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TECHNICAL NOTE

KODAK FILM TYPE SO-394-4-1 MOTTLING AND HYPERSENSITIZATION TEST

Prepared Under

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Task Order HT-35

Prepared By

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National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

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This report has been reviewed

and is approved.

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KODAK FILM TYPE SO-394-4-1 MOTTLING AND HYPERSENSITIZATION TEST

INTRODUCTION

Over the past two weeks, a number of tests have been conducted to show the effects of various environmental conditions in terms of mottling and hypersensitization on Kodak Film type SO-394-4-1.

The first two weeks of environmental testing as described in the letter from Mark Weinstein to Noel Lamar dated 15 August 1972, has been completed. The test plan and matrix are included in the Appendix.

TEST PROCEDURES

Sensitometric exposures were made on samples of the SO-394-4-1 film and placed in four different storage locations:

1. A freezer at approximately 32°F.
2. A cold vault at approximately 50° F. and 50 percent humidity.
3. The roof of Building 8 where the temperature varied from 70°F. to 130°F. with humidity changes from 40 to 80 percent.
4. An oven at 140°F.

The film strips were configured in four different manners for each of the four storage conditions. The configuration consisted of:

1. A single film strip in a double envelope
2. Two film strips placed emulsion to emulsion in a double envelope.
3. Two film strips placed base to base in a double envelope.
4. Two film strips placed emulsion to base in a double envelope.

Sufficient samples of these films were made up so that the test could be conducted over a period of 4 weeks.

The results after two weeks show that mottling is not a function of configuration. In other words, the film kept as a single strip in an envelope showed the same degree of mottling as those configured emulsion to emulsion, base to base, or emulsion to base. Very slight mottling was evident on films that were stored in the freezer. Slightly more noticeable mottling occurred on the films that were

stored in the cold vault. An order of magnitude, increase in mottling, was evident for the films stored on the roof over the films that were stored in the cold vault. The films stored in the oven were severely mottled and also had a high fog level. All these effects were seen after 1 week and were even more noticeable after 2 weeks.

Film hypersensitization tests were conducted in the following manner. Film kept at room temperature was exposed at that temperature in the sensitometer. Film that was frozen was exposed in the sensitometer while it was still in a frozen state. Film was heated to 140°F. for 5 minutes, and then, while at the temperature of 140°F., was exposed in the sensitometer. These three film strips were then processed together in a Versamat 11C-M with MX-641 chemistry at 85°F., 2 tanks 10 feet per minute. The resultant sensitometric curves are attached. (See Figures 1, 2, and 3). It can be seen from these D-Log E curves that there is no difference in response between the films exposed at room temperature and the film exposed while frozen. There is, however, an increase in speed for the film that was heated for 5 minutes at 140°F. as compared to the film that was kept at room temperature. The speed increase is about .06 Log E units.

Following this, a more extensive test was conducted. Film samples were placed in an oven at 140°F., unexposed, for 2 hours, and then removed from the oven, immediately exposed in the sensitometer, and processed along with some film that was kept at room temperature. The same test was repeated for film strips that were placed in the oven for a period of 4 hours at 140°F. The resultant D-Log E curves are attached (See Figures 4 and 5). It can be seen from an examination of the curves, after 2 hours at 140°F the film speed is increased by .18 Log-E units; after 4 hours at 140°F. the film speed is increased by .22 Log-E units. The density data for the film kept in an oven for 2 hours and then exposed was converted to T_a units and plotted with respect to exposure. This was compared to the film strip that

was kept at room temperature for 2 hours and then exposed. The two resultant T_a versus E curves are plotted as Figure 6. The effects shown by hypersensitization is quite different from the T_a versus V curves that were received from Mr. Ron Kelly (Figures 7 and 8).

RESULTS

For temperatures from 35°F. to 135°F., the T_a versus V curves show a decrease in slope for increases in temperature. The T_a versus E curves that were derived as a result of the testing done here show an increase in slope as a function of temperature, and do not show the same drastic effect as the T_a versus V curves. It appears then that the reason for the change in slope of the T_a versus V curves is the result of an increase in recorder exposure, rather than a drastic change in film sensitivity. It should also be noted that there was severe mottling on the film that was maintained at 140°F, then exposed, and processed for both 2 hour and 4 hour conditions.

To form a basis of comparison, for the film mottling tests, four different film types that are used normally in this laboratory were cut into sensitometric strips, placed in the oven for 2 hours, and then exposed and processed. This testing showed severe mottling for the SO-394 film. The films tested were types 3400, 3401, 2485, and 3414. These four films were kept in the oven at 140°F, then exposed in the sensitometer, and subsequently processed. There is no sign of mottling on any of these films.

CONCLUSIONS

These various tests then lead to the conclusions that:

1. Kodak film type SO-394-4-1 is unusually susceptible, in terms of mottling, to environmental conditions.
2. There is an increase in sensitivity with an increase in exposing temperature as a function of time.
3. The inherent mottling of Film type SO-394-4-1 emulsion makes it unsuitable for space flight.

Attachment 1

TEST PLAN

1. Prepare 126 Sensitometric strips on Kodak Film Type SO 394-4-1

2. Label the strips for positive identification
   #1 - Freezer
   #2 - Cold Vault
   #3 - Roof
   #4 - Oven (140°F).
   #5 - Emulsion to Base (EB)
   #6 - Base to Base (BB)
   #7 - Emulsion to Emulsion (EE)
   #8 - Single Strip (SS)

For example, a strip punched 25 means that it was stored in the cold vault and that the strips were placed in the package emulsion of one to base of the other.

3. Store strips in double light tight bags but do not seal. For configurations 5, 6, and 7, two strips will be stored in one bag.

4. After one week in storage remove one test package for each test condition. Process randomly in a Versamat at 85° 2T 10FPM with MX-641 chemistry. First verify that the processor and chemistry do not produce mottling with fresh strips.

5. Evaluate visually all strips for any signs of mottling.

6. Follow steps 4 and 5 for strips stored for 2, 3 and 4 weeks.

7. Note in the matrix that for some of the strips the clear gel backing will be removed.

Attachment 2

MATRIX

CONFIGURATION			STORAGE CONDITION																	
			(1) Freezer				(2) Cold Vault				(3) Roof				(4) Oven			
			Weeks				Weeks				Weeks				Weeks			
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
(5) EB	Backing	No				X								X				
		Yes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
(6) BB	Backing	No				X								X				
		Yes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
(7) EE	Backing	No				X								X				
		Yes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
(8) SS	Backing	No				X								X				
		Yes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

DATE 24 Aug 72 CONTROL # NORMAL TASK HT-35 PREPARED BY E. WEIZER

FILM SO-394 EMULSION # 4-1 (70mm) MFG E.K. Co. EXPIRATION DATE July 73

772 EXPOSURE DATA 3010		PROCESSING DATA		DENSITOMETRY			
SENSITOMETER	1-B	PROCESSOR	Versamat	INSTRUMENT	Macbeth	SPEED ( )	
ILLUMINANT	2850 °K	CHEMISTRY	MX-641	TYPE	TD 217 DR	D-MAX	
TIME	1/10 sec.	SPEED	2 TANKS 10 FPM	APERTURE SIZE	2 MM	GAMMA	
FILTER	P-11 pack	TEMP °F	85 TIME	FILTER	Visual	BASE + FOG	0.07

CHEMICAL ANALYSIS

SP GR

pH

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TRP

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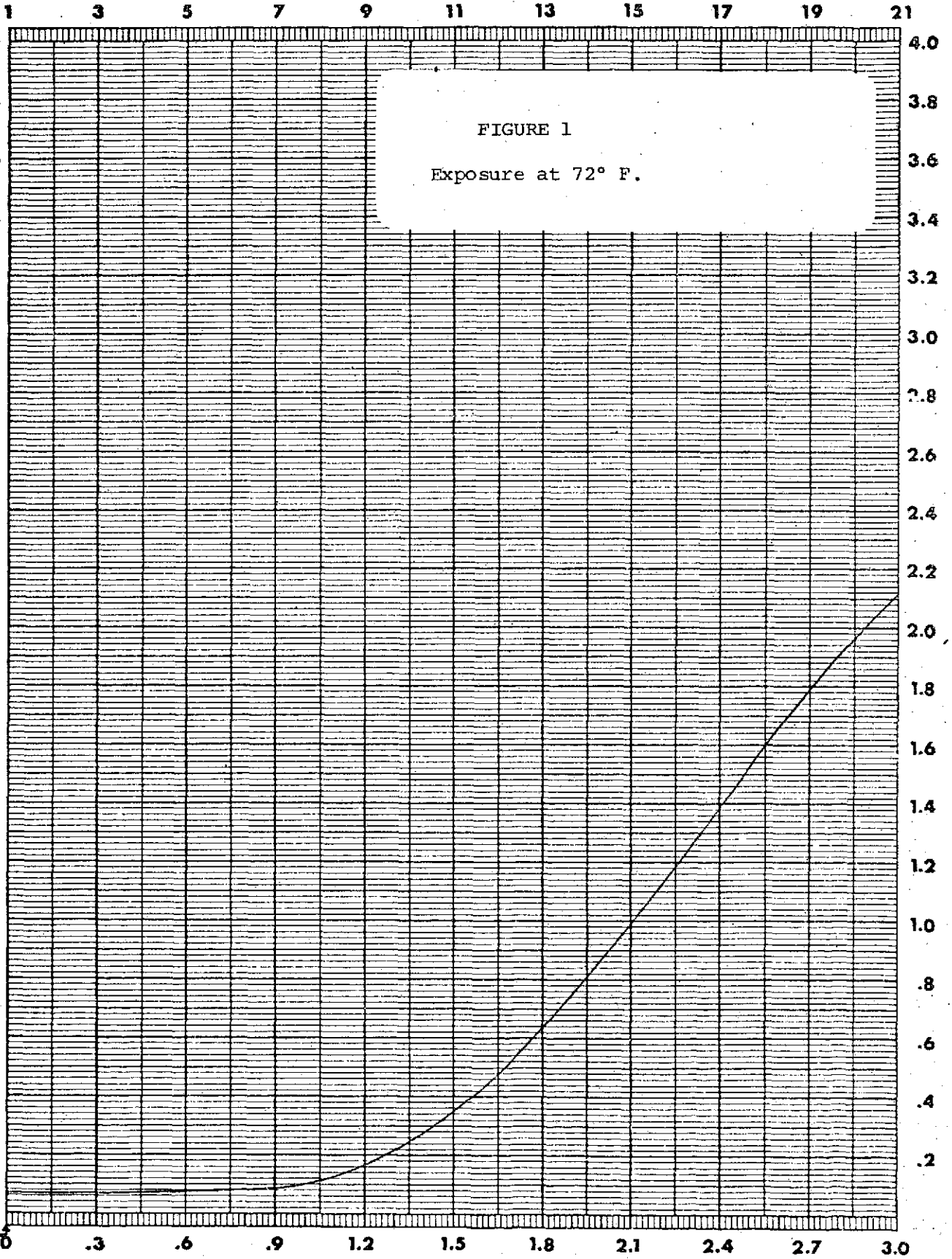

Technicolor

ABSOLUTE LOG E AT R.L.E. = 0

-10

DATE 24 Aug 72 CONTROL # FROZEN TASK HT-35 PREPARED BY E. Weizer

FILM SO-394 EMULSION # 4-1 (70mm) MFG E.K. Co EXPIRATION DATE July 73

772 EXPOSURE DATA 3010		PROCESSING DATA		DENSITOMETRY			
SENSITOMETER	1-B	PROCESSOR	Versamat	INSTRUMENT	Macbeth	SPEED ( )	
ILLUMINANT	2850 °K	CHEMISTRY	MX-641	TYPE	TD 217 DR	D-MAX	
TIME	1/10 SEC.	SPEED	2 TANKS 10 FPM	APERTURE SIZE	2 MM	GAMMA	
FILTER	P-11pack	TEMP °F	85 TIME	FILTER	Visual	BASE + FOG	0.07

CHEMICAL ANALYSIS

SP GR

pH

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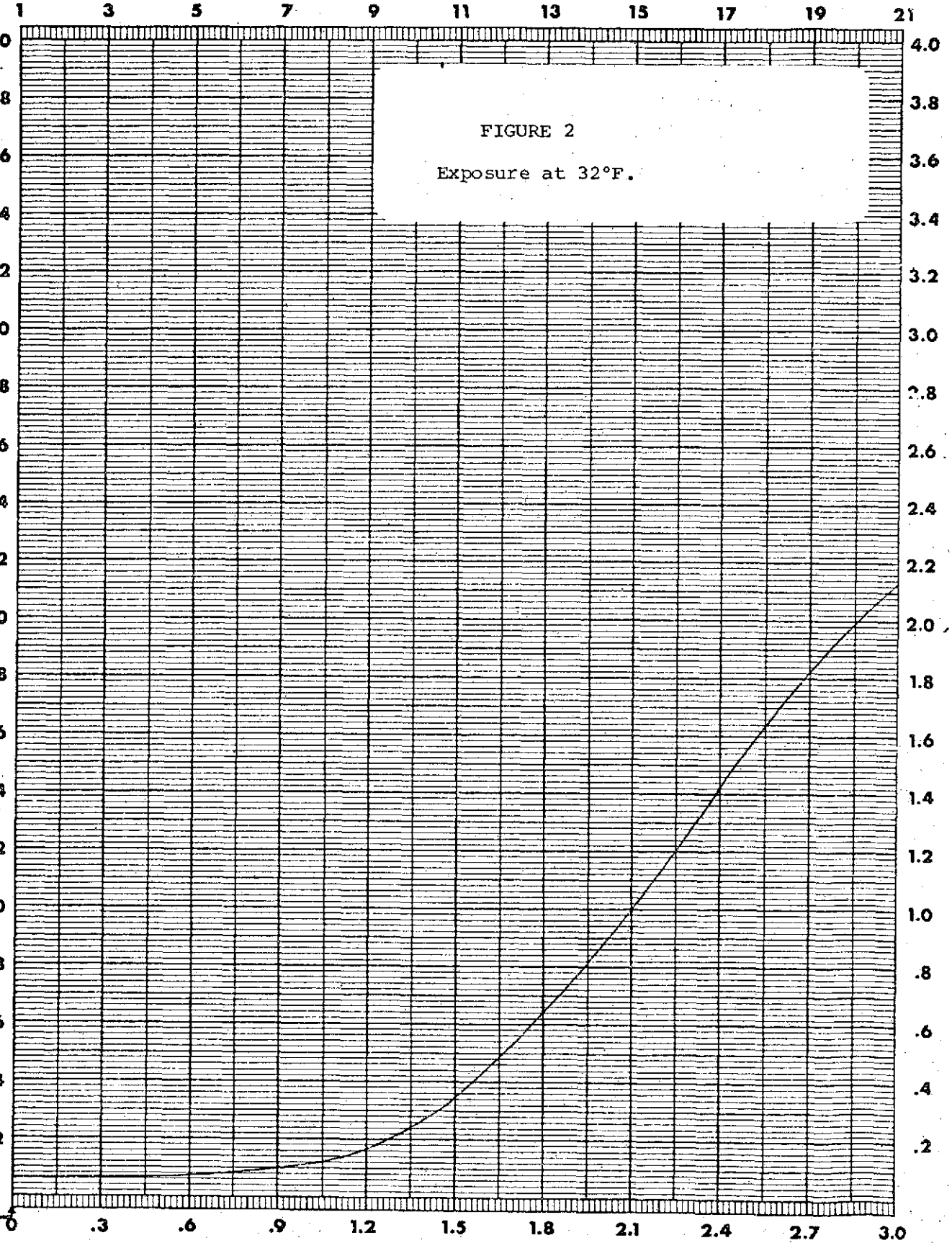

Technicolor

ABSOLUTE LOG E AT R.L.E. = 0

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DATE 24 Aug 72 CONTROL # HEATED TASK HT-35 PREPARED BY E. Weizer

FILM SO-394 EMULSION # 4-1 (70mm) MFG E.K. Co. EXPIRATION DATE July 73

772 EXPOSURE DATA 3010		PROCESSING DATA		DENSITOMETRY	
SENSITOMETER	1-B	PROCESSOR	Versamat	INSTRUMENT	Macbeth
ILLUMINANT	2850 °K	CHEMISTRY	MX-641	TYPE	TD 217 DR
TIME	1/10 SEC.	SPEED	2 TANKS 10 FPM	APERTURE SIZE	2 MM
FILTER	P-11pack	TEMP °F	85 TIME	FILTER	Visual
				SPEED ( )	
				D-MAX	
				GAMMA	
				BASE + FOG	0.07

CHEMICAL ANALYSIS

SP GR

pH

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TRP

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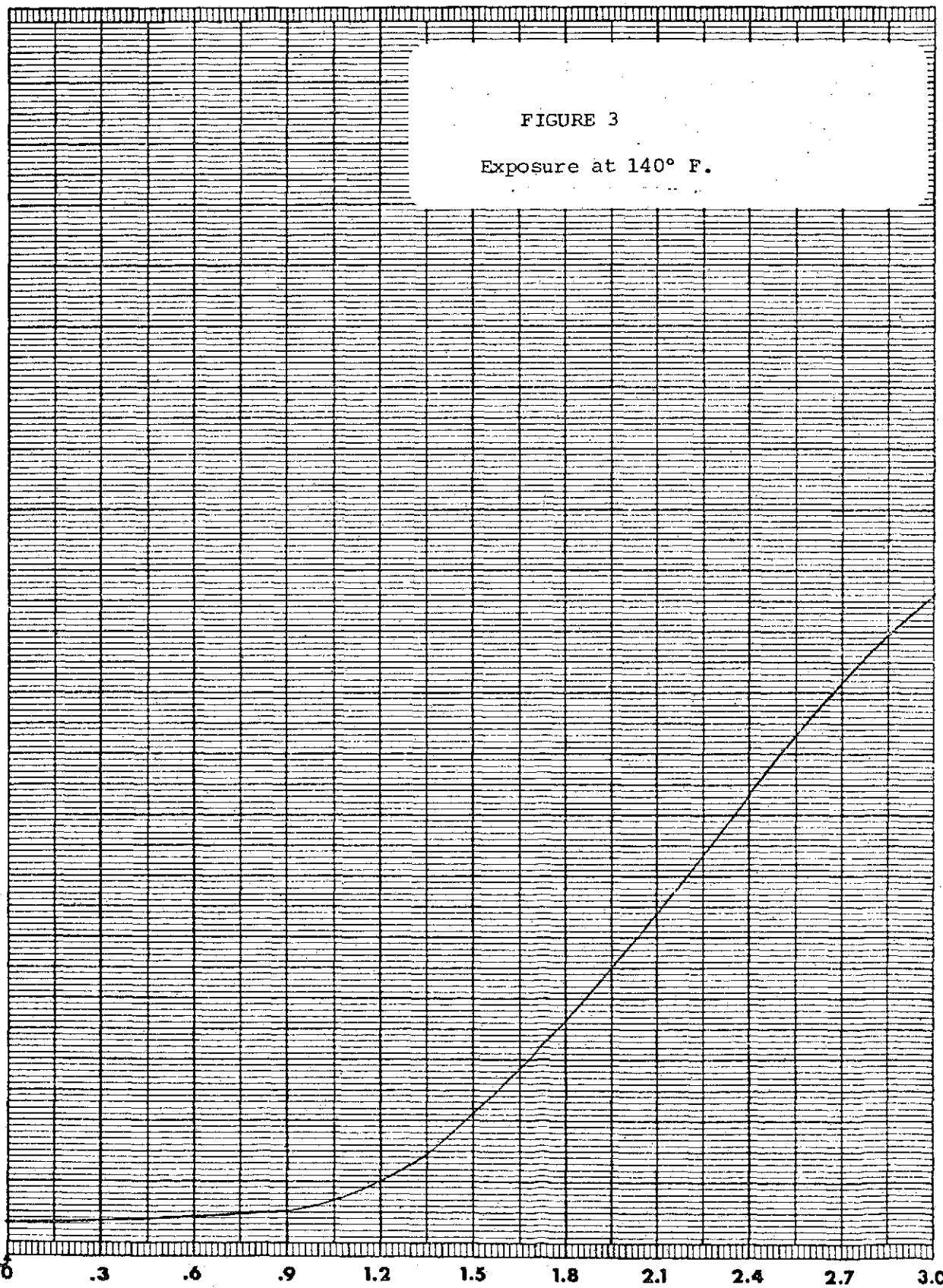
FIGURE 3

Exposure at 140° F.



Technicolor

ABSOLUTE LOG E AT R.L.E. = 0

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DATE 25 Aug 72 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SO-394 EMULSION # 4-1 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA		PROCESSING DATA		DENSITOMETRY	
SENSITOMETER	I-B	PROCESSOR	VMT 11	INSTRUMENT	MacBeth
ILLUMINANT	2850° °K	CHEMISTRY	MX-641	TYPE	TD203
TIME	1/10 SEC.	SPEED 2 TANKS	10 FPM	APERTURE SIZE	4 MM
FILTER	P-11	TEMP °F	85 TIME	FILTER	Visual
				SPEED ( )	
				D-MAX	
				GAMMA	
				BASE + FOG	.06

CHEMICAL ANALYSIS

SP GR

pH

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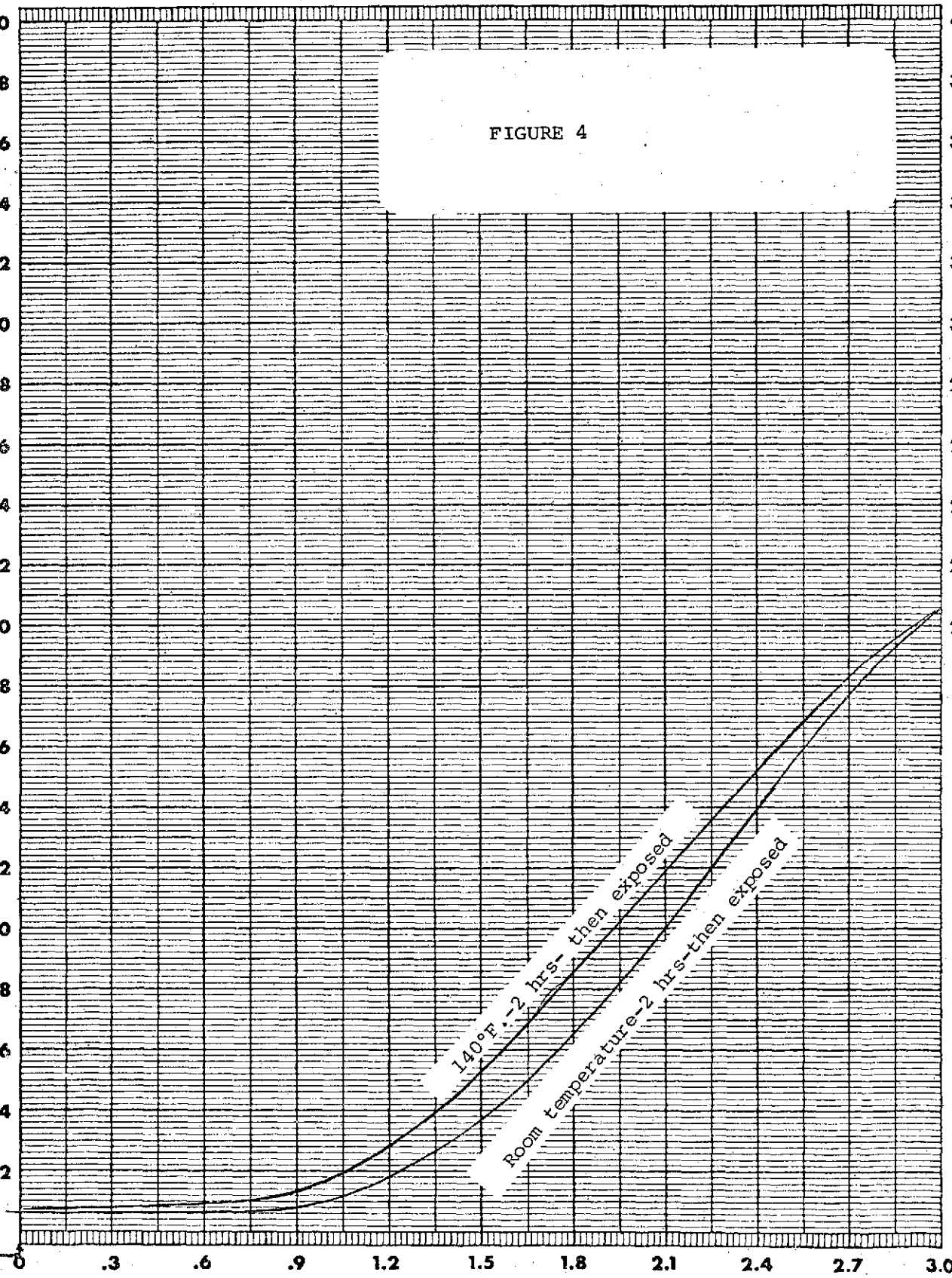
FIGURE 4



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ABSOLUTE LOG E AT R.L.E. = 0

-10

0 .3 .6 .9 1.2 1.5 1.8 2.1 2.4 2.7 3.0

DATE 25 Aug 72 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SO-394 EMULSION # 4-1 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER I-B	PROCESSOR VMT 11	INSTRUMENT MacBeth
ILLUMINANT 2850° °K	CHEMISTRY MX-641	TYPE TD203
TIME 1/10 SEC.	SPEED 2 TANKS 10 FPM	APERTURE SIZE 4 MM
FILTER P-11	TEMP °F 85 TIME _____	FILTER Visual

SPEED ( ) _____
D-MAX _____
GAMMA _____
BASE + FOG _____

CHEMICAL ANALYSIS

_____ SP GR

_____ pH

_____ TA

_____ TRP

_____ KB_r

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FIGURE 5

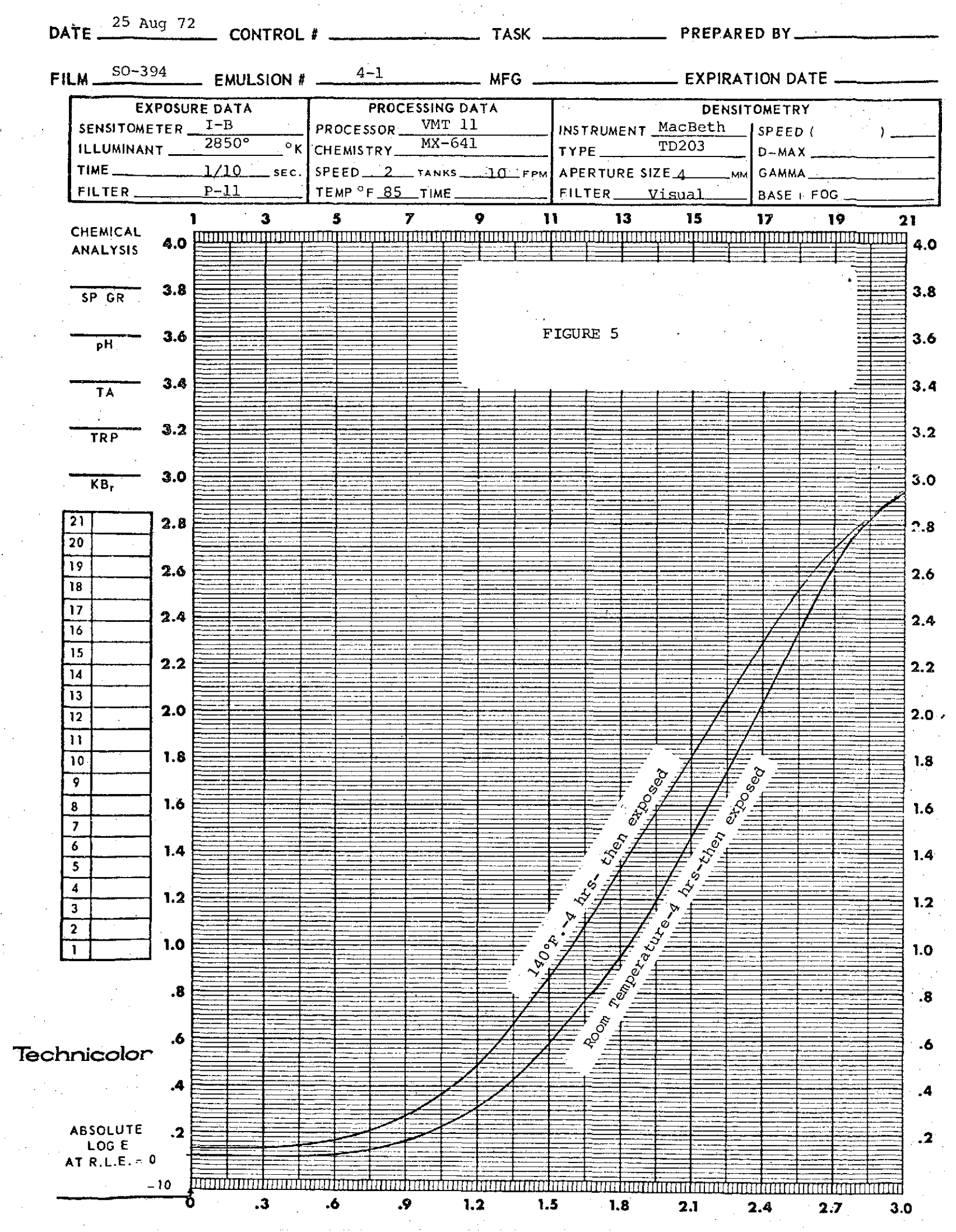

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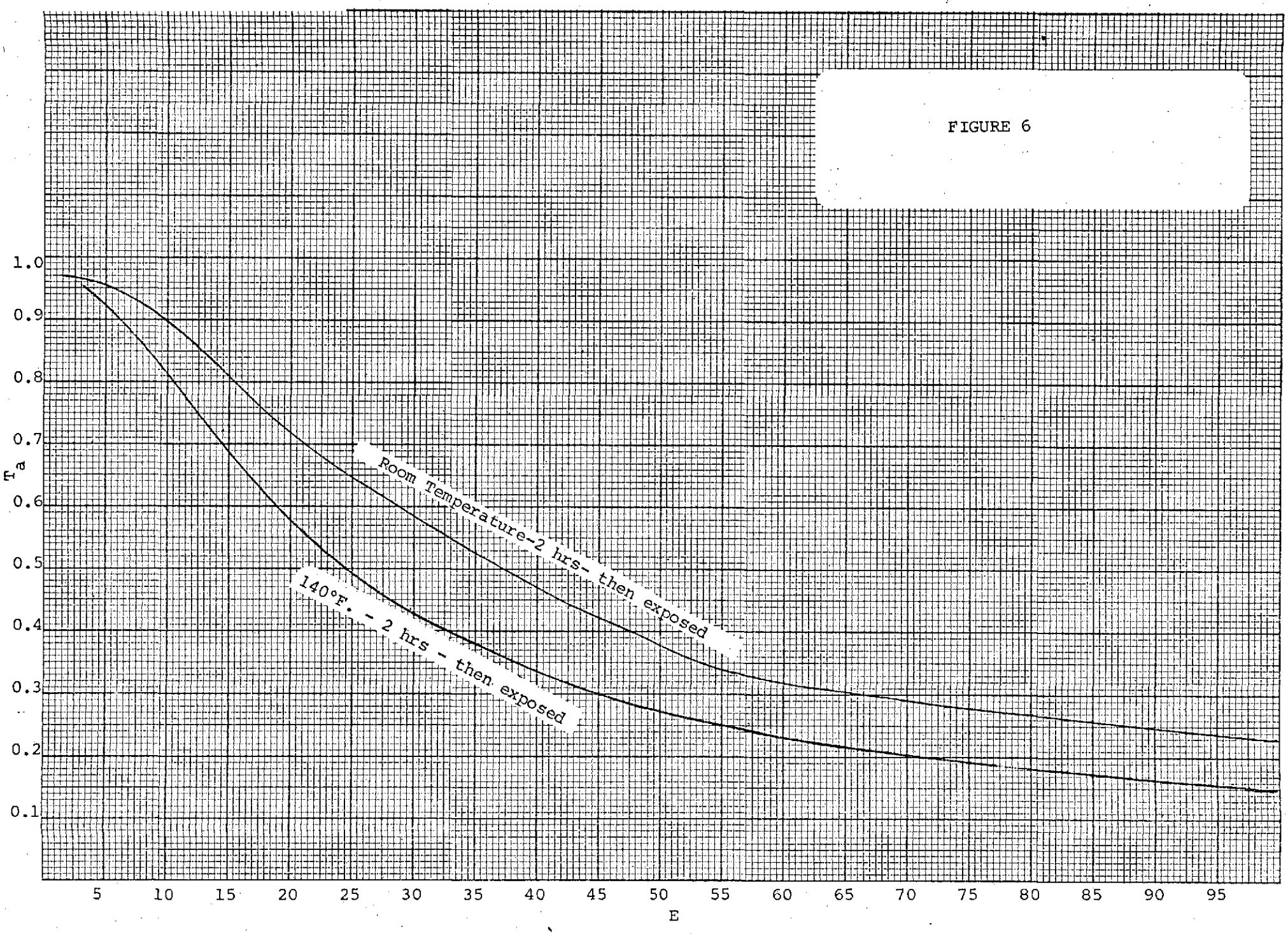
FIGURE 6



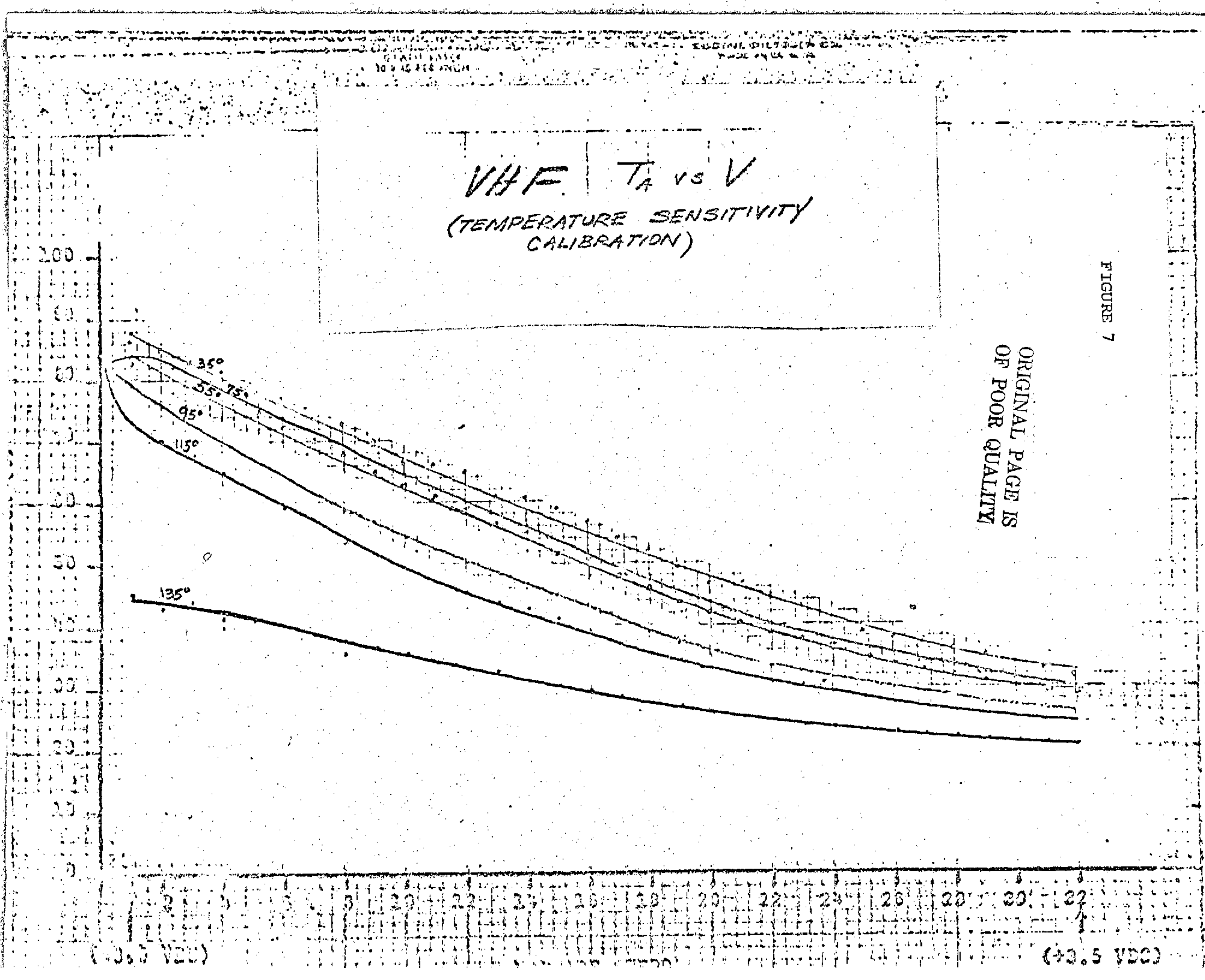


FIGURE 7

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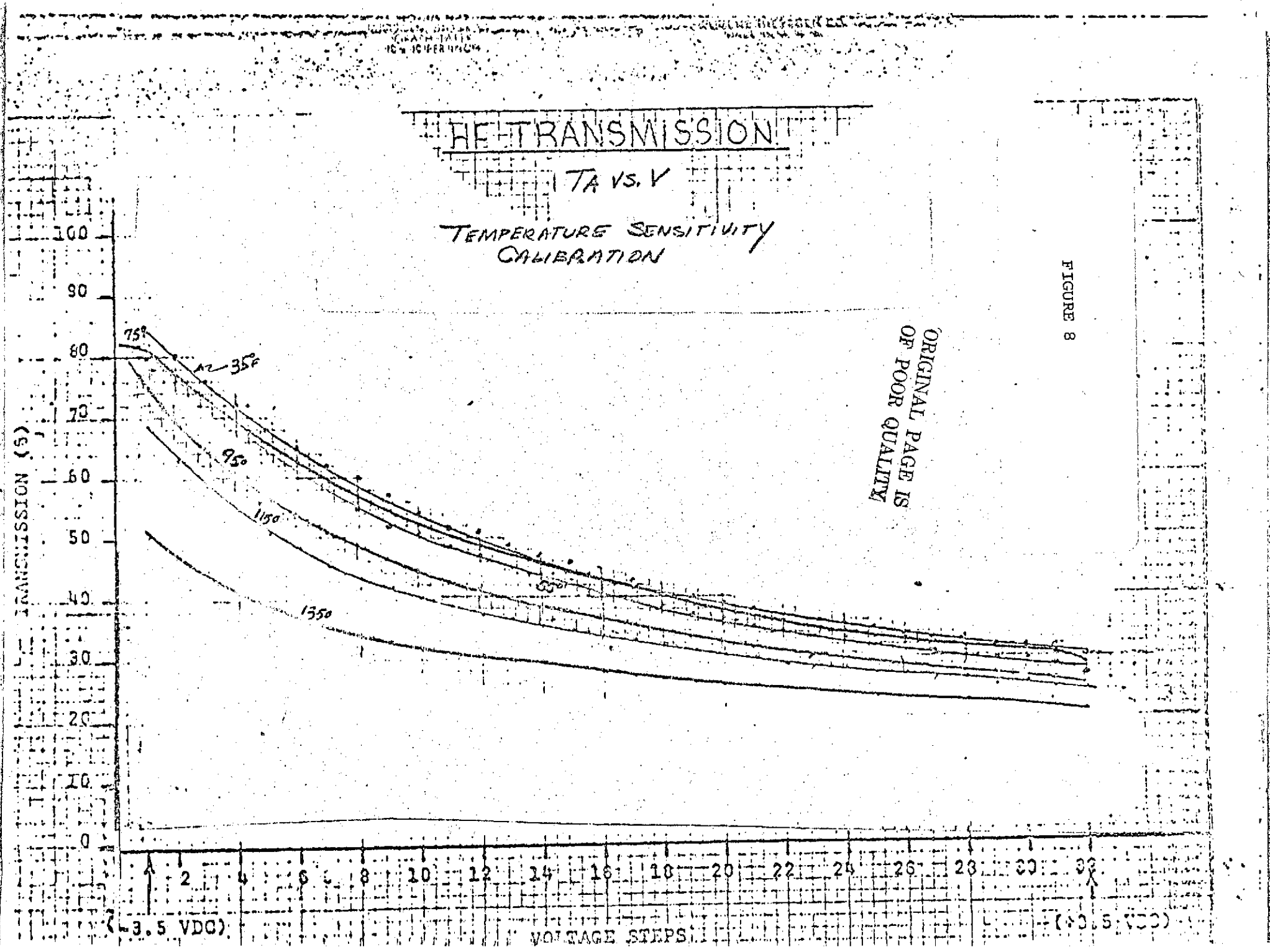

FIGURE 8

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