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## GENERAL STRATEGY

Our general strategy on fire-resistant turbine lubricants revolves around maintaining our current position with MCS 153 while work is started to resolve the technical problems. When this is accomplished, a full-scale effort is planned to promote the new and improved fire-resistant lubricants



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## 1964 GOALS

1 Sell $50,000 of MCS 153 to Texas Eastern Transmission Corporation

2 Provide customer and technical service to Texas Eastern as required



MONS 021121

## 1964 MARKET PLAN

| | Who | What | When |
|---|---|---|---|
| 1 | G. R. Buchanan | Accept MCS 153 from Development. | 7/64 |
| 2. | D. F. Smith & R. E. Hatton | Visit Texas Eastern and inform of our overall program. | 7/64 |
| 3 | D. F. Smith | Provide sales and technical service as required. | Continuing |



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APPENDIX I

# Fire-Resistant Turbine Fluid

...ate in 1957, Texas Eastern Transmission Corporation, with some 150,000 ... turbine horsepower, beg... ...ge consideration ro... ...matic-fired stations ... ...prime ... seemed par... ...ed to the type of op... ...ion ... what ... ...ers for ... ... ...

APPENDIX II

## COMPARATIVE DATA ON MONSANTO FIRE-RESISTANT TURBINE LUBRICANTS

| | MCS 153 | OS-81 |
|---|---|---|
| Viscosity, SUS | | |
| at 210°F | 37.1 | 36.6 |
| at 175°F | 42.1* | 44.2* |
| at 100°F | 108 | 159 |
| at 40°F | 2,160 | 14,800 |
| at 20°F | 17,000 | 920,000** |
| Pour Point, °F | 0 | +20 |
| Specific Gravity, 60°/60°F | 1.34 | 1.40 |
| Specific Gravity, variation with temp | | |
| 40°F/60°F | 1.356 | 1.420 |
| 100°F/60°F | 1.325 | 1.388 |
| 150°F/60°F | 1.294 | 1.356 |
| 200°F/60°F | 1.273 | 1.341 |
| Specific Heat, BTU/Lb/°F | | |
| 60°F | .297 | 304 |
| 100°F | .304 | 319 |
| 150°F | 318 | 337 |
| 200°F | .327 | 356 |
| Thermal Conductivity, BTU/°F/Ft/Hr | | |
| 80°F | 0.058 | 0.058 |
| Four-Ball Wear (in mm scar diameter) | | |
| 620 rpm, 167°F, 1 Hr | | |
| Steel/steel 10 kg | 0.23 | 0.27 |
| 40 kg | 0.53 | 0.55 |
| Steel/bronze 10 kg | 0.92 | 1.25 |
| Timken Test | | |
| Passing load | 40 lbs. | 30 lbs |
| Flash Point, COC | 360°F | 385°F |
| Fire Point, COC | 560°F | 660°F |
| AIT (Modified ASTM D-286) | 1130°F | 1260°F |

* Interpolated
**Extrapolated

| | MCS 153 | OS-81 |
|---|---|---|
| Oxidation-Corrosion (168 Hr. 250°F) | | |
| Metal Attack, mg/cm | | |
| Al | -0.01 | 0 |
| Mg | -0.01 | -0 01 |
| Cu | -0.04 | -0 08 |
| Fe | 0 | 0 |
| Cd/Fe | -0.01 | 0.10 |
| Viscosity, cs | | |
| 100°F Initial | 22.55 | 34.9 |
| 100°F Final | 24 71 | 35 6 |
| % Change | +9.6 | +2.0 |
| 210°F Initial | 3 24 | 3 12 |
| 210°F Final | 3 31 | 3 15 |
| % Change | +2.1 | +1 6 |
| Acidity | | |
| Initial, TAN | 0.0 | 0.6 |
| Final, TAN | 0.0 | 0.11 |

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OS-81

# FIRE RESISTANT TURBINE LUBRICANT

*Technical Bulletin*

November 11, 1958

Development Department
Monsanto Chemical Company

Organic Chemicals
Division

## GENERAL INFORMATION

OS-81 is a wholly synthetic, fire-resistant fluid designed specifically as a turbine and compressor lubricant. Laboratory tests and field experience indicate it to be a satisfactory replacement for the normally used petroleum oil lubricants in these applications. OS 81 is used primarily for its fire-resistance which greatly reduces or eliminates the hazard of fire which is ever-present when petroleum lubricants are used.

OS-81 is intended exclusively for turbine and compressor lubrication and should never be used as the lubricant in an internal combustion engine. Its chemical characteristics make it entirely unsatisfactory for this purpose, and its use in an automobile engine, for example, might result in serious engine damage.

One of the outstanding characteristics of OS-81 is its excellent stability under severe conditions. In the ASTM Turbine Oil Oxidation Stability Test, for example, it has been found considerably more stable than even top quality petroleum base turbine oils. After 7000 hours in this test, its properties are essentially unchanged. An excellent petroleum oil will show significantly more property degradation in 1000 - 2000 hours. On this basis it is expected that only contamination of OS-81 with some foreign material will make it necessary to change the oil in an operating unit. It is most important that contamination be avoided.

## PROPERTIES

Physical property specification limits and typical properties of OS-81 are given below:

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| | Specification | Typical |
|---|---|---|
| Appearance | Opalescent pale yellow liquid | Opalescent pale yellow liquid |
| Specific Gravity at 77/77°F. | 1.390 - 1.410 | 1.403 |
| Neutralization Number, mgKOH/gram | 0.10 max. | 0.07 |
| Water, % by weight | 0.10 max | 0.03 |
| Viscosity at 50°F., SUS | | 3872 |
| 60°F., SUS | | 1573 |
| 80°F., SUS | | 407.4 |
| 100°F., SUS | 150.2 - 168.2 | 154.2 |
| 130°F., SUS | | 70.5 |
| 210°F., SUS | 36.3 - 36.9 | 36.5 |
| Pour Point, °F. | +20 max | +15 |
| Specific Heat at 77°F., BTU/lb/°F. | | 0.31 |

## FIRE RESISTANCE

OS-81, while not completely non-flammable, affords a high degree of resistance to ignition and burning. Flammability test data on OS-81 are as follows:

| | |
|---|---|
| Autogenous Ignition Temperature (ASTM Method D286-30) | Greater than 1100°F. |
| Hot Manifold Test | No ignition at 1300°F. Highest temperature tried. |
| High Pressure Ignition Test | No flash or ignition of a high pressure spray of OS-81 exposed to an oxy-acetylene flame. |

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## LUBRICITY

Shell Four Ball Wear Test (167°F., 600 RPM, 1 Hour)

| Load | Wear, (Scar Diameter in Millimeters) Steel on Steel | Steel on Bronze |
|---|---|---|
| 4 kg | 0.22 | 1.20 |
| 10 kg | 0.27 | 1.25 |
| 40 kg | 0.55 | 1.75 |

These results are generally comparable to those on a good petroleum lubricant. The steel on bronze wear with OS 81 is, in fact, significantly lower than with the four first line petroleum turbine lubricants which have been evaluated.

## QUALITY CONTROL LIMITS

The only significant changes in the properties of OS-81 with use probably will result from fluid contamination. In the case of contamination with petroleum oil, the operability of OS 81 as a lubricant will not normally be affected. Its fire resistance, however, will decrease with increasing petroleum oil contamination and this should, therefore, be held to an absolute minimum. Any rapid and significant variation in other physical properties will also almost certainly be due to contamination. Contamination of OS-81 with 5% of a petroleum turbine oil, for example, will reduce its specific gravity by approximately 0.02%, or from a nominal 1.400 to 1.375. Similarly, changes in viscosity or acidity are indicators of probable contamination. As guide posts, the following control limits for field use have been established:

| | |
|---|---|
| Viscosity, SUS at 100°F. | 143 - 175 |
| Specific Gravity, 77/77°F. | 1.375 - 1.425 |
| Acidity, mgKOH/gram | 0.5 max |

Fluid having properties falling outside these limits is not necessarily unsuited to further use. It must, however, be subjected to additional testing to determine the cause of the property change and its acceptability for continued operation in the system.

## COMPATIBILITY WITH EQUIPMENT COMPONENTS

### Metallic Components

OS 81 is compatible with all the metals commonly used in industrial machinery, and no special materials are required.

### Non-Metallic Components

Packings, seals and gaskets for use with OS-81 are usually different from those designed for service with petroleum lubricants. Components resistant to OS-81 are readily available from most of the major packing suppliers.

Flat gaskets, flange packings and static seals in general perform satisfactorily even if made of non-resistant materials. Best practice, however, dictates replacement of non-resistant seals with resistant components where practicable.

Dynamic (moving) seals of non-resistant material will give decreased service life and should be replaced.

Recently completed test work has shown Viton A type packings to be excellent for dynamic sealing applications and superior even to butyl rubber in OS-81 service. Silicone rubber is also highly resistant to OS-81, but its lower mechanical strength makes it more suitable for static than dynamic seals.

Recommended packing manufacturers include:

Chicago Rawhide Manufacturing Company
1301 Elston Avenue
Chicago 22, Illinois

Garlock Packing Company
Palmyra, New York

Linear, Incorporated
State Road & Levick Street
Philadelphia, Pennsylvania

Parker Appliance Company
17325 Euclid Avenue
Cleveland 12, Ohio

Other resistant materials for miscellaneous applications include asbestos, Teflon, Micarta, Kel-F, Vulcumoid, nylon, and polyethylene.

Paints which have been found to be most resistant to OS-81 and otherwise

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most satisfactory include:

Nycote Laboratories
15002 Delano Street
Van Nuys, California

Nycote 4/10

Carboline Company
St. Louis 19, Missouri

Phenoline 100
Phenoline 105 (Gray and orange available. Other colors available on order)

Finch Paint & Chemical Company
Torrance, California

Cat-A-Lac Primer #454-L-1
Cat-A-Lac Top Coat

Filters for OS-81 are usually identical to those for petroleum oils. Very rarely, filter elements with non-resistant binders are encountered. Major filter manufacturers supply products suitable for use with Pydraul F-9 and are familiar with this fluid - the same filters are satisfactory with OS-81.

Pipe joint sealers satisfactory for OS-81 service include

Crane Packing Company
Chicago, Illinois

John Crane Plastic Lead Seal No. 2

Permalex Company
Brooklyn 35, New York

Permalex Special Sealant No. 1282

Shell Chemical Company
New York 36, New York

Epon Adhesive VI

## TOXICITY AND SAFE HANDLING INFORMATION

Animal toxicity studies with OS 81 indicate that this product does not present serious toxicity problems in intended use or recommended applications. The liquid may cause a solvent or defatting action on the skin and for this reason, it is recommended that prolonged or repeated skin contact be avoided.

Eye instillation studies in animals show that immediate irritation occurs but this rapidly passes and no permanent damage occurs. In the case of possible eye injury, human experience with fluids of similar composition indicates that although moderately severe pain will follow accidental eye contact, no permanent damage to eye tissues results. In treating eye irritation following accidental splashing or spraying into the eyes, copious and prolonged washing is recommended. To relieve the irritation, physicians have used 1% pontocaine solution as well as ophthalmic cortisone acetate solution.

Animals have survived six hours continuous exposure to atmospheres saturated with the vapors of OS-81 at room temperature. Inhalation at room temperature does not present acute hazards to humans because of the low volatility of the fluid. If, however, the material is used at elevated temperatures, repeated or continuous breathing of fumes must be avoided by workmen.

JBD:ej
11-11-58

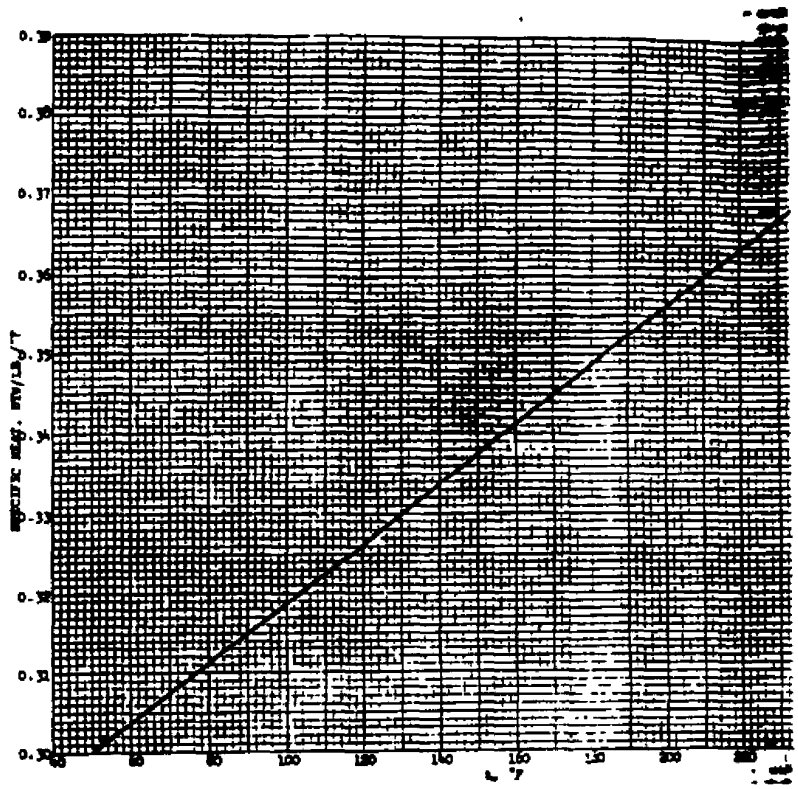
MONS 021133

## O INFORMATION

[illegible] product does not present [illegible] applications. The [illegible] skin and for this reason, [illegible] contact be avoided.

[illegible] irritation occurs but [illegible]. In the case of possible [illegible] composition indicates [illegible] accidental eye contact, no [illegible] eye irritation [illegible] eyes, copious and prolonged [illegible] physicians have used 1% [illegible] acetate solution

[illegible] to atmospheres saturated [illegible] inhalation at room temperature [illegible] the low volatility of the [illegible] temperatures, repeated or [illegible] workmen.

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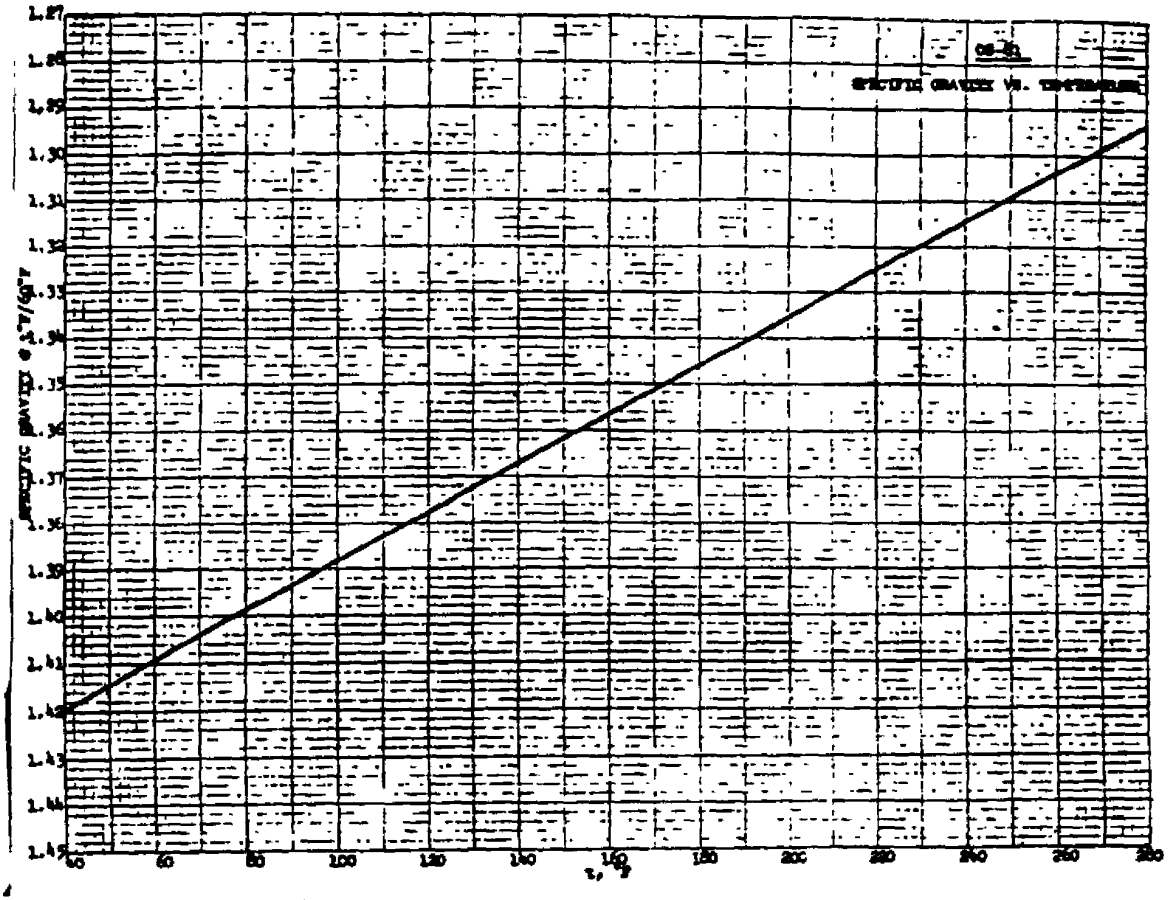
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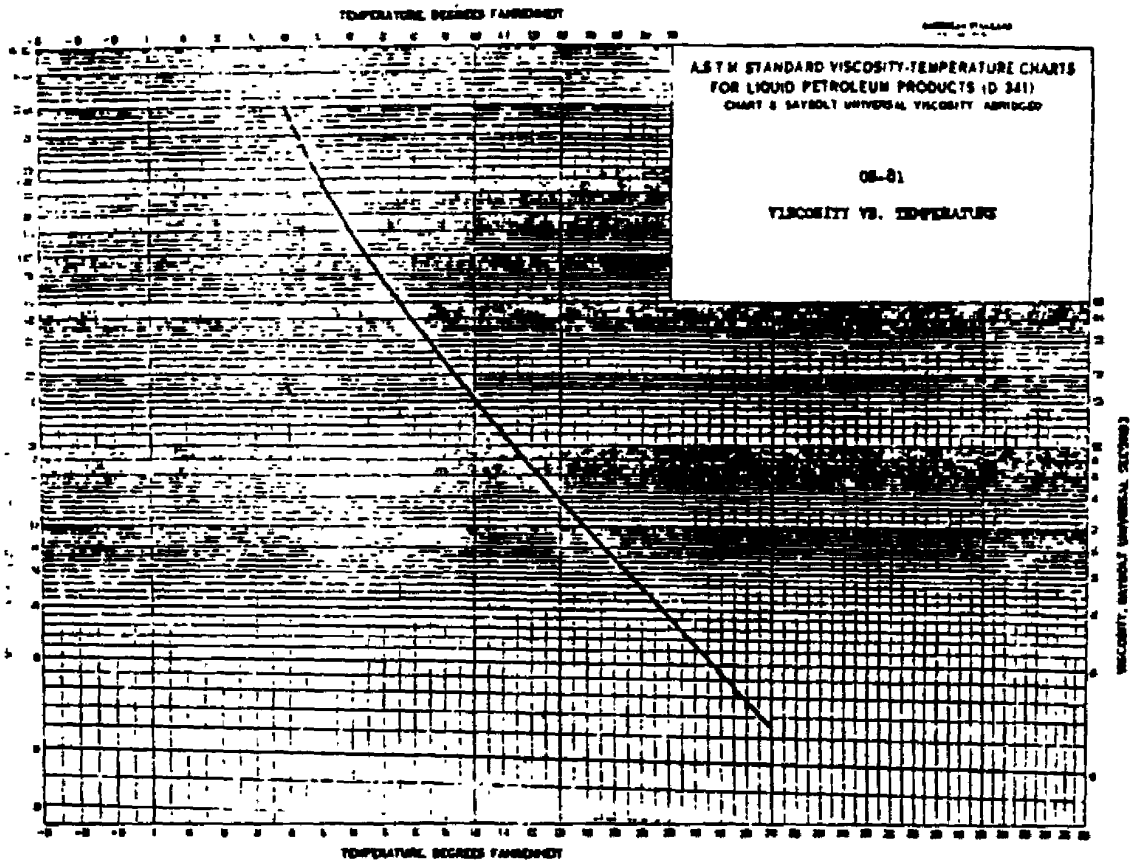
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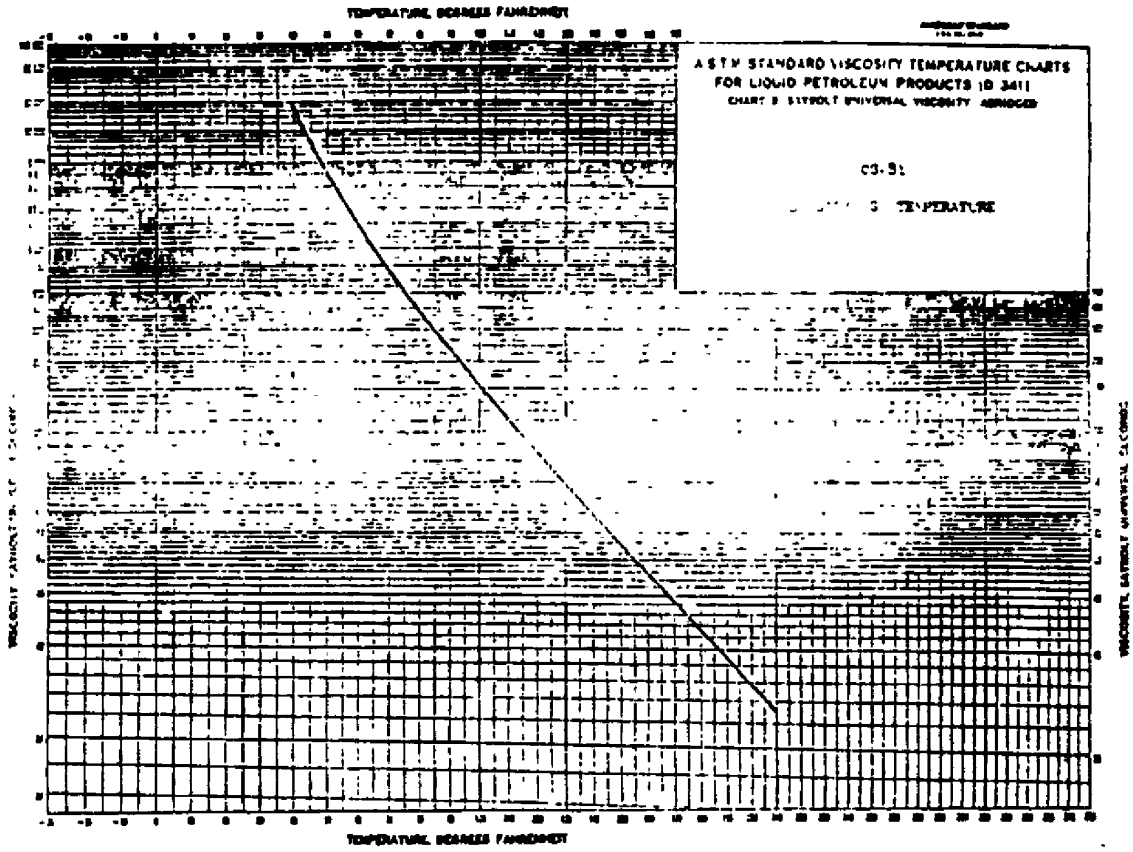
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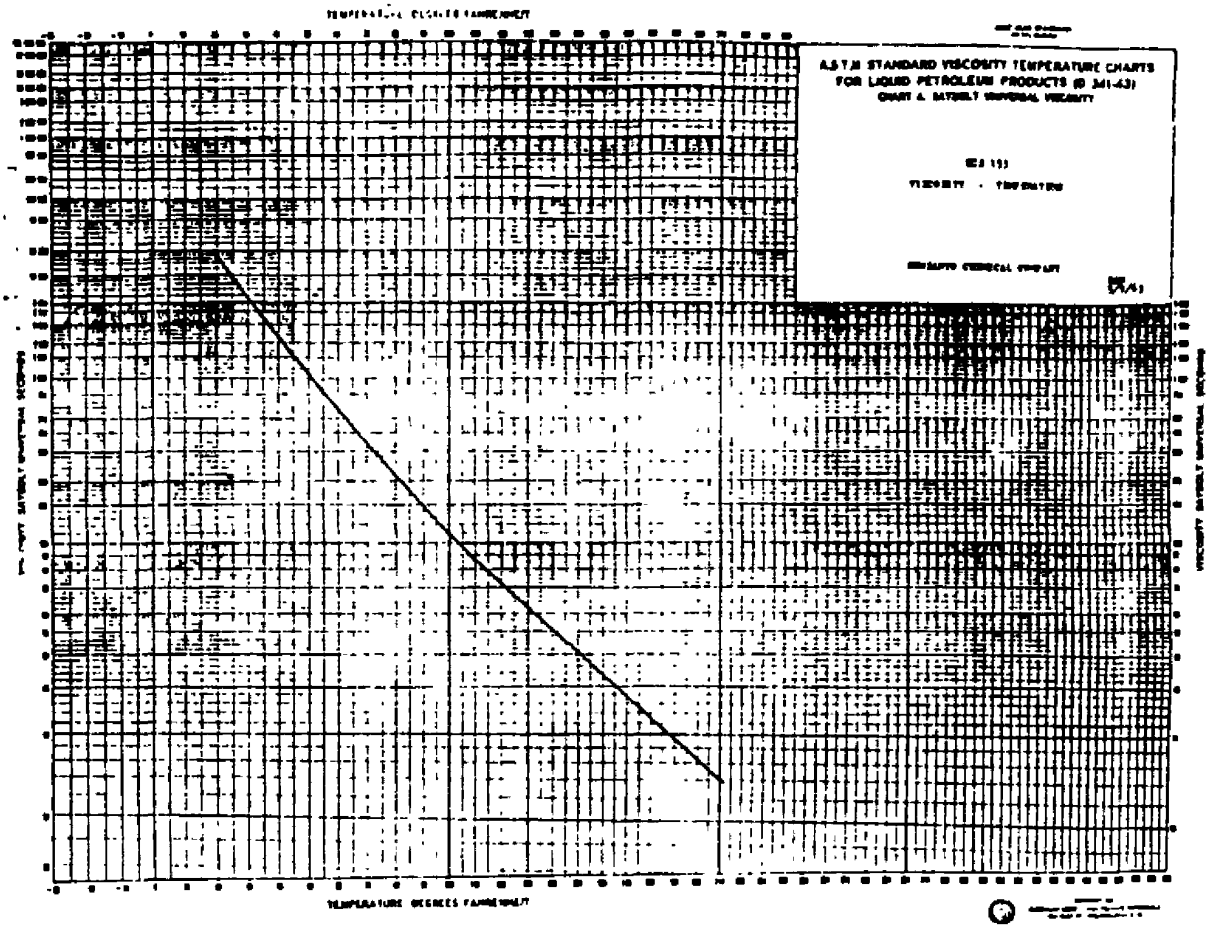
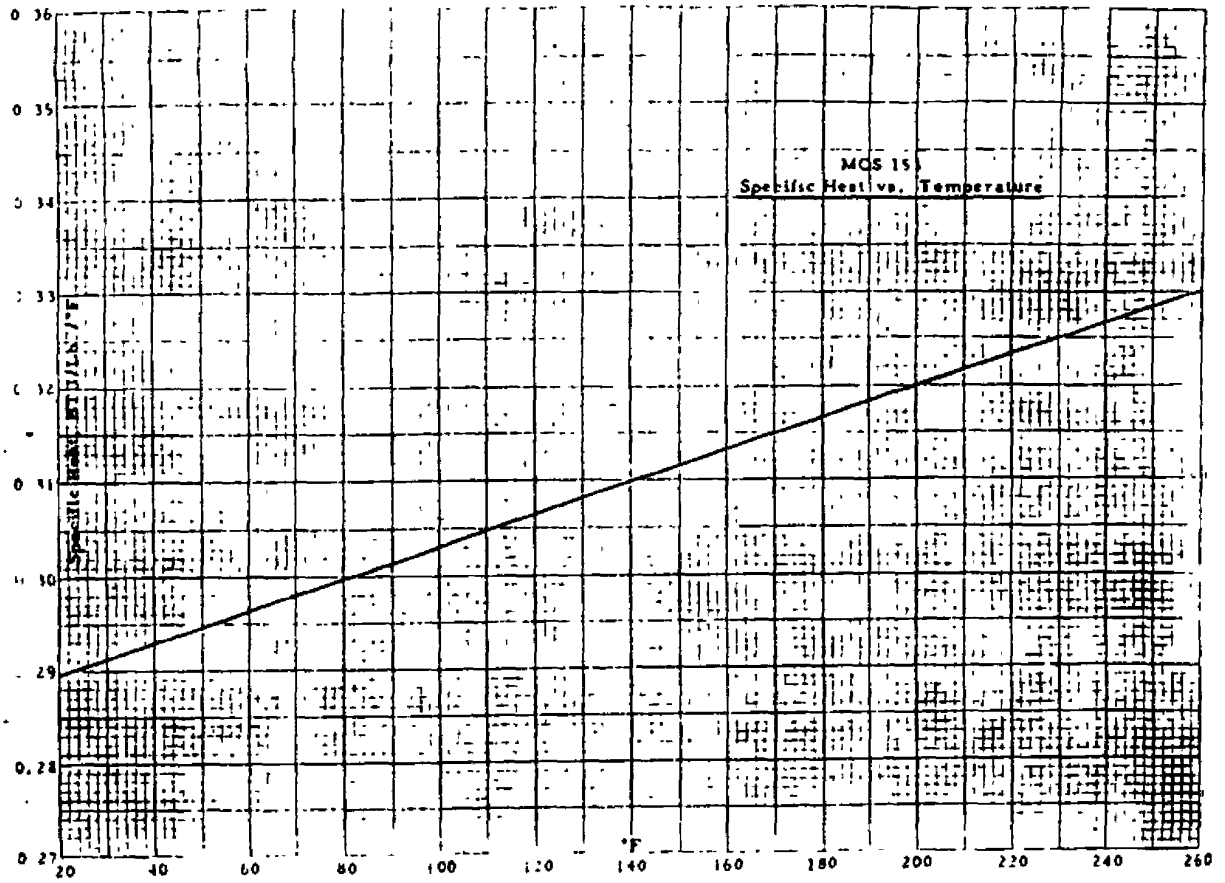
ASTM STANDARD VISCOSITY TEMPERATURE CHARTS
FOR LIQUID PETROLEUM PRODUCTS (D 341)
TEMPERATURE, DEGREES FAHRENHEIT

MONS 021137

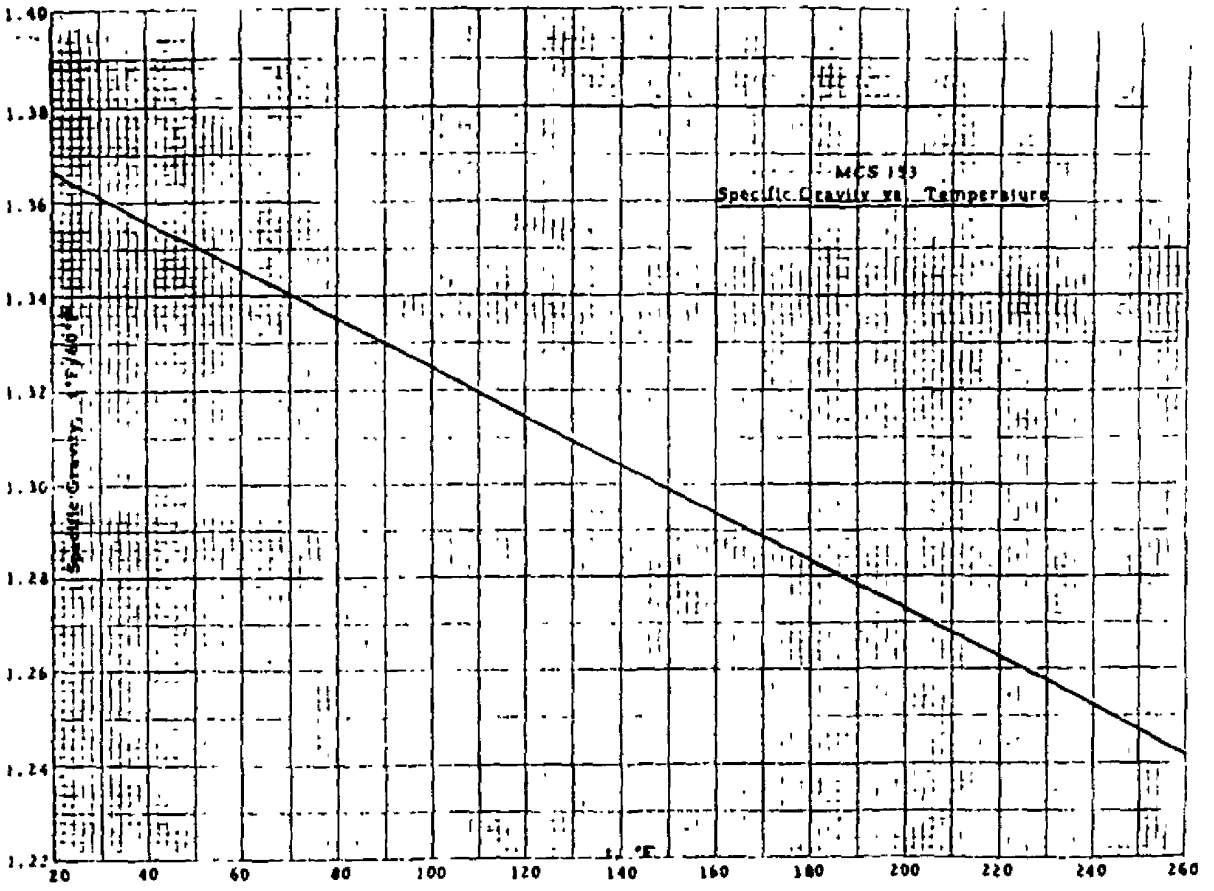
**APPENDIX III**


A.S.T.M. STANDARD VISCOSITY TEMPERATURE CHARTS
FOR LIQUID PETROLEUM PRODUCTS (D 341-43)
CHART A. SAYBOLT UNIVERSAL VISCOSITY
TEMPERATURE DEGREES FAHRENHEIT
VISCOSITY SAYBOLT UNIVERSAL SECONDS

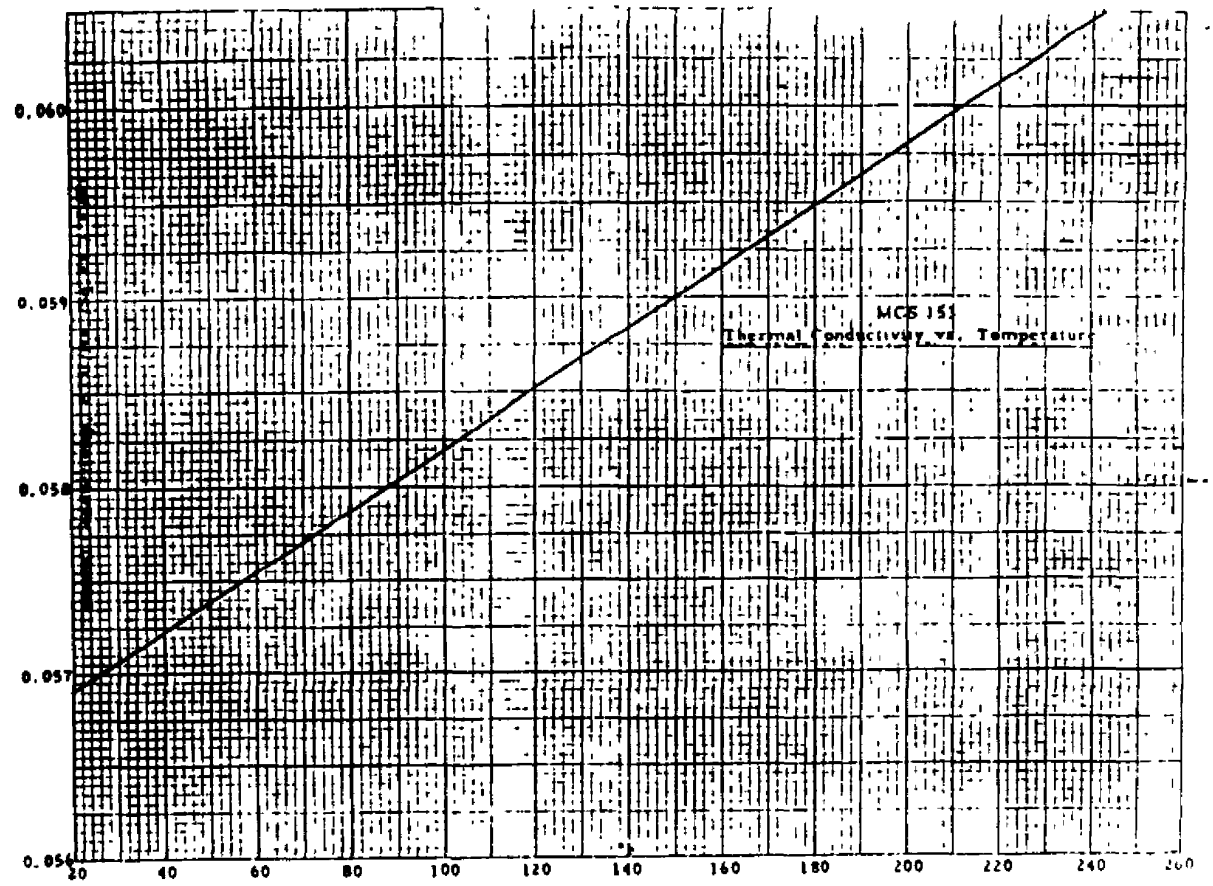
MONS 021139


MOS 15
Specific Heat vs. Temperature
Specific Heat BTU/LB/°F
°F
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
20
40
60
80
100
120
140
160
180
200
220
240
260

MONS 021140


MCS 153
Specific Gravity vs. Temperature
Specific Gravity, 1°F/60°F
1.40
1.38
1.36
1.34
1.32
1.30
1.28
1.26
1.24
1.22
20
40
60
80
100
120
140
160
180
200
220
240
260
°F

MONS 021141


0.060
0.059
0.058
0.057
0.056
20
40
60
80
100
120
140
160
180
200
220
240
MCS 151
Thermal Conductivity vs. Temperature

MONS 021142

APPENDIX IV

## Appendix IV

## Fire Resistance Tests

| | WCS 153 | OS-81 |
|---|---|---|
| AIT | 1130°F | 1260°F |
| Flash Point (C.O.C.) | 360°F | 385°F |
| Fire Point (C.O.C.) | 460°F | 660°F |
| High Pressure Spray Test (AMS 3150B) | Does not flash or burn | Does not flash or burn |
| Hot Manifold Test (AMS 3150B) | Intermittent flashing on tube, does not carry flame to pan (1300°F) | No flashing at 1300°F |
| Molten Metal Ignition Test | Intermittent ignition, self-extinguishing. Flashes by spark, self-extinguishing. | Does not ignite. Flashes by spark, self-extinguishing. |

HONS 021144

APPENDIX V

## Appendix V

### Electrical Properties

| | MCS 153 | OS-81 | DTE 797 | Call. 220 |
|---|---|---|---|---|
| Dielectric Constant at 25°C | | | | |
| at 60 cps | 6.52 | 5.95 | 2.22 | - |
| at 1000 cps | 5.94 | 5.84 | 2.24 | 6.91 |
| Power Factor (%) at 25°C | | | | |
| at 60 cps | 52.00 | 17.60 | 0 | - |
| at 1000 cps | 3.45 | 1.08 | 0 | 17.50 |
| Specific Resistivity (ohm-cm) | | | | |
| at 25°C | $1.7 \times 10_9^{10}$ | $5 \times 10_9^{10}$ | $1.4 \times 10_{11}^{13}$ | $2.0 \times 10_7^{9}$ |
| at 100°C | $2.0 \times 10$ | $3.3 \times 10$ | $3.9 \times 10$ | $8.6 \times 10$ |

Dielectric constants and power factors were measured at 60 and 1000 cycles per second at room temperature (25°C). Specific resistivity measurements were made at 25°C and 100°C with a megohm bridge.

APPENDIX VI

MONS 021147

## Toxicity and Safe Handling of OS-81

OS-81 has been the subject of acute toxicity screening tests and was found to have an oral $LD_{50}$ (the dose that kills one-half of the test animals) in rats of 8600 milligrams per kilogram. This indicates that the material is of a very low order of toxicity to this species. In rabbits, the toxicity was considerably higher with a minimum lethal oral dose of approximately 500 milligrams per kilogram. This difference in species sensitivity is not unusual with industrial fluids.

When tested on the skin and in the eyes of rabbits, OS-81 was classed as only a mild irritant. When rats were subjected for six hours to an atmosphere saturated with OS-81 vapors, there was no systemic toxic manifestation.

Our interpretation of the animal toxicity data and manufacturing and use experience may be summarized as follows:

> "Animal toxicity studies with OS-81 indicate that this product does not present serious toxicity problems in intended use or recommended applications. The liquid may cause a solvent or defatting action on the skin and for this reason it is recommended that prolonged or repeated skin contact be avoided. Reasonable care to prevent getting the fluid on the skin and washing with soap and water following accidental or necessary skin contact should be sufficient to avoid skin effects.
>
> "Eye instillation studies in animals show that immediate irritation occurs, but this rapidly passes and no permanent damage occurs. In the case of possible eye injury, human experience with fluids of similar composition indicates that although moderately severe pain will follow accidental eye contact, no serious damage to eye tissues results. In treating eye irritation following accidental splashing or spraying into the eyes, copious and prolonged washing is recommended. To relieve the irritation, physicians have used 1% pontocaine solution as well as ophthalmic cortisone acetate solution.

"Animals have survived six hours' continuous exposure to atmospheres saturated at room temperature to the vapors of OS-81. Inhalation at room temperature does not present acute hazards to humans because of the low volatility of the fluid. If, however, the material is used at elevated temperatures, repeated or continuous breathing of fumes must be avoided by workmen."