A COMPARATIVE TEST OF COMMERCIAL MAKES OF ELECTRIC LAMPS

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CHAPTER I

INTRODUCTION

With the problem of illumination becoming more involved each year, the present day electrical engineer finds it necessary to make a thorough study of this subject in order to be fitted for his profession. With this thought in view we have undertaken to take up one specific phase of the study of illumination, and by this study, determine facts that might be helpful to anyone confronted by a problem of this nature.

The reader will take into consideration the fact that the discussion which will be outlined in the following chapters is by no means a detailed study of the subject. In the short time alloted for such a study the authors have attempted to bring out those facts and conclusions which they considered most important. However, it is felt that anyone faced with the problem of economical and efficient illumination will certainly derive a certain amount of benefit from these observations.

CHAPTER II

GENERAL SURVEY AND PURPOSE

To the knowledge of the authors there has previously been no such comparative test made. No doubt the various manufactures when confronted with the problem of illumination have made individual test to the best of their ability. In such a test the average consumer is not adequately equipped to make a thorough and detailed study of their problem. In the majority of case the amount of power consumption, and in some cases

the life of the lamps are the only factors considered. In this respect this study will be most beneficial. The authors have attempted to make a complete and unbiased study of several different types of various commercial makes of lamps. For this test lamps bearing the labels General Electric, Hygrade, Kentucky and Jewel were selected. The number of lamps, their sizes, and types were as follows:

General Electric	3	60-watt frosted
	3	75-watt clear
	3	100-watt frosted
Hygrade	3	60-watt frosted
	3	75-watt clear
	3	100-watt frosted
Kentucky	3	60-watt frosted
	3	75-watt clear
	3	100-watt frosted
Jewel	3	60-watt frosted
	3	75-watt clear
	3	100-watt frosted

Not only has the amount of power consumption and the life of the lamps but also the actual output has been considered. From the observations and data accumulated the authors have attempted to show a comparision between the several makes of lamps used in the test. The object of such a comparision being to determine those makes which will give the greatest amount of illumination for the smallest amount of power consumption. The characteristics peculiar to each specific make

has been brought out and discussed. In making this test lamps of different retail prices were chosen in order to determine whether or not the initial cost of the lamps justified buying that particuliar make. The authors feel that a few of the above problems are solved by the discussion that is to follow.

CHAPTER III

DESCRIPTION OF METHOD AND APPARATUS USED

Since one of the main factors to be determined by this test was the illumination output, the first problem was to determine the most efficient method of measuring the light intensity. Because of the simplicity and also the comparative accuracy of the instrument, the foot-candle meter was chosen for this means of measurement. This instrument consists essentially of two photronic cells designed to absorb the energy of the light rays. Connected in series with these cells is a micro-ampere meter which records the current flowing through the circuit. By means of shunts a greater range of light intensity can be measured. These shunts are controlled by means of a four point switch, giving four different scales of intensity. Since the current flowing through the meter is proportional to the light intensity, by proper calibration the micro-ampere readings can be converted into foot-candles. For this particular instrument such a calibration had been made and the necessary curves drawn to convert the readings of the meter into foot-candles. In order to use this instrument effectively it is necessary that the lamp to be measured furnish

the sole source of light. Since there were thirty-six lamps alltogether to be tested, the isolation of each lamp would have required too much room. Also, since the test was to be a continous burning test it was not permissible to disconnect thirty-five lamps while one lamp was being measured. To overcome this situation it was necessary to provide some means of shielding each lamp during the test of that lamp. This was accomplished by designing a conical shield large enough to enclose the lamp and secure enough to prohibit the light rays of the surrounding lamps from entering the shield. The upper end of the cone was made just large enough to enclose a single photronic cell. Here again care was taken not to allow external light to enter the shield. Figure 1 shows a diagram of the cell with its enclosing shield.

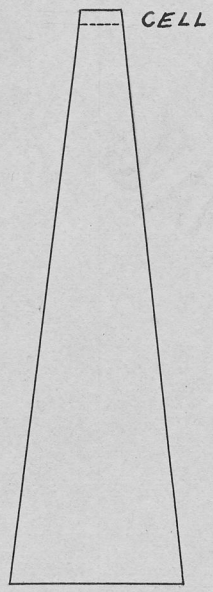


Fig. I

Since it was necessary that the lamps be in continous service, it was first thought that a separate would be needed for each lamp. Because of the complexity involved in making readings in such a circuit this plan was revised and a more simple one in which there were twelve separate circuits was designed. To make use of the more simple circuit it was necessary to have twelve banks of three lamps each. Each

three-lamp bank consisted of three lamps of the same type, size and make. One distinct advantage of the revised circuit is the fact that the power input to anyone of the twelve circuits gives the total power input of the three lamps of the same type, size and make and simplifies the determination of the value of the average power for one lamp.

Figure 2 is a diagram of the circuit actually used. From the figure it will be noted that jacks are provided for the insertion of current leads. By means of these jacks it was possible to insert the leads, open the switch and determine the power without interrupting the circuit.

It might be well at this point to explain some of the difficulties encountered in making the test. A 2300-volt breaker is in the circuit which supplies power to the laboratory. When this breaker kicks out for any reason it is necessary that it be put back in by hand. Due to changes made at the university power plant the circuit was interrupted during the first one-hundred hours of test. After considerable trouble the authors were able to obtain the exact time that the circuit was interrupted. Allowance was made for this time and the circuit put back into service. It was then decided that some precaution was necessary to prevent the circuit from being interrupted without knowing the exact time of interruption. This precaution was provided for by means of a recording voltmeter placed in the lamp circuit. Thereafter, if the service was interrupted at anytime, the actual time of interruption could be determined accurately by simply refering to the voltmeter chart. It was later found that this was a wise step because the cir-

cuit breaker was opened several times during the test. The actual time that the circuit was out in each case was recorded and allowances made accordingly. To the reader these occasional periods of time during which the lamps were not burning might seem contradictory to the original purpose of the experiment. Although a continous burning was desired as far as possible, and every precaution wa taken to provide for it, the primary purpose of the experiment was to arrive at a comparision between the different makes of lamps, and therefore the interruptions did not affect the results desired.

Another difficulty encountered was the variations of the supplied voltage at the different times of testing. It was found that the voltage ranged anywhere from 112 to 115 volts. The illumination is directly proportional to the power, and the power is proportional to the square of the voltage. By these proportionallities it was possible to revise the data of the readings to one corresponding voltage. An average voltage for the different test was determined and found to be 113 volts. With this voltage as a standard the entire data was revised correspondingly.

CHAPTER IV

CONCLUSIONS

Results of the experiment are clearly determined by a study of the curve sheets. Before any discussion of the curves is begun it would be well to tabulate the average position of the curves with relation to each other. The curves will have two different ratings, one for power and one for illumination. Each curve will be designated by a number from one to four,

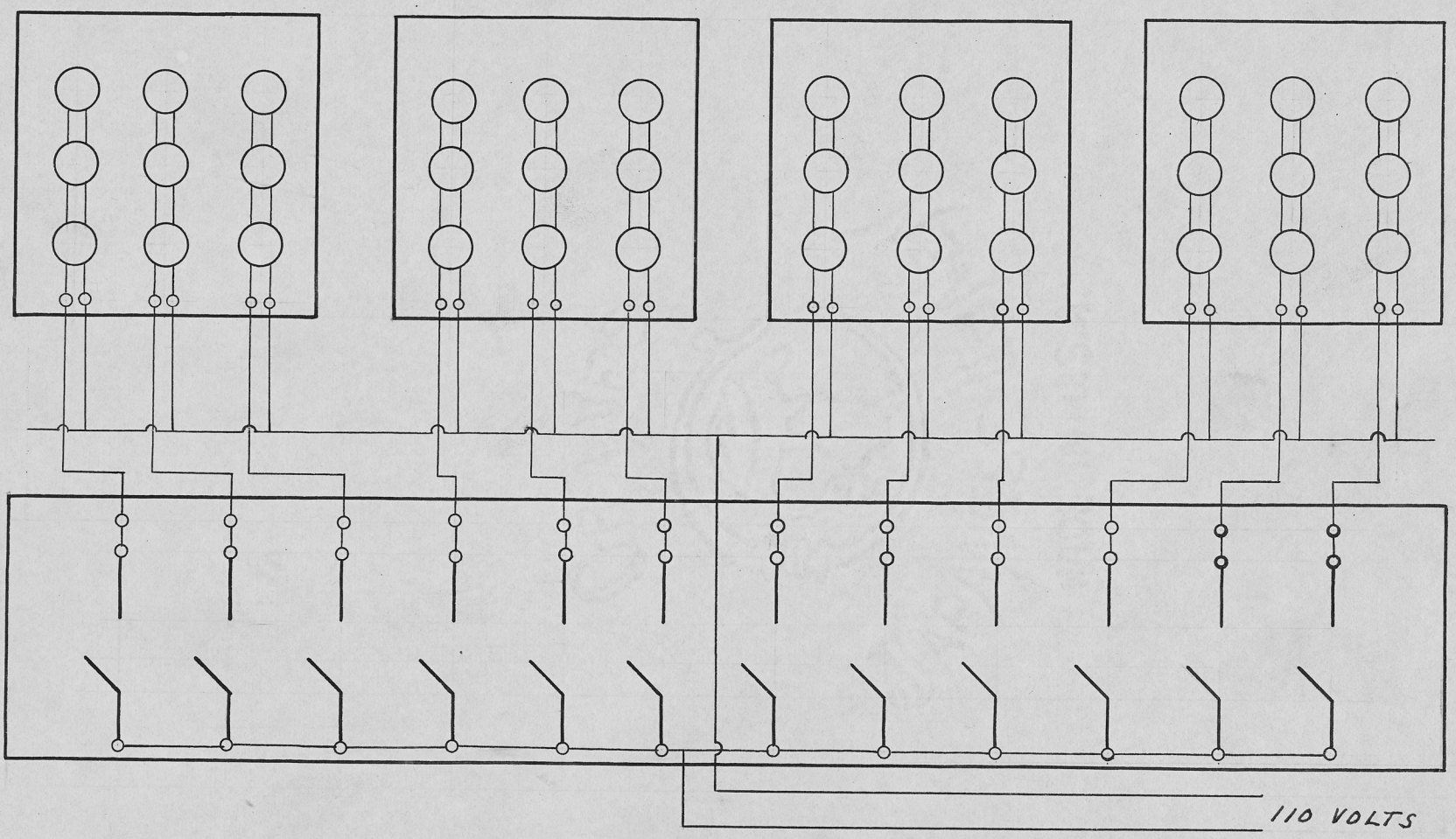


Fig. 2

number one being the largest amount of foot-candles in regard to illumination and the least amount of watts in regard to power input. There will be three separate tables, each table representing the four makes of each size and type of lamps. The following table is obtained from curve sheets No. 1-A and 1-B.

60-watt frosted lamps

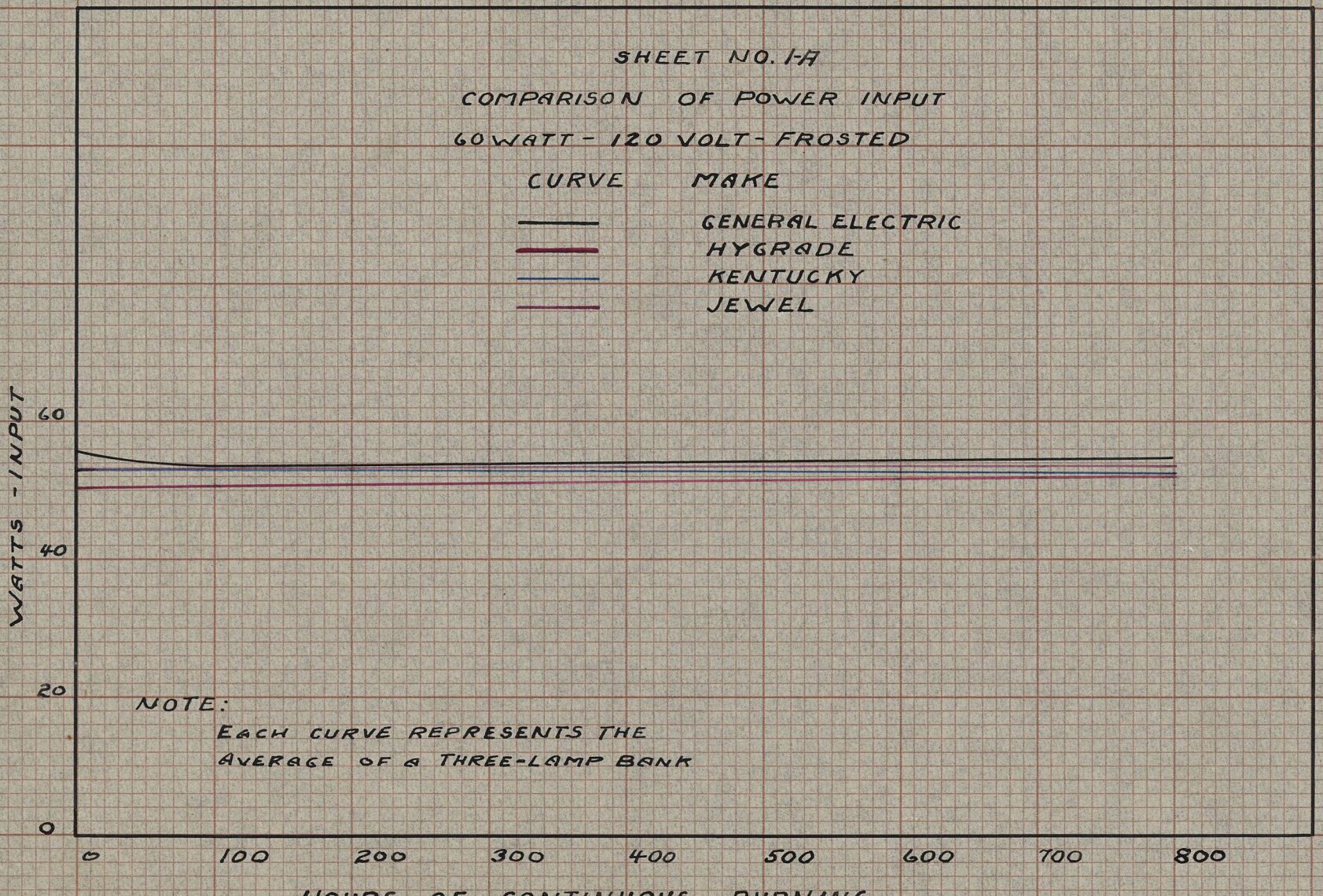
Make	Rating of the power curves	Rating of the illumination curves
General Electric	4	1
Hygrade	1	2
Kentucky	2	3
Jewel	3	4

From curve sheet No. 1-A it will be noted that there is little variation of power input of the several makes of lamps. Refering to curve sheet No. 1-B it can be seen that there is considerable variation of illumination output of the several makes. The ratings of the illumination curves, therefore, gives practically a complete comparision between the different makes of lamps. To illustrate this a comparision is drawn between the General Electric and the Kentucky lamps. The General Electric required on an average of three watts more than the Kentucky, and at the end of eight hundred hours the illumination of the General Electric lamps was three and one half foot-candles more than the illumination of the Kentucky lamps. On first thought the reader will think the above statement to be inconsistent, but it must be taken into consideration that the foot-candle is a relatively larger unit than the watt. This point can be further illustrate by another comparision. In the case

SHEET NO. 1-A

COMPARISON OF POWER INPUT

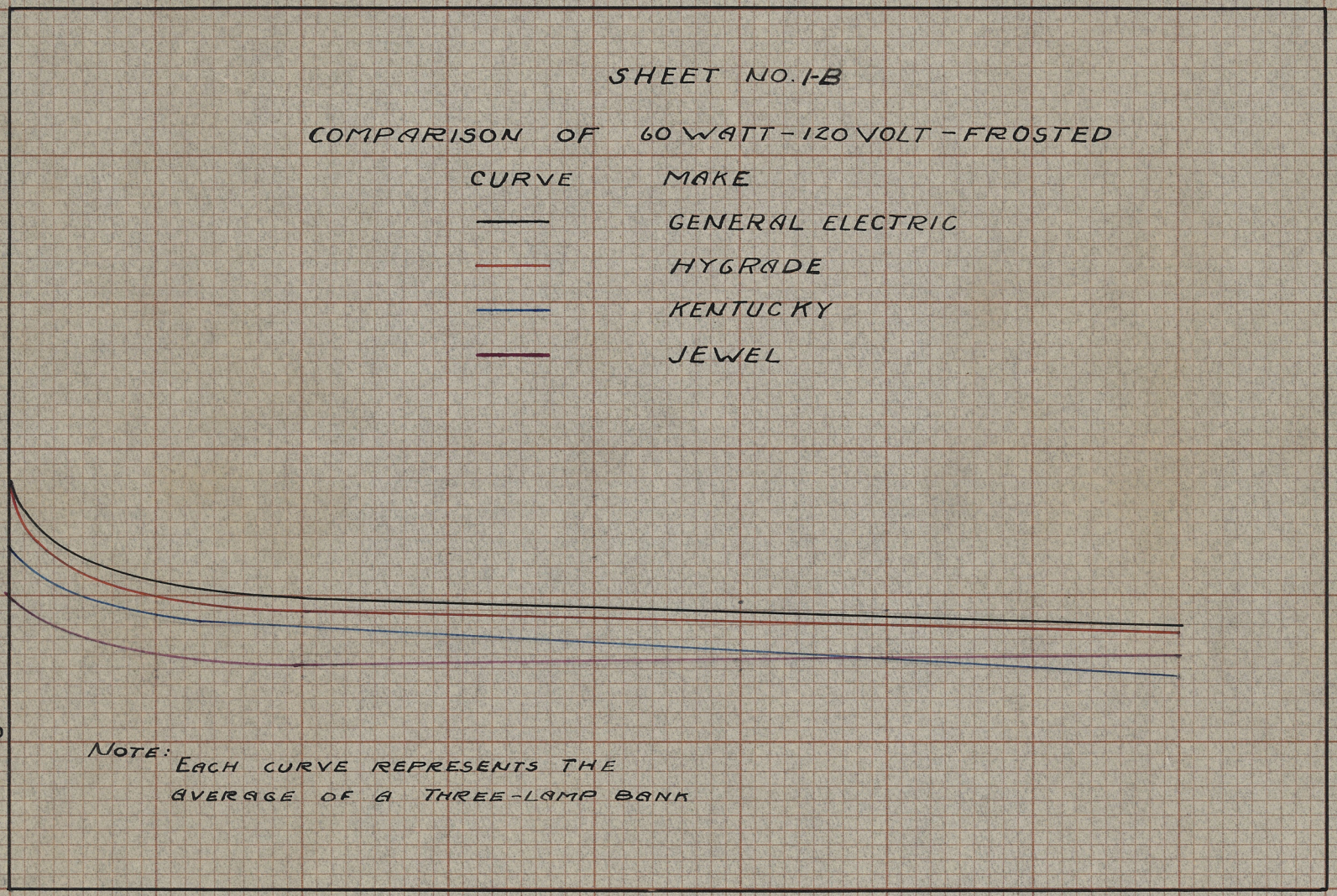
60 WATT - 120 VOLT - FROSTED



NOTE:
EACH CURVE REPRESENTS THE AVERAGE OF A THREE-LAMP BANK

SHEET NO. 1-B

COMPARISON OF 60 WATT - 120 VOLT - FROSTED



NOTE: EACH CURVE REPRESENTS THE AVERAGE OF A THREE-LAMP BANK

of the General Electric and the Hygrade lamps the General Electric used on an average of two and one half more watts than the Hygrade but produced an average illumination of about one foot-candle greater.

In every case the illumination decreased considerably during the first two hundred hours of burning with only a slight decrease of illumination thereafter. The power input remained practically constant throughout the test for each make of lamps. The illumination of the Kentucky lamps showed a more steady decline than any of the other three makes. The Jewel lamps showed an individual characteristic in that it dropped to a very low value during the first two hundred hours but showed a slight steady increase thereafter.

The following table is obtained from curve sheets No. 2-A and 2-B.

75-watt clear lamps

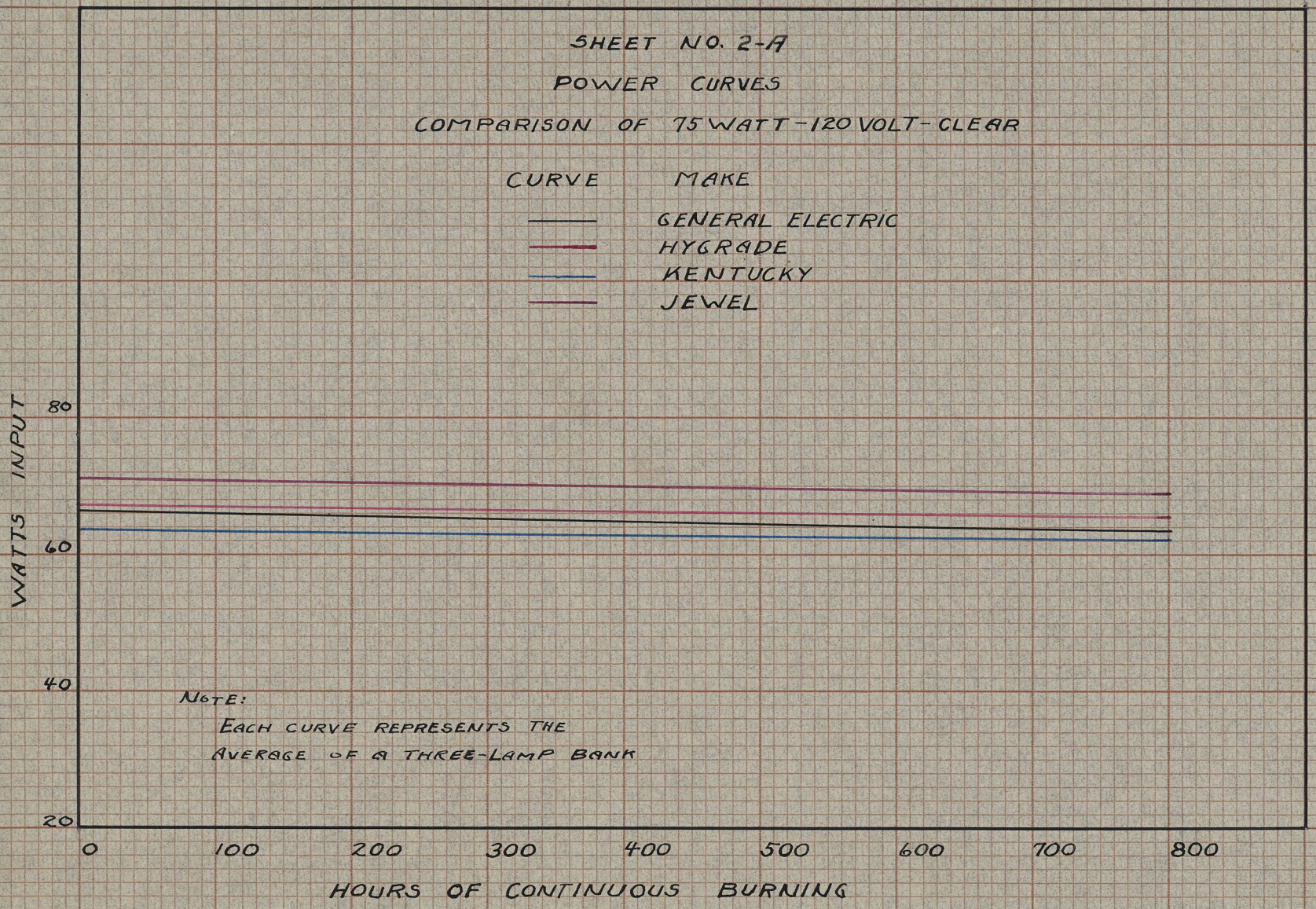
Make	Rating of the power curves	Rating of the illumination curves
General Electric	2	3
Hygrade	3	2
Kentucky	1	4
Jewel	4	1

After observing curve sheets 2-A and 2-B it can be easily seen that the above ratings give a good comparision of the different makes of lamps. Refering to curve sheet No. 2-B it will be noted that at the beginning of the test there was considerable variation of the illumination output, while at the end of the test this variation had decreased considerably. At the beginning of the test the Kentucky lamps produced sixteen and one half foot-candles less than the lamps producing the most

SHEET NO. 2-A

POWER CURVES

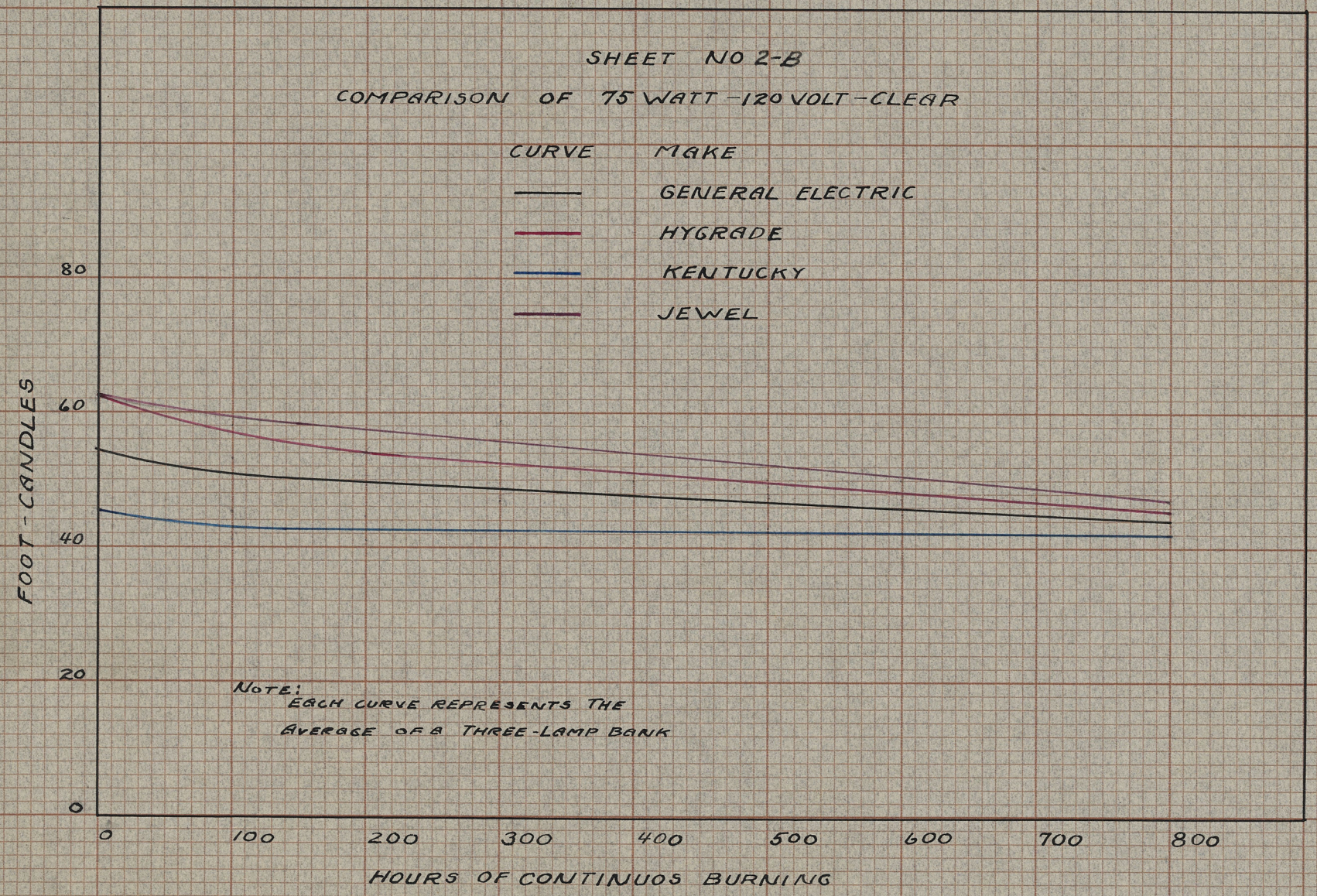
COMPARISON OF 75 WATT - 120 VOLT - CLEAR



NOTE:
EACH CURVE REPRESENTS THE
AVERAGE OF A THREE-LAMP BANK

SHEET NO 2-B

COMPARISON OF 75 WATT - 120 VOLT - CLEAR



NOTE:
EACH CURVE REPRESENTS THE
AVERAGE OF A THREE-LAMP BANK

illumination but at the end of the test the Kentucky lamps produced only five foot-candles less than the lamps producing the most illumination. This was due to the fact that the decline in the Kentucky lamps was less than the decline in the other three makes of lamps. As in the case of the 60-watt lamps the power was practically constant during the 800 hour period of the test.

The following table is obtained from curve sheets No. 3-A and 3-B.

100-watt frosted lamps

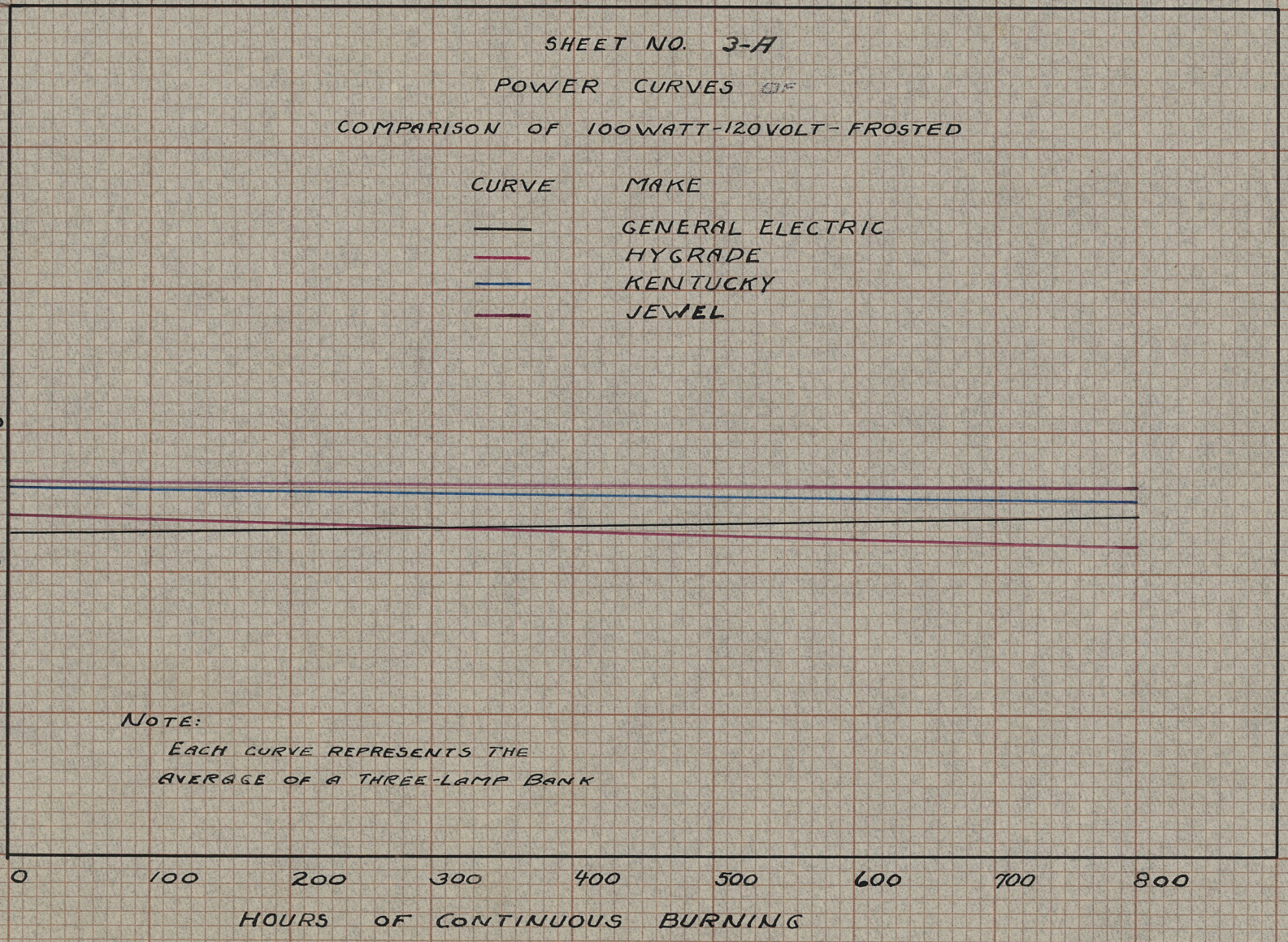
Make	Rating of the power curves	Rating of the illumination curve
General Electric	2	2
Hygrade	1	4
Kentucky	3	3
Jewel	4	1

The above table does not give an accurate comparision as in the case of the 75-watt lamps due to the fact that both the power and illumination curves cross in some instances. Refering to sheet No. 3-A it will be seen that the General Electric lamps required slightly less watts at the beginning than the Hygrade lamps, but their relation is interchanged at the completion of 330 hours burning. Refering to sheet No. 3-B it will be noted that the Jewel lamp produces considerably more illumination and also has a slighter decline than the other three makes. This is to be expected since it consumes more power. It will also be noted on sheet No. 3-B that the Kentucky and General Electric interchange positions at approximately 340 hours, the Kentucky lamps producing

SHEET NO. 3-A

POWER CURVES OF

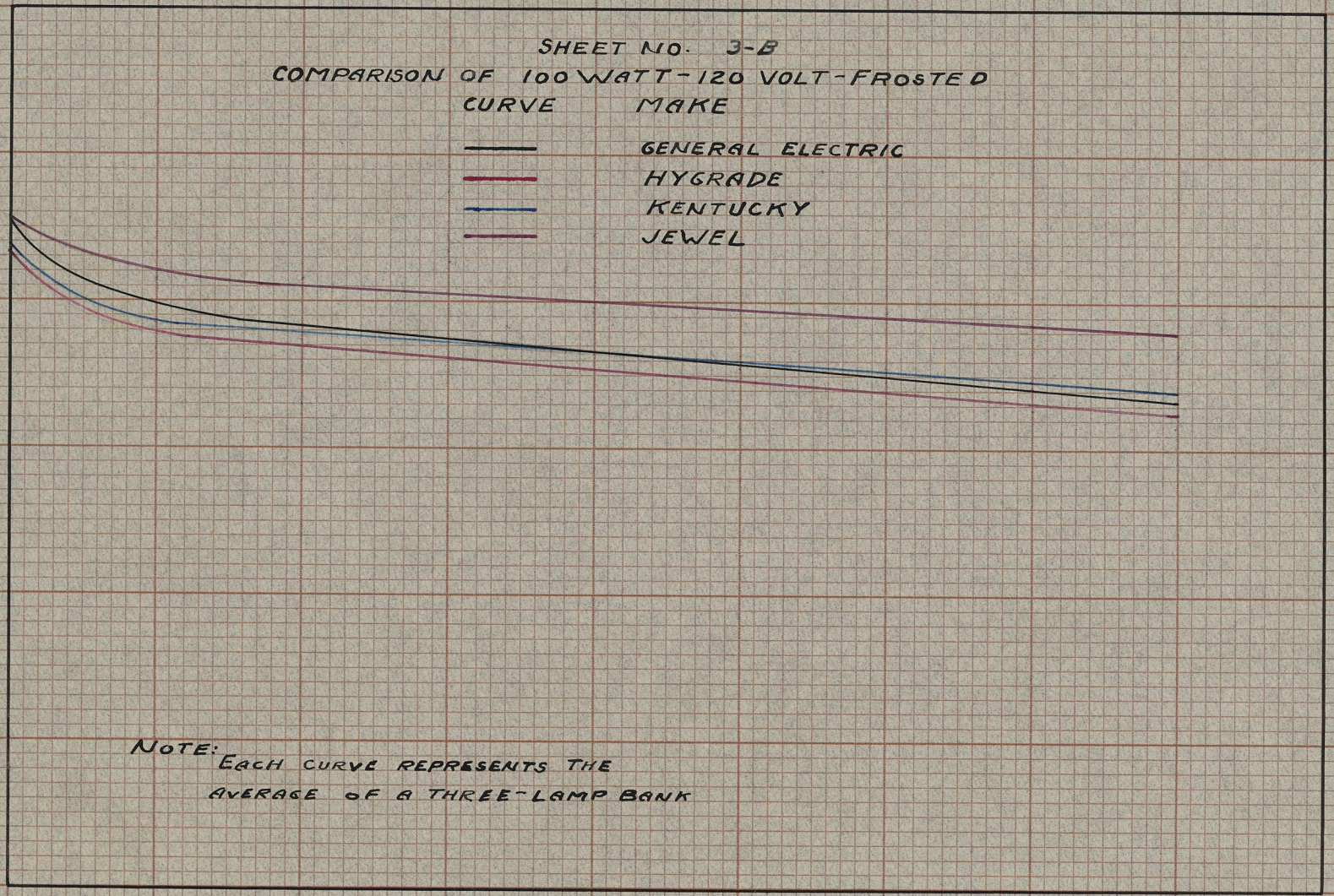
COMPARISON OF 100 WATT-120 VOLT-FROSTED



NOTE:
EACH CURVE REPRESENTS THE
AVERAGE OF A THREE-LAMP BANK

SHEET NO. 3-B

COMPARISON OF 100 WATT - 120 VOLT - FROSTED



NOTE: EACH CURVE REPRESENTS THE AVERAGE OF A THREE-LAMP BANK

slightly more illumination at the end of the test.

From the preceding discussion it is apparent that selection for the best make of lamps must be made for each size lamp. This is obvious since it would be impossible to say that anyone make would give the best result for all three sizes. In the case of the 60-watt frosted the General Electric is the make recommended to give the most efficient and economical service. For the 75-watt clear lamps the selection is more difficult. Even though the Jewel lamps require slightly more power it is felt that this is the make to recommend because it produces considerably more illuminaion. Proceeding along the same line of reasoning the Jewel lamps are recommended for service requiring the use of the 100-watt frosted lamps.

DATA SHEET NO. 1-A

READINGS OF FOOT-CANDLE METER IN MICRO-AMPERES 800 HOUR CONTINOUS BURNING TEST TESTED AT 100 HOUR INTERVALS. THESE READINGS USED TO DETERMINE FOOT-CANDLE OUTPUT FROM CALIBRATION CURVES. METER SWITCH ON POSITION NO. 3

No. of Test	GENRAL ELECTRIC 60-watt Frosted			HYGRADE 60-watt Frosted		
	A	B	C	A	B	C
0	27.5	26.5	27.5	27.0	27.0	27.0
100	23.3	22.2	22.8	22.2	22.5	22.2
200	22.5	22.2	22.0	21.5	22.0	21.9
300	28.0	27.0	27.0	27.3	27.2	27.0
400	24.2	25.0	24.4	27.4	27.0	26.7
500	23.1	22.5	22.1	22.4	22.3	23.7
600	23.0	22.2	22.2	23.0	22.9	22.8
700	23.0	23.0	22.3	23.3	23.4	23.3
800	20.8	20.9	20.6	21.7	21.7	21.6

No. of Test	KENTUCKY 60-watt Frosted			JEWELL 60-watt Frosted		
	A	B	C	A	B	C
0	25.0	24.8	24.4	22.9	23.5	22.1
100	20.8	20.8	20.6	19.7	20.9	19.7
200	19.9	20.5	22.0	20.2	21.3	20.0
300	23.5	24.6	23.5	24.5	24.6	24.6
400	26.4	26.4	26.4	22.0	23.0	21.8
500	20.5	20.4	20.4	20.1	21.1	20.1
600	21.1	20.7	21.1	21.1	22.0	21.0
700	21.1	21.2	21.6	20.9	21.8	21.6
800	20.8	21.4	20.4	20.0	19.6	20.1

DATA SHEET NO. 1-B

ILLUMINATION IN FOOT-CANDLES OF 60-WATT LAMPS

800 HOURS CONTINOUS BURNING TESTED AT 100 HOUR INTERVALS.

No. of Test	GENERAL ELECTRIC A	B	C	HYGRADE A	B	C
0	58.3	56.5	58.3	57.5	57.5	57.5
100	50.5	48.5	49.8	48.5	49.0	48.5
200	49.0	48.5	48.2	47.3	48.2	48.2
300	57.5	57.5	57.5	58.0	57.7	57.5
400	52.0	53.0	52.5	57.5	56.7	56.3
500	52.0	49.3	48.3	49.0	48.7	51.3
600	50.0	48.5	48.5	50.0	48.8	45.7
700	50.0	50.7	50.7	50.7	50.8	50.7
800	46.0	46.3	45.5	47.7	47.7	47.5

No. of Test	KENTUCKY A	B	C	JEWEL A	B	C
0	53.8	53.4	52.6	49.8	51.0	48.4
100	45.0	45.0	45.7	44.0	46.1	44.3
200	44.5	45.5	48.2	45.0	47.0	44.5
300	53.5	53.0	53.5	51.0	53.0	51.0
400	55.7	55.7	55.7	47.7	49.3	47.3
500	45.5	45.3	45.3	44.8	46.6	44.8
600	47.0	46.0	47.0	46.6	47.5	46.3
700	46.5	46.7	47.5	46.3	48.0	47.5
800	44.5	43.8	44.8	46.0	47.0	45.3

DATA SHEET NO. 2-A

READINGS OF FOOT-CANDLE METER IN MICRO-AMPERES 800 HOUR CONTINOUS BURNING TEST TESTED AT 100 HOUR INTERVALS. THESE READINGS USED TO DETERMINE FOOT-CANDLE OUTPUT FROM CALIBRATION CURVES. METER SWITCH ON POSITION NO. 4.

No. of Test	GENERAL ELECTRIC 75-watt Clear			HYGRADE 75-watt Clear		
	A	B	C	A	B	C
0	9.2	9.4	9.3	10.3	10.5	10.1
100	7.6	7.6	7.8	8.5	8.7	8.5
200	7.5	7.4	7.8	8.3	8.5	8.2
300	9.2	9.1	9.5	9.9	10.0	9.9
400	7.8	7.6	8.0	8.0	8.1	8.1
500	7.8	7.6	7.8	8.1	8.2	8.0
600	7.8	7.6	8.0	8.0	8.1	8.1
700	8.0	8.0	8.1	8.1	8.3	8.5
800	7.3	7.0	7.3	7.4	7.4	7.7

No. of Test	KENTUCKY 75-watt Clear			JEWEL 75-watt Clear		
	A	B	C	A	B	C
0	8.0	7.5	7.5	10.9	10.9	10.3
100	6.8	6.6	7.3	9.1	9.1	8.7
200	6.7	6.5	7.4	9.4	9.2	8.8
300	8.5	8.3	9.0	10.6	10.5	10.0
400	8.0	7.8	8.6	9.8	9.5	9.1
500	7.0	6.8	7.3	8.4	8.4	7.9
600	7.5	7.4	7.9	8.5	8.5	8.0
700	7.5	7.4	7.7	8.7	8.4	7.7
800	7.0	7.0	7.4	8.3	8.0	7.7

DATA SHEET NO. 2-B

ILLUMINATION IN FOOT-CANDLES OF 75-WATT LAMPS

800 HOURS CONTINOUS BURNING TESTED AT 100 HOUR INTERVALS.

No. of Test	GENERAL ELECTRIC			HYGRADE		
	A	B	C	A	B	C
0	54.5	55.7	55.0	60.9	62.1	59.8
100	45.0	48.0	46.2	50.5	51.5	50.5
200	44.5	44.0	46.2	49.2	50.1	48.8
300	54.5	53.7	56.4	58.5	59.1	58.5
400	45.0	44.8	45.1	52.1	51.7	52.2
500	47.4	46.4	47.4	49.9	50.5	49.2
600	46.3	45.0	47.3	47.3	48.0	48.0
700	45.6	45.6	45.6	45.6	47.4	48.0
800	43.5	42.2	43.5	44.0	44.0	45.5

No. of Test	KENTUCKY			JEWEL		
	A	B	C	A	B	C
0	47.2	44.5	44.5	64.5	64.5	61.0
100	40.5	39.2	43.5	54.0	54.0	51.5
200	40.0	38.5	44.0	55.7	54.5	52.0
300	50.5	49.2	41.7	62.9	62.2	59.1
400	47.4	46.2	51.0	51.0	58.0	56.9
500	42.8	41.6	45.0	51.7	51.7	48.5
600	44.5	44.0	46.8	50.5	50.5	47.4
700	44.5	44.0	45.7	51.5	50.0	45.6
800	40.0	42.0	44.0	49.3	47.4	45.5

DATA SHEET NO. 3-A

READINGS OF FOOT-CANDLE METER IN MICRO-AMPERES 800 HOUR CONTINOUS BURNING TEST TESTED AT 100 HOUR INTERVALS. THESE READINGS USED TO DETERMINE FOOT-CANDLE OUTPUT FROM CALIBRATION CURVES. METER SWITCH ON POSITION NO. 4. 100-WATT FROSTED LAMPS.

No. of Test	GENERAL ELECTRIC A	B	C	HYGRADE A	B	C
0	15.0	15.0	15.0	14.8	14.3	14.5
100	12.5	12.3	12.2	12.5	12.1	12.3
200	12.0	11.8	11.5	12.2	11.6	12.2
300	14.5	14.5	14.1	14.7	14.5	14.7
400	13.8	13.8	13.3	14.2	13.8	14.2
500	12.2	12.0	11.7	12.0	11.8	12.5
600	12.0	11.6	11.5	11.6	11.6	12.3
700	11.8	11.5	11.3	11.6	11.6	11.2
800	10.9	10.6	10.3	10.8	10.7	11.6

No. of Test	KENTUCKY A	B	C	JEWEL A	B	C
0	14.7	14.1	15.0	14.9	15.9	15.1
100	13.0	13.0	13.0	13.7	14.2	14.0
200	12.6	12.2	12.7	13.8	14.2	14.0
300	15.0	15.0	15.0	16.0	16.0	16.1
400	13.8	13.7	13.7	15.0	15.3	15.0
500	12.0	12.2	12.0	13.5	13.7	13.5
600	11.9	12.0	12.0	13.2	13.0	13.2
700	11.7	11.7	11.7	12.9	13.0	13.0
800	10.8	10.9	10.9	12.4	12.4	12.4

DATA SHEET NO. 3-B

ILLUMINATION IN FOOT-CANDLES OF 100-WATT LAMPS

800 HOURS CONTINOUS BURNING TESTED AT 100 HOUR INTERVALS.

No. of Test	GENERAL ELECTRIC A	B	C	HYGRADE A	B	C
0	89.5	89.5	91.2	87.5	84.0	89.5
100	74.5	73.0	72.6	74.5	72.0	73.2
200	71.3	64.0	62.4	72.6	68.7	72.6
300	86.5	86.5	84.0	87.8	86.5	87.8
400	79.0	76.0	79.8	83.5	80.3	81.5
500	72.5	71.4	69.5	71.4	70.0	74.5
600	71.4	68.8	68.0	68.8	68.8	73.0
700	70.0	68.1	67.0	68.8	68.8	65.3
800	64.5	62.8	61.0	64.0	63.5	68.6

No. of Test	KENTUCKY A	B	C	JEWEL A	B	C
0	87.5	84.0	89.5	88.5	94.8	90.0
100	77.4	77.4	77.4	81.7	84.5	83.3
200	75.0	72.6	75.5	81.2	84.5	83.4
300	89.5	87.5	89.5	95.5	96.2	96.2
400	79.8	79.7	79.7	87.7	89.5	87.7
500	71.4	72.5	71.4	80.2	81.5	80.2
600	70.7	71.2	71.4	77.3	78.6	78.6
700	69.5	69.5	69.5	76.8	77.4	77.4
800	64.0	64.5	64.5	73.8	73.8	72.8

DATA SHEET NO. 4

POWER INPUT IN WATTS OF 60-WATT LAMPS

800 HOUR CONTINOUS BURNING TESTED AT 100 HOUR INTERVALS

No. of Test	GENERAL ELECTRIC			HYGRADE		
	A	B	C	A	B	C
0	56.0	56.0	56.0	50.0	50.0	50.0
100	51.2	51.2	51.2	48.9	48.9	48.9
200	53.3	53.3	53.3	51.3	51.3	51.3
300	58.5	58.5	58.5	53.3	53.3	53.3
400	54.6	54.6	54.6	52.7	52.7	52.7
500	54.1	54.1	54.1	51.1	51.1	51.1
600	54.1	54.1	54.1	50.1	50.1	50.1
700	52.8	52.8	52.8	52.8	52.8	52.8
800	55.3	55.3	55.3	50.8	50.8	50.8

No. of Test	KENTUCKY			JEWEL		
	A	B	C	A	B	C
0	53.3	53.3	53.3	53.3	53.3	53.3
100	50.6	50.6	50.6	50.6	50.6	50.6
200	52.8	52.8	52.8	52.3	52.3	52.3
300	56.0	56.0	56.0	57.3	57.3	57.3
400	54.6	54.6	54.6	54.7	54.7	54.7
500	54.6	54.6	54.6	55.0	55.0	55.0
600	52.3	52.3	52.3	52.3	52.3	52.3
700	51.7	51.7	51.7	52.5	52.5	52.5
800	52.8	51.7	51.7	53.3	53.3	53.3

DATA SHEET NO. 5

POWER INPUT IN WATTS OF 75-WATT LAMPS

800 HOUR CONTINOUS BURNING TESTED AT 100 HOUR INTERVALS

No. Of Test	GENERAL ELECTRIC A	B	C	HYGRADE A	B	C
0	65.5	65.5	65.5	66.6	66.6	66.6
100	61.5	65.5	65.5	59.4	59.4	59.4
200	65.0	65.0	65.0	63.3	63.3	63.3
300	68.0	68.0	68.0	64.0	64.0	64.0
400	67.0	67.0	67.0	64.4	64.4	64.4
500	67.0	67.0	67.0	64.8	64.8	64.8
600	63.8	63.8	63.8	61.6	61.6	61.6
700	64.5	64.5	64.5	63.3	63.3	63.3
800	64.1	64.1	64.1	62.5	62.5	62.5

No. Of Test	KENTUCKY A	B	C	JEWEL A	B	C
0	63.3	63.3	63.3	71.3	71.3	71.3
100	67.7	67.7	67.7	67.3	67.3	67.3
200	66.0	66.0	66.0	70.1	70.1	70.1
300	70.6	70.6	70.6	72.5	72.5	72.5
400	67.0	67.0	67.0	71.5	71.5	71.5
500	68.2	68.2	68.2	72.3	72.3	72.3
600	65.0	65.0	65.0	68.5	68.5	68.5
700	66.2	66.2	66.2	68.8	68.8	68.8
800	65.0	65.0	65.0	69.1	69.1	69.1

DATA SHEET NO. 6

POWER INPUT IN WATTS OF 100-WATT LAMPS

800 HOUR CONTINOUS BURNING TESTED AT 100-HOUR INTERVALS

No. of Test	GENERAL ELECTRIC			HYGRADE		
	A	B	C	A	B	C
0	85.5	85.5	85.5	88.0	88.0	88.0
100	83.7	83.7	83.7	82.5	82.5	82.5
200	87.0	87.0	87.0	86.5	86.5	86.5
300	89.5	89.5	89.5	87.5	87.5	87.5
400	91.0	91.0	91.0	89.3	89.3	89.3
500	88.0	88.0	88.0	89.5	89.5	89.5
600	86.7	86.7	86.7	85.5	85.5	85.5
700	87.5	87.5	87.5	86.7	86.7	86.7
800	87.7	87.7	87.7	79.5	79.5	79.5

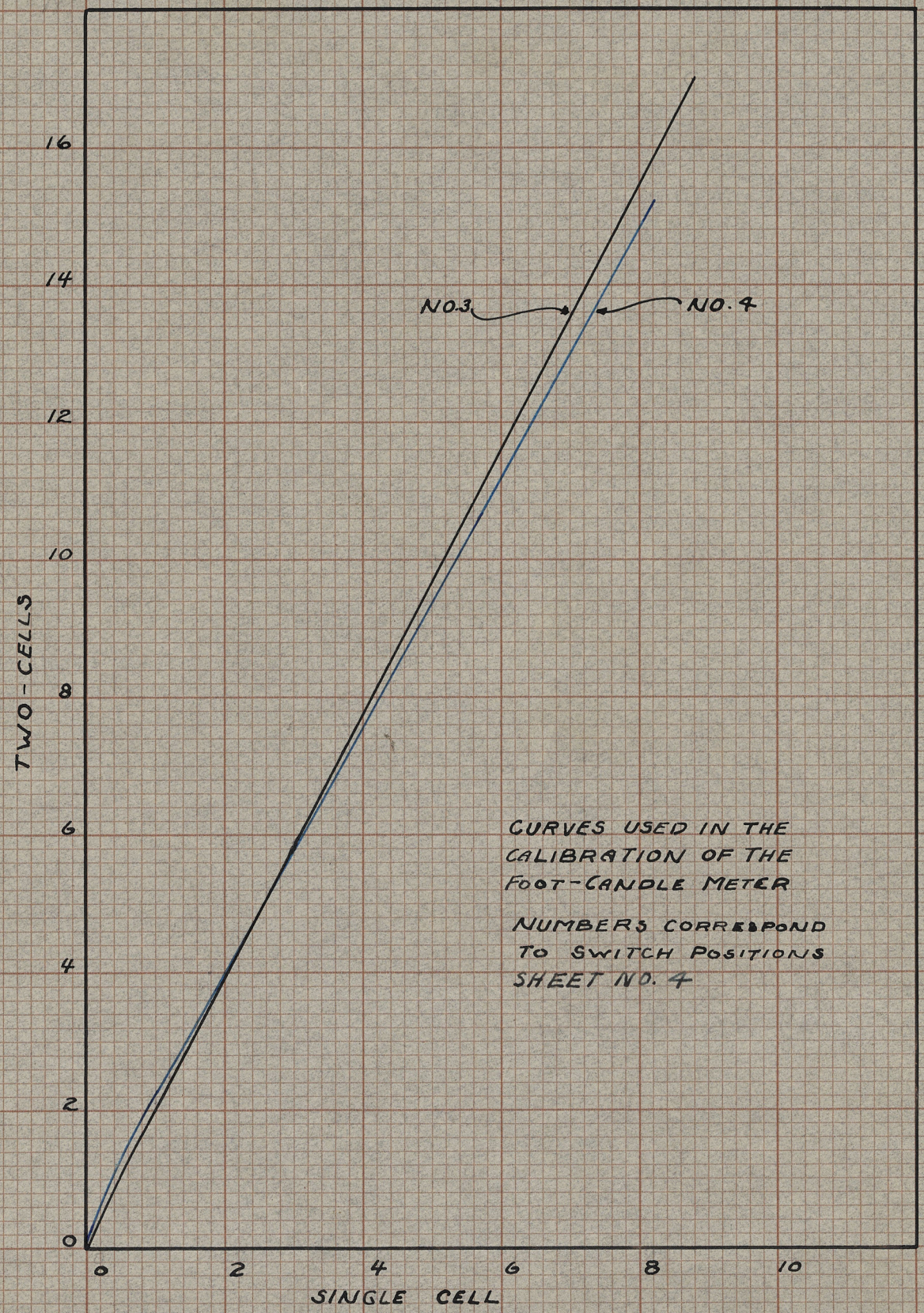
No. of Test	KENTUCKY			JEWEL		
	A	B	C	A	B	C
0	92.0	92.0	92.0	92.7	92.7	92.7
100	86.3	86.3	86.3	88.3	88.3	88.3
200	91.5	91.5	91.5	93.0	93.0	93.0
300	96.7	96.7	96.7	98.7	98.7	98.7
400	94.0	94.0	94.0	95.6	95.6	95.6
500	94.5	94.5	94.5	96.0	96.0	96.0
600	89.3	89.3	89.3	91.0	91.0	91.0
700	90.0	90.0	90.0	89.8	89.8	89.8
800	91.2	91.2	91.2	92.0	92.0	92.0

CHAPTER V

APPENDIX

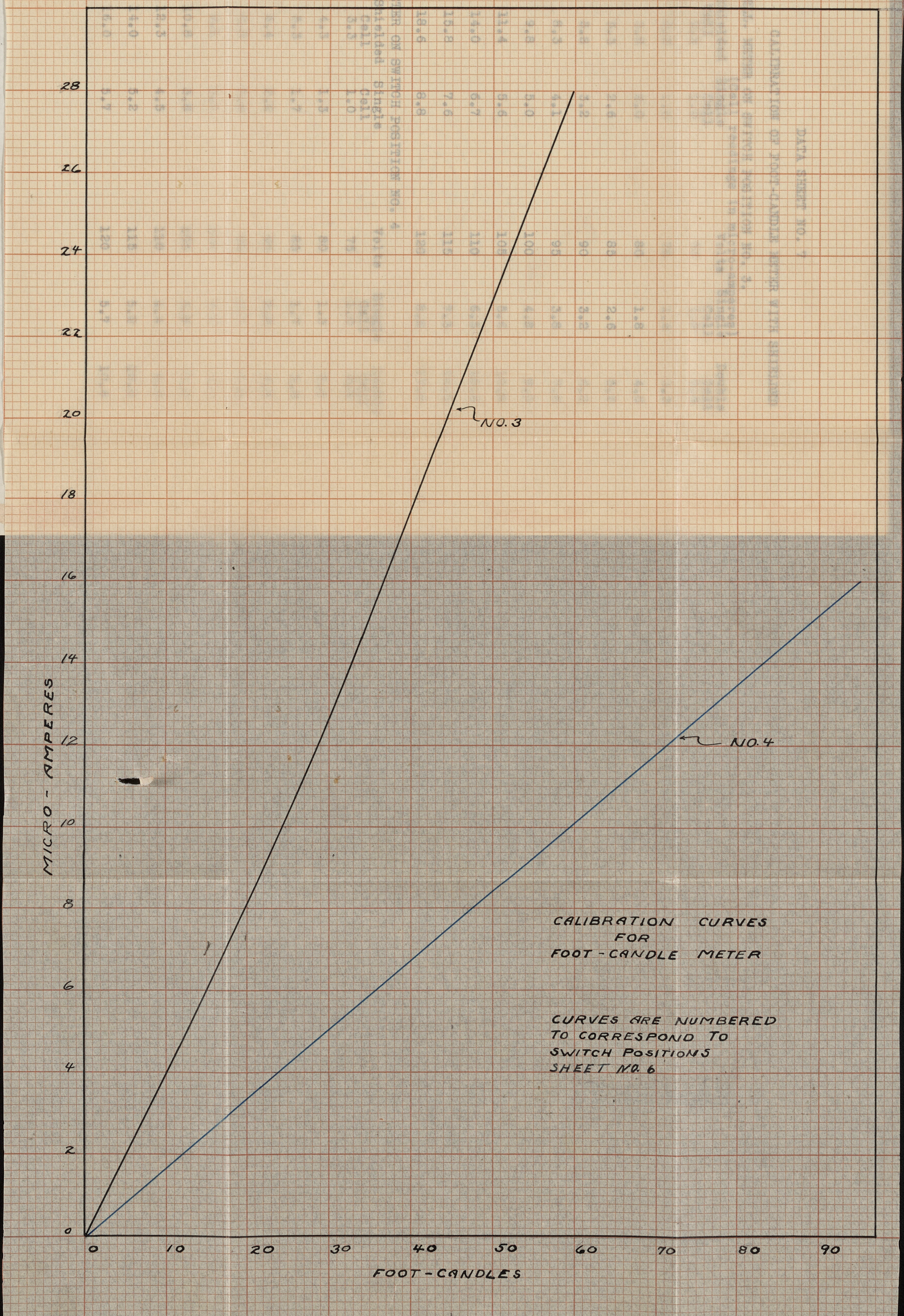
The foot-candle meter was not originally adapted to be used for making this special type of test. It was first necessary to make a shield for the photronic cell as has been explained in a previous chapter. Due to the fact that this shield, and also the fact that a single cell instead of two cells would be used, it was necessary to recalibrate the instrument. A brief explanation of the calibration will be given.

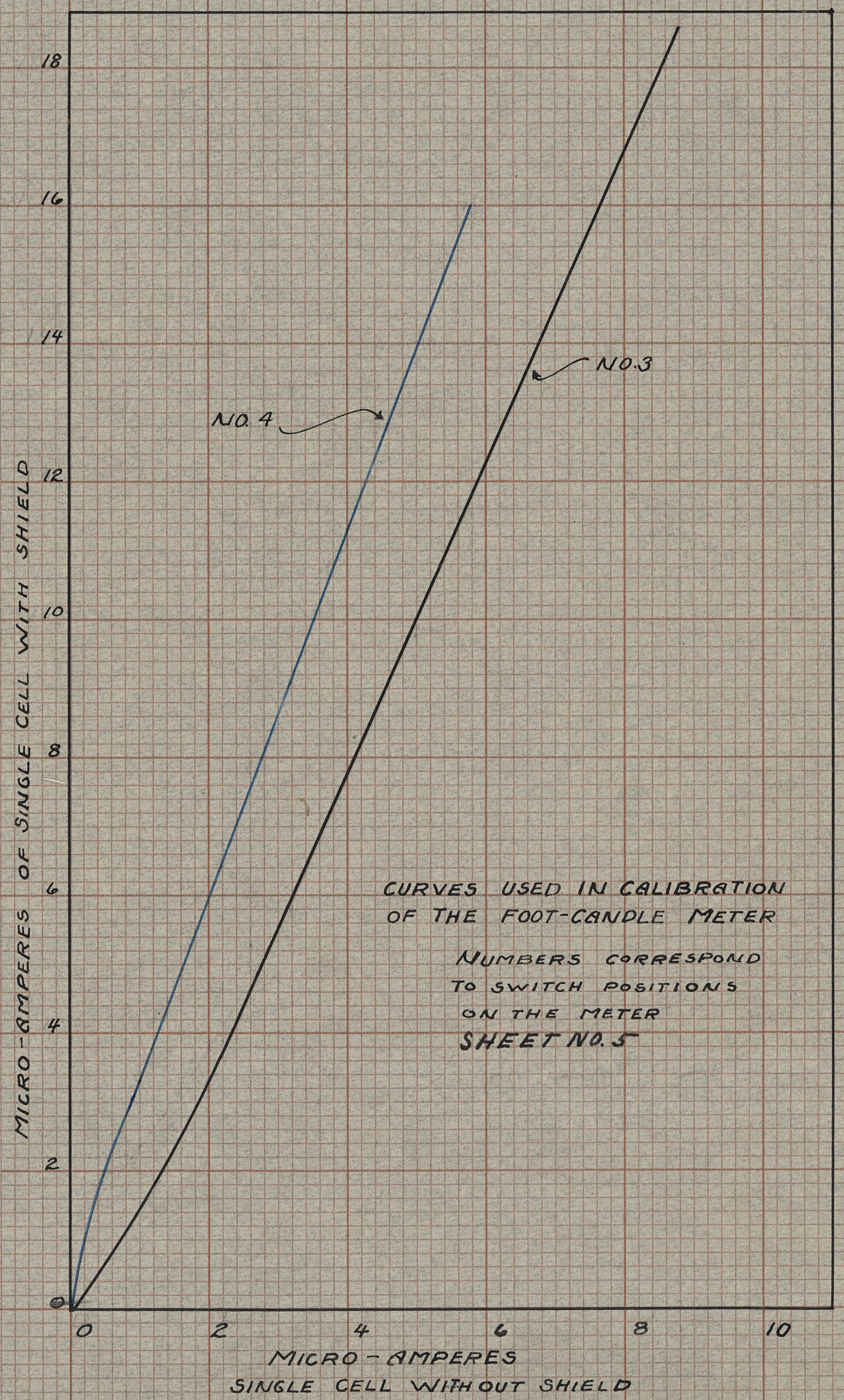
The first step was to find the relation between a single cell and the two calibrated cells. This procedure was carried out for switch positions No. 3 and 4 of the foot-candle meter. From the data obtained curve sheet No. 4 was drawn. The next operation consisted in determining a similiar relation between the single cell and the shielded cell. From this data obtained curve sheet No. 5 was drawn. Using curve sheets 4 and 5 it was possible to construct curve sheet No. 6 which gives directly the relation between the instrument as used and the actual light intensity. Curve sheet No.6 was obtained as follows. A specific value of micro-amperes taken during the test was refered to curve sheet No. 5 and a corresponding value of the single cell without the shield was found. This second value of micro-amperes was refered to curve sheet No. 4 and a corresponding value using two cells was found. Having found this value for two cells, and by using the calibration curves supplied with the instrument, the value of foot-candles was found for the original test value of micro-amperes. The data and curves obtained are included in this chapter.



CURVES USED IN THE CALIBRATION OF THE FOOT-CANDLE METER

NUMBERS CORRESPOND TO SWITCH POSITIONS SHEET NO. 4


MICRO - AMPERES
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
0
10
20
30
40
50
60
70
80
90
FOOT - CANDLES
NO. 3
NO. 4
CALIBRATION CURVES
FOR
FOOT - CANDLE METER
CURVES ARE NUMBERED
TO CORRESPOND TO
SWITCH POSITIONS
SHEET NO. 6



CURVES USED IN CALIBRATION
OF THE FOOT-CANDLE METER

NUMBERS CORRESPOND
TO SWITCH POSITIONS
ON THE METER
SHEET NO. 5

CHAPTER VI

APPROVAL

The foregoing thesis is hereby approved as a creditable study of an engineering subject, carried out and presented in a manner sufficiently satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is to be understood that by this approval the undersigned does not necessarily endorse or approve opinions expressed, or conclusions drawn therin, but approves the thesis only for the purpose for which it is submitted.

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Title Professor Elec. Eng.