

NATIONAL BUREAU OF STANDARDS REPORT

8169

An Investigation of Beam-Spreading Techniques
for
Semiflush-Prismatic Type Airport-Marker Lights

By

A. C. Wall
A. S. Brown
C. A. Douglas



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE

Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS

A. V. Astin, *Director*



THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications, including assistance to industry, business and consumers in the development and acceptance of commercial standards and simplified trade practice recommendations. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's research are published either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Central Radio Propagation Laboratory Ionospheric Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also seven series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, Technical Notes, Commercial Standards, and Simplified Practice Recommendations.

A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 (\$1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 (\$1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (includes Titles of Papers Published in Outside Journals 1950 to 1959) (\$2.25); available from the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

NBS REPORT

0201-20-02411

January 1964

8169

An Investigation of Beam-Spreading Techniques
for
Semiflush-Prismatic Type Airport-Marker Lights

By

A. C. Wall
A. S. Brown
C. A. Douglas

Photometry and Colorimetry Section
Metrology Division

Prepared For

Bureau of Naval Weapons
Department of the Navy
Washington 25, D. C.

IMPORTANT NOTICE

NATIONAL BUREAU OF STANDARDS
for use within the Government. Before
and review. For this reason, the present
whole or in part, is not authorized
Bureau of Standards, Washington
the Report has been specifically pre-

Approved for public release by the
director of the National Institute of
Standards and Technology (NIST)
on October 9, 2015

accounting documents intended
jected to additional evaluation
iting of this Report, either in
Office of the Director, National
e Government agency for which
es for its own use.



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

1. INTRODUCTION

Semiflush-prismatic type airport-marker lights have vertical beam spreads of approximately 4° and are designed to have beam elevations of 1.5° , 3.0° , or 4.5° , depending on their intended location relative to the reference point of the runway. When located in a displaced threshold, and, more particularly during conditions of reduced minimums, a light of even a 4.5° beam elevation does not provide sufficient guidance where needed, namely, up to about 12° elevation. This report gives the results of a preliminary investigation undertaken with a view to modifying existing lights to provide a broader vertical beam spread at something more than an elevation of 4.5° .

2. MATERIAL USED

The basic unit used for the test was a type BB45 light (with a 1/2 inch projection above the runway), designed for a beam elevation of 1.5° . The measured vertical beam spread at 50% of peak intensity using a typical 200-watt, 6.6-ampere lamp with stippled cover, was approximately 4° .

Lamps used in the unit during the test are described in Table I.

3. PROCEDURE AND RESULTS

3.1 General Photometric Procedure. The photometric equipment and methods used are described in Sections 2.1a and 2.3a of NBS Technical Note 198 (NBS Report 7410). The photometric distance was 30 meters. Each lamp was operated at its rated current or voltage.

3.1.1 Unit with Auxiliary Condensing Lens. A cylindrical condensing lens was placed between the lamp and the entrance face of the prism. This lens was plano-convex, approximately 2-1/2 inches by 4-1/4 inches, with a focal length of 2.58 inches. It was mounted with the convex side up and toward the prism. No provision was made for accurately positioning the lens for optimum performance or repeatability. Hence, the lens position was not necessarily the same for each of the figures included in the report.

Comparative measurements with and without the auxiliary lens with lamps numbered 2, 4, and 6 are shown in Figures 1, 2, and 3, and are summarized in Table II.

Figures 4 and 5 are representative horizontal intensity distributions.

Table I

<u>Lamp Number</u>	<u>Lamp Type</u>	<u>Cover</u>	<u>Filament</u>	<u>Power</u> (watts)	<u>Rating</u>	<u>Peak Intensity</u> ¹ (kilocandelas)	<u>Beam Spread at 10% of Maximum</u> ¹ (degrees)	
							Horiz.	Vert.
1	200PAR Locomotive	Clear	CC-8	200	30 volts	260	11	11
2	6.6A/PAR56/3 ²	Stippled	CC-6	200	6.6 amperes	150	11	9
3	Experimental	Clear		300	20 amperes	-	-	-
4	20A/PAR56/2 ^{2,3}	Stippled	CC-6	300	20 amperes	250	18	7
5	Experimental	Clear	CC-6	450	25 volts	-	-	-
6	20A/PAR56/3 ²	Stippled	CC-6	499	20 amperes	425 ⁴	15 ⁴	11 ⁴

¹ Manufacturer's data (except ⁴).
² See also NBS Report 21P-23/60.
³ See also NBS Reports 21P-91/62, -11/60, and -3/59.
⁴ From NBS Report 21P-9/60.

Table II

Lamp Number	Lamp Type	Auxiliary Lens	Vertical Beam			Figure Number
			Peak Intensity (kilocandelas)	Beam Elevation (degrees)	Spread at 50% of Peak (degrees)	
2	6.6A/PAR56/3	No	4.7	1.0	4.2	1
		Yes	5.5	7.5	15.1	1
4	20A/PAR56/2	No	9.5	2.0	4.6	2
		Yes	6.6	7.0	16.2	2
6	20A/PAR56/3	No	12.8	2.4	7.0	3
		Yes	13.0	7.0	15.4	3

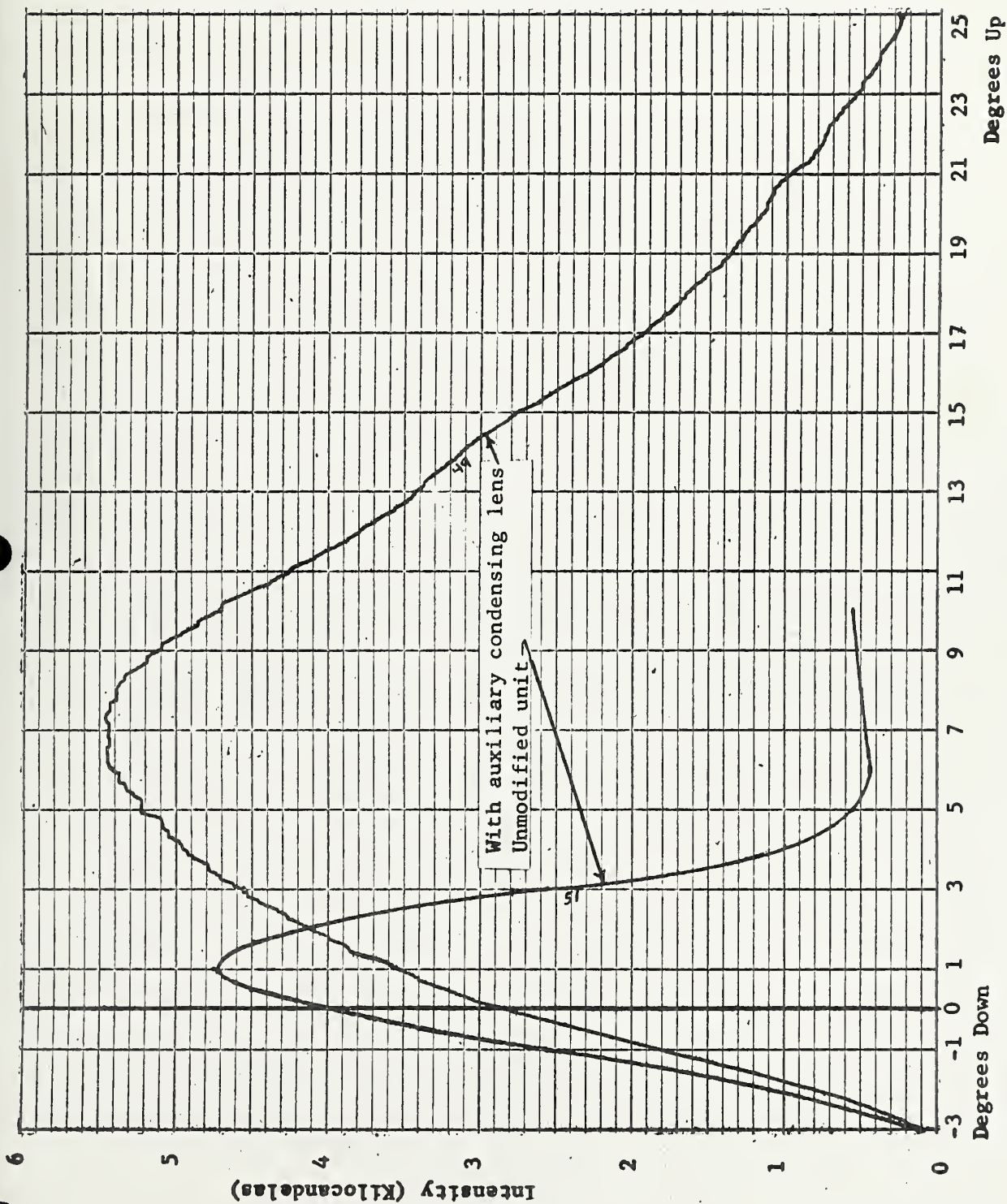


Figure 1. Vertical intensity distributions through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 200-watt type 6.6A/PAR56/3 lamp operated at 6.6 amperes. NBS Report 8169

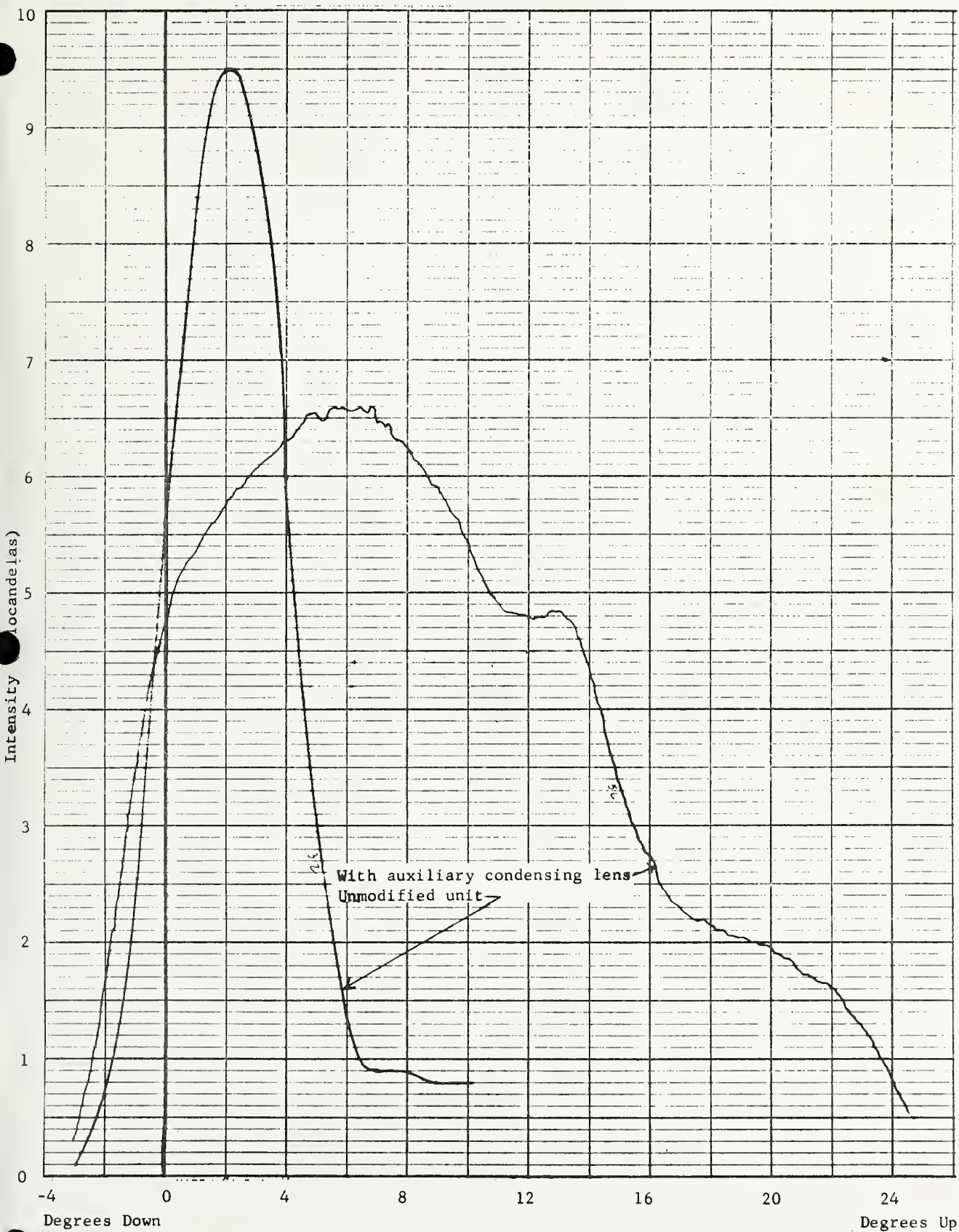
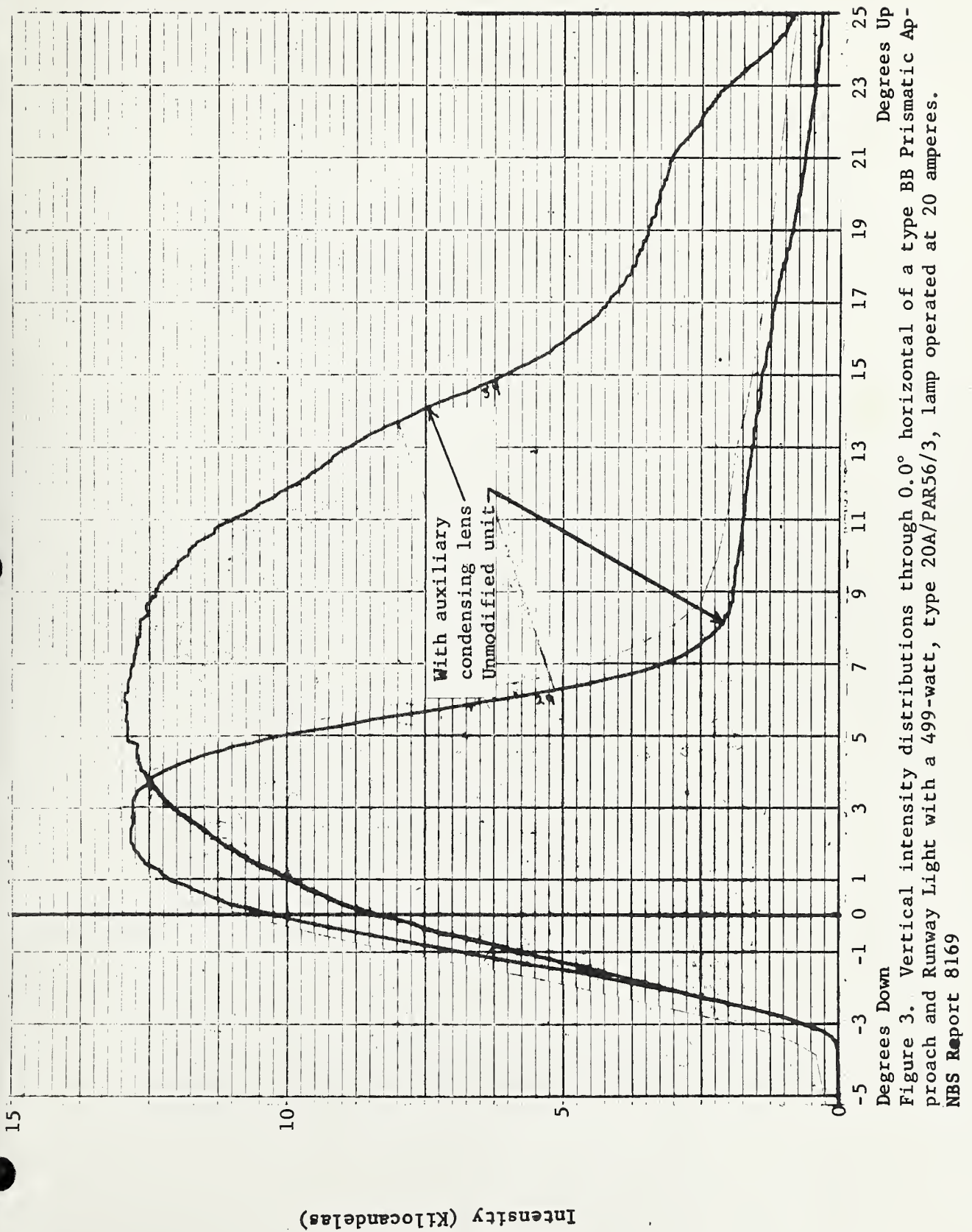


Figure 2. Vertical intensity distributions through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 300-watt, type 20A/PAR56/2, lamp operated at 20 amperes.
NBS Report 8169



Intensity (Kilandelas)

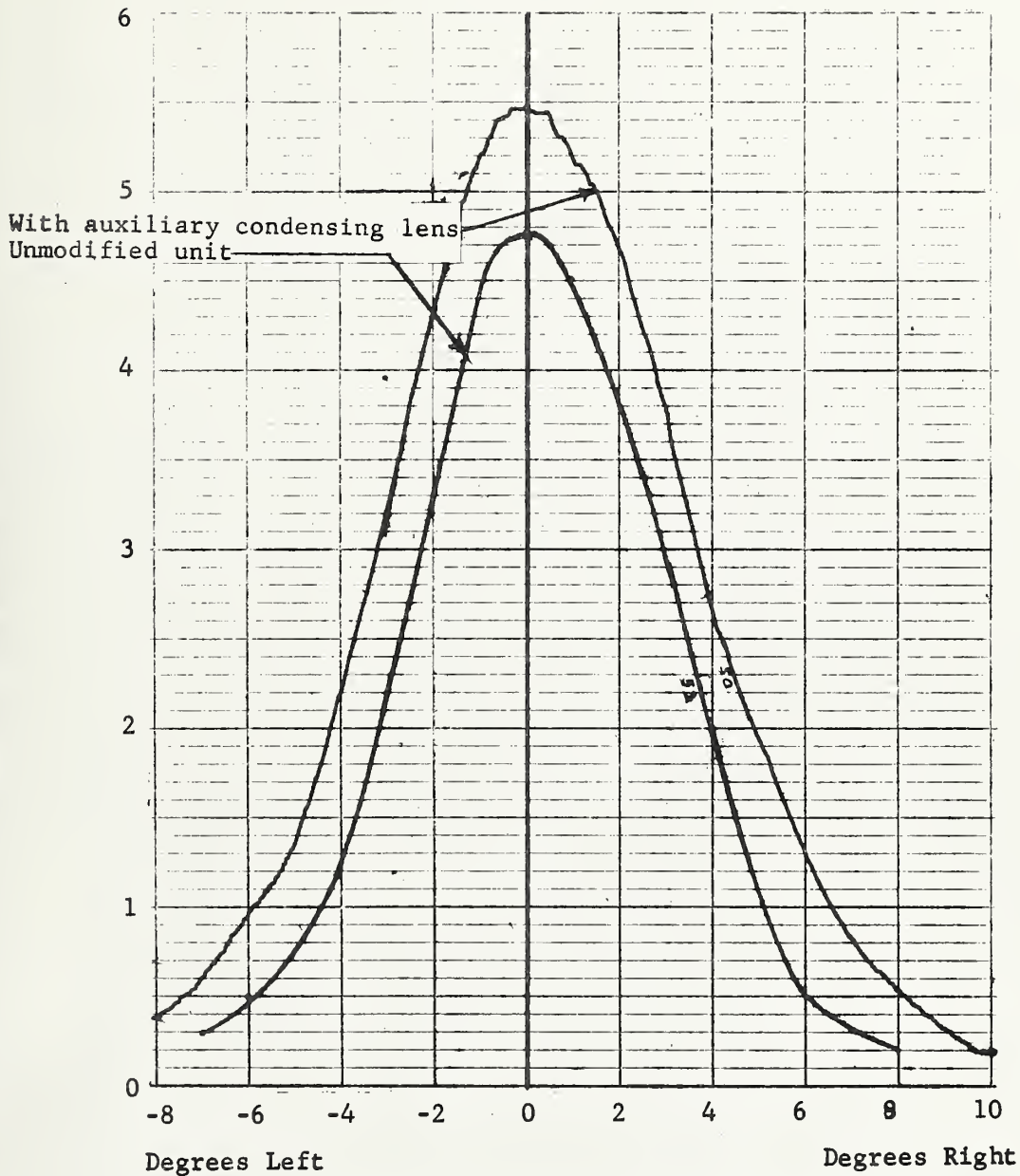


Figure 4. Horizontal intensity distributions through the vertical beam axis of a type BB Prismatic Approach and Runway Light with a 200-watt, type 6.6A/PAR56/3, lamp operated at 6.6 amperes. NBS Report 8169

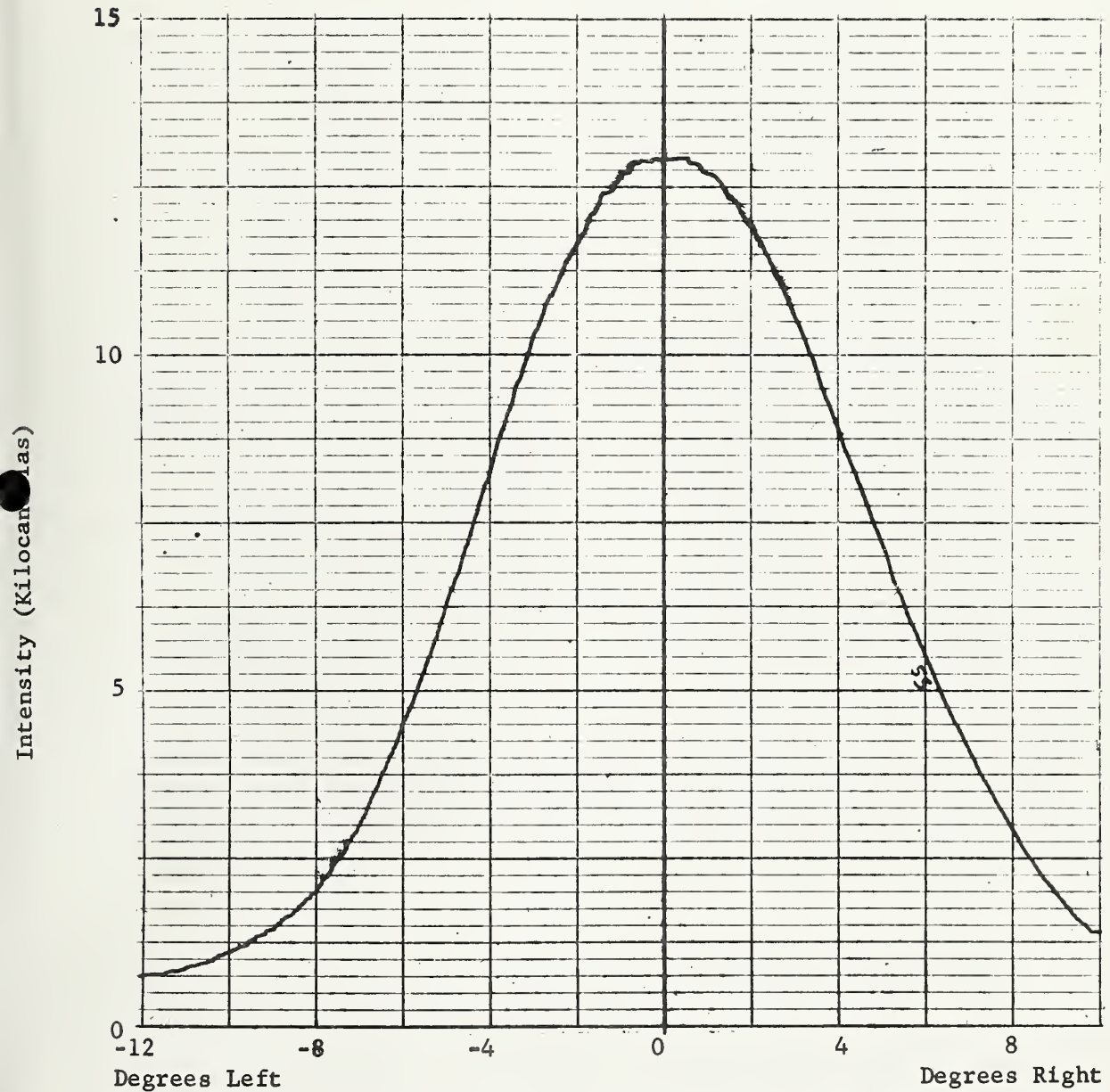


Figure 5. Horizontal intensity distribution through the vertical beam axis of a type BB Prismatic Approach and Runway Light with a 499-watt, type 20A/PAR56/3 lamp operated at 20 amperes.
NBS Report 8169

3.1.2 Other Lamps. Single vertical intensity distributions were made of the unit without the auxiliary lens using lamps number 1, 3, and 5 of Table I. These include a narrow-beam locomotive head-light lamp and two experimental airport lamps. The results obtained are summarized in Table III, taken from Figures 6, 7, and 8.

Table III

<u>Lamp Number</u>	<u>Lamp Type</u>	<u>Peak Intensity</u> (kilocandelas)	<u>Beam Elevation</u> (degrees)	<u>Beam Spread at</u> <u>50% of Peak</u> (degrees)	<u>Figure No.</u>
1	200 PAR Loco.	6.4	1.3	3.8	6
3	300-watt exp.	9.7	1.1	3.9	7
5	450-watt exp.	18.3	2.4	6.3	8

3.1.3 Effects of Lamp Tilt. In order to evaluate the effects of lamp tilt on beam elevation, washers 0.04 inch thick were placed between the lamp holder ring and one supporting leg, as shown in Figure 9.

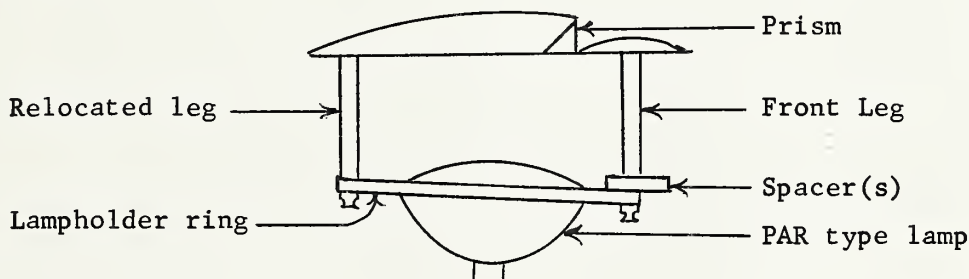


Figure 9. Location of spacer(s) used to tilt lamp. The front leg supporting the lampholder was left in its regular place. The two other legs were removed and one was relocated diametrically opposite the front leg.

The center-to-center distance between the two supporting legs was 7.25 inches. Each spacer, therefore, tilted the lamp $19'$, or approximately $1/3^\circ$. The maximum tilt (with 6 washers) was $1^\circ 54'$. The vertical intensity distributions taken with different lamp-tilt angles are shown in Figure 10, from which the data of Table IV are taken.

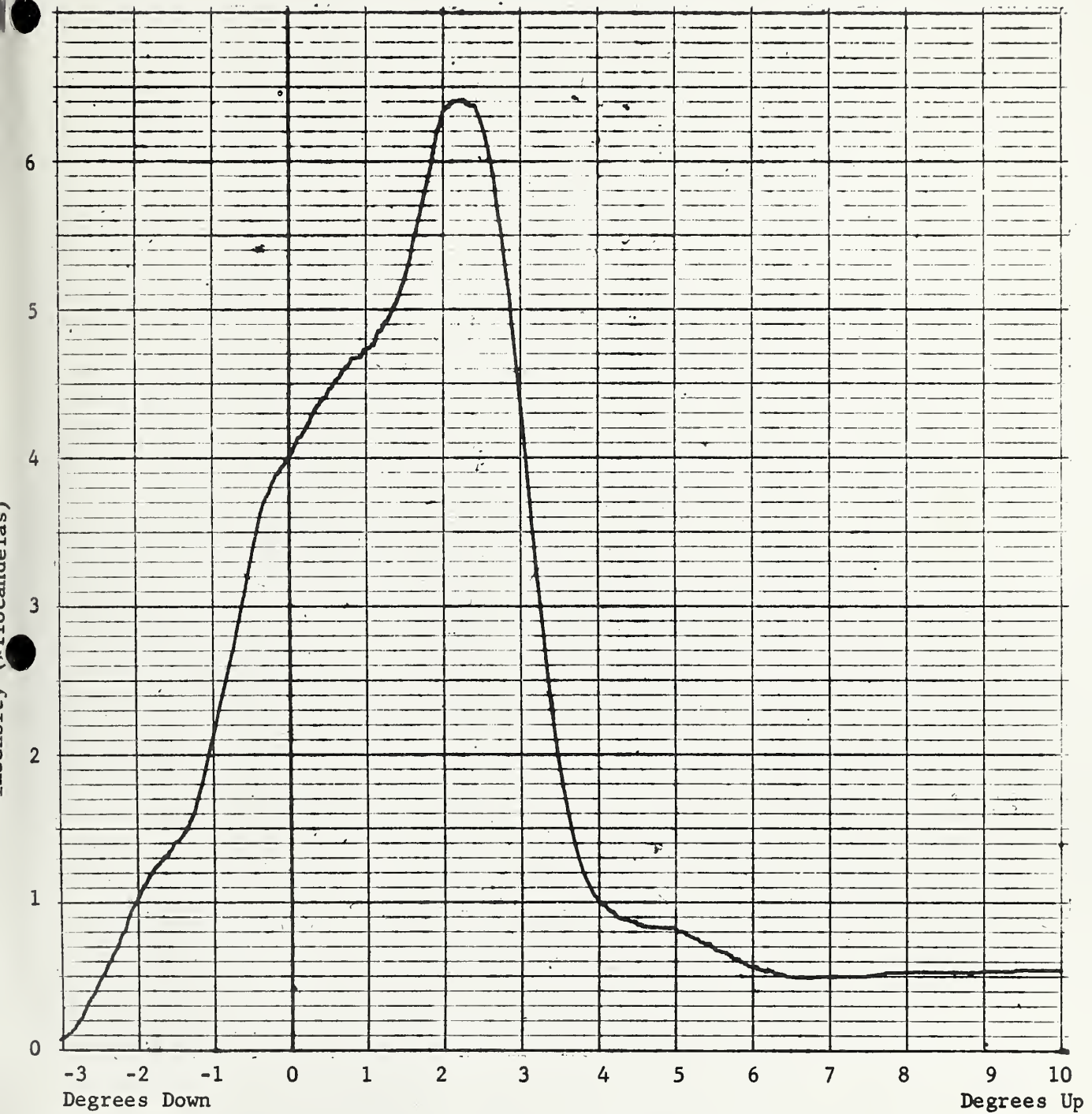


Figure 6. Vertical intensity distribution through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 200-watt, type 200PAR, Locomotive lamp operated at 30 volts.

NBS Report 8169

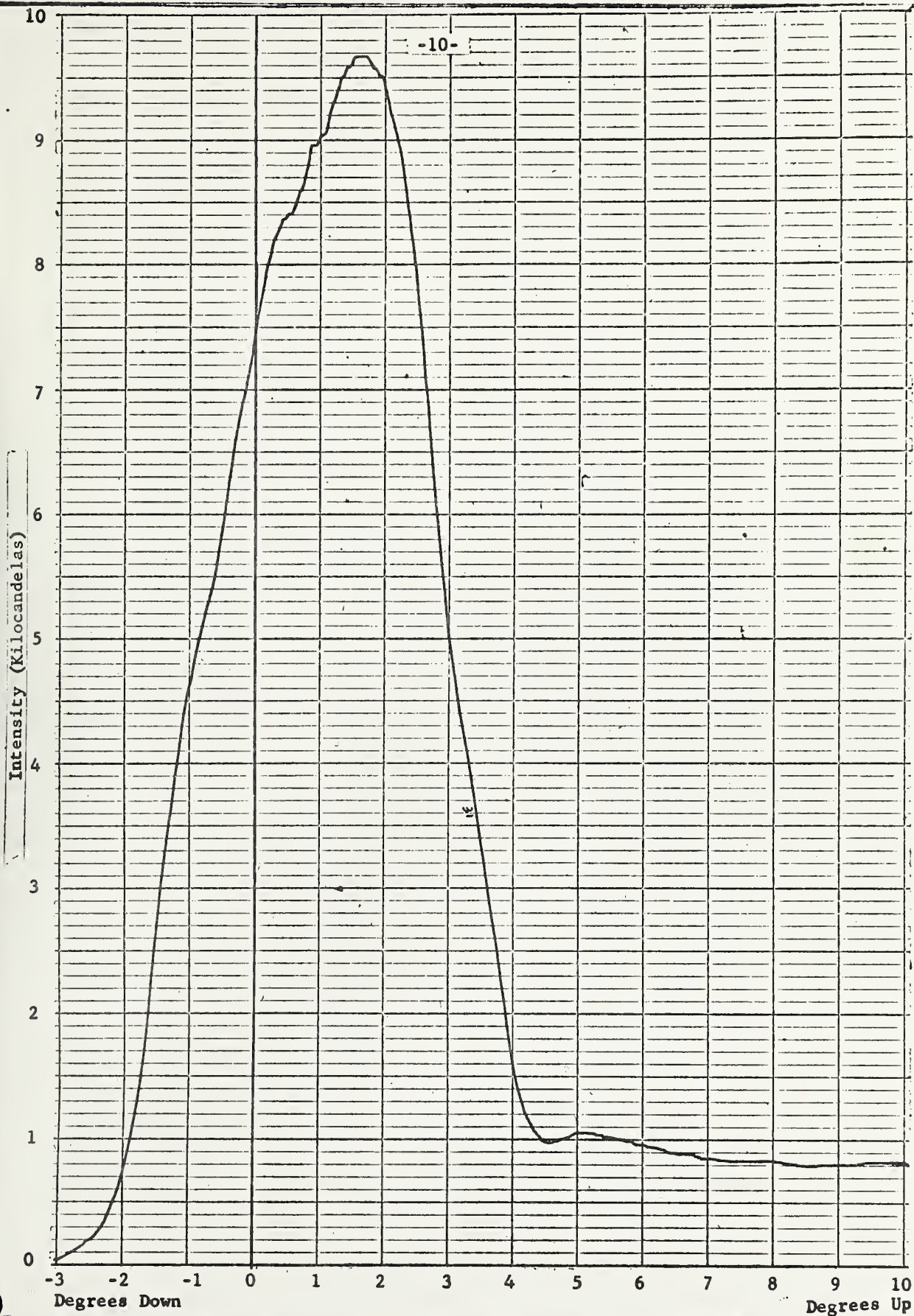


Figure 7. Vertical intensity distribution through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with an experimental 300-watt, 20-ampere lamp with a clear cover, operated at 20 amperes.

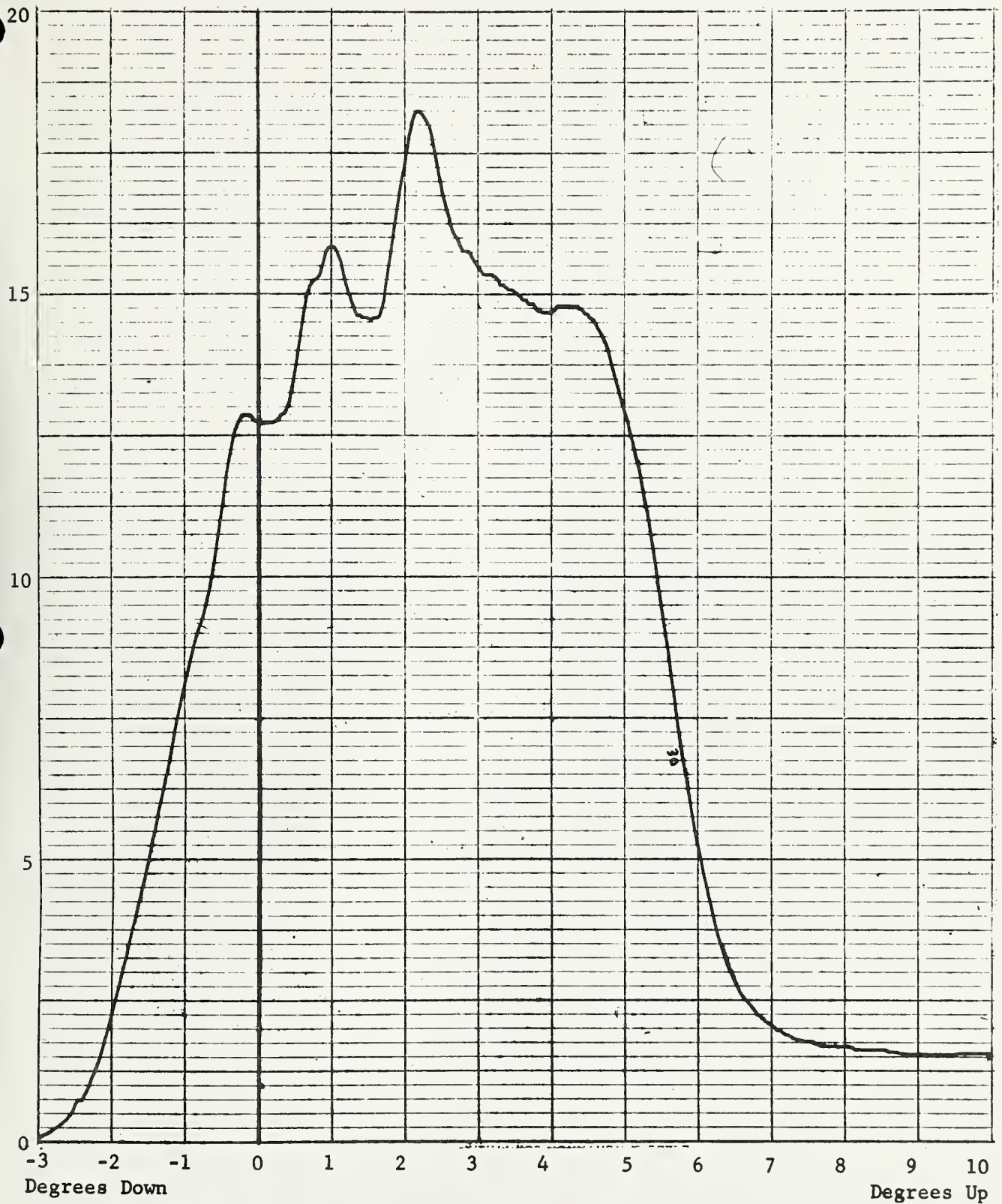


Figure 8. Vertical intensity distribution through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with an experimental 450-watt, 25-volt lamp operated at 25 volts.
NBS Report 8169

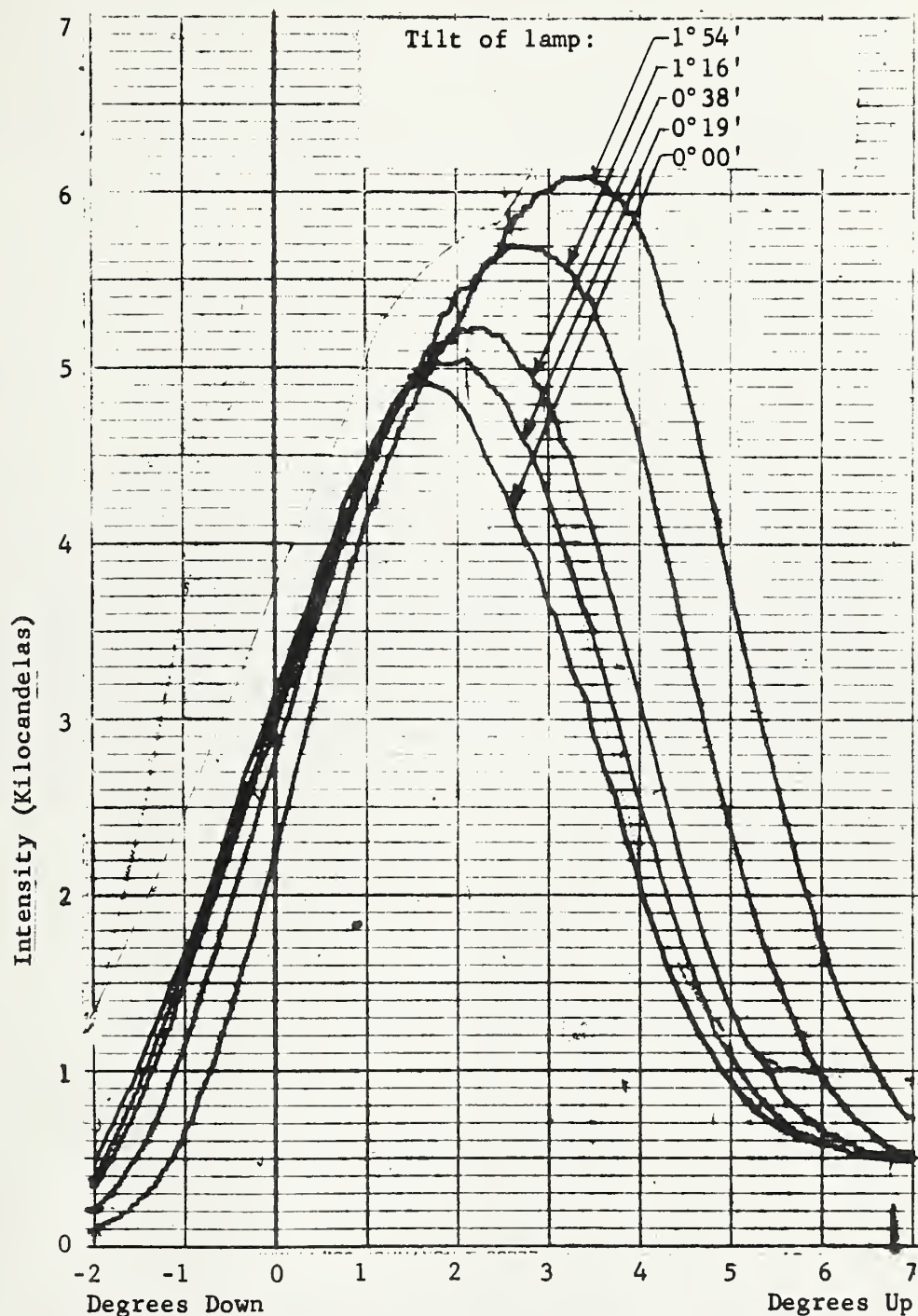


Figure 10. Vertical intensity distributions through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 200-watt, type 6.6A/PAW56/3 lamp operated at 6.6 amperes. The lamp and holder were tilted by means of spacers.

NBS Report 8169

Table IV

<u>No. of Spacers</u>	<u>Angle of Tilt</u>	<u>Peak Intensity (kilocandelas)</u>	<u>Elevation of Beam Axis (degrees)</u>	<u>Beam Spread at 50% of Peak (degrees)</u>
0	0	4.9	1.6	4.3
1	0°19'	5.1	1.8	4.3
2	0°38'	5.2	2.0	4.5
4	1°16'	5.7	2.4	4.7
6	1°54'	6.1	2.8 ₅	4.9

4. CONCLUSION

The data of Tables I and II, and, to a lesser degree, those of Table III, show that more effective use can be made of the flux available from the lamp in a prismatic type light by using an auxiliary lens, and that the angle of elevation of the beam can be changed by lamp selection, by lamp tilt or by the use of an auxiliary lens. The results given in this report are intended only to demonstrate the effectiveness of the use of these methods of modifying the intensity distribution of the light and should not be considered as showing the optimum choice of design parameters.

