NATIONAL BUREAU OF STANDARDS REPORT

4463

Current-Intensity, Voltage-Intensity, and Current-Voltage Characteristics of Runway- and Approach-Light Lamps

By
Photometry and Colorimetry Section
Optics and Metrology Division

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS REPORT

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Current-Intensity, Voltage-Intensity, and Current-Voltage Characteristics of Runway- and Approach-Light Lamps

By
Photometry and Colorimetry Section
Optics and Metrology Division

Prepared For
Visual Landing Aids Branch
Airborne Equipment Division
Department of the Navy
and
Equipment Laboratory
Wright Air Development Center
Department of the Air Force

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Report on the Current-Intensity, Voltage-Intensity, and Current-Voltage Characteristics of Runway- and Approach-Light Lamps

Abstract

This report is a compilation of measurements of the intensity-current-voltage characteristics of lamps of the types generally used in approach-, runway-, and taxiway-lighting systems. The results of a study of the effects of color filters on the relative intensity of the lamps are included.

1. INTRODUCTION

Intensity control is now used on nearly all runway- and approach-light systems and is being considered for taxiway-light systems. The increasing complexity of the problems of intensity control has increased the need for information on the relative intensity characteristics of lamps used in approach, runway, and taxiway lighting as a function of the applied current or voltage. In addition, information on the effect of color filters upon the relative intensity is needed. This report was prepared to meet this need.

Relative intensity is defined as the ratio in percent of the intensity of a lighting unit or lamp operated at a stated current or voltage to the intensity of the same unit or lamp operated at rated current or voltage. Note that in obtaining the relative intensity of a colored light, measurements of the intensity at both the stated current (or voltage) and the rated current (or voltage) are made with the color filter in place. Thus, the transmittance of the filter has only a second-order effect on the relative intensity.

2. METHOD OF MEASUREMENT

Measurements of relative intensity were made using a color-corrected barrier-layer photocell in a zero-resistance circuit. The response of this photometric system was checked. No significant deviations from linearity were found. When reflector-type lamps were tested, the center of the beam was directed at the photocell. The relative intensities of lamps other than the reflector type (325-lumen, 200-watt, T-14, etc.) were obtained by measuring the relative horizontal intensity in a given direction. Previous tests have shown that the relative intensity of clear

units in which these lamps are used does not differ significantly from the relative horizontal intensity of the lamp used. Voltage and current measurements were corrected for losses in the measuring circuits. Whenever possible several lamps of a given type were used. The results of the measurements of individual lamps were averaged.

3. LAMP CHARACTERISTICS

For convenience in use, the characteristics of each lamp (except for the 250-watt lamps) are given as three curves, a, relative intensity-current; b, relative intensity-voltage; and c, voltage-current. Curves for lamps with similar characteristics have been grouped on the same figures. The lamp types studied and the figures showing their characteristics are listed in table I.

Table I

Lamp Type	Designation	Figure
325-lumen, 6.6-ampere, airport marker	325/66/A21	1a, b, and c
1020-lumen, 6.6-ampere, airport marker	1020/66/A21	1a, b, and c
30-watt, 6.6-ampere, airport marker	6.6A/T10/1P	1a, b, and c
45-watt, 6.6-ampere, airport marker	6.6/T10P	1a, b, and c
200-watt, 6.6-ampere, T-14, airport marker	6.6A/T14P	2a, b, and c
200-watt, 6.6-ampere, PAR56, airport approach	6.6A/PAR56/2	2a, b, and c
500-watt, 6.6-ampere, T-20, airport marker	6.6A/T20P	3a, b, and c
500-watt, 20-ampere, T-20, airport approach	20A/T20/5	4a, b, and c
250-watt, 12.5-volt, T-10, airport approach	20A/T10/P	5
250-watt, 12.5-volt, PAR56, airport approach	250PAR	5
300-watt, 25-volt, PAR56, airport approach	---	6a, b, and c
350-watt, 25-volt, PAR56, airport approach	350PAR	6a, b, and c
399-watt, 115-volt, PAR56, airport approach	399PAR	7a, b, and c
500-watt, 120-volt, T-20, airport approach	500T20/25	7a, b, and c

Differences in relative intensity between lamps of the same type may become large when the relative intensity becomes less than 1%. The relative intensities may differ by as much as a factor of 2 when the relative intensity is about 0.2%.

4. EFFECTS OF COLOR FILTERS

Because the transmittance of color filters is a function of the color temperature of the source, the relative intensity characteristics of colored lights will differ from those of similar lights

which are "white". The determination and presentation of the relative intensity characteristics of each type of lamp for each aviation color would be unduly expensive. Therefore, a study was made to determine representative correction curves, in case the use of these curves proved feasible. Relative intensity characteristics were determined for several of the types of lamps listed in table I in combination with filters representative of the limits of the aviation colors. It was found that the data were adequately represented by the lines plotted on figure 8. These lines show the relative intensity of lights meeting the specification requirements for aviation colors as a function of the relative intensity of the same light used without a filter. The lines are representative of "average" filters. The relative intensity of lights with filters near the specification limits may differ from that indicated by the lines by about ten percent at the lowest relative intensities shown. The difference will, of course, be less at higher relative intensities.

5. DISCUSSION

Differences in the change of relative intensity with change in current or voltage for different lamps are significantly large so that generalized lamp-characteristic exponents cannot be satisfactorily used for all lamp types when the relative intensity is varied over a wide range.

For lamps with the same rated current and of similar design wattage (within 25%), the relative intensity-current characteristics are similar. See the curves on figure 1a. Also compare the curves for the 200-watt, 6.6-ampere lamps, figure 2a, with those of the 500-watt, 6.6-ampere lamp, figure 3a. The data shown on figures 6b and 7b indicate that relative intensity-voltage characteristics are similar for lamps of similar design wattage.

The data shown on figures 2a and 5 indicate that the characteristics of reflector-type lamps are not significantly different from other lamp types of the same rated wattage and voltage.

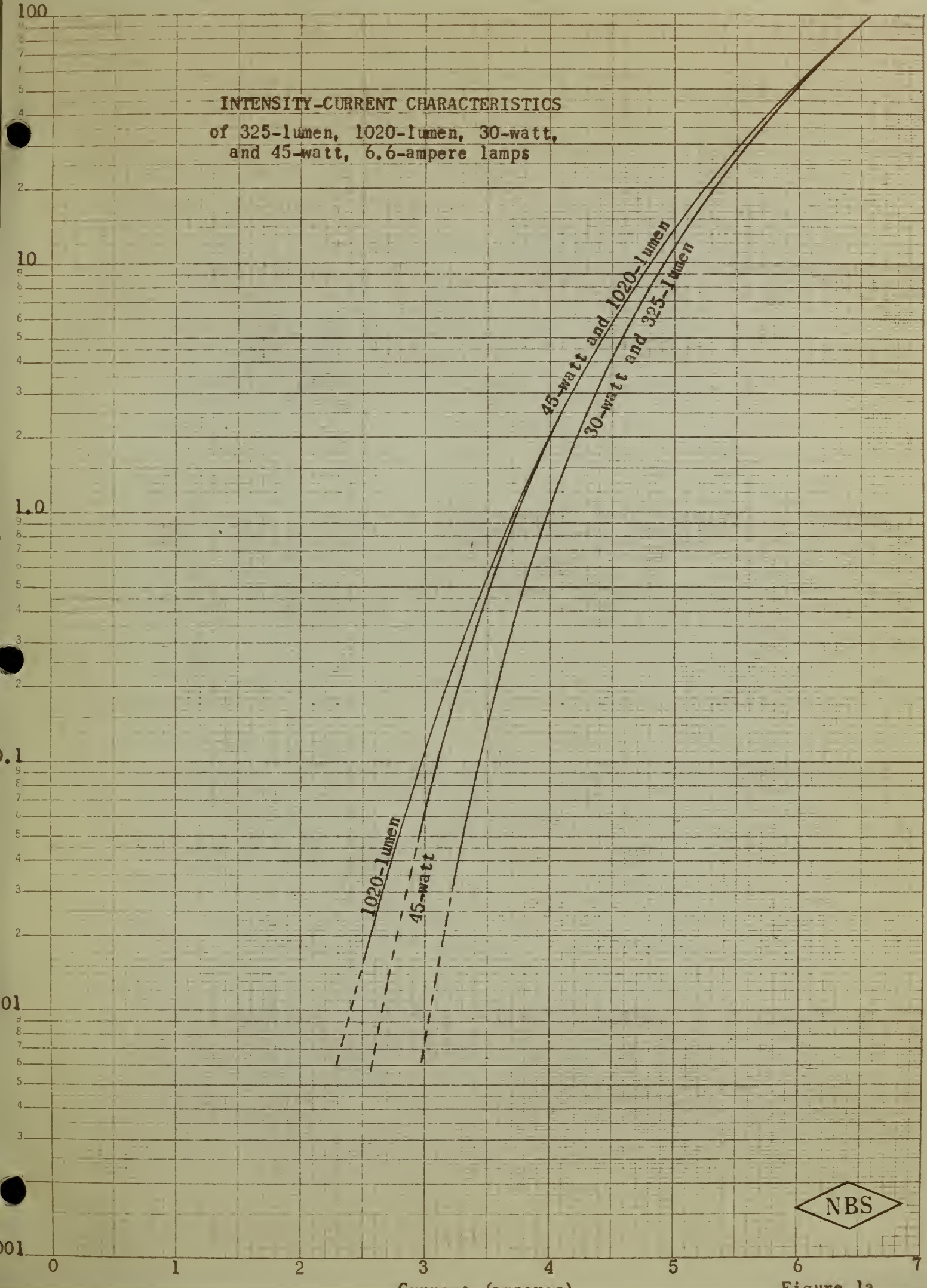
INTENSITY-CURRENT CHARACTERISTICS
of 325-lumen, 1020-lumen, 30-watt,
and 45-watt, 6.6-ampere lamps
45-watt and 1020-lumen
30-watt and 325-lumen
1020-lumen
45-watt
100
10
1.0
.1
.01
.001
0
1
2
3
4
5
6
7
Current (amperes)
NBS

Figure 1a

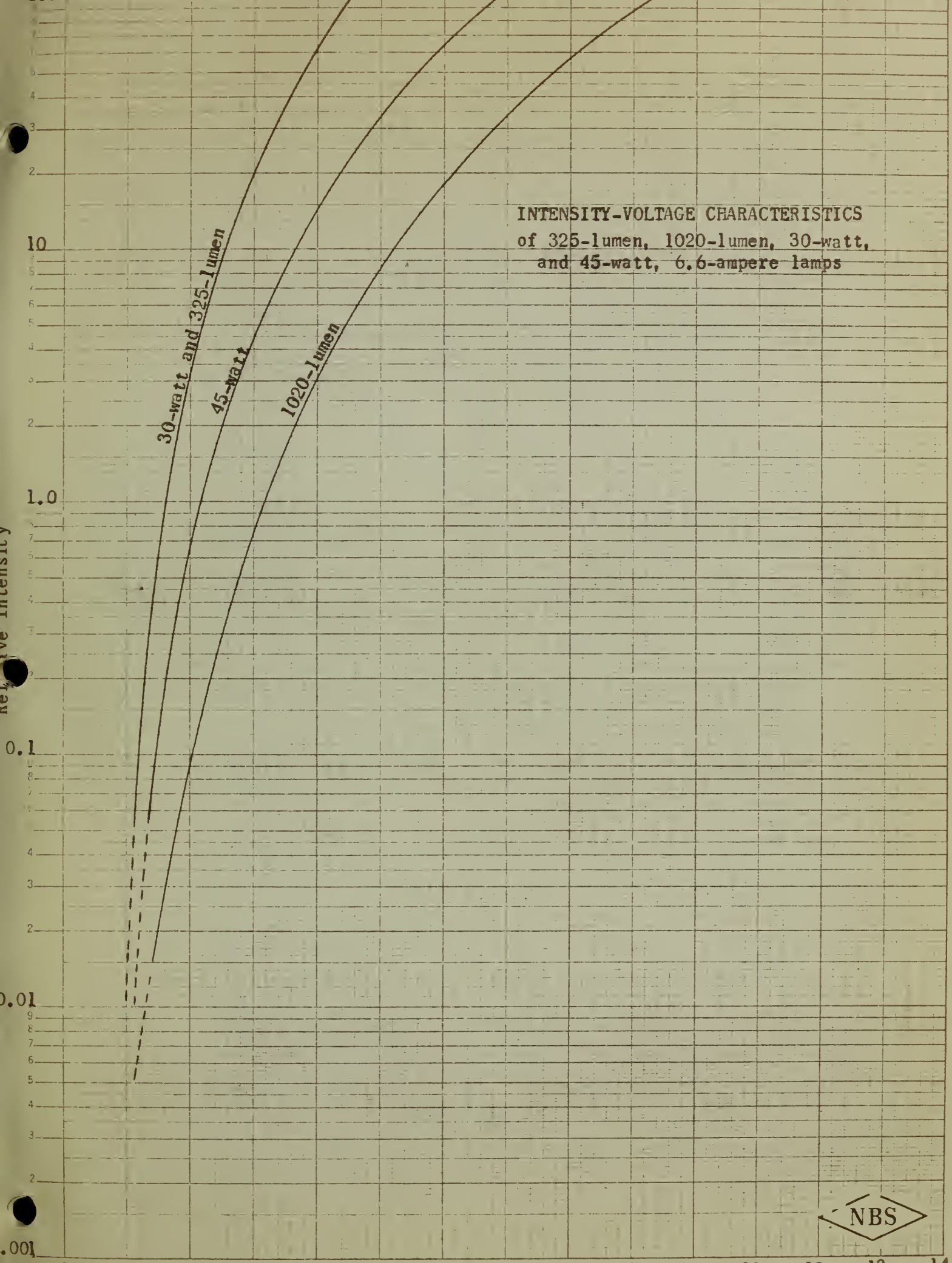
INTENSITY-VOLTAGE CHARACTERISTICS
of 325-lumen, 1020-lumen, 30-watt,
and 45-watt, 6.6-ampere lamps
30-watt and 325-lumen
45-watt
1020-lumen
Relative Intensity
10
1.0
0.1
0.01
.001
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Volts
NBS

Figure 1b

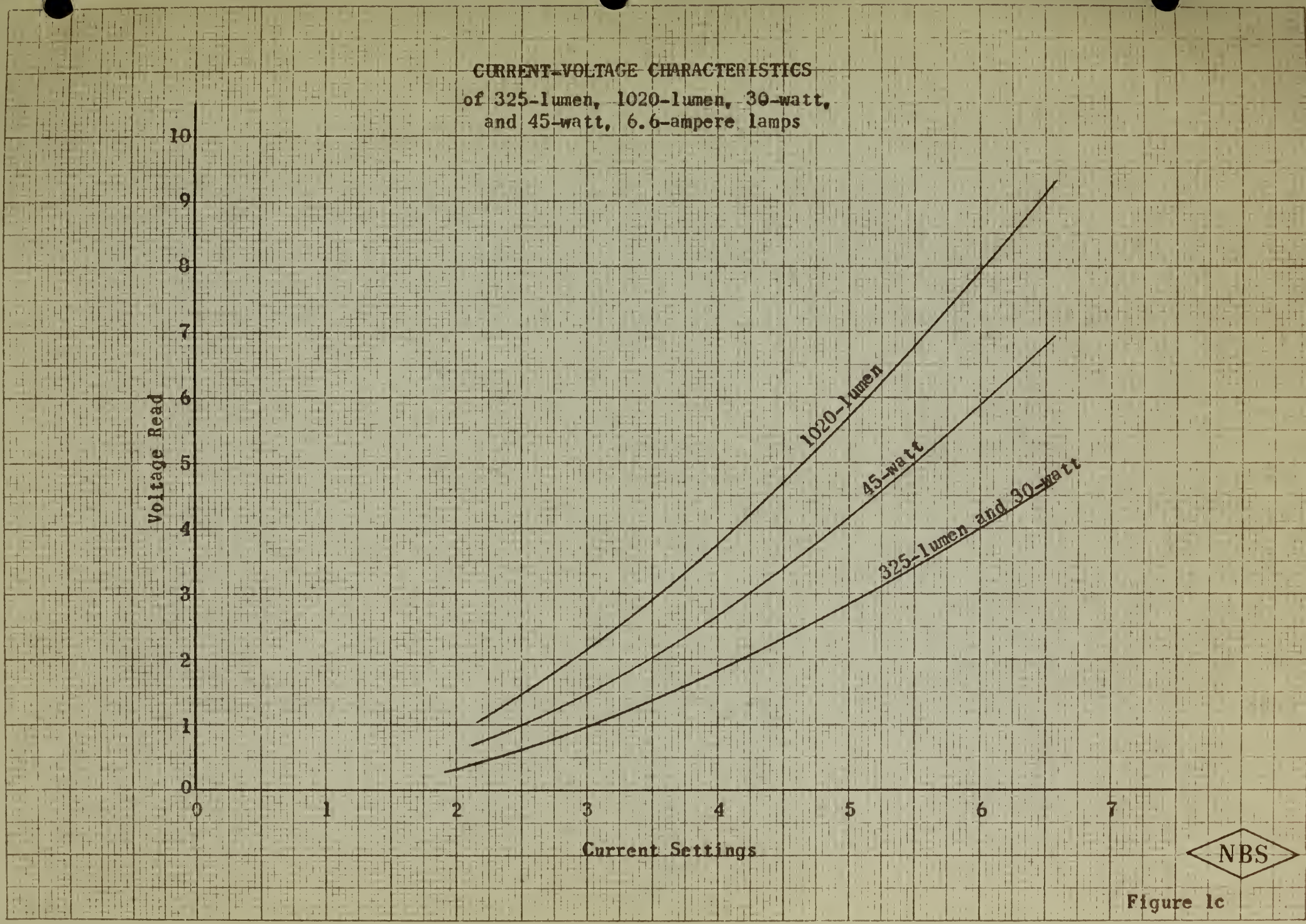
CURRENT-VOLTAGE CHARACTERISTICS
of 325-lumen, 1020-lumen, 30-watt,
and 45-watt, 6.6-ampere lamps
Voltage Read
0
1
2
3
4
5
6
7
8
9
10
1020-lumen
45-watt
325-lumen and 30-watt
0
1
2
3
4
5
6
7
Current Settings
NBS

Figure 1c

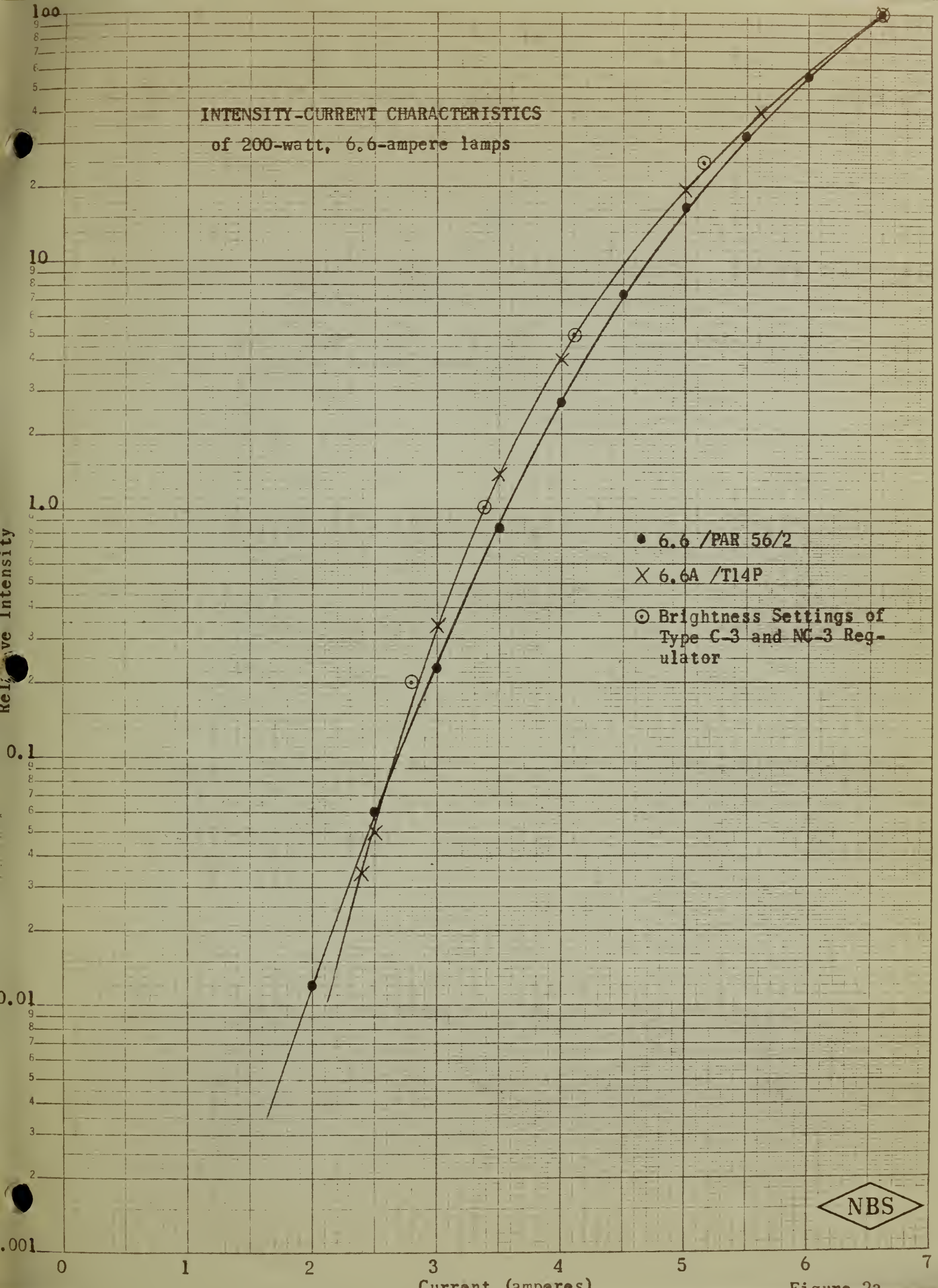
INTENSITY-CURRENT CHARACTERISTICS
of 200-watt, 6.6-ampere lamps
• 6.6 /PAR 56/2
X 6.6A /T14P
⊙ Brightness Settings of Type C-3 and NC-3 Regulator
NBS
Relative Intensity
Current (amperes)
100
10
1.0
0.1
0.01
.001
0
1
2
3
4
5
6
7

Figure 2a

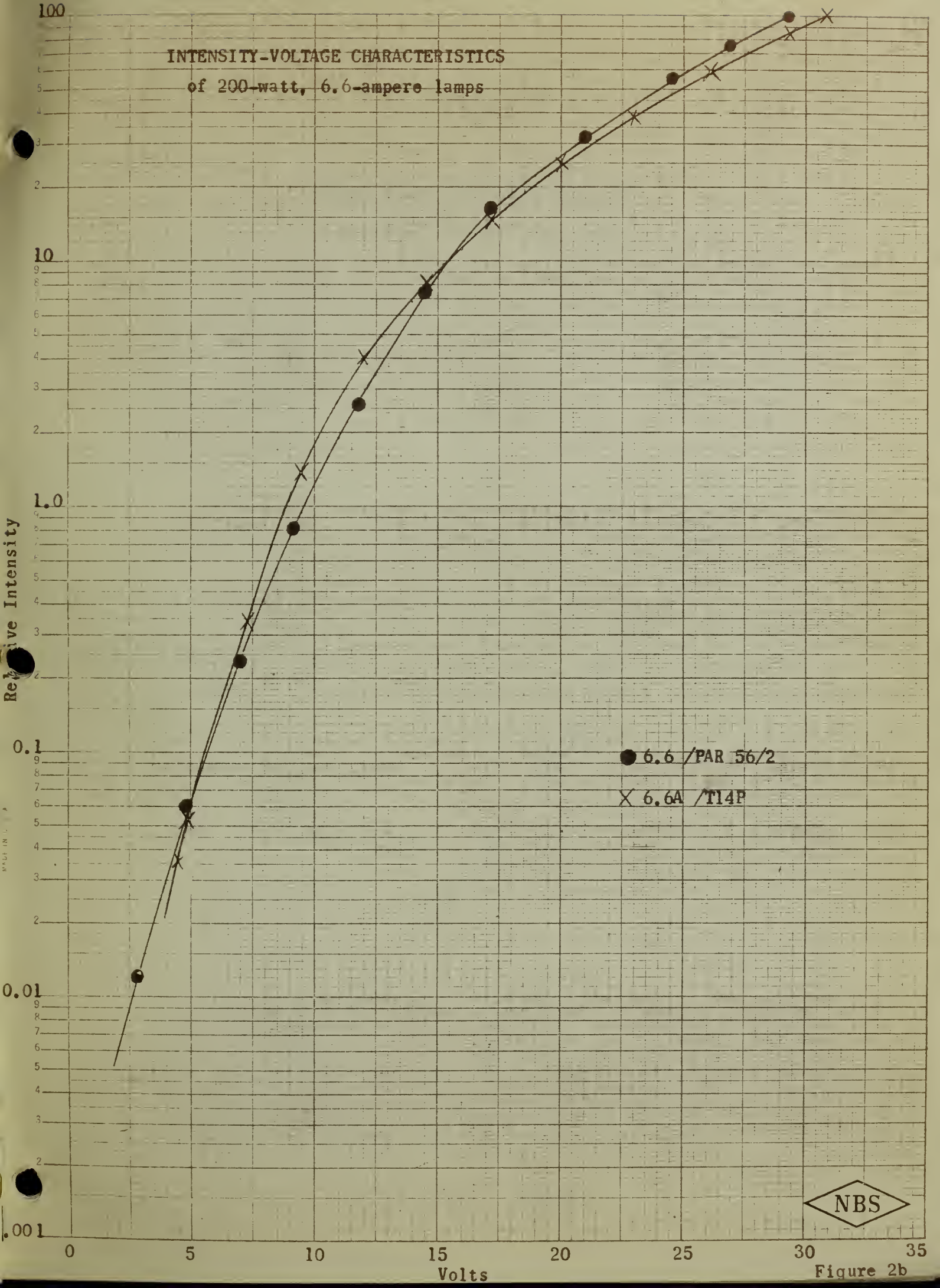
INTENSITY-VOLTAGE CHARACTERISTICS
of 200-watt, 6.6-ampere lamps
100
10
1.0
0.1
0.01
.001
Relative Intensity
0
5
10
15
20
25
30
35
Volts
6.6 /PAR 56/2
6.6A /T14P
NBS

Figure 2b

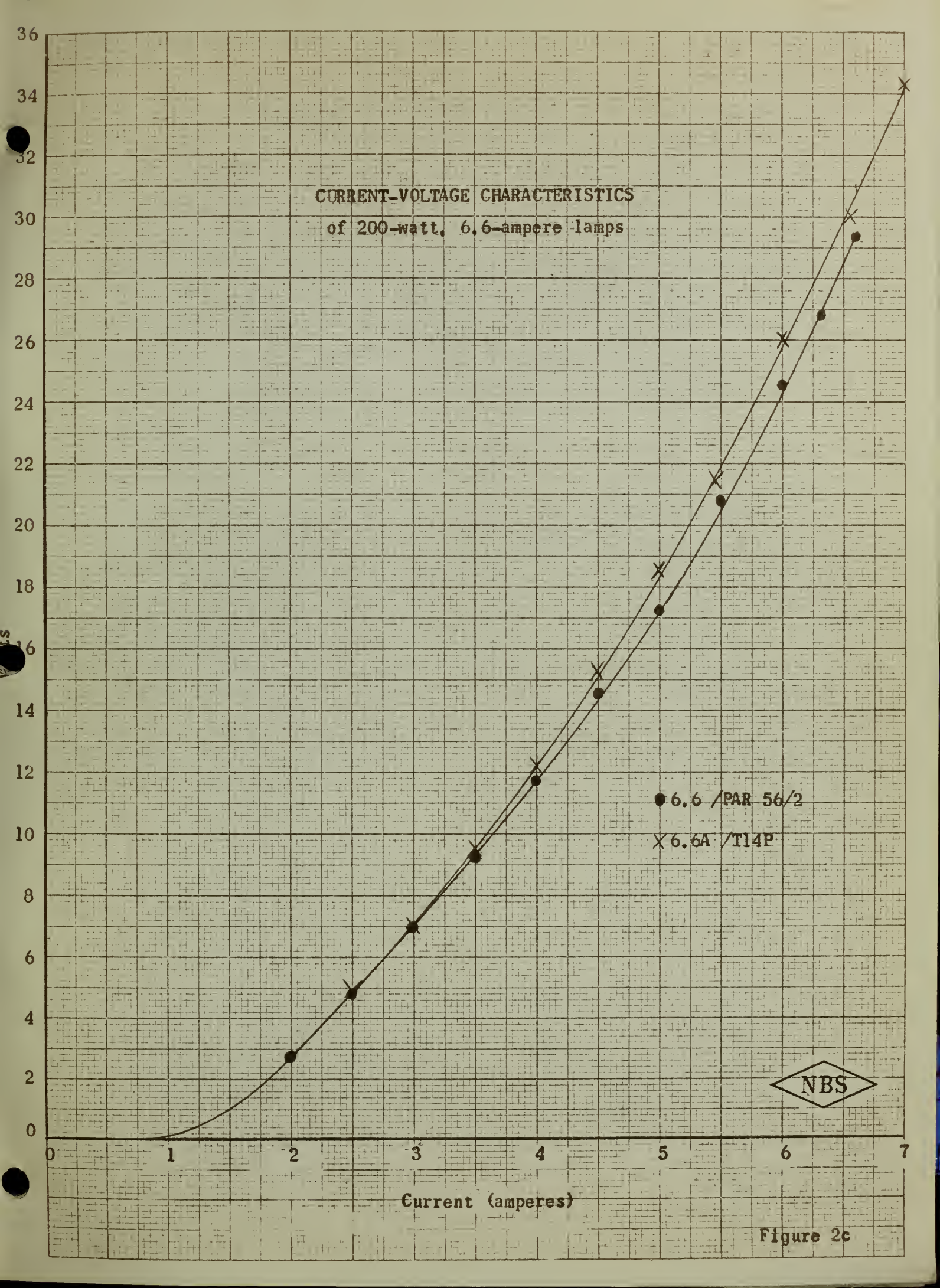
CURRENT-VOLTAGE CHARACTERISTICS
of 200-watt, 6.6-ampere lamps
6.6 /PAR 56/2
6.6A /T14P
NBS
Current (amperes)
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36

Figure 2c

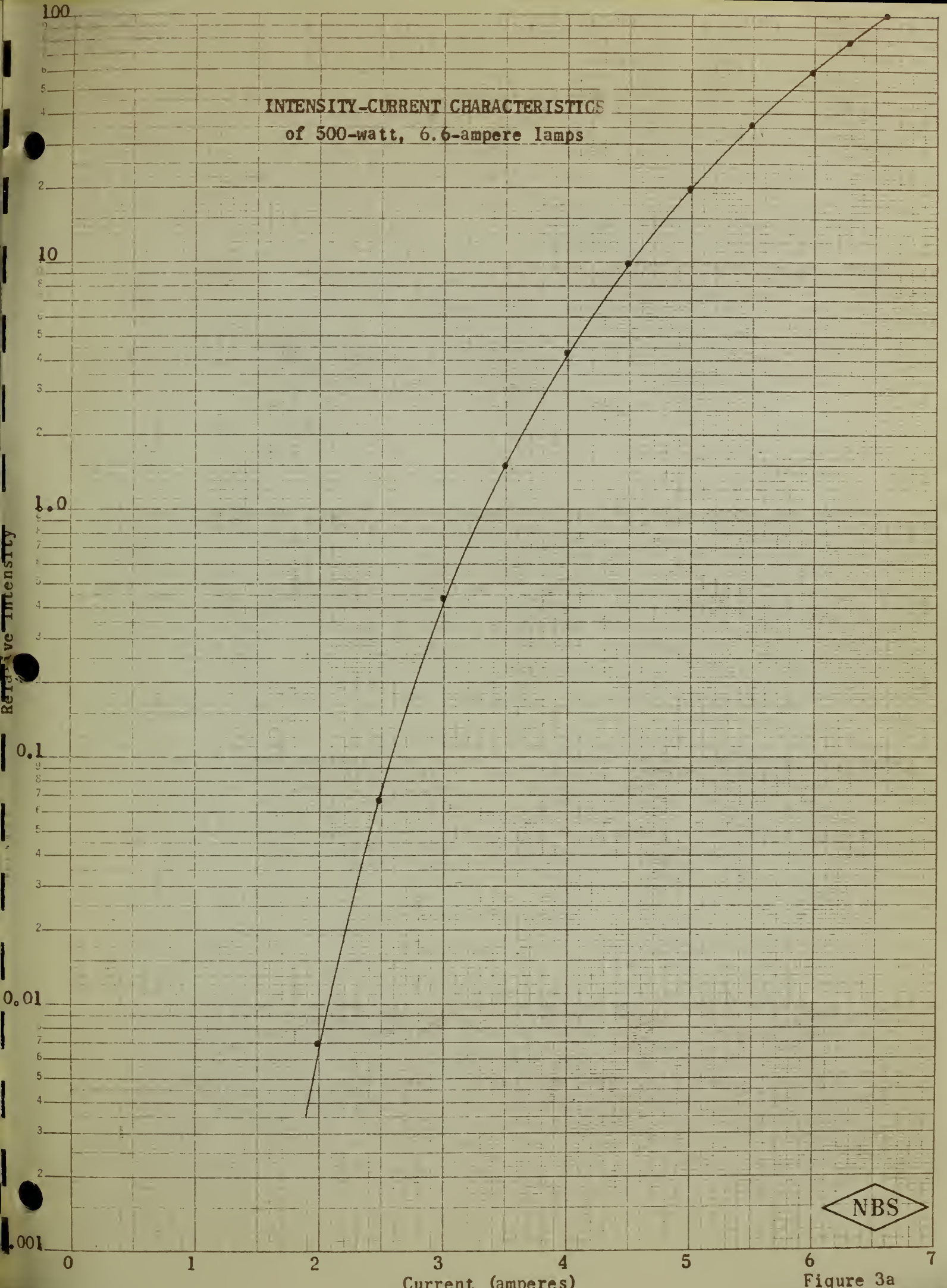
INTENSITY-CURRENT CHARACTERISTICS
of 500-watt, 6.6-ampere lamps
Relative Intensity
100
10
1.0
0.1
0.01
.001
0
1
2
3
4
5
6
7
Current (amperes)
NBS

Figure 3a

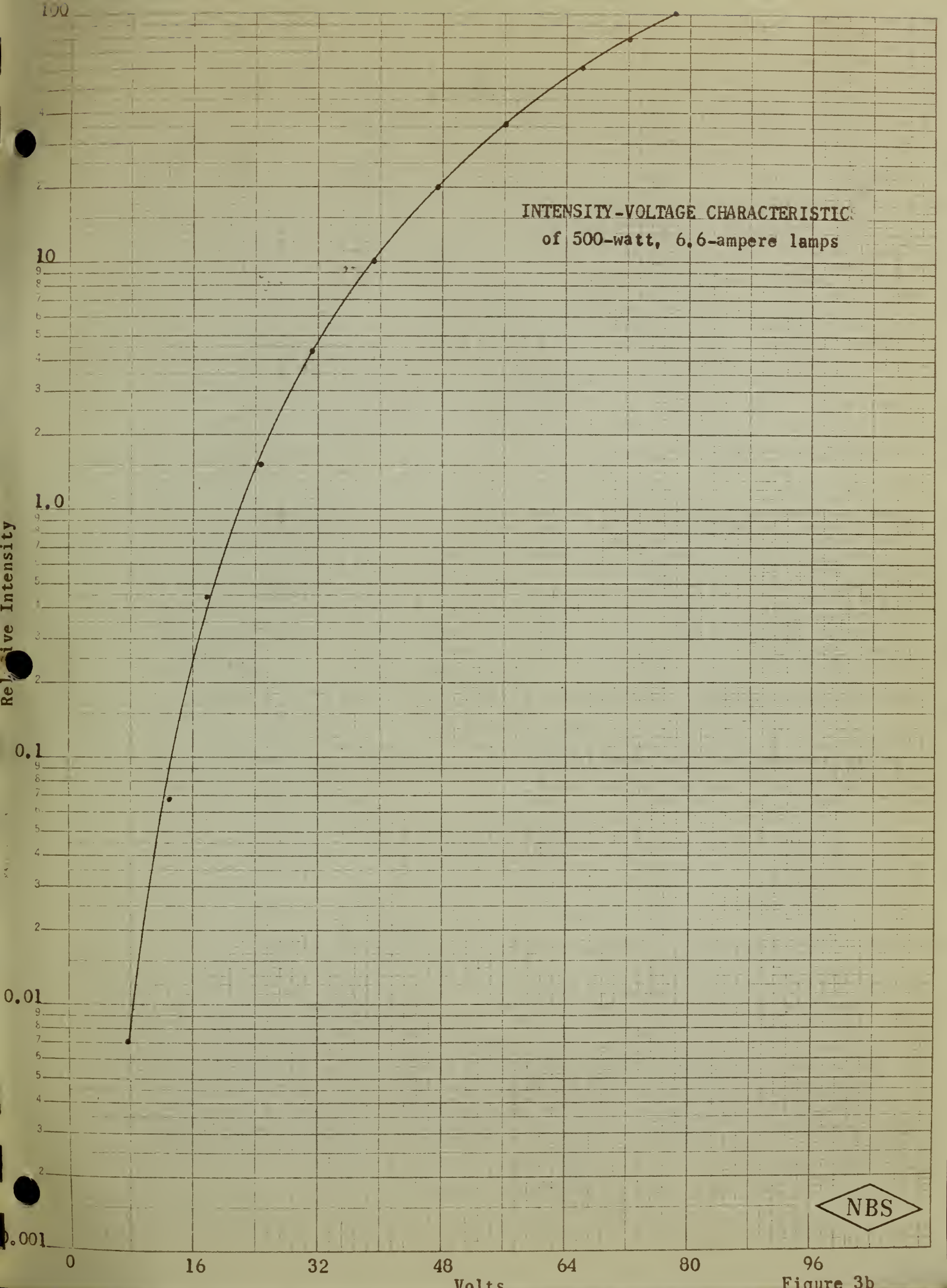
INTENSITY-VOLTAGE CHARACTERISTIC
of 500-watt, 6.6-ampere lamps
Relative Intensity
100
10
1.0
0.1
0.01
0.001
0
16
32
48
64
80
96
Volts
NBS

Figure 3b


CURRENT-VOLTAGE CHARACTERISTIC
of 500-watt, 6.6-ampere lamps
80
70
60
50
40
30
20
10
0
Volts
0
1
2
3
4
5
6
7
Current (amperes)
NBS

Figure 3c

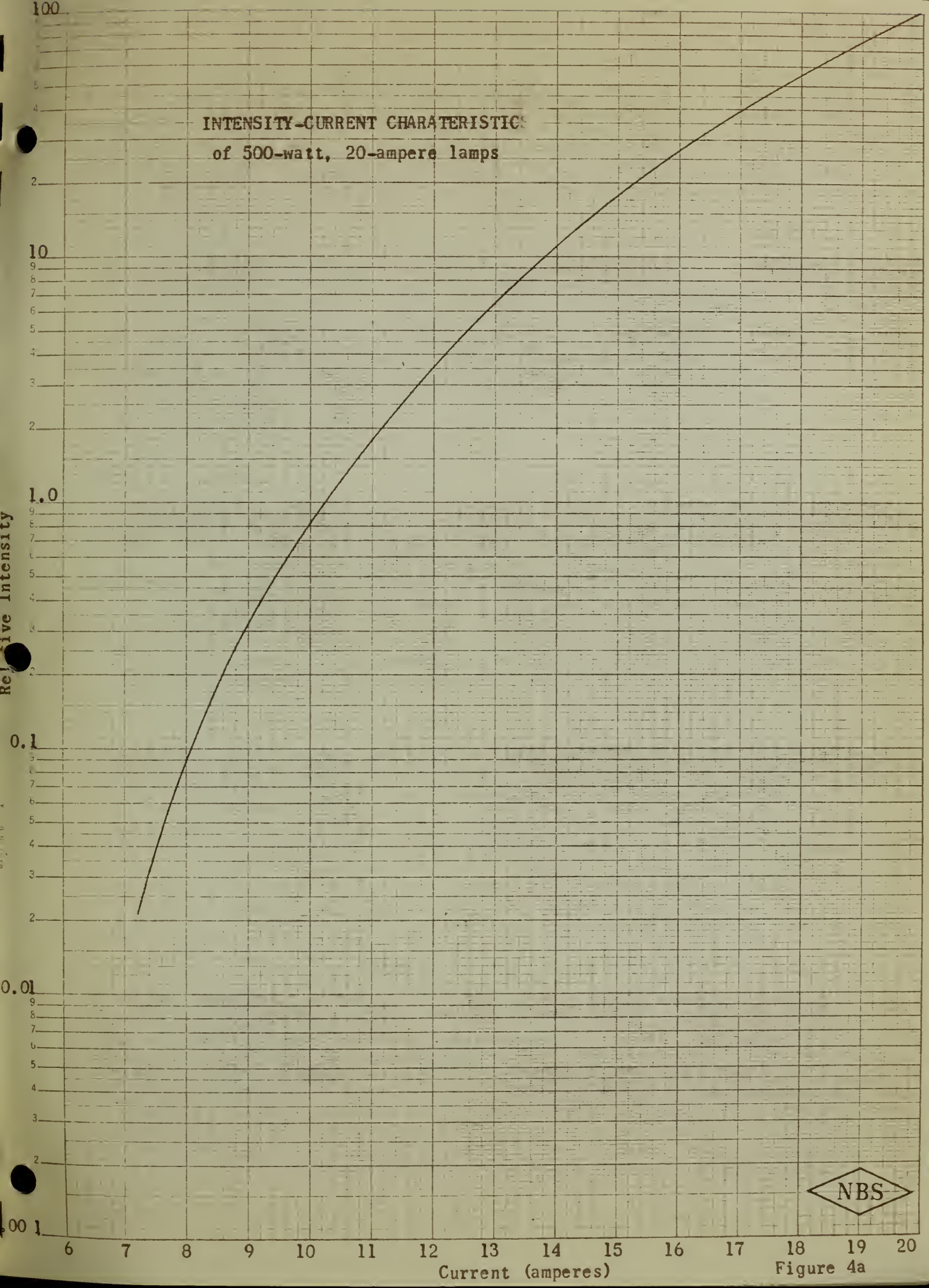
INTENSITY-CURRENT CHARACTERISTIC
of 500-watt, 20-ampere lamps
Relative Intensity
100
10
1.0
0.1
0.01
0.001
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Current (amperes)
NBS

Figure 4a

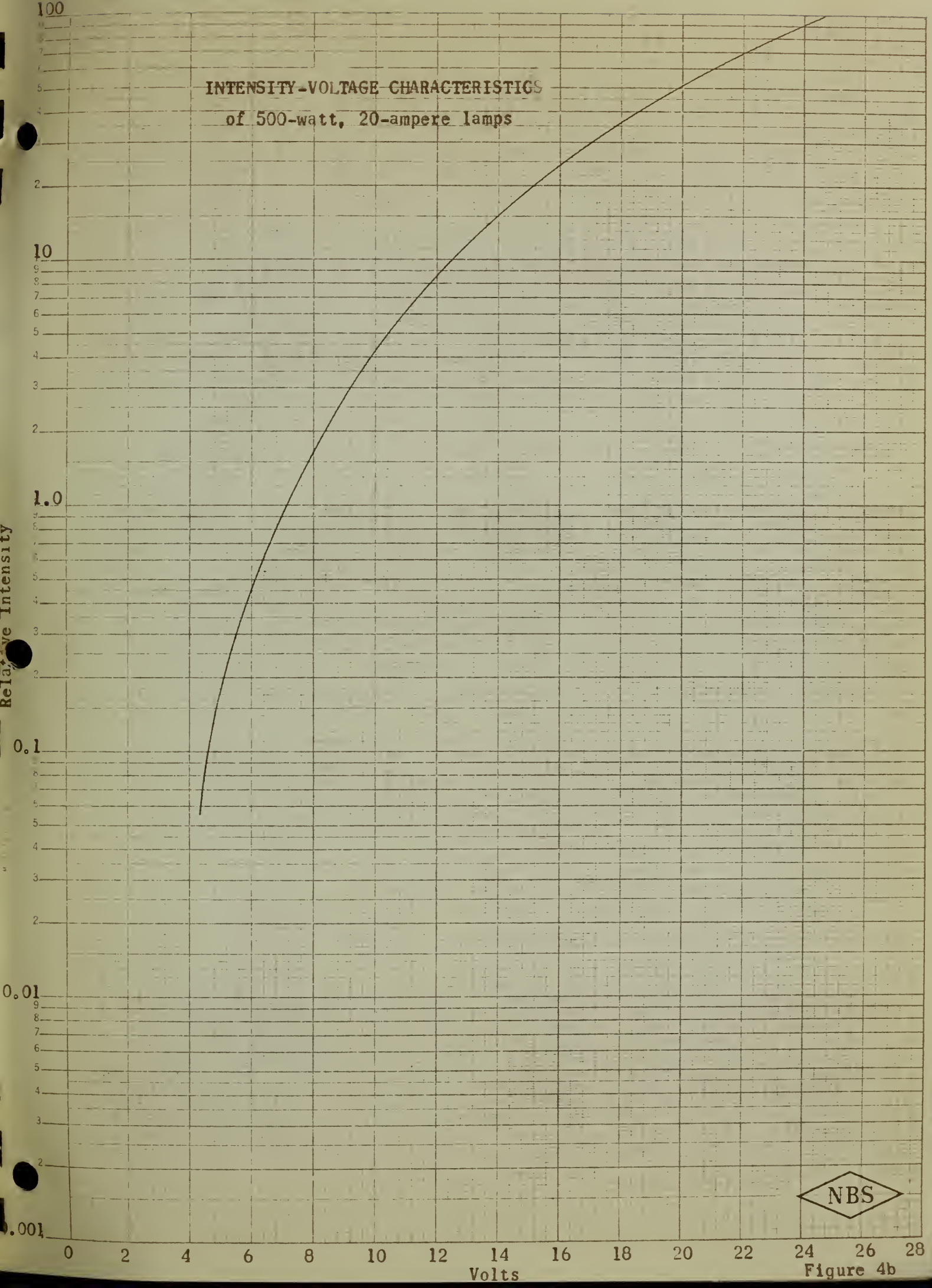
INTENSITY-VOLTAGE CHARACTERISTICS
of 500-watt, 20-ampere lamps
Relative Intensity
100
10
1.0
0.1
0.01
.001
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Volts
NBS

Figure 4b

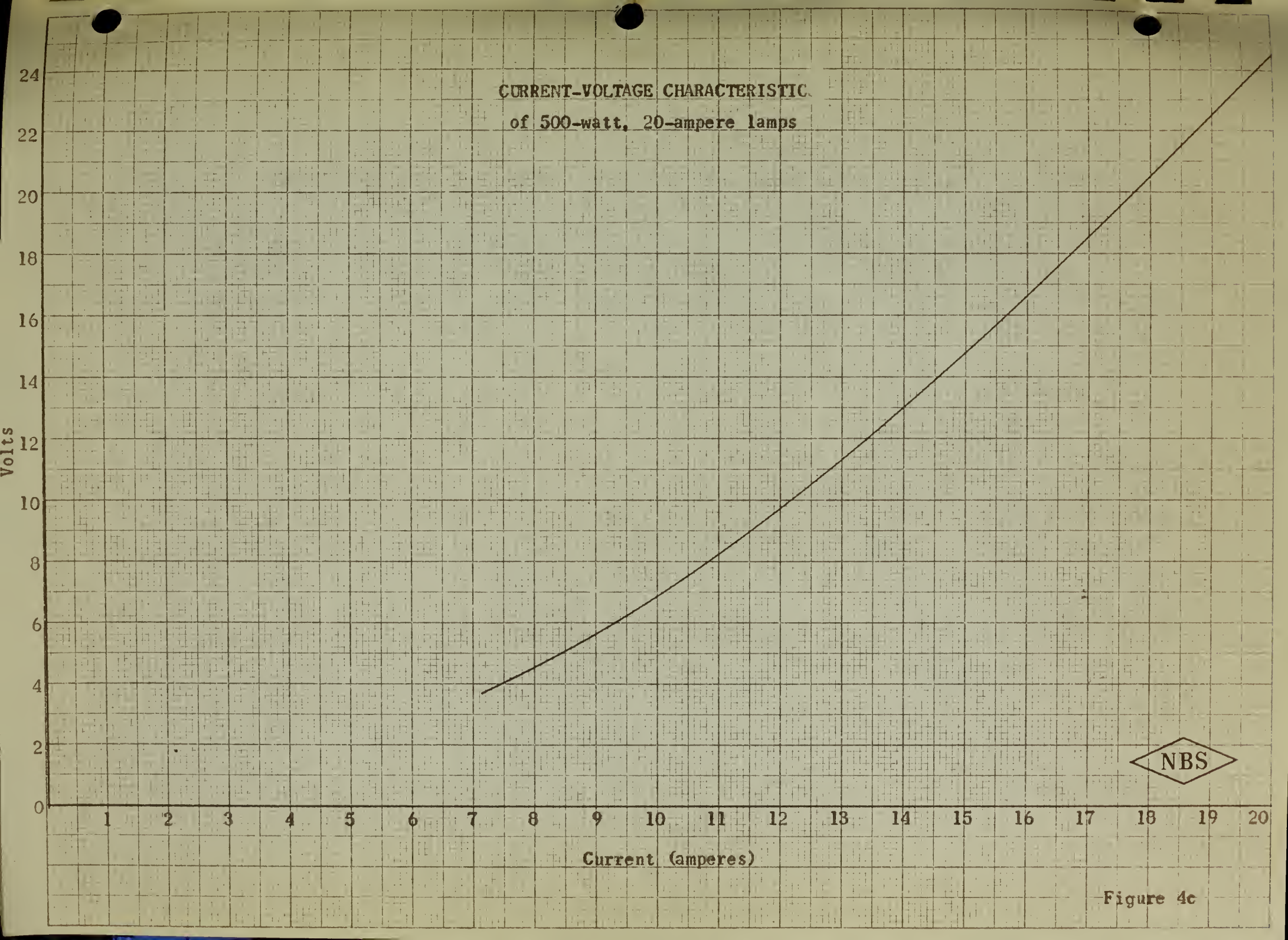
CURRENT-VOLTAGE CHARACTERISTIC
of 500-watt, 20-ampere lamps
Volts
0
2
4
6
8
10
12
14
16
18
20
22
24
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Current (amperes)
NBS

Figure 4c

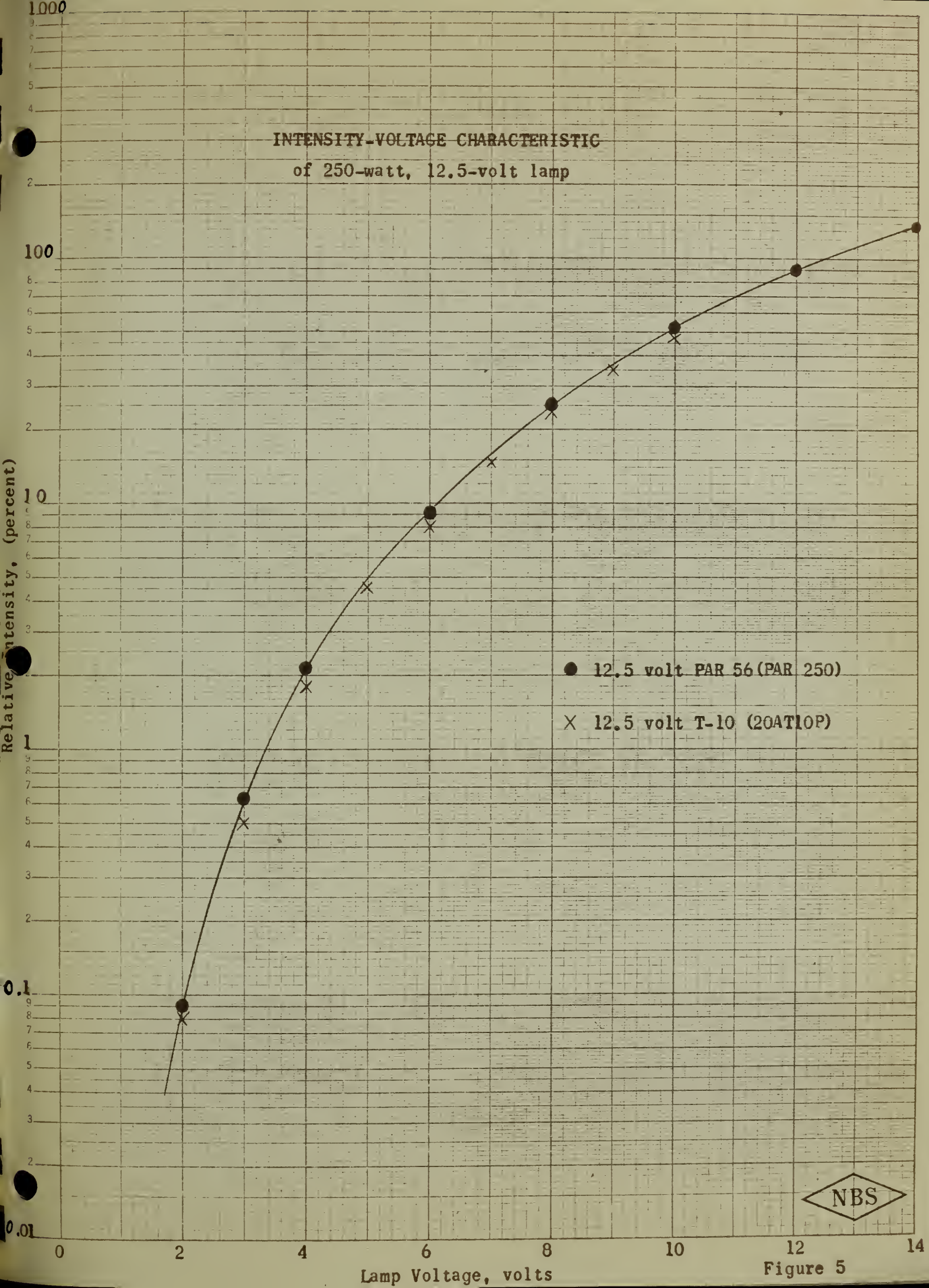
INTENSITY-VOLTAGE CHARACTERISTIC
of 250-watt, 12.5-volt lamp
Relative Intensity, (percent)
1,000
100
10
1
0.1
0.01
0
2
4
6
8
10
12
14
Lamp Voltage, volts
● 12.5 volt PAR 56 (PAR 250)
× 12.5 volt T-10 (20AT10P)
NBS

Figure 5

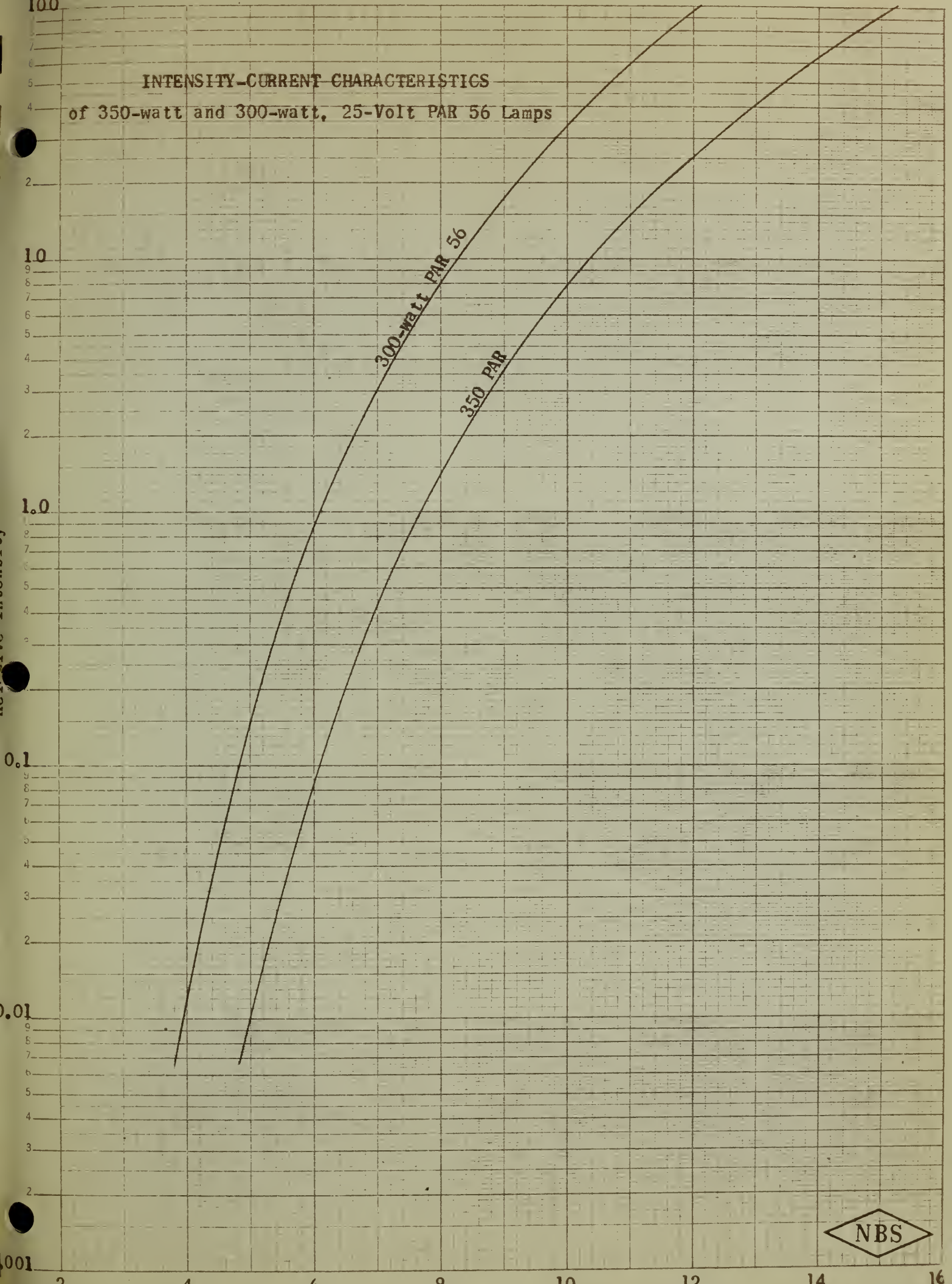
INTENSITY-CURRENT CHARACTERISTICS
of 350-watt and 300-watt, 25-Volt PAR 56 Lamps
300-watt PAR 56
350 PAR
100
10
1.0
0.1
0.01
.001
2
4
6
8
10
12
14
16
Current (amperes)
NBS

Figure 6a

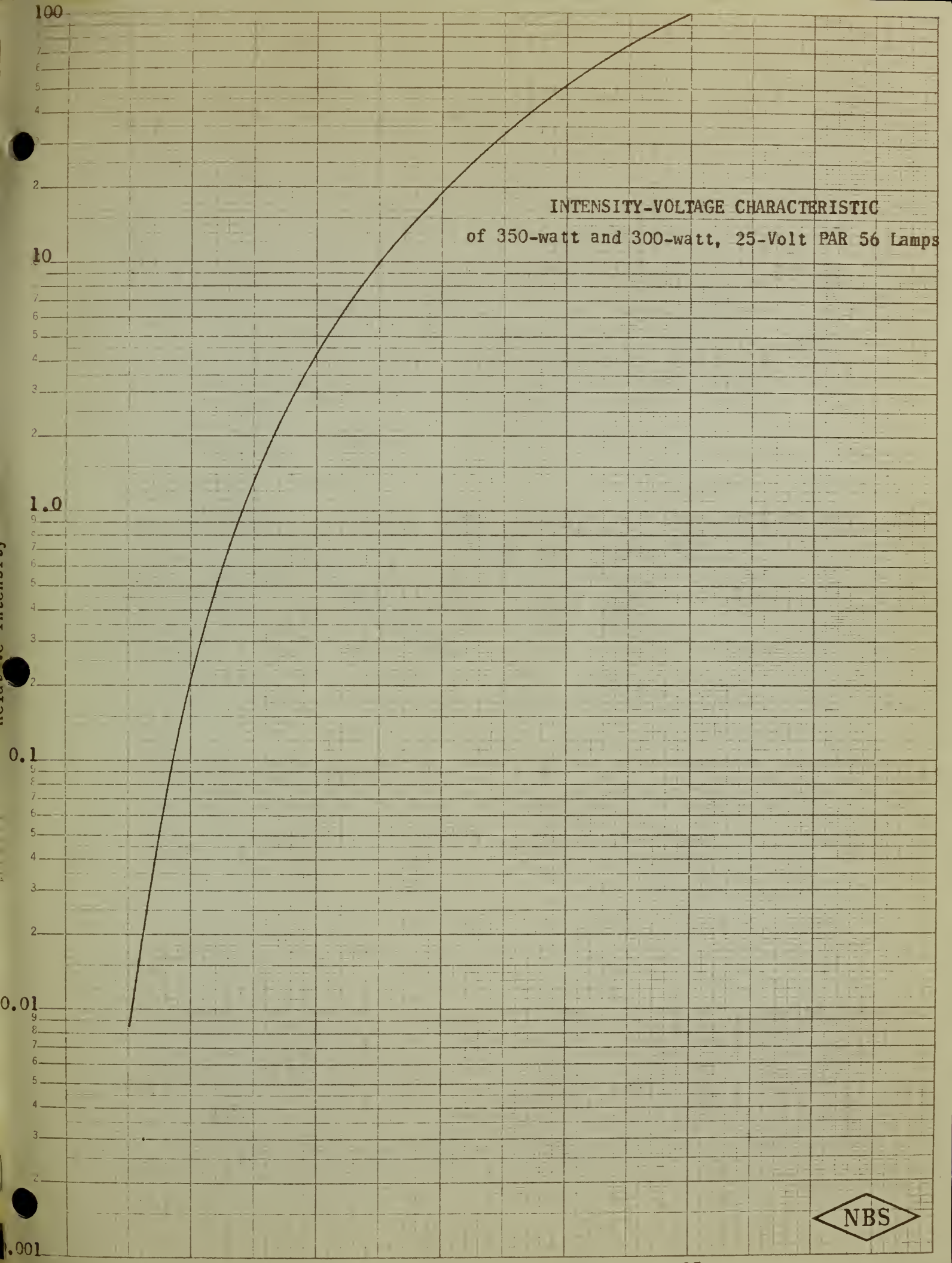
INTENSITY-VOLTAGE CHARACTERISTIC
of 350-watt and 300-watt, 25-Volt PAR 56 Lamps
100
10
1.0
0.1
0.01
.001
0
5
10
15
20
25
Volts
NBS

Figure 6b

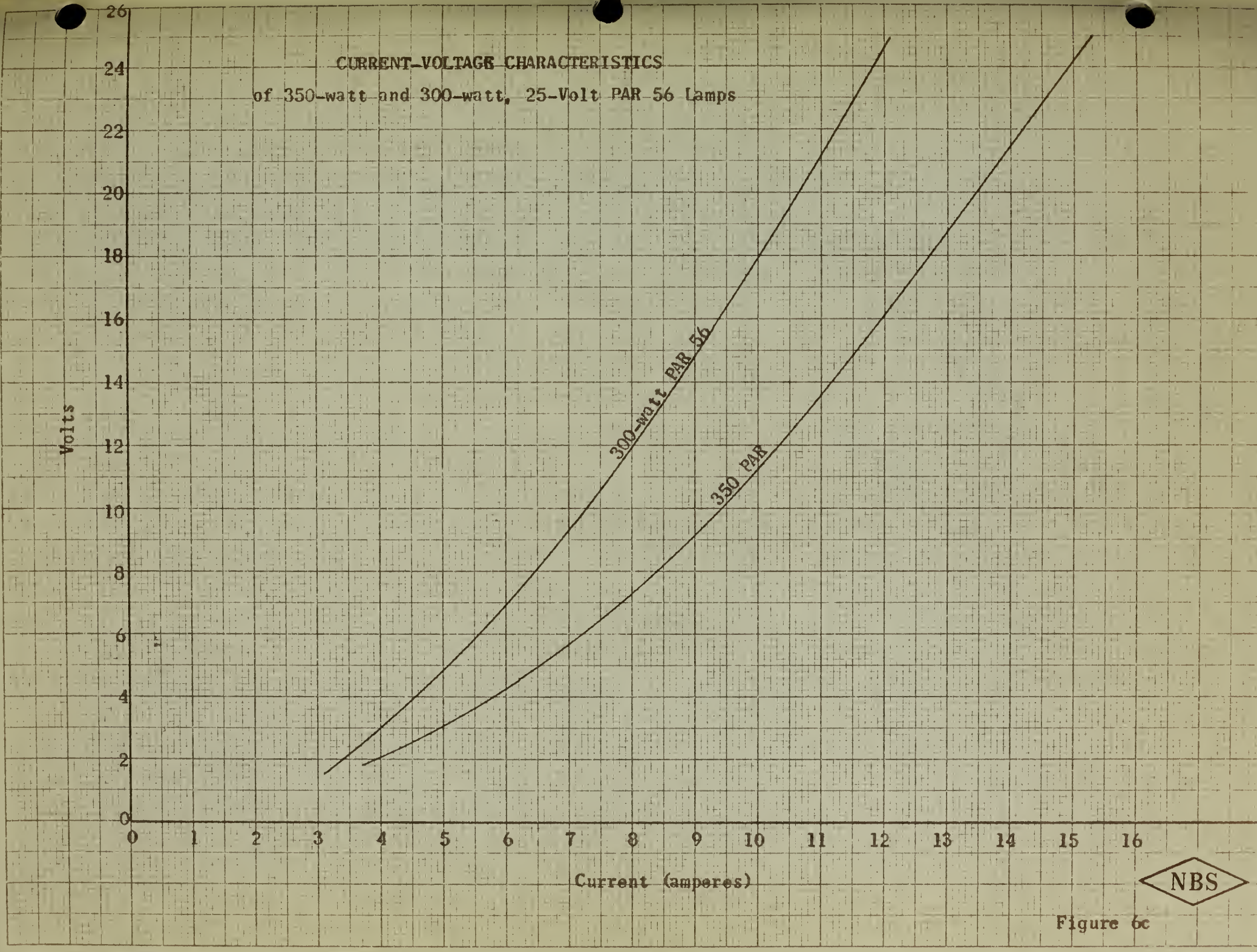
CURRENT-VOLTAGE CHARACTERISTICS
of 350-watt and 300-watt, 25-Volt PAR 56 Lamps
Volts
Current (amperes)
300-watt PAR 56
350 PAR
0
2
4
6
8
10
12
14
16
18
20
22
24
26
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
NBS

Figure 6c

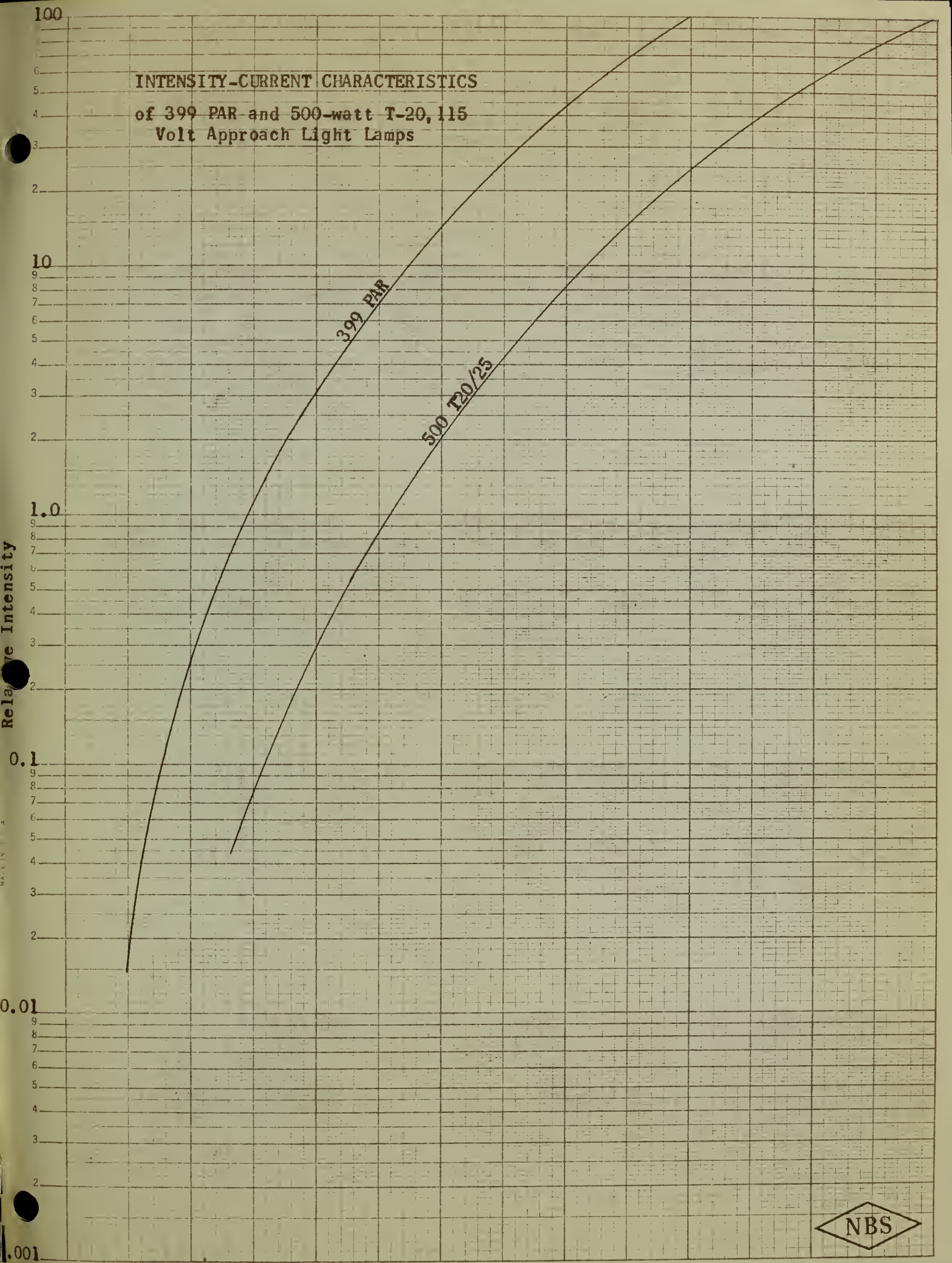
INTENSITY-CURRENT CHARACTERISTICS
of 399 PAR and 500-watt T-20, 115 Volt Approach Light Lamps
399 PAR
500 T20/25
Relative Intensity
100
10
1.0
0.1
0.01
.001
1
2
3
4
Current (amperes)
NBS

Figure 7a

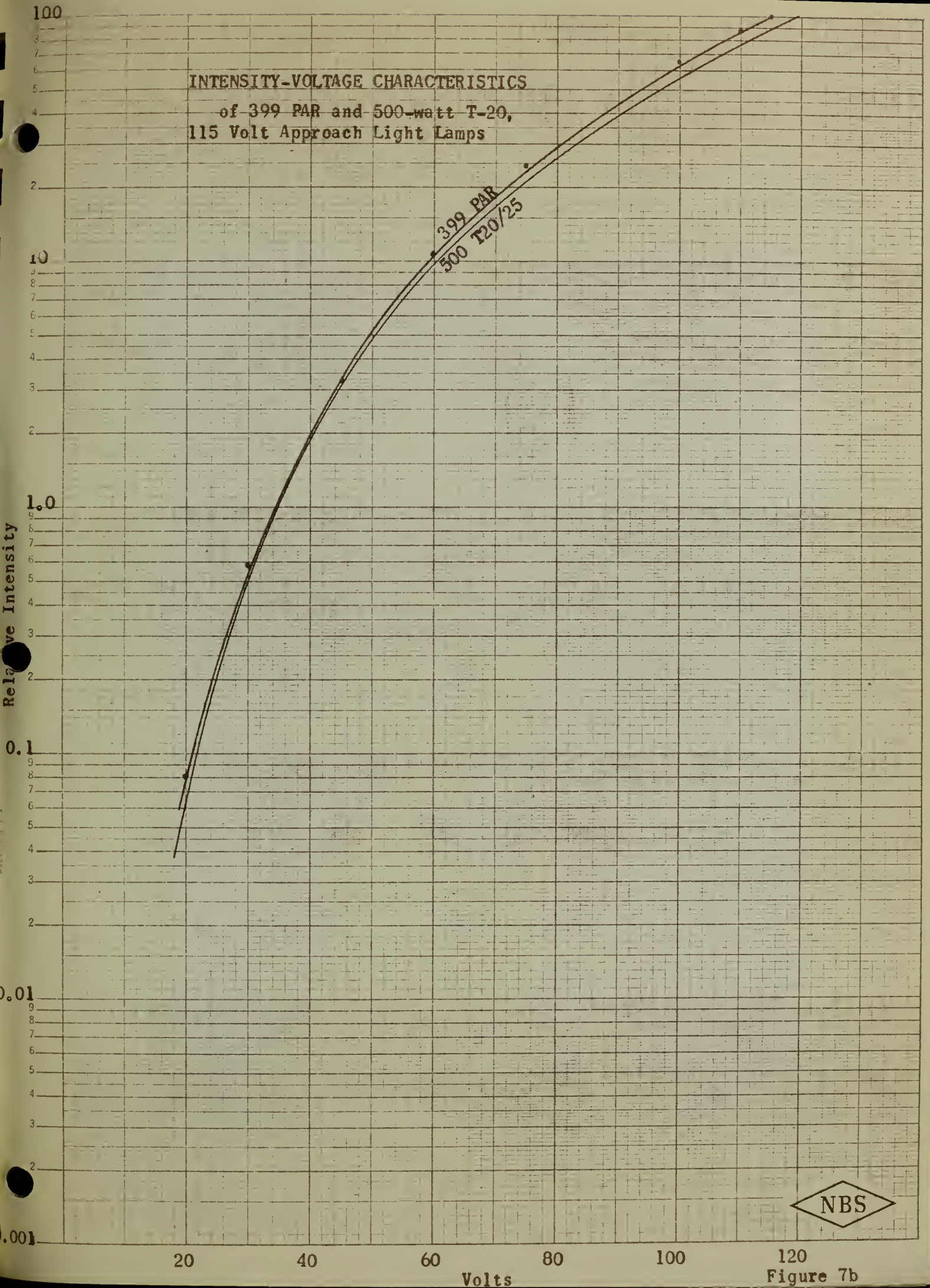
INTENSITY-VOLTAGE CHARACTERISTICS
of 399 PAR and 500-watt T-20,
115 Volt Approach Light Lamps
399 PAR
500 T20/25
Relative Intensity
100
10
1.0
0.1
0.01
0.001
20
40
60
80
100
120
Volts
NBS

Figure 7b

CURRENT-VOLTAGE CHARACTERISTICS
of 399 PAR and 500-watt T-20,
115 Volt Approach Light Lamps

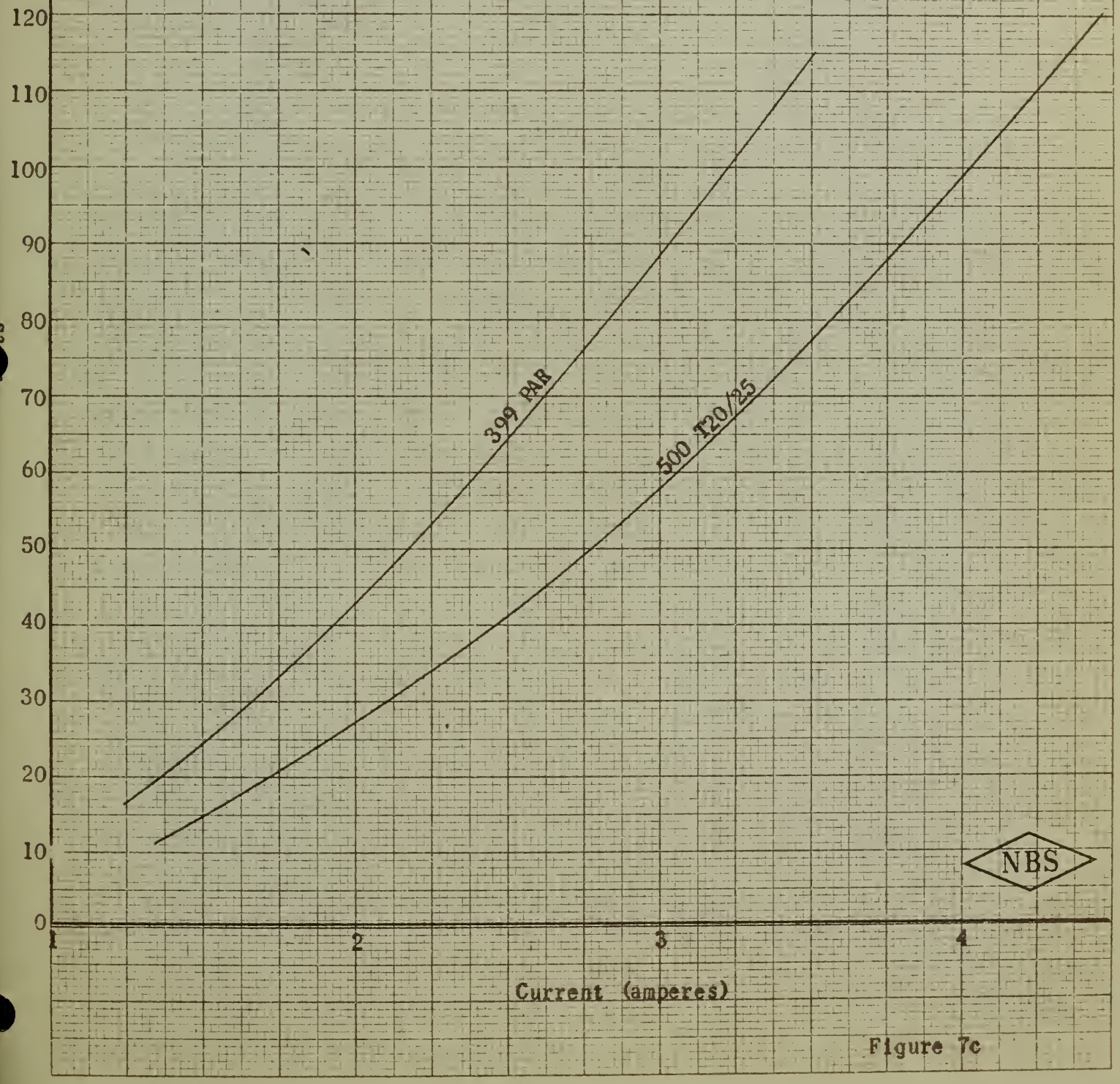

Figure 7c

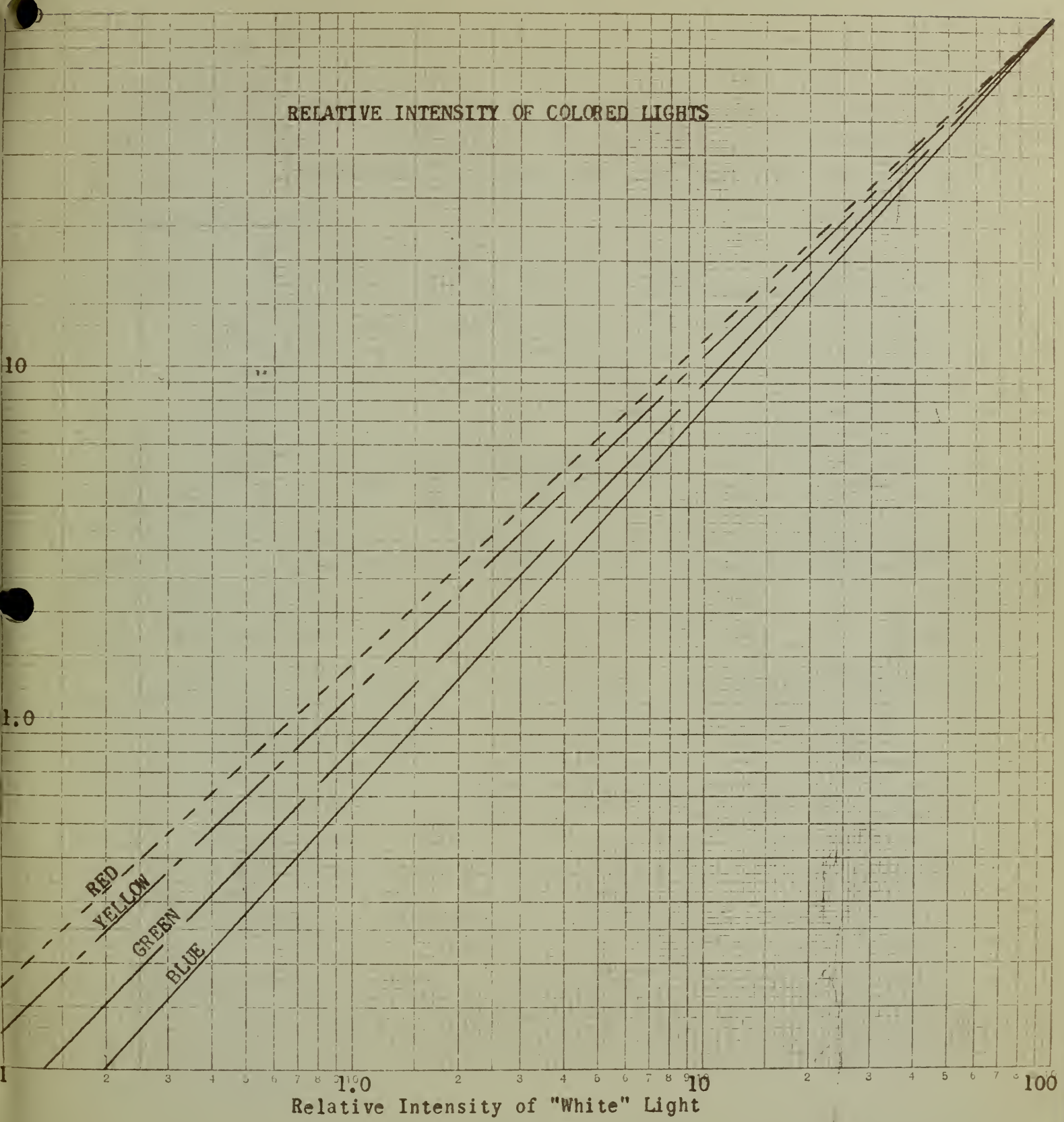
RELATIVE INTENSITY OF COLORED LIGHTS
10
1.0
1
RED
YELLOW
GREEN
BLUE
1.0
10
100
Relative Intensity of "White" Light

Figure 8

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THE NATIONAL BUREAU OF STANDARDS

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