A LOW COST BOUNDARY LIGHTING SYSTEM FOR SMALL AIRPORTS

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SUMMARY

This report describes the development of a low cost two-color gaseous tube boundary lighting system as installed at Aretz Airport, a privately owned and managed air field at Lafayette, Indiana.

Based on experience gained in maintaining two-color boundary lights installed at the Civil Aeronautics Administration Experimental Station at Weir Cook Municipal Airport, Indianapolis, Indiana, a new lighting-unit design was suggested by the author. A development contract was entered into with the Leland Electric Company at Dayton, Ohio, whereby ten of these units were furnished for a trial installation which was made by Civil Aeronautics Administration personnel at Aretz Airport under a contract with the owner

It was found that such an installation complete with obstruction lights, poles, lighted wind cone, miscellaneous wiring material, underground cable and ten two-color boundary lights could be made for approximately $2600 00, provided the owner purchased all material himself and hired union labor to do the work. If contracted the installation would cost appreciably more, depending upon the net profit of the contractor

Judging from available data the electrical energy to operate the installation should cost an average of 15 cents per hour.

Preliminary flights showed the lights to be distinctive in appearance and definitely discernible from an altitude of 1000 feet and from 15 to 18 miles distance during unlimited visibility weather The lights as designed are suitable for rectangular fields but may be difficult to interpret on many-sided fields, in particular those which are L-shaped or T-shaped.

INTRODUCTION

The idea of a two-color gaseous tube boundary light was suggested by Mr. F C. Breckenridge of the National Bureau of Standards, who observed single-tube units installed in Europe. In line with this suggestion, some two-color boundary lights were installed at the Civil Aeronautics Administration Experimental Station in 1943, the installation continuing in operation ever since.

As originally conceived, the two-color boundary light consisted of a red neon tube facing in one direction and a green fluorescent tube facing in the opposite direction The units were installed along the airport boundary so that the green faced away from the airport, indicating to an approaching pilot the area in which a landing could be safely made, while the red faced into the airport, indicating to a pilot inside the port that he must be off the ground before crossing the line of red lights

A number of unsatisfactory features developed in the original lights The tubes were started and operated at such a high voltage that spider webs caused them to ground out. Furthermore, they were designed without much thought to maintenance, which was carried on with difficulty. The installation itself was not too satisfactory as the connectors which linked the units to the multiple feed were not weatherproof and would collect moisture and short-circuit the installation In spite of these difficulties the lights operated most of the time, very few tube burn-outs occurred and the operating cost was not high

EQUIPMENT AND INSTALLATION

The two-color boundary lights proved to be so distinctive that when the need for small airport lighting was realized, it was decided to experiment further with this type of lighting, to the extent of making a trial installation at a typical small privately owned field. The Aretz Airport, Lafayette, Indiana, was selected because of its proximity to Indianapolis and the Civil Aeronautics Administration Experimental Station and its relative freedom from obstructions, existing underground circuits and other common obstacles

At this time, Mr Harold Cline of the Leland Electric Company developed and demonstrated a new low-voltage type of tube that apparently could be so adapted to a lighting unit as to make it efficient, inexpensive, and easy to operate and maintain while having flexibility for use on various voltage sources.

Accordingly, Leland Electric Company engineers were consulted and specifications were drawn up covering a unit that would eliminate the troublesome features of the old two-color boundary lighting units. A development contract was then entered into with the company, whereby the latter would produce ten each of the desired type of unit It was agreed that to be practical and within the reach of all, the new unit should sell for approximately $100 00 or less, and a design was accomplished on this basis This unit is shown in Figure 1

A 480-volt multiple system was selected for supplying power to these units as the voltage drop could thus be held to a satisfactory minimum while keeping within the insulation of common 600-volt underground cable

Although cable and lighting units were ordered early in the spring of 1946, delivery of the cable was not completed until late in September so that the installation of the system was considerably delayed Completion of the work was accomplished in October, 1946

The new lighting unit consists mainly of a transformer, fuse block, power factor-correcting capacitor, two horizontal reflectors and one each red and green gas-filled tubular lamps connected in series with each other, the whole assembly being mounted on a reinforced metal base (Figure 2) with a one-piece metal cover having tempered plate glass windows (Figure 3) The glass is sealed in place with a plastic cement in such a manner as to be weatherproof As in the case of the original units, the tubes and reflectors are arranged to face in opposite directions so that the green tube can face outside the field and the red inside the field when the unit is installed.

The lamps are of the cold cathode type The red lamp is constructed of pyrex glass five feet long overall and one inch in diameter In each end of the tube is a special condenser type ceramic electrode constructed to carry the relatively high currents used This electrode is shown in Figure 4 Although the tube is filled with neon gas especially purified, the current capacity of this lamp is approximately twenty times greater than that of the standard neon tube such as is used in neon signs. The lamp as used in this fixture draws 500 milliamperes at 375 volts, with a starting voltage less than 700 volts, while the average standard neon tube operates at not over 60 milliamperes and a relatively high operating voltage, with a starting voltage around 15,000 volts. In factory tests these lamps started at a temperature of minus 75 degrees Fahrenheit

The green lamp is similar in dimensions to the red lamp Its inside wall is coated with a green fluorescent phosphor, ordinarily known as Willimite. Instead of the electrodes and gas used in the red tube, it has filaments sealed into the ends of the tube. The tube is exhausted and filled with Argon gas and a minute quantity of mercury The mercury produces a source of ultra-violet which causes the phosphor to fluoresce. The lamp as used in this fixture operates at 500 milliamperes and approximately 130 volts

The reflectors are parabolic in shape and are made of "alzak" treated reflector sheet. They are mounted in such a manner that the beam is tilted 20 degrees above the horizontal and in practice it is cut off 10 degrees below the zenith The design of the fixture permits a visibility through a horizontal angle of 150 degrees. At each end of the light is mounted a slotted piece of bakelite cut to receive the reflectors The top and bottom edges of the reflectors fit into the slots which thus hold the reflectors rigid This is illustrated in Figure 2

The glass is Libby-Owens-Ford Tuf-flex tempered plate 5 x 56 x 1/4 inches which, as mentioned above, is sealed in place with a plastic cement The edges of the opening are flared out to the thickness of the glass, thus furnishing a rest or frame for the edges of the glass It is anticipated that during the winter any snow or ice that tends to accumulate on the fixture will be melted by the heat generated by the lamp without any danger to the glass.

The lamp transformers are tapped to operate on a primary voltage of 110 to 575 volts and are designed to give satisfactory results at plus or minus 25 per cent variation in line voltage A transformer is mounted on the base plate at one end of the light in such a manner that the one-piece lid will protect it

The power factor is corrected to 85 per cent plus

The lighting unit mounting consists of a pair of wood supports 30 inches above the ground with a horizontal board fastened across them as shown in Figure 1.

As the landing area of the field is approximately 973 feet by 2940 feet, lights were arranged at each corner with the red side directed to the center of the field One light was installed at the center of each end, and two lights between corners along each side at a spacing of approximately 950 feet The arrangement of lights is shown in Figure 5 This lighting system was proposed mainly for private flying which is primarily a fair weather operation for small aircraft not equipped for flying in instrument weather Such a variation from the standard boundary light spacing of 300 feet was therefore considered practical If the spacing can be increased over normal, a great reduction in cost can be effected This experimental installation was for the purpose of checking the effectiveness of such wide spacing and the operation of the new lights

The cable installation was made with No 12 solid single conductor 600-volt Crescent Impervex Trenchwire with insulation consisting of special Impervex moisture-resisting rubber 3/64-inch thick and armour in the form of a tough neoprene jacket 3/64-inch thick vulcanized over the rubber The cable was installed 18 inches deep with a cable plow feeding two reels at a time for a multiple system Two-conductor cables would have been satisfactory but were more expensive

The power for the system is supplied through a 5 KVA-240/480 volt step-up transformer which is connected to the 240-volt power service at the airport A time switch and relay are provided for turning the lights on and off, and for this experiment a watt-hour meter was installed to obtain power consumption data A schematic wiring diagram is shown in Figure 5

Inasmuch as Civil Aeronautics Administration regulations require that obstructions be lighted when lights for landing are provided, it was necessary to set four 45-foot poles approximately 7 feet in the ground for obstruction lights near trees at the west end of the field A lighted wind cone was also installed

A total of eleven 60-watt lamps were thus added to the load This amount would of course vary for different fields.

OPERATING DATA

The lights have not been operated long enough to determine exact maintenance or operating costs, but it is estimated that with a lamp life of at least 2000 hours, maintenance should not be expensive For the first 25 nights, while operating approximately 12 hours a night, the system consumed 1077 kwh at approximately 3 4 cents per kwh or $1 50 per night

CONCLUSION

Several preliminary flight tests showed these boundary lights to be most distinctive in appearance and readily discernible from a distance of 15 to 18 miles at a height of 1000 feet

In view of the low installation cost which will average around $2600 00 for a 10-unit installation (see Figure 6), this type of lighting should prove entirely satisfactory for small airports

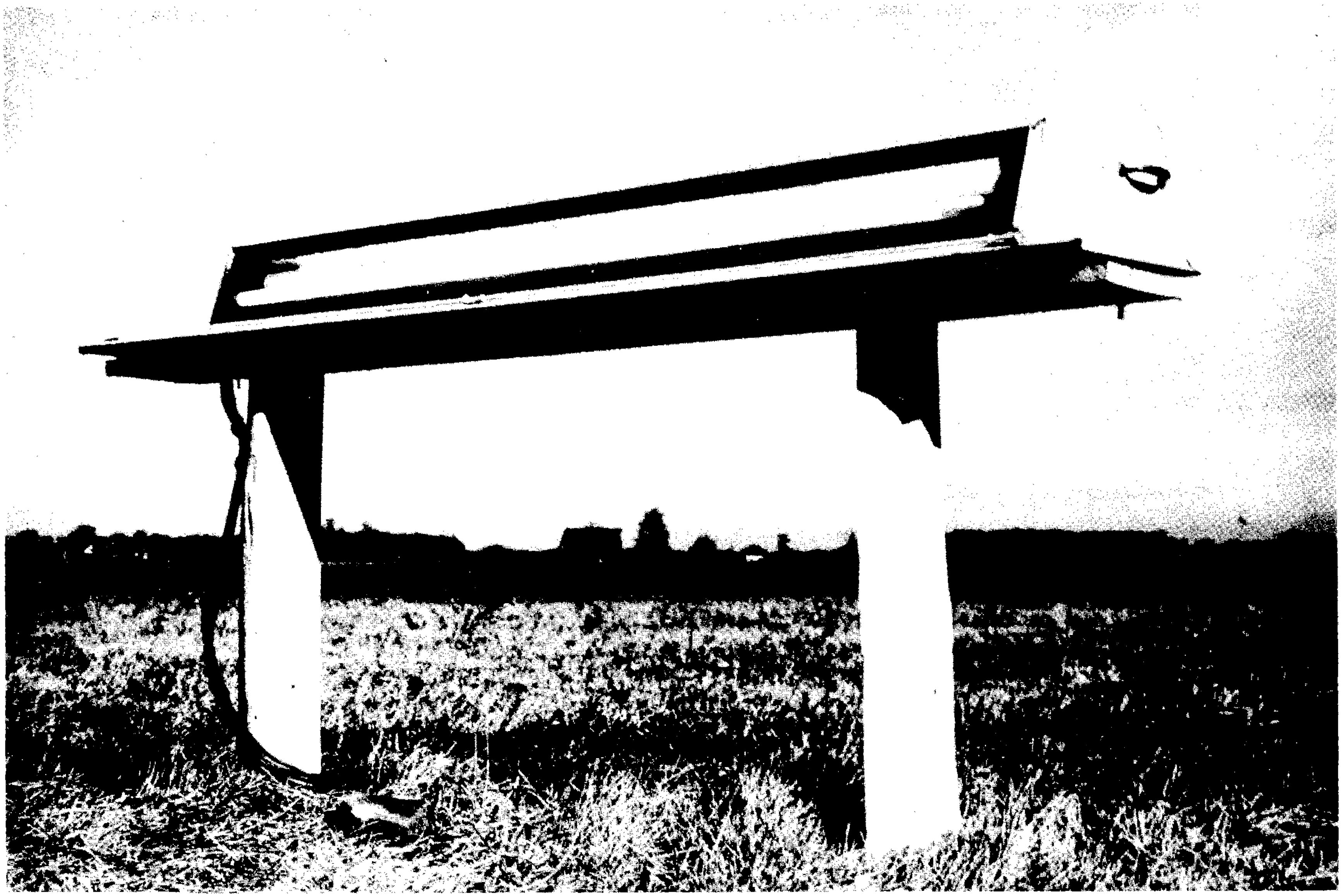


Figure 1. Leland Two-Color Boundary Light Installed at Aretz Airport, Lafayette, Indiana.

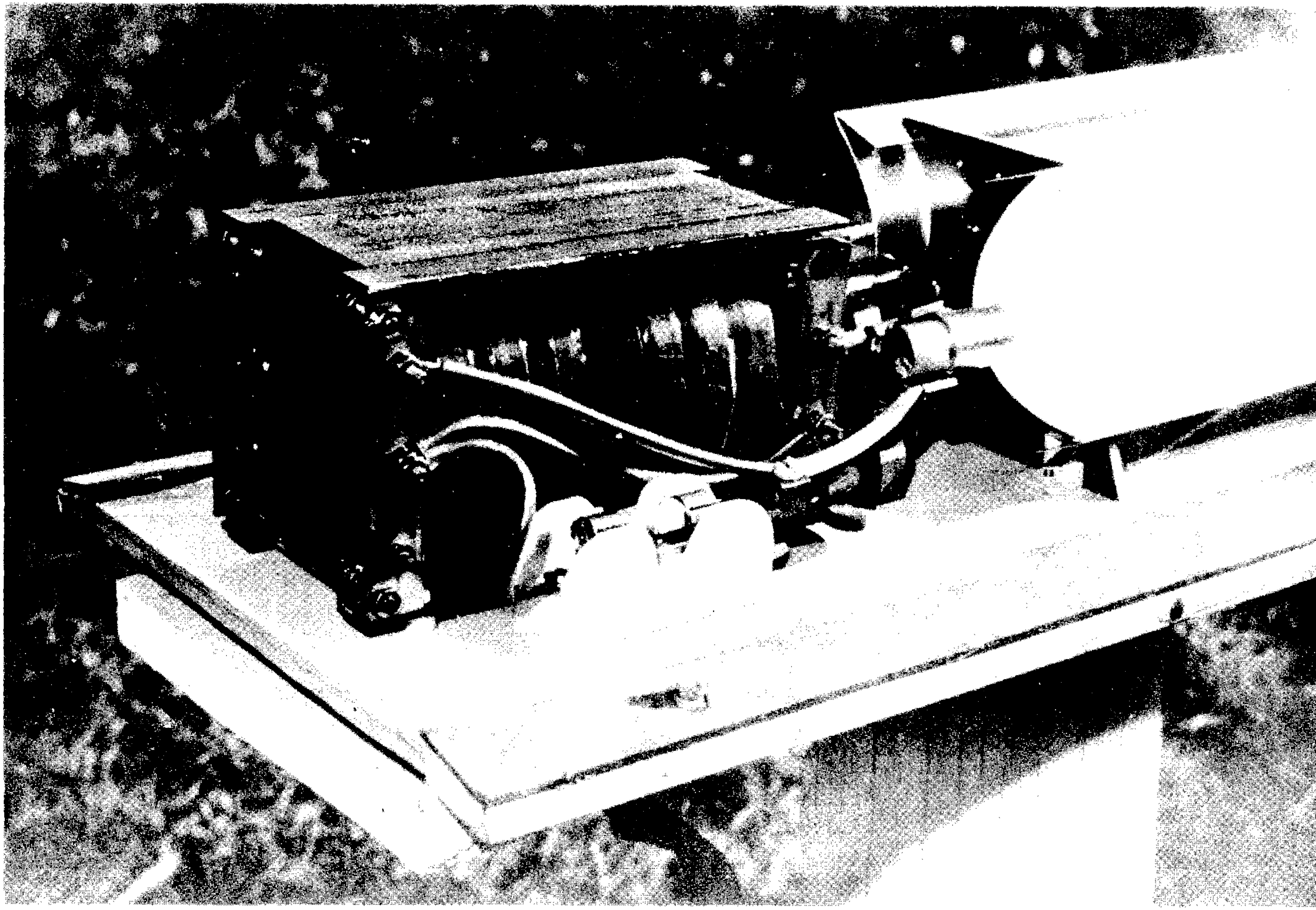


Figure 2. Boundary Light. End View Showing Transformer Fuse Block and Method of Mounting Reflectors.

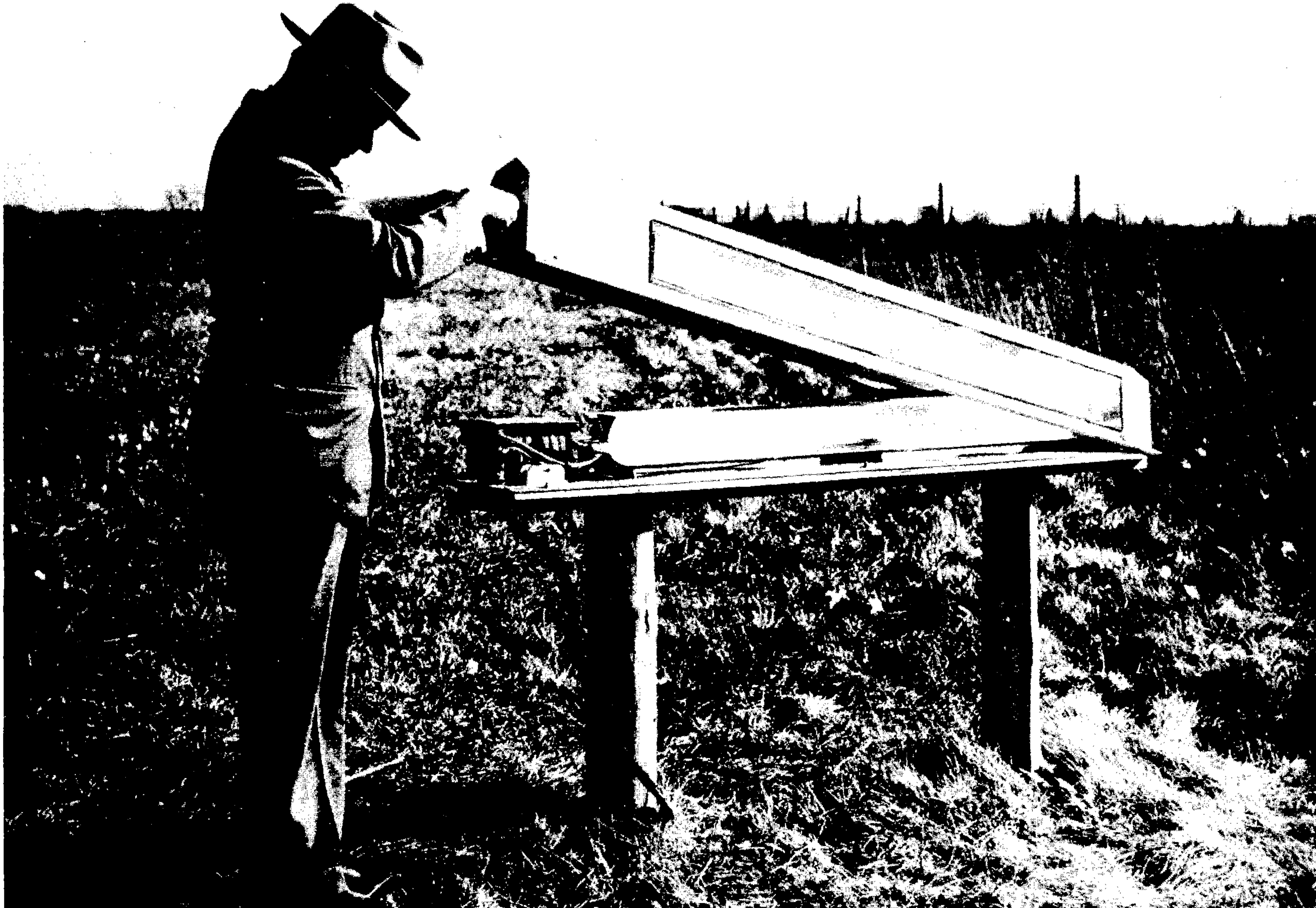


Figure 3. Method of Removing One-Piece Cover From Leland Boundary Light.

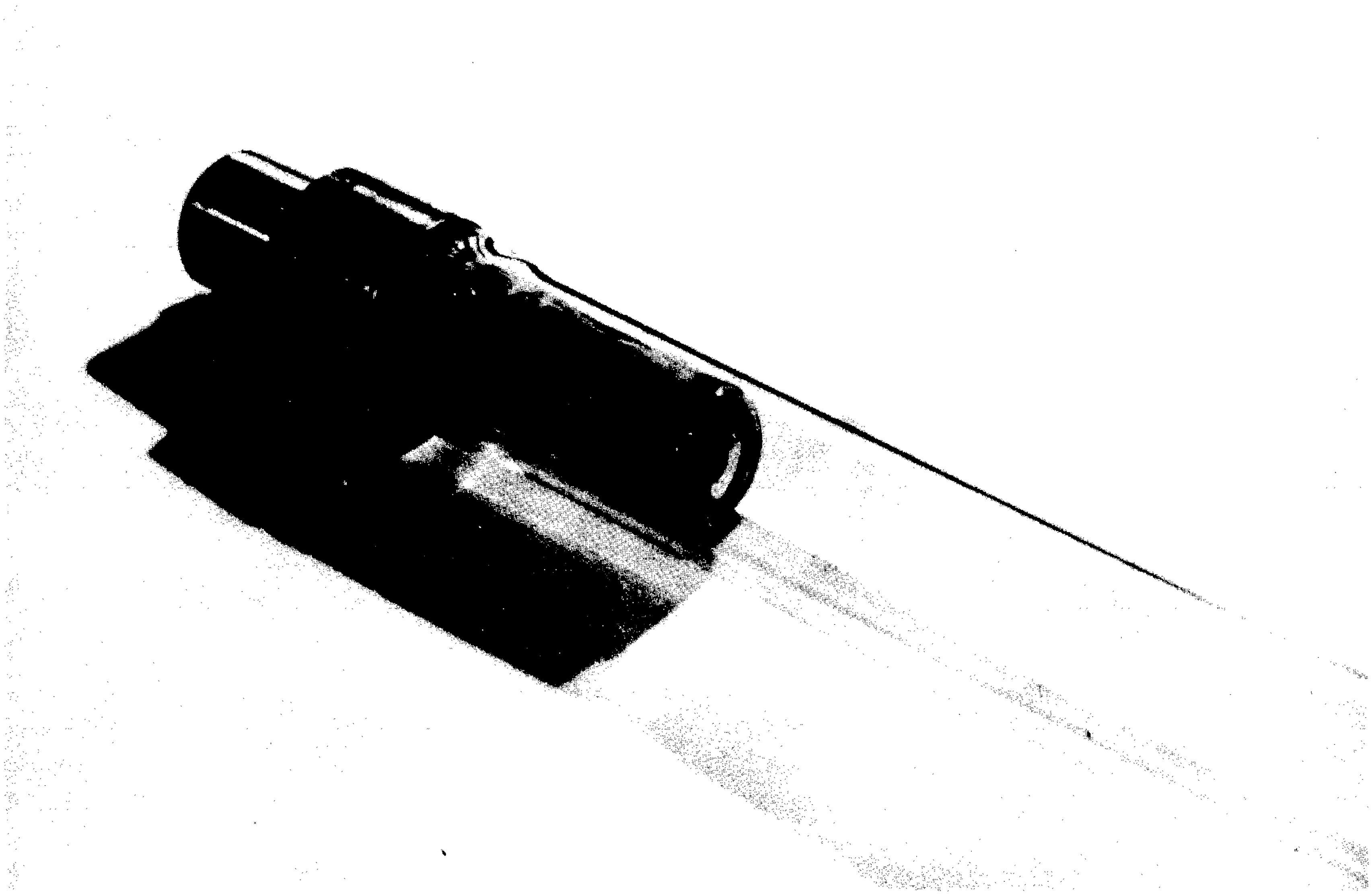
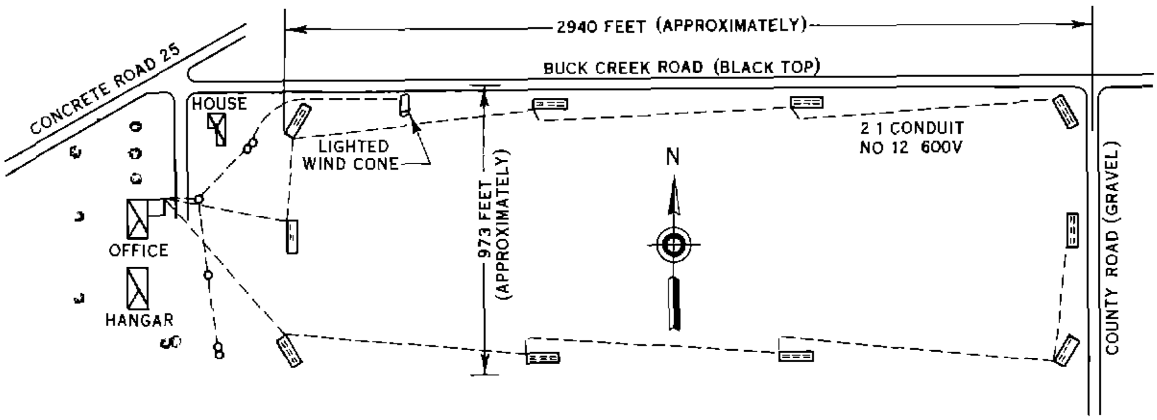
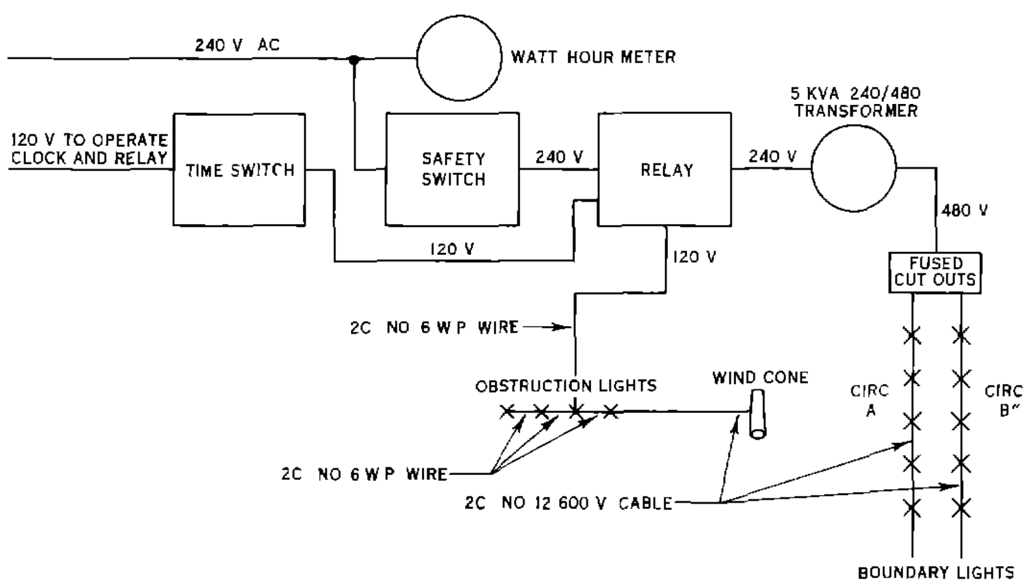


Figure 4. Leland High Intensity Neon Lamp. Close-Up View of Ceramic Electrode.



LEGEND

o SINGLE OBSTRUCTION LIGHT
oo DOUBLE OBSTRUCTION LIGHTS
2 COLOR BOUNDARY LIGHT



SCHEMATIC WIRING DIAGRAM

Figure 5 Two Color Experimental Boundary Lighting, Aretz Airport

COST ESTIMATE OF TYPICAL INSTALLATION

2000 feet No 6 weatherproof wire		$ 60 00
18,000 feet No 12 - 600-volt Crescent Trenchwire		590 00
1 - Time switch		15 00
1 - 60 ampere 2-pole safety switch		11 90
1 - 15 ampere relay or line starter		16 00
1 - 5 KVA 240/480-volt oil transformer		85 00
1 - 600-volt 30 ampere fused disconnect		11 90
5 - Pole brackets and insulators		2 50
2 - Single obstruction light assemblies		42 00
2 - Double obstruction light assemblies		72 00
10 - Leland two-color boundary lights @ $100 00		1000 00
1 - Westinghouse wind cone light assembly with folding mast		185 00
2 - Screw anchors		1 50
100 feet 3/8 inch guy wire		3 00
40 feet - 1 inch galvanized conduit		5 20
20 feet - 3/4 inch galvanized conduit		9 39
Miscellaneous ells, nipples, weatherheads, bushings, locknuts, wire and tape		5.00
Purchase and installation of four 45-foot Class 3 poles		200 00
1 yard ready mixed concrete for wind cone base		10 00
Miscellaneous posts and lumber for lighting unit mounts		15.00
Rental of cable plow		25 00
Labor to make installation		
1 Electrician 7 man days	99 70	
1 Electrician's helper 7 man days	75 50	
2 Laborers 14 man days	112 00	
		287 20
		$2652 59

OPERATING COST ESTIMATE OF BOUNDARY, OBSTRUCTION & WIND CONE LIGHTING FOR ARETZ AIRPORT, LAFAYETTE, INDIANA

10 Boundary lights @ approximately 300 watts	3 00 kw
6 Obstruction lights @ 60 watts	0 36 kw
5 Wind cone lights @ 60 watts	0 30 kw
Estimated line and transformer losses	0 34 kw
	4 00

Hourly power consumption estimated at not more than 4 KWH costing approximately 15 cents per hour

Figure 6 Cost Estimates

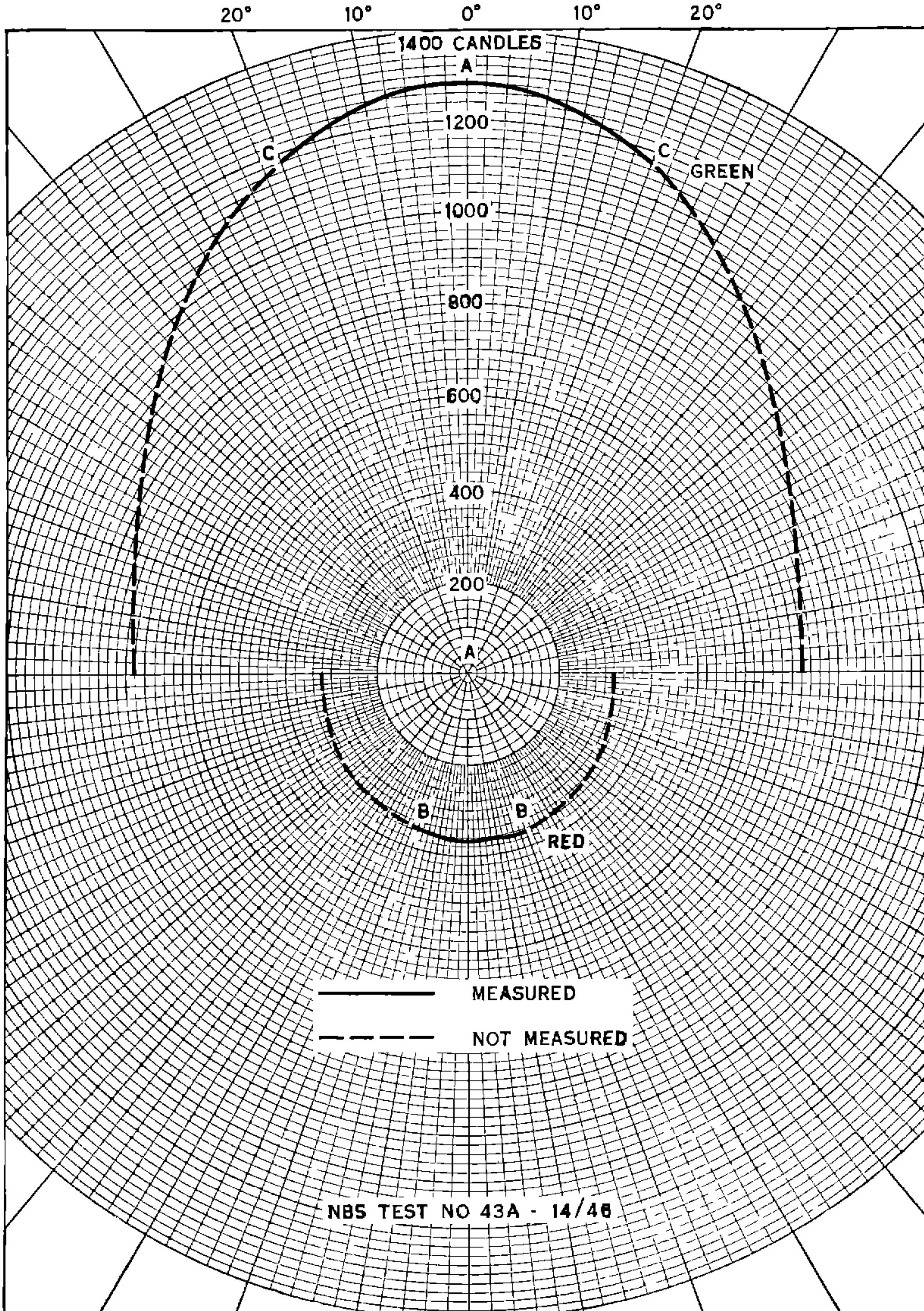


Figure 7 Horizontal Distribution – Leland Two Color Boundary Light

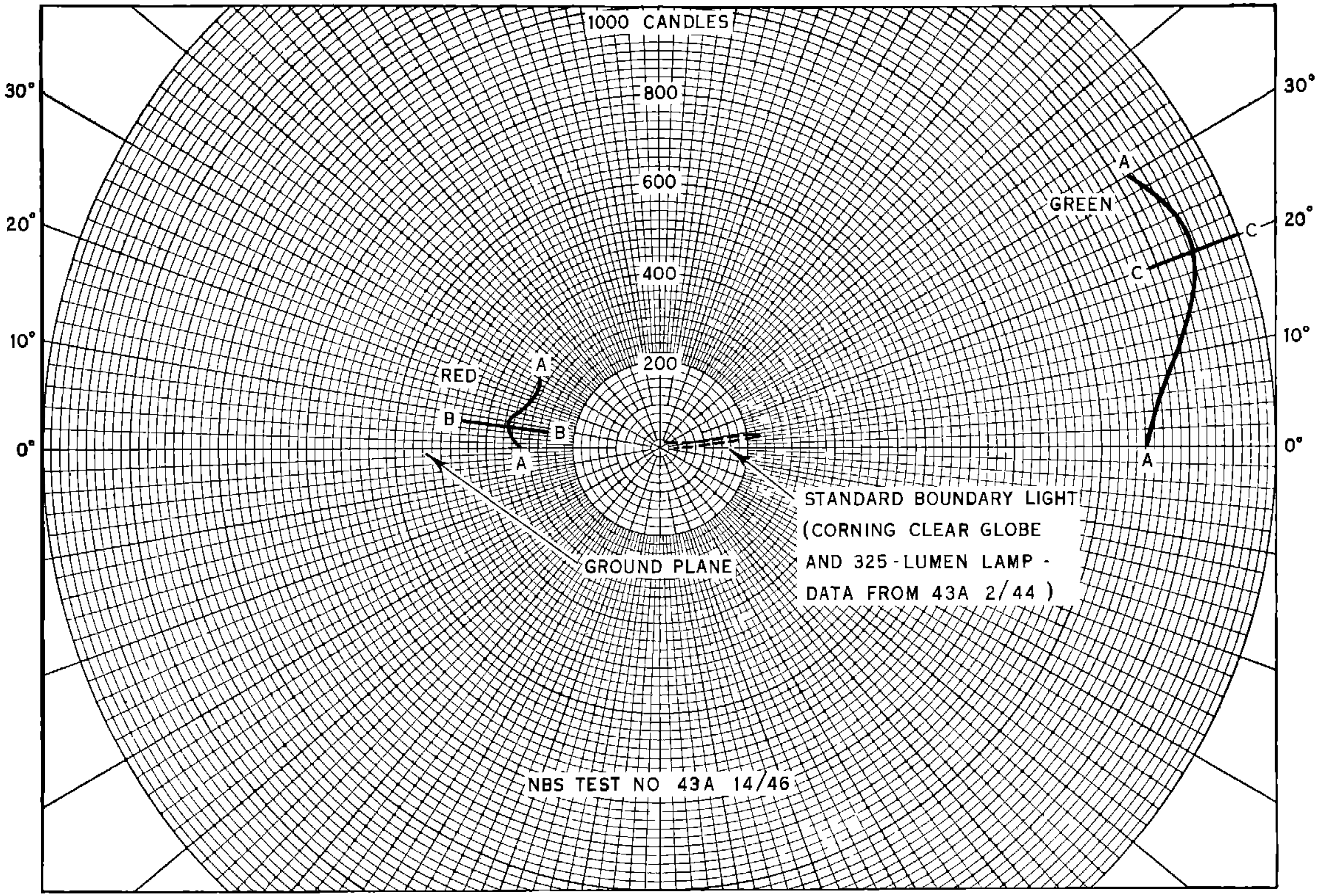


Figure 8 Vertical Distribution – Leland Two-Color Boundary Light
Compared with Standard Boundary Light