Monsanto INDUSTRIAL CHEMICALS CO.

FROM (NAME & LOCATION): J. G. Bryant - T1J - St. Louis

DATE: August 2, 1974 CC:

SUBJECT: GENERAL ELECTRIC RESEARCH VISIT - MINUTES OF JULY 30, 1974 MEETING

REFERENCE:

TO: H. S. Bergen - B2SL
W. R. Richard - T3A
R. H. Munch - T1B
P. G. Benignus - B2SC
E. Paton - B2SC
S. L. Reid - T3E
L. T. Johnson - NY - 1650
P. L. Slayton - NY - 1650
T. L. Gossage - B2SL
J. L. Wikoff - B2SL
E. S. Tucker - T2F

Those Present

For General Electric:

R. Stenger - Director, Research
F. Price - Manager, Development

For Monsanto:

W. R. Richard
R. H. Munch
P. G. Benignus
E. S. Tucker
S. L. Reid
L. T. Johnson
J. G. Bryant

SUMMARY

The G.E. representatives spent the full day of July 30, 1974 exchanging views with the Monsanto technical people. The G.E. people admitted that their relationship with Monsanto had become strained because G.E. did at one time plan to go out of Aroclor dielectric to DOP across the board. However, as a result of Luke Hart's visit and other activities, such as EPA attitude, public opinion, etc., G.E. is convinced that Aroclor will survive and continue to have a future. G.E. is convinced that DOP is a suitable non-PCB replacement for the specialized applications. Although G.E. is quite impressed with our aryl sulfone chemistry and believe that it has real merit, they are not going to drop DOP to use the sulfones at the present price differential. The G.E. people expressed a further view that they have found DOP may be suitable for application in DC energy storage, etc., which presently uses castor oil.

The meeting was quite successful in that it re-establishes the long needed line of technical communication with G.E.

However, nothing has changed in the utilization of DOP as a specialty replacement dielectric. The G.E. people again expressed the importance of cost-performance. The door is open for evaluation of our dielectric fluids and G.E. feels the chemistry has real merit but they question the cost performance. For example, our MCS 1475 phthalate ester offers a

higher dielectric constant but G.E. can produce a cheaper capacitor with the lower DK DOP combined with design changes in the capacitor. G.E. feel they have a unique cheaper dielectric in DOP. Our best defense of our material will be continued technical success at other locations and close evaluation of cost performance. As G.E. continue their push into film dielectric systems, our chemistry has merit, as does DOP. The fact that the government plans to establish limits on phthalate esters (300 p.p.b.) as in the case of PCB's may help our situation with our type chemistry.

At this time, the G.E. people seem anxious to work with us in evaluating materials which would yield them cost performance improvements.

DETAILS

W. R. Richard opened the meeting with a welcome to our guests. Richard reviewed the leadership position held by G.E. in the capacitor industry, EPA studies, replacement material tests, etc. Richard discussed the meeting objective of closer cooperation with G.E., etc.

R. Stenger of G.E. presented highlights on G.E.'s testing of Monsanto samples (see "Highlights" attached). R. Munch presented the Monsanto R&D program. F. Price followed with the "overview" of G.E.'s testing of Monsanto samples (see "Overview" attached).

Price mentioned that there is need to work up a price vs savings relationship on the dielectrics. G.E. is quite interested in MCS 1043 plus sulfone as a substitute for MCS 14B9. However, Dick Hopkins of G.E. (P.F. correction) objects to our high DK materials because of the higher P.F. and he feels there are too many voids in a P.F. correction capacitor to stand the increased cost of our high DK material.

Lunch was in the St. Louis Room of the Monsanto cafeteria with Howard Bergen and Cuming Paton joining us.

Immediately following lunch, the G.E. people were given a complete tour of our laboratory facilities - electrical tests, instrumentation, and environmental studies.

The G.E. people were asked about biodegradation of the non-PCB's and were given the attached sheets as reference; "Aroclor Residue Study" and "Dielectric Residue Study".

GENERAL ELECTRIC RESEARCH VISIT -
MINUTES OF JULY 30, 1974 MEETING

The various products were reviewed according to their prices. The values used were:

Aroclor 1016	35.5¢/lb. ? — Should be ~9¢/lb.
MCS 1043	~~5¢ to 6¢/lb~~ premium over Aroclor 1016
MCS 1475	65¢/lb.
MCS 1489	47¢/lb.
DOP	25¢/lb.
MCS 1588	65¢/lb.

G.E. expressed the importance of pricing of the dielectric in the future test program. Basically for a non-PCB, the present price basis is DOP at 25¢ per lb.

For future testing, Stenger expressed that G.E. seeks the following:

1. Price.
2. Interest in MCS 1043 + sulfone.

In review of the forces affecting the future, we discussed EPA activity, government action, clean up, etc., and their relationship to the Aroclor problem.

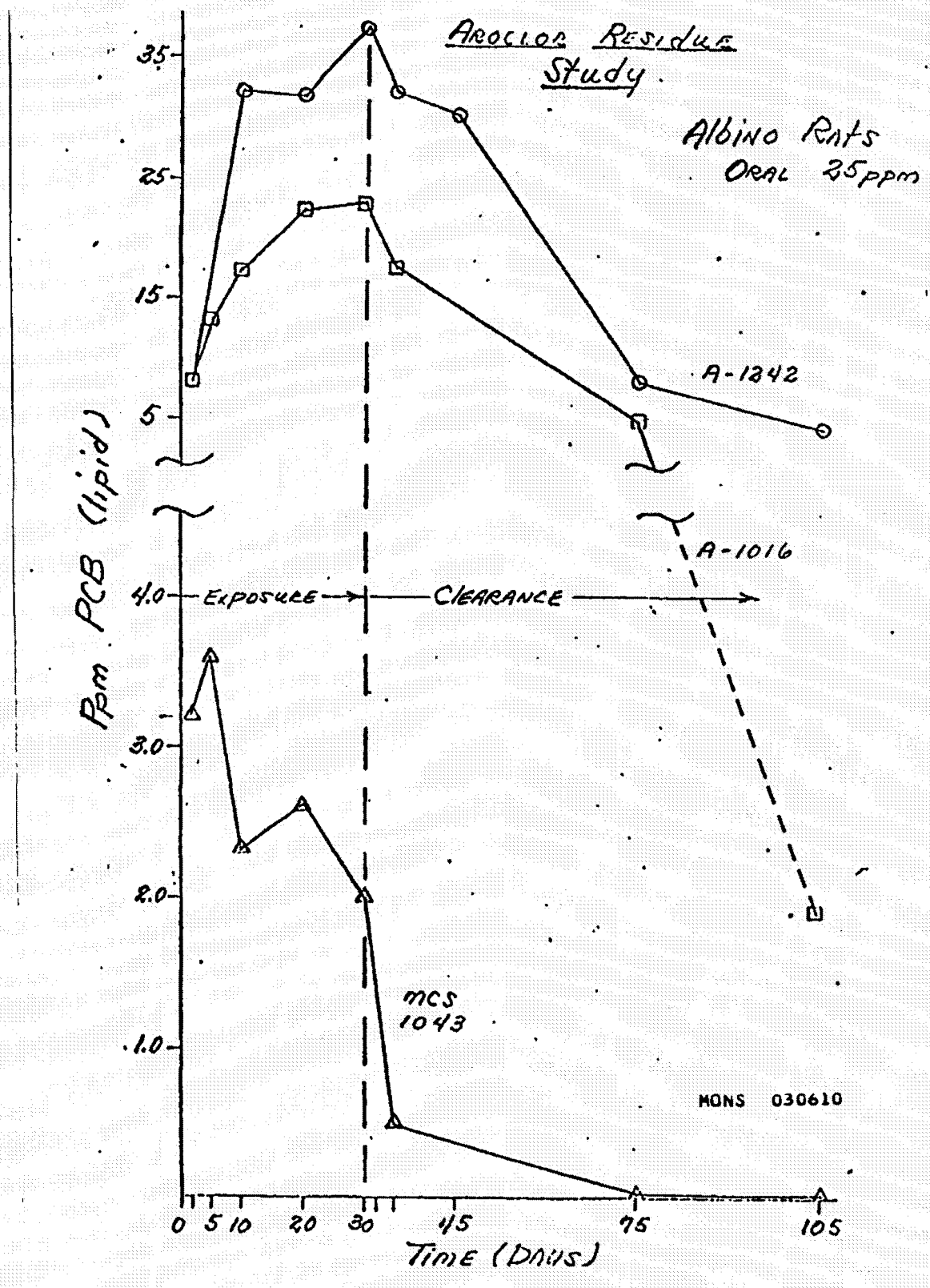
Discussions continued over dinner with the G.E. people at the Bayou Belle.

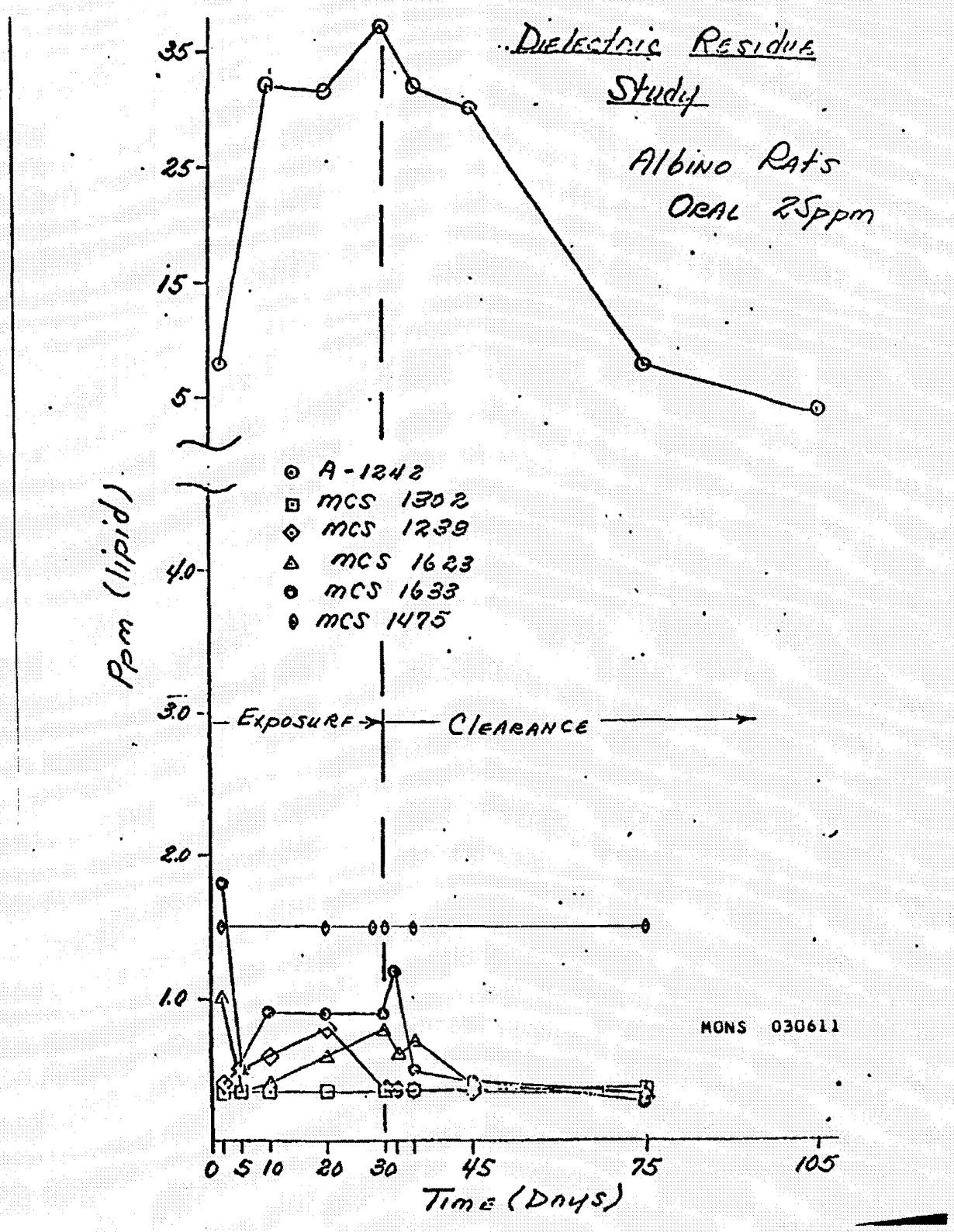
The G.E. people were taken for a brief tour of the WGK plant clean up facilities prior to departure from St. Louis the next A.M.

J. G. Bryant

db
Attach.

MONS 030609


Aroclor Residue Study
Albino Rats
Oral 25ppm
A-1242
A-1016
Exposure
Clearance
MCS 1043
MONS 030610
Ppm PCB (lipid)
Time (Days)
35
25
15
5
4.0
3.0
2.0
1.0
0
5
10
20
30
45
75
105


Dielectric Residue Study
Albino Rats
Oral 25ppm
35
25
15
5
4.0
3.0
2.0
1.0
Ppm (lipid)
A-1242
MCS 1302
MCS 1239
MCS 1623
MCS 1633
MCS 1475
Exposure
Clearance
MONS 030611
0 5 10 20 30 45 75 105
Time (Days)

GENERAL ELECTRIC VISIT
July 30-31, 1974

A G E N D A

Tuesday, July 30

8:30 AM	Introductions
8:35- 9:00 AM	Welcome and Statement of Objectives for Meeting - W. R. Richard
9:00-10:00 AM	G.E.'s View of Capacitor Technical Needs
10:00-10:15 AM	Coffee Break
10:15-10:45 AM	Monsanto's R&D Program - R. H. Munch
10:45-11:30 AM	Follow-up Test Results on R&D Samples Submitted to G.E.
11:30- 1:00 PM	LUNCH - St. Louis Room
1:00- 2:15 PM	Tour Labs
2:15- 3:15 PM	Review the Future Test Program
3:15- 4:00 PM	Review Forces Affecting the Manufacture and Distribution of Capacitors
4:15- 4:30 PM	Coffee Break
4:30- 5:00 PM	Summary
6:30 PM	Dinner - Bayou Belle

Wednesday, July 31

	Lv. Clayton Inn for Krummrich Plt.-E. E. Stewart
9:00 AM	Leave W. G. Krummrich Plant for Airport
10:20 AM	Depart St. Louis

PROPERTIES OF DIELECTRIC FLUIDS AND SYSTEMS

Properties	Aroclor 1016	MCS 1043	MCS 1489	MCS 1468	DCP	MCS 1475	MCS 1238	MCS 1588	MCS 1633
	Data on Fluids								
Sp. G. 25/25°C	1.360	1.246	1.348	0.969	0.983	0.988	1.018	1.030	1.0507
DK 25°C.	5.9	6.0	8.1	4.7	5.3	6.2	6.0	6.1	6.2
100°C.	4.85	5.0	6.5	4.0	4.3	5.0	5.1	5.1	5.1
Tan δ 60 Hz 100°C.	0.0025	0.0006	0.05	0.010	0.075	0.1	0.046	0.1	0.1
R_v 100°C x 10^9 Ω cm	150,000	10,000	2,000	3,075	211	500	1,000	620	1500
Viscosity, cs.									
@ 100°F.	14.3	5.6	21.5	23.0	29.0	26.4	9.1	7.14	9.68
@ 210°F.	2.12	1.47	2.54	4.2	4.3	4.33	1.98	1.96	2.08
Flash Point °F.	358°	318°	358°	425°	440°	432°	303°	325°	310°
Fire Point °F	None to BP (620)	None to BP (515)	410°	480°	-	495°	328°	350°	318°
AIT °F.	1185°	1155°	1125°	-	-	730°	835°	870°	770°
Hydrolysis***	0.00	0.00	0.00	0.18	0.11	0.17	0.00	0.00	0.00
	Data on 2 μF Capacitors* Impregnated with Above Fluids								
Capacitance @ 25°C.	1.95	1.99**	2.20	1.78	1.85	1.95	1.97	1.98	1.97
Dissipation Factor @ 25°C.	0.0034	0.0037	0.0040	0.0032	0.0033	0.0034	0.0037	0.00361	0.0038
Capacitance @ 90°C.	1.83	1.89**	2.07	1.67	-	1.84	1.87	1.87	1.87
Dissipation Factor @ 90°C.	0.0032	0.0037	0.0033	0.0028	-	0.0032	0.0039	0.0035	0.0034
Terminal to Case Resist.	240×10^6		89×10^9	11×10^9	1×10^9	2.6×10^9		51×10^9	-

* Standard 2 μF, 385 VAC Capacitors, 2 layers 0.00066, 0.90 density paper, 0.3% Unox 221 added.

** Standard 2 μF, 385 VAC Capacitors, 2 layers 0.00066, 0.90 density paper, without 0.3% Unox 221 added.

*** Neutralization number of sample with 0.5% water added heated for 168 hrs. at 210°F. in a stainless steel bomb along with an aluminum and a mild steel coupon.

MON S 030613

EVALUATION OF EXPERIMENTAL DIELECTRIC FLUIDS

FD PRICE
RA STENGER

7/30/74

MONS 030614

HIGHLIGHTS

A. MCS - 1043: MORE DEGRADABLE PCB

- GOOD LT PERFORMANCE IN PAPER CAPACITORS.
- INCREASED FLAMMABILITY.
- FURTHER WORK DEPENDS ON EPA DIRECTION.

B. MCS - 1489: HIGHER DK PCB

- SATISFACTORY LT PERFORMANCE IN PAPER CAPACITORS
- DISSIPATION FACTOR TOO HIGH FOR CONSIDERATION IN POWER CAPACITORS.
- HIGHER DK PROMISES SOME SI DESIGN ADVANTAGES.

MQNS 030615

HIGHLIGHTS CON'T

C. MCS - 1238 AND MCS - 1588: SULFONE-HYDROCARBON BLENDS.

- GOOD LT PERFORMANCE TO DATE.
- DESIRABLE CORONA AND DISSIPATION FACTOR CHARACTERISTICS
- GOOD IMPREGNATION BEHAVIOR.
- REFINING DIFFICULTIES.

D. MCS - 1475: SULFONE-ESTER BLEND.

- GOOD LT RESULTS TO 2500 HR.
- APPEARS COMPARABLE TO DOP.

OVERVIEW

THE SULFONE ADDITIVE TECHNOLOGY APPEARS TO HAVE REAL MERIT, BOTH IN COMBINATION WITH AND INDEPENDENT OF PCR FLUIDS. LONG TERM RATED CONDITION TESTING AND TOXICITY/BIODEGRADABILITY INFORMATION ARE NEEDED FOR FULL QUALIFICATION OF THIS TECHNOLOGY. SOME ADDITIONAL FORMULATION DEVELOPMENT MAY ALSO BE REQUIRED TO OPTIMIZE FOR SPECIFIC APPLICATIONS.

A. MCS - 1043

Liquid Properties

As reported 11/20/'72. All satisfactory

Type of Capacitors Treated

I. 1.95 ufd 600 VAC lighting capacitor 1.0 mil 2 sheet paper dielectric

II. 4 ufd 290 VAC lighting capacitor, 0.35 mil 1 sheet film dielectric.

Life Test Conditions and Results

I. 1000 VAC, 70°C
880 VAC, 85°C
775 VAC, 100°C

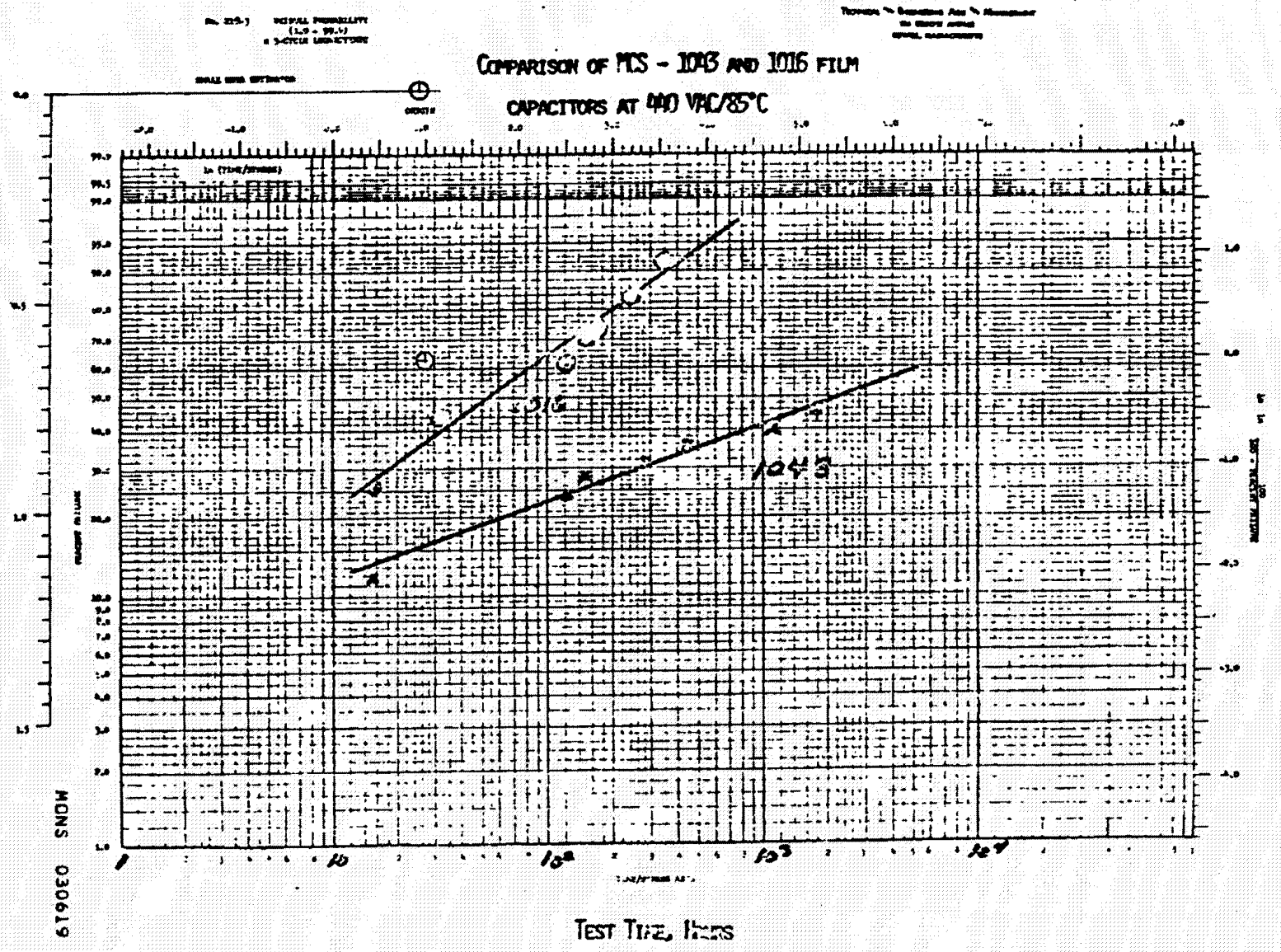
II. 440 VAC, 85°C

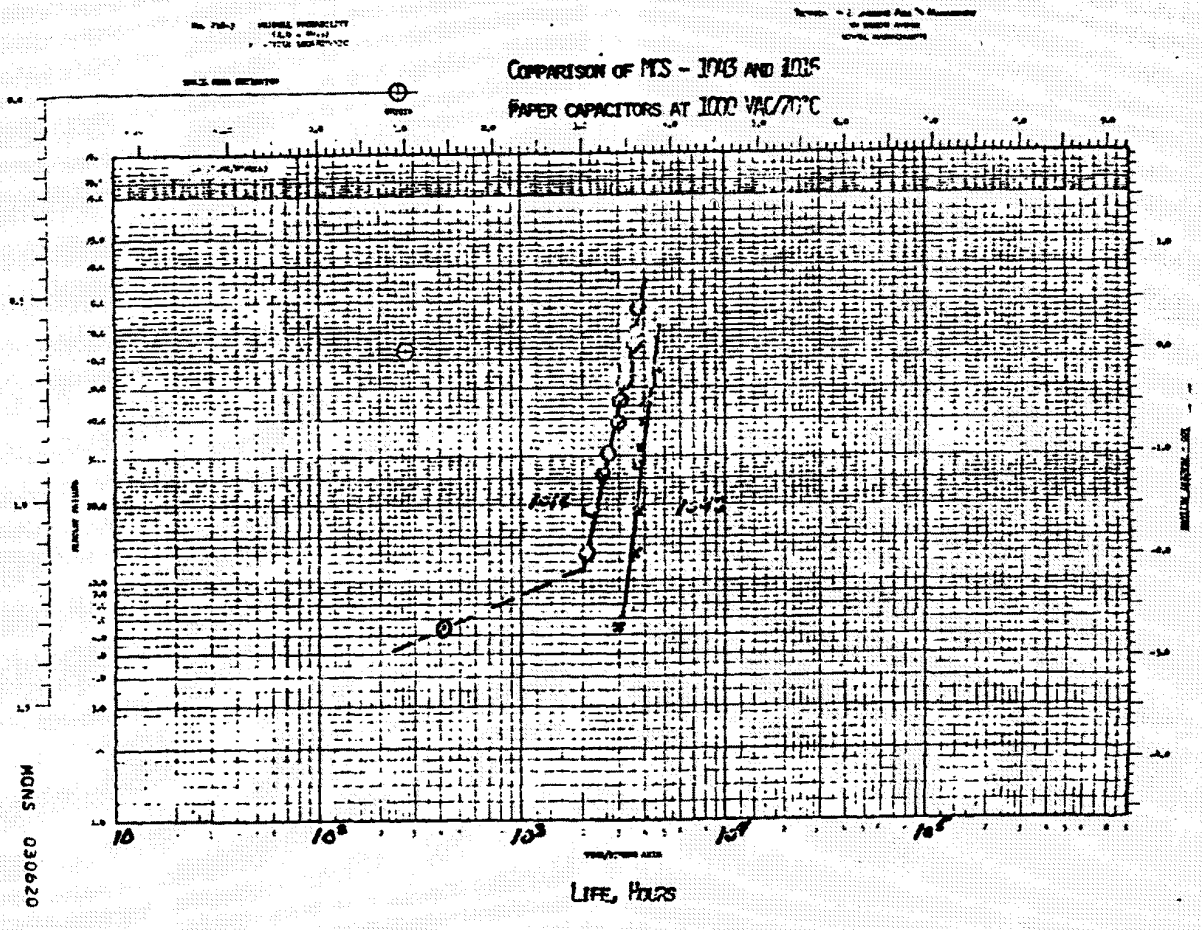
1043 groups have fewer failures than 1016 controls at all conditions. All paper unit testing is in the 15000 hr. range.

Conclusions

From a life and stability standpoint 1043 appears to be exceptionally good. Increased flammability vs. 1016 is of concern.

MONS 030618


COMPARISON OF MCS - 1043 AND 1016 FILM
CAPACITORS AT 440 VAC/85°C
1043
1016
TEST TIME, HOURS
MONS 030619


COMPARISON OF MTS - 1043 AND 1035
PAPER CAPACITORS AT 1000 VAC/70°C
LIFE, HOURS

MDNS 030620

B. MCS - 1489

Liquid Properties

Dissipation factor (100°C, 100 Hz)	0.8%
Dielectric constant, 25°C	8.0%
Viscosity, centistokes at 25°C	50
Specific Gravity, 25°C	1.346
Water content	22 ppm
Acid number (mg kom/gm)	0.004
Refractive index	1.6182

Type of Capacitors Treated

8 ufd 525 VAC high intensity discharge 1.26 mil 2 sheet paper dielectric. Found initial DF about 12% above 1016 as would be expected for higher DK.

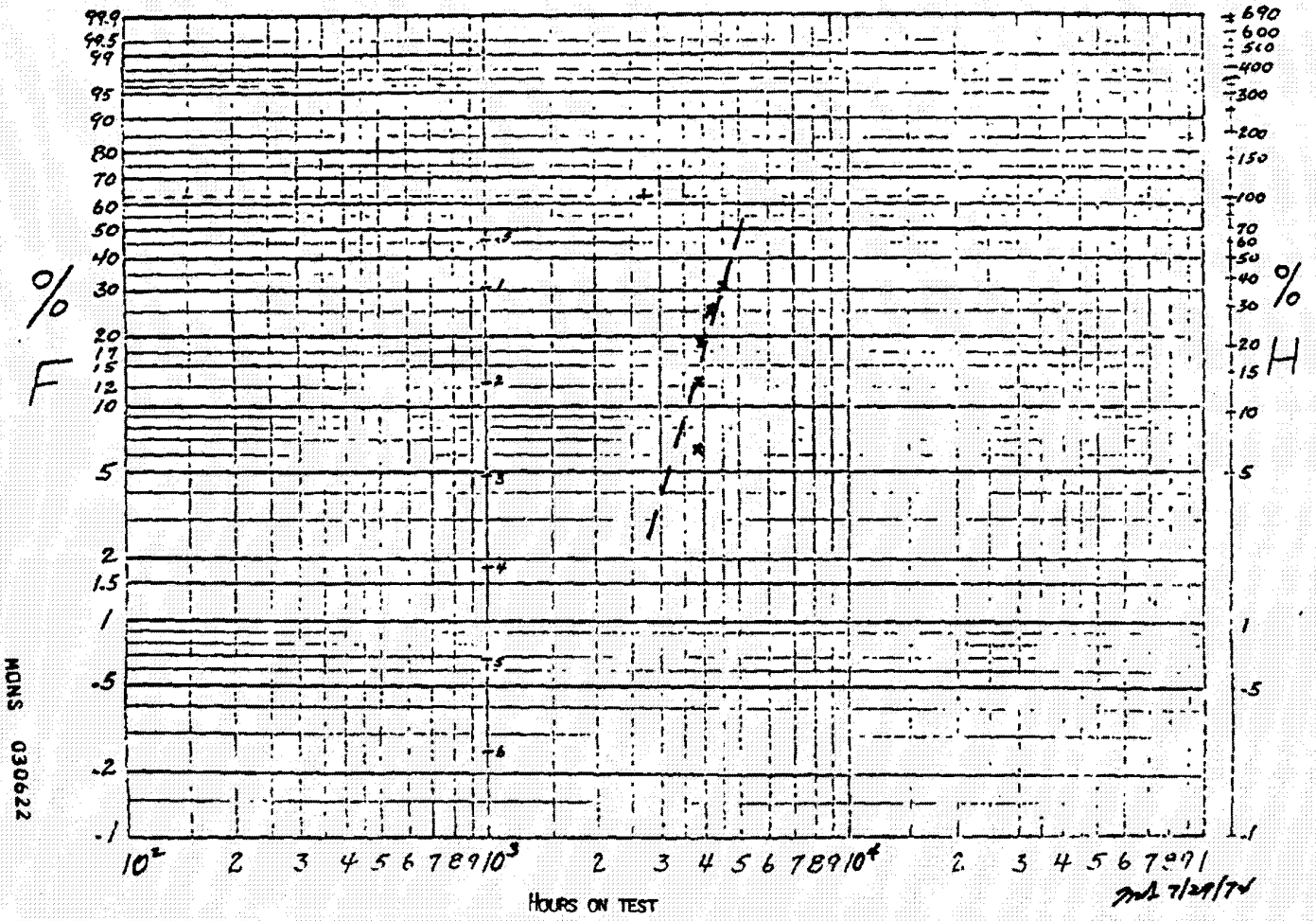
Life Test Conditions and Results

775 VAC, 100°C	5 failures in 15 at 4500 hr.
880 VAC, 85°C	1 failure in 14 at 4500 hr.

Stability is somewhat below 1016, in the DDP range. This liquid has considerable potential value, based upon the high dielectric constant.

MONS 030621

FAILURE DISTRIBUTION MONSANTO MCS 1480 + EPOXIDE IN 8μF,
525 VAC PAPER CAPACITORS ON LIFE TEST AT 775 VAC, 110°C



MONS 030622

7/29/74

C. MCS - 1238

Liquid Properties

Dissipation factor (100°C, 100HZ)	5.9
Dielectric constant, 25°C	6.0
Viscosity, centistokes, 25°C	16
Specific gravity, 25°C	1.016
Water content	-
Acid number (mg KOH/gm)	0.005
Flash point (coc)	152°C
Refractive index	1.5795

Type of Capacitors Treated

I. 4 ufd 290VAC lighting capacitor, 0.32 mil single sheet film dielectric.

II. 1.9 ufd VAC lighting capacitor, 1.0 mil 2 sheet paper dielectric.

Life Test Results and Other Findings

I. 440 VAC/85°C 7 failures in 24 to 5500 hr. vs. 10/24 for 1016.

II. 775 VAC/100°C 5 failures in 15 to 7000 hr. vs. no failures for 1016.

880 VAC/85°C No failures in 15 for 7000 hr.

1000 VAC/70°C 11 failures in 15 to 6000 hr. vs. 12/15 for 1016.

MONS 030623

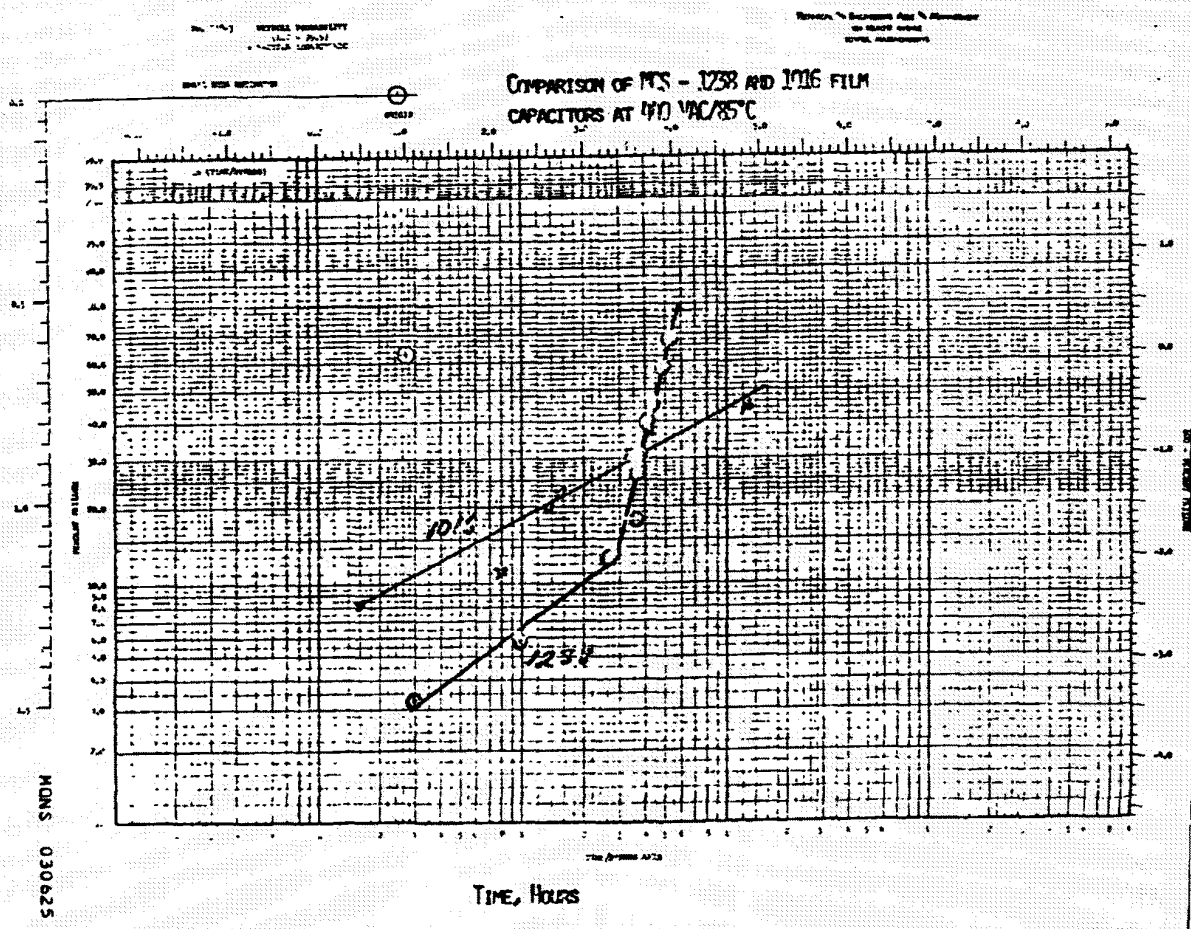
Corona measurements indicate close similarity to 1016.

Permeability through polypropylene is in the 1016 and mineral oil range, substantially above ester impregnants.

Solubility in polypropylene, as measured by swell factor at 60°C is comparable to 1016.

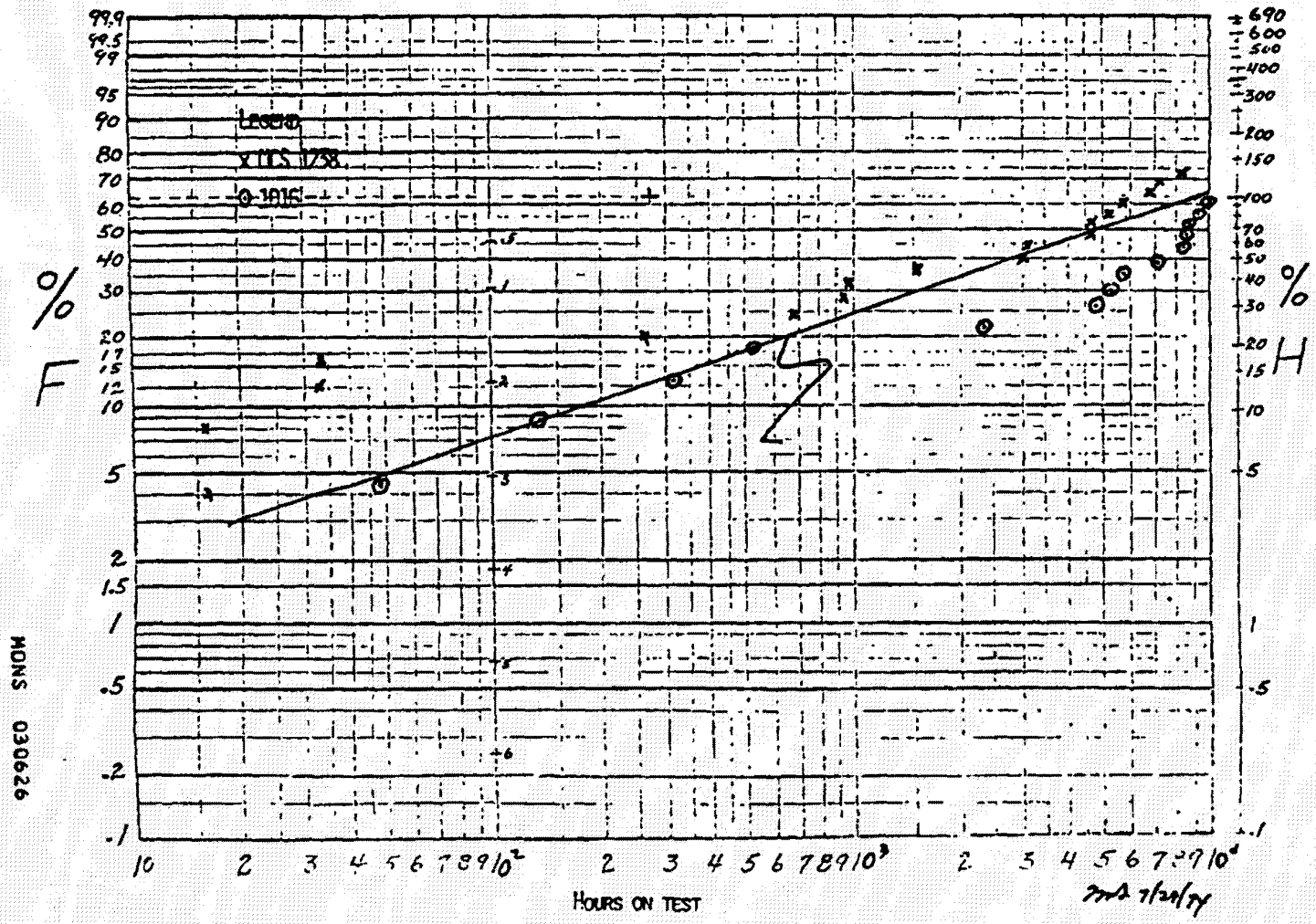
Interim Conclusions

This fluid appears to have utility for power capacitors. It is difficult to refine to low DF and to hold low DF during treat. (Preliminary work suggests that use of an antioxidant will alleviate this problem.) The low flash point is of concern. The life test results suggest a possible deficiency at high operating temperatures, above 90°C.


COMPARISON OF MCS - 1238 AND 1016 FILM
CAPACITORS AT 400 VAC/85°C
1012
1238
TIME, HOURS
MONS 030625

LIFE DISTRIBUTION COMPARISON OF MCS 1238 AND 1015 IN 4μF

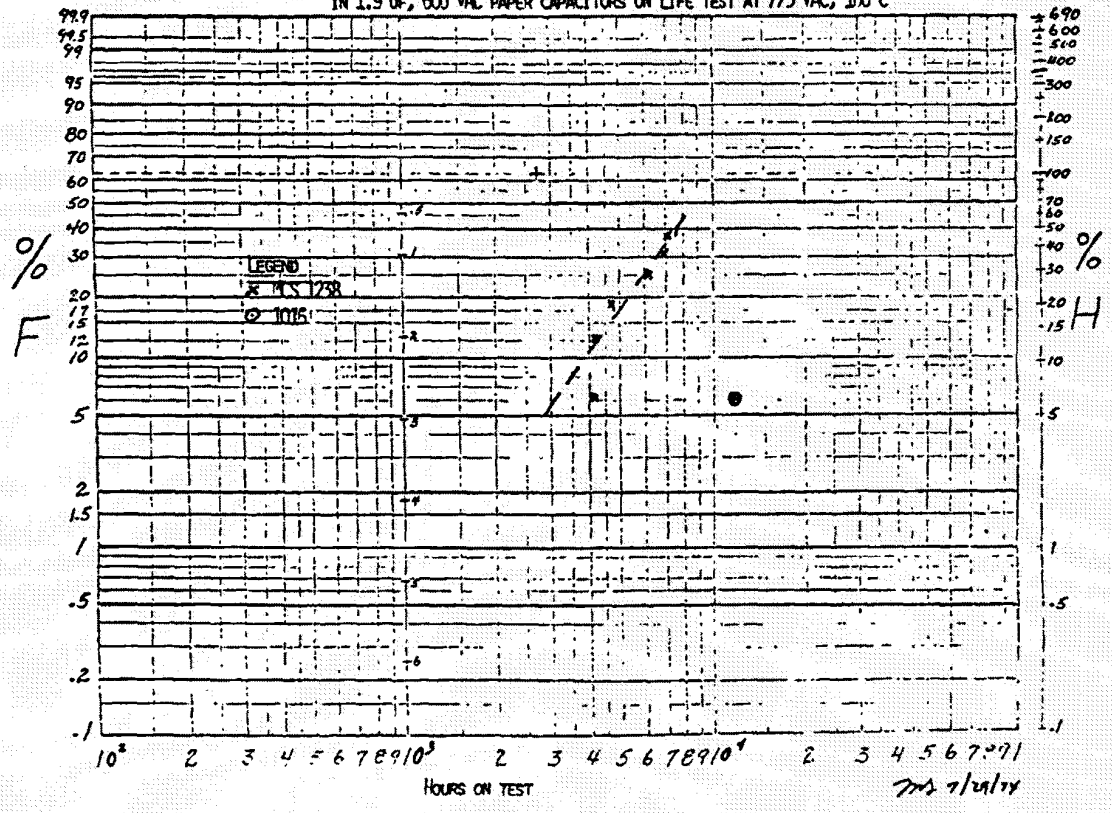
PP FILM CAPACITORS ON LIFE TEST AT 440 VAC, 85°C.



MONS 030626

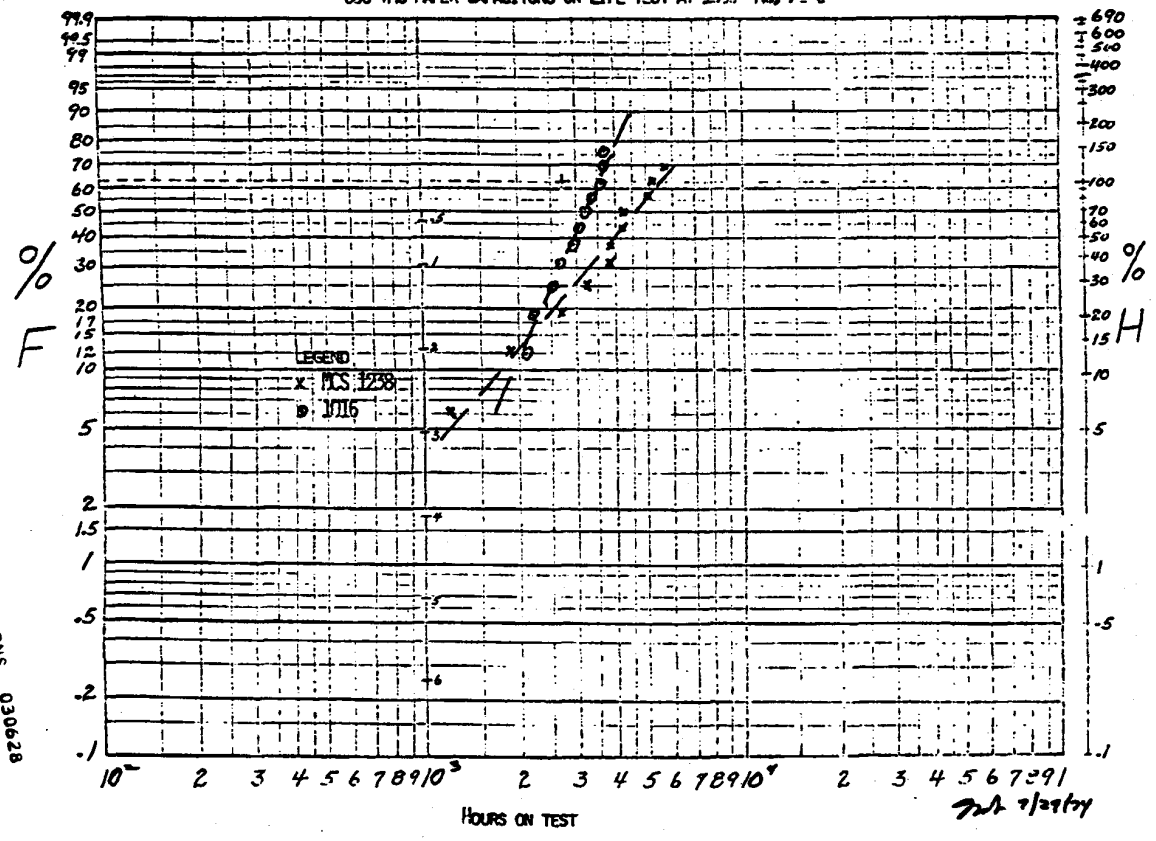
LIFE DISTRIBUTION COMPARISON OF 1016 AND MCS 1238

IN 1.9 UF, 600 VAC PAPER CAPACITORS ON LIFE TEST AT 775 VAC, 100°C



MDNS 030627

LIFE DISTRIBUTION COMPARISON OF 1016 AND MCS 1238 IN 1.0 UF,
600 VAC PAPER CAPACITORS ON LIFE TEST AT 1000 VAC, 70°C



MDNS 030628

D. MCS - 1588

Liquid Properties

Dissipation factor (100°C, 100 Hz)	3-5%
Dielectric constant, 25°C	6.1
Viscosity, centistokes at 25°C	11
Specific gravity, 25°C	1.030
Water content	-
Acid number	-
Flash point, coc	160°C
Refractive index	-

Type of Capacitors Treated

I. 1.95 ufd 600 VAC, lighting capacitor 1 mil 2 sheet paper dielectric.

II. 8 ufd 525 VAC, HID capacitor 1.26 mil 2 sheet paper dielectric.

III. 0.9 ufd 1400 VAC Magvar pad (2 groups).

Had to repeat treat to obtain satisfactory dissipation factor. Also had difficulty refining to usual range of liquid TF.

Life Test Conditions and Results.

I. 775 VAC/100°C

II. 775 VAC/100°C

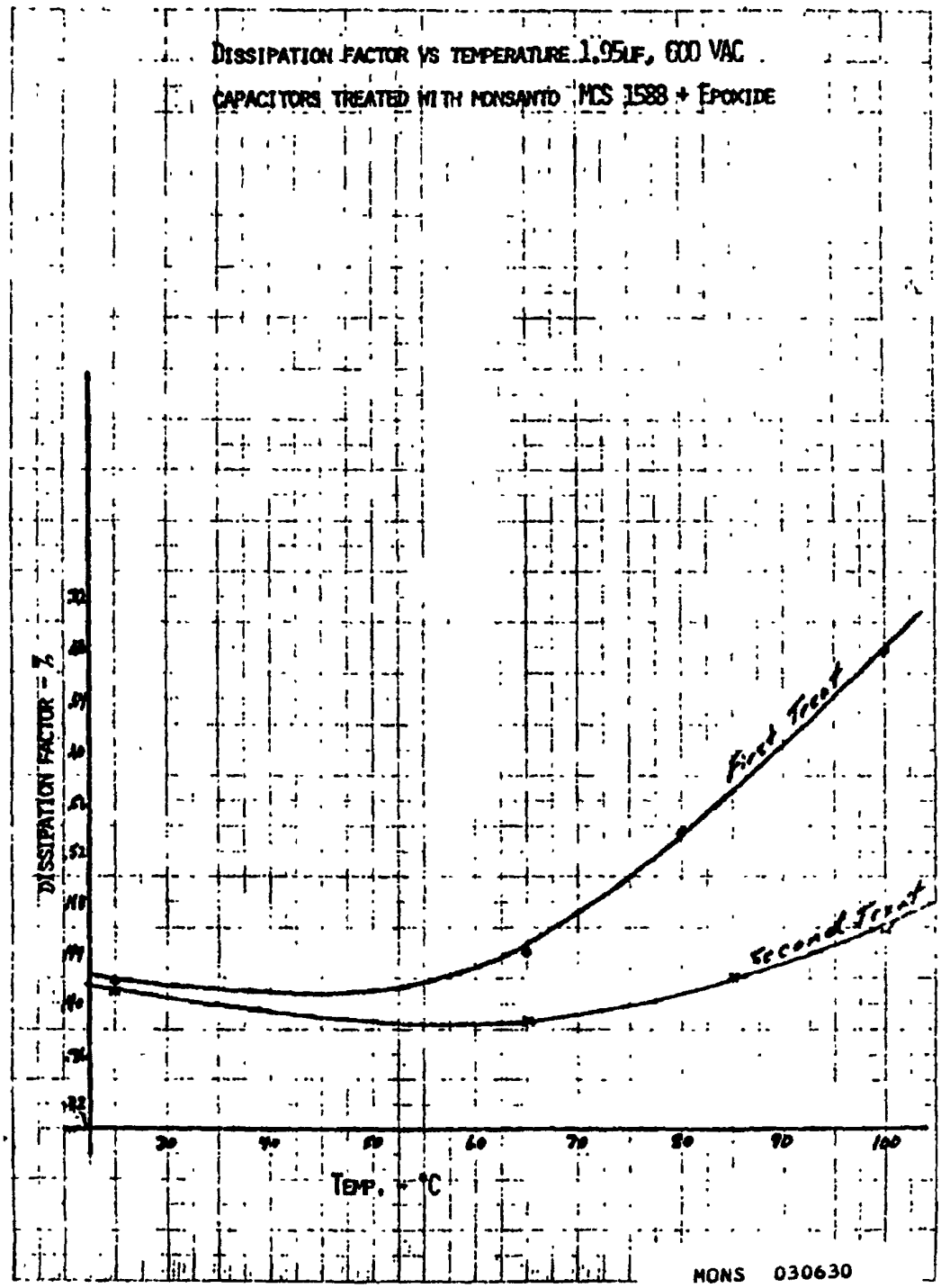
III. 2600 VAC/70°C

Life tests just beginning. No failures.

MONS 030629

Interim Conclusions

Too early for definitive results, but liquid property comparisons with MCS - 1238 make this fluid attractive thus far.


DISSIPATION FACTOR VS TEMPERATURE 1.95uF, 600 VAC
CAPACITORS TREATED WITH MONSANTO MCS 1588 + EPOXIDE
DISSIPATION FACTOR = %
TEMP. - °C
30
40
50
60
70
80
90
100
First Treat
Second Treat
MONS 030630

E. MCS - 1475

Liquid Properties

Dissipation factor (100°C, 100 Hz)	2.80%
Dielectric constant, 25°C	5.8
Viscosity, centistokes, 25°C	50
Water content	98 ppm
Acid number (mg KOH/gm)	0.003
Flash point (COC)	228°C
Refractive index	1.4906
Specific gravity, 25°C	0.984

Type of Capacitors Treated

10 ufd 370 VAC motor run capacitor 0.8 mil 2 sheet paper dielectric. Dissipation factor (100°C, 100Hz) 0.45%

Life Test Conditions and Results

550 VAC, 80°C

2 failures in 15 at 2500 hr.

Interim Conclusions

Possibly slightly inferior to 1916 in this unit at this condition. Similar to DOP.

MONS 030631