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NBSIR 73-146

# Outdoor Performance of Plastics X. Final Update of Weathering Data

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Walter J. Rossiter, Jr.

Center for Building Technology  
Institute for Applied Technology  
National Bureau of Standards

March 1973

Final Report

Prepared for  
Manufacturing Chemists Association  
1825 Connecticut Avenue, N. W.  
Washington, D. C. 20009



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**X. FINAL UPDATE OF WEATHERING DATA**

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**U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary**  
**NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director**

for the  
of the

## Abstract

Twenty plastics samples have been weathered in Arizona, Florida, and Washington, D. C. for 72 months. The weathering of these samples has been followed by measuring changes in the specimen's color, tensile, flexure, gloss, and haze properties. Computer-generated graphs of these changes with time are presented.



This is the final updating of the Manufacturing Chemists' Association's (MCA) project which studied the outdoor performance of plastics. Since 1966, twenty plastics samples (Table I) have been exposed outdoors at three different exposure sites (Table II) which represent varying climatic conditions encountered in the United States. The MCA project and preliminary results have been described in a series of National Bureau of Standards Reports. These reports [1-9]\*, all entitled Outdoor Performance of Plastics, have the following subtitles:

- I. Introduction and Color-Change [1].
- II. Tensile and Flexural Properties [2].
- III. Statistical Model for Predicting Weatherability [3].
- IV. Significance of Climate [4].
- V. Surface Roughness [5].
- VI. Electrical Properties [6].
- VII. Haze and Gloss [7].
- VIII. First Update of Weathering Data [8].
- IX. Second Update of Weathering Data [9].

Changes in those properties listed in the above subtitles were the means for determining the outdoor performance of the twenty samples. A computer was used for data storage and retrieval. Graphs of property vs. outdoor exposure time were generated by the computer. These graphs were reproduced in the various reports as the method of reporting property changes.

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\* Numbers in brackets refer to references which are found in the back of this report.

From the preliminary results, it was decided that color, tension, flexure, gloss, and haze would be the significant properties to follow for the remainder of the project. The samples remaining have now been exposed outdoors for 72 months. These five properties have been measured for each plastic. The physical testing was again performed by MCA member companies (Table III), and the test results sent here to the National Bureau of Standards for incorporation with the earlier data. Although these data were originally reported in three separate NBS reports [1, 2, 7], the data through 72 months for the five properties are all presented in this single report.

Experimental details are not given here; such details can be found in the earlier reports. Again, the data are presented as reproductions of the computer-generated graphs (Figures 1-81B). These graphs differ from the earlier ones in that the X-axis (time in months) has been expanded to 72 months. Thus, the data points are compressed when compared to those of the original graphs.

This report includes all previous data. Some plastics have failed in the field and obviously there are no additional data for these samples. Graphs with the expanded time have been reproduced for those samples for which there are no additional data. This report is meant to be a replacement for the two previous supplemental ones [8, 9]. The weathering of the plastics can be followed without reference to them. The graphs are identical except for the additional data.

The color data presented in the first report [1] were erroneous. These data were corrected in the first supplemental report [8]. No



comparisons can be made between the graphs for color change in the first report and any of the updates.

This report is only intended as a presentation of the new data. No discussion of the accumulated data is presented.

## References

- [1] "Outdoor Performance of Plastics. I. Introduction and Color-Change", J. E. Clark, N. E. Green, and P. Giesecke, NBS Report #9912, Sept. 1968.
- [2] "Outdoor Performance of Plastics. II. Tensile and Flexural Properties", J. E. Clark, G. E. Gulmer, R. C. Neuman, and J. A. Slater, NBS Report #10014, March 1969.
- [3] "Outdoor Performance of Plastics. III. Statistical Model for Predicting Weatherability", J. E. Clark and J. A. Slater, NBS Report #10016, Oct. 1969.
- [4] "Outdoor Performance of Plastics. IV. Significance of Climate", J. E. Clark and C. Bal Krishna, NBS Report #10156, Jan. 1970.
- [5] "Outdoor Performance of Plastics. V. Surface Roughness", J. E. Clark, C. Bal Krishna, H. C. Gunst, and J. R. Dagon, NBS Report #10179, March 1970.
- [6] "Outdoor Performance of Plastics. VI. Electrical Properties", J. E. Clark, J. A. Slater, and V. L. Bergeron, NBS Report #10185, March 1970.
- [7] "Outdoor Performance of Plastics. VII. Haze and Gloss", J. E. Clark, C. Bal Krishna, G. C. Claver, and F. H. McTigue, NBS Report #10188, March 1970.
- [8] "Outdoor Performance of Plastics. VIII. First Update of Weathering Data", W. J. Rossiter, Jr. and W. D. Hayes, Jr., NBS Report #10479, September 1971.
- [9] "Outdoor Performance of Plastics. IX. Second Update of Weathering Data", W. J. Rossiter, Jr., NBS Report #10856, May 1972.

Table I

List of Twenty Plastics

<u>Base Polymer</u>	<u>Plastic</u>
Polyethylene	Translucent - 1 mil - 60 mil
Poly (methyl methacrylate)	Clear - 60 mil
Poly (vinyl fluoride)	Clear - 1 mil
Poly (ethylene terephthalate)	Clear - 5 mil
Polyester/x-linked	Clear - 60 mil
Poly (vinyl chloride)	Clear - 4 mil - 10 mil - 60 mil <u>Ba-Cd</u> Clear - 4 mil - 10 mil - 60 mil <u>Sn</u> Clear - 60 mil White - 4 mil - 10 mil - 60 mil <u>Ba-Cd</u> White - 4 mil - 10 mil - 60 mil <u>Sn</u> White - 60 mil

Table II

Exposure Sites

<u>Name and Location</u> *	<u>Letter Designation for Graphs</u>
Desert Sunshine Exposure Tests, Inc. Phoenix, Arizona	A
South Florida Test Service, Inc. Miami, Florida	F
Old NBS Site Connecticut & Van Ness Streets Washington, D. C.	W

\* Samples were placed on the exposure racks facing south at 45° from the horizontal.

Table III

Plastics Evaluation

Property	Company & Location
Color	American Cyanamid Company Stamford, Connecticut
Tensile Flexure	W. R. Grace & Company Clarksville, Maryland
Haze	Monsanto Company Indian Orchard, Massachusetts
Gloss	Hercules Incorporated Wilmington, Delaware

## List of Figures

### Numbers

1 - 20	Color-change, $\Delta E$ (Delta E)
21 - 40	Ultimate Elongation (% of Initial Value)
41 - 48	5 Percent Stress (PSI)
49 - 68	Gloss (in percent)
69A - 81A	Haze at 421 nm (in percent)
69B - 81B	Haze at 550 nm (in percent)

FIGURE 1

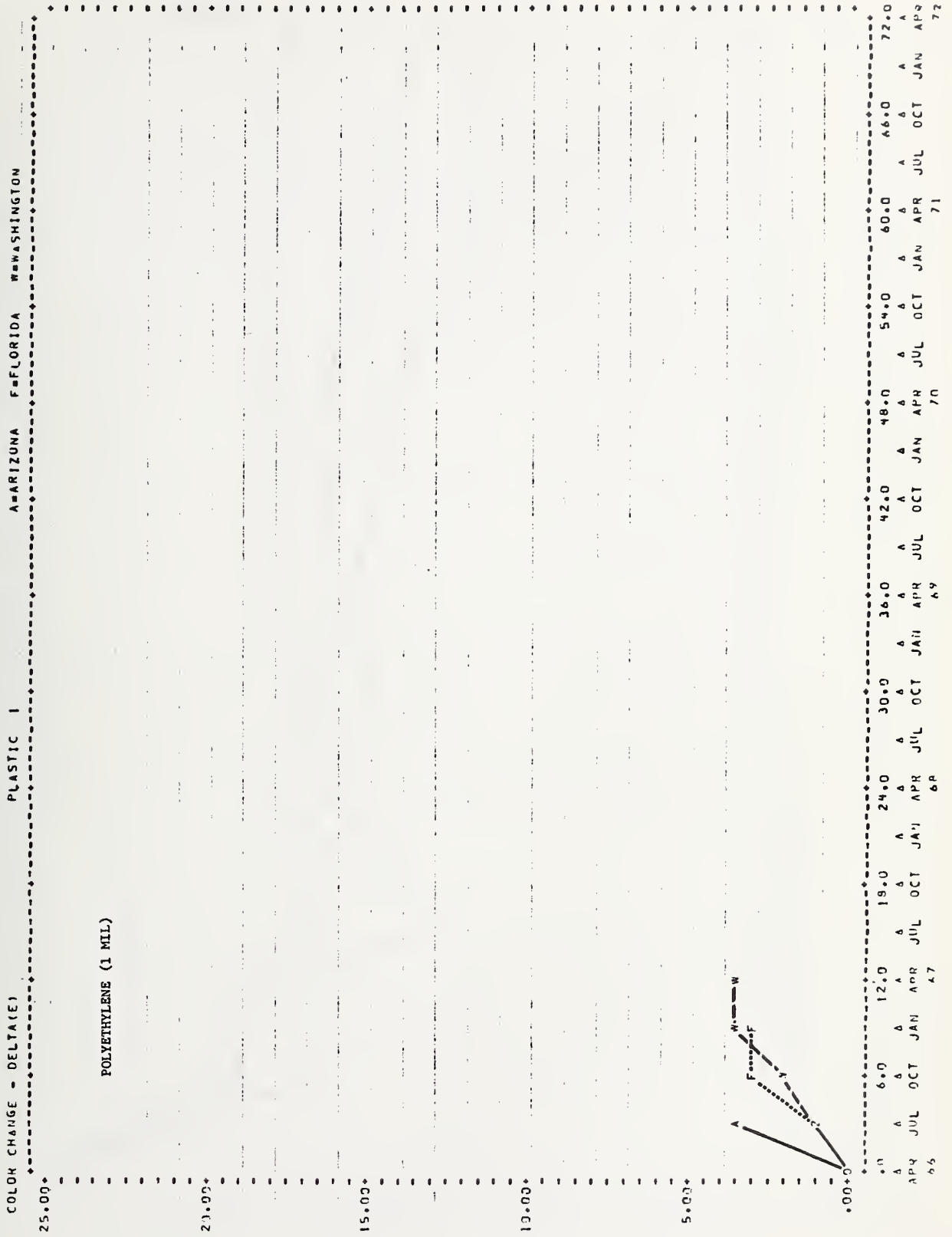


FIGURE 2

COLOR CHANGE - DELTA(E) PLASTIC 2 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYETHYLENE (60 MIL)

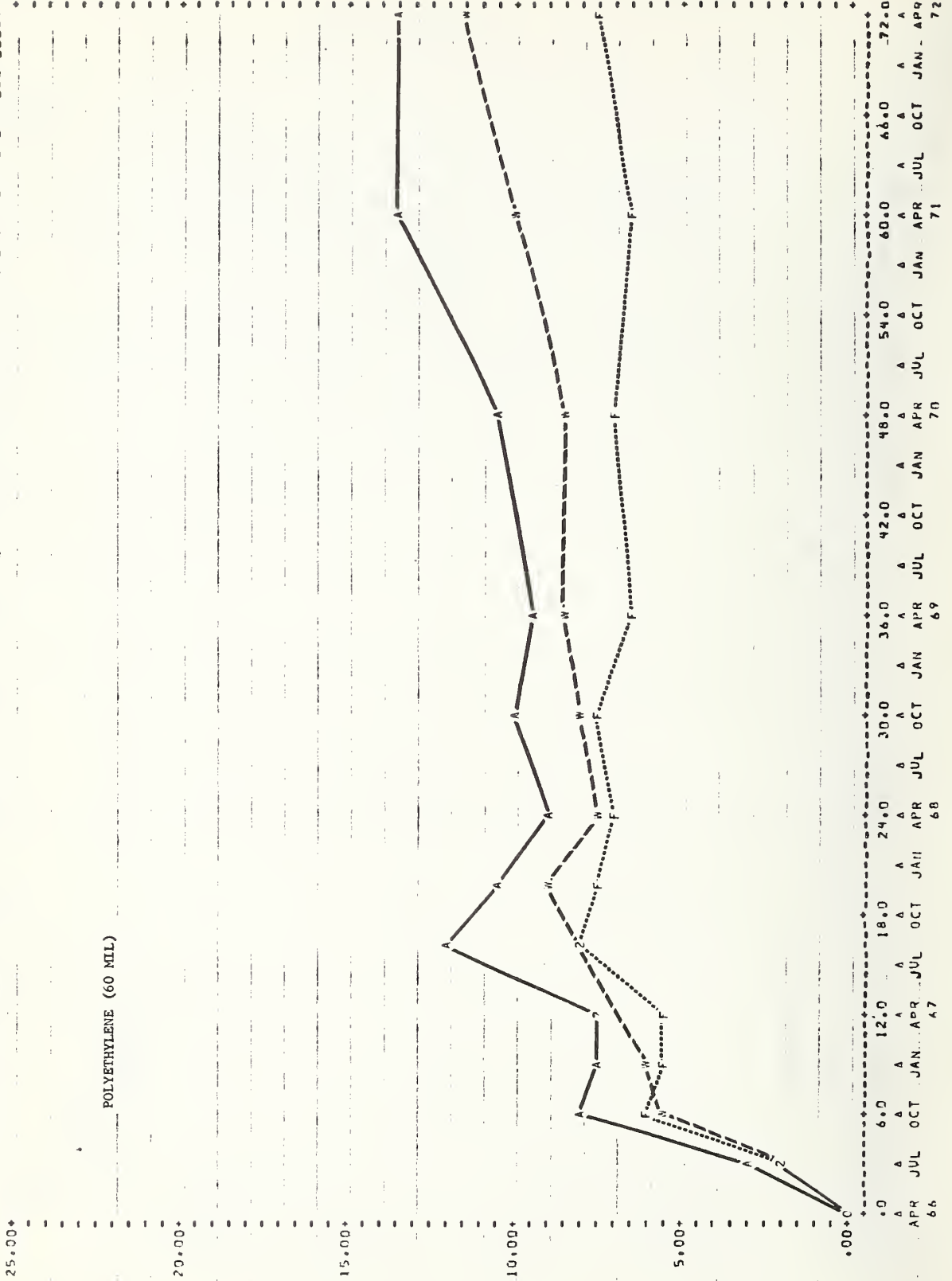




FIGURE 3

COLOR CHANGE - DELTA(E) PLASTIC 3 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYMETHYL METHACRYLATE (60 MIL)

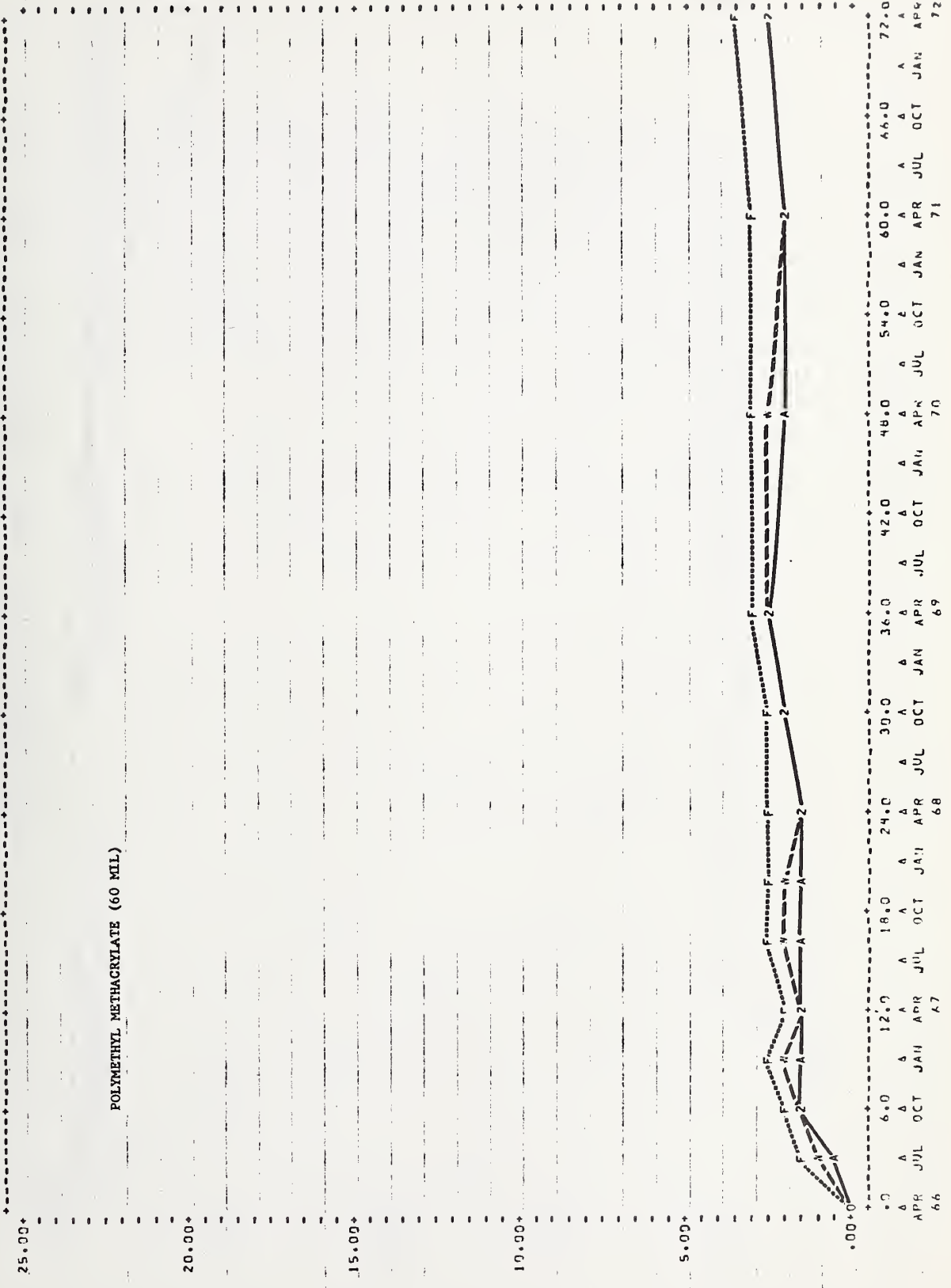
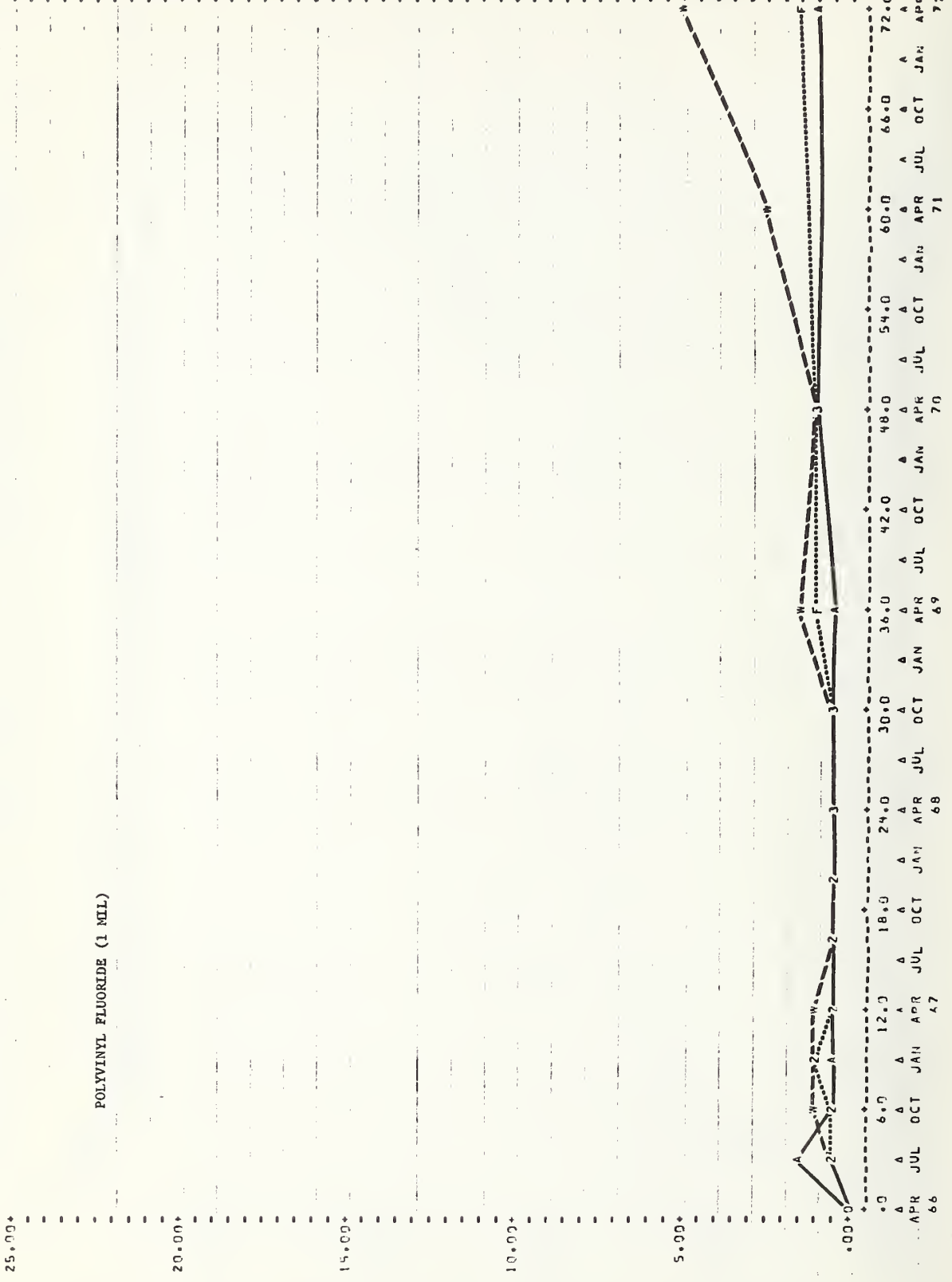


FIGURE 4

COLOR CHANGE - DELTA(E) PLASTIC 4 ARIZONA F=FLORIDA W=WASHINGTON



POLYVINYL FLUORIDE (1 MIL)

25.00  
20.00  
15.00  
10.00  
5.00  
0.00

APR JUL OCT APR JUL OCT APR JUL OCT APR JUL OCT APR JUL OCT APR JUL OCT APR JUL OCT

FIGURE 5

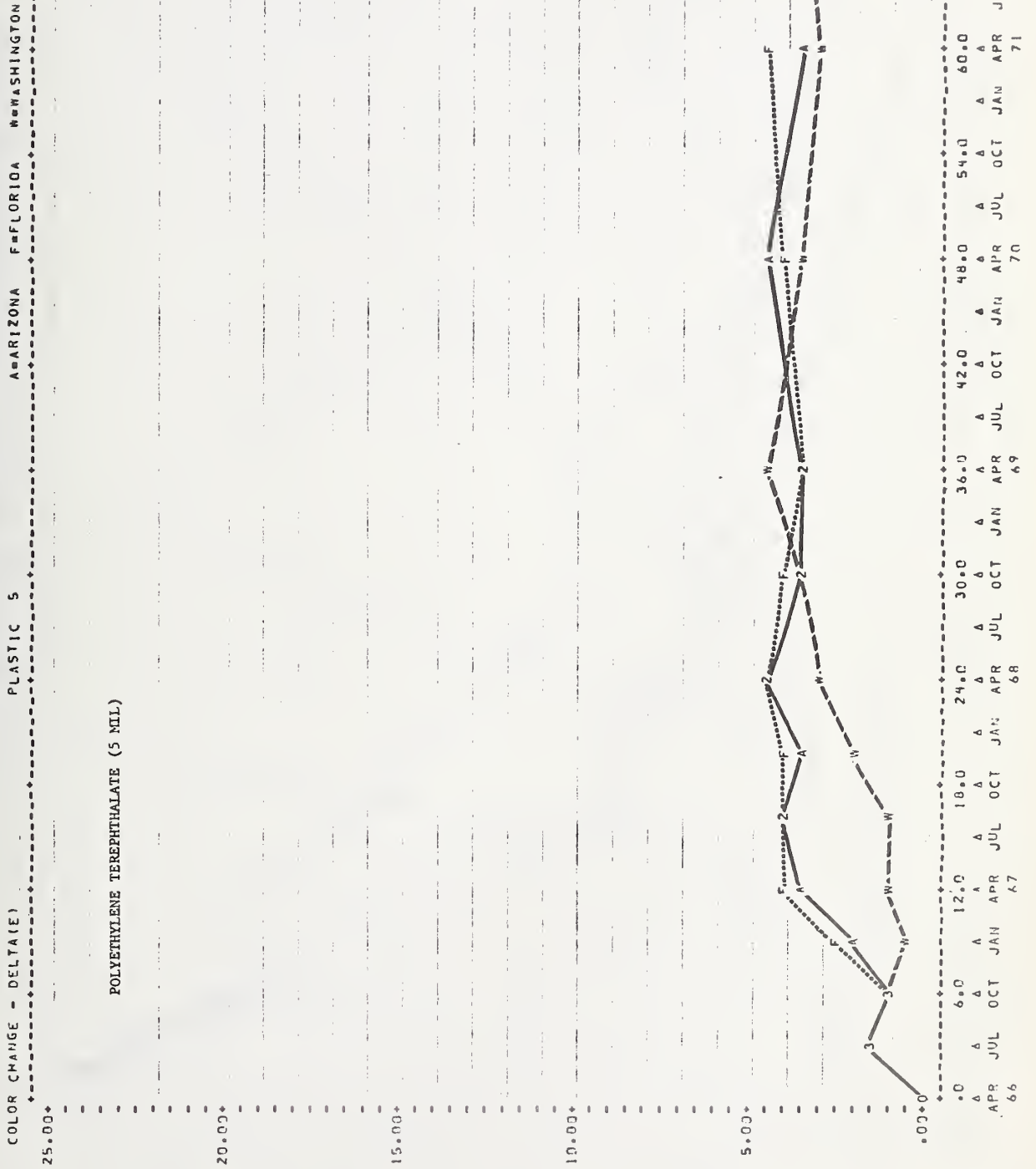
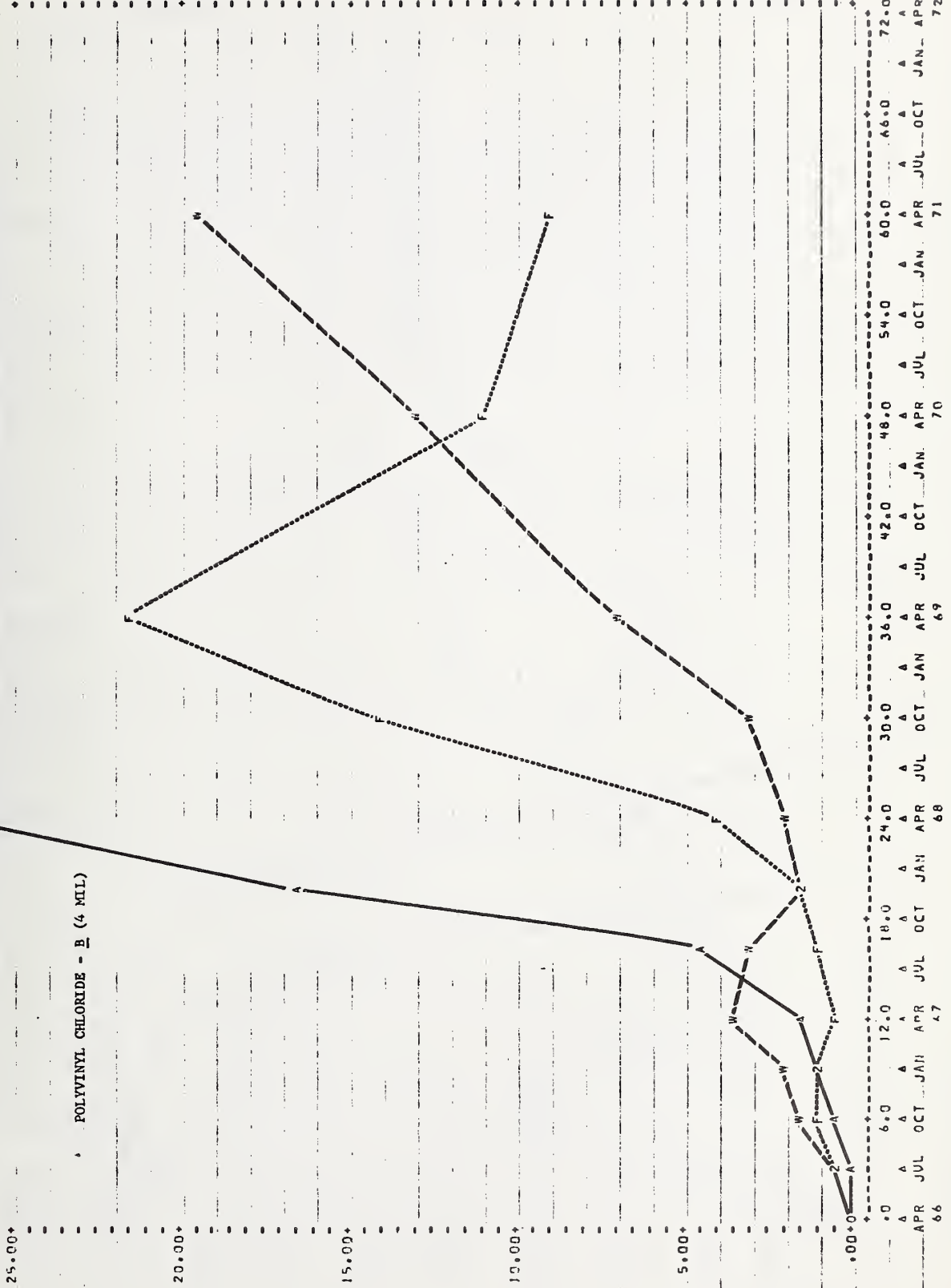




FIGURE 7

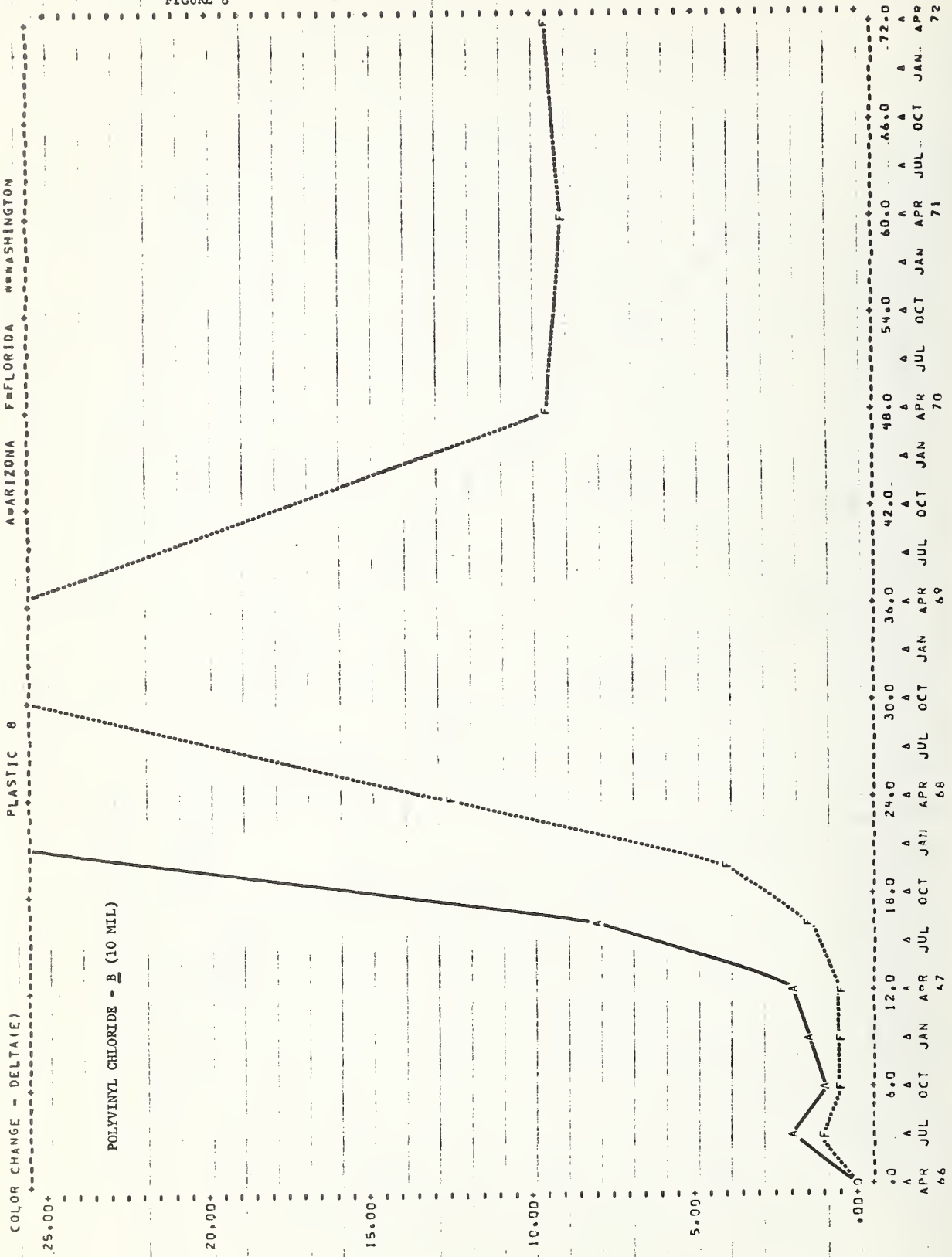
COLOR CHANGE - DELTA(E) PLASTIC 7 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - B (4 MIL)



NOTE. 2 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 8



NOTE. 6 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.



FIGURE 10

COLOR CHANGE - DELTA(E)

PLASTIC 10

A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - C (4 MIL)

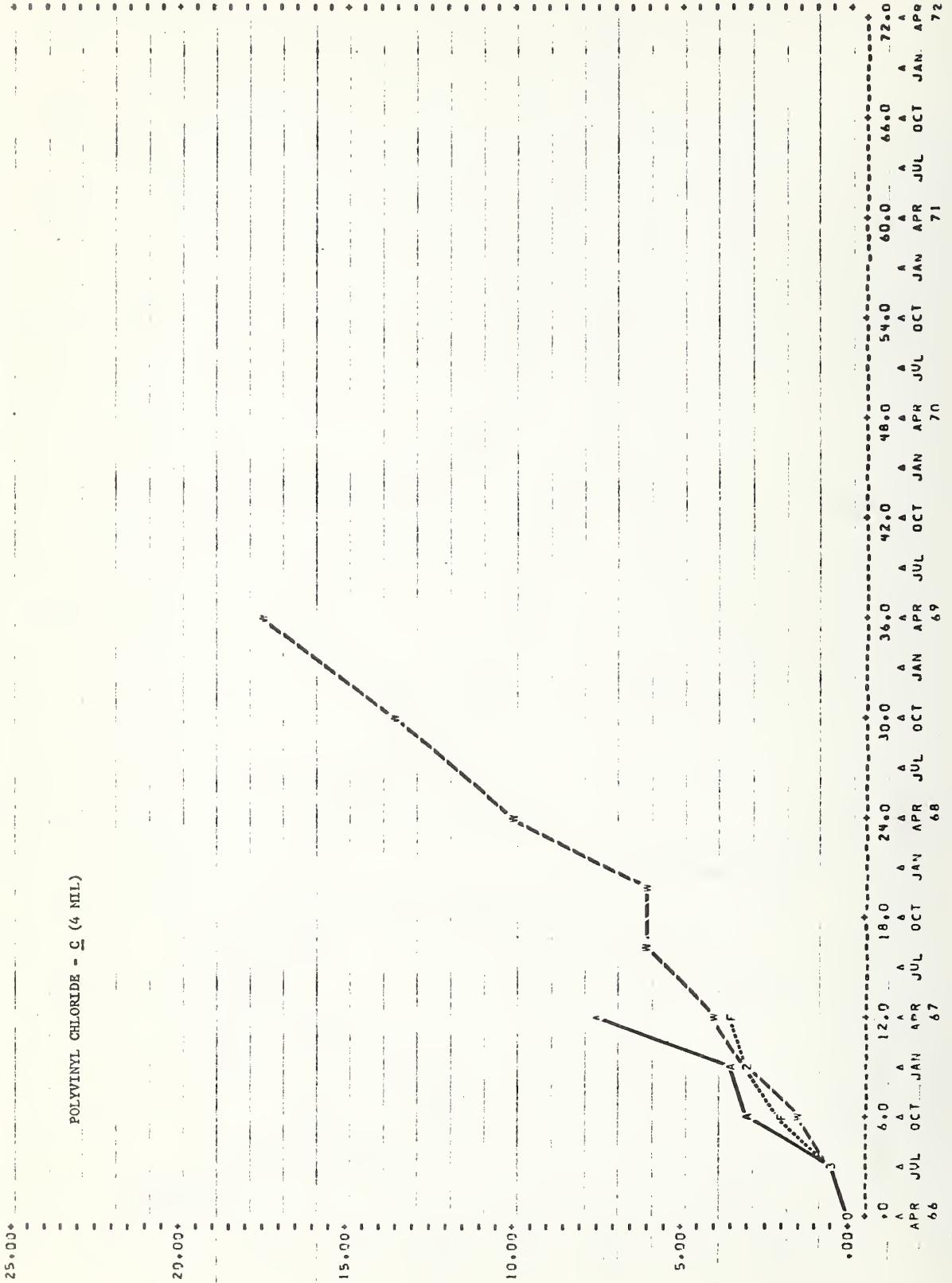
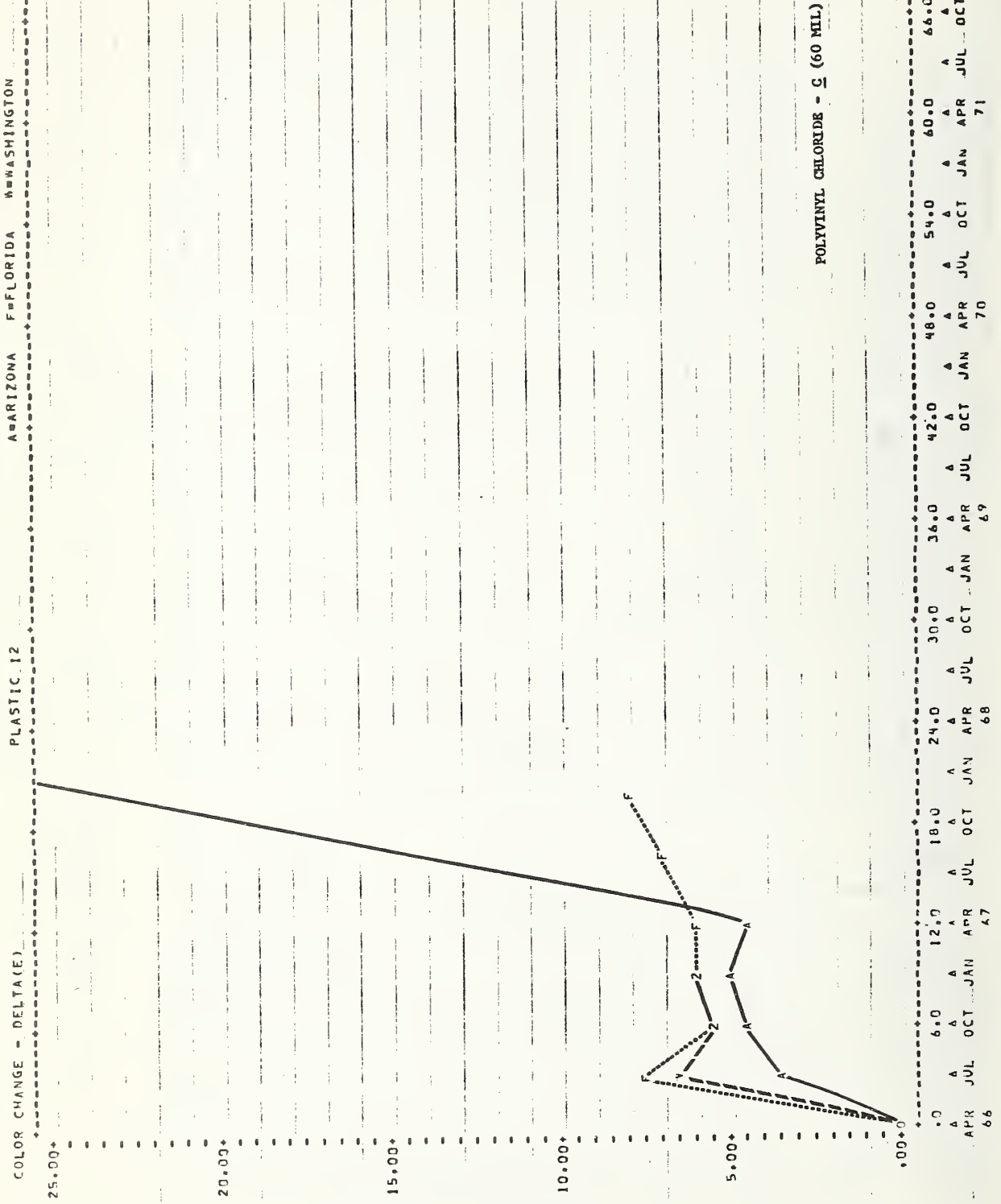






FIGURE 12



NOTE. 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.



FIGURE 14

COLOR CHANGE - DELTA(E) PLASTIC 14 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - A (4 MIL)

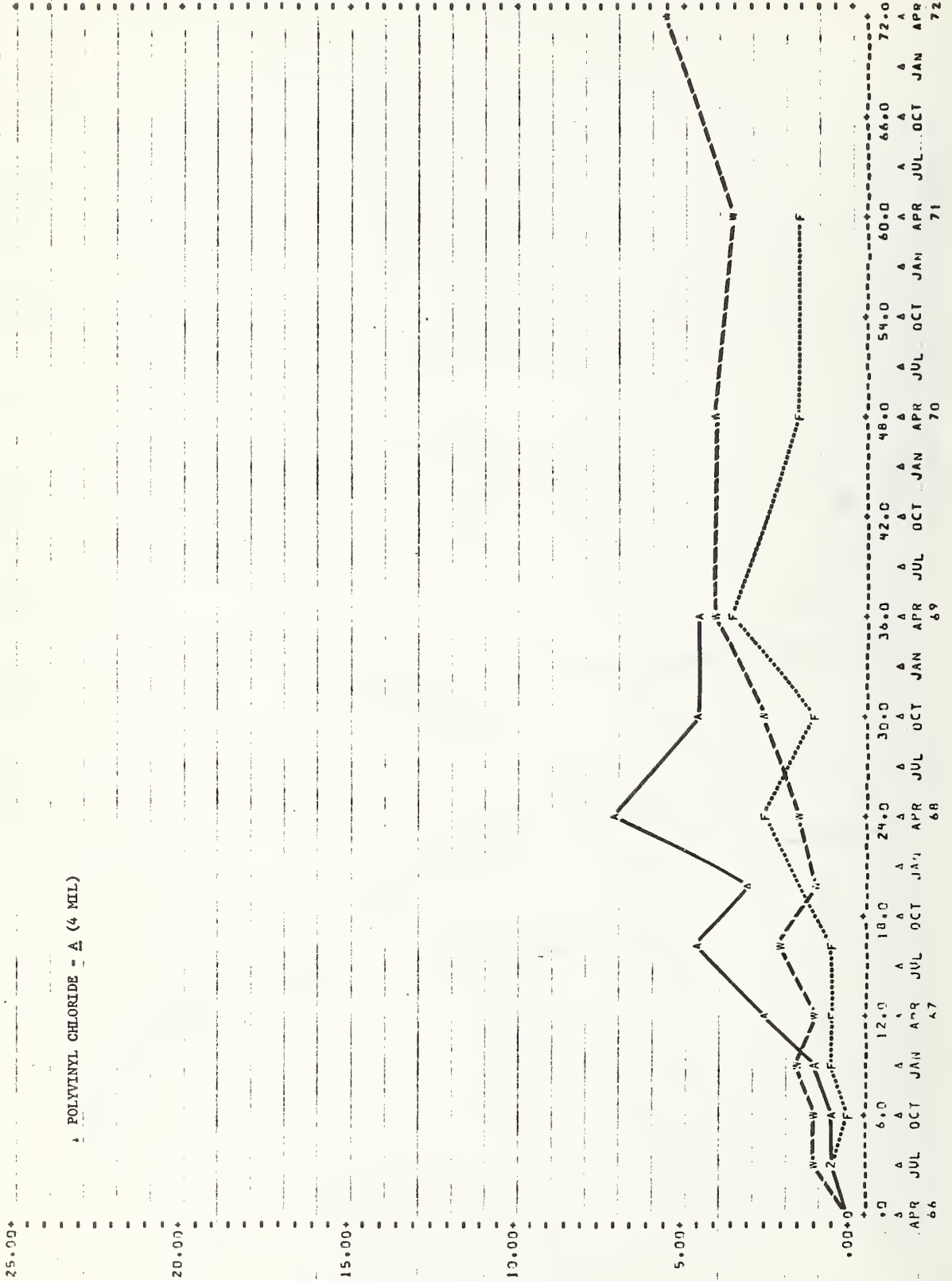


FIGURE 15

COLOR CHANGE - DELTA(E) PLASTIC 15 A=ARIZONA F=FLORIDA W=WASHINGTON

25.00+

POLYVINYL CHLORIDE - A (10 MIL)

20.00+

15.00+

10.00+

5.00+

1.00+

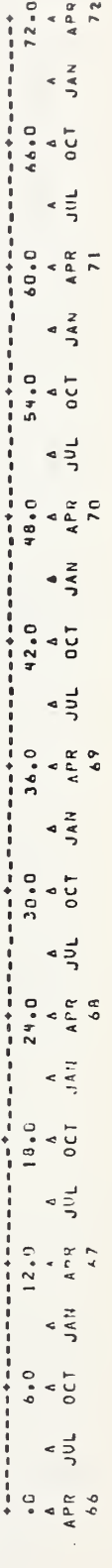


FIGURE 16

PLASTIC 16

A=ARIZONA F=FLORIDA W=WASHINGTON

COLOR CHANGE - DELTA(E)

POLYVINYL CHLORIDE - A (60 MIL)

25.00+

20.00+

15.00+

10.00+

5.00+

0.00+

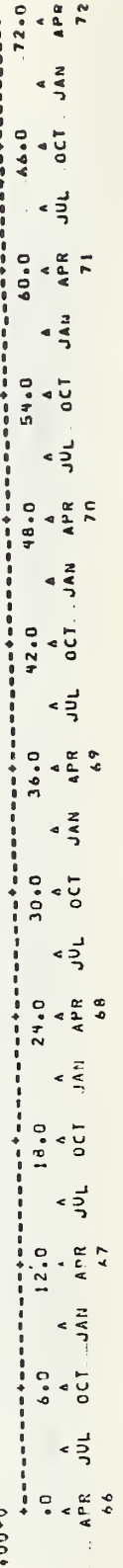


FIGURE 17

COLOR CHANGE - DELTA(E) PLASTIC 17 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - D (4 MIL)

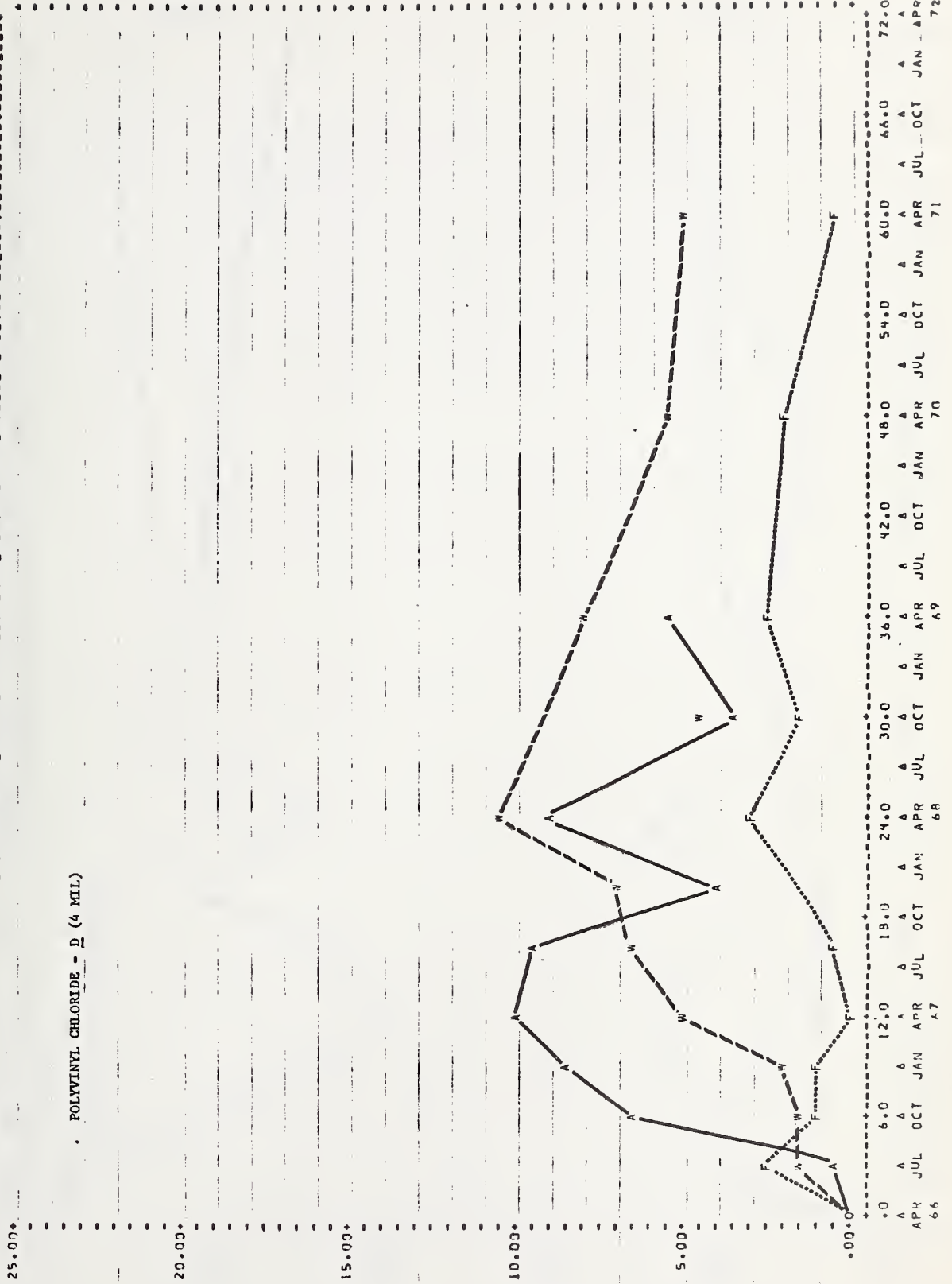


FIGURE 18

COLOR CHANGE - DELTA(E)      PLASTIC 1B      ARIZONA      FLORIDA      WASHINGTON

POLYVINYL CHLORIDE - D (10 ML)

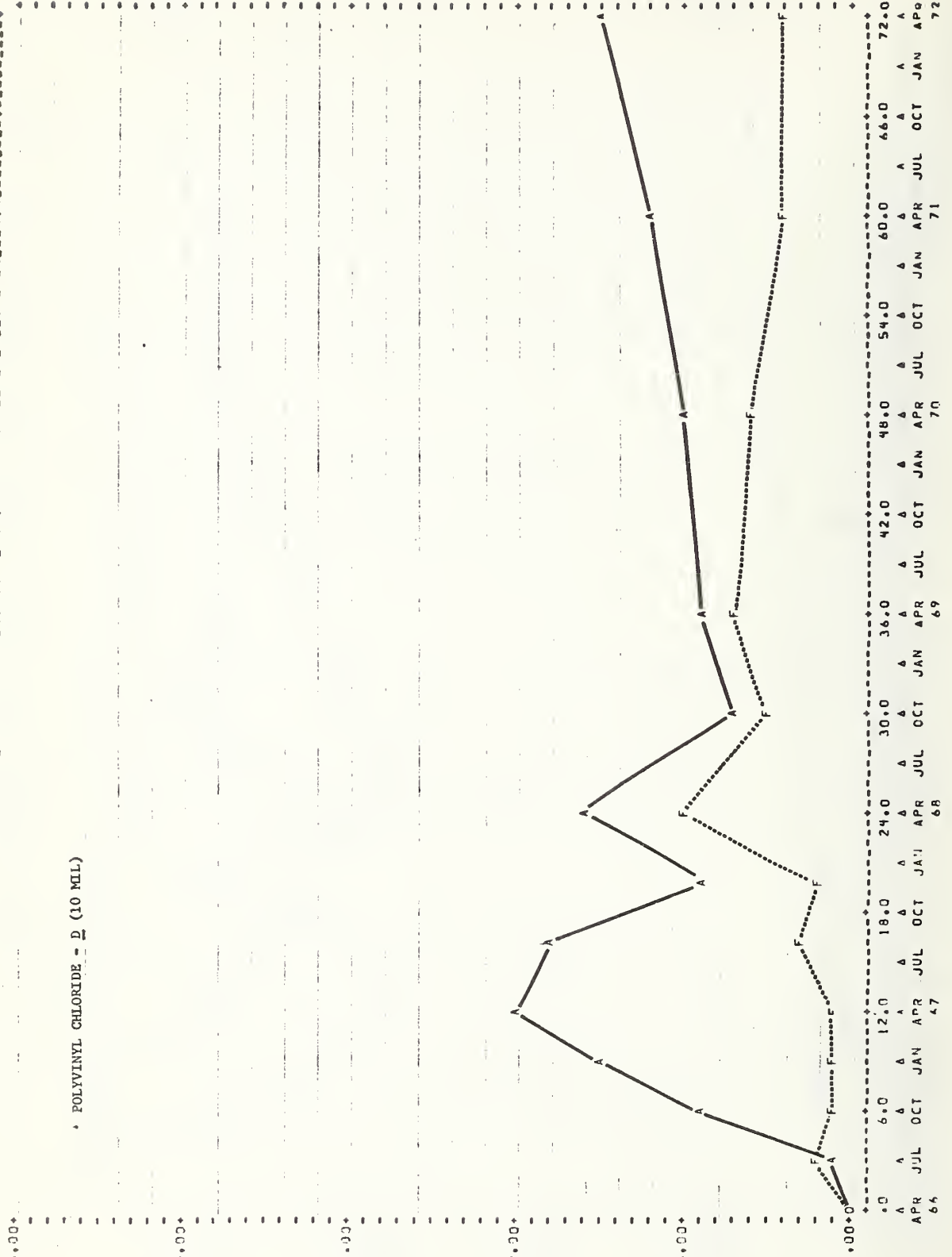




FIGURE 19

COLOR CHANGE - DELTA(E) PLASTIC 19 A=ARIZONA F=FLORIDA W=WASHINGTON

25.00+

POLYVINYL CHLORIDE - D (60 MIL)

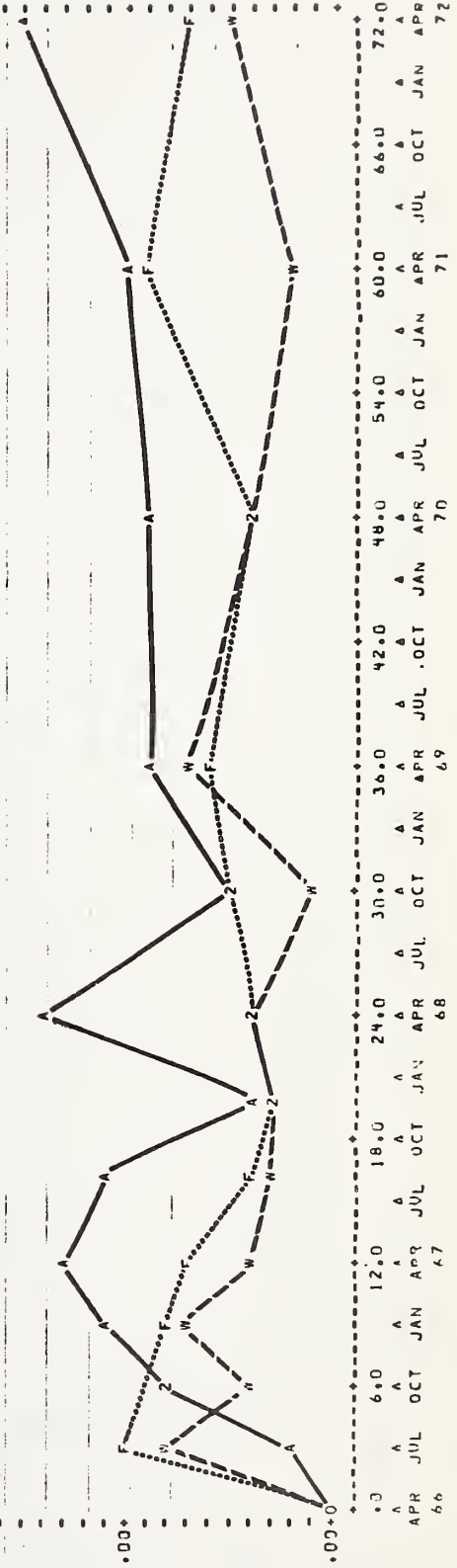
20.00+

15.00+

10.00+

5.00+

0.00+



66 67 68 69 70 71 72

FIGURE 20

COLOR CHANGE - DELTA(E) PLASTIC 20

POLYVINYL CHLORIDE - M (60 MIL)

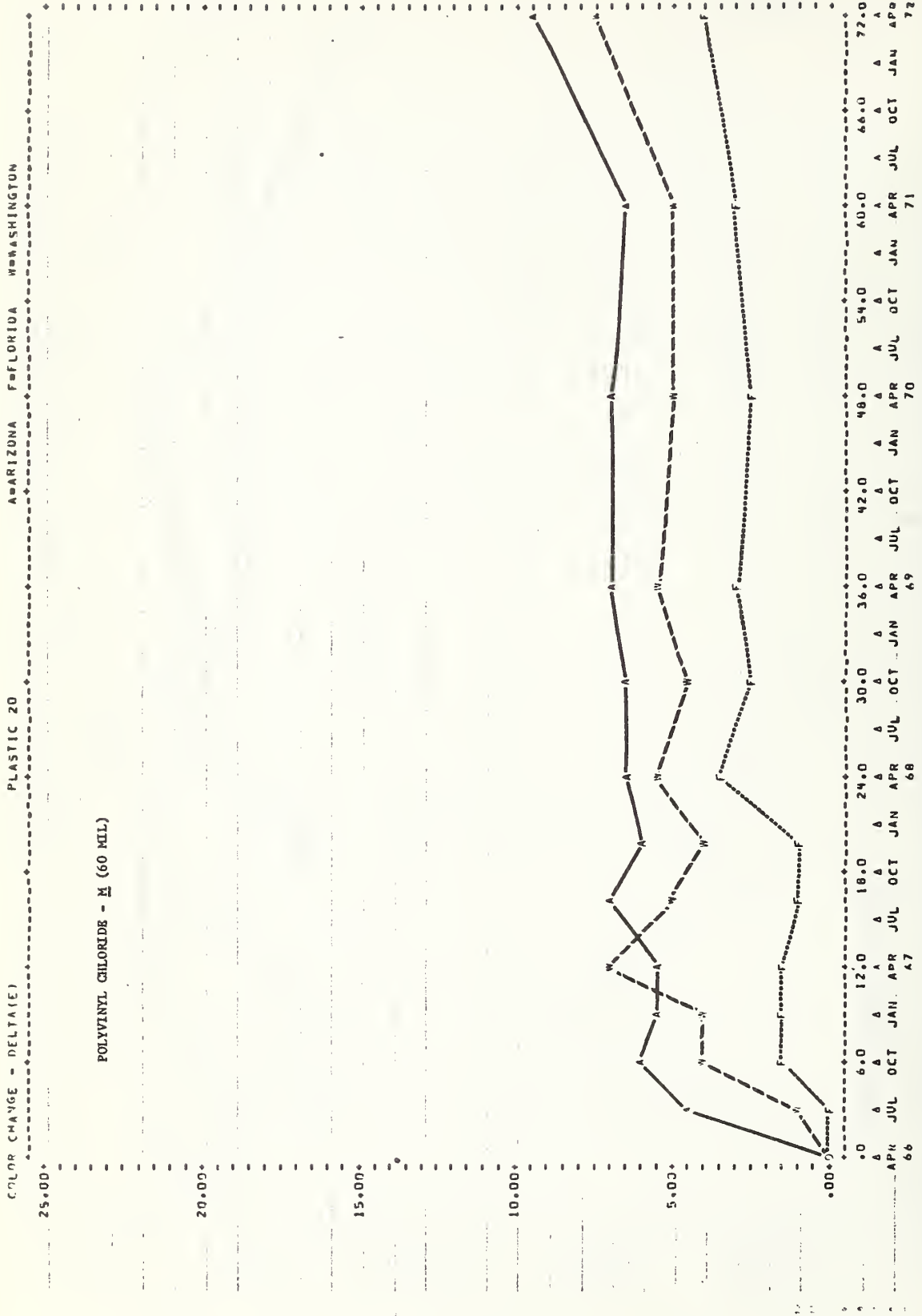


FIGURE 21

ULTIMATE FLOWGATION (PERCENT OF INITIAL VALUE) PLASTIC 1 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYETHYLENE (1 MIL)

INITIAL VALUE = 504.0%

150.00+

120.00+

90.00+

60.00+

30.00+

0.00+

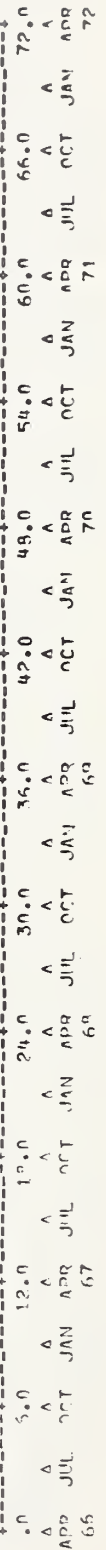


FIGURE 22

ULTIMATE FLOCCATION (PERCENT OF INITIAL VALUE) PLASTIC 2 ARIZONA FLOERINA MEMPHINGTON

POLYETHYLENE (60 MIL)  
INITIAL VALUE = 814.0%

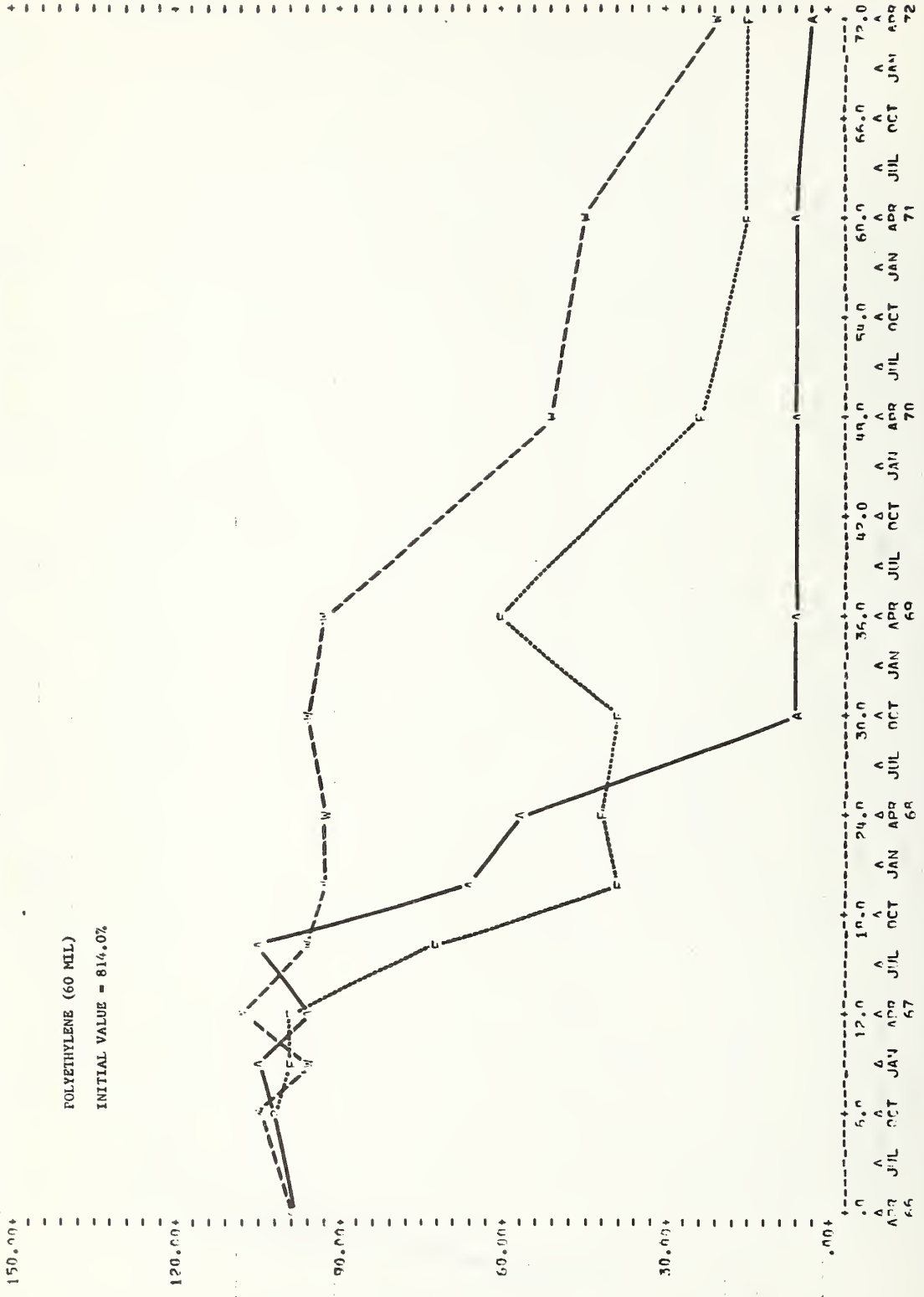
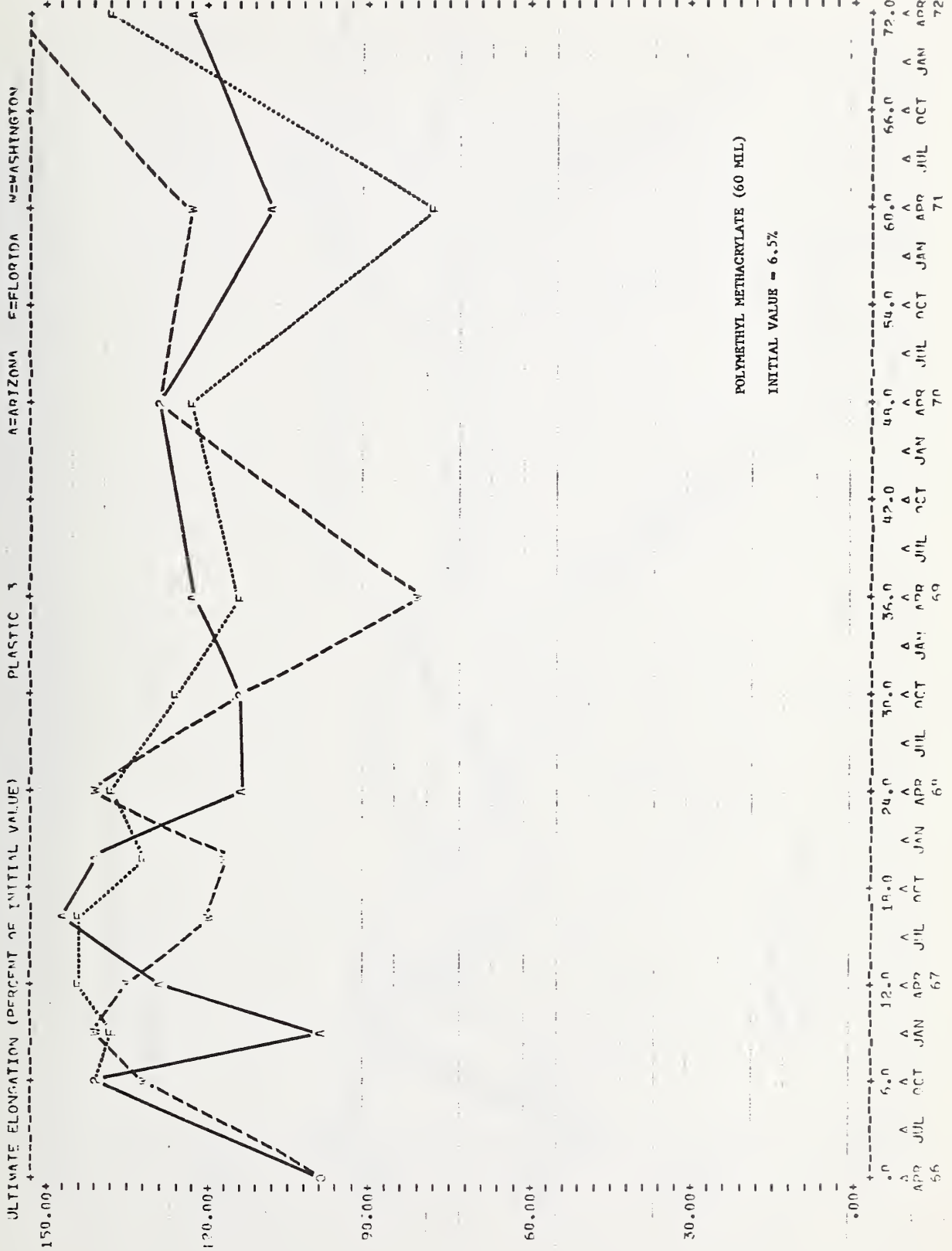


FIGURE 23



\*\*NOTE. 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.



FIGURE 25

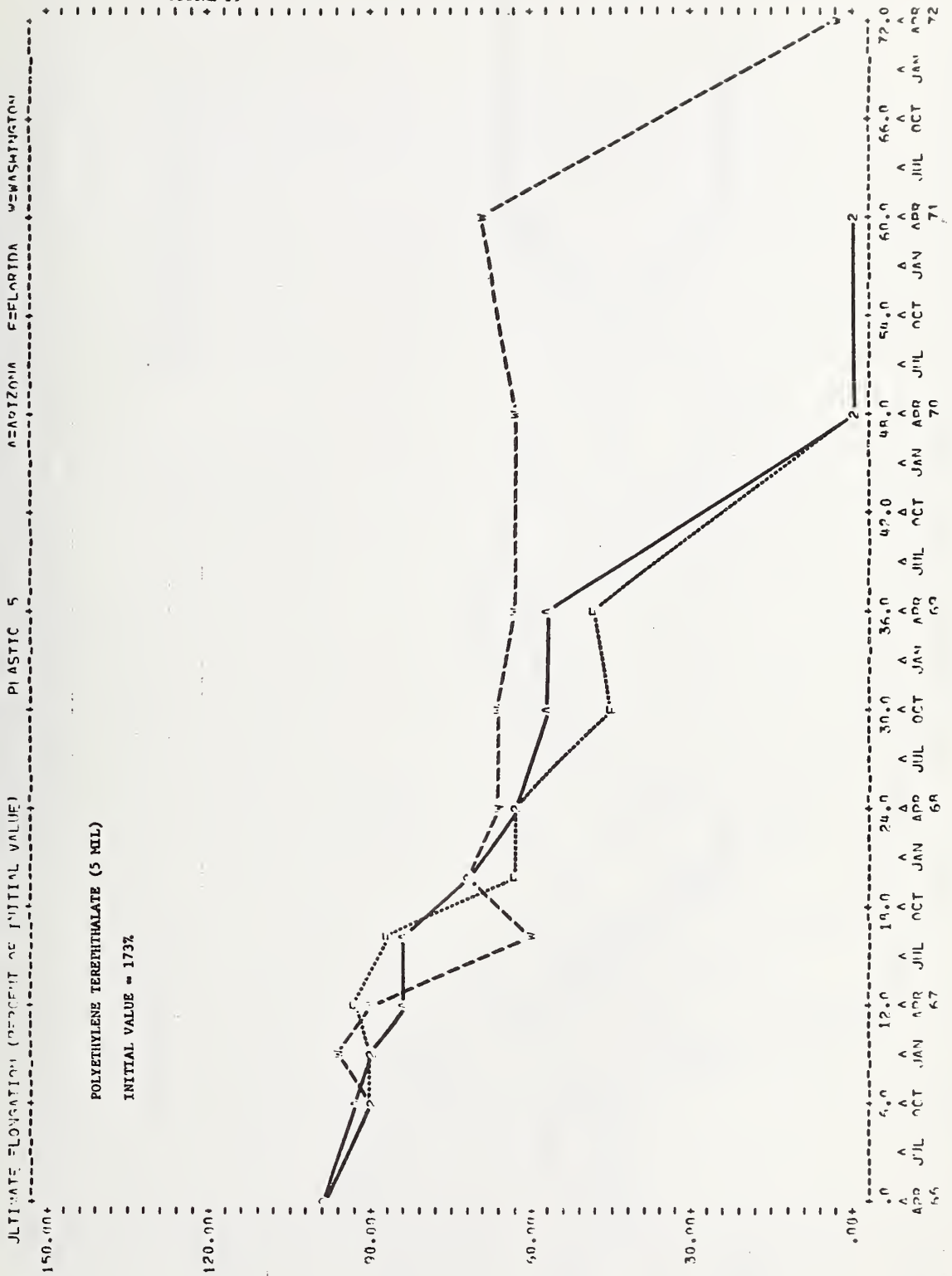


FIGURE 26

WASHINGTON

FLORIDA

ARIZONA

PLASTIC 6

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE)

150.00+

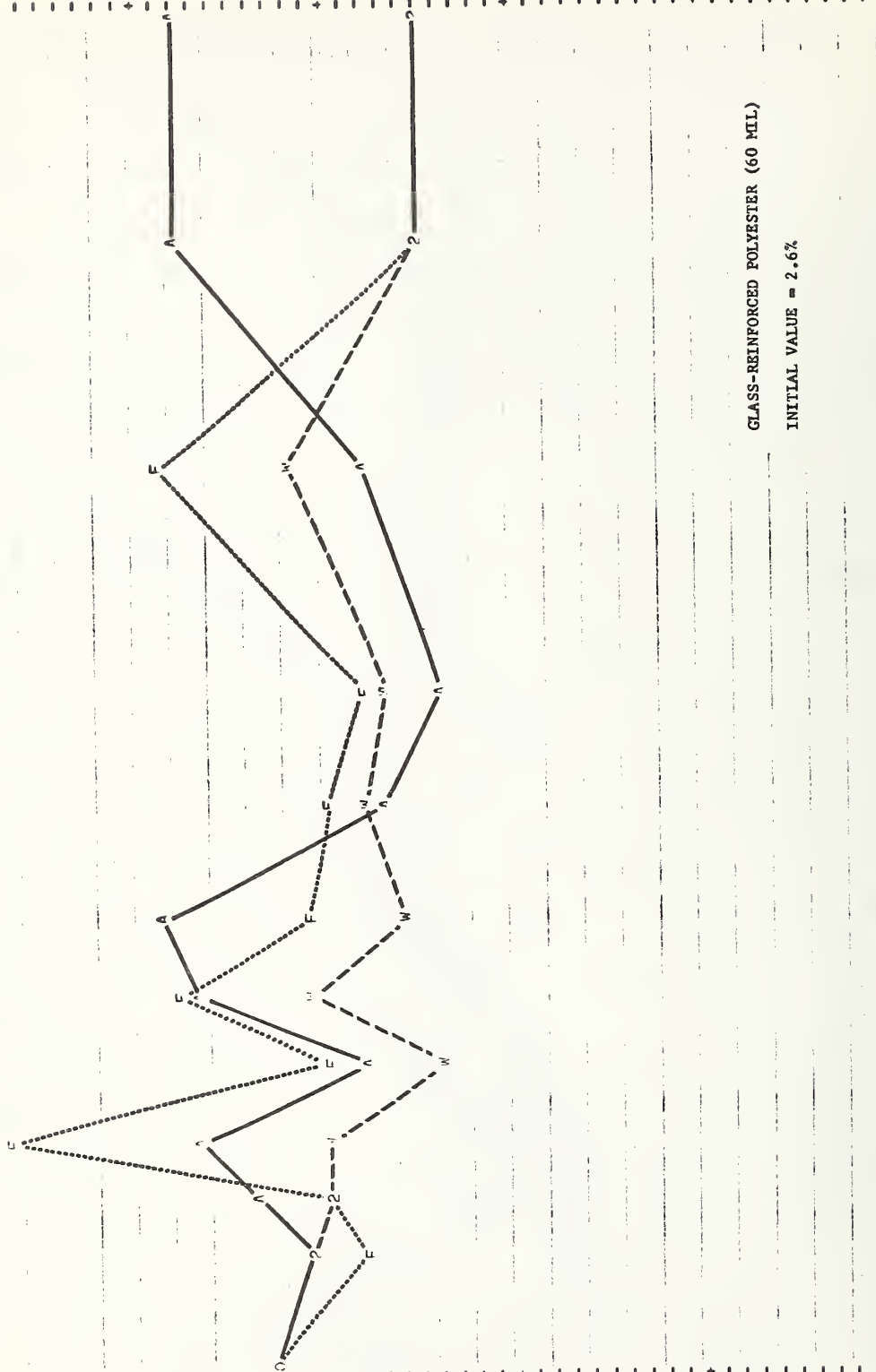
120.00+

90.00+

60.00+

30.00+

.00+



GLASS-REINFORCED POLYESTER (60 MIL)

INITIAL VALUE = 2.6%

12  
 11  
 10  
 9  
 8  
 7  
 6  
 5  
 4  
 3  
 2  
 1  
 0  
 APR 65 JUL 65 OCT 65 JAN 66 APR 66 JUL 66 OCT 66 JAN 67 APR 67 JUL 67 OCT 67 JAN 68 APR 68 JUL 68 OCT 68 JAN 69 APR 69 JUL 69 OCT 69 JAN 70 APR 70 JUL 70 OCT 70 JAN 71 APR 71 JUL 71 OCT 71 JAN 72 APR 72



FIGURE 27

ULTIMATE FLOWGATION (PERCENT OF INITIAL VALUE) PLASTIC 7 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - B (4 MIL)

INITIAL VALUE = 198.0%

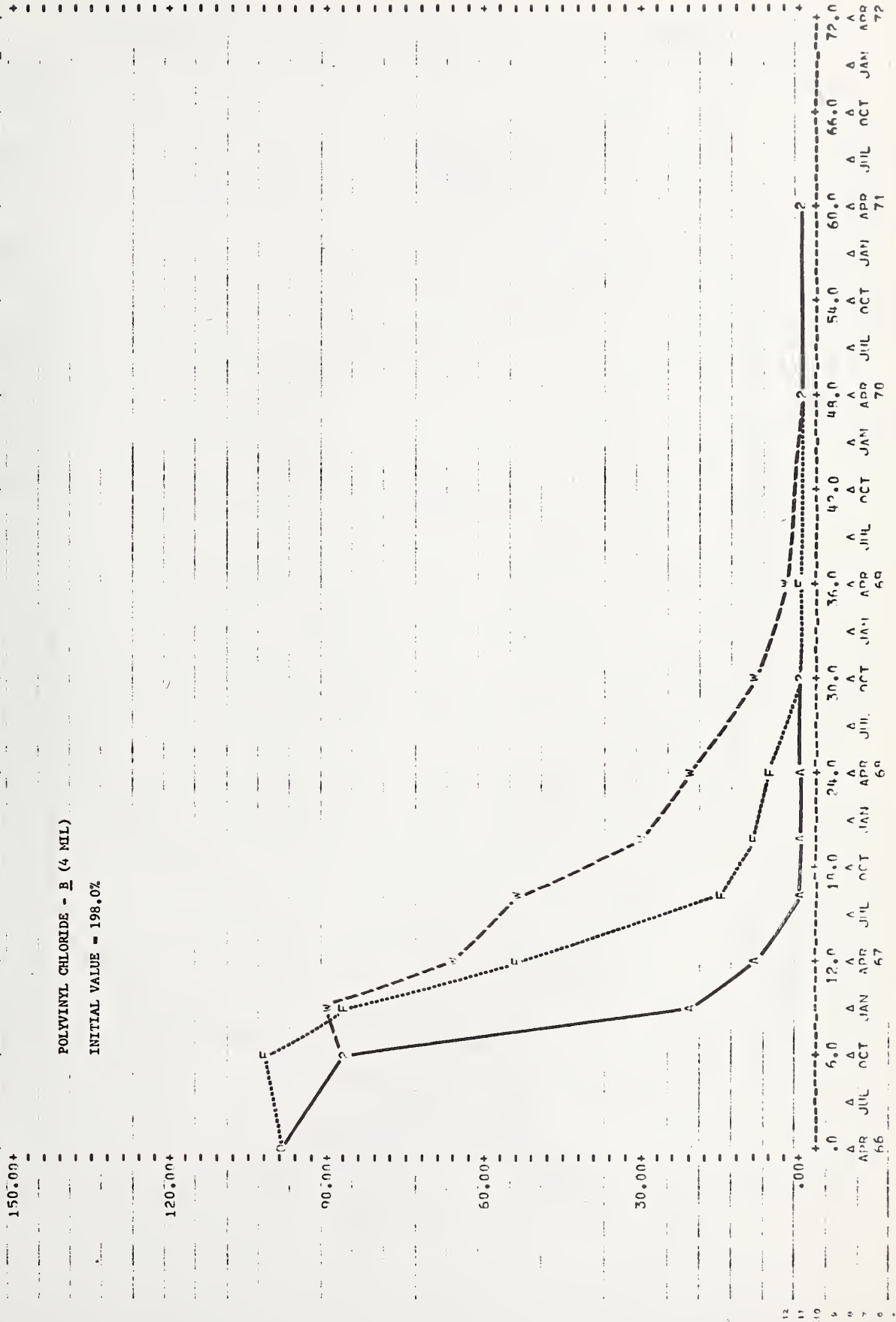


FIGURE 28

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC A=ALABAMA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - B (10 MIL)

INITIAL VALUE = 203.0%

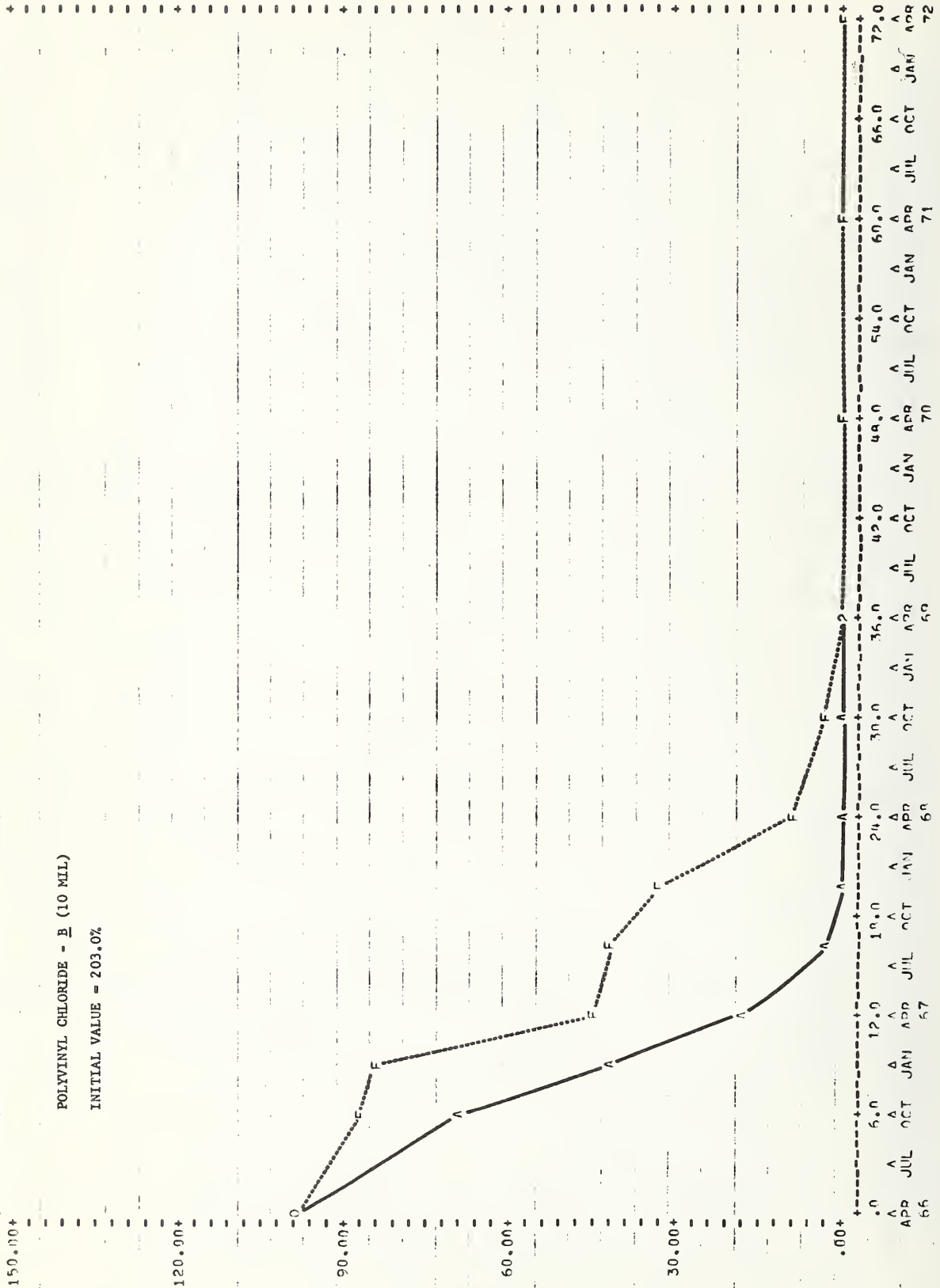


FIGURE 29

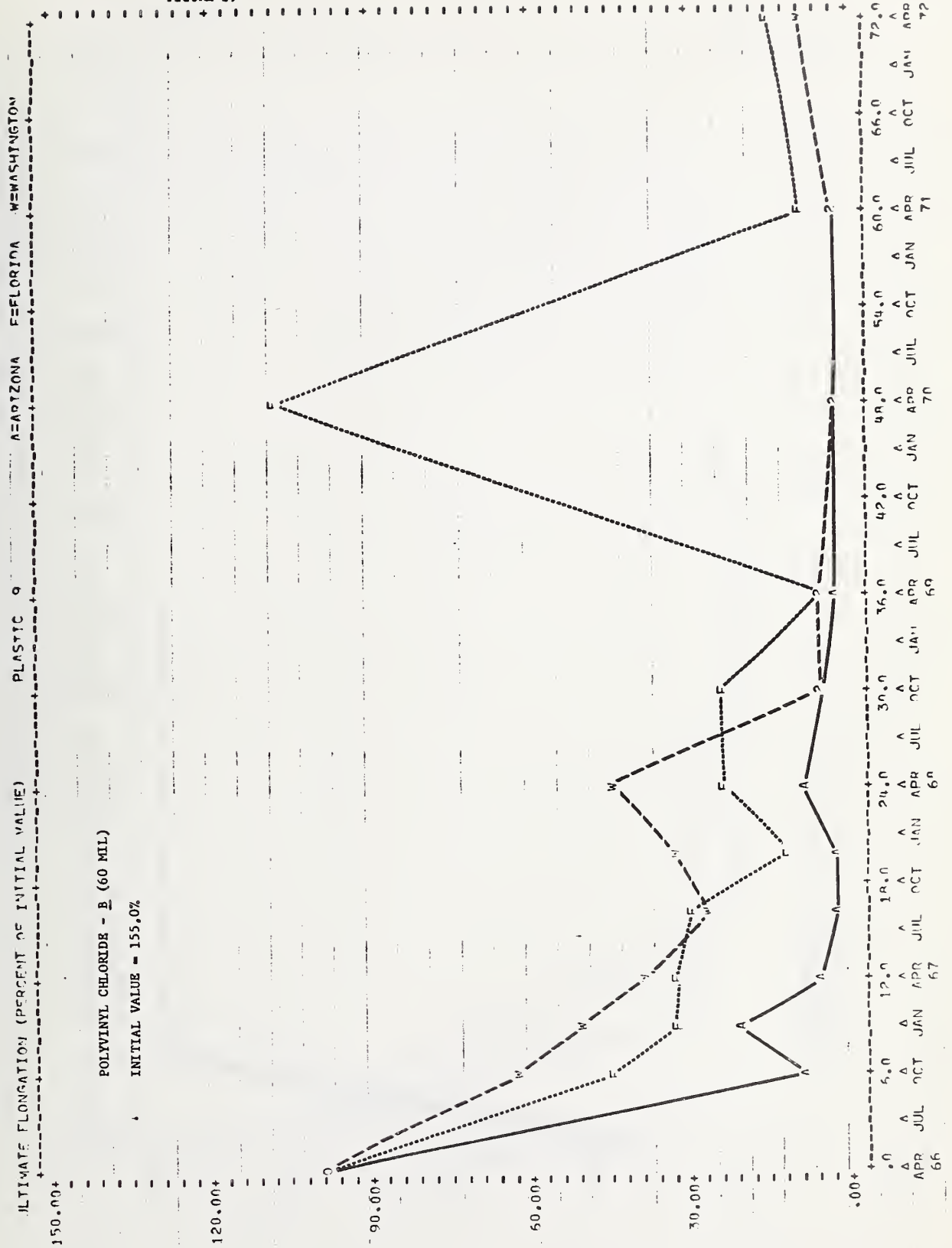






FIGURE 32

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 12

A=ARIZONA F=FLORIDA M=WASHINGTON

POLYVINYL CHLORIDE - C (60 MIL)

INITIAL VALUE = 32.1%

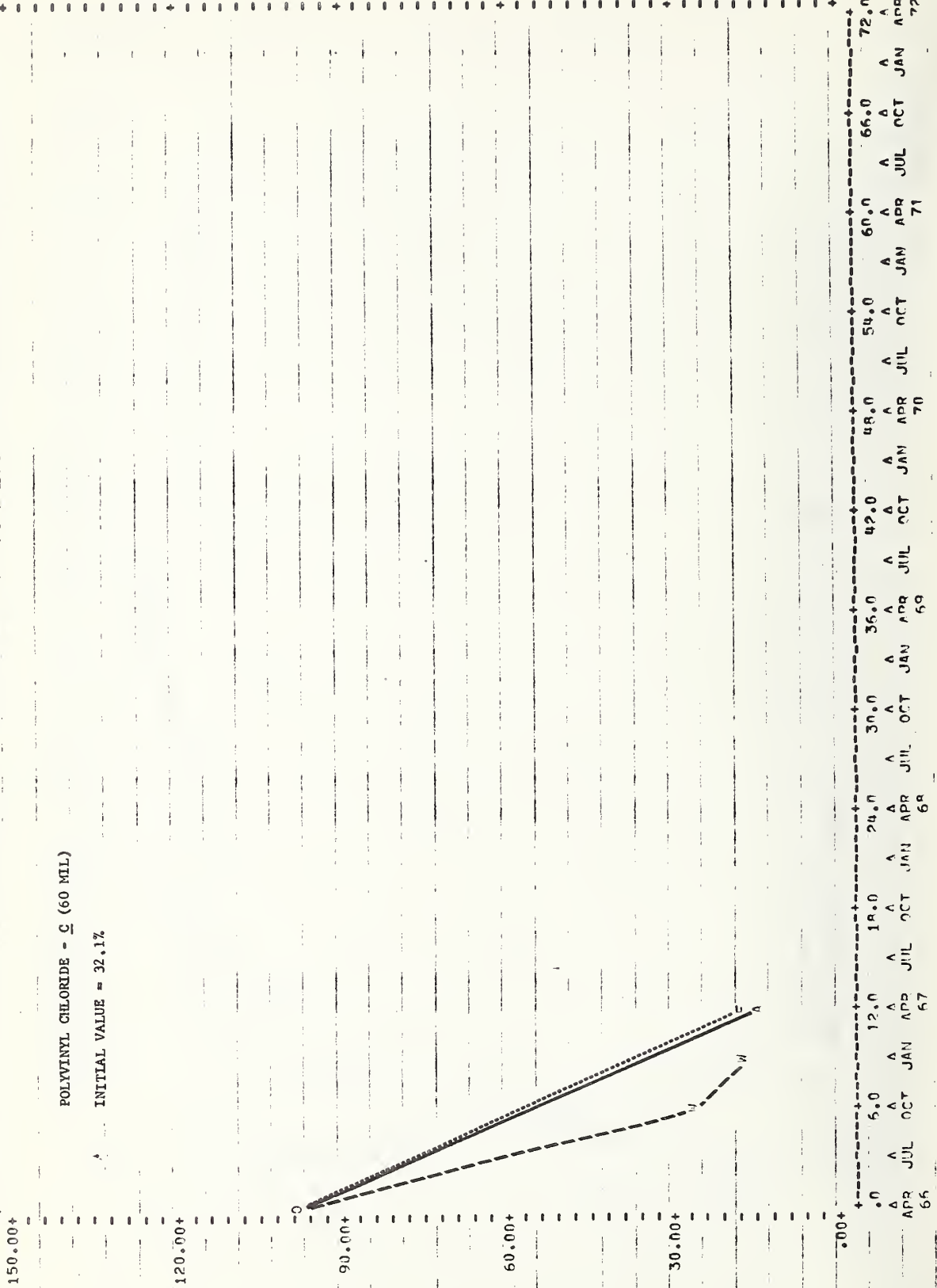


FIGURE 33

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 13

A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - N (60 MIL)

INITIAL VALUE = 85.5%

150.00+

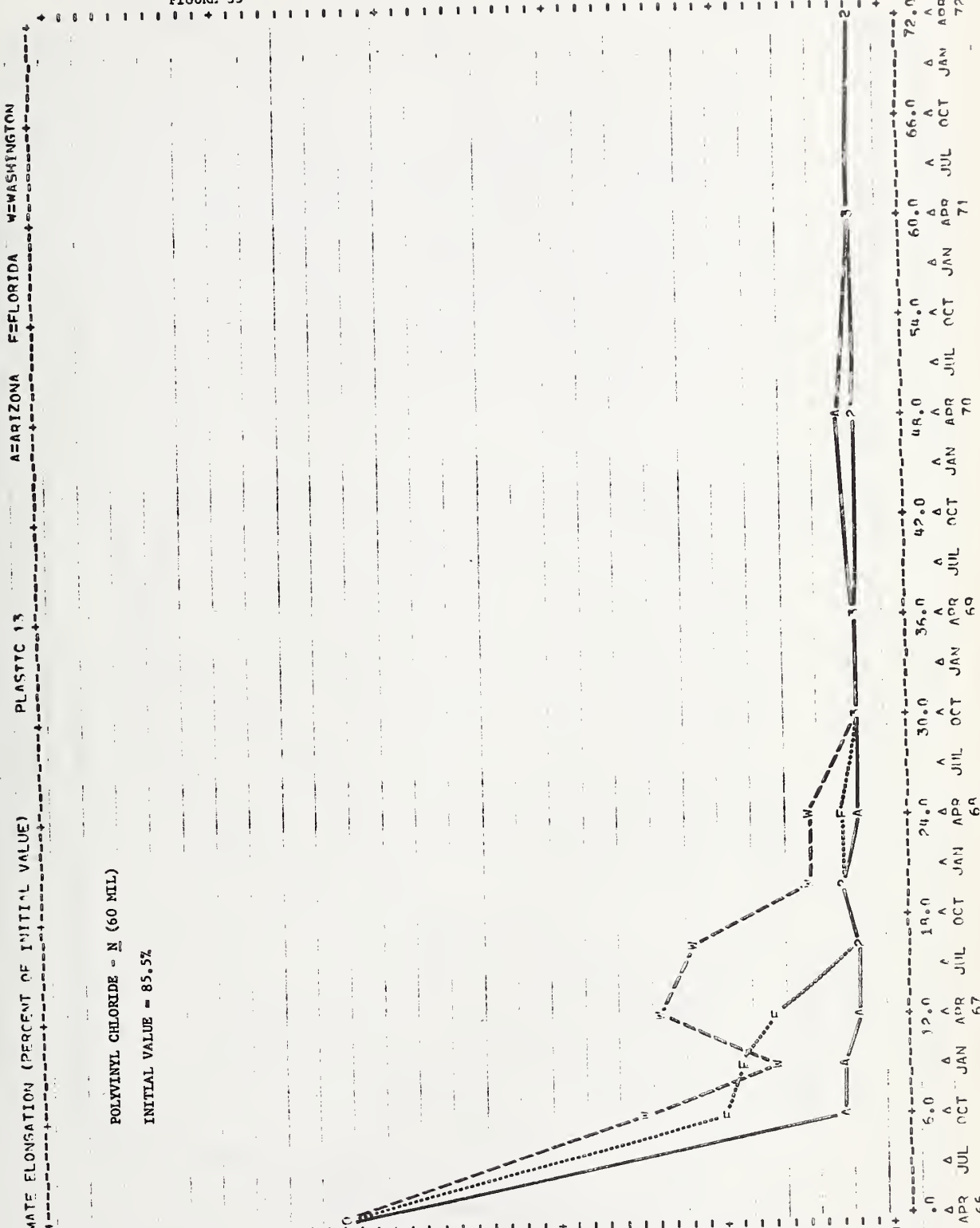
120.00+

90.00+

60.00+

30.00+

0.00+



72.0  
66.0  
60.0  
54.0  
48.0  
42.0  
36.0  
30.0  
24.0  
18.0  
12.0  
6.0  
0.0  
APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT





FIGURE 35

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 15 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - A (10 MIL)

INITIAL VALUE = 155.0%

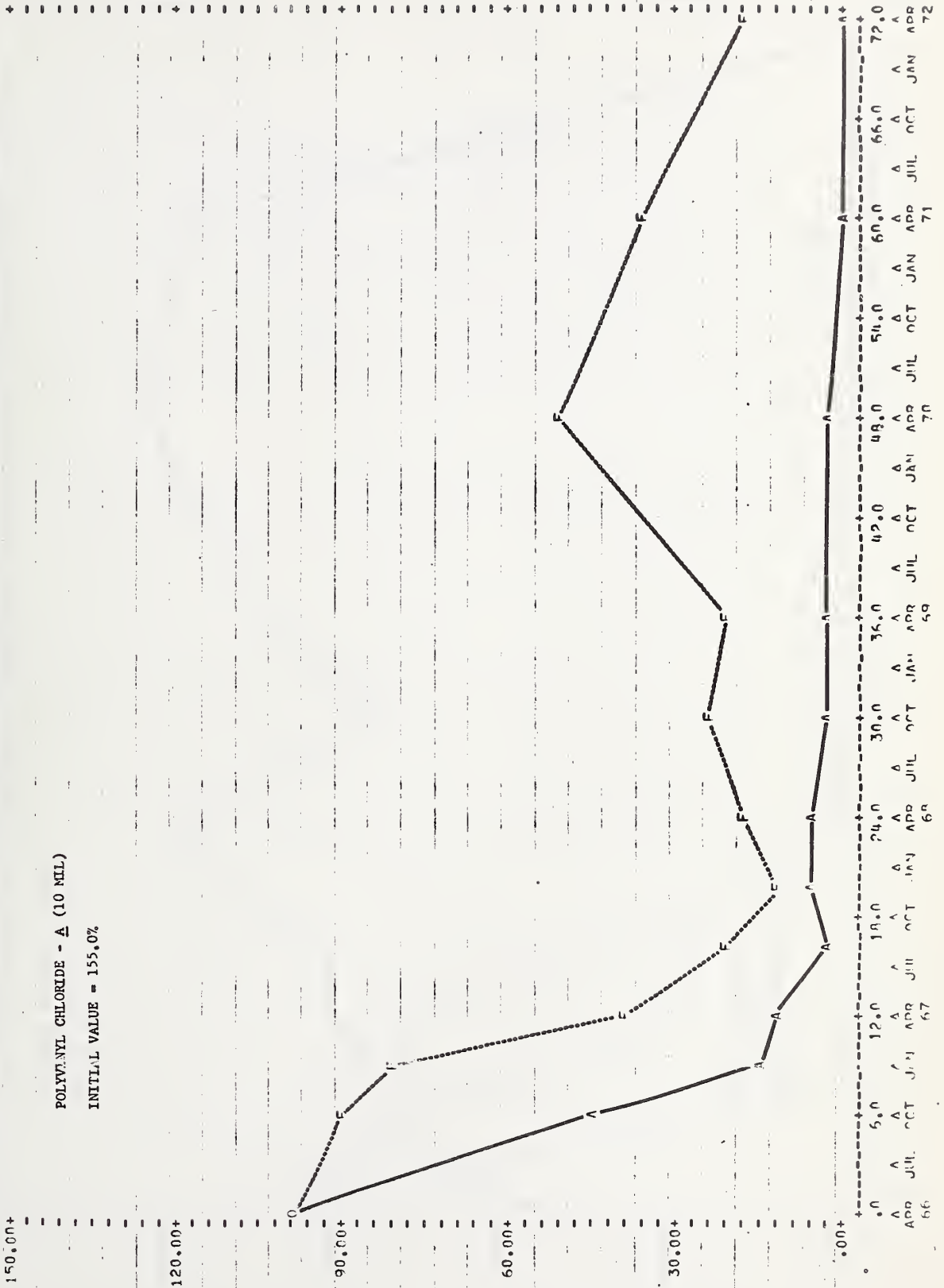


FIGURE 36

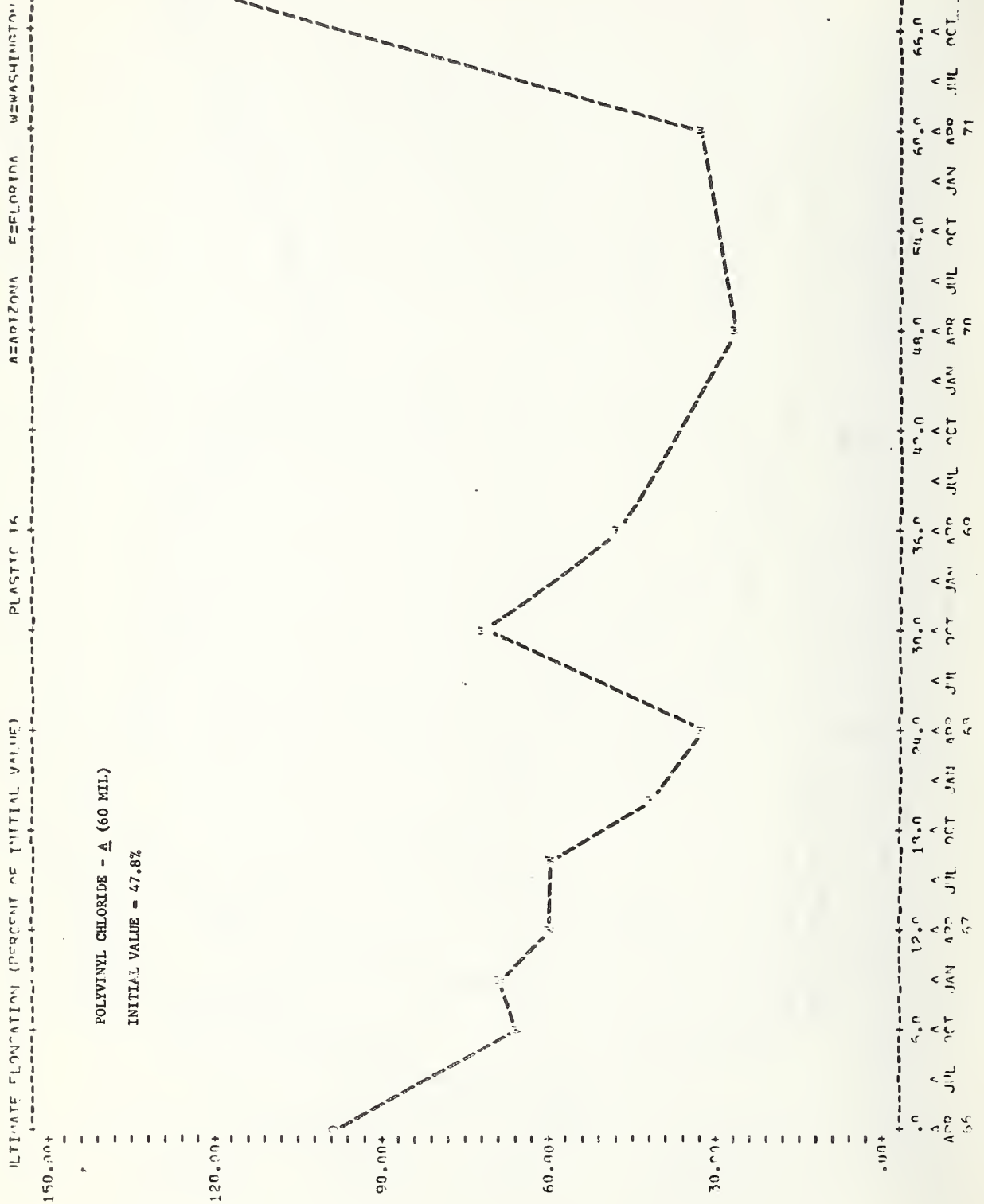


FIGURE 37

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 17 ARIZONA FLORIDA WASHINGTON

POLY VINYL CHLORIDE - D (4 MIL)  
INITIAL VALUE = 191.0%

150.00+

120.00+

90.00+

60.00+

30.00+

0.00+

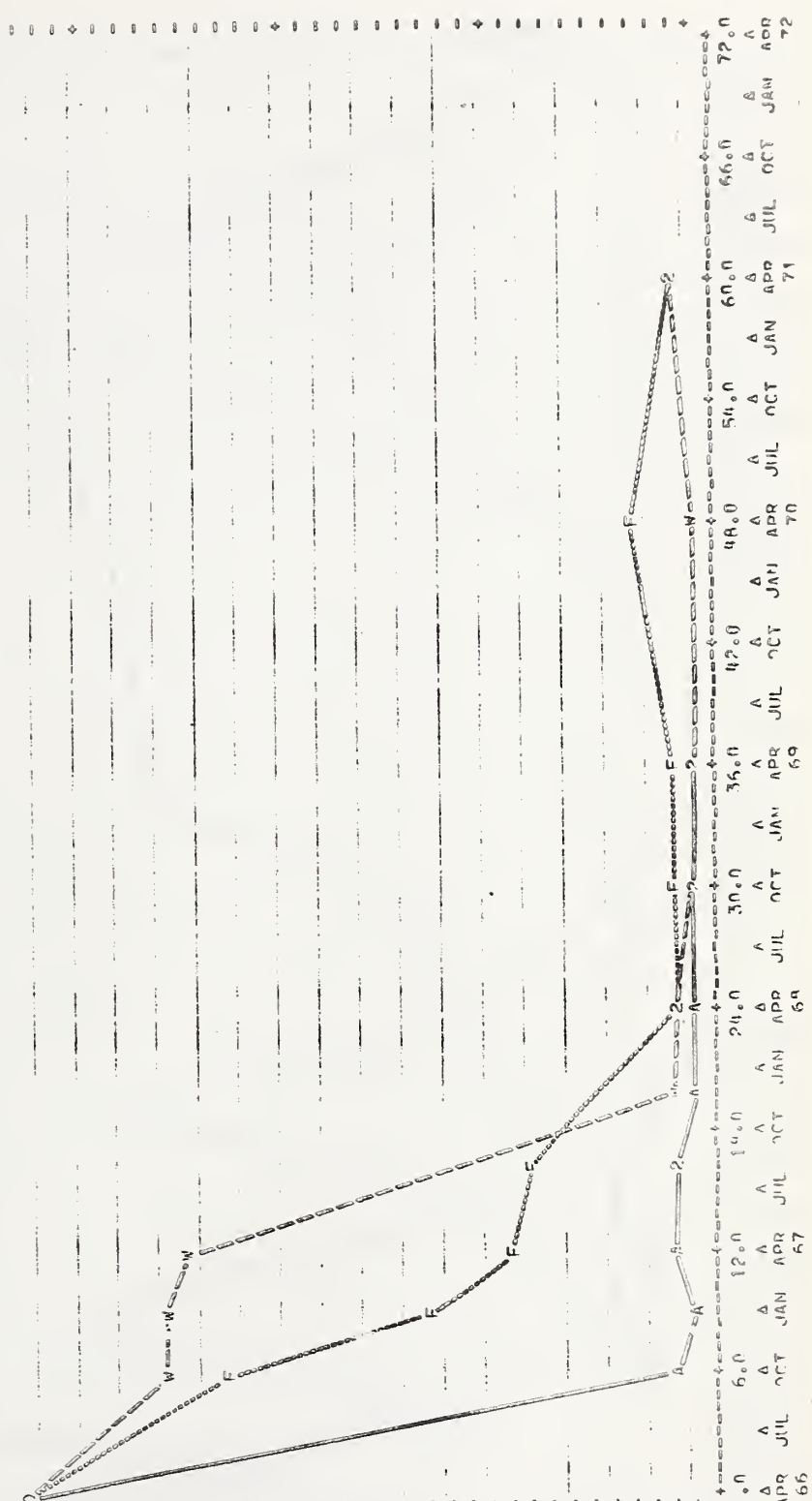


FIGURE 38

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 1A ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - D (10 MIL)

INITIAL VALUE = 142.0%

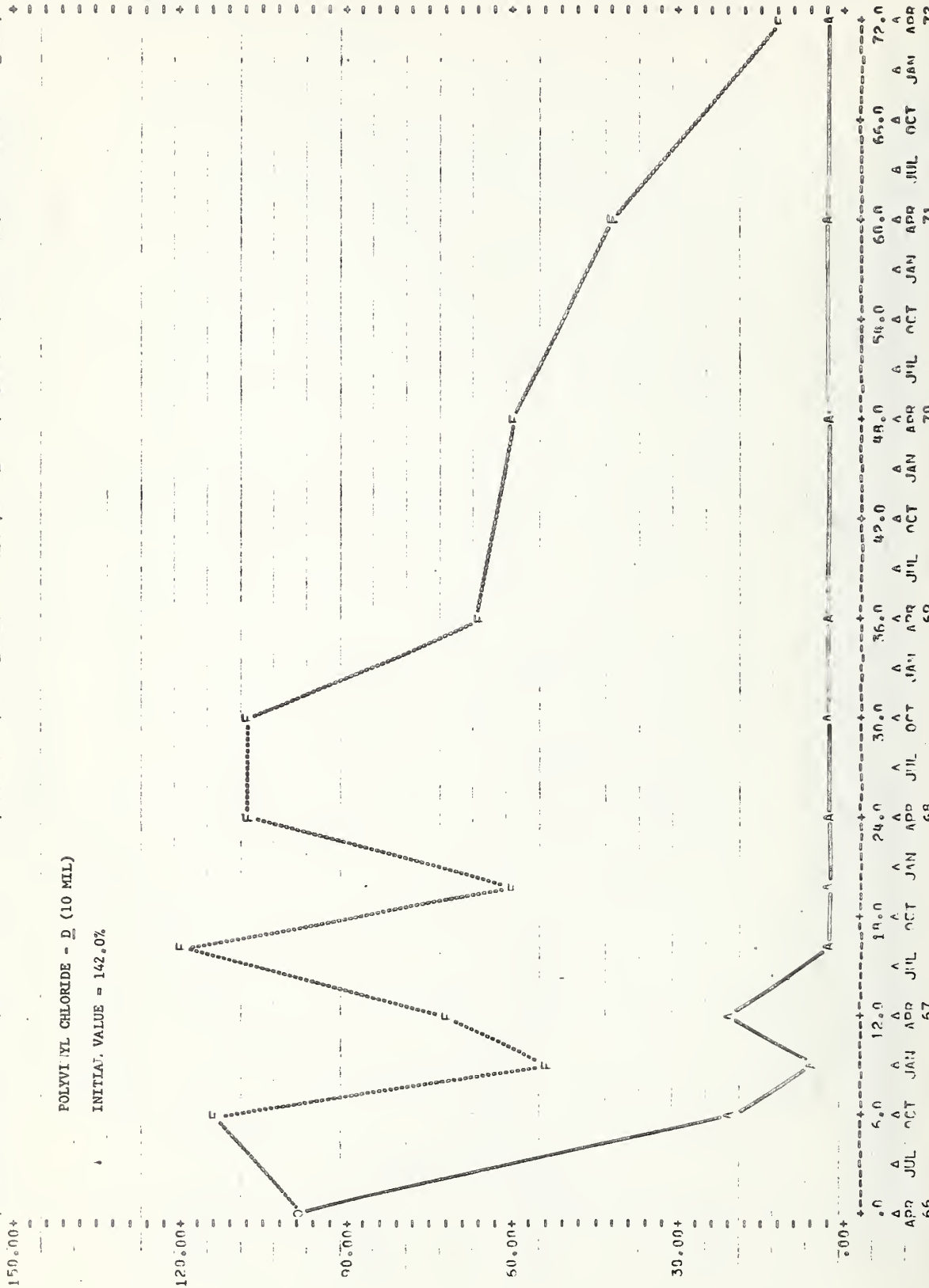




FIGURE 40

ULTIMATE FLOWNATION (PERCENT OF INITIAL VALUE) PLASTIC OF

FLORIDA

ARIZONA

FLORIDA

WASHINGTON

POLYVINYL CHLORIDE - M (60 MIL)

INITIAL VALUE = 178.0%

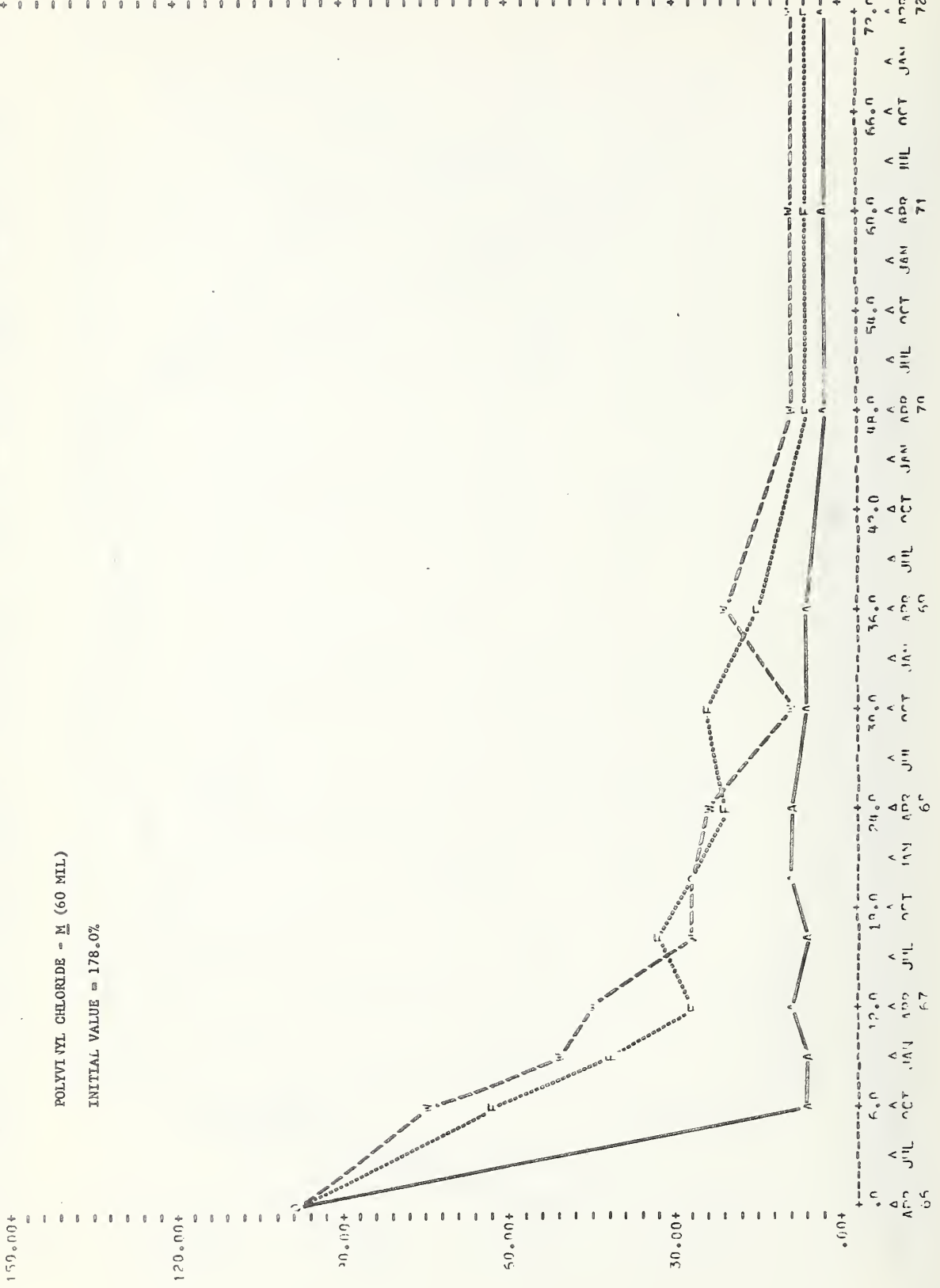


FIGURE 41

5 PERCENT STRESS (PSI) PLASTIC 2 ARIZONA FLORIDA WASHINGTON

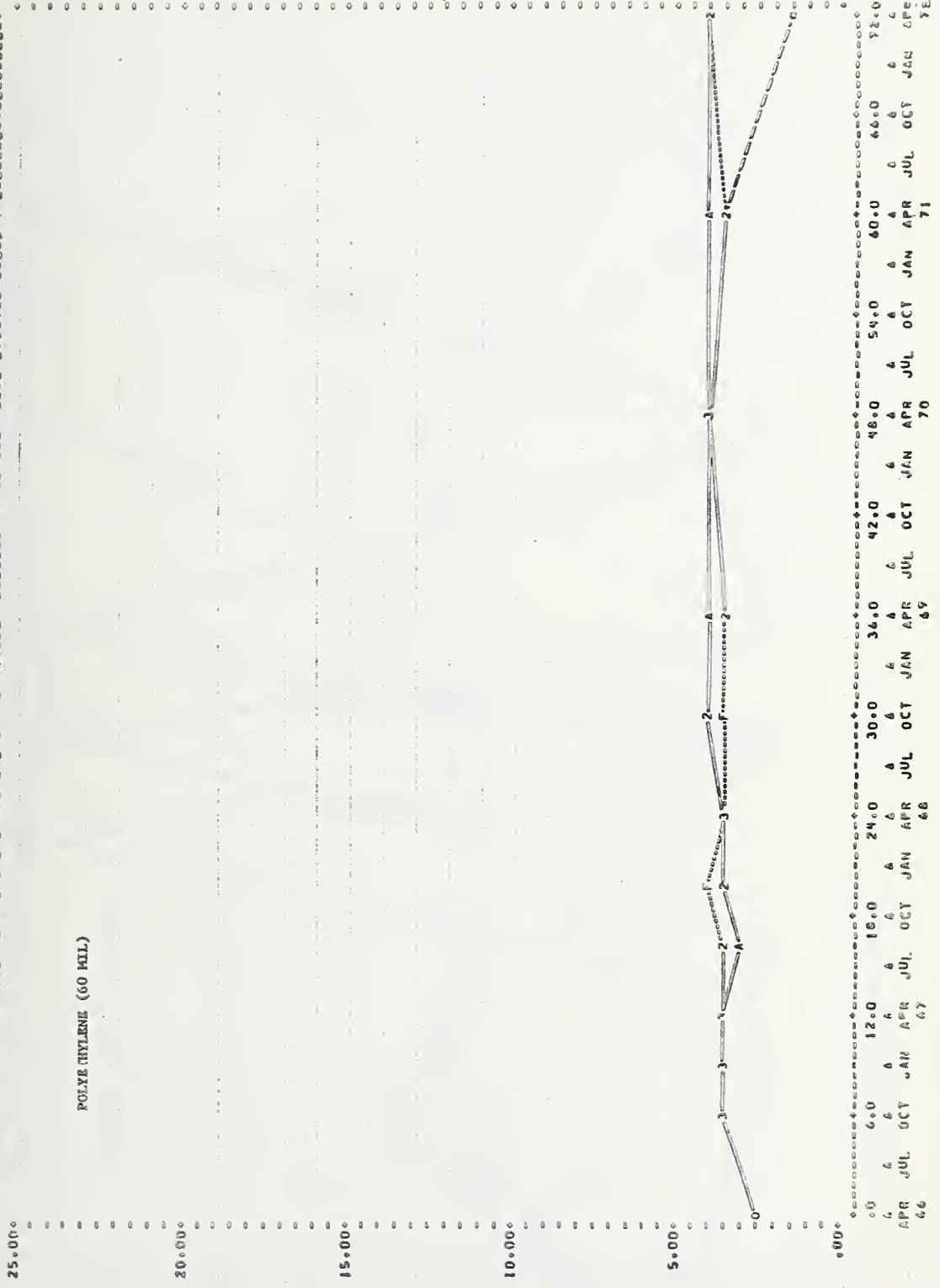


FIGURE 42

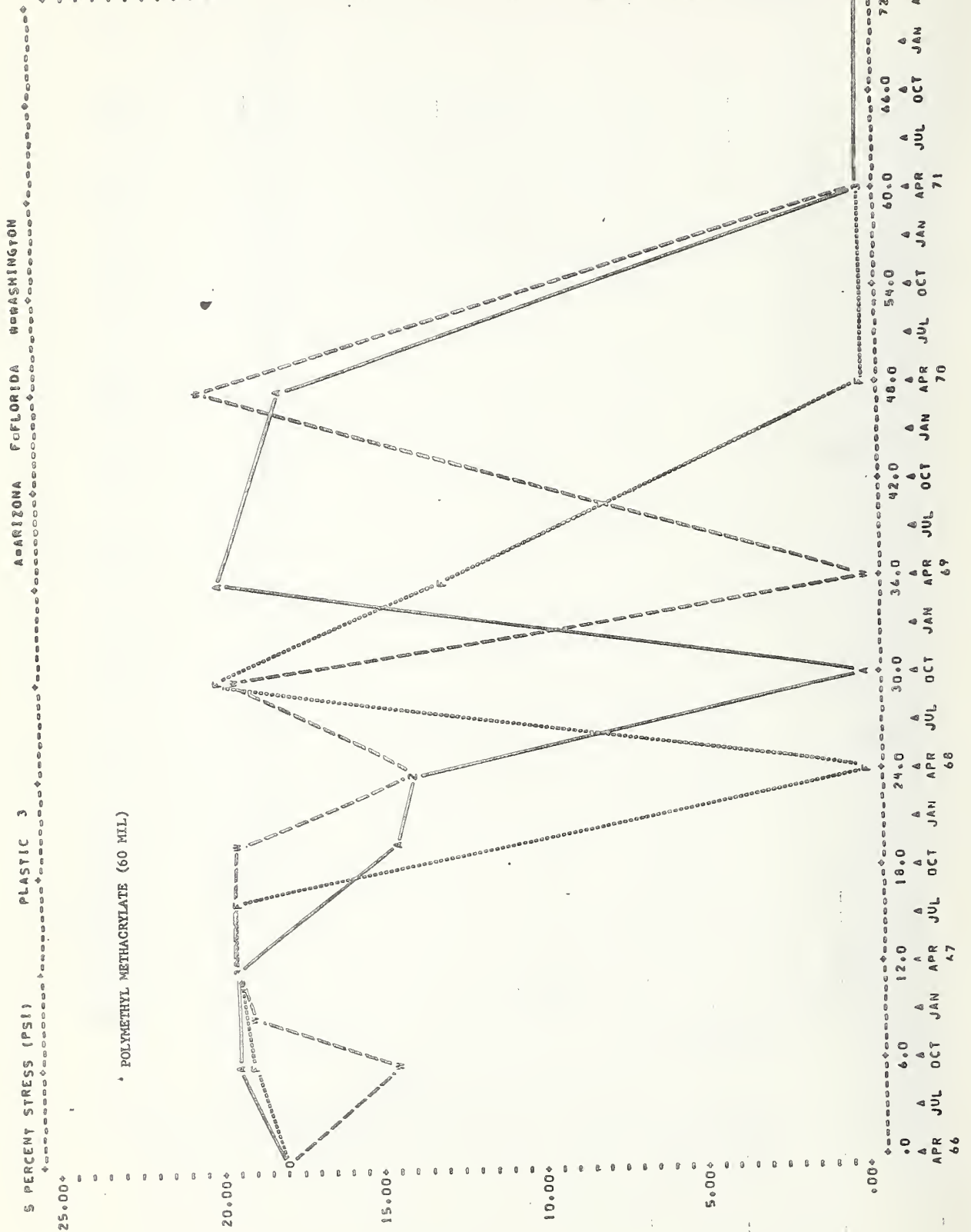
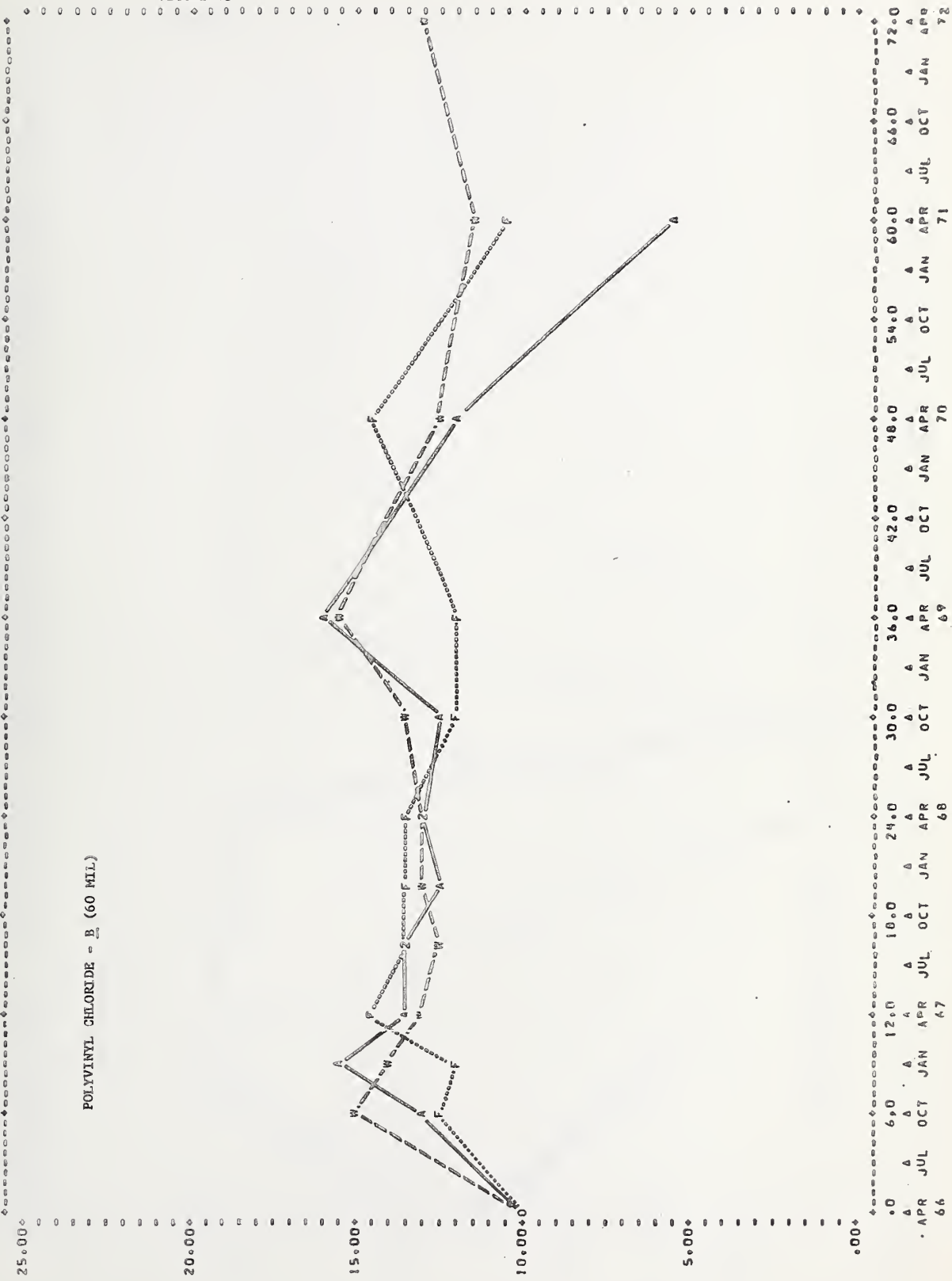




FIGURE 43

5 PERCENT STRESS (PSI) PLASTIC 9 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - B (60 MIL)

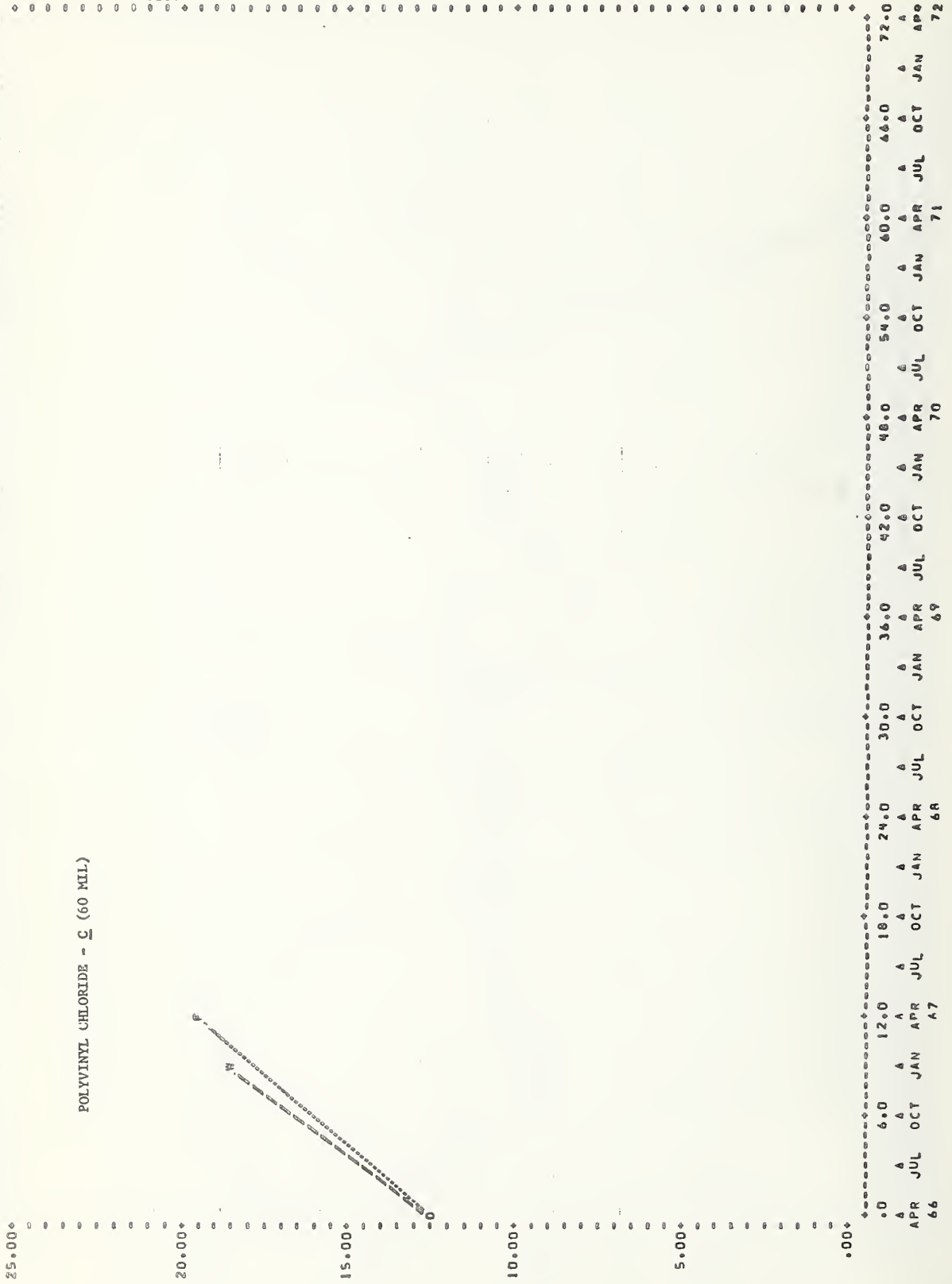


NOTE: 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 44

5 PERCENT STRESS (PSI) PLASTIC 12 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - C (60 MIL)



5 PERCENT STRESS (PSI) PLASTIC 13

ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - N (60 HLL)

FIGURE 45

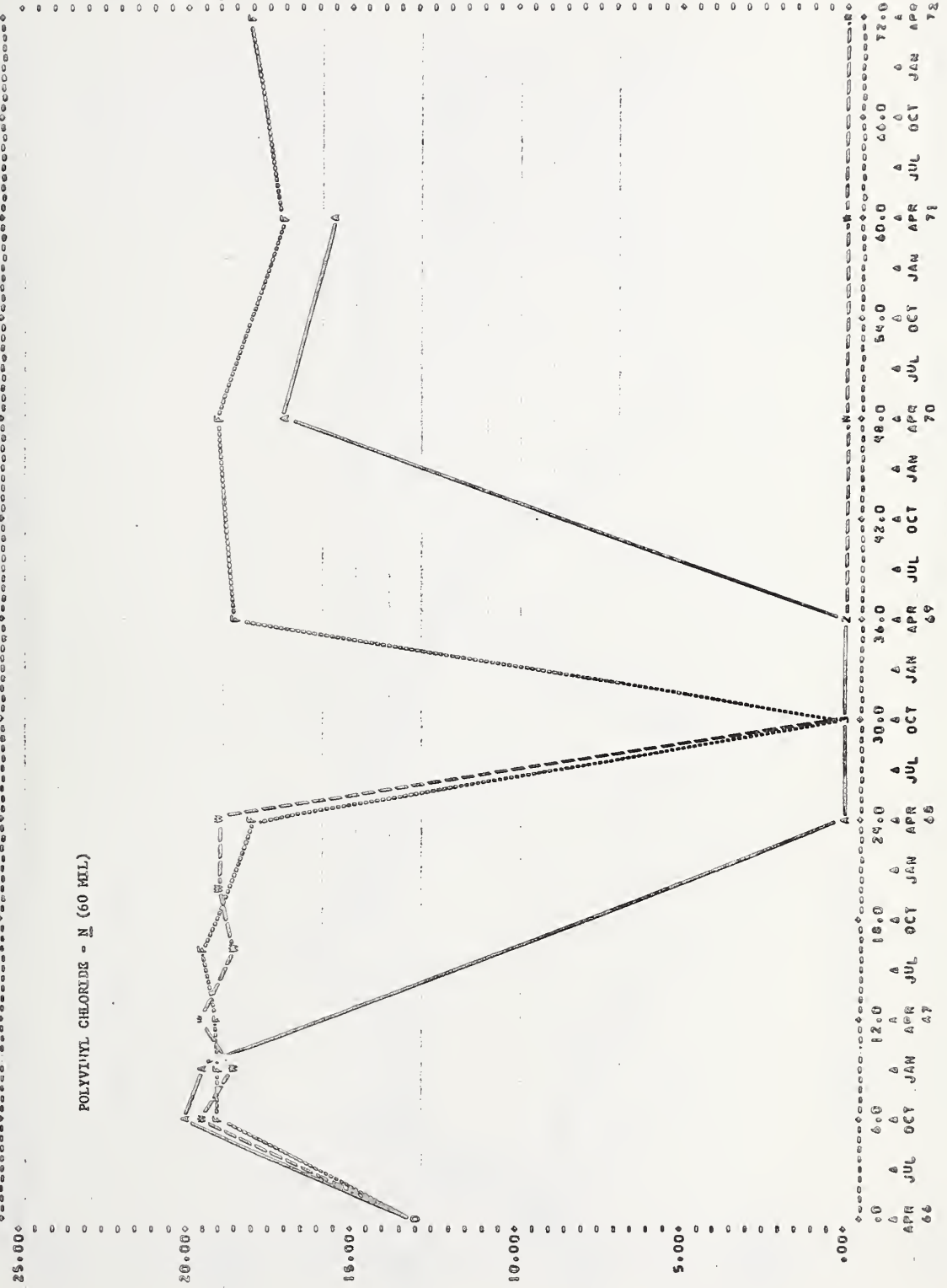
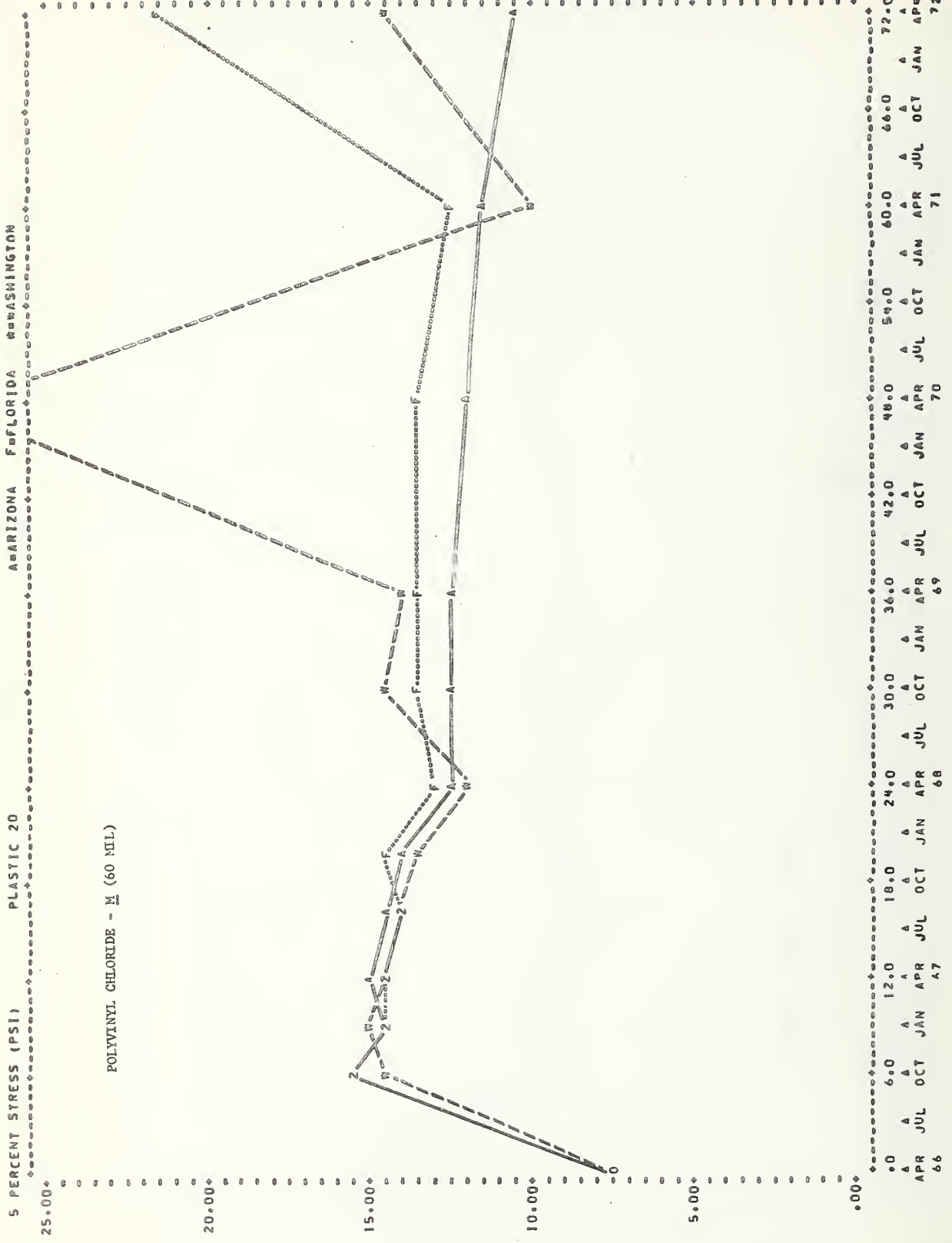






FIGURE 48



NOTE. 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 49

GLASS (IN PERCENT) PLASTIC 1 ARIZONA FELORDINA WASHINGTON



POLYETHYLENE (1 MIL)

150.00  
120.00  
90.00  
60.00  
30.00  
0.00

Material	Gloss (in percent)	Plastic 1	Material	Gloss (in percent)	Plastic 1
Arizona	150.00	0	Arizona	60.00	0
Felordina	120.00	0	Felordina	30.00	0
Washington	90.00	0	Washington	0.00	0

FIGURE 50

GLASS (IN PERCENT) PLASTIC WASHINGTON

ARIZONA F-FLORIDA

POLYETHYLENE (60 MIL)

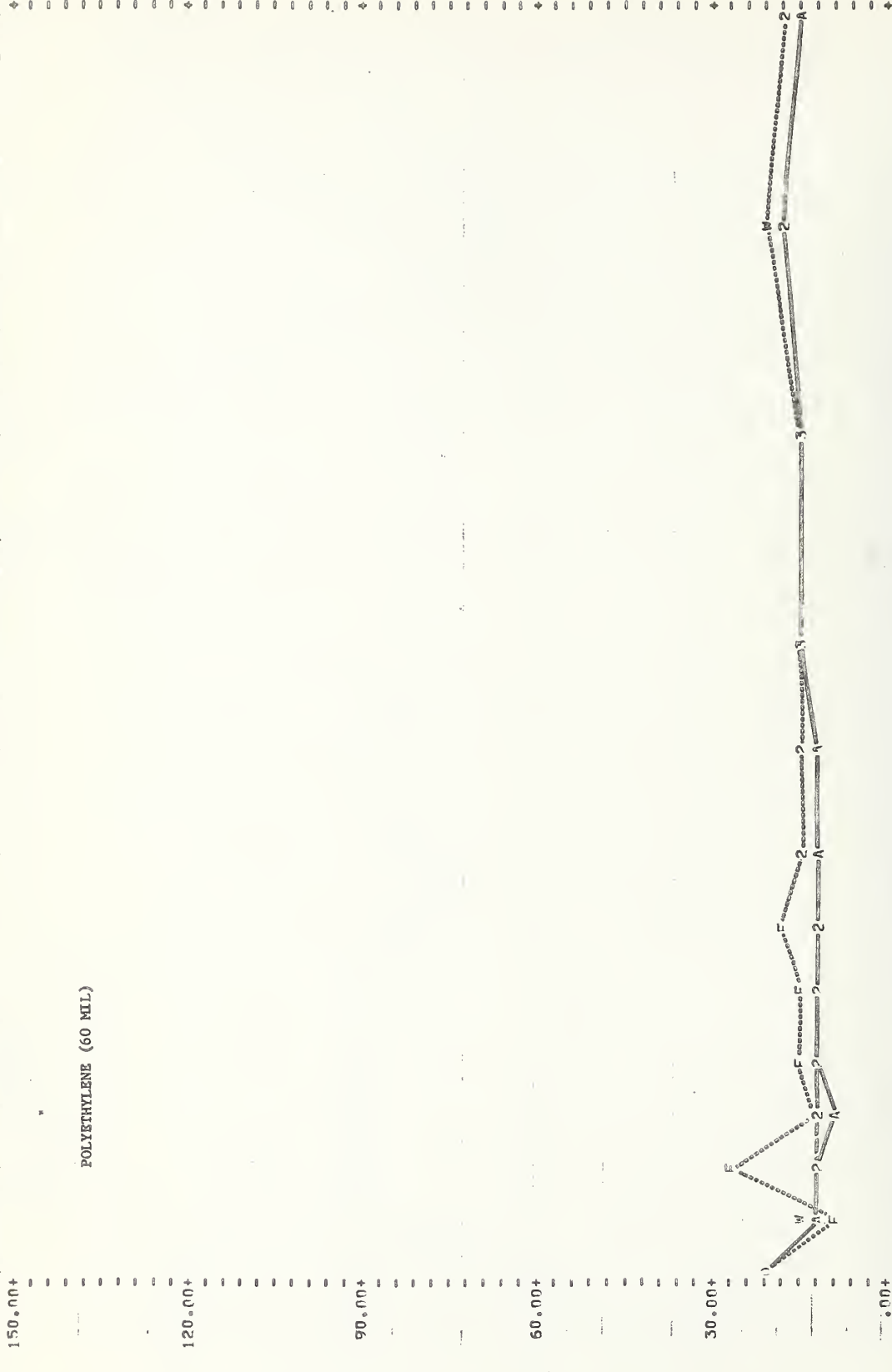




FIGURE 51

LOSS (IN PERCENT) PLASTIC ARIZONA FLORIDA WASHINGTON

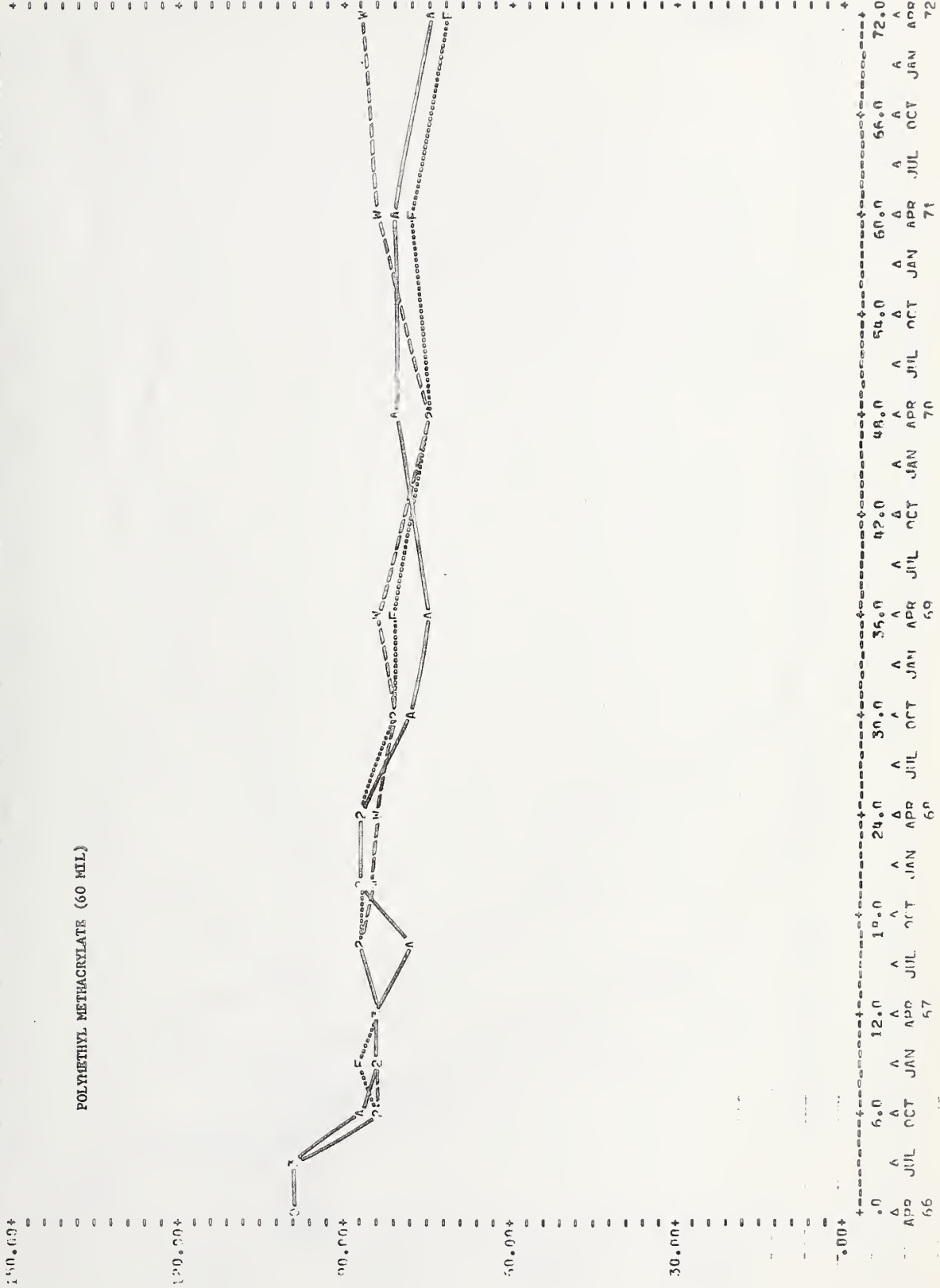
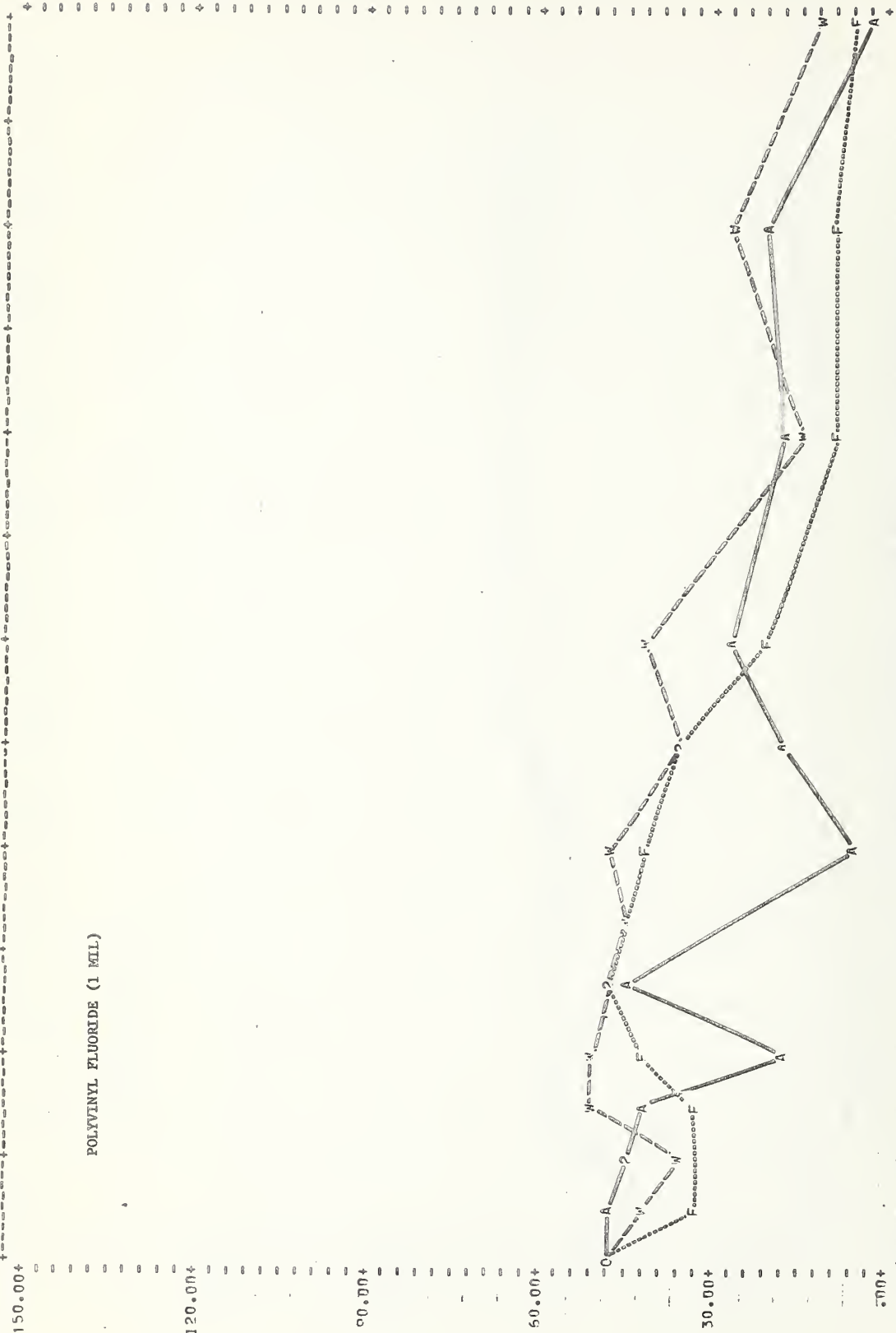


FIGURE 52

GLOSS (IN PERCENT) PLASTIC " ARIZONA FLORIDA WASHINGTON

POLYVINYL FLUORIDE (1 MIL)



150.00+  
120.00+  
90.00+  
60.00+  
30.00+  
0.00+

0.00  
5.00  
10.00  
15.00  
20.00  
25.00  
30.00  
35.00  
40.00  
45.00  
50.00  
55.00  
60.00  
65.00  
70.00  
75.00

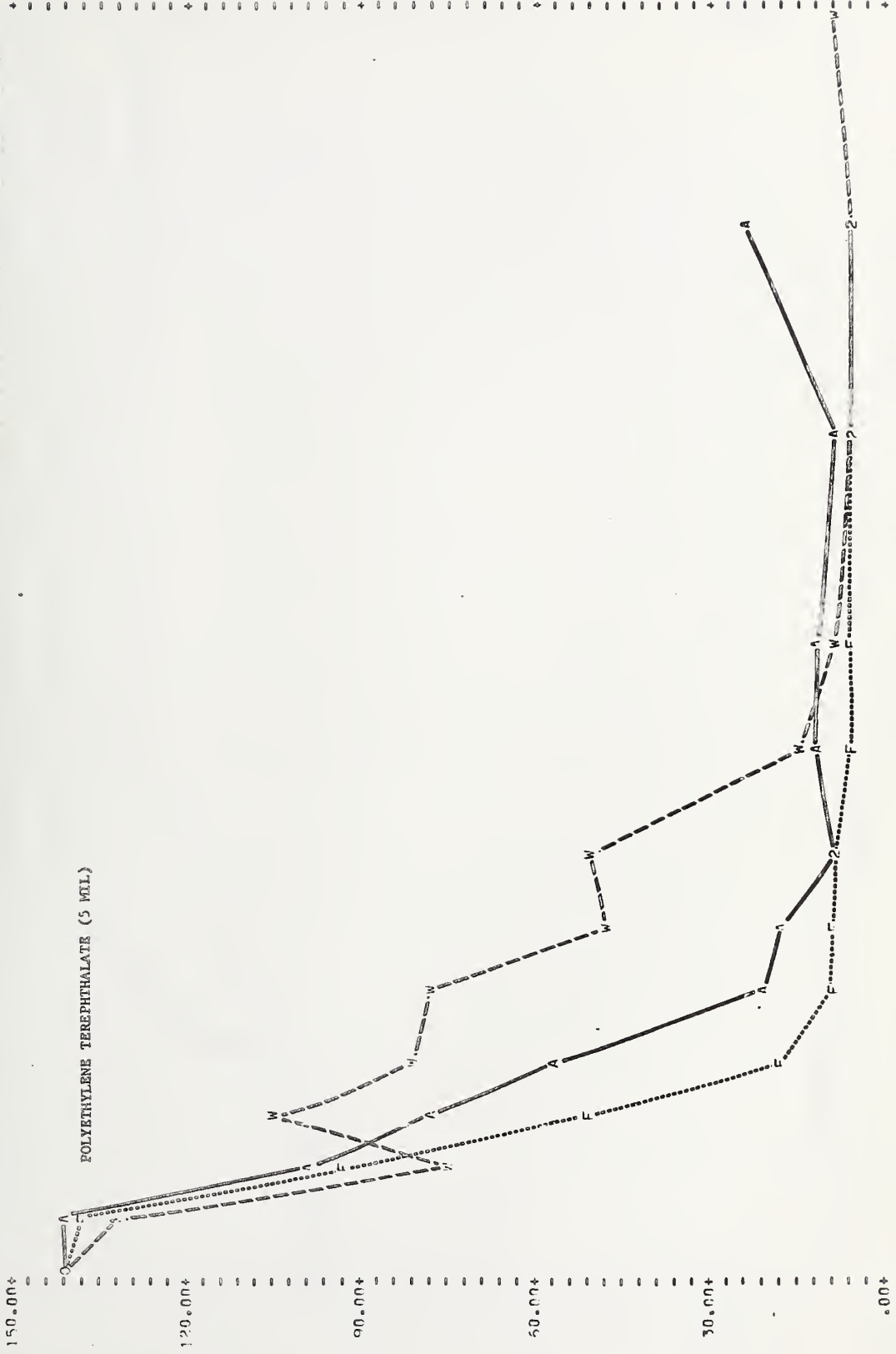
APR 65  
JUL 65  
OCT 65  
JAN 66  
APR 66  
JUL 66  
OCT 66  
JAN 67  
APR 67  
JUL 67  
OCT 67  
JAN 68  
APR 68  
JUL 68  
OCT 68  
JAN 69  
APR 69  
JUL 69  
OCT 69  
JAN 70  
APR 70  
JUL 70  
OCT 70  
JAN 71  
APR 71  
JUL 71  
OCT 71  
JAN 72  
APR 72  
JUL 72  
OCT 72

FIGURE 53

GLASS (IN PERCENT) ARIZONA FLORIDA WASHINGTON

PLASTIC

POLYETHYLENE TEREPHTHALATE (5 MIL)



150.00+  
120.00+  
90.00+  
60.00+  
30.00+  
0.00+

65  
66  
67  
68  
69  
70  
71  
72

FIGURE 54

WASHINGTON

FLORIDA

ARIZONA

PLASTIC

GLASS (IN PERCENT)

GLASS-REINFORCED POLYESTER (60 MIL)

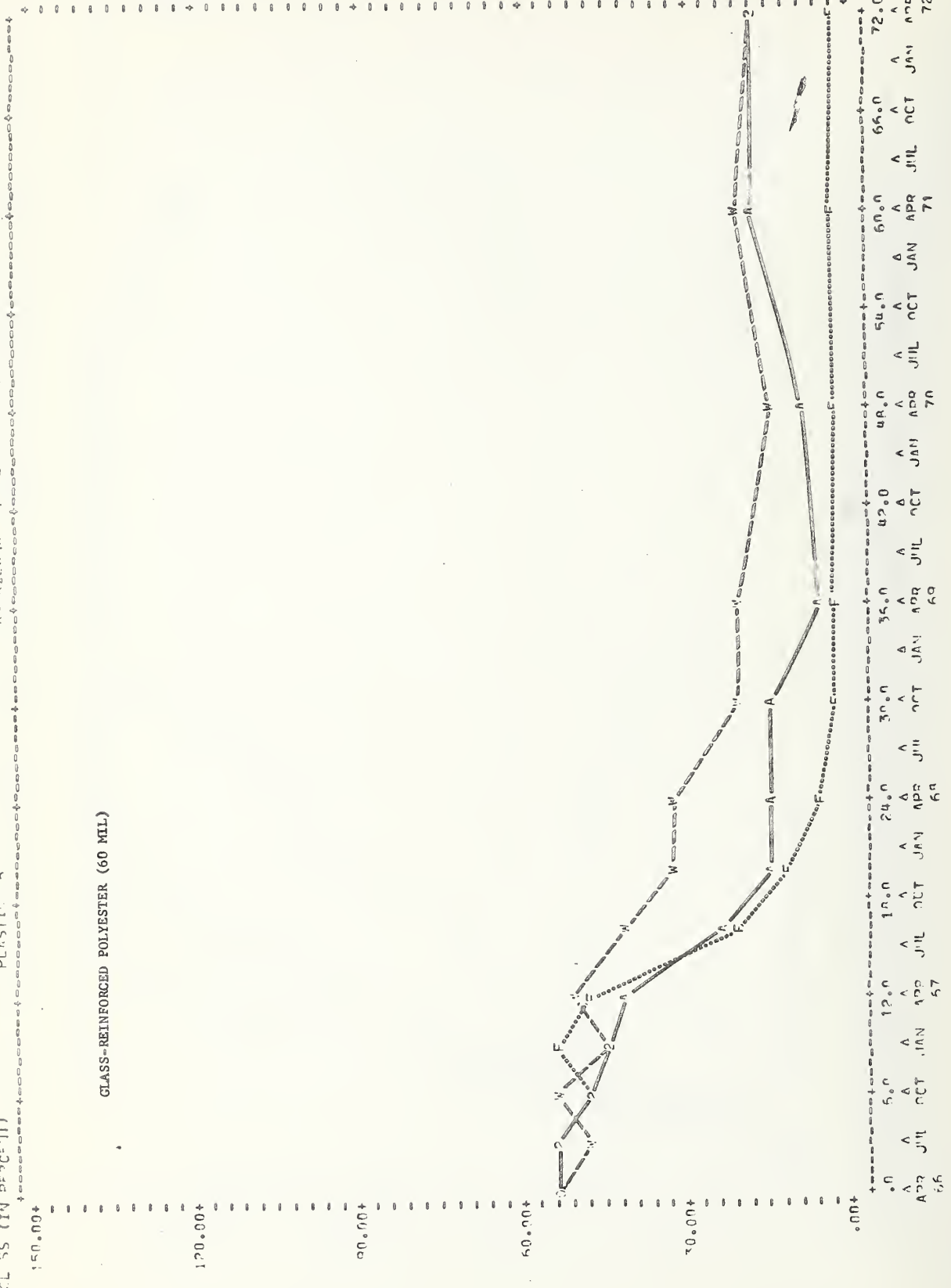


FIGURE 55

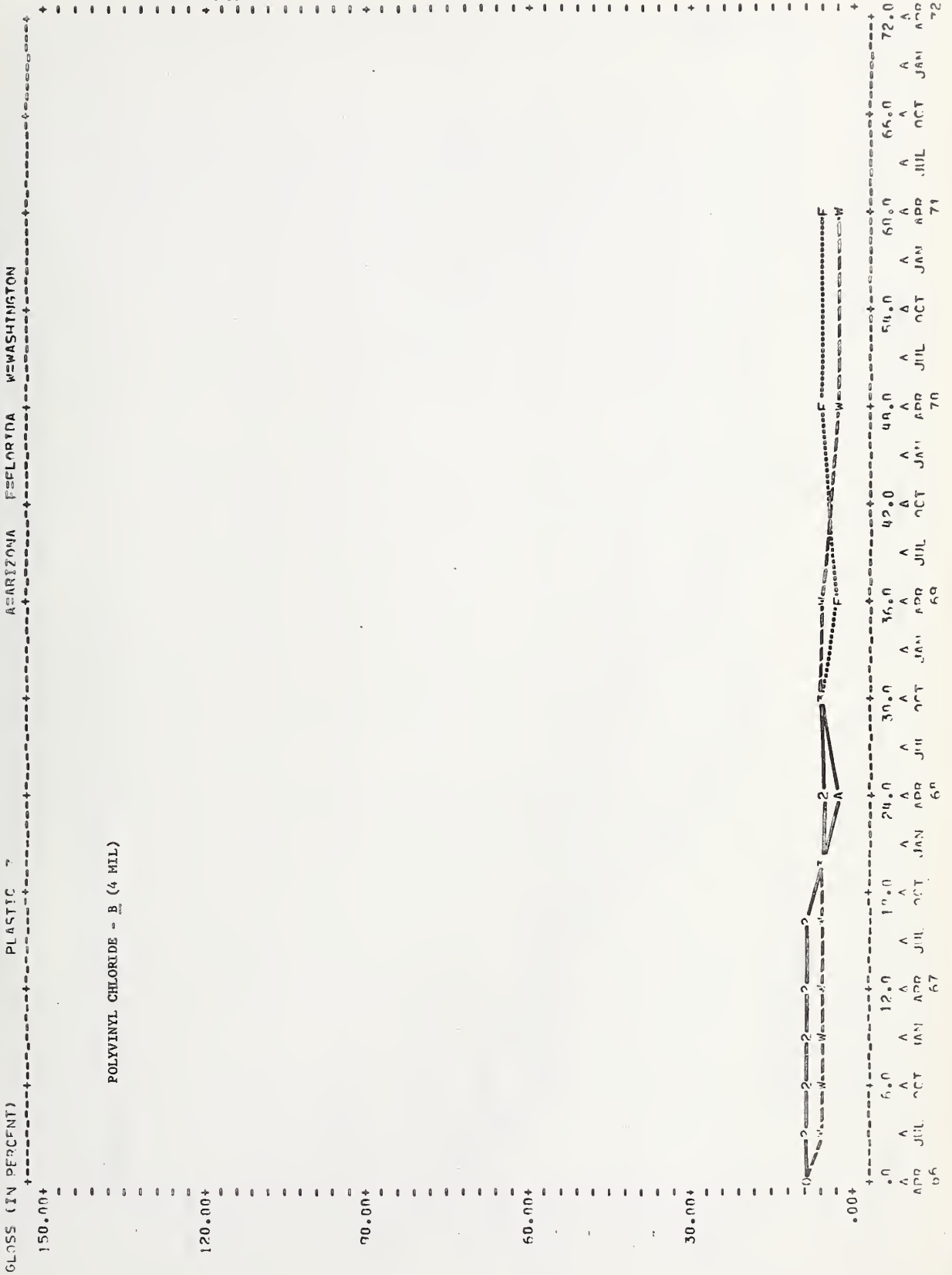


FIGURE 56

ARIZONA FLORIDA WASHINGTON

PLASTIC

GLOSS (IN PERCENT)

POLYVINYL CHLORIDE - B (10 MIL)

150.00+

120.00+

90.00+

60.00+

30.00+

0.00+

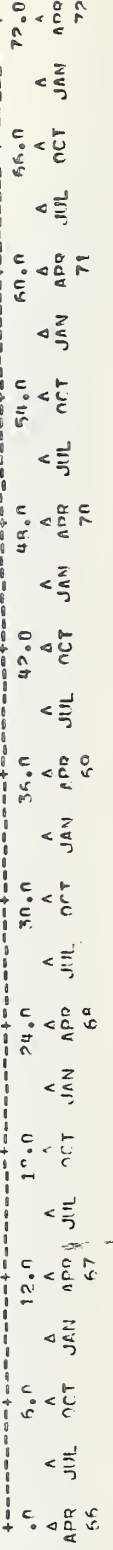


FIGURE 57

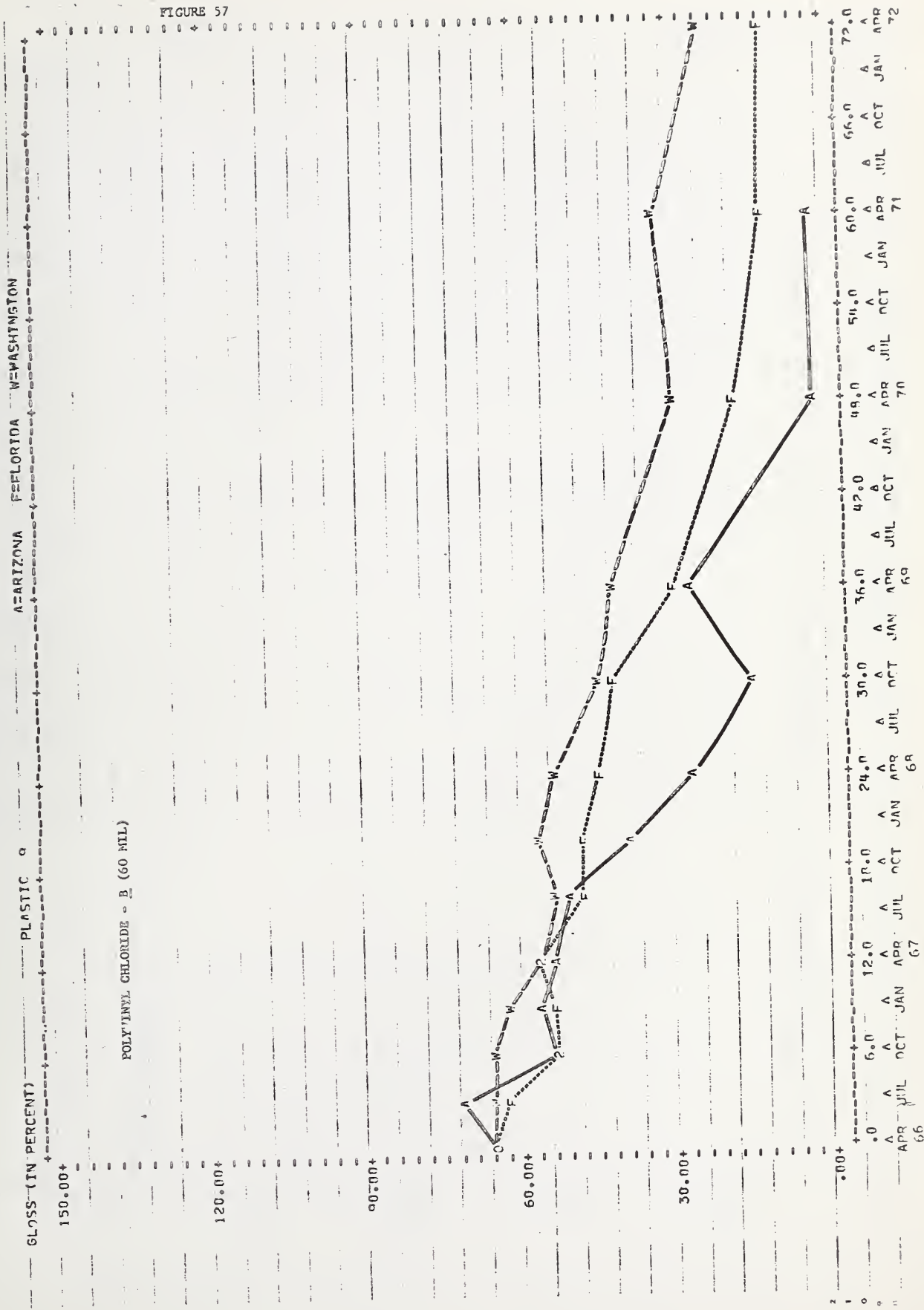


FIGURE 58

ARIZONA FLORIDA WASHINGTON

PLASTIC 10

POLYVINYL CHLORIDE - C (4 MIL)

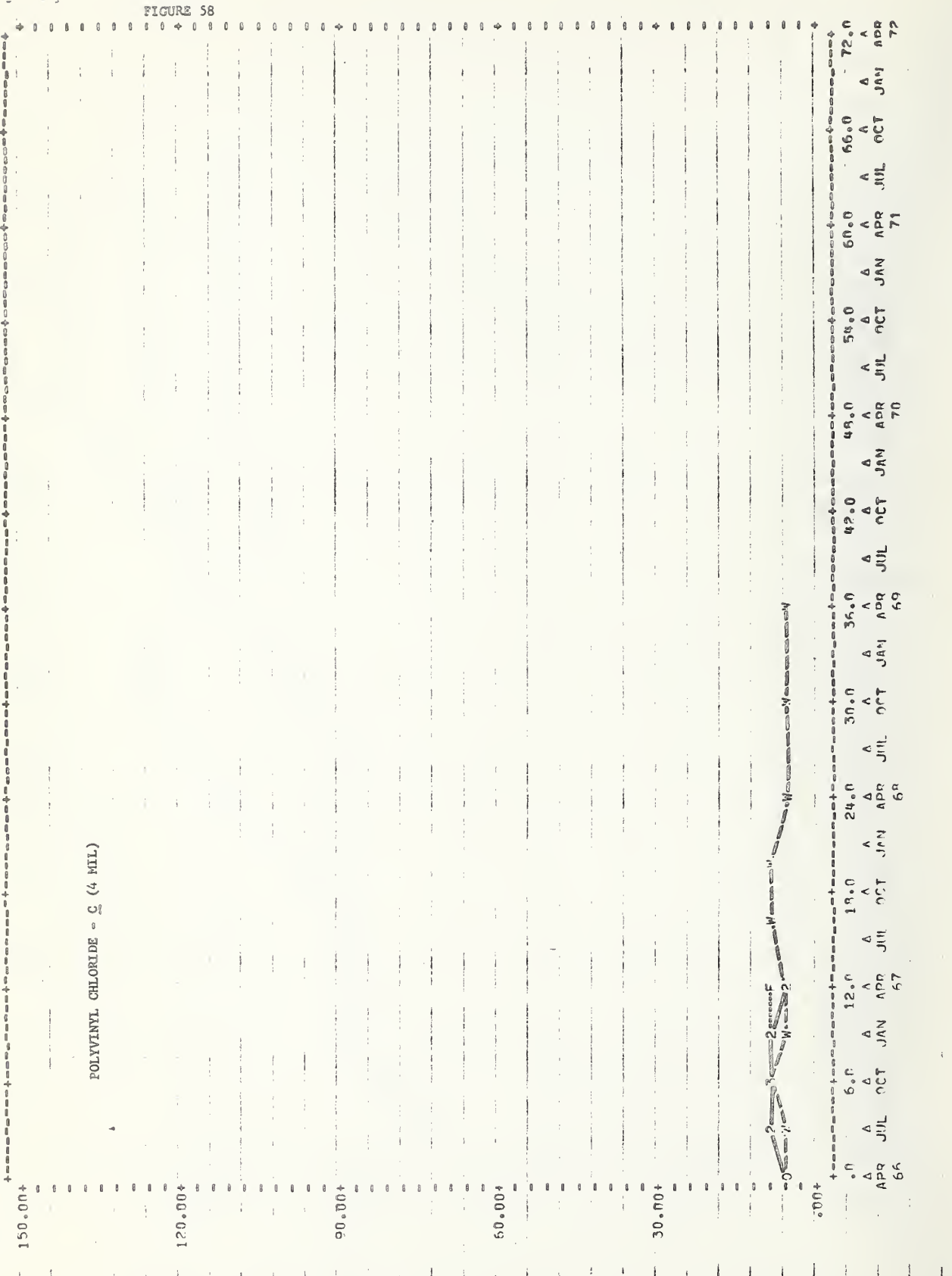






FIGURE 60

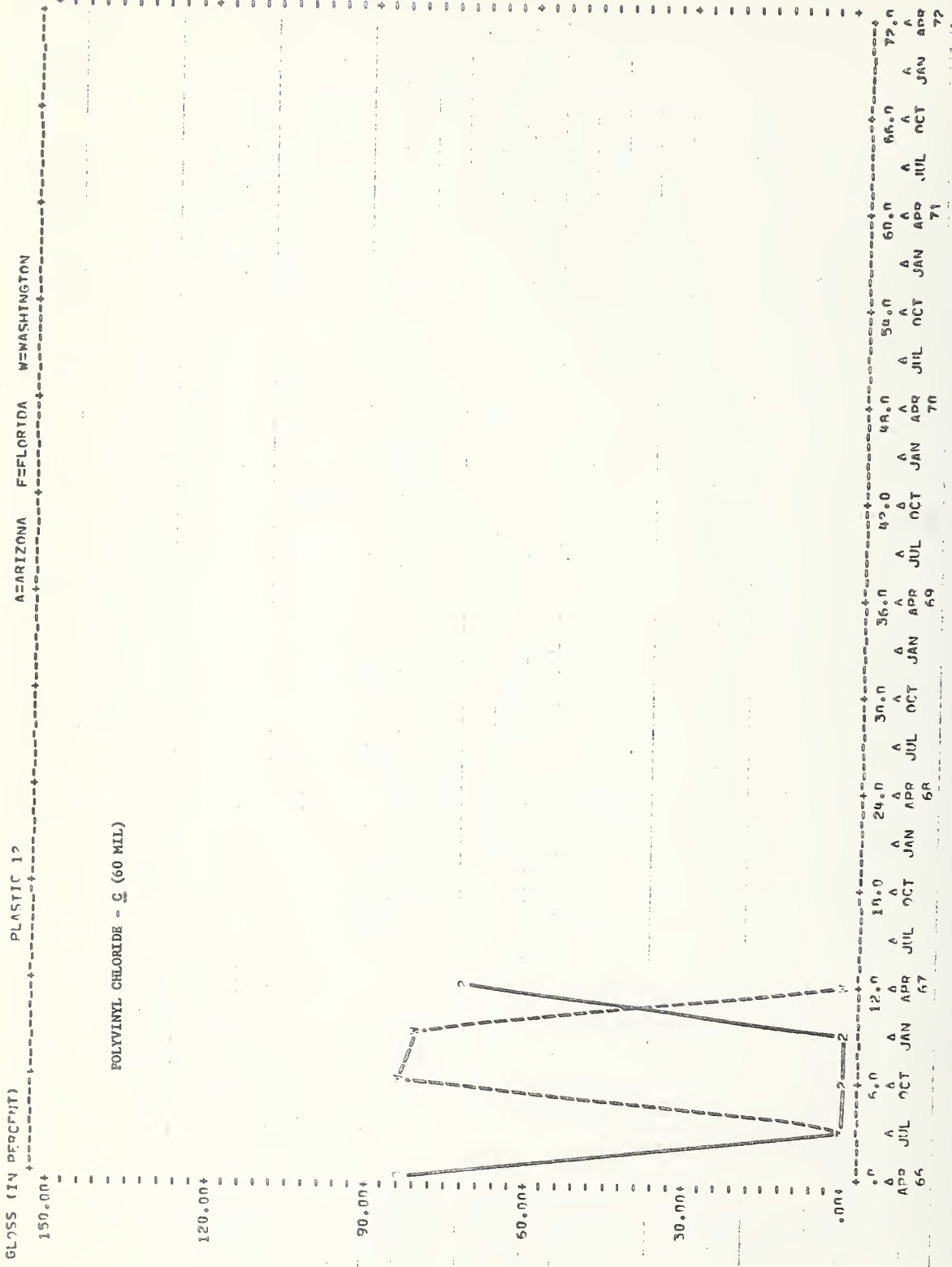


FIGURE 61

GLASS (IN PERCENT) PLASTIC 13 ARIZONA FLORIDA WASHINGTON

150.00+

POLYVINYL CHLORIDE - N (60 MEL)

120.00+

90.00+

60.00+

30.00+

.00+

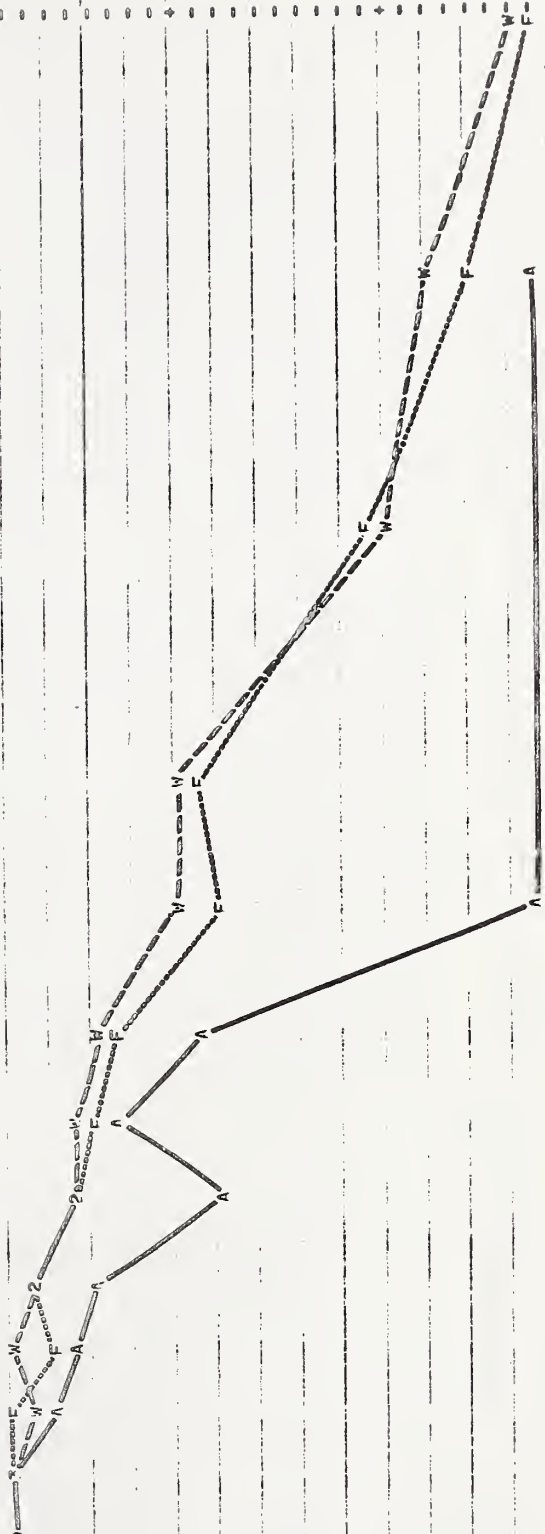
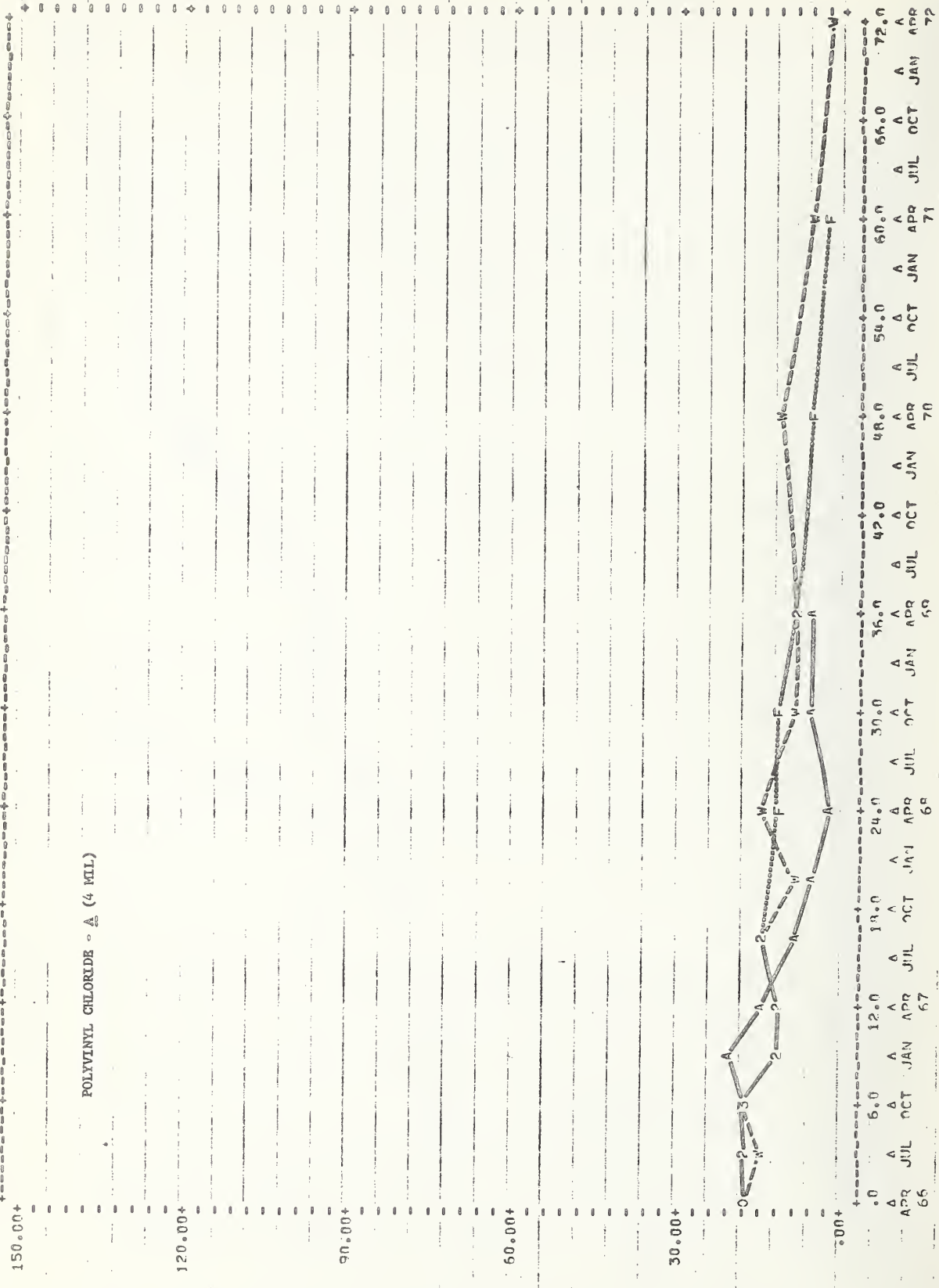


FIGURE 62

GLOSS (IN PERCENT) PLASTIC 14 ARIZONA FLORIDA WASHINGTON



POLYVINYL CHLORIDE - A (4 MIL)



FIGURE 63

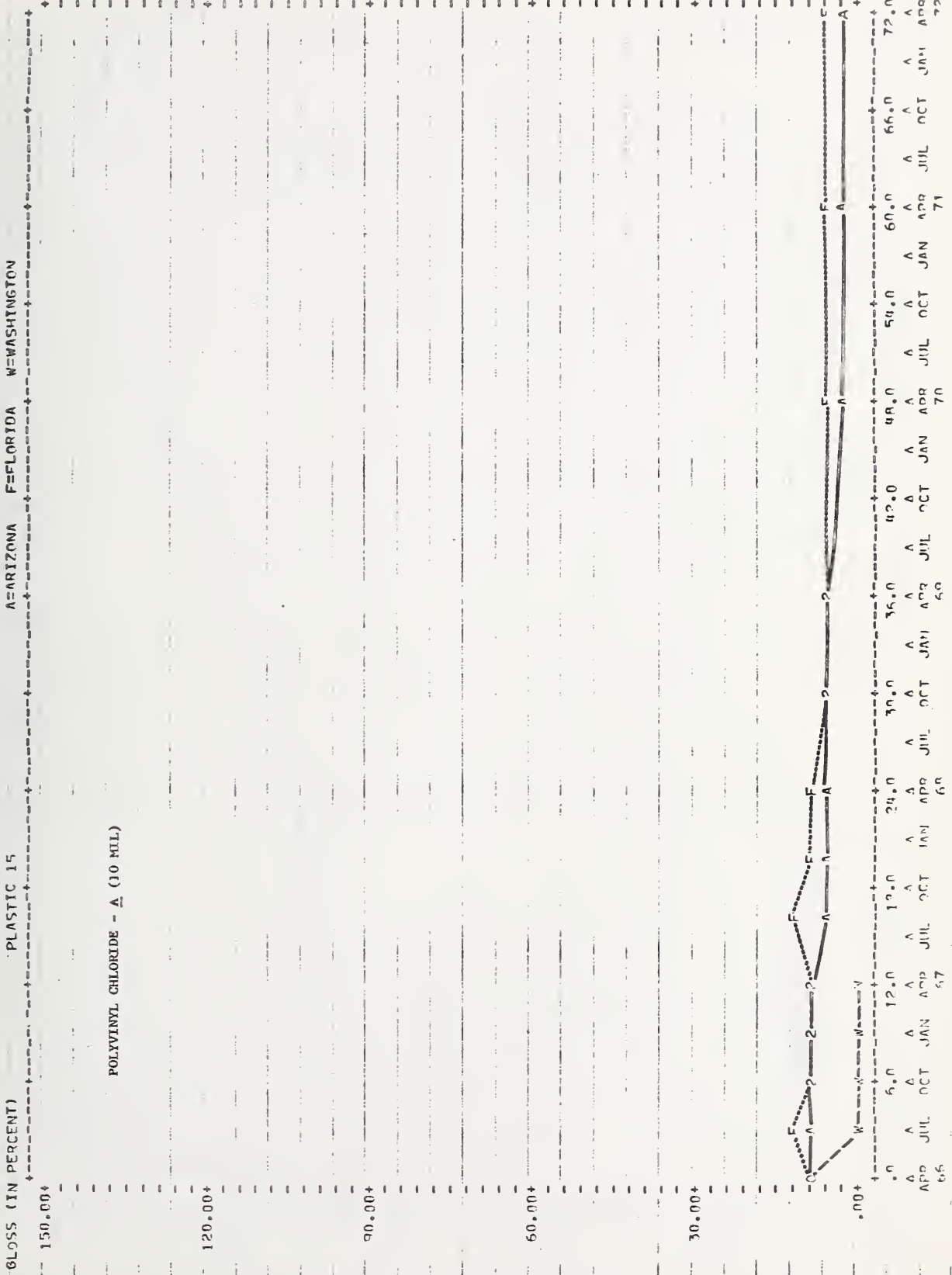


FIGURE 64

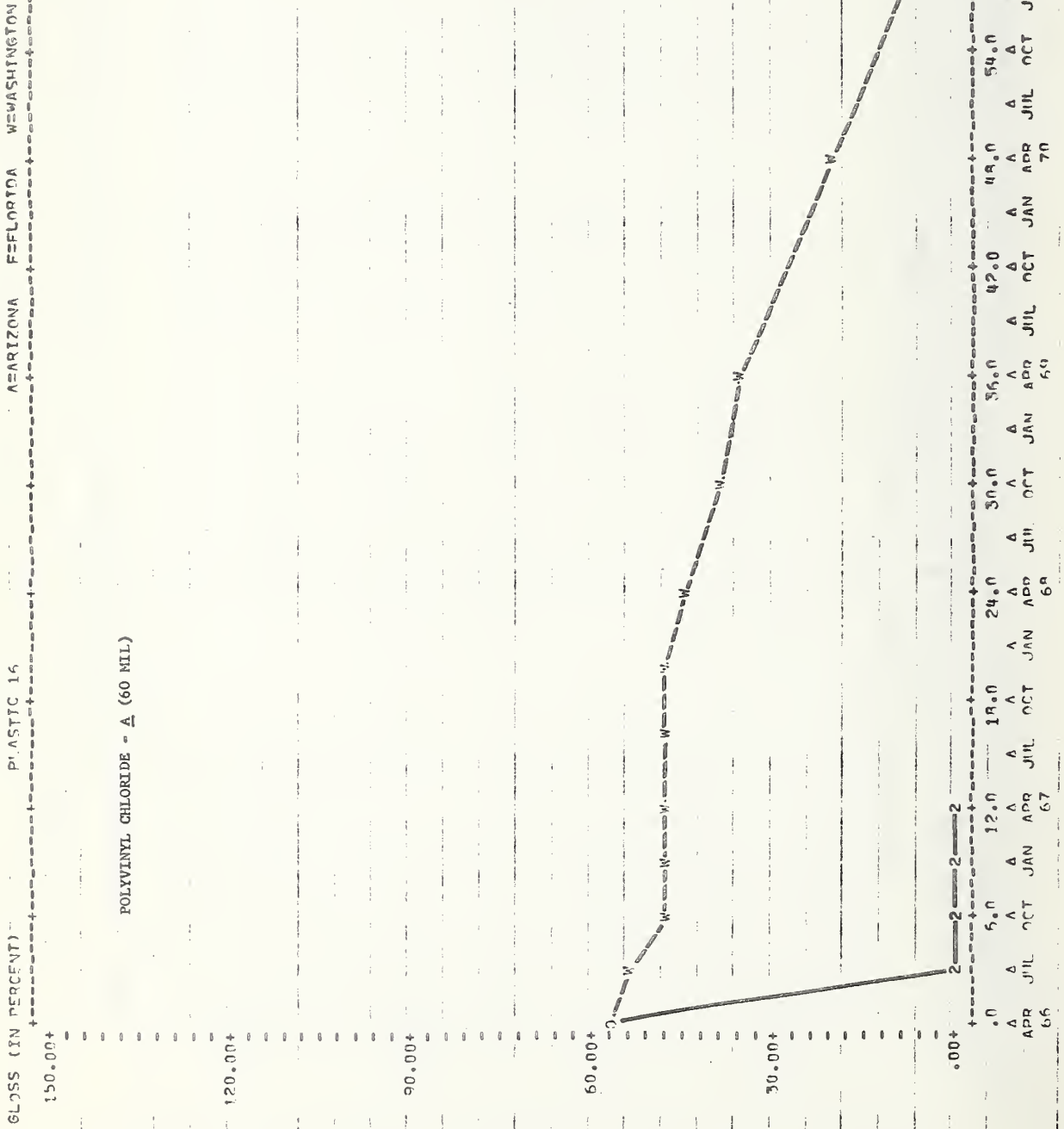


FIGURE 65

PLASTIC 17 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - D (4 MIL)

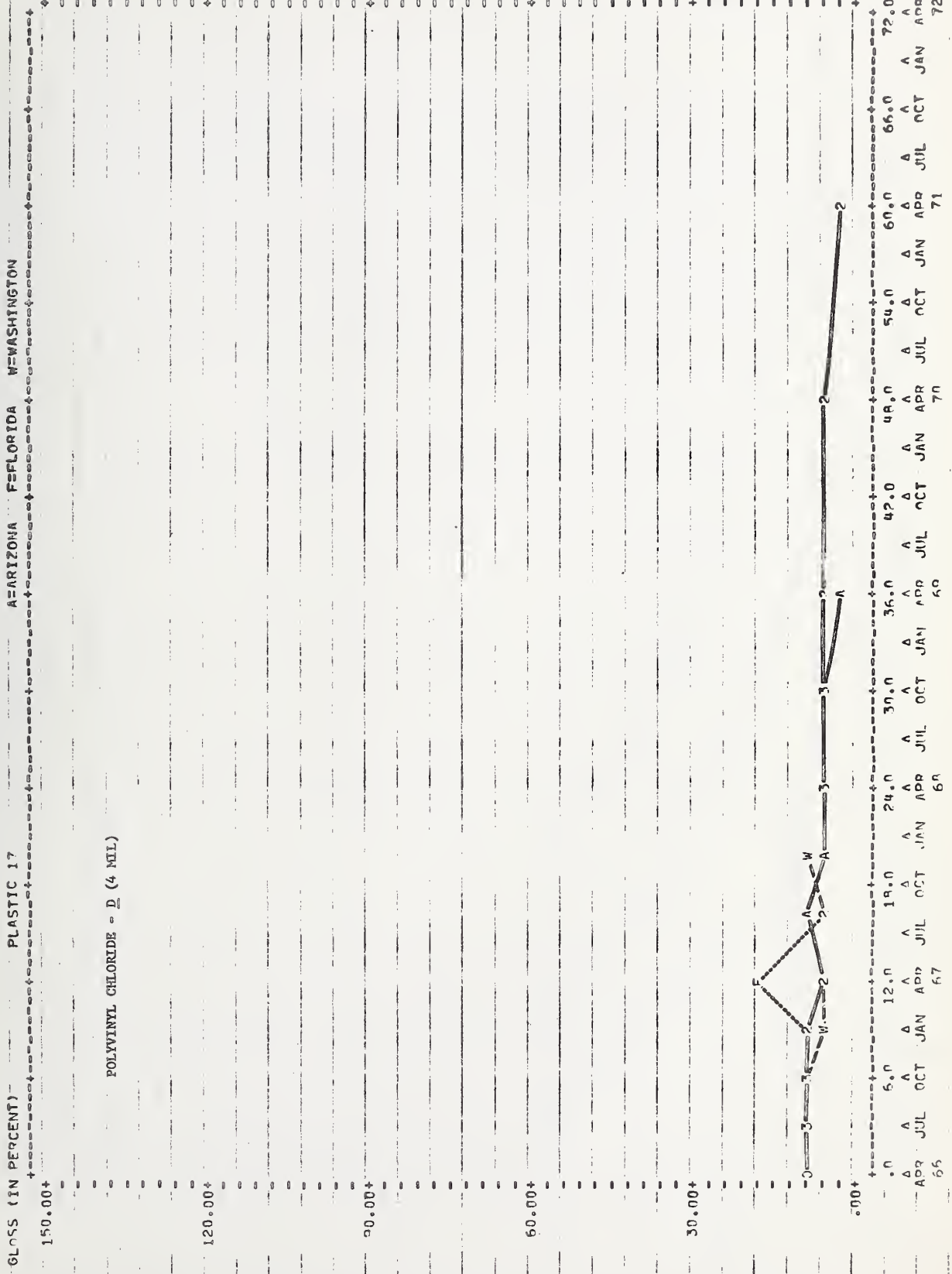


FIGURE 66

ARIZONA FLORIDA WASHINGTON

PLASTIC 10

GLOSS (IN PERCENT)

POLYVINYL CHLORIDE - D (10 MLL)

150.00+

120.00+

90.00+

60.00+

30.00+

0.00+

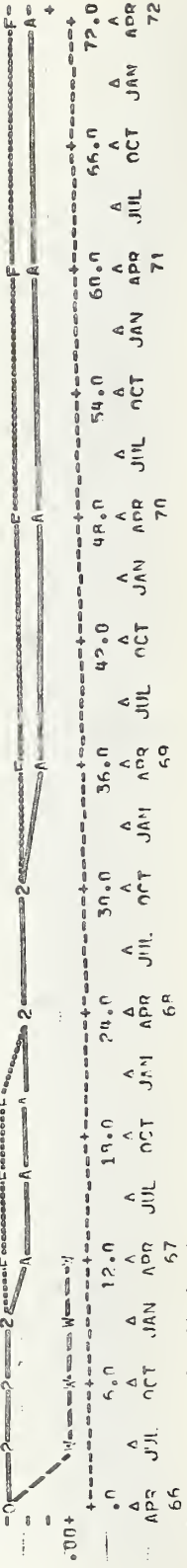






FIGURE 68

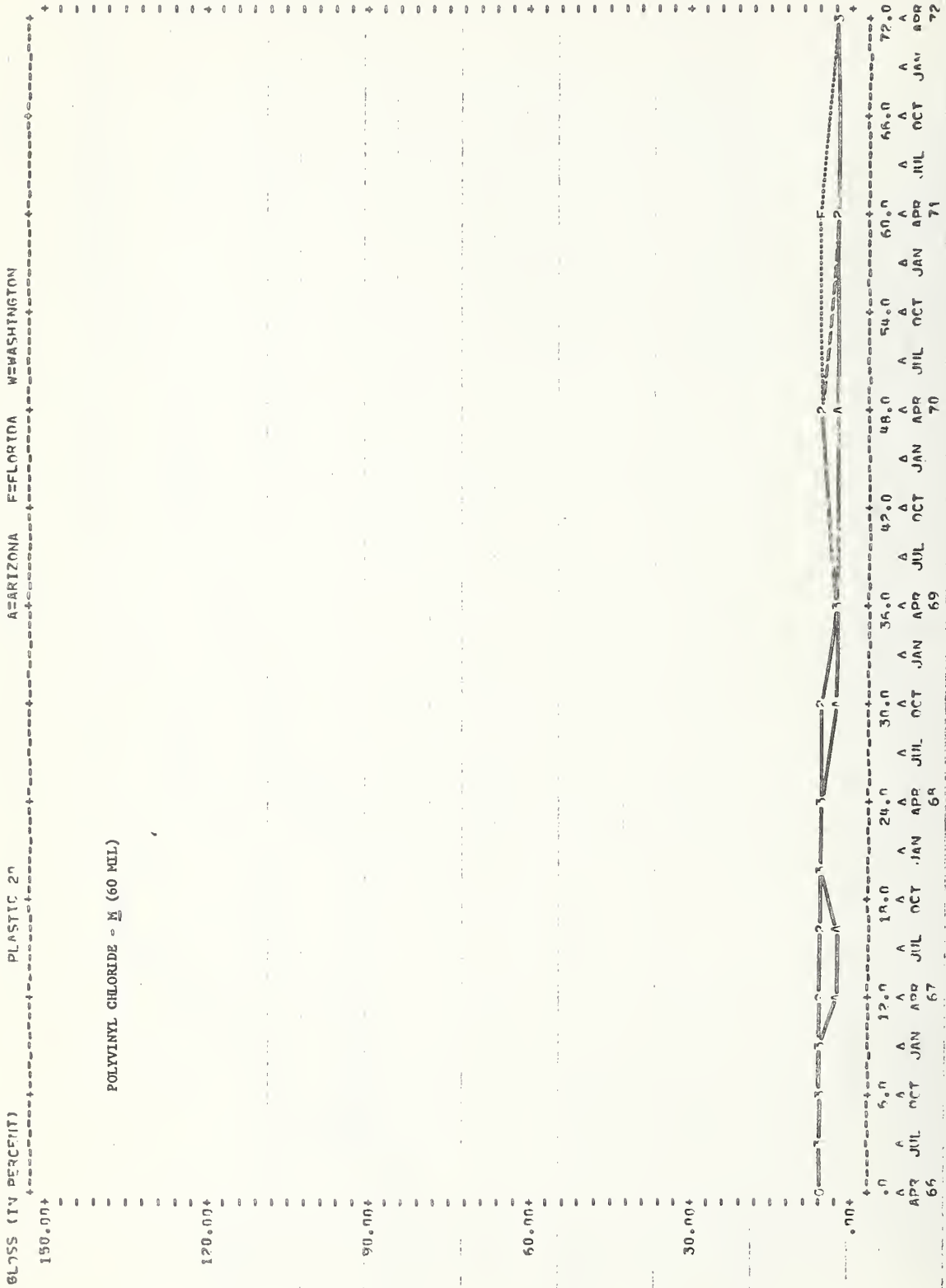


FIGURE 69A

HAZE AT 420NM (IN PERCENT) PLASTIC I ARIZONA FLORIDA WASHINGTON

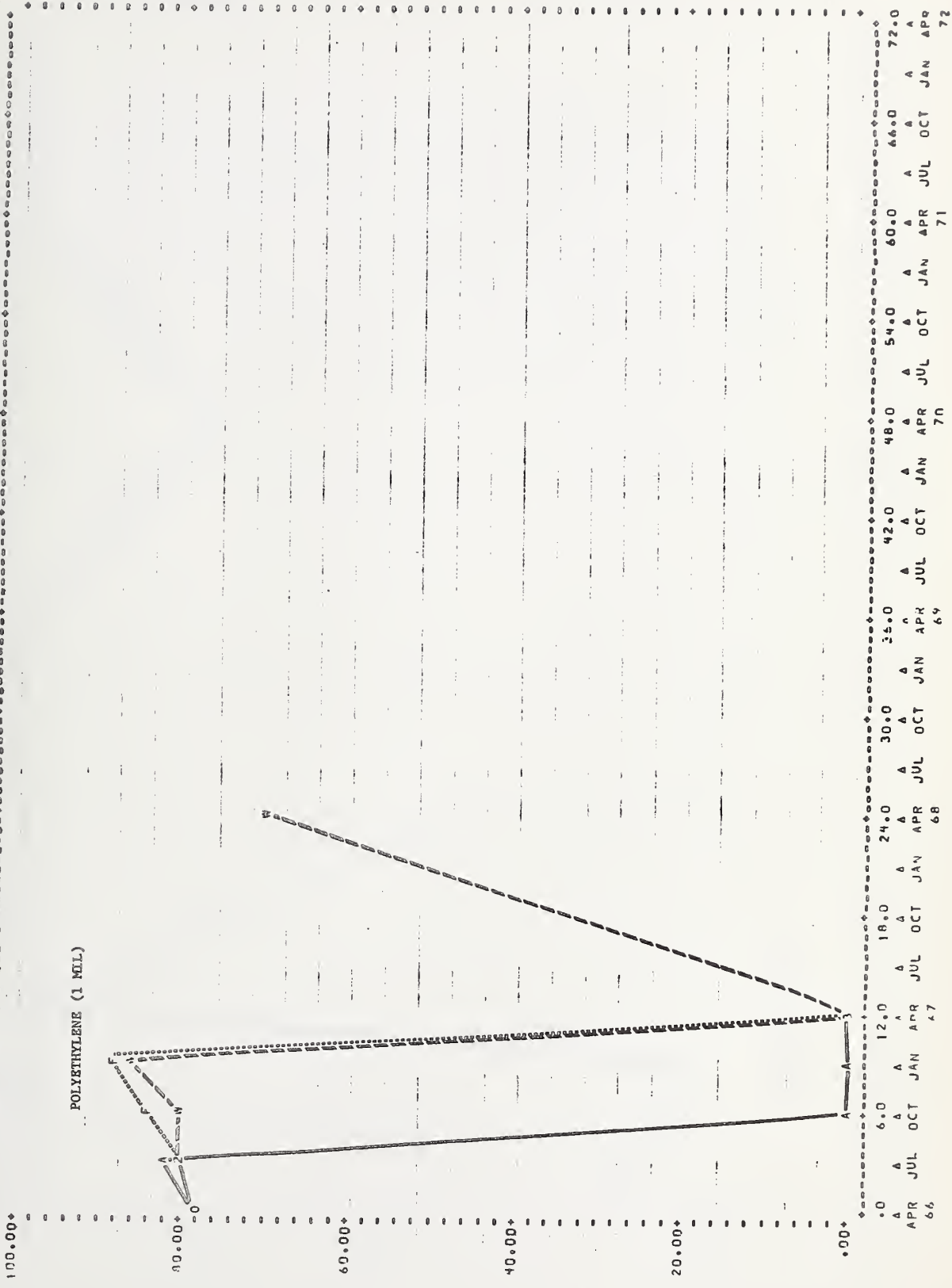
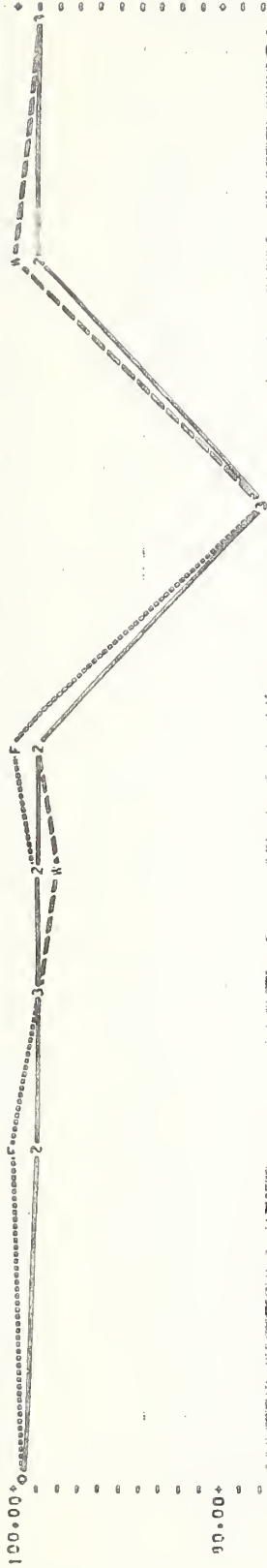






FIGURE 70B

HAZE AT 550NM (IN PERCENT) PLASTIC 2 ARIZONA FLORIDA WASHINGTON



POLYETHYLENE (60 MIL)

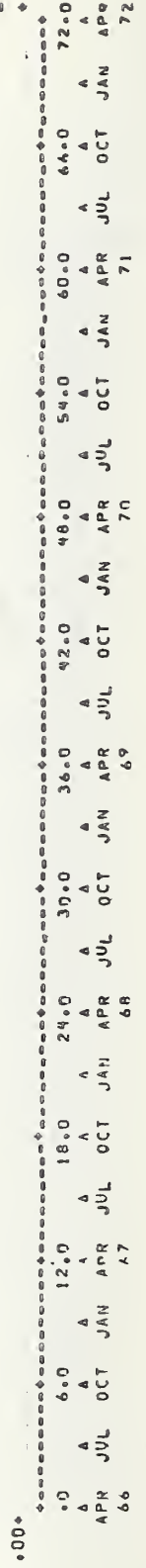




FIGURE 71B

HAZE AT 550NM (IN PERCENT)

PLASTIC 3

ARIZONA FLORIDA WASHINGTON

POLYMETHYL METHACRYLATE (60 MIL)

100.00

80.00

60.00

40.00

20.00

0.00

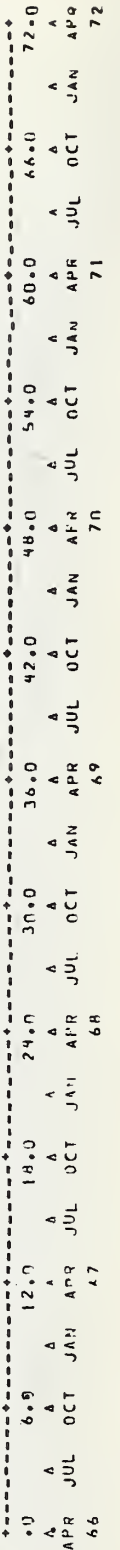




FIGURE 72A

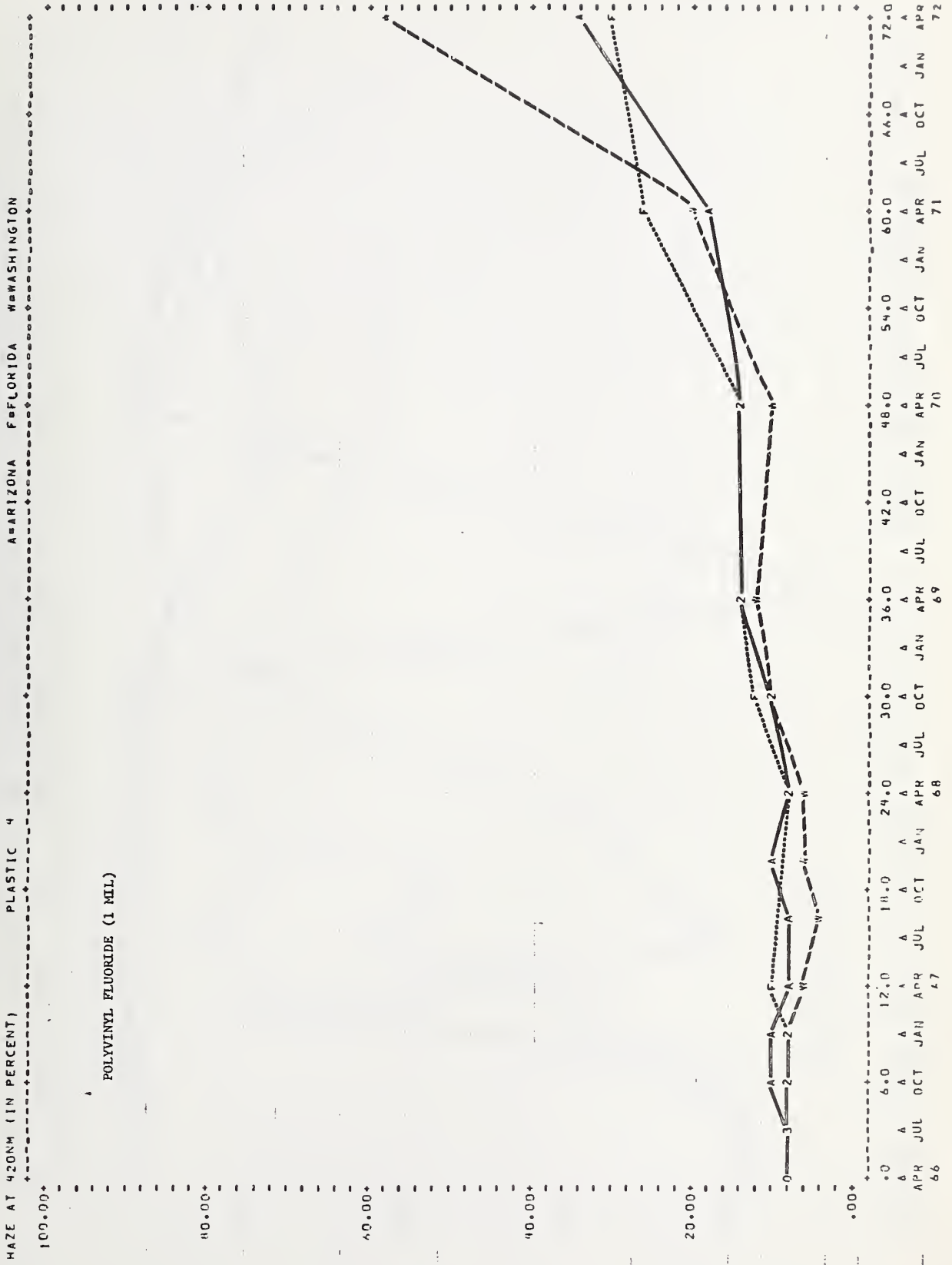
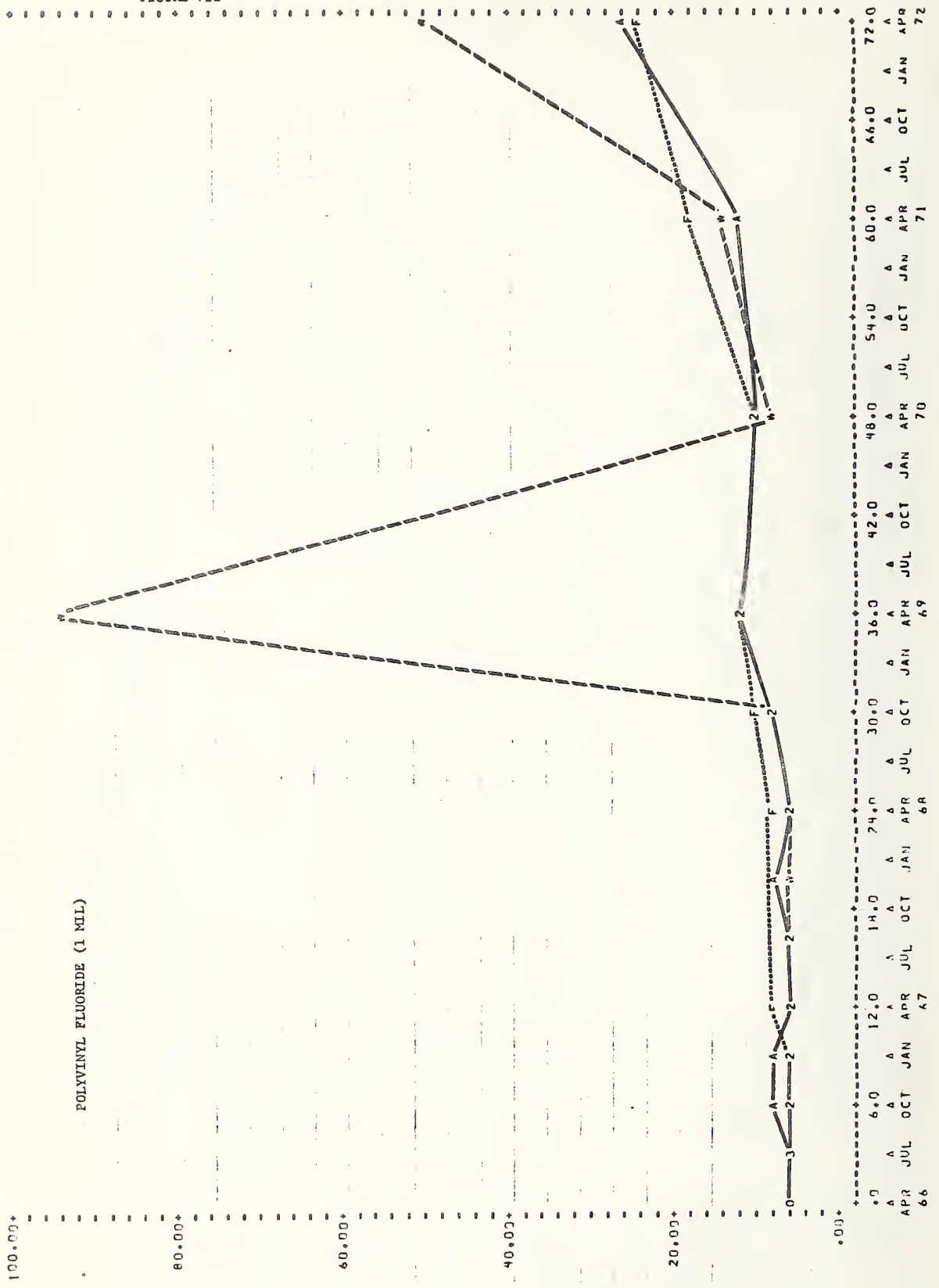


FIGURE 72B

HAZE AT 550NM (IN PERCENT) PLASTIC # ARIZONA FLORIDA WASHINGTON

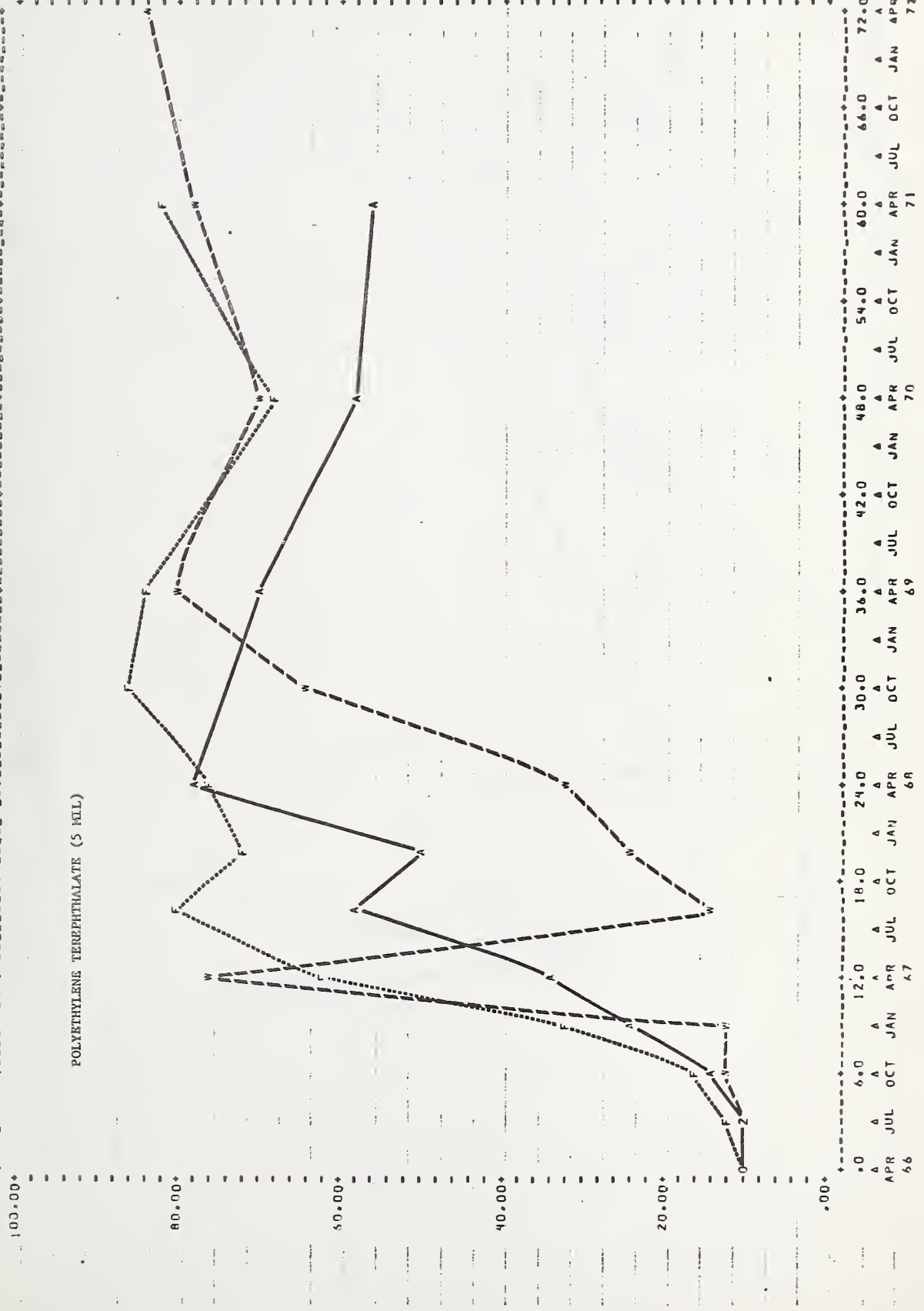
POLYVINYL FLUORIDE (1 MIL)



HAZE AT 420M $\mu$  (IN PERCENT) PLASTIC 5 ARIZONA FLORIDA WASHINGTON

POLYETHYLENE TEREPHTHALATE (5 MIL)

FIGURE 73A



HAZE AT 550NM (IN PERCENT) PLASTIC 5 ARIZONA F=FLORIDA W=WASHINGTON

POLYETHYLENE TEREPHTHALATE (5 MIL)

FIGURE 73B

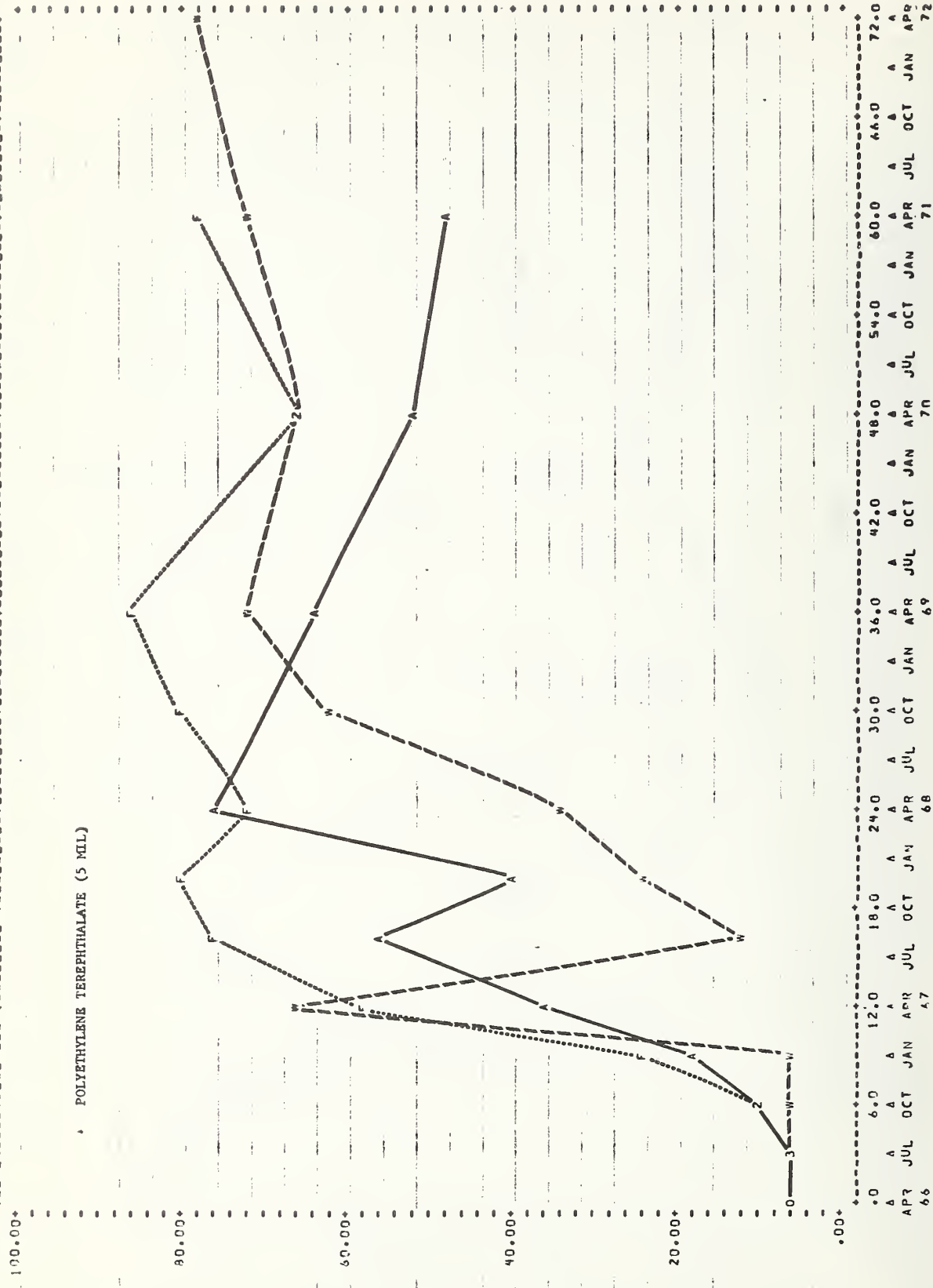
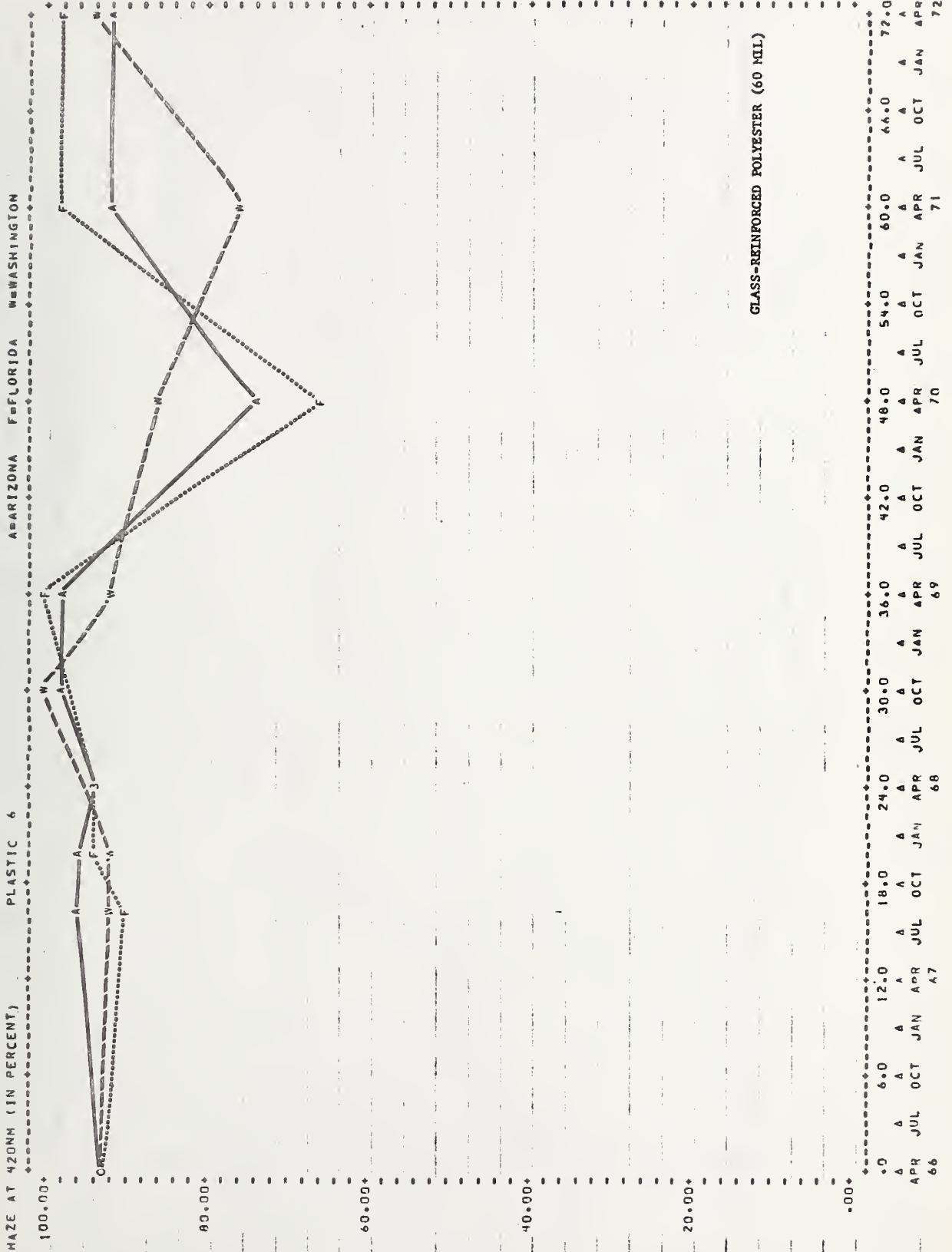


FIGURE 74A



GLASS-REINFORCED POLYESTER (60 MIL)

HAZE AT 550NM (IN PERCENT)

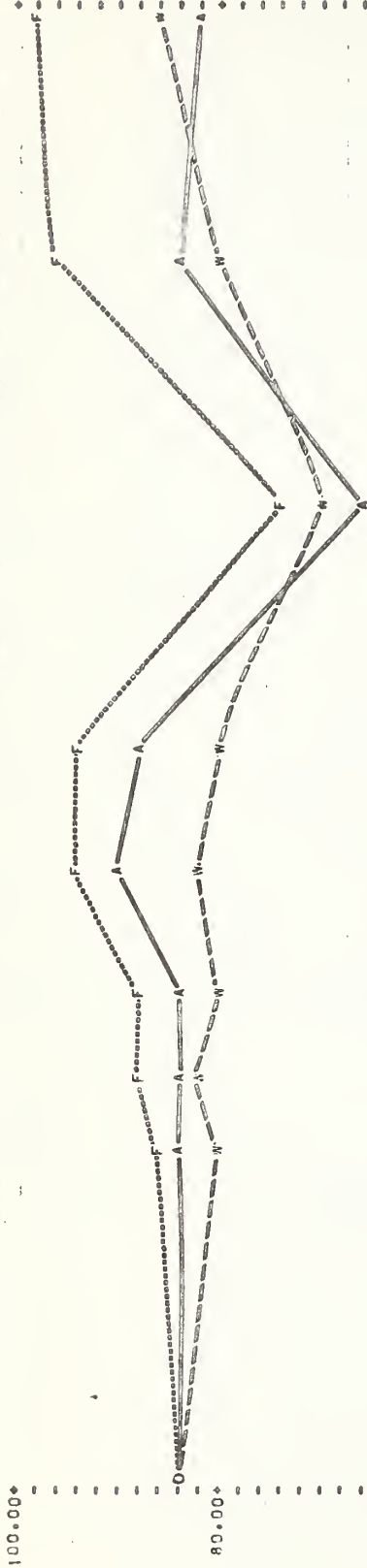
PLASTIC 6

ARIZONA

F=FLORIDA

W=WASHINGTON

FIGURE 74B



GLASS-REINFORCED POLYESTER (60 MIL)

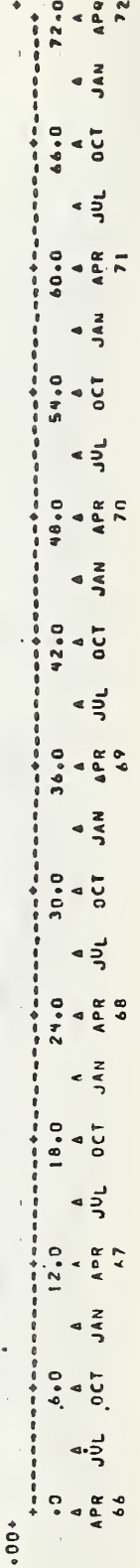
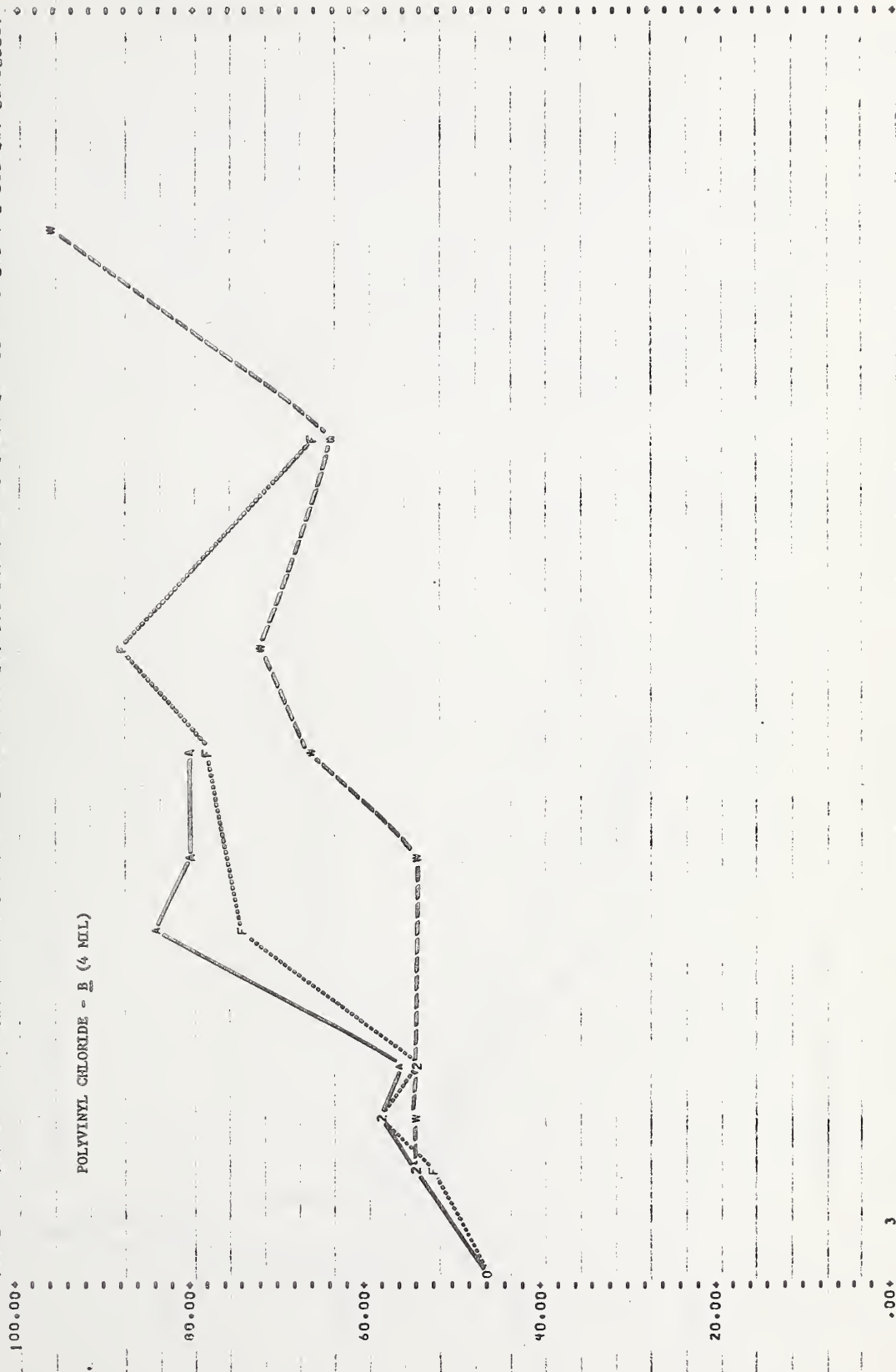


FIGURE 75A

HAZE AT 420NM (IN PERCENT) PLASTIC 7 ARIZONA FLORIDA WASHINGTON



00+ 3  
 0 6.0 12.0 18.0 24.0 30.0 36.0 42.0 48.0 54.0 60.0 66.0 72.0  
 APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR  
 66 67 68 69 70 71 72

FIGURE 75B

HAZE AT 550NM (IN PERCENT) PLASTIC 7 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - B (4 MIL)

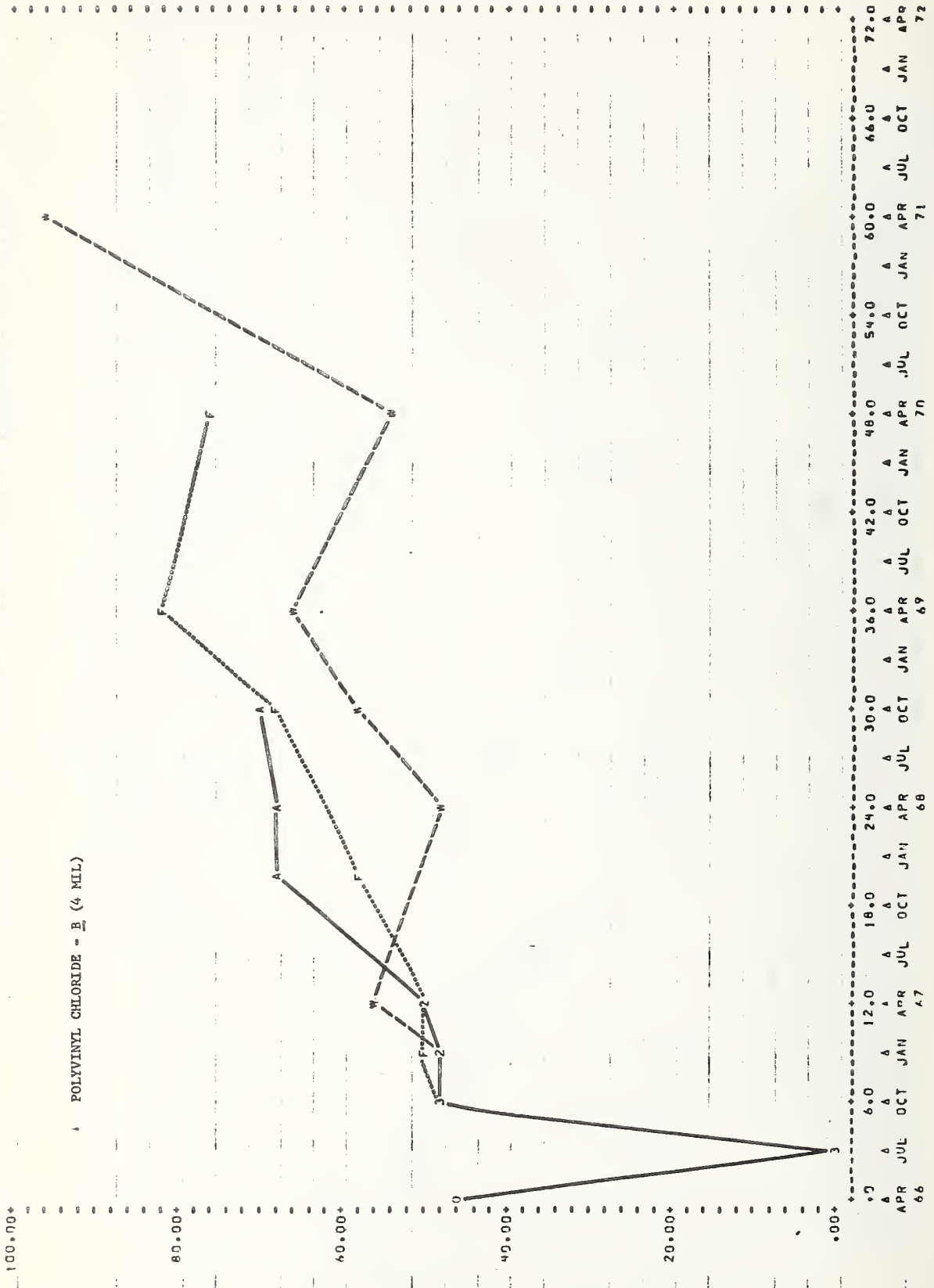


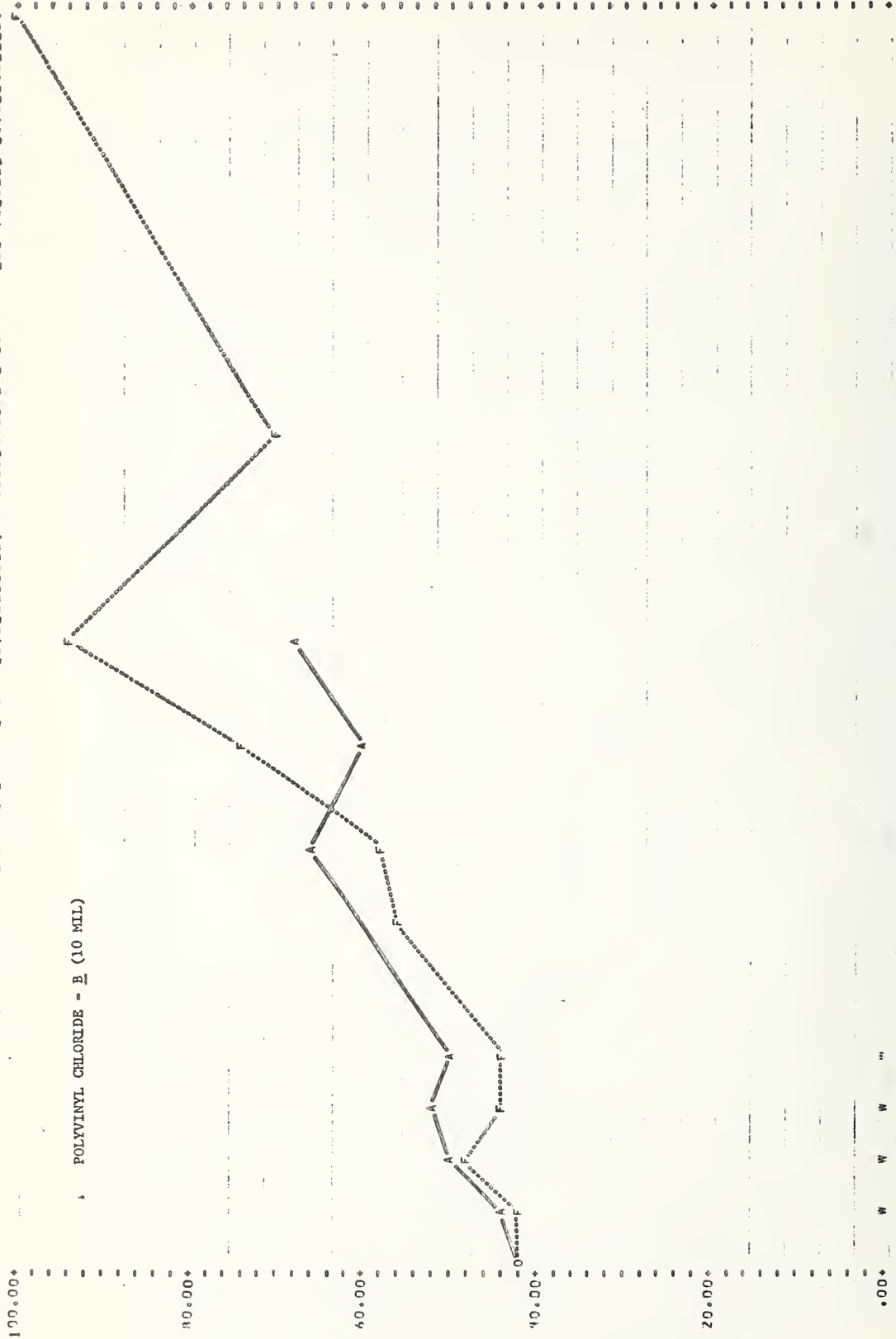




FIGURE 76B

HAZE AT 550NM (IN PERCENT) PLASTIC B ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - B (10 MIL)



0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00

APR JUL OCT APR JUL OCT APR JUL OCT APR JUL OCT APR JUL OCT APR JUL OCT

66 67 68 70 71 72

FIGURE 77A

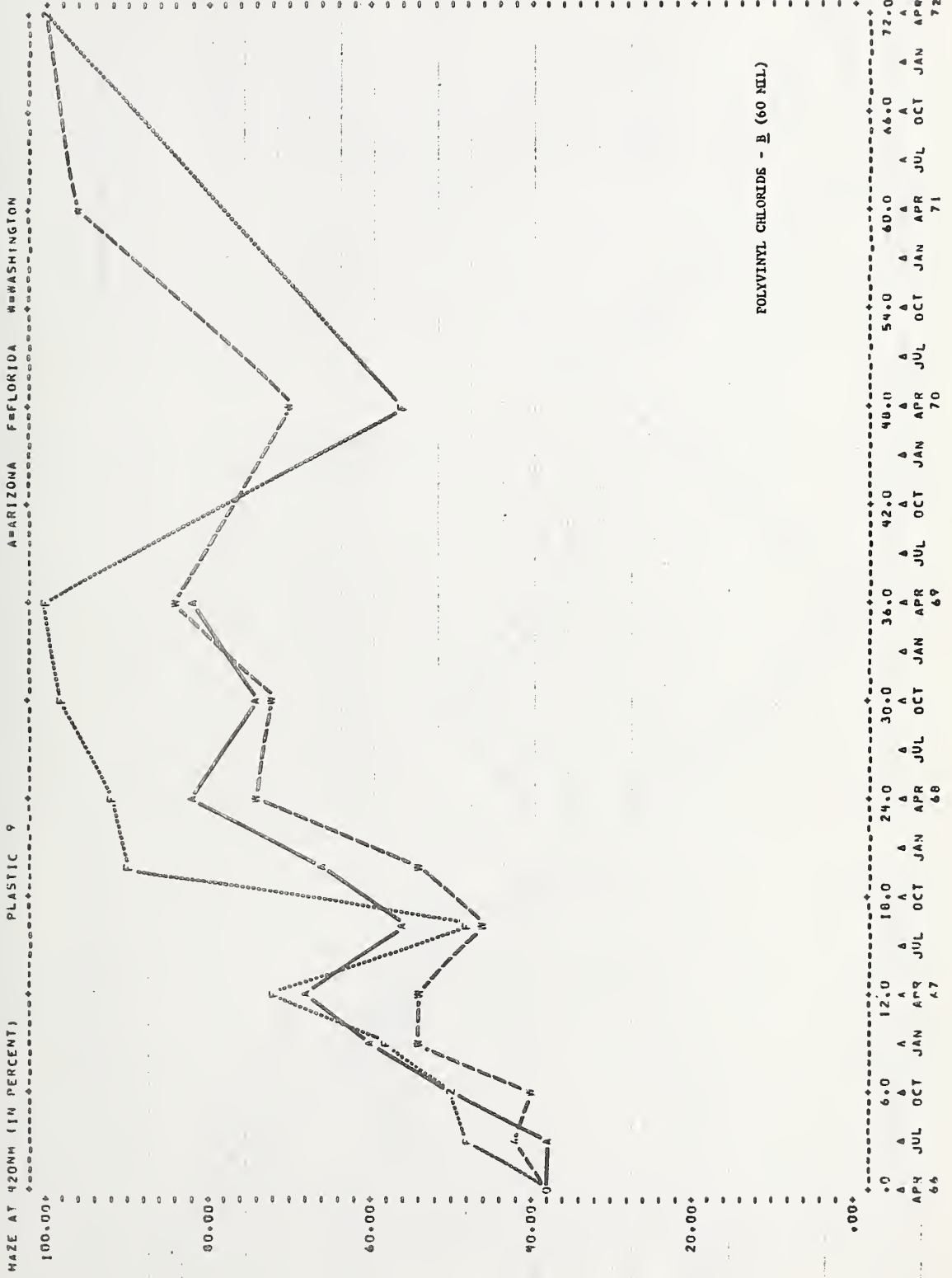
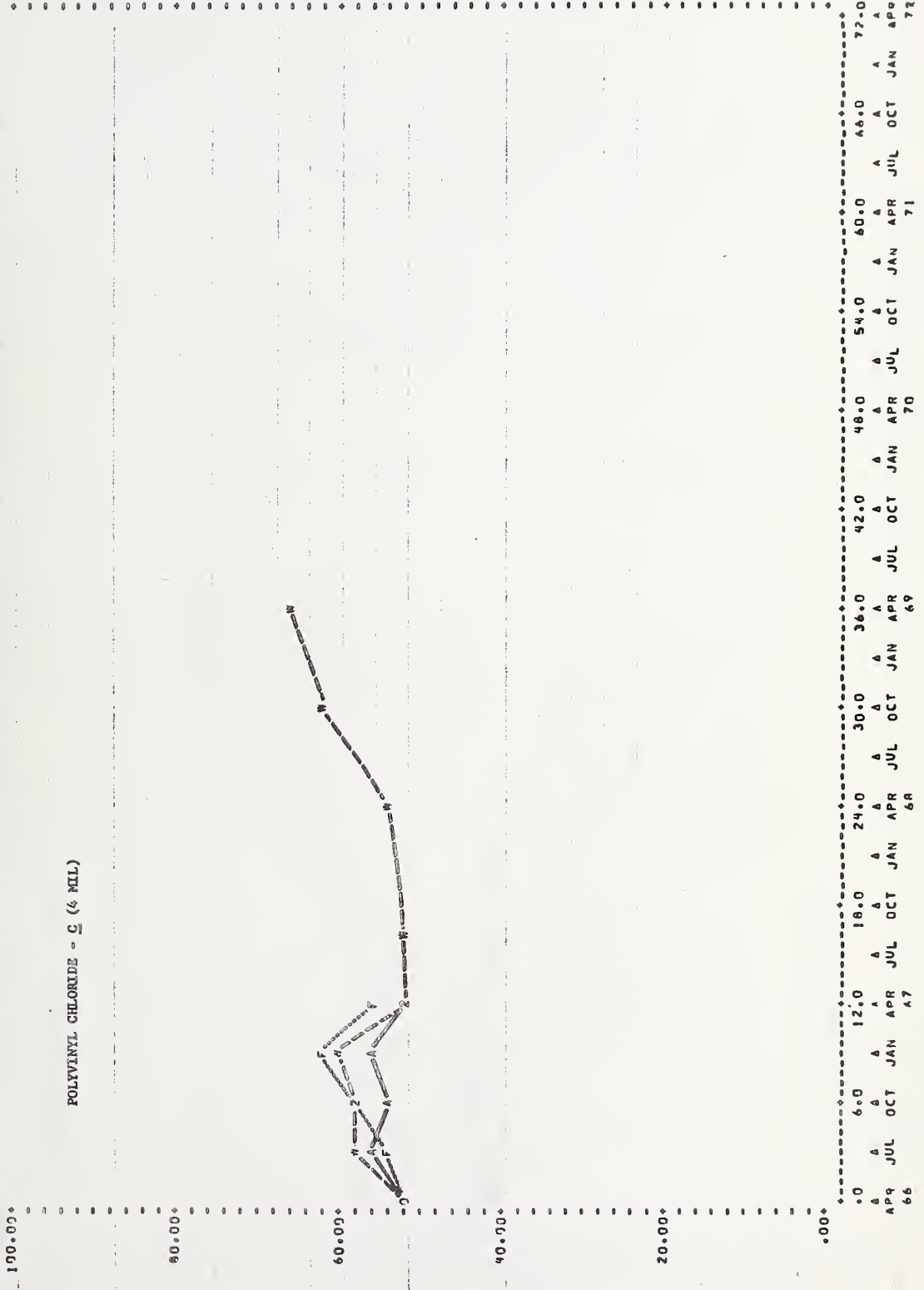




FIGURE 78A

HAZE AT 420NM (IN PERCENT) PLASTIC 10 ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - C (6 MIL)



HAZE AT 550MM (IN PERCENT)

PLASTIC 10

ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - C (4 MLL)

FIGURE 78B

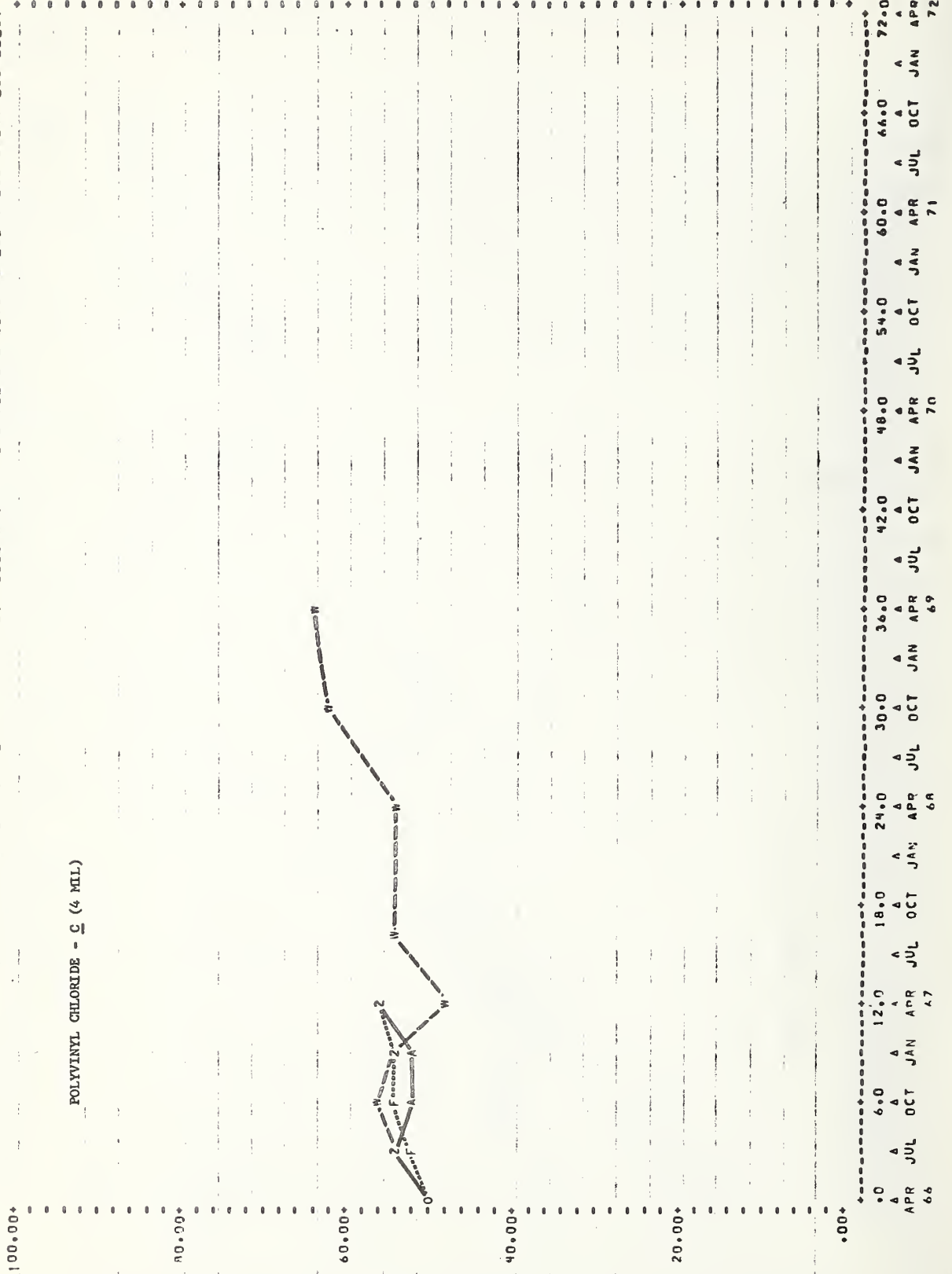


FIGURE 79A

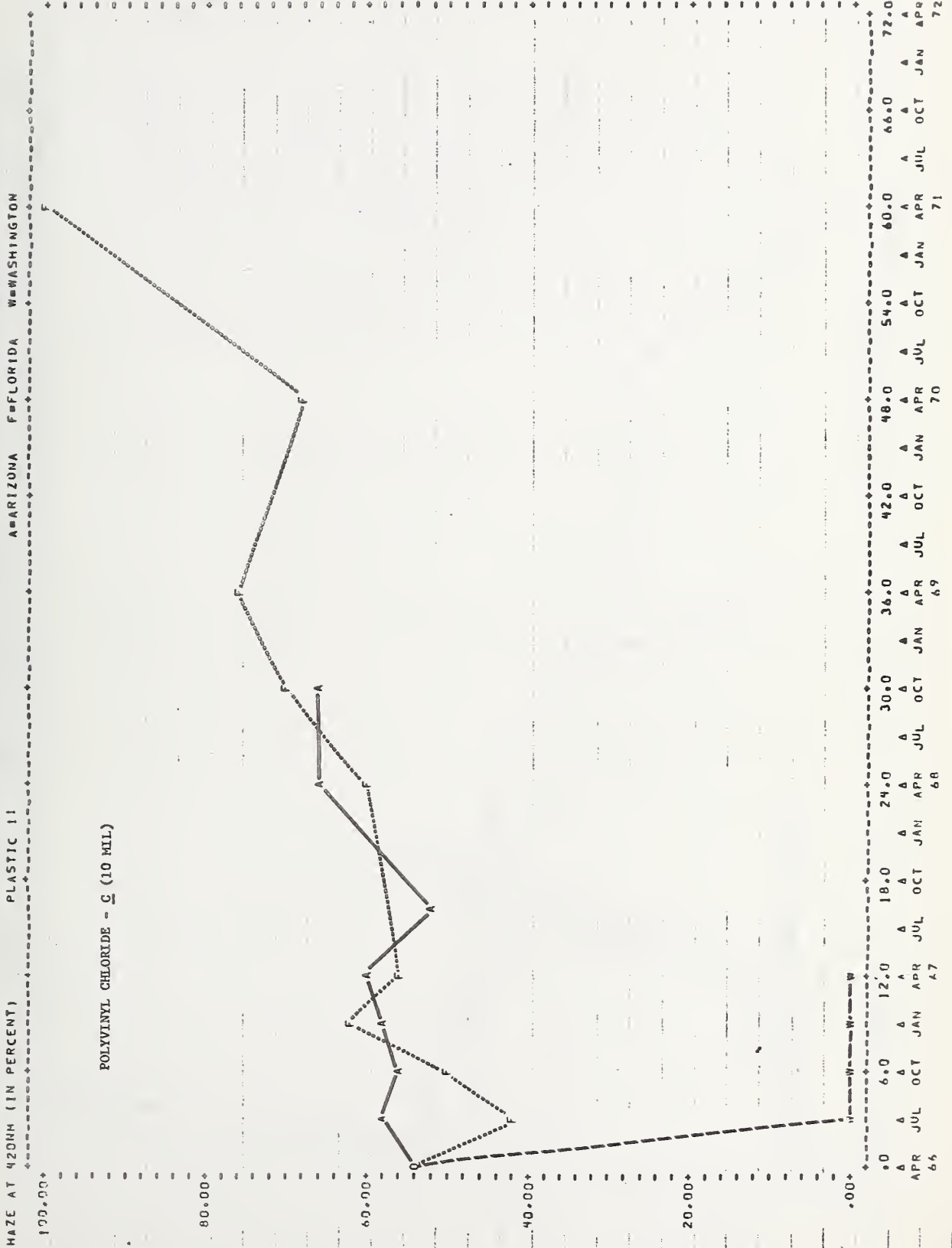


FIGURE 79B

HAZE AT 550NM (IN PERCENT) PLASTIC II ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - C (10 ML)

100.00

80.00

60.00

40.00

20.00

0.00

6.0 12.0 18.0 24.0 30.0 36.0 42.0 48.0 54.0 60.0 66.0 72.0

JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT

66 67 68 69 70 71 72

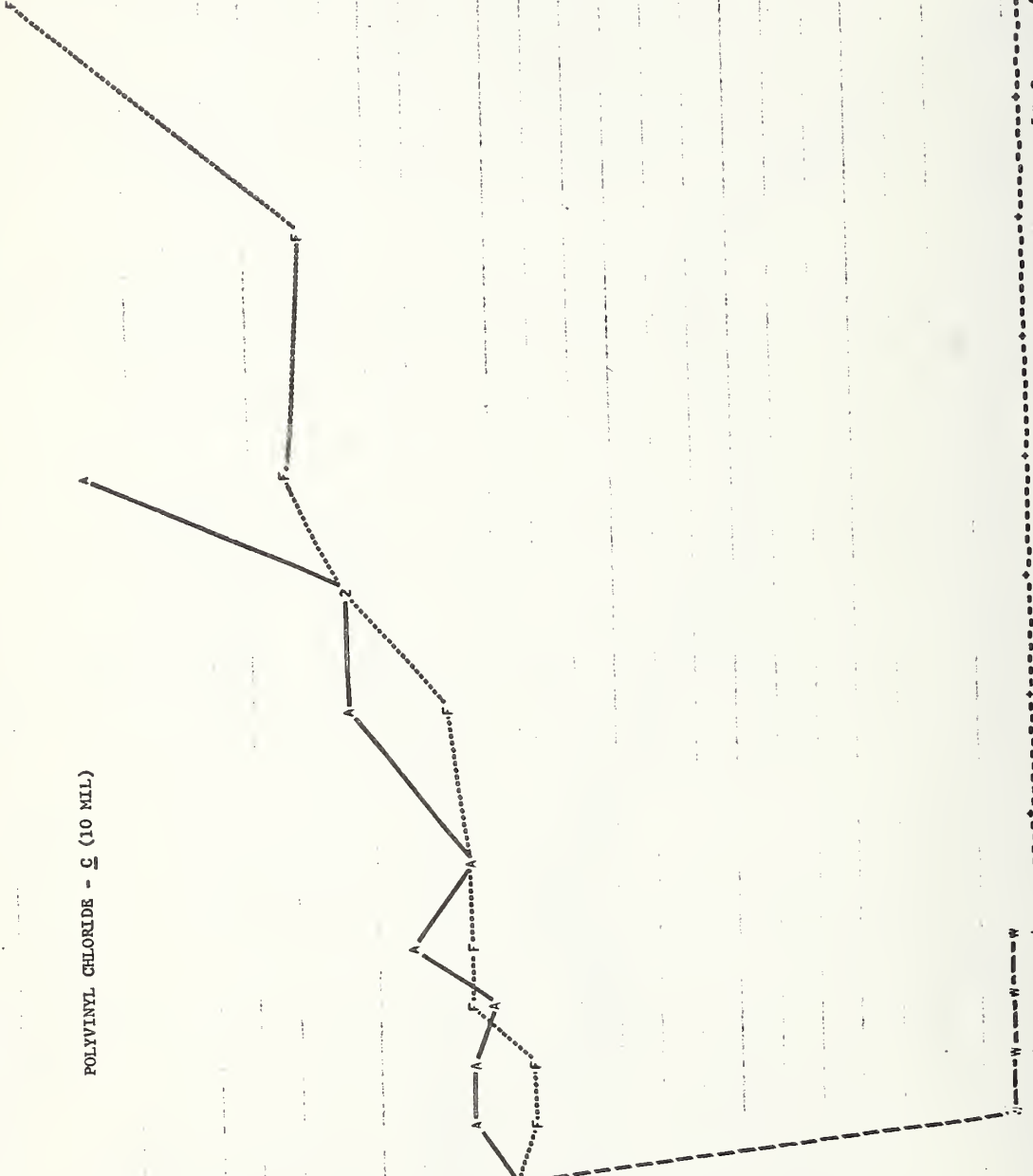




FIGURE 80A

HAZE AT 420NH (IN PERCENT) PLASTIC 12 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE = C (60 MIL)

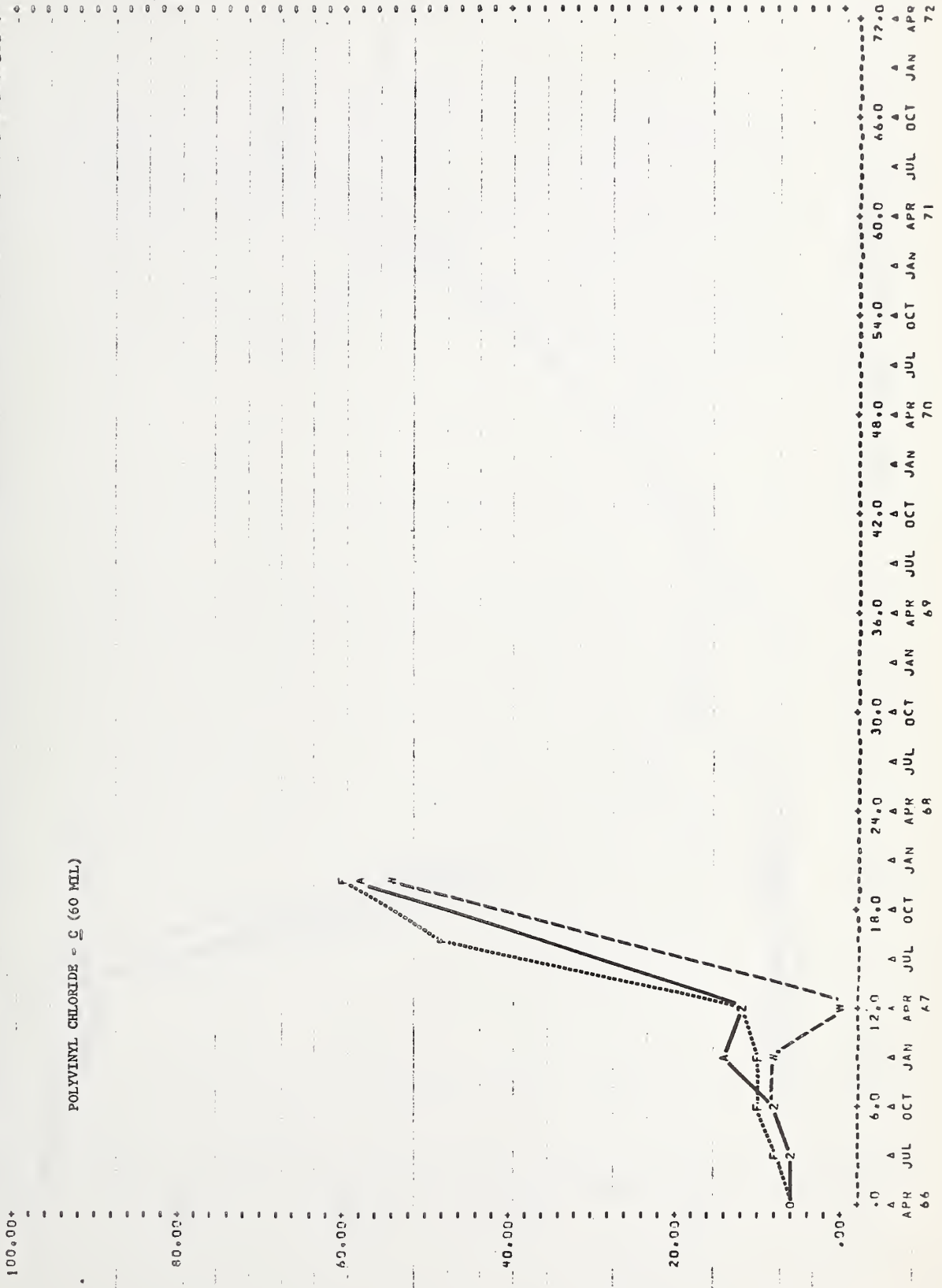


FIGURE 80B

WASHINGTON

FLORIDA

ARIZONA

PLASTIC 12

HAZE AT 550NM (IN PERCENT)

POLYVINYL CHLORIDE - C (60 MIL)

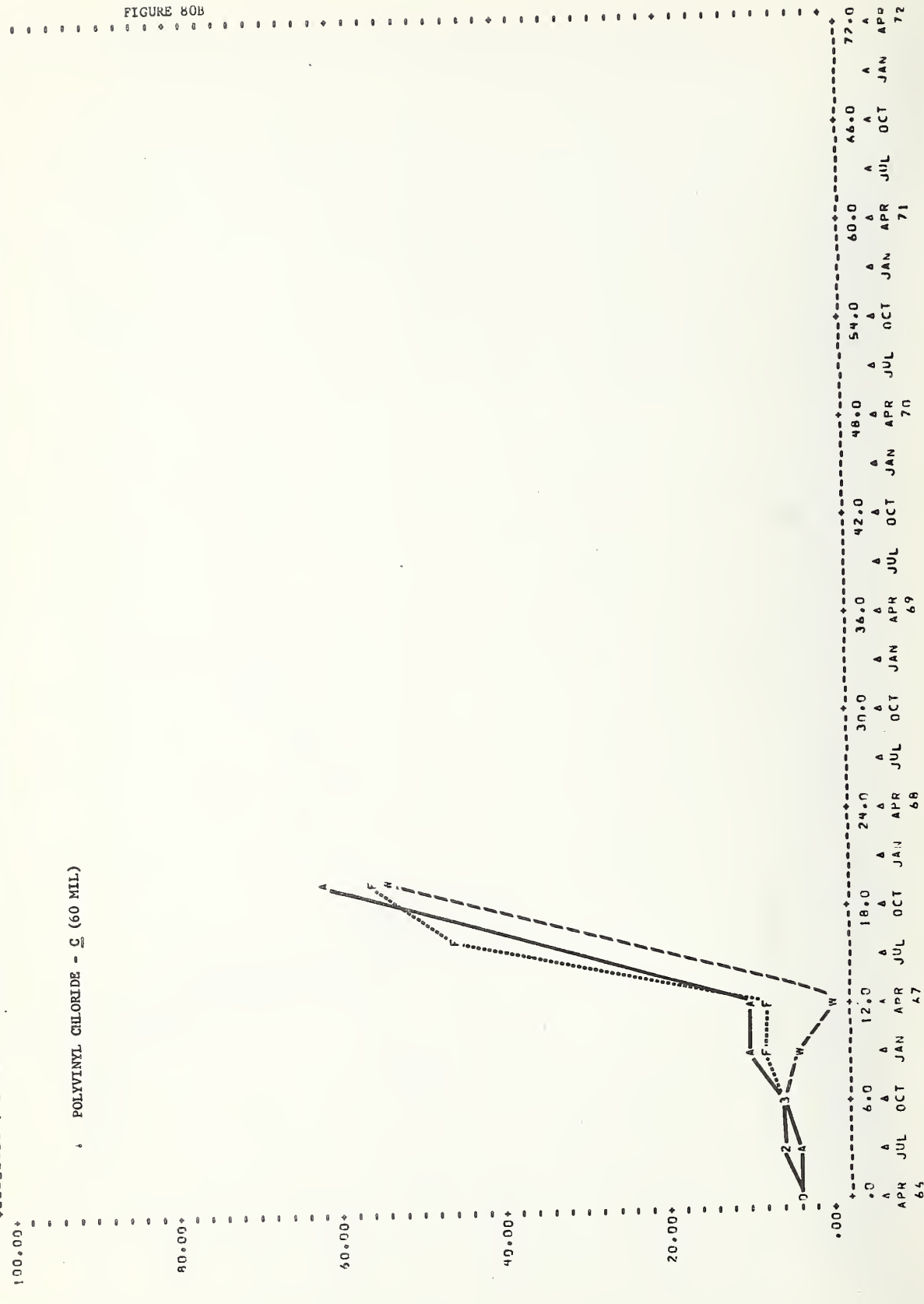


FIGURE 81A

HAZE AT 420NM (IN PERCENT) PLASTIC 13 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - N (60 MIL)



100.00  
80.00  
60.00  
40.00  
20.00  
0.00

0.0 6.0 12.0 18.0 24.0 30.0 36.0 42.0 48.0 54.0 60.0 66.0 72.0

APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR

66 67 68 69 70 71 72

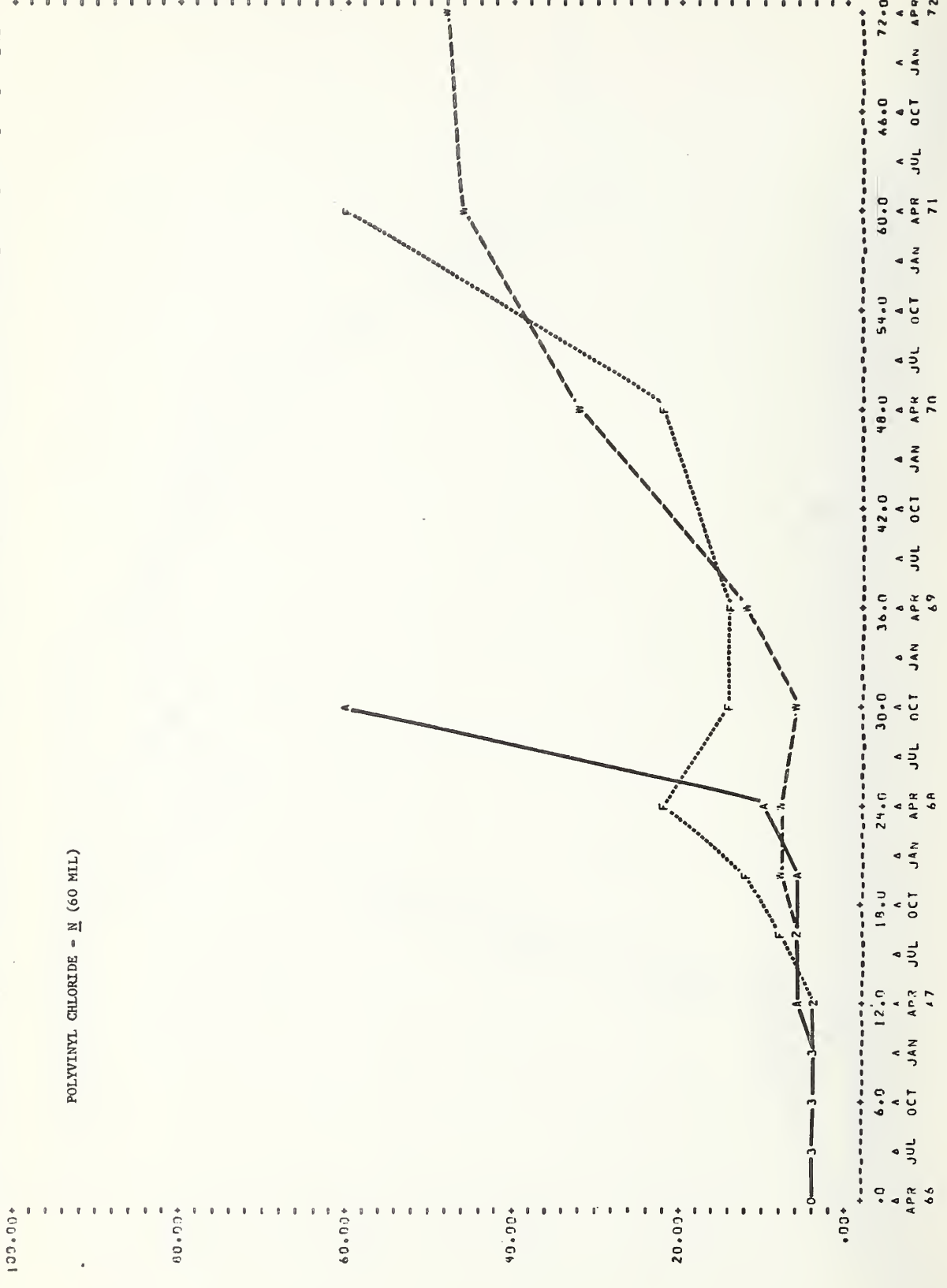
FIGURE 81B

HAZE AT 550NM (IN PERCENT)

PLASTIC 13

ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - N (60 MIL)



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