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CLOTHING AND ORGANIC MATERIALS DIVISION  
Textile Dyeing Branch

Materials Research and Engineering Report  
No. 65-5

DEVELOPMENT OF SHADE STANDARDS  
FOR  
RIBBON COLORS

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by

F. J. Rizzo, A. M. Campbell  
and  
R. J. Evans

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## FOREWORD

The work reported in the following pages was in response to MIPR-T10H-M-1-63, dated 27 June 1963 from the Institute of Heraldry, to reproduce a series of ribbon standards that had been exhausted. The procedure used is one that has been reasonably standardized for piece dyeable materials. The work performed may be considered as part of the general effort to have available for procurement purposes, shade standards in all military colors.

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## ABSTRACT

Eighteen shade standards for ribbons were developed to reproduce the colors of earlier standards which had been depleted. New up-to-date formulations were used and the results, both as to shade characteristics and as to colorfastness, represent optimum levels on the basis of present day technology.

DEVELOPMENT OF SHADE STANDARDS  
FOR  
RIBBON COLORS

A. Introduction

In the normal distribution of physical shade standards to the Industry in connection with procurements, depletion and replacement of shade standards are normal occurrences. This situation formed the basis for the program being reported herein. The basic question raised in this instance was whether to proceed to other shades of closely allied characteristics to those depleted, since such were available, or whether to attempt to reproduce the original shades. The former action would establish a pattern that could lead to a gradual deviation from the original color standards. This course of action was not considered to be appropriate to the maintenance of traditional military colors. Accordingly, it was decided to reproduce the original shades.

B. Experimental

On initiating the project, a decision was needed as to whether to yarn-dye the standards, as had been the case for the original colors, or whether to accept piece dyeing because of the very limited quantities required, of the cost factors involved, and of the complexities of controlling the shade, particularly in respect to effects of weaving.

The decision was made to accept piece dyeing. Although the dye formulae used in the original standard colors were not recorded, it was appropriate to update the formulae to present-day technology. Also, there was a good likelihood that many of the dyes originally used were no longer available because new types with better application characteristics and colorfastness properties have displaced many of the older types.

A decision was then made to reformulate with new combinations but to hold the basic shade characteristics of the older standards both in daylight and in artificial light. Vat dyes were specified for all shades where possible, but naphthol and the newer reactive dyes were permitted for those cases where vat dyes could not achieve the shade. The original standards had permitted naphthols and, in some cases, substantive directs. However, many of the ribbon standards still available were on silk, and this, in itself, presented a problem in formulation.

A contract was written with Bally Ribbon Mills, Bally, Pa., and the technical control on the program was exercised by the authors. The construction of the ribbon was the same as in the original standards,

namely, a grosgrain and satin-banded ribbon to provide color characteristics in two different textures.

The procedure used was as follows:

- (1) Dye formulae were selected by mutual consent of the authors and the contractor and approved by the authors.
- (2) Laboratory dyeings were made and submitted by the contractor for approval.
- (3) Production lots were dyed.
- (4) Samples of the production lots were submitted by the contractor for approval.
- (5) Correction to shades, where necessary, were recommended by the authors and executed by the contractor followed by a second review of the shade. Corrections were made only where minor changes were necessary; otherwise new dyeings were undertaken.

The woven ribbon was prepared for dyeing by scouring in a solution containing a nonionic scouring agent and a sequestering agent. All vat dyeings were made in the presence of a leveling agent and a sequestering agent, and were oxidized with sodium perborate at 120°F, followed by soaping with a synthetic detergent characterized as sodium naphthalene sulfonate. No treatments were given the ribbons after dyeing.

### C. Results

The approved formulae are given in Appendix I, and in Appendix II are recorded the adjustments made to the basic formulae to match each shade. Appendix III, Figures 1 to 18, shows the spectral reflectance curves of these dyeings under Source "C", using freshly smoked MgO as 100% reference.

Table I lists the integrated tristimulus values and the trichromatic coefficients for each of the 18 colors. In Table II are listed the colorfastness to light data in terms of total chromaticity differences and total color differences. Table III gives the data for Colorfastness to Perspiration, Method 5680; Laundering, Method 5614; Wet/Dry Cleaning, Method 5622; and Crocking, Method 5650. Table IV provides data for Colorfastness to Light, Method 5660. The cited methods are those contained in Federal Specification CCC-T-191b, Textile Test Methods.

TABLE I  
 INTEGRATED TRISTIMULUS VALUES AND TRICHROMATIC COEFFICIENTS  
 FOR RIBBON SHADES

<u>Shade</u>	<u>Tristimulus Values</u>			<u>Trichromatic Coefficients</u>	
	<u>X</u>	<u>Y</u>	<u>Z</u>	<u>x</u>	<u>y</u>
Defense Blue, Cable #1120	.1785	.1987	.3645	.2407	.2679
Grebe, Cable #10659	.1880	.1880	.2100	.3208	.3208
Imperial Blue, Cable #10686	.0982	.0900	.3210	.1928	.1767
Drapeau Blue, Cable #11280	.0695	.0624	.2146	.2006	.1801
Prophet Green, Cable #11586	.0782	.1390	.0985	.2477	.4403
Polo Blue, Cable #11921	.0850	.0735	.2766	.1954	.1689
Checker Red, Cable #11948	.2835	.1815	.1067	.4959	.3175
Blarney Green, Cable #12215	.1041	.1765	.1018	.2723	.4617
Aspic Green, Cable #12269	.4175	.4800	.1194	.4146	.4767
Hacienda Red, Cable #12438	.1795	.1005	.0378	.5648	.3162
Star Yellow, Cable #13143	.5134	.5283	.1285	.4387	.4515
Melody Green, Cable #13608	.1962	.2560	.0970	.3572	.4661
Rally Red, Cable #13802	.0830	.0539	.0385	.4732	.3073
Starlight Yellow, Cable #13871	.4685	.4462	.0968	.4632	.4411
Soldier Red, Cable #14270	.1250	.0710	.0352	.5407	.3071
Oriole Orange, Cable #14389	.2735	.2132	.0735	.4982	.3806
Four Leaf Clover, Cable #14950	.1115	.1686	.0910	.3005	.4543
Goldenlite, Cable #17425	.4985	.4795	.1560	.4396	.4228



TABLE II

CHROMATICITY DATA FOR LIGHT-  
EXPOSED SAMPLES OF RIBBON SHADES

Shade	Hours Exposed	Chromaticity Difference			Total Color Difference MacAdam Units	
		$\Delta Y$	$\Delta x$	$\Delta y$	$\Delta C$	$\Delta E$
Defense Blue, Cable #1120	140	0.23	.0017	.0004	0.6	0.7
Grebe, Cable #10659	---	----	-----	-----	---	---
Imperial Blue, Cable #10686	60	0.15	.0008	.0068	2.5	2.6
	120	0.35	.0005	.0010	8.5	8.6
Drapeau Blue, Cable #11280	140	-0.13	-.0011	-.0029	2.4	2.5
Prophet Green, Cable #11586	40	-0.12	.0043	-.0007	1.7	1.8
	80	-0.25	.0047	.0041	3.0	3.2
Polo Blue, Cable #11921	140	-0.05	.0001	.0011	0.5	0.6
Checker Red, Cable #11948	60	0.10	-.0014	.0021	1.9	2.0
	120	0.05	-.0011	.0012	1.6	1.7
Blarney Green, Cable #12215	80	0.24	.0044	-.0054	2.4	2.6
	140	0.25	.0053	-.0080	3.1	3.2
Aspic Green, Cable #12269	---	----	-----	-----	---	---
Hacienda Red, Cable #12438	60	0.25	-.0042	.0037	3.5	3.7
	120	0.30	-.0039	.0054	4.3	4.5
Star Yellow, Cable #13143	80	0.14	-.0024	-.0031	1.6	1.6
	140	-2.11	-.0025	-.0073	3.5	4.8
Melody Green, Cable #13608	80	-0.15	-.0023	.0020	2.1	2.2
	140	-0.19	-.0019	.0022	2.2	2.3
Rally Red, Cable #13802	140	-0.14	.0015	-.0015	3.2	3.3
Starlight Yellow, Cable #13871	80	-0.09	-.0015	.0002	1.2	1.3
	140	-0.15	-.0022	.0002	1.8	1.9
Soldier Red, Cable #14270	60	0.40	-.0018	-.0011	.6	2.2
	120	0.47	-.0047	.0014	2.1	3.1
Oriole Orange, Cable #14389	40	-0.89	-.0044	.0038	4.2	5.0
	80	-0.19	-.0095	.0049	6.2	6.3
Four Leaf Clover, Cable #14950	80	0.01	-.0005	.0004	0.2	0.2
	140	0.35	-.0023	.0002	1.1	1.3
Goldenlite, Cable #17425	60	1.20	-.0006	.0009	1.0	2.1
	120	1.26	-.0007	.0005	1.6	2.6

TABLE III

## COLORFASTNESS OF RIBBON SHADES

	<u>Perpiration</u>		<u>Laundry</u> <u>100°F</u>	<u>Wet/Dry</u> <u>Cleaning</u>	<u>Cracking</u>	
	<u>Alkaline</u>	<u>Acid</u>			<u>Dry</u>	<u>Wet</u>
Defense Blue, Cable #1120	E	E	E	E	N9-E	
Grebe, Cable #10659	E	E	E	E	N9-E	
Imperial Blue, Cable #10686	E	E	E	E	N9-E	
Drapeau Blue, Cable #11260	E	E	E	E	N9-E	
Prophet Green, Cable #11586	E	E	E	E	N9-E	
Polo Blue, Cable #11921	E	E	E	E	N9-E	
Checker Red, Cable #11948	E	E	E	E	N9-E	
Blarney Green, Cable #12215	E	E	E	E	N9-E	
Aspic Green, Cable #12269	E	E	E	E	N9-E	
Hacienda Red, Cable #12438	F	F	F	E	N7-F	
Star Yellow, Cable #13143	E	E	E	E	N9-E	
Melody Green, Cable #13608	E	E	E	E	N9-E	
Rally Red, Cable #13802	U	U	G	E	N7-F	
Starlight Yellow, Cable #13871	E	E	E	E	N9-E	
Soldier Red, Cable #14270	E	E	E	E	N8-G	
Oriole Orange, Cable #14389	E	E	E	E	N9-E	
Four Leaf Clover, Cable #14950	E	E	E	E	N9-E	
Goldenlite, Cable #17425	E	E	E	E	N9-E	

Code: E-Excellent  
G-Good  
F-Fair  
U-Unsatisfactory

TABLE IV

COLORFASTNESS-TO-LIGHT  
OF RIBBON SHADES

<u>Shade</u>	<u>Lightfastness Hours</u>					
	<u>20</u>	<u>40</u>	<u>60</u>	<u>80</u>	<u>120</u>	<u>140</u>
Defense Blue, Cable #1120						=
Grebe, Cable #10659	B	P				
Imperial Blue, Cable #10686			B		P	
Drapeau Blue, Cable #11280						=
Prophet Green, Cable #11586		B		=		
Polo Blue, Cable #11921						=
Checker Red, Cable #11948			B		=	
Blarney Green, Cable #12215				B		=
Aspic Green, Cable #12269	B	P				
Hacienda Red, Cable #12438			B		=	
Star Yellow, Cable #13143				B		=
Melody Green, Cable #13608				B		=
Rally Red, Cable #13802						=
Starlight Yellow, Cable #13871				B		=
Soldier Red, Cable #14270			B		=	
Oriole Orange, Cable #14389		B		P		
Four Leaf Clover, Cable #14950				B		=
Goldenlite, Cable #17425			B		=	

Code: B-Break  
P-Progressive  
==Equal to break or 140 maximum

#### D. Discussion

Most of the shades were dyed with vat dyes. Only Hacienda Red, Cable #12438, and Soldier Red, Cable #14270, were dyed with reactive dyes. These two shades could have been dyed with naphthols but it was considered more appropriate to use the more modern and more easily controlled reactive dyes for these two shades. Only Aspic Green, Cable #12269, and Grebe, Cable #10659, fall below 40 standard fading hours for lightfastness. The break on both of these shades at 20 standard fading hours is admittedly quite large and these two shades require reformulation as soon as more acceptable formulae can be developed. These shades presently are difficult to formulate with readily available dyes. Special dyes could have been selected but these would have been from foreign sources and would have been somewhat restricted. Because of the limited amounts required, continuing importation of these dyes would be required and it was not felt advisable to use these in establishing military shade standards. All formulae used were found to apply without difficulty and with good penetration of the ribbon.

#### E. Conclusion

The actions taken in this program have led to reproduction of the various shades to quite close limits of the original colors. With the exception of two shades, all show 40 standard fading hours or more of lightfastness, and all shades show excellent to good colorfastness. In other respects, the dye formulae are good practical combinations of dyes which the industry can use if it so desires. However, as a matter of basic policy, the industry should be permitted to use its own discretion in meeting the shade and the level of colorfastness exhibited by the standard sample.

#### F. Acknowledgements

The authors are indebted to Bally Ribbon Mills for an extremely cooperative approach to the program and for considerable patience in executing the dyeings. The spectral data reported were obtained by Mr. Alfred Merola, of the Textile Dyeing Branch. To these and all others who have participated in the program, the authors wish to express their appreciation for the assistance rendered.

APPENDIX I

BASIC FORMULAE FOR RIBBON SHADES

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BASIC FORMULAE FOR RIBBON SHADES

Defense Blue, Cable #1120

1 lb. 4 ozs. Vat Blue 6, Color Index #69825  
1/2 oz. Vat Yellow 2, Color Index #67300  
2 ozs. Vat Green 1, Color Index #59825

Grebe, Cable #10659

3 lbs. Vat Black 30, No Color Index No.  
3 ozs. Vat Brown 1, Color Index #70800  
1 lb. Vat Black 25, Color Index #69525

Imperial Blue, Cable #10686

1500 grams Vat Blue 14, Color Index #69810  
350 grams Vat Green 1, Color Index #59825

Drapeau Blue, Cable #11280

3 lbs. Vat Blue 14, Color Index #69810  
6 ozs. Vat Green 1, Color Index #59825

Prophet Green, Cable #11586

1 lb. 8 ozs. Vat Green 1, Color Index #59825  
4 lbs. Vat Yellow 2, Color Index #67300

Folo Blue, Cable #11921

1 lb. 8 ozs. Vat Blue 14, Color Index #69810

Checker Red, Cable #11948

3 lbs. Vat Red 10, No Color Index No.  
1 lb. Vat Orange 7, Color Index #71105

Blarney Green, Cable #12215

3 lbs. Vat Green 1, Color Index #59825  
11 lbs. Vat Yellow 10, Color Index #65430

Aspic Green, Cable #12269

9 lbs. Vat Yellow 2, Color Index #67300  
1½ ozs. Vat Green 1, Color Index #59825  
1 lb. Vat Yellow 10, Color Index #65430

Hacienda Red, Cable #12438

2 lbs. 4 ozs. Reactive Red 2B, No Color Index No.  
1 lb. 4 ozs. Reactive Orange S3GL, No Color Index No.

Star Yellow, Cable #13143

6 lbs. Vat Yellow 2, Color Index #67300  
6 ozs. Vat Yellow PGA, No Color Index No.

Melody Green, Cable #13608

3½ ozs. Vat Green 1, Color Index #59825  
2 lbs. 8 ozs. Vat Yellow 2, Color Index #67300  
2 ozs. Vat Orange 1, Color Index #59105/6

Rally Red, Cable #13802

6 lbs. Vat Red 13, No Color Index No.  
2 lbs. 8 ozs. Vat Orange 1, Color Index #59105/6

Starlight Yellow, Cable #13871

1 lb. 8 ozs. Vat Yellow PGA, No Color Index No.  
1 lb. Vat Yellow 2, Color Index #67300

Soldier Red, Cable #14270

2 lbs. 9 ozs. Reactive Red 2B, No Color Index No.  
14 ozs. Reactive Orange 3GL, No Color Index No.  
1/4 oz. Reactone Blue GRL

Oriole Orange, Cable #14389

1 lb. 8 ozs. Vat Orange 2, Color Index #59705  
4 ozs. Vat Brown 1, Color Index #70800

Four Leaf Clover, Cable #14950

8 ozs. Vat Green 1, Color Index #59825  
4 lbs. Vat Yellow 2, Color Index #67300

Goldenlite, Cable #17425

5 ozs. Vat Orange 1, Color Index #59105/6



APPENDIX II

ADJUSTMENTS TO BASIC FORMULAE FOR RIBBON SHADES

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ADJUSTMENTS TO BASIC FORMULAE FOR RIBBON SHADES

Defense Blue, Cable #1120

First lot rejected. Now lot dyed using original formula slightly cut.

Grebe, Cable #10659

Original dyeing rejected. New lot dyed using original formula slightly increasing the Vat Black 30.

Imperial Blue, Cable #10686

Original submission rejected. Re-vat-dyed using an additional add of Vat Blue 14, Color Index #69810.

Drapeau Blue, Cable #11280

Original formula rejected. Reduced with Hydrosulphite and Caustic Soda, which was sufficient to match standard.

Prophet Green, Cable #11586

First lot rejected. New lot dyed using original formula with a slightly greater addition of Vat Green 1, Color Index #59825 and slightly less Vat Yellow 2, Color Index #67300.

Checker Red, Cable #11948

Original dyeing rejected. Corrected with addition of Direct Red 81, Color Index #28160.

Blarney Green, Cable #12215

Original submission rejected. New lot dyed using original formula adding more Vat Green 1, Color Index #59825 and cutting down on Vat Yellow 10, Color Index #65430.

Aspic Green, Cable #12269

Original formula rejected. New lot dyed slightly increasing the original formula.

Hacienda Red, Cable #12438

First lot adjusted with additions of Reactive Red 2B and Reactive Orange S3GL.

Melody Green, Cable #13608

After rejection a new lot was dyed; this was too dark. It was reduced with Hydrosulphite and Caustic Soda, sufficient for color approval.

Rally Red, Cable #13802

Original submission rejected. New lot dyed, cutting down slightly on original formula.

Soldier Red, Cable #14270

Original formula rejected. Reduced with Hydrosulphite and Caustic Soda with additions of Reactive Red 2B and Reactive Orange S3GL.

Oriole Orange, Cable #14389

First lot rejected. Color reduced with Hydrosulphite and Caustic Soda and touched up with Reactive Orange S3GL.

Four-Leaf Clover, Cable #14950

Original dyeing rejected. Color too dark; new lot dyed cutting down on Vat Green 1, Color Index #59825.

Goldenlite, Cable #17425

Original submission rejected. Reduced with Hydrosulphite and Caustic Soda and touched up with Direct Red 81, Cable #28160, and Direct Blue 106.

APPENDIX III

SPECTRAL REFLECTANCE CURVES

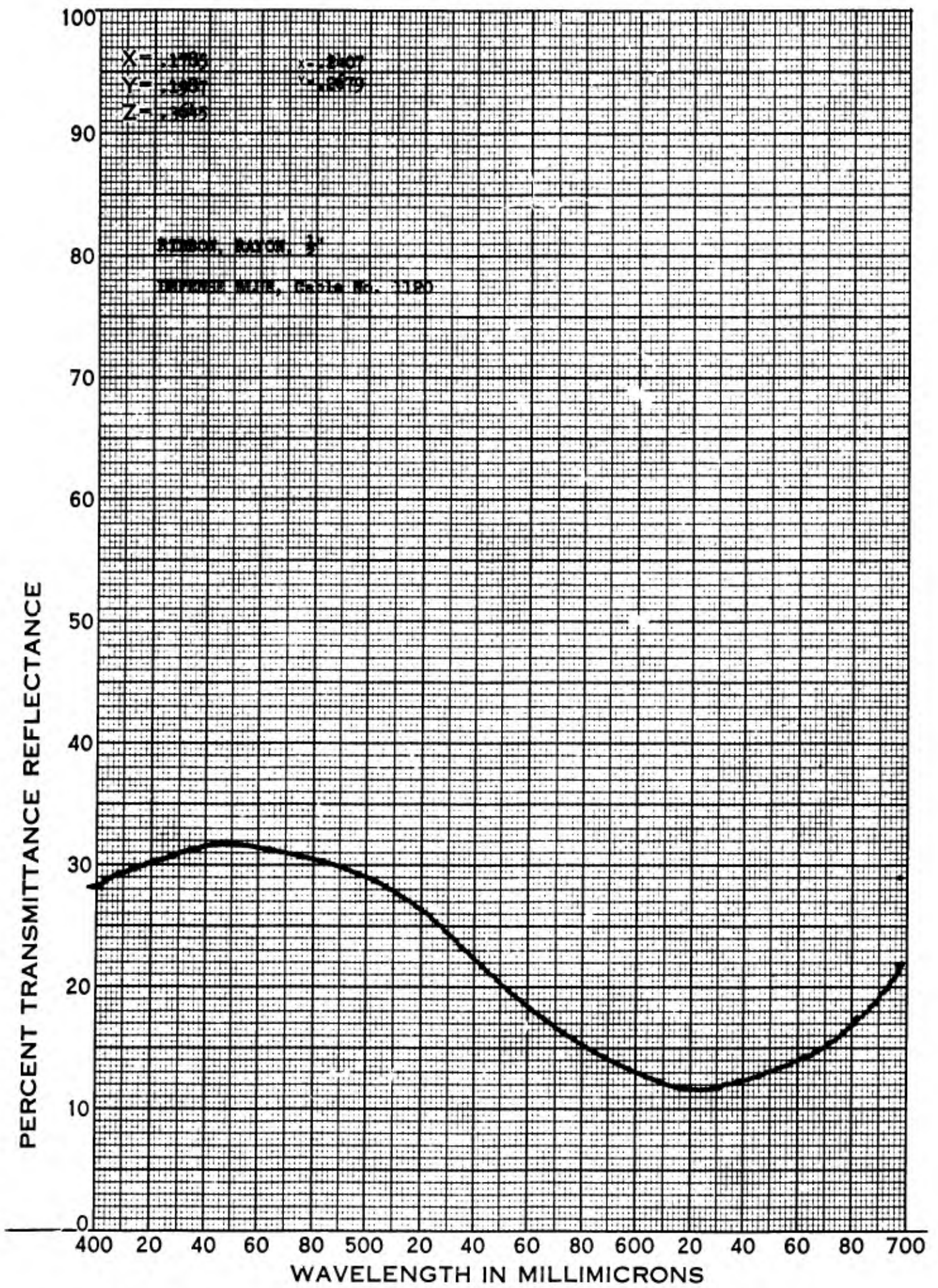


Figure 1. Spectral reflectance curve of Defense Blue, Cable #1120

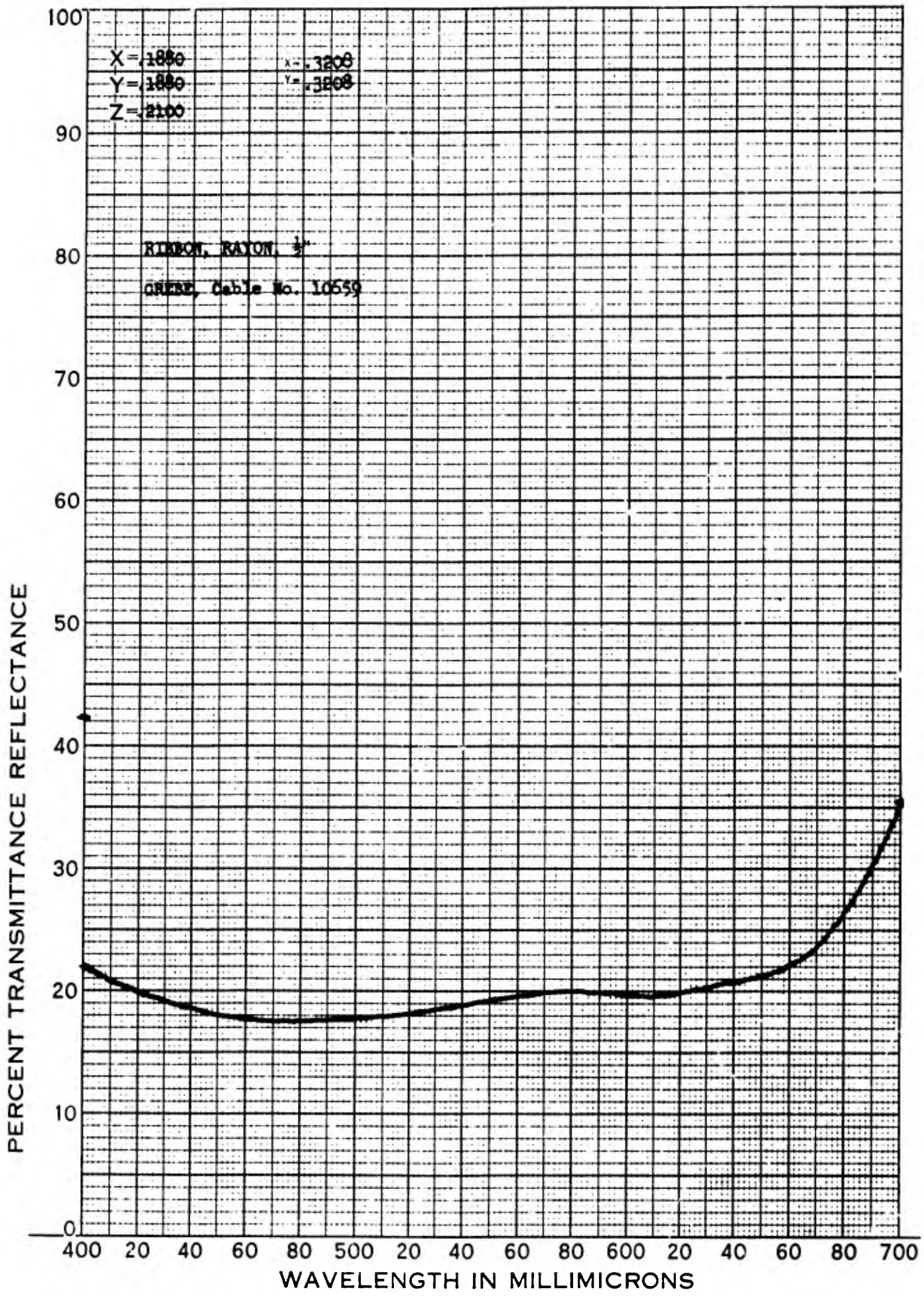


Figure 2. Spectral reflectance curve of Grebe, Cable #10659

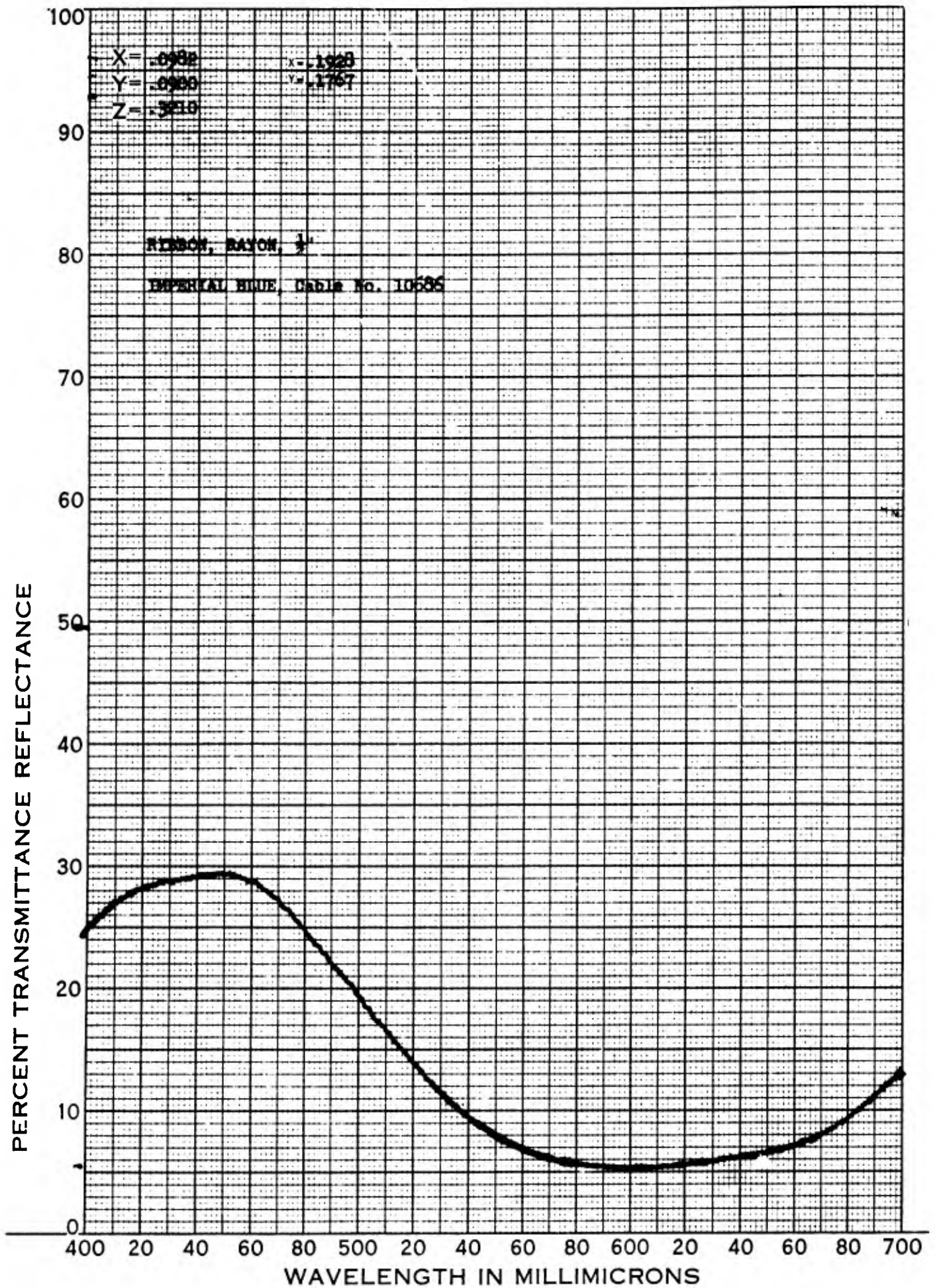


Figure 3. Spectral reflectance curve of Imperial Blue, Cable #10686

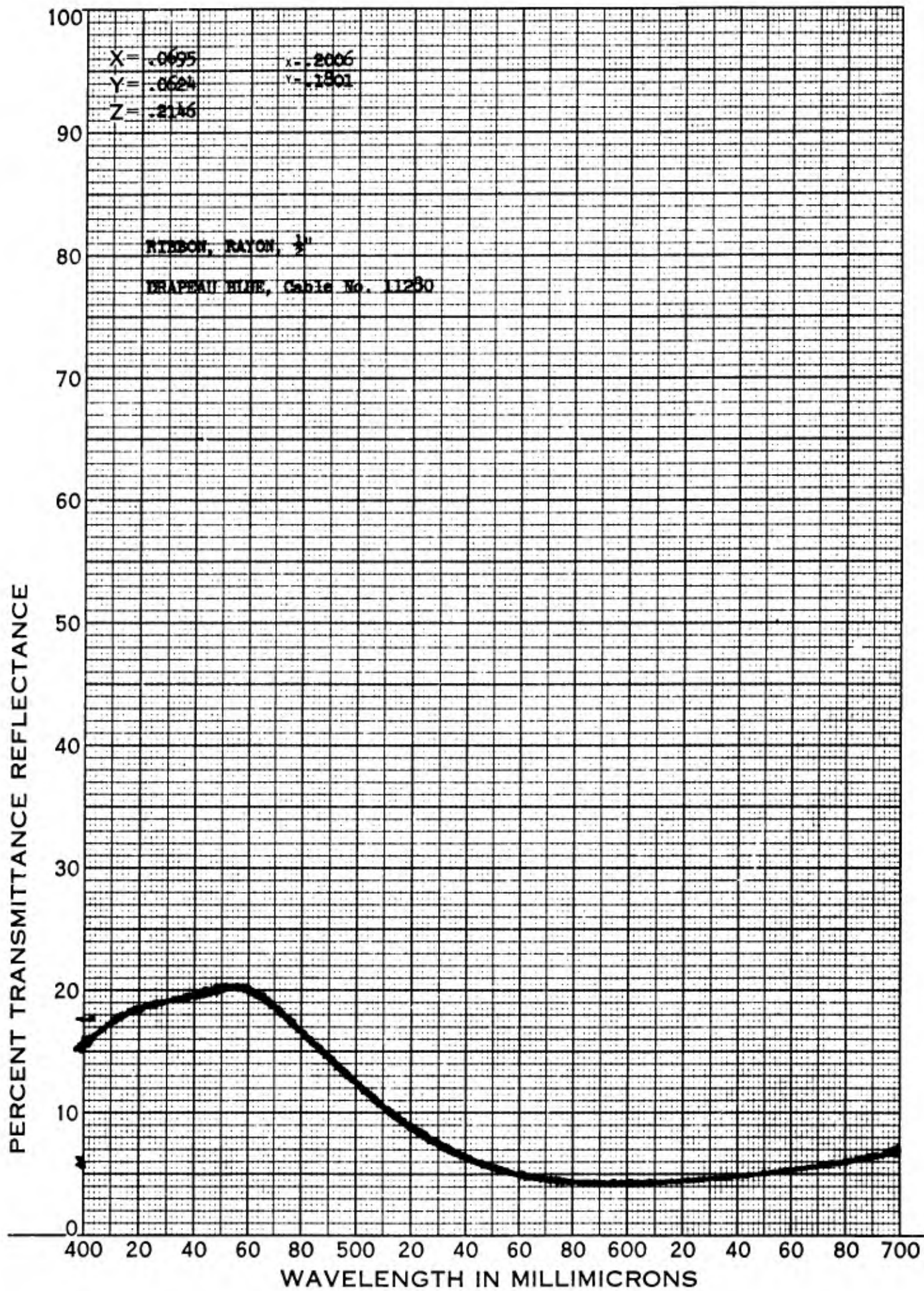


Figure 4. Spectral reflectance curve of Drapeau Blue, Cable #11280



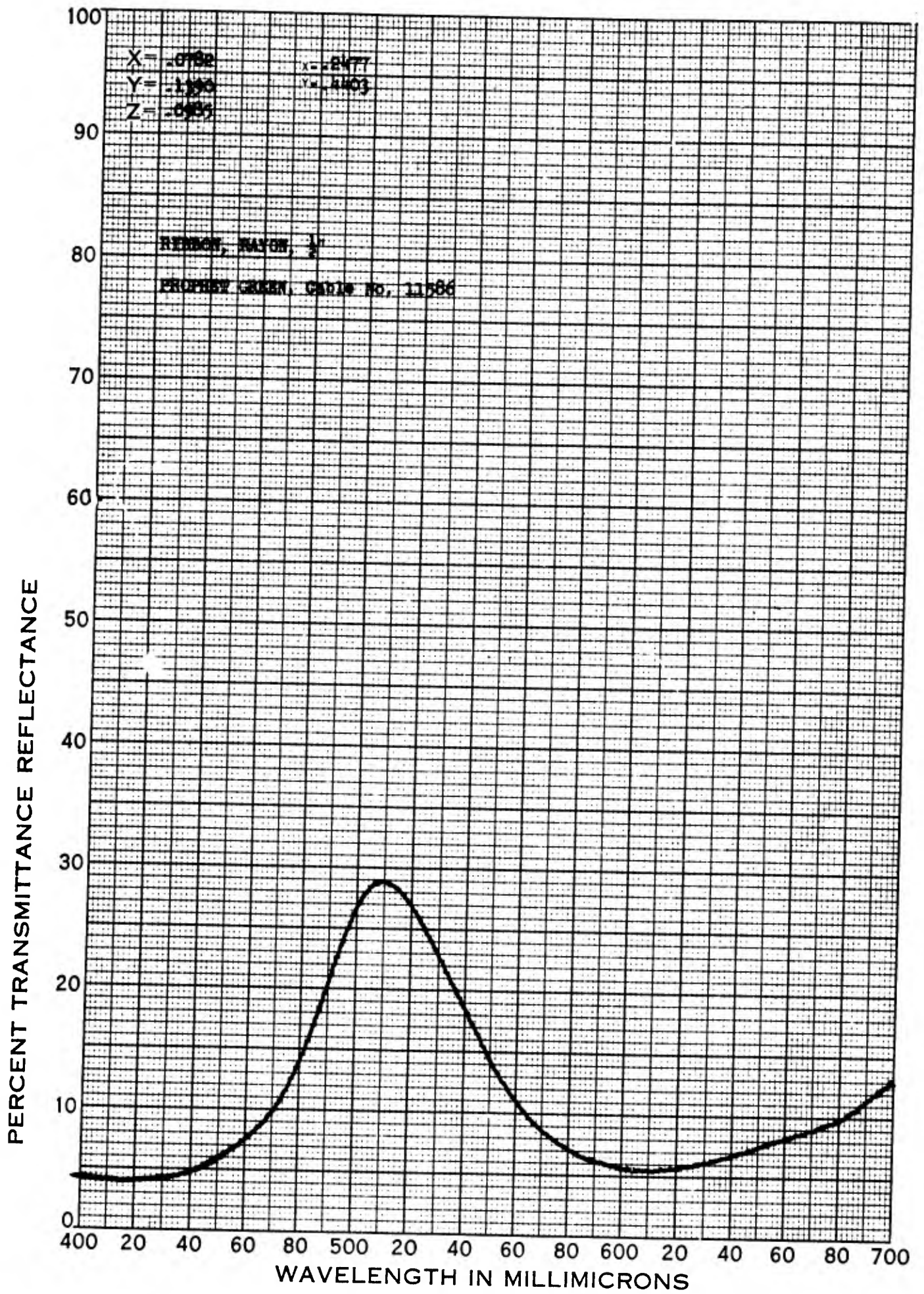


Figure 5. Spectral reflectance curve of Prophet Green, Cable #11586

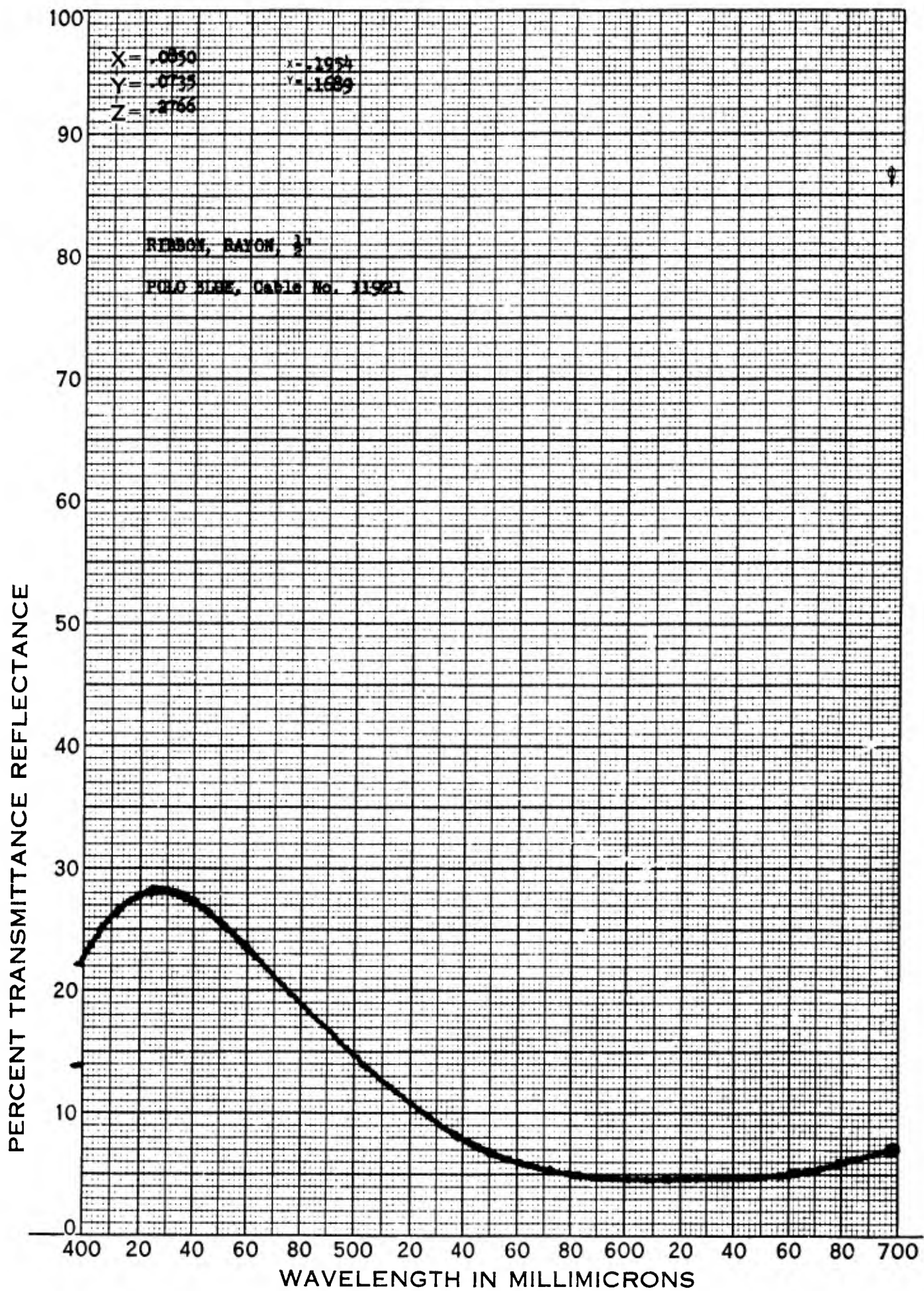


Figure 6. Spectral reflectance curve of Polo Blue, Cable #11921

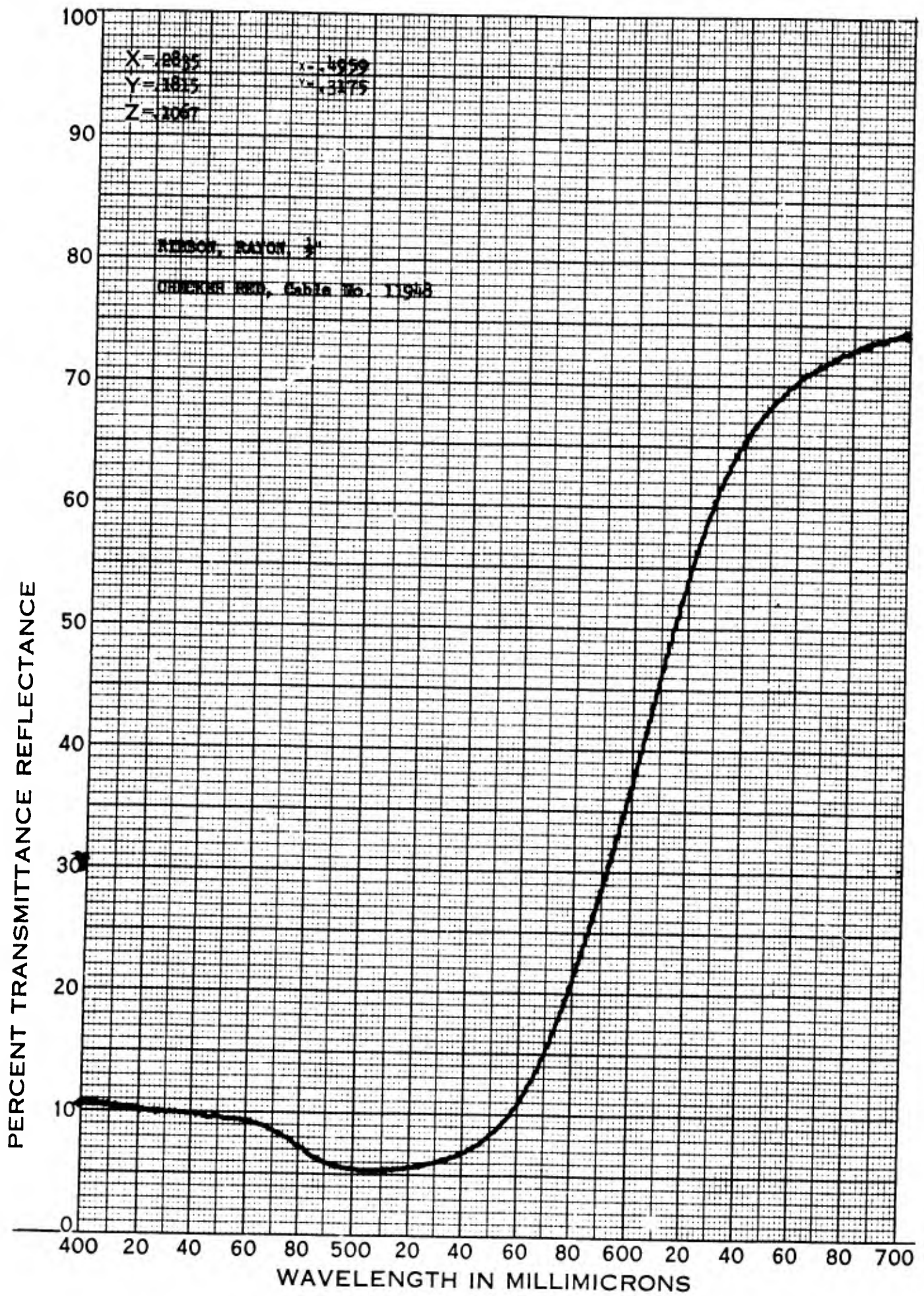


Figure 7. Spectral reflectance curve of Checker Red, Cable #11948

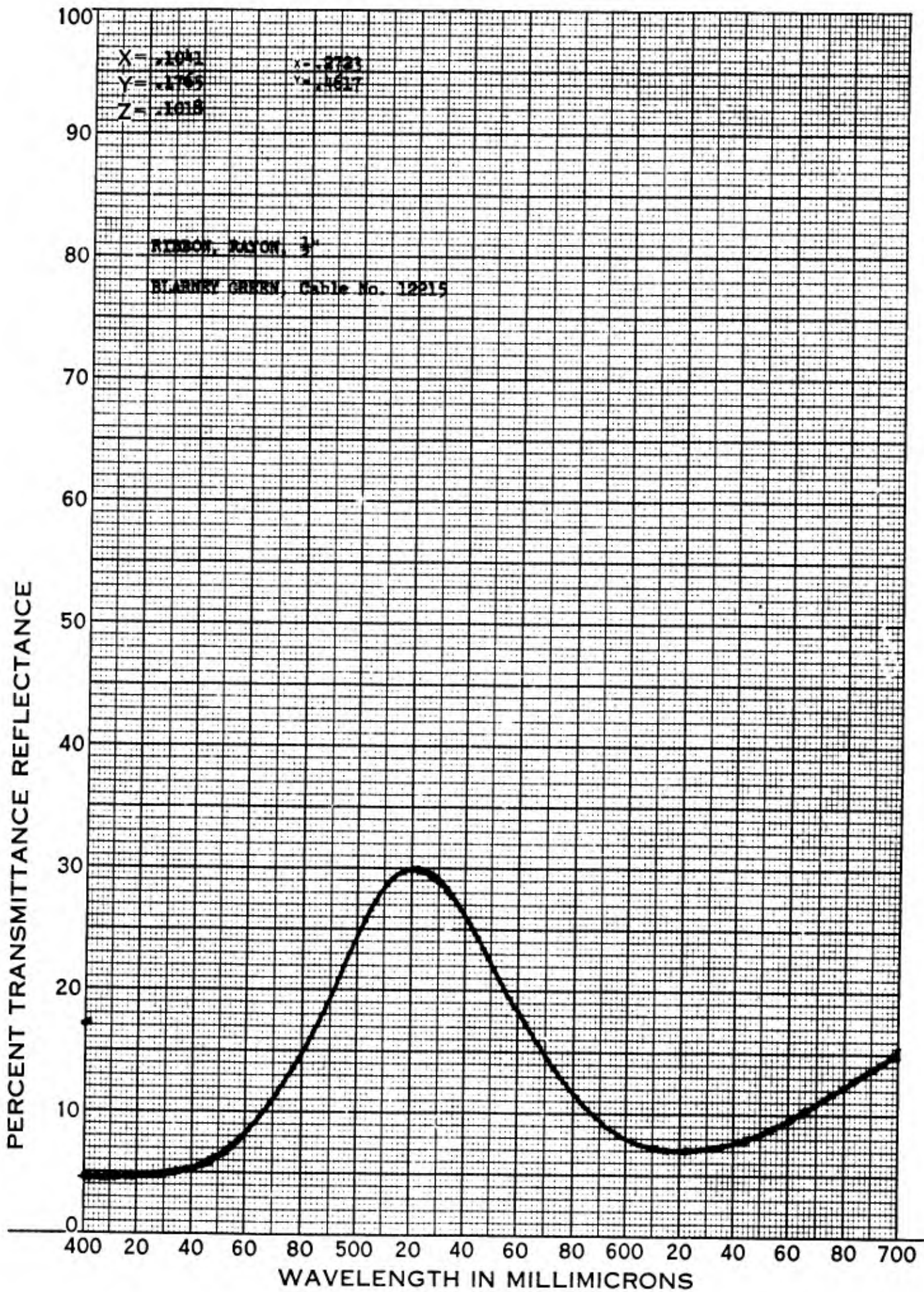


Figure 8. Spectral reflectance curve of Blarney Green, Cable #12215

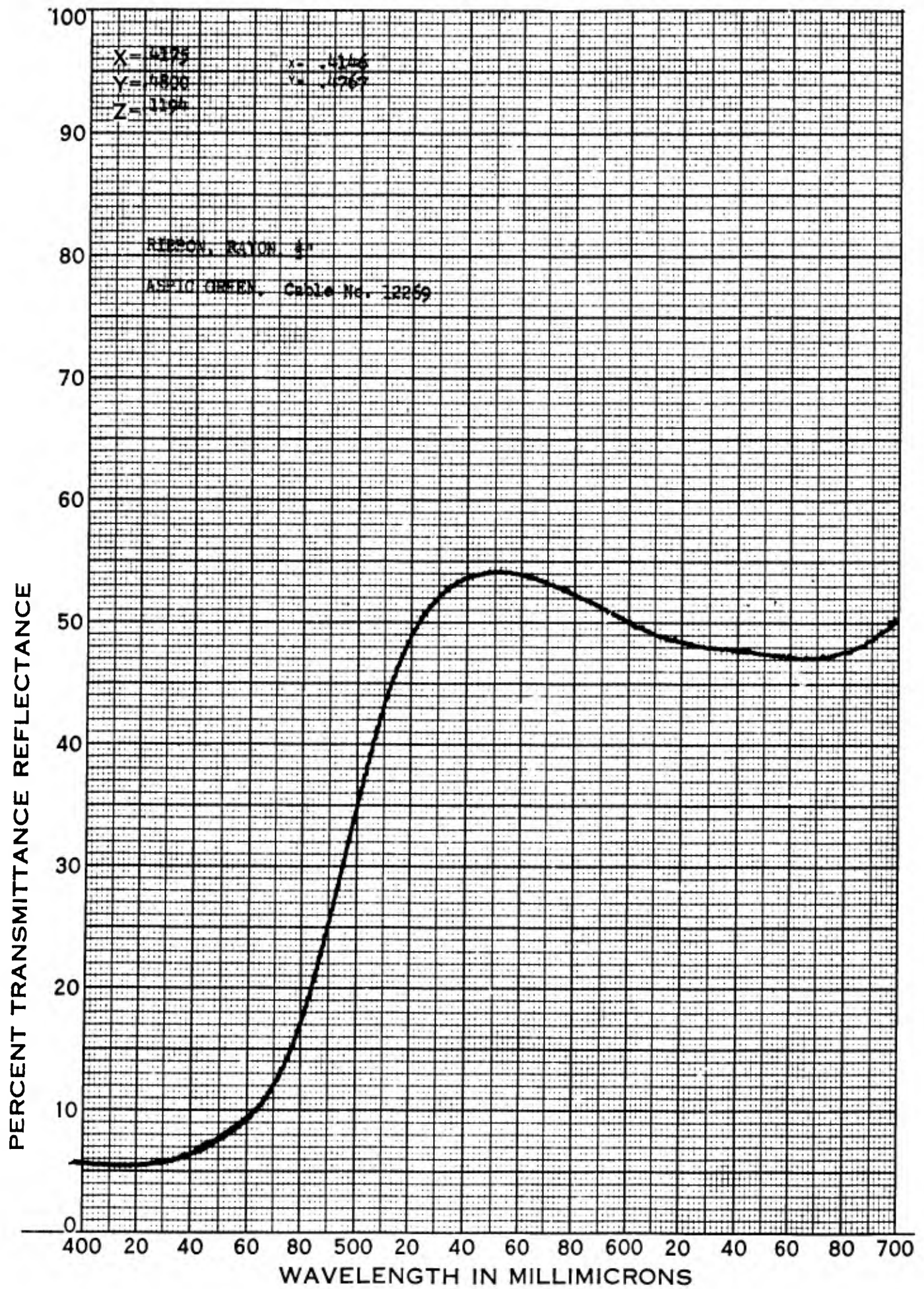


Figure 9. Spectral reflectance curve of Aspic Green, Cable #12269

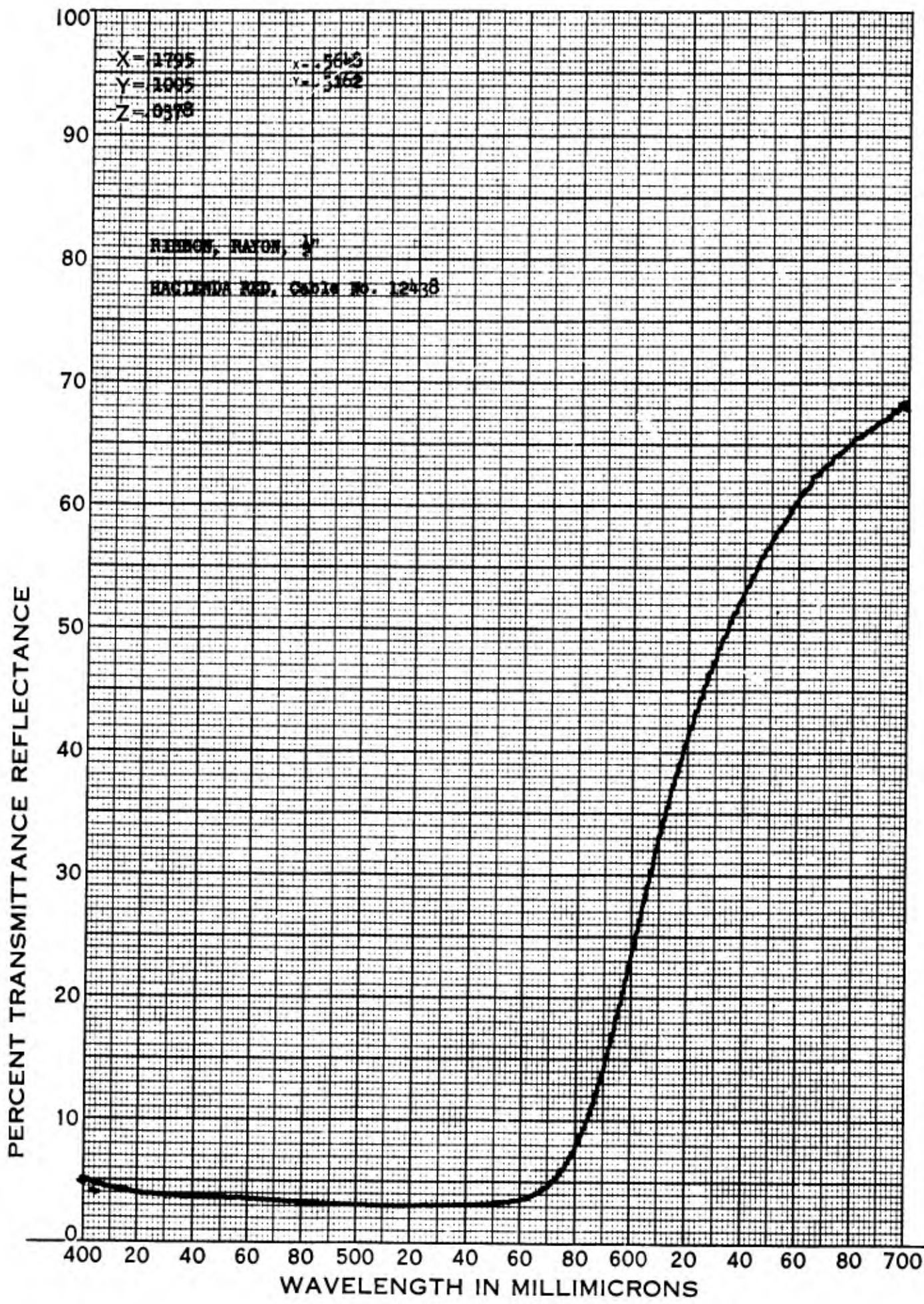


Figure 10. Spectral reflectance curve of Hacienda Red, Cable #12438

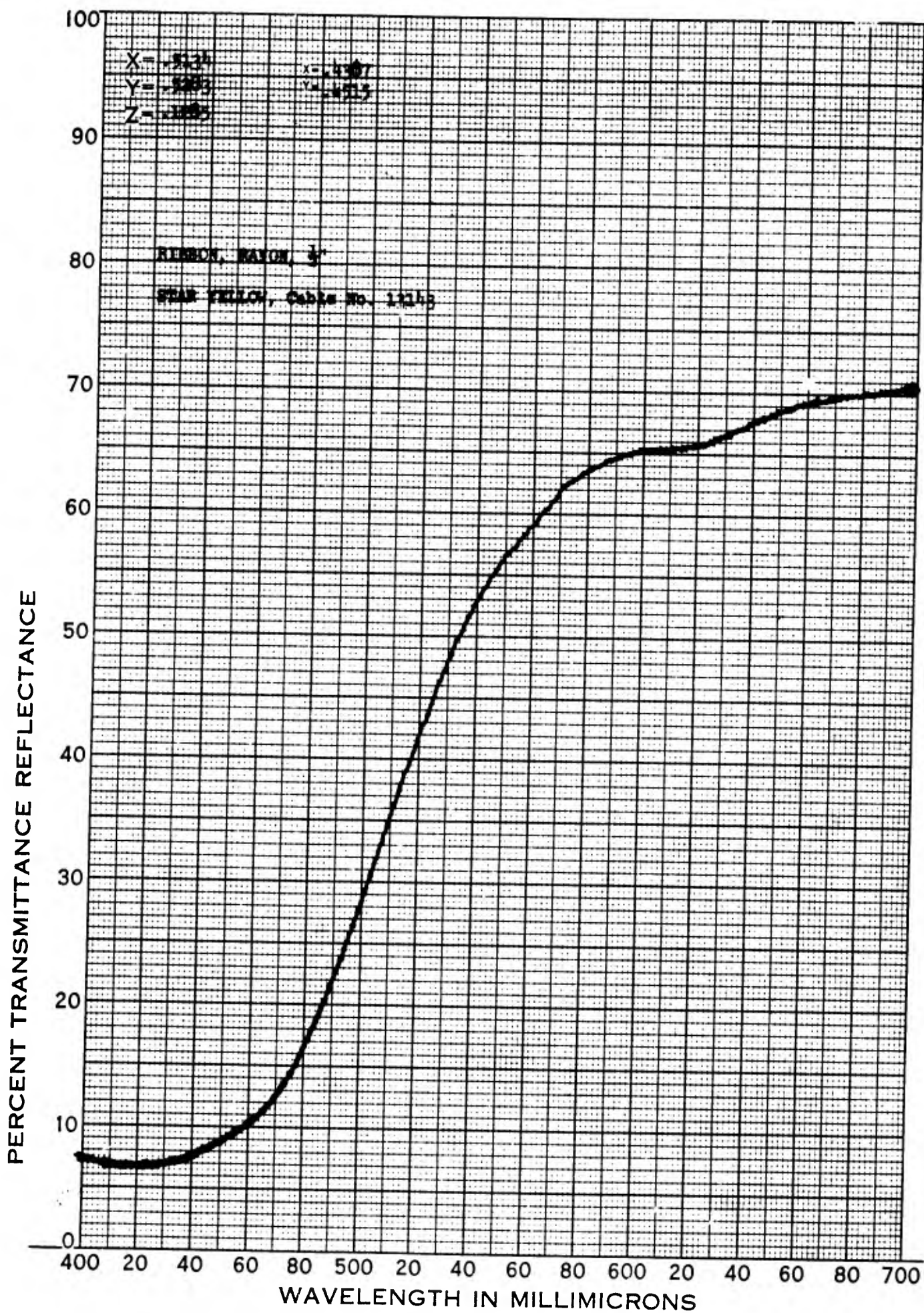


Figure 11. Spectral reflectance curve of Star Yellow, Cable #13143

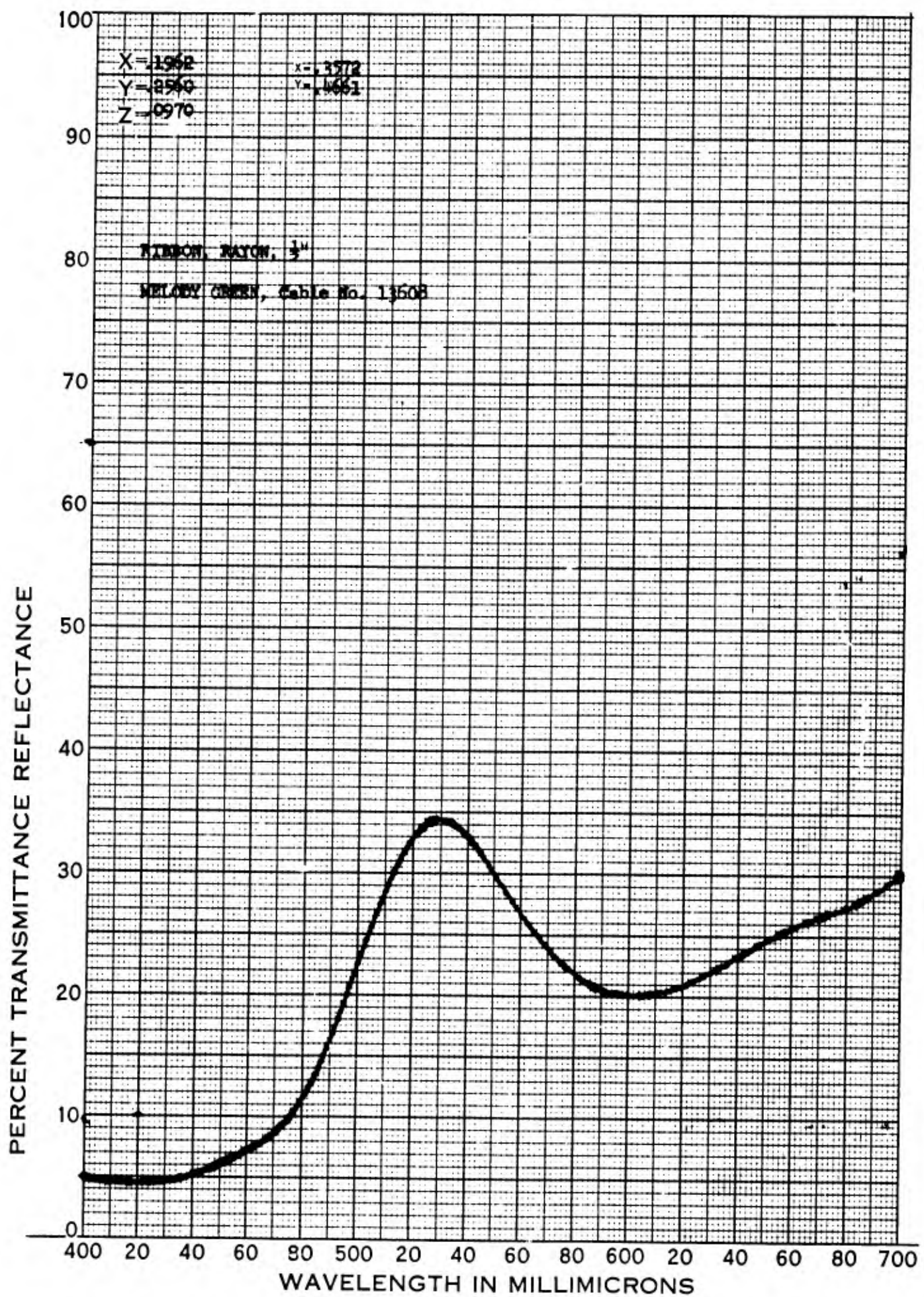


Figure 12. Spectral reflectance curve of Melody Green, Cable #13608



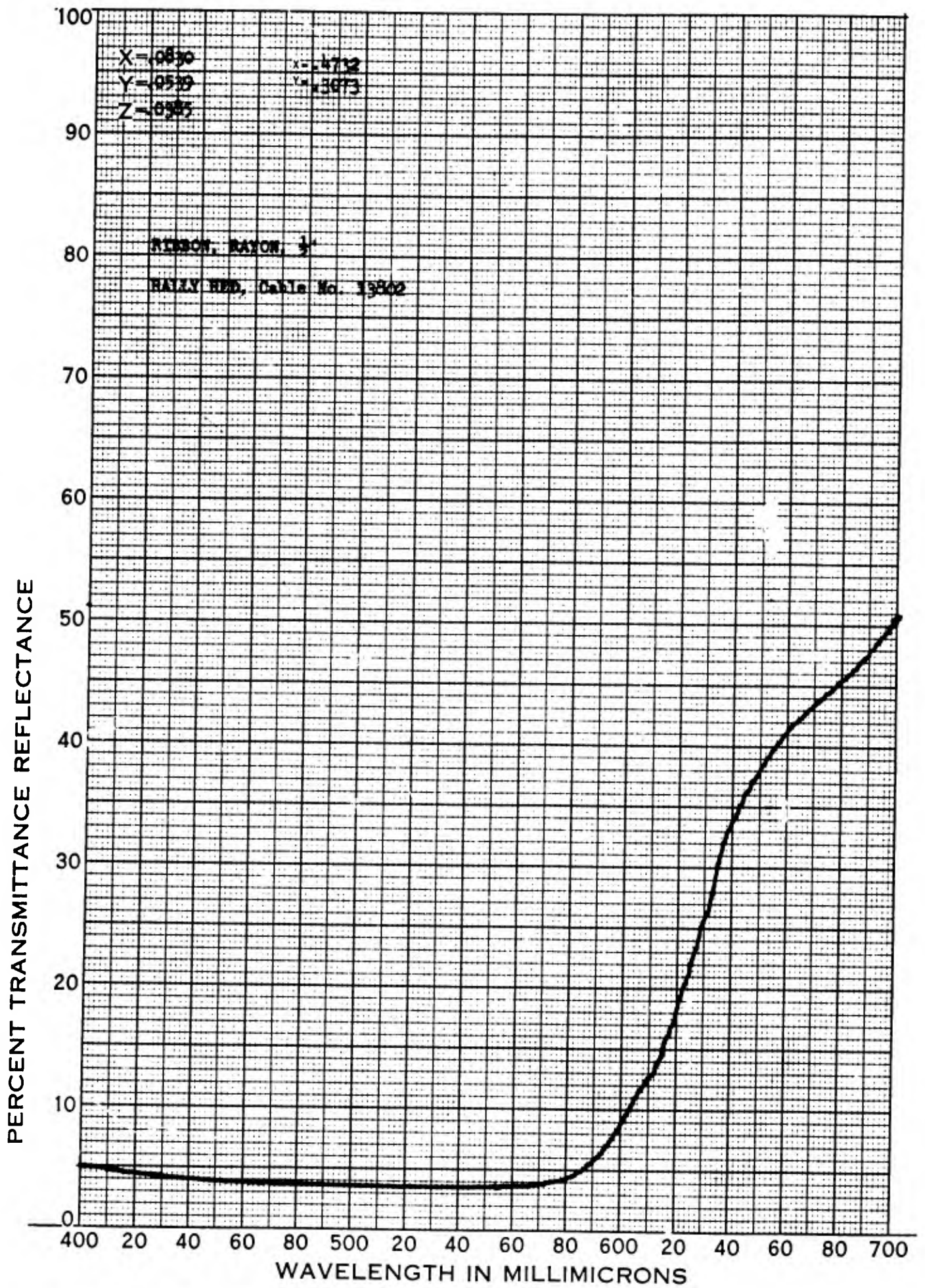


Figure 13. Spectral reflectance curve of Rally Red, Cable #13802

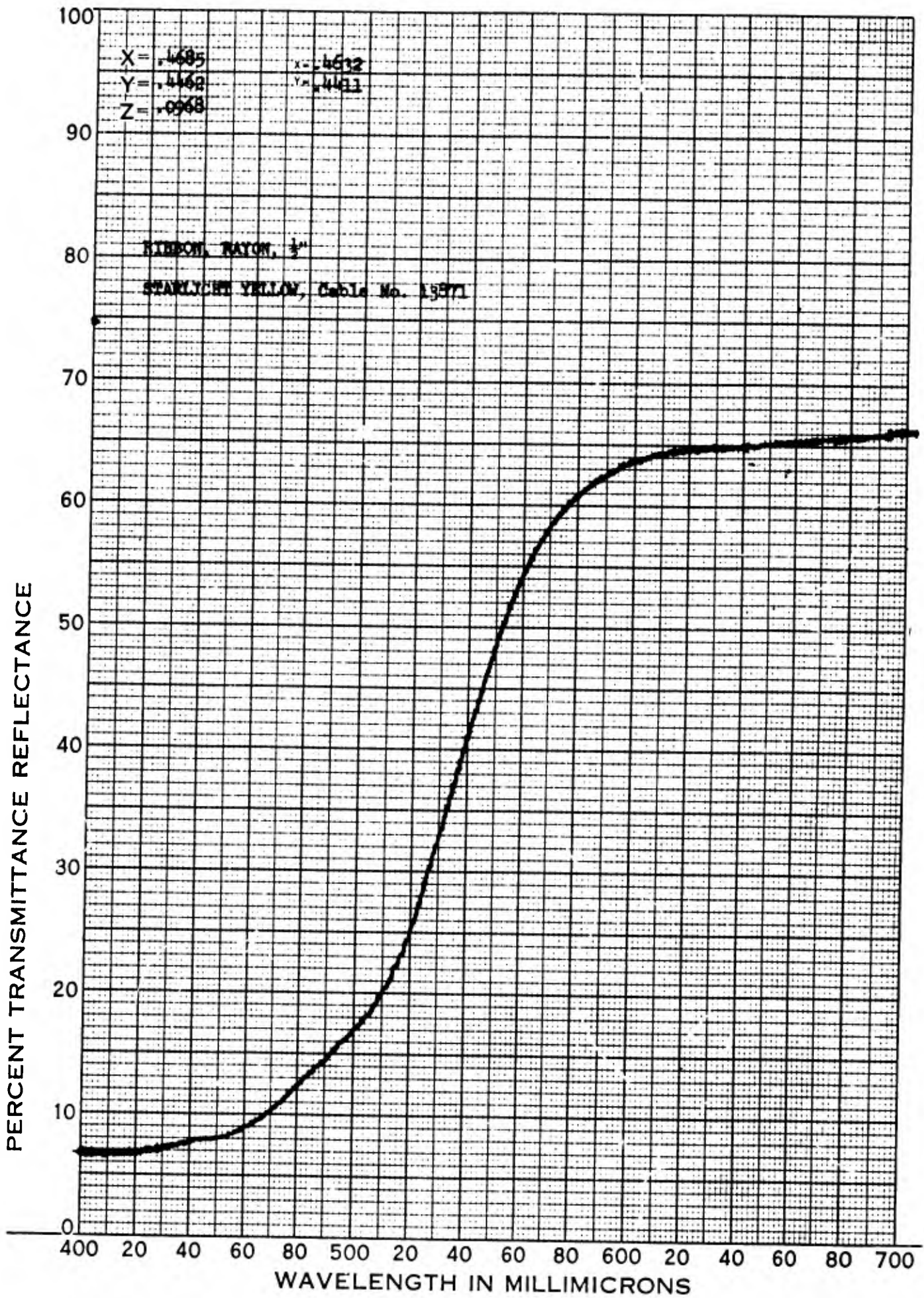


Figure 14. Spectral reflectance curve of Starlight Yellow, Cable #13871

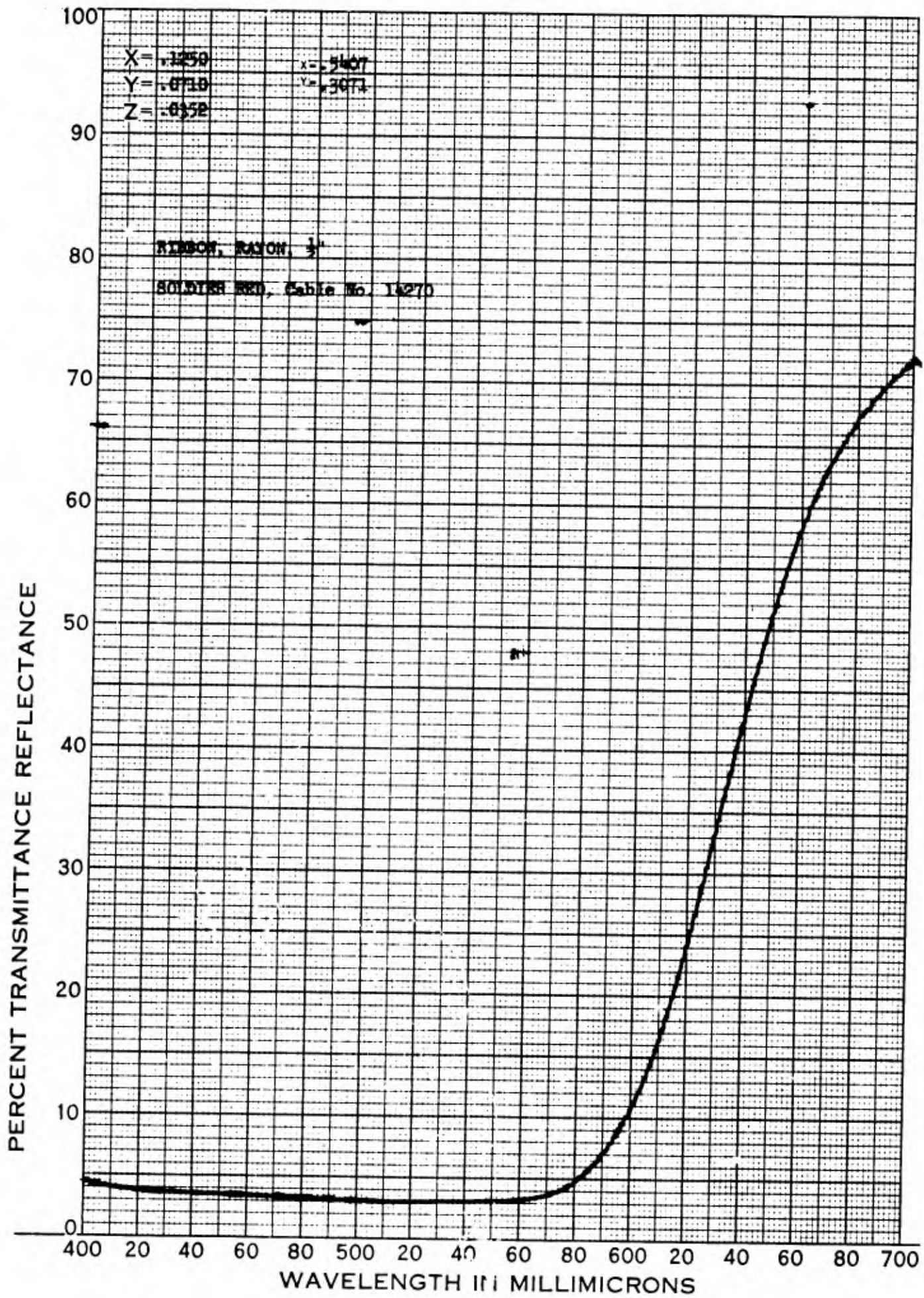


Figure 15. Spectral reflectance curve of Soldier Red, Cable #14270

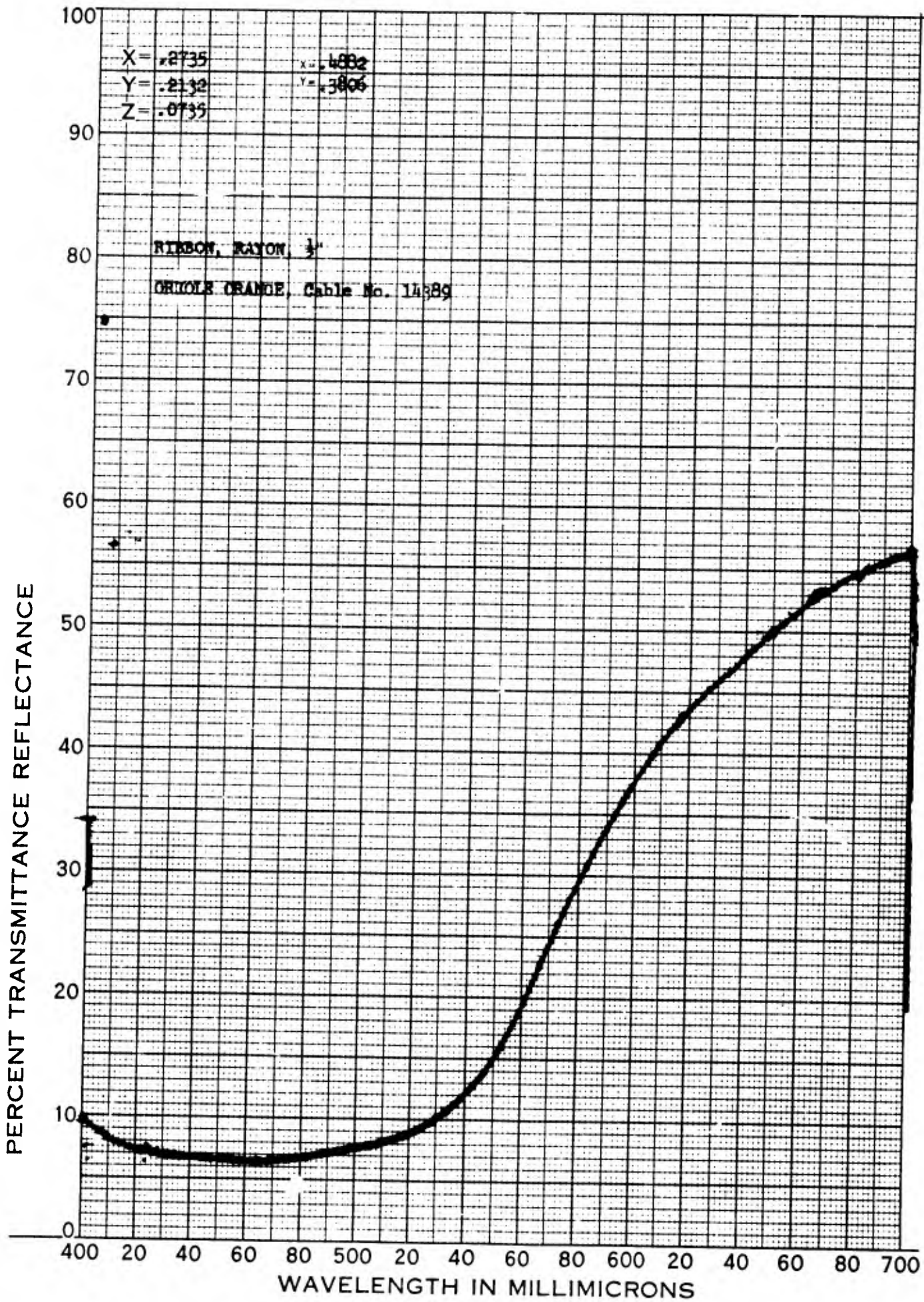


Figure 16. Spectral reflectance curve of Oriole Orange, Cable #14389

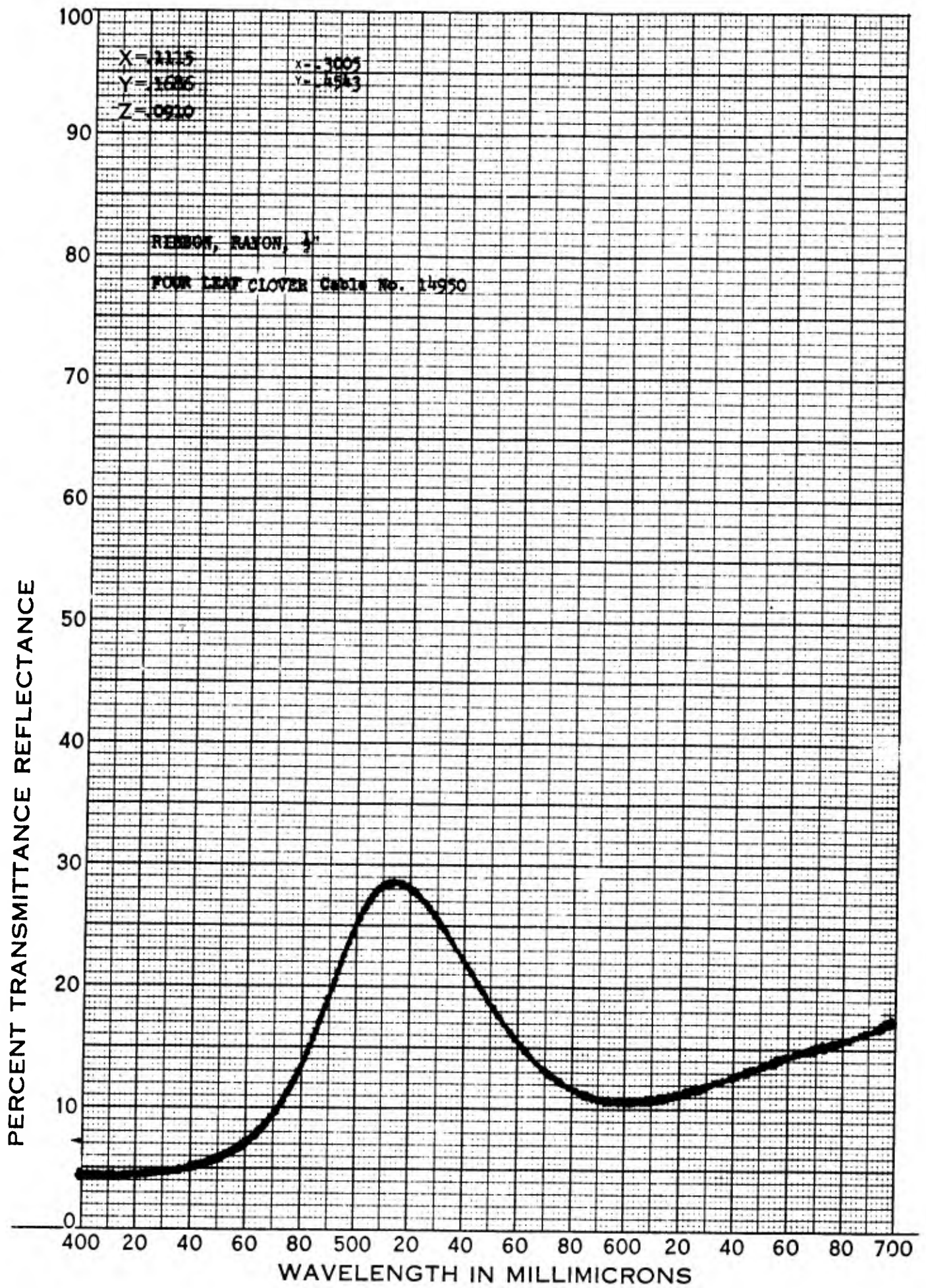


Figure 17. Spectral reflectance curve of Four Leaf Clover, Cable #14950

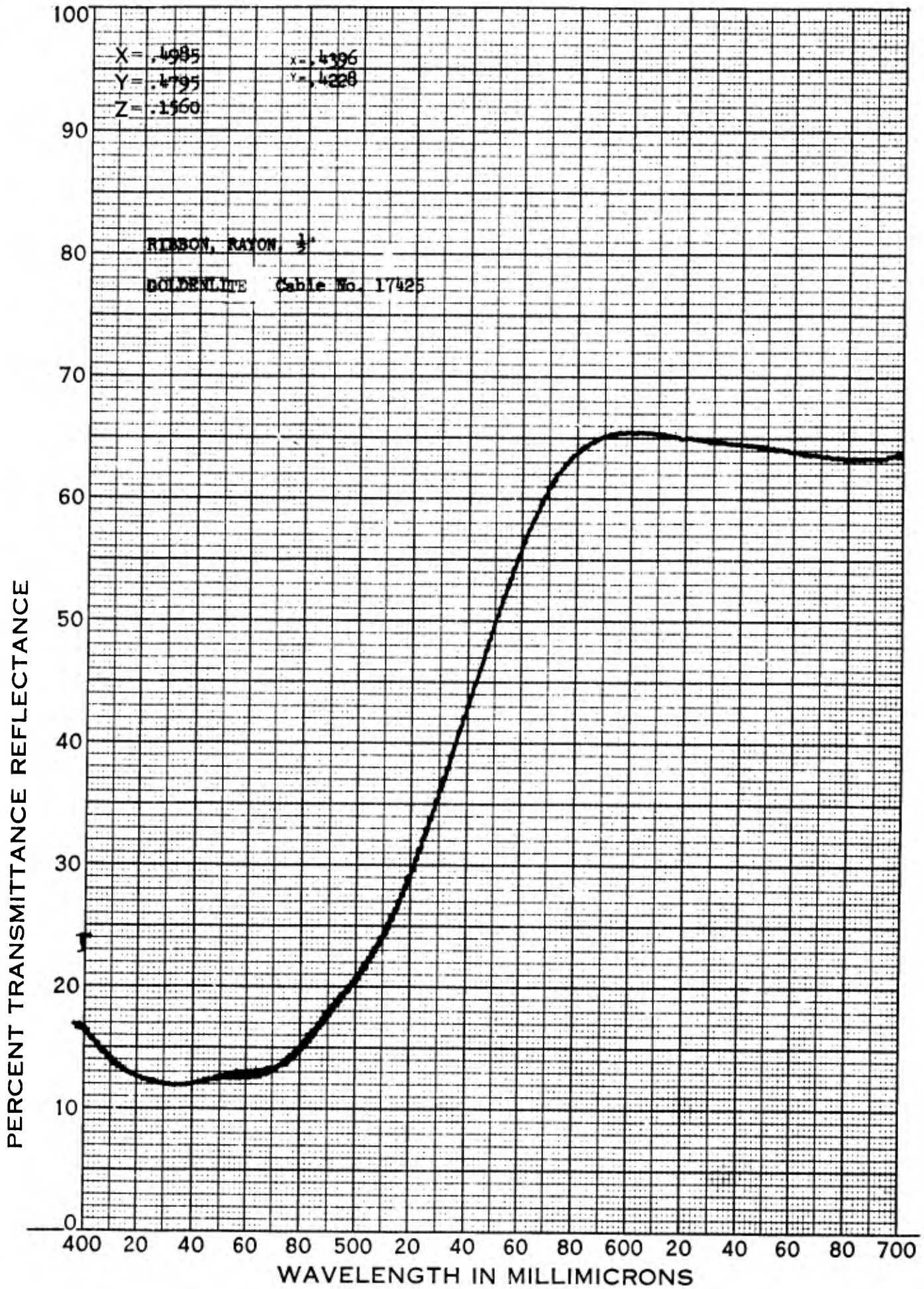


Figure 18. Spectral reflectance curve of Goldenlite, Cable #17425