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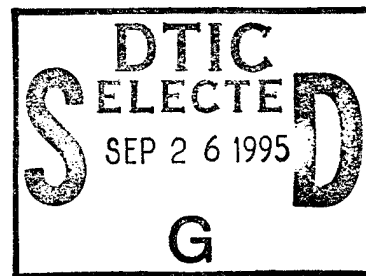
Compact Fluorescent Retrofits for Incandescent Downlight Fixtures

by
William R. Taylor

Compact fluorescent (CF) lamps, which are available as an energy-efficient replacement for ordinary incandescent light bulbs, can be used in a variety of fixture types, including existing incandescent, ceiling-mounted, recessed downlights. However, CF lamps are not shaped or sized identically to the incandescent bulbs being replaced; therefore, light distribution will be changed by these retrofits.

Army facilities have numerous incandescent downlight fixtures that are candidates for compact fluorescent retrofits. The information in this study can provide guidance for selecting appropriate retrofits.

This study examined the photometric effects of installing several types of CF lamps in several types of incandescent downlight fixtures. Test results show that, for shallow depth fixtures, several types of CF lamps perform adequately. For deeper fixtures using nonreflective baffle rings, retrofitting with some CF lamps causes light output from the fixture to drop drastically. CF retrofits also caused a wider pattern of light distribution and increased luminance values. Changes in distribution and luminance need to be considered by Army facility managers contemplating CF retrofits.



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Foreword

This study was conducted for the U.S. Army Center for Public Works (USACPW), and for the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE) under Project 40162784AT45, "Energy and Energy Conservation"; Work Unit FE-XH4, "Lighting Technology Retrofits." The technical monitors were Samuel Baidoo, CECPW-EE, and Robert Billmyre, CEMP-ET-E.

The research was performed by the Utilities Division (UL-U) of the Utilities and Industrial Operations Laboratory (UL), U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was William R. Taylor. Martin J. Savoie is Chief, CECER-UL-U; John T. Bandy is Operations Chief, CECER-UL; and Gary W. Schanche is Chief, CECER-UL.

COL James T. Scott is Commander and Acting Director, USACERL, and Dr. Michael J. O'Connor is Technical Director.

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1 Introduction

Background

Compact fluorescent (CF) lamps were introduced in the early 1980s as an energy-efficient substitute for the standard incandescent light bulb. CF input power is typically about one-fourth of the input power of the incandescent lamp having approximately the same light output (lumens). Also, CF lamps have a lamp life up to 10 times longer than that of the standard incandescent. Like all gaseous discharge lamps, CFs require a ballast to supply the proper voltage and to control electrical current. CF ballasts are equipped with a screw-in Edison base, which permits CFs to directly replace ordinary incandescent light bulbs. The popularity of CFs due to their energy savings and long life continues to increase despite initial purchase prices that are significantly higher than incandescent lamps.

One popular application of CF lamps is in recessed ceiling downlights, sometimes referred to as "can" downlights. In new construction, downlights designed for CF lamps can be specified. For existing incandescent downlights, a popular and economical retrofit is to replace the existing incandescent lamp with a lower wattage CF lamp. With proper selection, CF lamps can be an excellent retrofit choice. CF lamps are available in a variety of wattages, sizes, shapes, and constructions. Choosing an inappropriate CF lamp for a specific retrofit can lead to deficient lighting conditions related to quantity or quality of light output. Changes in distribution and luminance need to be considered by Army facility managers contemplating CR retrofits. Army facilities have numerous incandescent downlight fixtures that are candidates for compact fluorescent retrofits, and the information in this study can provide guidance for selecting appropriate retrofits.

Objective

The objective of this study is to test and evaluate the effects on light output of several downlight fixtures produced by retrofits with selected CF lamps. These test results lead to recommendations on selecting or avoiding some specific combinations of downlight fixtures and CF lamps.

Approach

Several types of downlight fixtures and common types of CF lamps were selected and purchased for testing. A test plan indicating which lamp/fixture combinations were reasonable for testing was developed. No testing was performed on incompatible lamps and fixtures; for example, when the lamp protruded out of the fixture (although this inappropriate retrofit has occasionally been observed in the field). Photometric testing was performed in a laboratory and results were analyzed.

Mode of Technology Transfer

The results of these tests will be provided to the U.S. Army Center for Public Works (USACPW), Alexandria, VA for dissemination to Army installations via a Public Works Technical Bulletin (PWTB) or other appropriate publications.

2 General Characteristics of Compact Fluorescent Lamps

This chapter describes some of the basic characteristics and features of compact fluorescent lamp products.

CF lamps are available as modular or integral units. Integral units have lamp and ballast incorporated into one unit; when replacement is required, both lamp and ballast are disposed. Modular units have the advantage that, after the 10,000-hour (typical) lamp life, the lamp can be replaced using the same ballast that might typically have an estimated life of 40,000 to 50,000 hours.

Ballasts may be magnetic or electronic. Generally, magnetic ballasts do not create total harmonic distortion (THD) levels that are considered excessive (since THD values are comparable to standard 4-foot fluorescent lighting, typically in the 10 to 20 percent range). Electronic ballasts have produced electrical current THDs of 100 percent or more. Manufacturers are expected to continue introducing products with lower THDs, but even with the high-percentage THD levels, retrofits using such CF lamps generally have not caused problems in buildings.

Ballasts are also available as normal power factor (NPF) or high power factor (HPF). HPF, by definition, insures a power factor of 90 percent or greater. For retrofit situations, power factor (and THD) are typically not a problem since electrical loading on circuits is likely to be greatly reduced by the retrofit. However, for new construction electrical designers will need to consider power factor and THD to avoid overloading circuits.

CF lamps are available in a variety of correlated color temperatures (CCT) that are measured in kelvins. A common CCT range is 2700 to 3000, similar to incandescent lamps. CF lamps typically have good color-rendering attributes since most use rare earth phosphors that yield color-rendering index (CRI) values in the 80s.

CF lamps also come in a variety of shapes, sizes, and wattages. Lamps are configured as twin tubes, double twin tubes, and other shapes, and some lamps offer surrounding reflectors or globe covers. The shape and size of the lamp makes some lamps more or less suitable for use in different types of fixtures. Figure 1 shows the suitability of

various CF lamps with various fixture types. One type of fixture found in Figure 1 and commonly used in buildings is the ceiling-mounted recessed downlight. Testing and analysis in the following chapters of this report will focus on application of several types of CF lamps in recessed downlights.














A P P L I C A T I O N S							
	 Downlights	 Surface Lights	 Pendant Fixtures	 2' x 2' Fixtures	 Sconce	 Exit/Step	 Floodlights
 Incandescent	+	+	+	-	+	+	+
 T-4 Twin-Tube	+	+	-	-	+	+	+
 T-4 Quad-Tube	+	+	+	-	+	-	-
 Integral Ballast Lamp	+	-	++	-	-	-	-
 Circline	-	+	+	-	+	-	-
 Reflector Unit	++	+	+	-	-	-	+
++ Superior lamp choice + Suitable lamp choice - Unsuitable lamp choice							

Figure 1. Applications of CF lamps in various fixtures.

3 CF Retrofit of Incandescent Downlights

Both incandescent fixtures and compact fluorescent lamps come in a variety of sizes and shapes, which creates the possibility of numerous retrofit combinations of fixtures and lamps (Figure 1 shows which CF lamp types work best with various fixture types). One of the most popular CF retrofits is in incandescent downlight ("can") fixtures. This chapter examines the effects of various CF lamp types in incandescent fixtures.

Test Plan

Several incandescent downlight fixtures were selected to be representative of commonly found fixtures in the field. The fixtures selected were:

- Incandescent downlight, shallow ($7 \frac{3}{8}$ in.) can, about 6 in. diameter, short reflector
- Incandescent downlight, shallow ($7 \frac{3}{8}$ in.) can, about 6 in. diameter, full reflector
- Incandescent downlight, deep (11 in.) can, about 6 in. diameter, full reflector
- Incandescent downlight, deep (11 in.) can, about 6 in. diameter, no reflector, black baffle
- CF downlight, shallow can, about 6 in. diameter, partial reflector, vertical lamp
- CF downlight, shallow can, about 6 in. diameter, partial reflector, horizontal lamp.

Several types of CF lamps were selected to be representative of lamps that might commonly be selected for retrofits. The CF lamp types selected were:


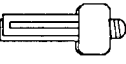





- 15-watt integral unit with opal globe (bullet shaped)
- 11-watt double twin tube integral unit
- 13-watt double twin tube modular unit, adapter (ballast) selected by test lab
- 13-watt double twin tube modular unit with reflector and lens, adapter from reflector manufacturer
- 15-watt double twin tube modular unit with open reflector.

For comparison with the CF lamps, a 60-watt A-19 incandescent lamp and a 150-watt R40 spot incandescent lamp were tested in the incandescent downlights. Also for comparison, two CF fixtures with a 13-watt double twin tube CF lamp were tested.

Figure 2 shows a matrix of lamp types and fixture types and indicates which lamp and fixture combinations were tested. Test numbers (e.g., ITL40777) correspond to the photometric reports in the Appendix. Where lamp/fixture combinations indicate no test was performed, the primary reasons for not testing were (1) the fixture reflector was too narrow at the base to allow the CF lamp to reach the socket, or (2) the CF lamp was too long, causing the lamp to protrude out of the fixture.

Analysis of Photometric Test Data

The photometric test data (shown in the Appendix) is presented in Figures 3 through 7 to permit a comparison of data from identical tests performed on various lamp/fixture combinations.

TEST PLAN (numbers indicate ITL Report No. in Appendix A)		Bare Lamp Test	CF Fixture - shallow can, vertical lamp	CF Fixture - shallow can, horizontal lamp	Incandescent fixture - shallow can, short reflector	Incandescent fixture - shallow can, full reflector	Incandescent fixture - deep can, full reflector	Incandescent fixture - deep can, black baffle
Opal Globe 15 Watts Integral Unit			X	X	40777	40779	40781	40785
Double Twin Tube 11 watts Integral Unit			X	X	X	X	40782	40786
Double Twin Tube 13 watts Modular			40775	40776	X	X	X	40787
Reflector Unit with Lens, 13 Watt Modular			X	X	X	X	40783	40788
Open Reflector Unit 15 Watts			X	X	X	X	X	40789
Incandescent A-19 60 Watts			X	X	40778	40780	40784	X
Incandescent R40 Spot 150 Watts			X	X	X	X	X	40790

X indicates NO TEST performed (all remaining squares tested)

Figure 2. Test plan for lamp and fixture combinations.

Total Luminaire Efficiency

Figure 3 shows luminaire efficiencies from the test data. The CF fixture with the horizontally mounted lamp has a luminaire efficiency of 66 percent compared to 44 percent for the vertically mounted lamp. Incandescent fixture efficiencies ranged from 56 to 65 percent. Efficiency data for the shallow can fixtures and the deep can fixture with reflector ranged from 70 to 80 percent except for the enclosed reflector lamp in the deep can fixture, which had a 44 percent efficiency. Several of the CF lamps were not tested in these fixtures (for reasons stated before). The deep can fixture with black baffle showed very low efficiencies with all but one of the CF lamps, with efficiencies ranging from 9 to 28 percent except for the open reflector lamp, which raised luminaire efficiency to 72 percent.

Zonal Lumen Summary and Bare Lamp Lumen Outputs

Figure 4 shows lumen output for the lamp/fixture test combinations, calculated by multiplying the luminaire efficiency by the measured lamp lumen output. (Note that total lumens in the zonal lumen summary of the photometric data is calibrated for the lamps' nominal rated lumens, not measured bare lamp lumens.) Photometric testing of the bare lamps showed total lumen output to be lower than lamp rated lumens for all lamps but one.

LUMINAIRE EFFICIENCY							
	Bare Lamp Lumens	CF Fixture - shallow can, vertical lamp	CF Fixture - shallow can, horizontal lamp	Incandescent fixture - shallow can, short reflector	Incandescent fixture - shallow can, full reflector	Incandescent fixture - deep can, full reflector	Incandescent fixture - deep can, black baffle
Opal Globe™ 15 Watts Integral Unit	668	X	X	80%	76%	72%	
	657						19%
Double Twin Tube 11 watts Integral Unit	633	X	X	X	X	70%	9%
Double Twin Tube 13 watts Modular	662	44%	66%	X	X	X	
	788						11%
Reflector Unit with Lens, 13 Watt Modular	(707)	X	X	X	X		
	371					44%	28%
Open Reflector Unit 15 Watts	726	X	X	X	X	X	
							72%
Incandescent A-19 60 Watts	818	X	X	58%	65%	56%	
Incandescent R40 Spot 150 Watts	1791						60%

Figure 3. Luminaire efficiencies.


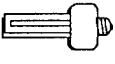
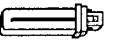




		LAMP RATED LUMENS		CF Fixture - shallow can, vertical lamp	CF Fixture - shallow can, horizontal lamp	Incandescent fixture - shallow can, short reflector	Incandescent fixture - shallow can, full reflector	Incandescent fixture - deep can, full reflector	Incandescent fixture - deep can, black baffle
		Lamp Lumens	Bare Lamp Lumens						
Opal Globe 15 Watts Integral Unit		700	668	X	X	532	508	480	
		700	657						123
Double Twin Tube 11 watts Integral Unit		600	633	X	X	X	X	440	58
Double Twin Tube 13 watts Modular		860	664	291	436	X	X	X	
		860	788						90
Reflector Unit with Lens, 13 Watt Modular		800	707	X	X	X	X		
			371					165	104
Open Reflector Unit 15 Watts		900	726	X	X	X	X		523
Incandescent A-19 60 Watts		870	818	X	X	470	533	456	
Incandescent R40 Spot 150 Watts		1900	1791						1073

Figure 4. Lumen output for lamp/fixture test combinations.

Lumen output for the following lamp/fixture combinations were comparable to the 60-watt incandescent lamp: (1) the opal globe CF lamp with the 3 reflector fixtures; (2) the double twin tube 11-watt unit with the deep can, full reflector fixture; (3) the double twin tube 13-watt unit in the horizontally mounted CF fixture; and (4) the open reflector 13-watt unit in the deep can, black baffle fixture.

The 150-watt R40 spot lamp was tested in the deep can black baffle fixture to represent a lamp that might be used in such a fixture in the field, given the maximum wattage stamped on the fixture was 150 watts. As expected, lumen output of the 150-watt lamp was significantly greater than the other lamp/fixture combinations, approximately double the lumen output of the 60-watt incandescent in the reflector fixtures and other comparable combinations.

Input Power and Efficacy

Figure 5 shows input watts for the lamps and the calculated efficacy (lumens/watt) for both the bare lamps and the lamp/fixture combinations. (The lumen values from Figure 4 were used to calculate efficacy.)


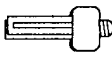
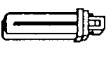



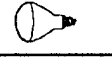
		EFFICACY (Lumens/watt)		CF Fixture - shallow can, vertical lamp	CF Fixture - shallow can, horizontal lamp	Incandescent fixture - shallow can, short reflector	Incandescent fixture - shallow can, full reflector	Incandescent fixture - deep can, full reflector	Incandescent fixture - deep can, black baffle
		(for lamp/fixture combined)	Input Watts at 120v.						
Opal Globe 15 Watts Integral Unit		16.1	41	X	X	33	32	30	
		16.1	41						8
Double Twin Tube 11 watts Integral Unit		11.6	55	X	X	X	X	38	5
Double Twin Tube 13 watts Modular		15.8	42	19	27	X	X	X	
		17.2	46						5
Reflector Unit with Lens, 13 Watt Modular		15.6	24	X	X	X	X	11	7
Open Reflector Unit 15 Watts		15.1	48	X	X	X	X		35
Incandescent A-19 60 Watts		60	14	X	X	8	9	8	
Incandescent R40 Spot 150 Watts		150	12						7

Figure 5. Efficacy (lumens/watt) for lamp/fixture combinations.

Efficacies for the two incandescent lamps were 12 and 14 lumens per watt (lm/W) for the bare lamps and ranged from 7 to 9 lm/W for the combined lamp and fixture. CF bare lamp efficacies ranged from 24 to 55 lm/W. CF lamp and fixture combinations produced efficacies of 19 to 38 lm/W for reasonable retrofit combinations and efficacies of 5 to 7 lm/W for less desirable retrofits.

Candela Distribution Curves

Figure 6 shows candela distribution curves for the lamp/fixture test combinations. The curves are presented in reduced size which, although it is difficult to read the scales, will permit side-by-side comparison of the light distribution patterns. The Appendix contains more legible curves.

Candela distribution for the incandescent lamps in various fixtures all exhibited a relatively narrow beam spread. The CF reflector lamps had a slightly less narrow beam, and the opal globe unit with a length that protruded nearly to the end of the fixture exhibited a wide beam spread. The 11-watt CF required several adapters to reach the socket and, therefore, also reached nearly to the end of the fixture, producing

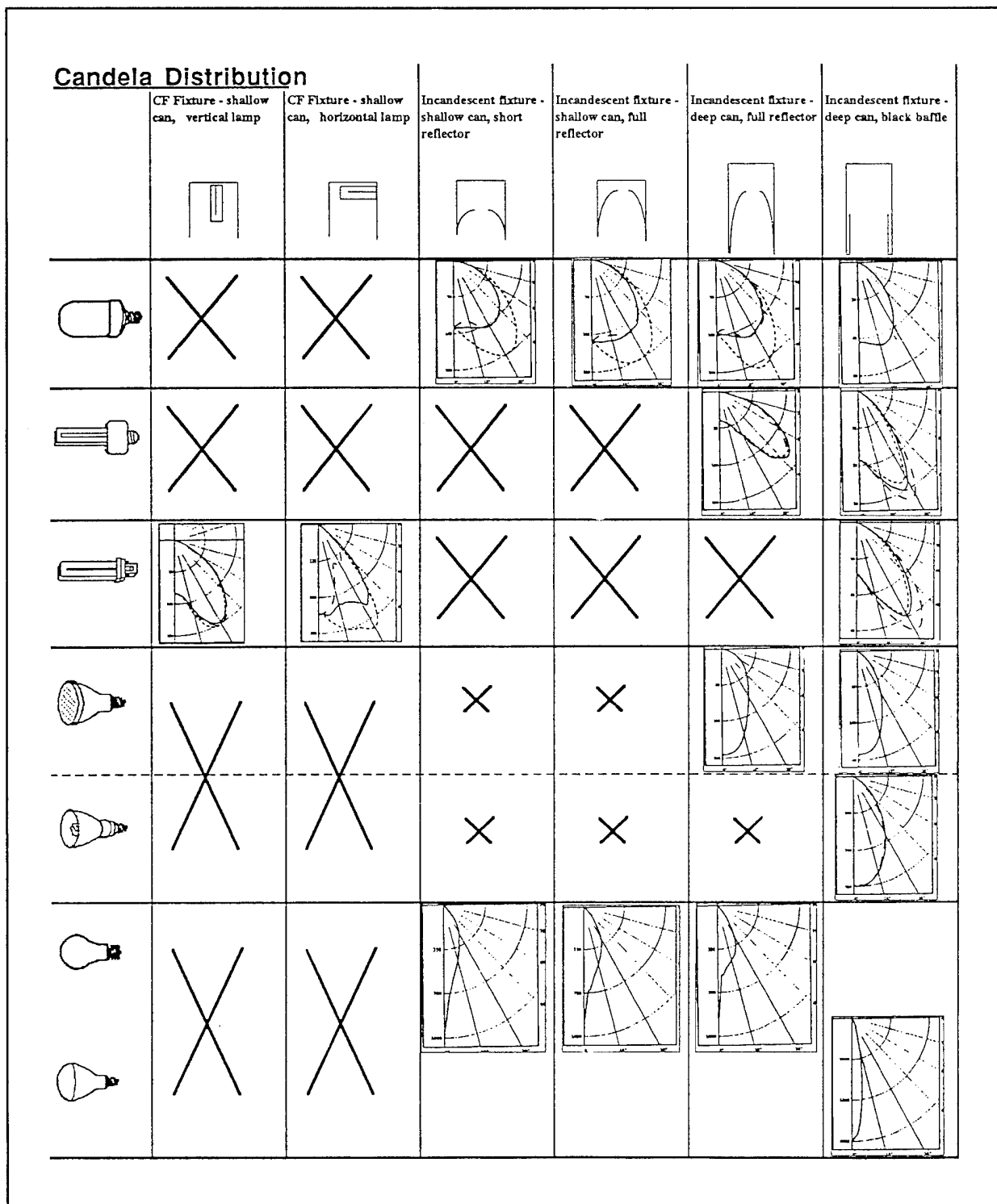


Figure 6. Candela distribution curves for lamp/fixture test combinations.

a wide beam spread. The CF fixtures exhibited a medium beam spread. Not surprisingly, the horizontally mounted CF produced a less symmetric beam than the vertically mounted CF.

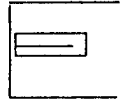
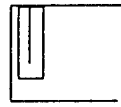
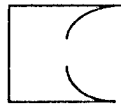
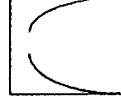

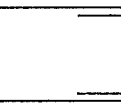
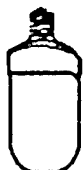




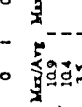
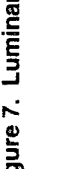





Luminance Data

Luminance data provides an indication of the "brightness" of the fixture opening when viewed from various angles. For the fixtures tested, the fixture opening is approximately a 6-inch diameter when viewed directly beneath the fixture. Luminance data shown in Figure 7 indicates the average and maximum luminance of the fixture opening, and a ratio of maximum to average luminance is calculated.

As expected, the incandescent lamps with narrow beam patterns, probably indicative of a light source recessed into the fixture, had very low luminance values at medium and high cutoff angles. Luminance values for the deep can black baffle fixture were very low.

The opal globe lamp produced slightly higher luminance values through a broader range of viewing angles than the other CF lamps. However, the maximum to average ratios were very low, probably due to the soft light appearance of the opal globe.

Luminance Data

CF Fixture - shallow can, vertical lamp	CF Fixture - shallow can, horizontal lamp	Incandescent fixture - shallow can, short reflector	Incandescent fixture - shallow can, full reflector	Incandescent fixture - deep can, full reflector	Incandescent fixture - deep can, black baffle																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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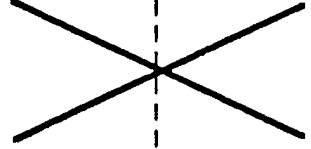
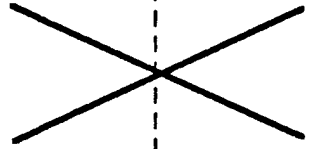




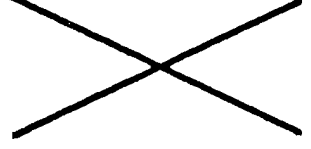
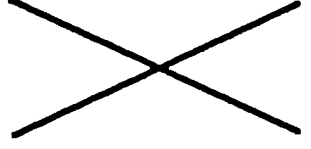


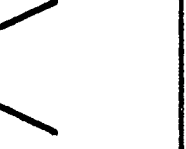
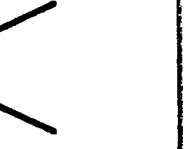

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75	0.0																																																																																			
85	0.0																																																																																			

Figure 7. (Cont'd)

4 Conclusions and Recommendations

Of the two CF fixtures tested, the horizontally mounted lamp configuration showed a significantly higher fixture efficiency than the vertically mounted lamp. It is recommended that designers be aware of this and, where manufacturers' data confirms this to be the case, specify horizontally mounted lamps in CF fixtures.

When retrofitting incandescent downlights that are constructed as a deep (about 11 in.) can with a black baffle ring, selection of a suitable CF lamp is critical. From the limited testing being reported here, the only CF lamp that was capable of directing light out of the fixture with reasonable efficiency (72 percent) was the open-ended reflector CF lamp unit. Other CF lamps caused fixture efficiency to drop to a range of 9 to 28 percent.

Several of the CF lamps that were retrofitted into incandescent downlights for these tests produced fixture efficiencies that were as high as the efficiency of the CF fixture manufactured for use with a CF lamp.

All but one of the CF lamps tested produced lower bare lamp lumens than the nominal lumen rating of the lamp. While the sample size of this testing was very small, these results are consistent with observations in other testing.* Lumen output of several CF lamps in the various fixtures confirmed the general rule-of-thumb that CF lamps consuming one-fourth the watts of the incandescent being replaced will produce approximately the same amount of light; this assumes a proper retrofit lamp selection for the fixture. Inappropriate CF lamp and fixture combinations showed overall efficacies no better than properly matched incandescent lamps and fixtures.

Candela distribution indicates that fixtures with the CF lamps create a wider spread in the distribution pattern. Even when total lumen output is approximately equal, the incandescents provide more intense light directly beneath the fixture (0 to 30 degrees) while the CF lamps provide more light than incandescents at 50 to 60 degrees. For general area lighting applications, this wider distribution from CF lamps may not be a problem. In applications where downlights are lighting a specific area (walls, objects, and so on), the wider distribution could be undesirable. In such cases it is

* Lighting Research Center, "Screwbase Compact Fluorescent Lamp Products," *Speci:ier Reports*, vol 1, No. 6 (April 1993).

recommended that a trial installation of the proposed retrofit be used to determine the appropriateness of the selected CF lamp.

In addition to affecting the candela distribution, the geometry and placement of retrofit CF lamps will affect the luminance of the light source, with excessive luminance causing discomfort glare. The test data indicate luminance values for many of the lamp/fixture combinations (including the incandescents) exceed the Illuminating Engineering Society of North America (IESNA) values,* which indicates that discomfort glare is a problem. The opal globe CF units had the most consistently high luminance values, but they also had some of the lowest maximum to average luminance ratios. The diffusing action of the opal globe reduces the luminance difference between the brightest spot and the surrounding area of the fixture. While luminance data from these tests do not show that discomfort glare will be a problem for various field applications, the generally higher luminance values for CF lamps compared to the incandescent lamps is a warning that discomfort glare warrants consideration when evaluating retrofits.

The conclusions from this testing are summarized in Figure 8, which shows lamp/fixture combinations recommended or not recommended for retrofits. It is assumed that even for the recommended retrofits, the user will need to evaluate the potential change in candela distribution and luminance as discussed previously.

* IESNA, *Lighting Handbook* (IESNA, 1993).


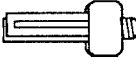
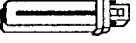




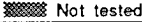
		D O W N L I G H T A P P L I C A T I O N S					
		CF Fixture - shallow can, vertical lamp	CF Fixture - shallow can, horizontal lamp	Incandescent fixture - shallow can, short reflector	Incandescent fixture - shallow can, full reflector	Incandescent fixture - deep can, full reflector	Incandescent fixture - deep can, black baffle
Opal Globe Integral Unit				+	+	+	-
Double Twin Tube Integral Unit						+	-
Double Twin Tube Modular		+	++				-
Reflector Unit with Lens, Modular						-	-
Open Reflector Unit							++
Incandescent A-19				Not Energy Efficient	Not Energy Efficient	Not Energy Efficient	
Incandescent R40 Spot							Not Energy Efficient
		++ Superior lamp/fixture combination + Suitable lamp/fixture combination - Unsuitable lamp/fixture combination  Not tested					

Figure 8. Summary of testing of lamp/fixture combinations.

Appendix: Photometric Test Data



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1257 FAX (303) 449-5277

REPORT NUMBERS: ITL40775-ITL40790
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 8-30-1993

ABSOLUTE LUMEN OUTPUTS

All lamps were seasoned according to IES LM-54 prior to testing. Lumen output of each lamp was measured prior to photometric testing. The lamps were mounted on the goniophotometer and twelve planes of data were recorded at 2.5 degree vertical increments. The planes were averaged and lumen output was calculated using zonal constants from the candela data. The candela calibration is traceable to the National Institute of Standards and Technology (formerly the National Bureau of Standards). Testing was performed in a 25 +/- 1 degree Celsius free air ambient. Lumen output is for the particular sample when operated on the ballast described in the report. Due to retesting, the lumen output of the FLB15/TL was measured more than once. The Lumatech RAS-130 was measured bare and with the reflector installed, both values are shown. Since the lumen rating is for the bare lamp, the bare lamp lumen output was used for calculating luminaire efficiency. All photometric reports are issued as standard relative photometry, all data is reported as if the lamps produced rated lumens.

Lamp	Rated Lumens	Measured Lumens	Report Numbers
13-Watt DTT Compact Fluorescent, BU	860	664	40775
13-Watt DTT Compact Fluorescent, Hor	860	662	40776
15-Watt FLB15/TL Fluorescent, BU	700	668	40777, 40779, 40780
GE A60 60-Watt Incandescent	870	818	40778, 40780, 40781
11-Watt Osram DULUX EL, BU	600	633	40782, 40786
13-Watt Lumatech RAS-130, Bare, BU	860	707	40783, 40788
13-Watt Lumatech RAS-130, w/reflector	—	371	40783, 40788
15-Watt FLB15/TL Fluorescent, BU	700	657	40785
13-Watt AO13/13DTT Adapter/lamp, BU	860	788	40787
15-Watt Osram DULUX EL Reflector, BU	900	726	40789
150-Watt R40 Spot Incandescent	1900	1791	40790

MAXIMUM LUMINANCE MEASUREMENTS

Maximum luminance was measured using a Tektronix J6523 1 Degree Luminance probe instead of ITL's standard Maximum Brightness meter due to the small luminous area of these units. All values were adjusted using the ratio of the rated lumens versus the measured lumens and reported at rated lamp lumens (standard relative photometry procedure).

NOTE: Test ITL40784 required the addition of one adapter in order for the lamp to screw into the socket.

Respectfully Submitted,

Randall P. Bergin
Director of Engineering



FAX (303) 449-5274

INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255

REPORT NUMBER: ITL40775

DATE: 7-26-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

CATALOG NUMBER: SHALLOW CAN, VERTICAL LAMP

LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH WHITE PAINTED INTERIOR, SPECULAR ALUMINUM LOWER CONE REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.

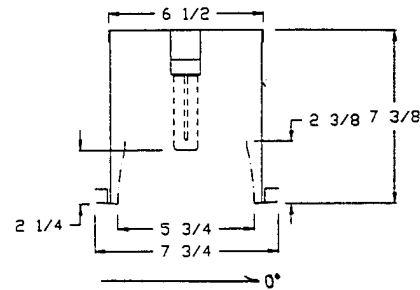
LAMP: 13-WATT DOUBLE TWIN TUBE COMPACT FLUORESCENT, RATED 860 LUMENS, VERTICAL BASE-UP POSITION.

BALLAST: ROBERTSON HP-S1

MOUNTING: RECESSED

TOTAL INPUT WATTS= 15.6 AT 120.0 VOLTS

CANDELA DISTRIBUTION						FLUX
	0.0	22.5	45.0	67.5	90.0	
0	83	83	83	83	83	
5	85	85	85	85	85	8
15	120	120	116	113	110	33
25	150	152	146	147	143	68
35	141	146	145	147	142	90
45	108	111	111	113	113	86
55	72	72	72	74	75	65
65	25	25	26	28	28	26
75	0	0	0	0	0	0
85	0	0	0	0	0	0
90	0	0	0	0	0	0

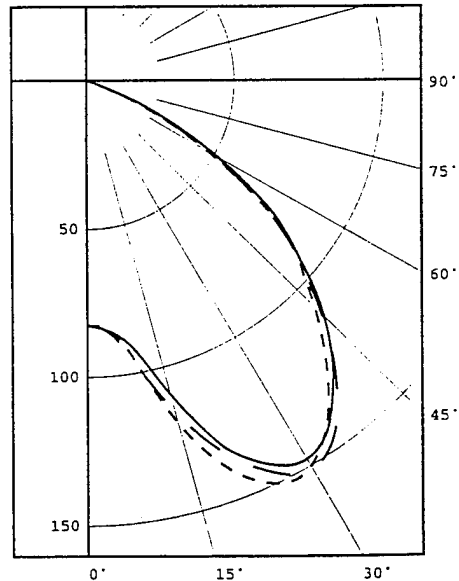


ZONAL LUMEN SUMMARY			
ZONE	LUMENS	%LAMP	%FIXT
0- 30	110	12.8	29.1
0- 40	200	23.2	53.0
0- 60	350	40.8	93.0
0- 90	377	43.8	100.0
90-180	0	0.0	0.0
0-180	377	43.8	100.0

TOTAL LUMINAIRE EFFICIENCY = 43.8 %
 CIE TYPE - DIRECT
 PLANE : 0-DEG 90-DEG
 SPACING CRITERIA : 1.9 2.0
 LUMINOUS DIAMETER: 5.750

LUMINANCE DATA IN CANDELA/SQ M			
ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
45	9129.	9391.	9492.
55	7479.	7489.	7812.
65	3473.	3656.	3981.
75	0.	23.	0.
85	0.	0.	0.

ANGLE LUMINANCE DATA IN CANDELA/SQ M				
ANGLE IN DEG	MAXIMUM 0-DEG	MAXIMUM 90-DEG	MAX/AVG 0-DEG	MAX/AVG 90-DEG
45	35151.	40167.	3.9	4.2
55	30358.	32400.	4.1	4.1
65	19839.	22724.	5.7	5.7
75	352.	138.	0.0	0.0
85	12.	8.	0.0	0.0



LEGEND:
 0-deg: - - - - -
 45-deg: ————
 90-deg: ————

Checked *B. Ludwig*
 Approved *R.P. Dent*

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE



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FAX (303) 449-5274

REPORT NUMBER: ITL40775
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-26-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0
0.0	83	83	83	83	83
2.5	83	83	83	83	83
5.0	85	85	85	85	85
7.5	89	90	90	88	87
10.0	97	98	98	94	92
12.5	108	109	106	103	100
15.0	120	120	116	113	110
17.5	130	131	125	124	120
20.0	139	140	133	134	130
22.5	146	147	140	141	137
25.0	150	152	146	147	143
27.5	152	155	150	152	146
30.0	150	155	151	153	147
32.5	146	152	149	152	146
35.0	141	146	145	147	142
37.5	133	139	138	140	135
40.0	125	130	130	132	129
42.5	117	121	121	123	121
45.0	108	111	111	113	113
47.5	100	102	102	104	103
50.0	93	93	93	94	93
52.5	84	84	83	85	85
55.0	72	72	72	74	75
57.5	59	60	60	62	63
60.0	47	48	49	50	51
62.5	36	36	37	39	40
65.0	25	25	26	28	28
67.5	14	14	15	17	18
70.0	2	3	4	4	5
72.5	0	0	0	0	0
75.0	0	0	0	0	0
77.5	0	0	0	0	0
80.0	0	0	0	0	0
82.5	0	0	0	0	0
85.0	0	0	0	0	0
87.5	0	0	0	0	0
90.0	0	0	0	0	0

ZONAL LUMEN SUMMARY

0- 5	2.
5- 10	6.
10- 15	13.
15- 20	21.
20- 25	30.
25- 30	38.
30- 35	44.
35- 40	46.
40- 45	45.
45- 50	41.
50- 55	36.
55- 60	28.
60- 65	18.
65- 70	8.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.



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REPORT NUMBER: ITL40775

DATE: 7-26-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	52	52	52	52	51	51	51	51	49	49	49	47	47	47	45	45	45	44
1	49	47	45	44	47	46	45	43	44	43	42	42	42	41	41	40	39	39
2	45	42	39	37	44	41	39	37	39	37	36	38	36	35	37	35	34	33
3	41	37	34	31	40	36	33	31	35	33	31	34	32	30	33	31	30	29
4	38	33	29	27	37	32	29	27	31	29	26	30	28	26	29	27	26	25
5	35	29	26	23	34	29	26	23	28	25	23	27	25	23	27	24	22	21
6	32	27	23	20	31	26	23	20	25	22	20	25	22	20	24	21	20	19
7	30	24	20	18	29	24	20	18	23	20	18	22	20	17	22	19	17	16
8	27	22	18	16	27	21	18	16	21	18	16	20	18	15	20	17	15	15
9	26	20	16	14	25	20	16	14	19	16	14	19	16	14	18	16	14	13
10	24	18	15	13	23	18	15	13	18	15	12	17	14	12	17	14	12	12

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE.



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INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255

REPORT NUMBER: ITL40776

DATE: 7-28-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

CATALOG NUMBER: SHALLOW CAN, HORIZONTAL LAMP

LUMINAIRE: FABRICATED METAL FRAME, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PLASTIC TRIM RING, OPEN BOTTOM.

LAMP: 13-WATT DOUBLE TWIN TUBE COMPACT FLUORESCENT, RATED 860 LUMENS, HORIZONTAL POSITION.

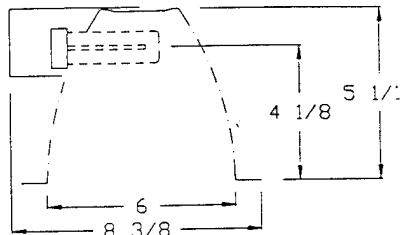
BALLAST: ROBERTSON HP-S1

MOUNTING: RECESSED

TOTAL INPUT WATTS= 16.0 AT 120.0 VOLTS
THE 0 DEGREE PLANE IS OPPOSITE THE SOCKET.

LAMP CALIBRATION POSITION: HORIZONTAL

(** explanation to follow **)



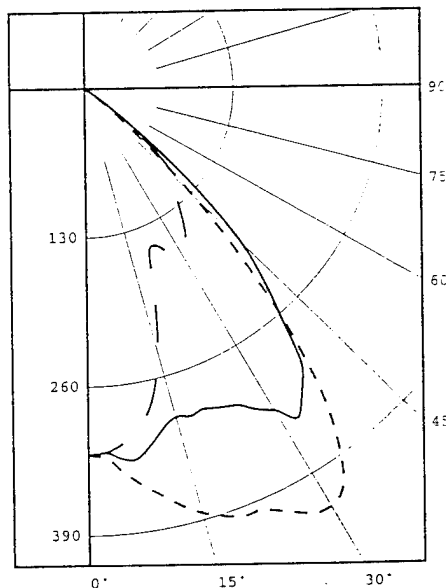
CANDELA DISTRIBUTION

	0.0	45.0	90.0	135.0	180.0	FLUX
0	320	320	320	320	320	31
5	335	333	324	317	313	88
15	384	359	297	270	238	133
25	409	353	306	197	153	174
35	380	348	326	176	150	121
45	132	192	191	131	109	16
55	5	8	14	16	16	1
65	0	1	1	1	1	0
75	0	0	0	0	0	0
85	0	0	0	0	0	0
90	0	0	0	0	0	0

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	251	29.2	44.6
0- 40	426	49.5	75.4
0- 60	563	65.5	99.8
0- 90	564	65.6	100.0
90-180	0	0.0	0.0
0-180	564	65.6	100.0

TOTAL LUMINAIRE EFFICIENCY = 65.6 %
 CIE TYPE - DIRECT
 PLANE : 0-DEG 90-DEG 180-DEG
 SPACING CRITERIA : 1.6 1.5 0.7
 LUMINOUS DIAMETER: 6.000



LEGEND:
 0-deg: - - - - -
 90-deg: _____
 180-deg: - - - - -

Checked *[Signature]*
 Approved *[Signature]*

LUMINANCE DATA IN-CANDELA/SQ M

ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 90-DEG	AVERAGE 180-DEG	MAXIMUM 0-DEG	MAXIMUM 90-DEG	MAXIMUM 180-DEG	MAX/AVG 0-DEG	MAX/AVG 90-DEG	MAX/AVG 180-DEG
45	10230.	14802.	8447.	36076.	39505.	34160.	3.5	2.7	4.0
55	478.	1338.	1529.	11045.	12738.	15900.	23.1	9.5	10.4
65	0.	130.	130.	74.	155.	604.	0.0	1.2	4.6
75	0.	0.	0.	36.	60.	63.	0.0	0.0	0.0
85	0.	0.	0.	16.	17.	22.	0.0	0.0	0.0

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REPORT NUMBER: ITL40776
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-28-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0
0.0	320	320	320	320	320	320	320	320	320
2.5	322	322	321	324	318	317	320	319	318
5.0	335	335	333	335	324	318	317	315	313
7.5	348	347	343	341	326	317	312	309	304
10.0	360	358	348	336	316	304	301	299	291
12.5	373	369	354	331	304	292	286	277	269
15.0	384	379	359	327	297	283	270	244	238
17.5	392	386	366	331	300	277	251	218	200
20.0	398	387	363	334	298	267	234	195	164
22.5	399	384	361	347	302	262	217	166	149
25.0	409	376	353	348	306	256	197	156	153
27.5	420	370	354	350	317	260	186	152	165
30.0	423	368	370	354	326	263	177	152	167
32.5	413	363	360	384	342	268	174	148	161
35.0	380	359	348	362	326	265	176	140	150
37.5	333	337	328	338	308	257	186	138	136
40.0	269	291	306	299	264	236	189	141	123
42.5	198	227	266	263	229	197	162	135	113
45.0	132	158	192	201	191	161	131	118	109
47.5	77	97	121	137	137	124	105	96	90
50.0	42	55	66	76	81	75	69	62	61
52.5	19	24	26	33	39	39	38	35	35
55.0	5	6	8	12	14	15	16	16	16
57.5	2	2	3	4	4	4	5	6	6
60.0	1	2	2	2	3	3	3	3	3
62.5	1	1	1	1	1	1	2	2	2
65.0	0	1	1	1	1	1	1	1	1
67.5	0	0	1	1	1	1	1	1	0
70.0	0	0	1	1	1	1	1	1	0
72.5	0	0	1	1	1	1	1	1	0
75.0	0	0	0	0	0	0	0	0	0
77.5	0	0	0	0	0	0	0	0	0
80.0	0	0	0	0	0	0	0	0	0
82.5	0	0	0	0	0	0	0	0	0
85.0	0	0	0	0	0	0	0	0	0
87.5	0	0	0	0	0	0	0	0	0
90.0	0	0	0	0	0	0	0	0	0

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE



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FAX (303) 449-527-

REPORT NUMBER: ITL40776
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-28-1993

ZONAL LUMEN SUMMARY

0- 5	8.
5- 10	23.
10- 15	38.
15- 20	50.
20- 25	61.
25- 30	72.
30- 35	86.
35- 40	89.
40- 45	76.
45- 50	45.
50- 55	14.
55- 60	2.
60- 65	1.
65- 70	0.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1251 • FAX (303) 449-527

REPORT NUMBER: ITL40776
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-28-1993

*** IMPORTANT ***

The compact fluorescent lamps of the type used in this report require special attention in photometry and luminaire application. Specifically, the lamps generate lower flux output when operated in the horizontal position than when operated in the vertical position. Unfortunately, at the time of this report, only the vertical flux output (lumens) is available from lamp manufacturers.

It is critical to note that, all else equal, a horizontal lamp calibration will yield higher luminaire candela and efficiency than a vertical lamp calibration. However, for a report which was generated using a horizontal lamp calibration, any application calculations should use the actual flux output (lumens) from a horizontal lamp -- at this time, no such published lumen figures are available. For a report which was generated using a vertical lamp calibration, the flux output from a vertical lamp should be used. The published lamp lumen figure given on this report is for a vertical lamp.

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE.



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1234

FAX (303) 449-5271

REPORT NUMBER: ITL40776

DATE: 7-28-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	78	78	78	78	76	76	76	76	73	73	73	70	70	70	67	67	67	66
1	74	72	70	68	72	70	69	67	68	66	65	65	64	63	63	62	61	60
2	69	66	63	60	68	64	62	59	62	60	58	60	58	57	58	57	55	54
3	65	60	56	53	64	59	55	53	57	54	52	56	53	51	54	52	50	49
4	61	55	51	47	59	54	50	47	53	49	46	51	48	46	50	47	45	44
5	57	50	46	42	56	50	45	42	48	45	42	47	44	41	46	43	41	40
6	53	46	42	38	52	46	41	38	45	41	38	44	40	37	43	40	37	36
7	50	43	38	35	49	42	38	34	41	37	34	40	37	34	40	36	34	33
8	47	39	35	31	46	39	34	31	38	34	31	37	34	31	37	33	31	30
9	44	36	32	29	43	36	32	29	35	31	29	35	31	28	34	31	28	27
10	41	34	29	26	40	33	29	26	33	29	26	32	29	26	32	28	26	25

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.



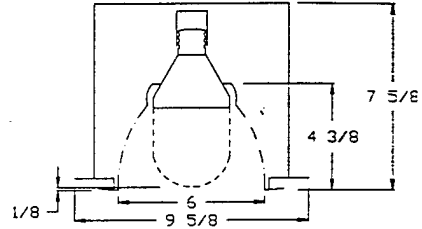
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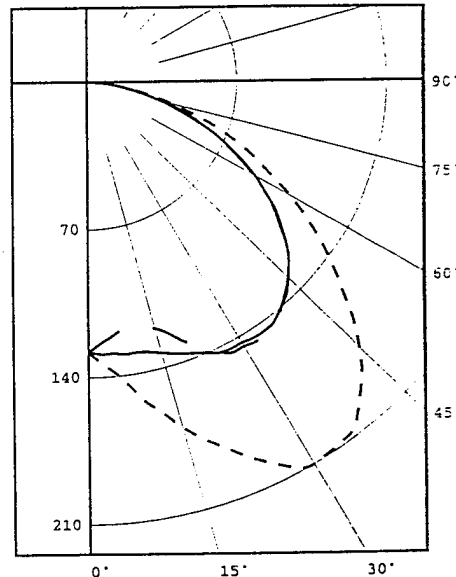
REPORT NUMBER: ITL40777
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: SHALLOW CAN, SHORT LAMP
 LUMINAIRE: FABRICATED SQUARE METAL HOUSING, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: 15-WATT FLB15/TL COMPACT FLUORESCENT, RATED 700 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED
 TOTAL INPUT WATTS= 16.3 AT 120.0 VOLTS

DATE: 7-21-1993

CANDELA DISTRIBUTION						FLUX
	0.0	45.0	90.0	135.0	180.0	
0	128	128	128	128	128	
5	138	136	129	122	121	12
15	170	156	133	123	121	40
25	200	175	142	137	141	72
35	208	179	144	139	145	100
45	179	156	132	128	132	110
55	133	118	107	103	106	100
65	86	79	72	70	71	74
75	42	40	36	36	37	40
85	6	7	7	7	7	8
90	0	0	0	0	0	



ZONAL LUMEN SUMMARY			
ZONE	LUMENS	%LAMP	%FIXT
0- 30	124	17.8	22.3
0- 40	224	32.0	40.3
0- 60	435	62.1	78.1
0- 90	557	79.6	100.0
90-180	0	0.0	0.0
0-180	557	79.6	100.0



TOTAL LUMINAIRE EFFICIENCY = 79.6 %
 CIE TYPE - DIRECT
 PLANE : 0-DEG 90-DEG 180-DEG
 SPACING CRITERIA : 2.0 1.7 1.7
 LUMINOUS DIAMETER: 6.000

LEGEND:
 0-deg: - - - - -
 90-deg: _____
 180-deg: _____

Checked *L. Gudwig*
 Approved *R. B.*

LUMINANCE DATA IN CANDELA/SQ M			
ANGLE	AVERAGE	AVERAGE	AVERAGE
IN DEG	0-DEG	90-DEG	180-DEG
45	13872.	10230.	10230.
55	12707.	10223.	10127.
65	11151.	9336.	9206.
75	8893.	7622.	7834.
85	3773.	4401.	4401.

LUMINANCE DATA IN CANDELA/SQ M						
ANGLE	MAXIMUM	MAXIMUM	MAXIMUM	MAX/AVG	MAX/AVG	MAX/AVG
IN DEG	0-DEG	90-DEG	180-DEG	0-DEG	90-DEG	180-DEG
45	18196.	17047.	19021.	1.3	1.7	1.9
55	17083.	16329.	17873.	1.3	1.6	1.8
65	15899.	15181.	15863.	1.4	1.6	1.7
75	14320.	12023.	12920.	1.6	1.6	1.6
85	8793.	7321.	7357.	2.3	1.7	1.7



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REPORT NUMBER: ITL40777
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-21-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0
0.0	128	128	128	128	128	128	128	128	128
2.5	133	133	132	131	129	127	126	124	124
5.0	138	138	136	132	129	125	122	121	121
7.5	145	145	141	135	130	125	122	119	118
10.0	154	152	146	139	130	125	120	118	116
12.5	161	159	152	141	131	124	121	119	119
15.0	170	166	156	143	133	126	123	121	121
17.5	178	172	162	147	135	128	127	126	125
20.0	185	180	165	149	137	130	129	130	131
22.5	193	186	170	152	139	134	133	135	135
25.0	200	193	175	155	142	136	137	140	141
27.5	207	198	178	156	143	139	139	142	145
30.0	210	200	180	158	143	139	141	143	145
32.5	209	202	180	158	144	140	140	143	146
35.0	208	201	179	156	144	139	139	142	145
37.5	205	198	177	155	143	138	139	141	144
40.0	197	191	170	151	140	136	136	139	140
42.5	189	184	164	147	137	133	133	134	136
45.0	179	175	156	140	132	128	128	130	132
47.5	168	164	148	134	127	124	123	124	127
50.0	155	153	137	126	121	118	117	118	121
52.5	144	142	128	118	114	112	111	112	113
55.0	133	131	118	110	107	104	103	104	106
57.5	121	119	108	100	98	96	95	97	98
60.0	109	109	98	91	90	87	87	88	89
62.5	96	97	88	83	81	79	79	80	80
65.0	86	87	79	73	72	70	70	72	71
67.5	75	75	69	64	63	62	62	63	63
70.0	64	64	59	54	53	53	53	54	54
72.5	52	53	49	46	44	44	45	45	46
75.0	42	42	40	37	36	36	36	36	37
77.5	31	32	31	28	27	28	28	28	28
80.0	22	23	22	20	20	20	20	20	21
82.5	14	15	14	13	13	13	13	13	13
85.0	6	7	7	7	7	7	7	6	7
87.5	1	1	1	1	1	1	1	1	1
90.0	0	0	0	0	0	0	0	0	0

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE.



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FAX (303) 449-5275

REPORT NUMBER: ITL40777
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-21-1993

ZONAL LUMEN SUMMARY

0- 5	3.
5- 10	9.
10- 15	16.
15- 20	24.
20- 25	32.
25- 30	40.
30- 35	47.
35- 40	53.
40- 45	55.
45- 50	55.
50- 55	52.
55- 60	48.
60- 65	41.
65- 70	33.
70- 75	25.
75- 80	15.
80- 85	7.
85- 90	1.

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FAX (303) 449-527-

REPORT NUMBER: ITL40777

DATE: 7-21-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	
0	95	95	95	95	92	92	92	92	88	88	88	84	84	84	81	81	81	79
1	86	82	79	76	84	80	77	74	77	74	72	74	72	70	71	69	68	66
2	78	71	66	61	76	70	65	60	67	63	59	64	61	57	62	59	56	54
3	71	62	55	50	69	61	55	49	58	53	49	56	52	48	54	50	47	45
4	64	54	47	42	63	53	47	41	51	45	41	50	44	40	48	43	40	38
5	59	48	41	35	57	47	40	35	46	40	35	44	39	34	43	38	34	32
6	54	43	36	30	53	42	35	30	41	35	30	40	34	30	38	33	29	28
7	50	39	32	27	49	38	31	26	37	31	26	36	30	26	35	30	26	24
8	46	35	28	23	45	35	28	23	34	27	23	33	27	23	32	27	23	21
9	43	32	25	21	42	32	25	21	31	25	21	30	24	20	29	24	20	19
10	40	29	23	19	39	29	23	19	28	22	18	27	22	18	27	22	18	17

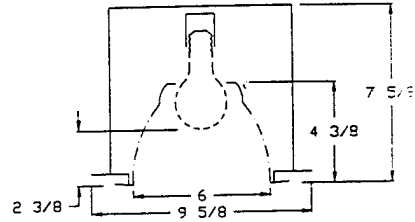
ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255 FAX (303) 449-5271

REPORT NUMBER: ITL40778 DATE: 7-29-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: SHALLOW CAN, SHORT REFLECTOR
 LUMINAIRE: FABRICATED SQUARE METAL HOUSING, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: STANDARD GE A60 60-WATT A-19 INCANDESCENT, RATED 870 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED

DEG	CANDELA	LUMENS
0	1015	
5	672	61
15	452	126
25	305	141
35	199	122
45	54	44
55	4	5
65	1	1
75	0	0
85	0	0
90	0	0



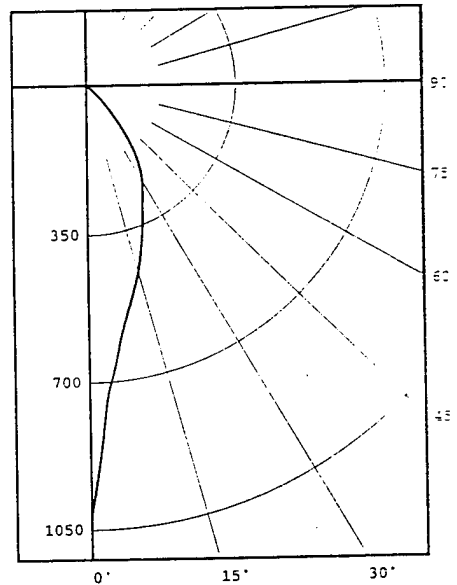
ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	328	37.7	65.6
0- 40	450	51.7	89.9
0- 60	500	57.4	99.8
0- 90	501	57.5	100.0
90-180	0	0.0	0.0
0-180	501	57.5	100.0

TOTAL LUMINAIRE EFFICIENCY = 57.5 %
 CIE TYPE - DIRECT
 LUMINAIRE SPACING CRITERION = 0.4
 LUMINOUS DIAMETER: 6.000

LUMINANCE DATA IN CANDELA/SQ M

ANGLE IN DEG	AVERAGE	MAXIMUM	MAX/AVG
45	4185.	26538.	6.3
55	382.	6385.	16.7
65	130.	130.	1.0
75	0.	32.	0.0
85	0.	18.	0.0



Checked *S. Guduzg*
 Approved *[Signature]*



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REPORT NUMBER: ITL40778
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-29-1993

CANDELA DISTRIBUTION

0.0	0.0
2.5	1015
5.0	789
7.5	672
10.0	590
12.5	536
15.0	492
17.5	452
20.0	410
22.5	371
25.0	336
27.5	305
30.0	280
32.5	257
35.0	230
37.5	199
40.0	162
42.5	120
45.0	82
47.5	54
50.0	34
52.5	20
55.0	10
57.5	4
60.0	2
62.5	1
65.0	1
67.5	1
70.0	0
72.5	0
75.0	0
77.5	0
80.0	0
82.5	0
85.0	0
87.5	0
90.0	0

ZONAL LUMEN SUMMARY

0- 5	19.
5- 10	42.
10- 15	58.
15- 20	68.
20- 25	70.
25- 30	71.
30- 35	68.
35- 40	54.
40- 45	30.
45- 50	14.
50- 55	4.
55- 60	1.
60- 65	0.
65- 70	1.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.



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REPORT NUMBER: ITL40778

DATE: 7-29-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD
EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	68	68	68	68	67	67	67	67	64	64	64	61	61	61	59	59	59	57
1	65	64	62	61	64	62	61	60	60	59	58	58	57	56	56	55	55	54
2	62	59	57	55	61	58	56	54	56	55	53	55	53	52	53	52	51	50
3	59	55	52	50	58	54	52	49	53	50	49	51	49	48	50	48	47	46
4	56	51	48	46	55	51	48	45	49	47	45	48	46	44	47	45	44	43
5	53	48	45	42	52	47	44	42	46	44	41	45	43	41	44	42	41	40
6	50	45	41	39	49	44	41	39	44	41	39	43	40	38	42	40	38	37
7	48	42	39	36	47	42	38	36	41	38	36	40	38	36	40	37	36	35
8	45	40	36	34	44	39	36	34	39	36	34	38	35	33	38	35	33	32
9	43	37	34	32	42	37	34	32	37	34	31	36	33	31	36	33	31	30
10	41	35	32	30	40	35	32	30	35	32	30	34	31	30	34	31	29	29

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE.



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REPORT NUMBER: ITL40779 DATE: 7-22-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: SHALLOW CAN, FULL REFLECTOR
 LUMINAIRE: FABRICATED SQUARE METAL HOUSING, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: 15-WATT FLB15/TL COMPACT FLUORESCENT, RATED 700 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED
 TOTAL INPUT WATTS= 16.0 AT 120.0 VOLTS

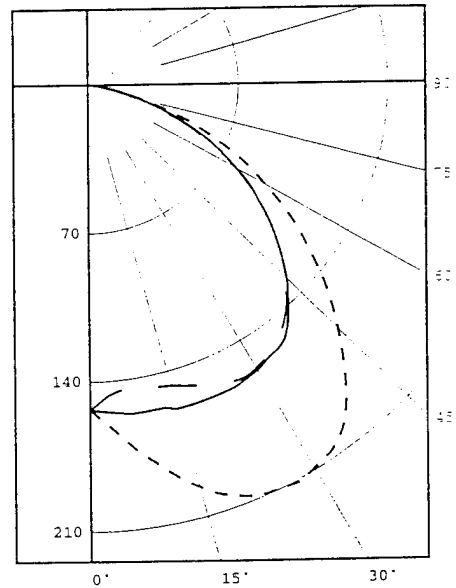
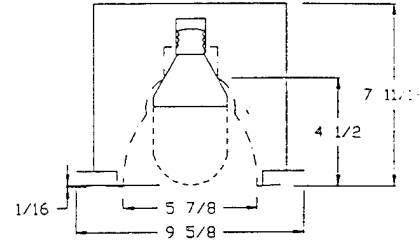
CANDELA DISTRIBUTION						FLUX
	0.0	45.0	90.0	135.0	180.0	
0	153	153	153	153	153	
5	166	163	155	148	145	15
15	196	182	158	148	147	47
25	210	188	158	152	155	79
35	203	180	153	148	151	103
45	164	147	130	126	129	106
55	119	107	97	96	97	91
65	72	67	61	60	59	63
75	26	26	24	23	22	26
85	2	2	2	2	2	3
90	0	0	0	0	0	

ZONAL LUMEN SUMMARY				
ZONE	LUMENS	%LAMP	%FIXT	
0- 30	140	20.0	26.4	
0- 40	243	34.7	45.6	
0- 60	441	63.0	82.8	
0- 90	532	76.1	100.0	
90-180	0	0.0	0.0	
0-180	532	76.1	100.0	

TOTAL LUMINAIRE EFFICIENCY = 76.1 %
 CIE TYPE - DIRECT
 PLANE : 0-DEG 90-DEG 180-DEG
 SPACING CRITERIA : 1.8 1.5 1.5
 LUMINOUS DIAMETER: 5.875

LUMINANCE DATA IN CANDELA/SQ M			
ANGLE	AVERAGE	AVERAGE	AVERAGE
IN DEG	0-DEG	90-DEG	180-DEG
45	13256.	10507.	10427.
55	11858.	9665.	9665.
65	9737.	8249.	7979.
75	5741.	5300.	4858.
85	1312.	1312.	1312.

LUMINANCE DATA IN CANDELA/SQ M						
ANGLE	MAXIMUM	MAXIMUM	MAXIMUM	MAX/AVG	MAX/AVG	MAX/AVG
IN DEG	0-DEG	90-DEG	180-DEG	0-DEG	90-DEG	180-DEG
45	19595.	17441.	17514.	1.5	1.7	1.7
55	19416.	17047.	16006.	1.6	1.8	1.7
65	17334.	15863.	16078.	1.8	1.9	2.0
75	13351.	12489.	12920.	2.3	2.4	2.7
85	3790.	2017.	3094.	2.9	1.5	2.4



LEGEND:
 0-deg: - - - - -
 90-deg: _____
 180-deg: _____

Checked *B. Ludwig*
 Approved *[Signature]*



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REPORT NUMBER: ITL40779
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-22-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0
0.0	153	153	153	153	153	153	153	153	153
2.5	159	159	158	156	154	152	150	149	148
5.0	166	165	163	159	155	151	148	146	145
7.5	174	172	168	162	156	151	147	146	144
10.0	181	179	173	165	156	150	147	145	145
12.5	189	186	178	167	156	150	147	147	146
15.0	196	192	182	169	158	151	148	148	147
17.5	202	197	185	170	158	151	149	150	149
20.0	206	201	186	170	158	151	150	151	151
22.5	209	203	188	170	158	151	151	153	153
25.0	210	205	188	170	158	152	152	155	155
27.5	211	205	188	169	157	152	152	155	156
30.0	209	204	186	168	156	151	152	154	155
32.5	207	201	183	166	154	150	150	152	153
35.0	203	198	180	163	153	148	148	149	151
37.5	196	192	175	159	150	145	144	146	147
40.0	186	183	167	152	144	140	139	141	142
42.5	175	173	157	144	137	134	133	135	136
45.0	164	162	147	135	130	127	126	128	129
47.5	153	151	137	126	122	119	119	121	122
50.0	142	140	127	117	114	112	111	114	114
52.5	130	129	117	108	106	104	104	106	106
55.0	119	118	107	99	97	96	96	98	97
57.5	107	106	97	90	89	87	87	89	88
60.0	95	95	87	81	79	79	79	79	79
62.5	84	83	77	72	70	70	70	70	69
65.0	72	71	67	62	61	61	60	60	59
67.5	60	60	56	53	51	51	51	50	50
70.0	49	48	45	43	42	42	41	40	40
72.5	37	37	35	34	33	33	32	30	30
75.0	26	27	26	25	24	24	23	22	22
77.5	17	18	17	17	17	16	15	14	14
80.0	10	10	9	10	10	9	9	8	8
82.5	5	5	5	5	5	5	5	4	4
85.0	2	2	2	2	2	2	2	2	2
87.5	0	0	0	0	0	1	1	1	1
90.0	0	0	0	0	0	0	0	0	0

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE.



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1251 • FAX (303) 449-5271

REPORT NUMBER: ITL40779
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-22-1993

ZONAL LUMEN SUMMARY

0- 5	4.
5- 10	11.
10- 15	19.
15- 20	28.
20- 25	36.
25- 30	43.
30- 35	49.
35- 40	53.
40- 45	54.
45- 50	52.
50- 55	48.
55- 60	43.
60- 65	36.
65- 70	27.
70- 75	17.
75- 80	9.
80- 85	3.
85- 90	0.



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REPORT NUMBER: ITL40779

DATE: 7-22-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	91	91	91	91	89	89	89	89	85	85	85	81	81	81	78	78	78	76
1	83	80	77	74	81	78	76	73	75	73	71	72	70	69	69	68	67	65
2	76	70	65	61	74	69	64	60	66	62	59	63	60	57	61	58	56	54
3	69	61	55	51	67	60	55	50	58	53	49	56	52	48	54	51	48	46
4	63	54	48	43	62	53	47	42	51	46	42	50	45	41	48	44	41	39
5	58	48	42	37	57	48	41	36	46	40	36	45	40	36	43	39	35	34
6	54	44	37	32	52	43	36	32	41	36	31	40	35	31	39	34	31	29
7	50	39	33	28	48	39	32	28	38	32	28	36	31	27	35	31	27	26
8	46	36	29	25	45	35	29	25	34	29	25	33	28	24	32	28	24	23
9	43	33	26	22	42	32	26	22	31	26	22	31	26	22	30	25	22	20
10	40	30	24	20	39	30	24	20	29	24	20	28	23	20	28	23	20	18

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

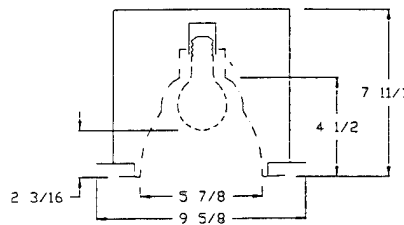
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INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255 FAX (303) 449-5274

REPORT NUMBER: ITL40780 DATE: 7-29-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: SHALLOW CAN, FULL REFLECTOR
 LUMINAIRE: FABRICATED SQUARE METAL HOUSING, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: STANDARD GE A60 60-WATT A-19 INCANDESCENT, RATED 870 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED

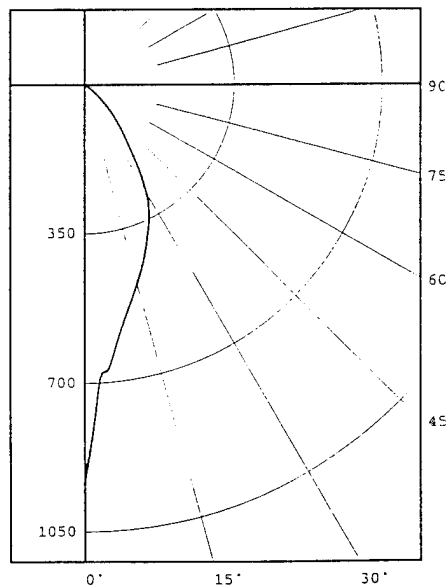
DEG	CANDELA	LUMENS
0	930	
5	666	60
15	482	136
25	360	165
35	198	126
45	82	63
55	18	16
65	0	0
75	0	0
85	0	0
90	0	0



ZONAL LUMEN SUMMARY			
ZONE	LUMENS	%LAMP	%FIXT
0- 30	361	41.5	63.7
0- 40	487	56.0	86.0
0- 60	566	65.0	99.9
0- 90	566	65.1	100.0
90-180	0	0.0	0.0
0-180	566	65.1	100.0

TOTAL LUMINAIRE EFFICIENCY = 65.1 %
 CIE TYPE - DIRECT
 LUMINAIRE SPACING CRITERION = 0.5
 LUMINOUS DIAMETER: 5.875

LUMINANCE DATA IN CANDELA/SQ M			
ANGLE IN DEG	AVERAGE	MAXIMUM	MAX/AVG
45	6628.	41710.	6.3
55	1794.	29181.	16.3
65	0.	40.	0.0
75	0.	21.	0.0
85	0.	6.	0.0



Checked *B. Ludwig*
 Approved *P. D.*



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FAX (303) 449-527-

REPORT NUMBER: ITL40780
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-29-1993

CANDELA DISTRIBUTION

0.0	930
2.5	720
5.0	666
7.5	602
10.0	554
12.5	516
15.0	482
17.5	451
20.0	419
22.5	388
25.0	360
27.5	330
30.0	293
32.5	247
35.0	198
37.5	160
40.0	131
42.5	105
45.0	82
47.5	59
50.0	43
52.5	30
55.0	18
57.5	7
60.0	1
62.5	1
65.0	0
67.5	0
70.0	0
72.5	0
75.0	0
77.5	0
80.0	0
82.5	0
85.0	0
87.5	0
90.0	0

ZONAL LUMEN SUMMARY

0- 5	17.
5- 10	43.
10- 15	61.
15- 20	74.
20- 25	81.
25- 30	84.
30- 35	73.
35- 40	53.
40- 45	39.
45- 50	24.
50- 55	13.
55- 60	3.
60- 65	0.
65- 70	0.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1111

FAX (303) 449-5111

REPORT NUMBER: ITL40780

DATE: 7-29-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC	80				70				50			30			10			0	
	RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	77	77	77	77	76	76	76	76	72	72	72	69	69	69	66	66	66	65	65
1	74	72	70	69	72	70	69	68	68	67	65	65	64	64	63	62	62	61	61
2	70	67	64	62	68	65	63	61	63	61	59	61	60	58	60	58	57	56	56
3	66	62	58	56	65	61	58	55	59	56	54	57	55	53	56	54	53	52	52
4	62	57	54	51	61	57	53	50	55	52	50	54	51	49	53	50	49	48	48
5	59	53	49	46	58	53	49	46	52	48	46	50	48	45	49	47	45	44	44
6	56	50	46	43	55	49	45	43	48	45	42	47	44	42	47	44	42	41	41
7	53	47	43	40	52	46	42	40	45	42	39	45	41	39	44	41	39	38	38
8	50	44	40	37	49	43	40	37	43	39	37	42	39	37	41	38	36	35	35
9	48	41	37	34	47	41	37	34	40	37	34	40	36	34	39	36	34	33	33
10	45	39	35	32	45	39	35	32	38	35	32	37	34	32	37	34	32	31	31

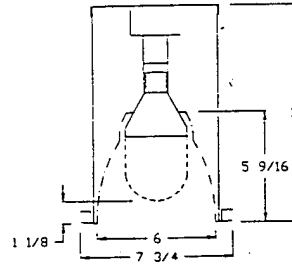
ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.



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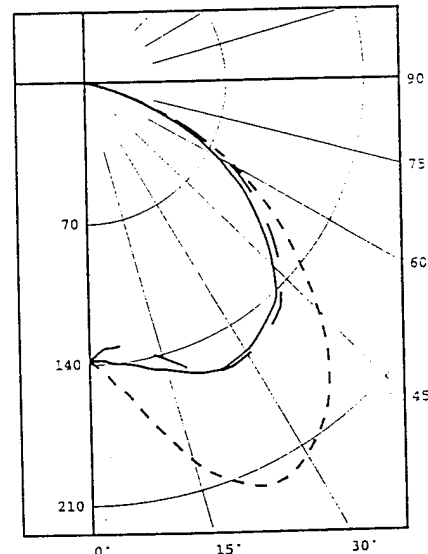
REPORT NUMBER: ITL40781 DATE: 7-22-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: DEEP CAN, FULL REFLECTOR
 LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: 15-WATT FLB15/TL COMPACT FLUORESCENT, RATED 700 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED
 TOTAL INPUT WATTS= 16.1 AT 120.0 VOLTS

CANDELA DISTRIBUTION						FLUX
	0.0	45.0	90.0	135.0	180.0	
0	138	138	138	138	138	
5	151	147	140	134	132	14
15	195	175	148	140	142	45
25	220	191	157	152	158	79
35	204	179	150	147	154	103
45	162	146	130	130	136	107
55	111	103	95	96	102	89
65	58	57	53	55	59	55
75	6	7	8	8	9	11
85	0	0	0	0	0	0
90	0	0	0	0	0	0



ZONAL LUMEN SUMMARY			
ZONE	LUMENS	%LAMP	%FIXT
0- 30	138	19.7	27.4
0- 40	241	34.4	47.8
0- 60	437	62.4	86.9
0- 90	503	71.8	100.0
90-180	0	0.0	0.0
0-180	503	71.8	100.0

TOTAL LUMINAIRE EFFICIENCY = 71.8 %
 CIE TYPE - DIRECT PLANE : 0-DEG 90-DEG 180-DEG
 SPACING CRITERIA : 1.8 1.6 1.6
 LUMINOUS DIAMETER: 6.000



LUMINANCE DATA IN CANDELA/SQ M			
ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 90-DEG	AVERAGE 180-DEG
45	12555.	10075.	10540.
55	10605.	9076.	9745.
65	7521.	6872.	7650.
75	1270.	1694.	1906.
85	0.	0.	0.

ANGLE MAXIMUM MAXIMUM MAXIMUM MAX/AVG MAX/AVG MAX/AVG						
IN DEG	0-DEG	90-DEG	180-DEG	0-DEG	90-DEG	180-DEG
45	18770.	18160.	19057.	1.5	1.8	1.8
55	17155.	16581.	16185.	1.6	1.8	1.7
65	15073.	12705.	13817.	2.0	1.8	1.8
75	7967.	9869.	10515.	6.3	5.8	5.5
85	251.	251.	72.	0.0	0.0	0.0

LEGEND:
 0-deg: - - - - -
 90-deg: _____
 180-deg: _____

Checked *B. Ludwig*
 Approved *R. D.*

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INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1225

FAX (303) 449-527

REPORT NUMBER: ITL40781
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-22-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0
0.0	138	138	138	138	138	138	138	138	138
2.5	143	143	142	141	138	137	135	133	133
5.0	151	150	147	144	140	136	134	133	132
7.5	158	158	153	147	141	137	134	133	132
10.0	170	166	160	151	143	138	135	135	135
12.5	182	178	168	155	146	140	138	138	138
15.0	195	189	175	160	148	142	140	141	142
17.5	205	198	182	164	151	145	144	146	147
20.0	212	206	187	167	154	148	148	151	153
22.5	218	210	190	169	156	150	151	155	156
25.0	220	212	191	170	157	151	152	156	158
27.5	219	211	190	169	156	151	153	156	158
30.0	215	208	187	166	155	150	151	156	157
32.5	210	204	183	163	153	148	150	154	156
35.0	204	199	179	160	150	146	147	153	154
37.5	196	192	173	156	147	143	145	150	151
40.0	186	184	167	151	144	140	141	147	148
42.5	175	173	157	144	138	135	136	142	142
45.0	162	160	146	134	130	128	130	135	136
47.5	149	148	135	124	122	120	122	128	128
50.0	136	135	124	115	113	112	114	119	120
52.5	124	123	113	105	104	103	105	110	111
55.0	111	111	103	95	95	94	96	101	102
57.5	98	98	92	85	84	84	87	91	92
60.0	85	86	81	75	75	74	77	81	82
62.5	72	73	70	65	64	64	66	70	70
65.0	58	59	57	54	53	53	55	58	59
67.5	45	46	45	42	41	42	43	45	46
70.0	31	32	32	31	30	30	31	33	34
72.5	18	19	19	19	18	18	19	19	20
75.0	6	7	7	7	8	8	8	8	9
77.5	1	1	1	2	2	2	2	2	2
80.0	0	0	0	0	0	0	0	0	0
82.5	0	0	0	0	0	0	0	0	0
85.0	0	0	0	0	0	0	0	0	0
87.5	0	0	0	0	0	0	0	0	0
90.0	0	0	0	0	0	0	0	0	0

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INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1234 • FAX (303) 449-5211

REPORT NUMBER: ITL40781
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-22-1993

ZONAL LUMEN SUMMARY

0- 5	3.
5- 10	10.
10- 15	18.
15- 20	27.
20- 25	36.
25- 30	43.
30- 35	49.
35- 40	53.
40- 45	55.
45- 50	52.
50- 55	48.
55- 60	41.
60- 65	33.
65- 70	22.
70- 75	10.
75- 80	1.
80- 85	0.
85- 90	0.



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REPORT NUMBER: ITL40781

DATE: 7-22-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC	80				70				50			30			10			0	
	RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	86	86	86	86	84	84	84	84	80	80	80	76	76	76	73	73	73	72	
1	79	76	74	71	77	75	72	70	72	70	68	69	67	66	66	65	64	62	
2	73	67	63	59	71	66	62	58	63	60	57	61	58	56	59	57	54	53	
3	66	59	54	49	65	58	53	49	56	52	48	54	50	47	52	49	46	45	
4	61	53	47	42	59	52	46	42	50	45	41	48	44	41	47	43	40	38	
5	56	47	41	36	54	46	40	36	45	39	35	43	39	35	42	38	35	33	
6	51	42	36	31	50	41	35	31	40	35	31	39	34	31	38	34	30	29	
7	48	38	32	27	46	37	32	27	36	31	27	35	31	27	34	30	27	25	
8	44	35	29	24	43	34	28	24	33	28	24	32	27	24	31	27	24	22	
9	41	32	26	22	40	31	26	22	30	25	22	30	25	21	29	25	21	20	
10	38	29	23	20	38	29	23	20	28	23	19	27	23	19	27	22	19	18	

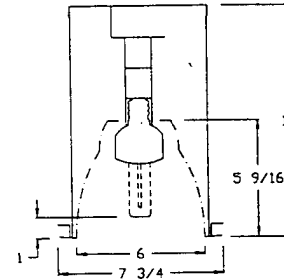
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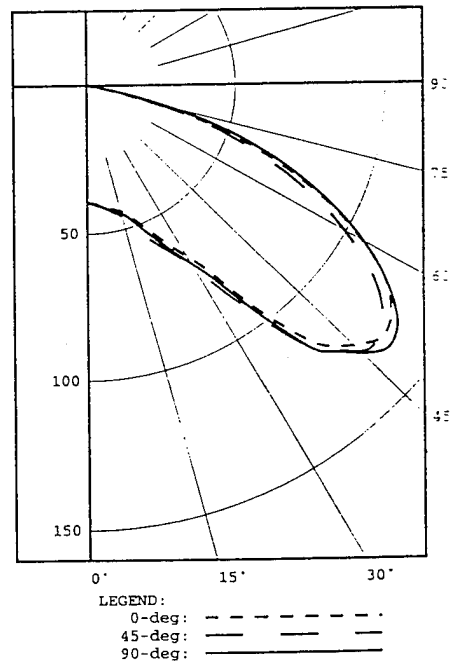
REPORT NUMBER: ITL40782 DATE: 7-22-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: DEEP CAN, FULL REFLECTOR
 LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: 11-WATT OSRAM DULUX EL COMPACT FLUORESCENT, RATED 600 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED
 TOTAL INPUT WATTS= 11.6 AT 120.0 VOLTS

CANDELA DISTRIBUTION						FLUX
	0.0	22.5	45.0	67.5	90.0	
0	39	39	39	39	39	
5	41	40	40	40	40	4
15	44	45	46	45	45	13
25	57	59	61	60	59	28
35	86	90	92	93	89	58
45	126	132	129	132	129	100
55	123	124	118	121	124	108
65	83	81	76	79	84	79
75	22	23	24	26	28	27
85	0	0	0	0	0	0
90	0	0	0	0	0	0



ZONE	LUMEN SUMMARY	%LAMP	%FIXT
0- 30	45	7.5	10.7
0- 40	103	17.1	24.6
0- 60	311	51.8	74.5
0- 90	417	69.5	100.0
90-180	0	0.0	0.0
0-180	417	69.5	100.0

TOTAL LUMINAIRE EFFICIENCY = 69.5 %
 CIE TYPE - DIRECT PLANE : 0-DEG 90-DEG
 SPACING CRITERIA : 3.0 3.0
 LUMINOUS DIAMETER: 6.000



LUMINANCE DATA IN CANDELA/SQ M				
ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG	
45	9734.	9966.	10028.	
55	11761.	11245.	11857.	
65	10698.	9907.	10918.	
75	4658.	5103.	6013.	
85	126.	189.	189.	
ANGLE IN DEG	MAXIMUM 0-DEG	MAXIMUM 90-DEG	MAX/AVG 0-DEG	MAX/AVG 90-DEG
45	38965.	35521.	4.0	3.5
55	40525.	41923.	3.4	3.5
65	40850.	40005.	3.8	3.7
75	24796.	25641.	5.3	4.3
85	172.	189.	1.4	1.0

Checked: *[Signature]*
 Approved: *[Signature]*

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255

FAX (303) 449-5271

REPORT NUMBER: ITL40782
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-22-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0
0.0	39	39	39	39	39
2.5	40	40	40	40	40
5.0	41	40	40	40	40
7.5	41	41	42	42	42
10.0	42	42	43	43	42
12.5	43	43	44	44	43
15.0	44	45	46	45	45
17.5	46	47	49	48	47
20.0	49	51	53	52	50
22.5	52	55	57	56	54
25.0	57	59	61	60	59
27.5	62	64	65	66	64
30.0	67	70	71	71	70
32.5	74	78	81	81	77
35.0	86	90	92	93	89
37.5	99	104	105	107	103
40.0	113	117	117	120	118
42.5	121	125	123	127	123
45.0	126	132	129	132	129
47.5	130	136	130	134	134
50.0	131	135	129	133	134
52.5	128	131	124	128	131
55.0	123	124	118	121	124
57.5	116	116	109	113	116
60.0	106	105	99	103	107
62.5	95	94	89	92	96
65.0	83	81	76	79	84
67.5	69	68	64	67	72
70.0	56	54	52	55	60
72.5	41	40	39	42	45
75.0	22	23	24	26	28
77.5	9	10	10	12	13
80.0	1	1	2	2	2
82.5	0	1	1	1	1
85.0	0	0	0	0	0
87.5	0	0	0	0	0
90.0	0	0	0	0	0

ZONAL LUMEN SUMMARY

0- 5	1.
5- 10	3.
10- 15	5.
15- 20	8.
20- 25	12.
25- 30	16.
30- 35	23.
35- 40	35.
40- 45	46.
45- 50	54.
50- 55	56.
55- 60	52.
60- 65	45.
65- 70	34.
70- 75	21.
75- 80	6.
80- 85	0.
85- 90	0.



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REPORT NUMBER: ITL40782

DATE: 7-22-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	83	83	83	83	81	81	81	81	77	77	77	74	74	74	71	71	71	70
1	75	72	68	66	73	70	67	65	67	65	62	64	62	61	62	60	59	57
2	67	61	56	51	65	59	55	51	57	53	49	55	51	48	52	50	47	45
3	60	52	45	40	58	51	45	40	48	43	39	46	42	38	45	41	38	36
4	54	44	38	32	52	43	37	32	42	36	32	40	35	31	38	34	31	29
5	49	39	31	26	47	38	31	26	36	30	26	35	29	25	33	29	25	23
6	44	34	27	22	43	33	26	22	32	26	21	30	25	21	29	25	21	19
7	40	30	23	18	39	29	23	18	28	22	18	27	22	18	26	21	18	16
8	37	27	20	15	36	26	20	15	25	19	15	24	19	15	23	18	15	13
9	34	24	17	13	33	23	17	13	23	17	13	22	17	13	21	16	13	11
10	32	22	16	11	31	21	15	11	20	15	11	20	15	11	19	15	11	10

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.



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FAX (303) 449-5274

REPORT NUMBER: ITL40783

DATE: 7-27-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

CATALOG NUMBER: DEEP CAN, FULL REFLECTOR

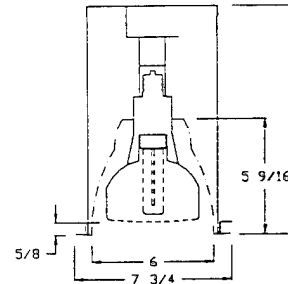
LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.

LAMP: 13-WATT LUMATECH RAS-130 REFLECT-A-STAR WITH 13-WATT QUAD TUBE FLUORESCENT, RATED 860 LUMENS, VERTICAL BASE-UP POSITION.

MOUNTING: RECESSED

TOTAL INPUT WATTS= 15.7 AT 120.0 VOLTS

DEG	CANDELA	LUMENS
0	232	
5	230	22
15	195	55
25	143	66
35	107	67
45	81	63
55	61	54
65	39	39
75	15	16
85	0	1
90	0	



ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	143	16.6	37.3
0- 40	210	24.4	54.8
0- 60	327	38.0	85.5
0- 90	382	44.4	100.0
90-180	0	0.0	0.0
0-180	382	44.4	100.0

TOTAL LUMINAIRE EFFICIENCY = 44.4 %

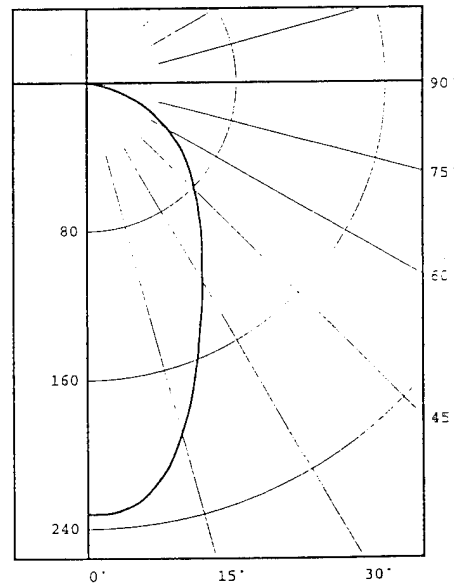
CIE TYPE - DIRECT

LUMINAIRE SPACING CRITERION = 0.9

LUMINOUS DIAMETER: 6.000

LUMINANCE DATA IN CANDELA/SQ M

ANGLE IN DEG	AVERAGE 0-DEG	MAXIMUM 0-DEG	MAX/AVG 0-DEG
45	6277.	34067.	5.4
55	5828.	29444.	5.1
65	5057.	22822.	4.5
75	3176.	10661.	3.4
85	0.	1624.	0.0



Checked *B. Gudwary*
Approved *R. B. D.*



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1252 • FAX (303) 449-5272

REPORT NUMBER: ITL40783
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-27-1993

CANDELA DISTRIBUTION

0.0	0.0
0.5	232
1.0	232
1.5	230
2.0	226
2.5	218
3.0	208
3.5	195
4.0	182
4.5	168
5.0	155
5.5	143
6.0	133
6.5	123
7.0	114
7.5	107
8.0	100
8.5	93
9.0	87
9.5	81
10.0	76
10.5	71
11.0	66
11.5	61
12.0	55
12.5	50
13.0	44
13.5	39
14.0	34
14.5	28
15.0	21
15.5	15
16.0	9
16.5	5
17.0	2
17.5	0
18.0	0
18.5	0
19.0	0

ZONAL LUMEN SUMMARY

0- 5	6.
5- 10	16.
10- 15	25.
15- 20	30.
20- 25	33.
25- 30	34.
30- 35	34.
35- 40	33.
40- 45	32.
45- 50	31.
50- 55	29.
55- 60	25.
60- 65	21.
65- 70	17.
70- 75	11.
75- 80	5.
80- 85	1.
85- 90	0.



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FAX (303) 449-5271

REPORT NUMBER: ITL40783

DATE: 7-27-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC	80				70				50			30			10			0	
	RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	53	53	53	53	52	52	52	52	49	49	49	47	47	47	45	45	45	45	45
1	49	47	46	44	48	46	45	44	44	43	42	43	42	41	41	40	40	40	39
2	45	42	39	37	44	41	39	37	40	38	36	38	36	35	37	35	34	34	33
3	42	37	34	32	41	37	34	31	35	33	31	34	32	30	33	31	30	30	29
4	38	34	30	27	37	33	30	27	32	29	27	31	28	26	30	28	26	26	25
5	36	30	27	24	35	30	26	24	29	26	24	28	26	23	27	25	23	23	22
6	33	28	24	21	32	27	24	21	26	23	21	26	23	21	25	23	21	21	20
7	31	25	22	19	30	25	22	19	24	21	19	24	21	19	23	21	19	19	18
8	29	23	20	17	28	23	20	17	23	19	17	22	19	17	21	19	17	17	16
9	27	22	18	16	27	21	18	16	21	18	16	20	18	16	20	18	16	16	15
10	26	20	17	15	25	20	17	15	20	17	15	19	16	15	19	16	14	14	14

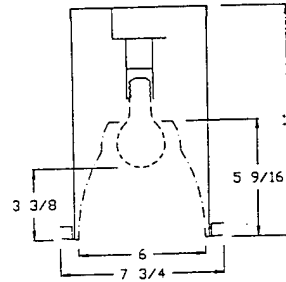
ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.



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REPORT NUMBER: ITL40784 DATE: 7-29-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: DEEP CAN, FULL REFLECTOR
 LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, SPUN SPECULAR ALUMINUM REFLECTOR, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: STANDARD GE A60 60-WATT A-19 INCANDESCENT, RATED 870 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED

DEG	CANDELA	LUMENS
0	924	
5	556	51
15	449	128
25	360	163
35	176	109
45	45	34
55	1	1
65	0	0
75	0	0
85	0	0
90	0	0



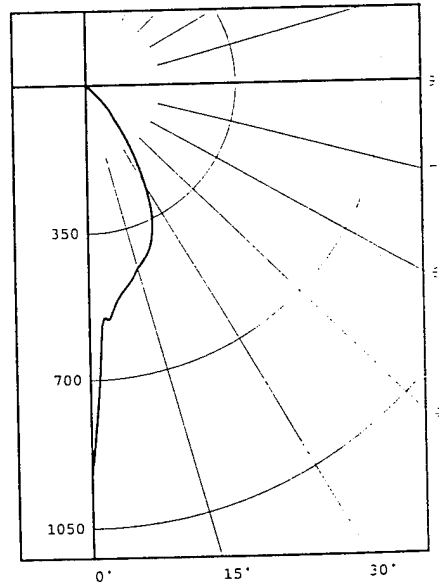
ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	342	39.3	70.4
0- 40	451	51.8	92.9
0- 60	486	55.8	100.0
0- 90	486	55.8	100.0
90-180	0	0.0	0.0
0-180	486	55.8	100.0

TOTAL LUMINAIRE EFFICIENCY = 55.8 %
 CIE TYPE - DIRECT
 LUMINAIRE SPACING CRITERION = 0.4
 LUMINOUS DIAMETER: 6.000

LUMINANCE DATA IN CANDELA/SQ M

ANGLE IN DEG	AVERAGE	MAXIMUM	MAX/AVG
45	3487.	22782.	6.5
55	96.	190.	2.0
65	0.	61.	0.0
75	0.	29.	0.0
85	0.	8.	0.0



Checked *G. Ludwig*
 Approved *R. D.*



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REPORT NUMBER: ITL40784
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-29-1993

CANDELA DISTRIBUTION

0.0	924
2.5	615
5.0	556
7.5	514
10.0	490
12.5	472
15.0	449
17.5	434
20.0	417
22.5	391
25.0	360
27.5	320
30.0	272
32.5	223
35.0	176
37.5	130
40.0	95
42.5	77
45.0	45
47.5	13
50.0	4
52.5	1
55.0	1
57.5	1
60.0	1
62.5	0
65.0	0
67.5	0
70.0	0
72.5	0
75.0	0
77.5	0
80.0	0
82.5	0
85.0	0
87.5	0
90.0	0

ZONAL LUMEN SUMMARY

0- 5	15.
5- 10	37.
10- 15	56.
15- 20	72.
20- 25	82.
25- 30	81.
30- 35	66.
35- 40	43.
40- 45	29.
45- 50	5.
50- 55	0.
55- 60	0.
60- 65	0.
65- 70	0.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.



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REPORT NUMBER: ITL40784

DATE: 7-29-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	67	67	67	67	65	65	65	65	62	62	62	59	59	59	57	57	57	56
1	63	62	61	59	62	61	59	58	58	57	57	56	56	55	54	54	53	52
2	60	58	55	54	59	57	55	53	55	53	52	53	52	51	52	51	50	49
3	57	54	51	49	56	53	50	48	51	49	48	50	48	47	49	47	46	45
4	54	50	47	45	53	50	47	44	48	46	44	47	45	43	46	44	43	42
5	52	47	44	41	51	46	43	41	45	43	41	45	42	40	44	42	40	39
6	49	44	41	38	48	44	40	38	43	40	38	42	40	38	41	39	37	37
7	47	41	38	36	46	41	38	36	40	37	35	40	37	35	39	37	35	34
8	44	39	36	33	44	39	35	33	38	35	33	37	35	33	37	35	33	32
9	42	37	33	31	41	36	33	31	36	33	31	35	33	31	35	33	31	30
10	40	35	31	29	40	34	31	29	34	31	29	34	31	29	33	31	29	28

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE.



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FAX (303) 449-5274

REPORT NUMBER: ITL40785

DATE: 7-22-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

CATALOG NUMBER: DEEP CAN, BLACK BAFFLE

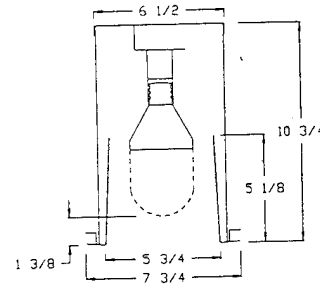
LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, BLACK PLASTIC LOWER BAFFLE, WHITE PAINTED METAL TRIM RING.

LAMP: 15-WATT FLB15/TL COMPACT FLUORESCENT, RATED 700 LUMENS, VERTICAL BASE-UP POSITION.

MOUNTING: RECESSED

TOTAL INPUT WATTS= 16.1 AT 120.0 VOLTS

DEG	CANDELA	LUMENS
0	64	
5	64	6
15	68	19
25	64	30
35	51	32
45	33	26
55	15	14
65	3	3
75	1	1
85	0	0
90	0	0



ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	55	7.9	42.0
0- 40	87	12.4	66.4
0- 60	126	18.0	96.6
0- 90	131	18.7	100.0
90-180	0	0.0	0.0
0-180	131	18.7	100.0

TOTAL LUMINAIRE EFFICIENCY = 18.7 %

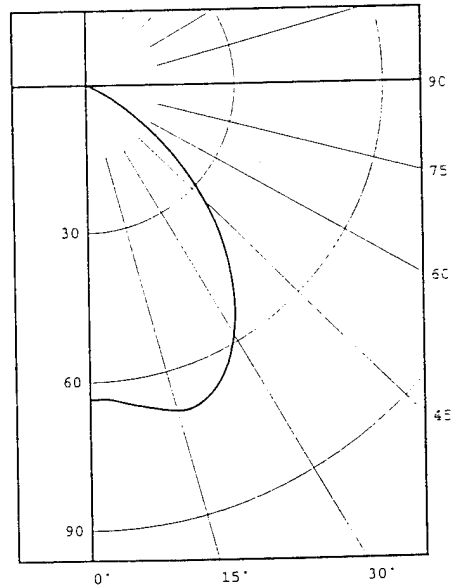
CIE TYPE - DIRECT

LUMINAIRE SPACING CRITERION = 1.3

LUMINOUS DIAMETER: 5.750

LUMINANCE DATA IN CANDELA/SQ M

ANGLE IN DEG	AVERAGE 0-DEG	MAXIMUM 0-DEG	MAX/AVG 0-DEG
45	2810.	16838.	6.0
55	1602.	13149.	8.2
65	367.	3462.	9.4
75	184.	256.	1.4
85	274.	274.	1.0



Checked *[Signature]*
 Approved *[Signature]*



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255 FAX (303) 449-5274

REPORT NUMBER: ITL40785
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-22-1993

CANDELA DISTRIBUTION

	0.0
0.0	64
2.5	64
5.0	64
7.5	65
10.0	66
12.5	67
15.0	68
17.5	69
20.0	68
22.5	66
25.0	64
27.5	62
30.0	58
32.5	55
35.0	51
37.5	47
40.0	43
42.5	38
45.0	33
47.5	29
50.0	24
52.5	20
55.0	15
57.5	11
60.0	8
62.5	5
65.0	3
67.5	2
70.0	1
72.5	1
75.0	1
77.5	1
80.0	1
82.5	1
85.0	0
87.5	0
90.0	0

ZONAL LUMEN SUMMARY

0- 5	2.
5- 10	5.
10- 15	8.
15- 20	11.
20- 25	14.
25- 30	16.
30- 35	16.
35- 40	16.
40- 45	14.
45- 50	12.
50- 55	9.
55- 60	5.
60- 65	2.
65- 70	1.
70- 75	1.
75- 80	0.
80- 85	0.
85- 90	0.



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FAX (303) 449-5222

REPORT NUMBER: ITL40785

DATE: 7-22-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC	80				70				50			30			10			0	
	RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30		10
0	22	22	22	22	22	22	22	22	22	21	21	21	20	20	20	19	19	19	19
1	21	20	20	19	20	20	19	19	19	19	19	18	18	18	18	18	17	17	17
2	20	18	17	17	19	18	17	16	17	17	16	17	16	16	16	16	16	15	15
3	18	17	15	14	18	16	15	14	16	15	14	15	15	14	15	14	14	14	13
4	17	15	14	13	17	15	14	13	14	13	12	14	13	12	14	13	12	12	12
5	16	14	12	11	15	14	12	11	13	12	11	13	12	11	12	12	11	11	11
6	15	13	11	10	14	12	11	10	12	11	10	12	11	10	11	11	10	10	9
7	14	11	10	9	13	11	10	9	11	10	9	11	10	9	11	10	9	9	9
8	13	11	9	8	13	10	9	8	10	9	8	10	9	8	10	9	8	8	8
9	12	10	8	7	12	10	8	7	9	8	7	9	8	7	9	8	7	7	7
10	11	9	8	7	11	9	8	7	9	8	7	9	8	7	8	7	7	6	6

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

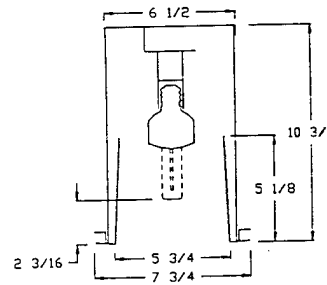


INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255 FAX (303) 449-5274

REPORT NUMBER: ITL40786
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: DEEP CAN, BLACK BAFFLE
 LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, BLACK PLASTIC LOWER BAFFLE, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: 11-WATT OSRAM DULUX EL COMPACT FLUORESCENT, RATED 600 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED
 TOTAL INPUT WATTS= 11.6 AT 120.0 VOLTS

DATE: 7-26-1993

CANDELA DISTRIBUTION						FLUX
	0.0	22.5	45.0	67.5	90.0	
0	20	20	20	20	20	2
5	21	21	22	22	22	8
15	25	27	28	28	27	15
25	30	34	35	34	32	17
35	22	27	29	28	25	10
45	10	13	13	14	13	2
55	1	1	2	2	2	1
65	1	1	1	1	1	0
75	0	0	0	0	0	0
85	0	0	0	0	0	0
90	0	0	0	0	0	0

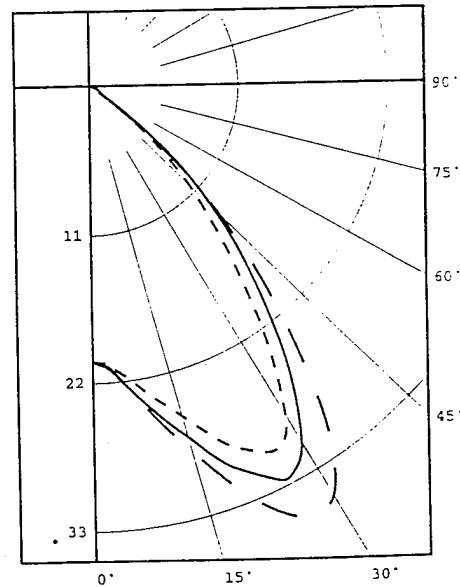


ZONAL LUMEN SUMMARY			
ZONE	LUMENS	%LAMP	%FIXT
0- 30	25	4.2	46.3
0- 40	42	7.0	76.7
0- 60	54	9.0	98.3
0- 90	55	9.1	100.0
90-180	0	0.0	0.0
0-180	55	9.1	100.0

TOTAL LUMINAIRE EFFICIENCY = 9.1 %
 CIE TYPE - DIRECT
 PLANE : 0-DEG 90-DEG
 SPACING CRITERIA : 1.5 1.6
 LUMINOUS DIAMETER: 5.750

LUMINANCE DATA IN CANDELA/SQ M			
ANGLE	AVERAGE	AVERAGE	AVERAGE
IN DEG	0-DEG	45-DEG	90-DEG
45	869.	1131.	1080.
55	114.	166.	198.
65	85.	85.	99.
75	46.	46.	46.
85	0.	0.	0.

ANGLE MAXIMIM MAXIMIM MAX/AVG MAX/AVG				
IN DEG	0-DEG	90-DEG	0-DEG	90-DEG
45	15989.	21579.	18.4	20.0
55	4192.	7442.	36.8	37.6
65	349.	427.	4.1	4.3
75	78.	140.	1.7	3.0
85	19.	30.	0.0	0.0



LEGEND:
 0-deg: - - - - -
 45-deg: — — — — —
 90-deg: ————

Checked *S. Budwig*
 Approved *R. J. B.*

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255

FAX (303) 449-527-

REPORT NUMBER: ITL40786
PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-26-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0
0.0	20	20	20	20	20
2.5	21	21	21	21	21
5.0	21	21	22	22	22
7.5	22	23	23	23	23
10.0	23	24	25	24	24
12.5	24	26	26	26	26
15.0	25	27	28	28	27
17.5	27	29	30	29	29
20.0	28	31	32	31	30
22.5	29	33	34	33	31
25.0	30	34	35	34	32
27.5	30	34	36	35	32
30.0	28	33	35	34	31
32.5	25	31	33	32	28
35.0	22	27	29	28	25
37.5	18	23	25	24	22
40.0	15	20	21	21	19
42.5	13	16	17	17	16
45.0	10	13	13	14	13
47.5	8	9	10	10	10
50.0	6	6	7	7	7
52.5	3	3	4	4	4
55.0	1	1	2	2	2
57.5	1	1	1	1	1
60.0	1	1	1	1	1
62.5	1	1	1	1	1
65.0	1	1	1	1	1
67.5	1	1	1	1	1
70.0	0	0	0	0	0
72.5	0	0	0	0	0
75.0	0	0	0	0	0
77.5	0	0	0	0	0
80.0	0	0	0	0	0
82.5	0	0	0	0	0
85.0	0	0	0	0	0
87.5	0	0	0	0	0
90.0	0	0	0	0	0

ZONAL LUMEN SUMMARY

0- 5	0.
5- 10	2.
10- 15	3.
15- 20	5.
20- 25	7.
25- 30	9.
30- 35	9.
35- 40	8.
40- 45	6.
45- 50	4.
50- 55	2.
55- 60	0.
60- 65	0.
65- 70	0.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.

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INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255 FAX (303) 449-5271

REPORT NUMBER: ITL40786

DATE: 7-26-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	11	11	11	11	11	11	11	11	10	10	10	10	10	10	9	9	9	9
1	10	10	10	9	10	10	10	9	9	9	9	9	9	9	9	9	9	8
2	10	9	9	8	9	9	9	8	9	8	8	8	8	8	8	8	8	8
3	9	8	8	7	9	8	8	7	8	8	7	8	7	7	7	7	7	7
4	8	8	7	7	8	7	7	6	7	7	6	7	7	6	7	7	6	6
5	8	7	6	6	8	7	6	6	7	6	6	7	6	6	6	6	6	5
6	7	6	6	5	7	6	6	5	6	6	5	6	6	5	6	5	5	5
7	7	6	5	5	7	6	5	5	6	5	5	6	5	5	5	5	5	4
8	6	5	5	4	6	5	5	4	5	5	4	5	5	4	5	5	4	4
9	6	5	4	4	6	5	4	4	5	4	4	5	4	4	5	4	4	4
10	6	5	4	4	6	5	4	4	4	4	4	4	4	4	4	4	4	3

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255 FAX (303) 449-5274

REPORT NUMBER: ITL40787 DATE: 7-26-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: DEEP CAN, BLACK BAFFLE
 LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, BLACK PLASTIC LOWER BAFFLE, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.

LAMP: 13-WATT DOUBLE TWIN TUBE COMPACT FLUORESCENT WITH MODULAR BALLAST/SOCKET ADAPTER, RATED 860 LUMENS, VERTICAL BASE-UP POSITION.

BALLAST: SYLVANIA MODULAR BALLAST/SOCKET ADAPTER, 535F LAMP HOLDER FITTING MODEL AE013

MOUNTING: RECESSED
 TOTAL INPUT WATTS= 17.2 AT 120.0 VOLTS

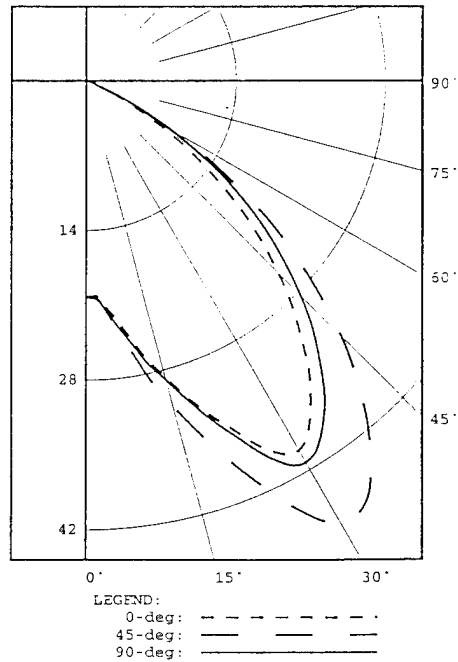
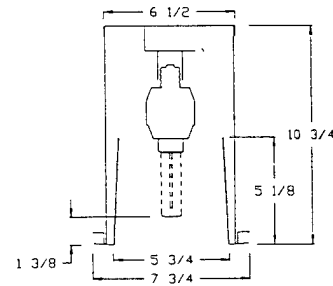
CANDELA DISTRIBUTION						FLUX
	0.0	22.5	45.0	67.5	90.0	
0	20	20	20	20	20	
5	21	21	22	22	22	2
15	29	31	32	30	29	9
25	38	42	43	41	38	19
35	37	44	46	44	39	27
45	25	31	34	33	28	24
55	13	16	17	17	16	14
65	2	2	3	3	3	3
75	1	1	0	1	1	1
85	0	0	0	0	0	0
90	0	0	0	0	0	0

ZONAL LUMEN SUMMARY			
ZONE	LUMENS	%LAMP	%FIXT
0- 30	30	3.5	30.4
0- 40	57	6.6	57.5
0- 60	95	11.0	96.3
0- 90	98	11.4	100.0
90-180	0	0.0	0.0
0-180	98	11.4	100.0

TOTAL LUMINAIRE EFFICIENCY = 11.4 %
 CIE TYPE - DIRECT
 PLANE : 0-DEG 90-DEG
 SPACING CRITERIA : 1.9 2.0
 LUMINOUS DIAMETER: 5.750

LUMINANCE DATA IN CANDELA/SQ M			
ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
45	2143.	2852.	2396.
55	1311.	1779.	1623.
65	339.	353.	424.
75	115.	92.	115.
85	0.	0.	0.

ANGLE MAXIMUM MAXIMUM MAX/AVG MAX/AVG				
IN DEG	0-DEG	90-DEG	0-DEG	90-DEG
45	23347.	27456.	10.9	11.5
55	13560.	20358.	10.4	12.5
65	1177.	4307.	3.5	10.2
75	219.	362.	1.9	3.1
85	31.	65.	0.0	0.0



Checked *G. Gudwig*
 Approved *R. J. [Signature]*

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REPORT NUMBER: ITL40787
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-26-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0
0.0	20	20	20	20	20
2.5	20	20	20	20	20
5.0	21	21	22	22	22
7.5	23	23	24	23	23
10.0	25	26	26	26	25
12.5	27	28	29	28	27
15.0	29	31	32	30	29
17.5	31	33	34	33	31
20.0	33	36	37	36	34
22.5	35	39	40	38	36
25.0	38	42	43	41	38
27.5	39	44	46	44	40
30.0	40	45	48	46	41
32.5	39	45	48	46	41
35.0	37	44	46	44	39
37.5	34	41	44	42	37
40.0	31	38	41	39	34
42.5	29	35	37	36	31
45.0	25	31	34	33	28
47.5	22	28	30	29	25
50.0	19	24	26	25	22
52.5	16	20	22	21	19
55.0	13	16	17	17	16
57.5	10	12	13	13	12
60.0	7	8	9	9	9
62.5	4	5	6	6	6
65.0	2	2	3	3	3
67.5	1	1	1	1	1
70.0	1	1	1	1	1
72.5	1	1	1	1	1
75.0	1	1	0	1	1
77.5	0	0	0	0	0
80.0	0	0	0	0	0
82.5	0	0	0	0	0
85.0	0	0	0	0	0
87.5	0	0	0	0	0
90.0	0	0	0	0	0

ZONAL LUMEN SUMMARY

0- 5	0.
5- 10	2.
10- 15	3.
15- 20	5.
20- 25	8.
25- 30	11.
30- 35	13.
35- 40	14.
40- 45	13.
45- 50	11.
50- 55	9.
55- 60	6.
60- 65	3.
65- 70	1.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.

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REPORT NUMBER: ITL40787

DATE: 7-26-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	14	14	14	14	13	13	13	13	13	13	13	12	12	12	12	12	12	12
1	13	12	12	12	13	12	12	11	12	11	11	11	11	11	11	11	10	10
2	12	11	10	10	12	11	10	10	10	10	10	10	10	9	10	9	9	9
3	11	10	9	8	11	10	9	8	9	9	8	9	9	8	9	8	8	8
4	10	9	8	7	10	9	8	7	8	8	7	8	8	7	8	7	7	7
5	9	8	7	6	9	8	7	6	8	7	6	7	7	6	7	7	6	6
6	9	7	6	6	8	7	6	6	7	6	5	7	6	5	7	6	5	5
7	8	6	6	5	8	6	6	5	6	5	5	6	5	5	6	5	5	5
8	7	6	5	4	7	6	5	4	6	5	4	6	5	4	5	5	4	4
9	7	5	4	4	7	5	4	4	5	4	4	5	4	4	5	4	4	4
10	6	5	4	3	6	5	4	3	5	4	3	5	4	3	5	4	3	3

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.



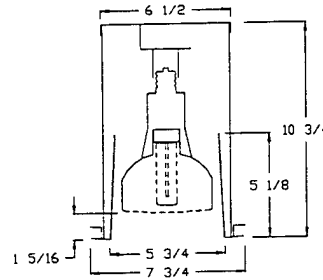
INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255

FAX (303) 449-5274

REPORT NUMBER: ITL40788
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: DEEP CAN, BLACK BAFFLE
 LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, BLACK PLASTIC LOWER BAFFLE, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: 13-WATT LUMATECH RAS-130 REFLECT-A-STAR WITH 13-WATT QUAD TUBE FLUORESCENT, RATED 860 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED
 TOTAL INPUT WATTS= 15.5 AT 120.0 VOLTS

DATE: 7-27-1993

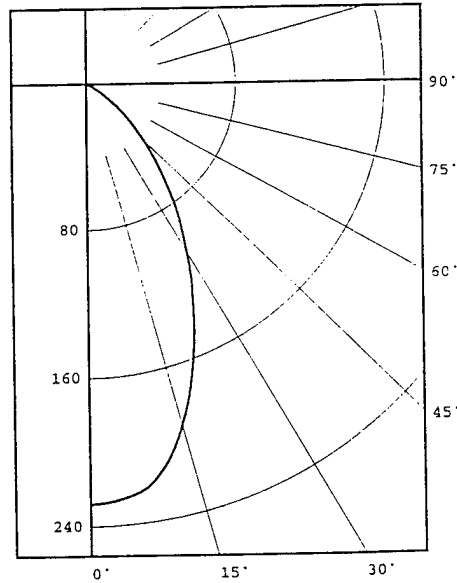
DEG	CANDELA	LUMENS
0	228	
5	225	21
15	192	54
25	133	61
35	83	51
45	43	33
55	16	15
65	3	3
75	0	1
85	0	0
90	0	



ZONAL LUMEN SUMMARY	ZONE	LUMENS	%LAMP	%FIXT
0- 30		136	15.9	56.9
0- 40		188	21.8	78.3
0- 60		236	27.5	98.6
0- 90		240	27.9	100.0
90-180		0	0.0	0.0
0-180		240	27.9	100.0

TOTAL LUMINAIRE EFFICIENCY = 27.9 %
 CIE TYPE - DIRECT
 LUMINAIRE SPACING CRITERION = 0.8
 LUMINOUS DIAMETER: 5.750

LUMINANCE DATA IN CANDELA/SQ M			
ANGLE IN DEG	AVERAGE	MAXIMUM	MAX/AVG
45	3628.	22322.	6.2
55	1664.	16159.	9.7
65	424.	3823.	9.0
75	0.	175.	0.0
85	0.	46.	0.0



Checked *G. Sudwig*
 Approved *R. J. [Signature]*



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FAX (303) 449-5274

REPORT NUMBER: ITL40788
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-27-1993

CANDELA DISTRIBUTION

0.0	0.0
2.5	228
5.0	227
7.5	225
10.0	222
12.5	215
15.0	205
17.5	192
20.0	178
22.5	163
25.0	148
27.5	133
30.0	120
32.5	106
35.0	94
37.5	83
40.0	71
42.5	61
45.0	52
47.5	43
50.0	35
52.5	28
55.0	22
57.5	16
60.0	12
62.5	8
65.0	5
67.5	3
70.0	1
72.5	1
75.0	0
77.5	0
80.0	0
82.5	0
85.0	0
87.5	0
90.0	0

ZONAL LUMEN SUMMARY

0- 5	5.
5- 10	16.
10- 15	24.
15- 20	29.
20- 25	31.
25- 30	30.
30- 35	28.
35- 40	24.
40- 45	19.
45- 50	14.
50- 55	10.
55- 60	6.
60- 65	2.
65- 70	1.
70- 75	1.
75- 80	0.
80- 85	0.
85- 90	0.



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REPORT NUMBER: ITL40788

DATE: 7-27-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	
0	33	33	33	33	32	32	32	32	31	31	31	30	30	30	28	28	28	28
1	31	30	30	29	31	30	29	29	29	28	28	28	27	27	27	26	26	26
2	30	28	27	26	29	28	26	25	27	26	25	26	25	24	25	24	24	23
3	28	26	24	23	27	25	24	23	25	23	22	24	23	22	23	22	22	21
4	26	24	22	21	26	23	22	21	23	21	20	22	21	20	22	21	20	19
5	25	22	20	19	24	22	20	19	21	20	19	21	19	18	20	19	18	18
6	23	20	19	17	23	20	18	17	20	18	17	19	18	17	19	18	17	16
7	22	19	17	16	21	19	17	16	18	17	16	18	17	16	18	16	15	15
8	21	18	16	15	20	18	16	15	17	16	14	17	15	14	17	15	14	14
9	20	17	15	14	19	16	15	14	16	15	13	16	14	13	16	14	13	13
10	19	16	14	13	18	15	14	13	15	14	13	15	14	13	15	13	13	12

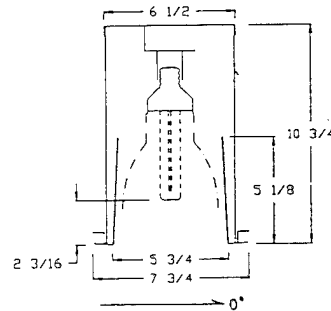
ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

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INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 449-5274
 REPORT NUMBER: ITL40789 DATE: 7-29-1993
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS
 CATALOG NUMBER: DEEP CAN, BLACK BAFFLE
 LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, BLACK PLASTIC LOWER BAFFLE, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.
 LAMP: 15-WATT DULUX EL REFLECTOR COMPACT FLUORESCENT, RATED 900 LUMENS, VERTICAL BASE-UP POSITION.
 MOUNTING: RECESSED
 TOTAL INPUT WATTS= 15.1 AT 120.0 VOLTS

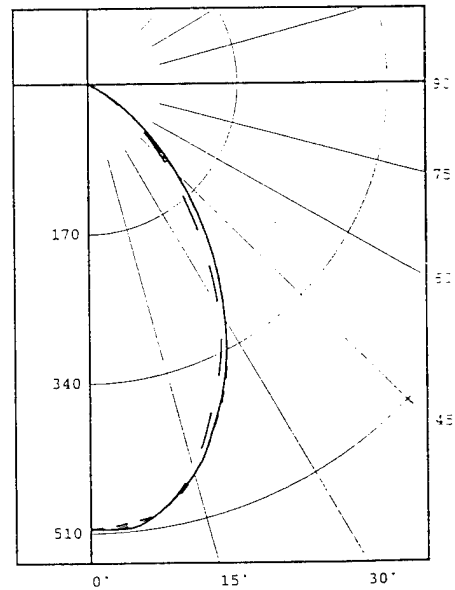
CANDELA DISTRIBUTION						FLUX
	0.0	22.5	45.0	67.5	90.0	
0	505	505	505	505	505	
5	500	502	504	506	506	48
15	458	457	452	455	458	128
25	366	360	351	358	364	164
35	252	242	230	241	251	151
45	140	134	123	134	142	103
55	56	54	49	55	58	48
65	5	5	5	5	5	6
75	1	1	1	1	1	1
85	0	0	0	0	0	0
90	0	0	0	0	0	0



ZONAL LUMEN SUMMARY			
ZONE	LUMENS	%LAMP	%FIXT
0- 30	340	37.8	52.3
0- 40	490	54.5	75.5
0- 60	642	71.3	98.8
0- 90	649	72.1	100.0
90-180	0	0.0	0.0
0-180	649	72.1	100.0

TOTAL LUMINAIRE EFFICIENCY = 72.1 %
 CIE TYPE - DIRECT
 PLANE : 0-DEG 90-DEG
 SPACING CRITERIA : 1.0 1.0
 LUMINOUS DIAMETER: 5.750

LUMINANCE DATA IN CANDELA/SQ M				
ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG	
45	11812.	10378.	11981.	
55	5825.	5097.	6033.	
65	706.	706.	706.	
75	231.	231.	231.	
85	0.	0.	0.	
ANGLE IN DEG	MAXIMUM 0-DEG	MAXIMUM 90-DEG	MAX/AVG 0-DEG	MAX/AVG 90-DEG
45	52224.	52349.	4.4	4.4
55	39522.	43062.	6.8	7.1
65	4181.	12369.	5.9	17.5
75	307.	419.	1.3	1.8
85	84.	159.	0.0	0.0



LEGEND:
 0-deg: - - - - -
 45-deg: _____
 90-deg: _____

Checked *S. Gudwig*
 Approved *R. De...*



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FAX (303) 449-5274

REPORT NUMBER: ITL40789
 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 7-29-1993

CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0
0.0	505	505	505	505	505
2.5	503	504	506	506	506
5.0	500	502	504	506	506
7.5	497	498	499	500	500
10.0	488	490	488	488	488
12.5	476	476	472	473	474
15.0	458	457	452	455	458
17.5	438	434	428	433	438
20.0	414	409	401	407	413
22.5	391	385	376	383	389
25.0	366	360	351	358	364
27.5	338	333	324	332	337
30.0	308	303	294	303	308
32.5	280	273	262	272	279
35.0	252	242	230	241	251
37.5	223	212	199	212	223
40.0	194	184	170	184	195
42.5	166	158	145	158	167
45.0	140	134	123	134	142
47.5	117	112	102	113	119
50.0	95	92	84	92	97
52.5	75	72	66	73	77
55.0	56	54	49	55	58
57.5	38	37	34	38	41
60.0	23	22	21	23	24
62.5	12	11	11	11	12
65.0	5	5	5	5	5
67.5	2	2	2	2	2
70.0	1	1	1	1	1
72.5	1	1	1	1	1
75.0	1	1	1	1	1
77.5	0	1	1	1	1
80.0	0	0	0	0	0
82.5	0	0	0	0	0
85.0	0	0	0	0	0
87.5	0	0	0	0	0
90.0	0	0	0	0	0

ZONAL LUMEN SUMMARY

0- 5	12.
5- 10	36.
10- 15	56.
15- 20	71.
20- 25	80.
25- 30	84.
30- 35	80.
35- 40	71.
40- 45	58.
45- 50	45.
50- 55	31.
55- 60	17.
60- 65	5.
65- 70	1.
70- 75	1.
75- 80	0.
80- 85	0.
85- 90	0.



INDEPENDENT TESTING LABORATORIES, INC. • 3386 LONGHORN ROAD, BOULDER, COLORADO 80302 • PHONE (303) 442-1255 FAX (303) 449-5277

REPORT NUMBER: ITL40789

DATE: 7-29-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC RW	80				70				50			30			10			0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	86	86	86	86	84	84	84	84	80	80	80	77	77	77	74	74	74	72
1	81	79	77	75	79	77	76	74	74	73	72	72	71	69	69	68	67	66
2	76	72	69	66	75	71	68	65	69	66	64	66	64	62	64	63	61	60
3	72	66	62	59	70	65	61	58	63	60	57	61	59	56	60	57	55	54
4	67	61	56	53	66	60	56	52	58	55	52	57	54	51	55	53	50	49
5	63	56	51	47	62	55	51	47	54	50	47	53	49	46	51	48	46	45
6	59	52	47	43	58	51	46	43	50	46	43	49	45	42	48	45	42	41
7	56	48	43	39	55	47	43	39	46	42	39	45	42	39	45	41	39	37
8	52	45	40	36	51	44	39	36	43	39	36	42	39	36	42	38	36	34
9	49	42	37	33	49	41	36	33	40	36	33	40	36	33	39	36	33	32
10	47	39	34	31	46	39	34	31	38	34	31	37	33	31	37	33	31	30

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

THIS REPORT IS BASED ON PUBLISHED INDUSTRY PROCEDURES. FIELD PERFORMANCE MAY DIFFER FROM LABORATORY PERFORMANCE.



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REPORT NUMBER: ITL40790

DATE: 8-25-1993

PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

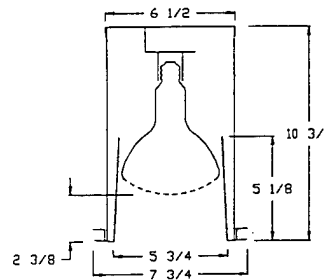
CATALOG NUMBER: DEEP CAN, BLACK BAFFLE

LUMINAIRE: FABRICATED CYLINDRICAL METAL HOUSING WITH BLACK PAINTED INTERIOR, BLACK PLASTIC LOWER BAFFLE, WHITE PAINTED METAL TRIM RING, OPEN BOTTOM.

LAMP: 150-WATT R40 SPOT INCANDESCENT, RATED 1900 LUMENS, VERTICAL BASE-UP POSITION.

MOUNTING: RECESSED

DEG	CANDELA	LUMENS
0	5954	
5	4936	418
15	1405	403
25	464	205
35	88	67
45	44	32
55	14	11
65	0	0
75	0	0
85	0	0
90	0	0



ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%FIXT
0- 30	1027	54.0	90.2
0- 40	1094	57.6	96.2
0- 60	1138	59.9	100.0
0- 90	1138	59.9	100.0
90-180	0	0.0	0.0
0-180	1138	59.9	100.0

TOTAL LUMINAIRE EFFICIENCY = 59.9 %

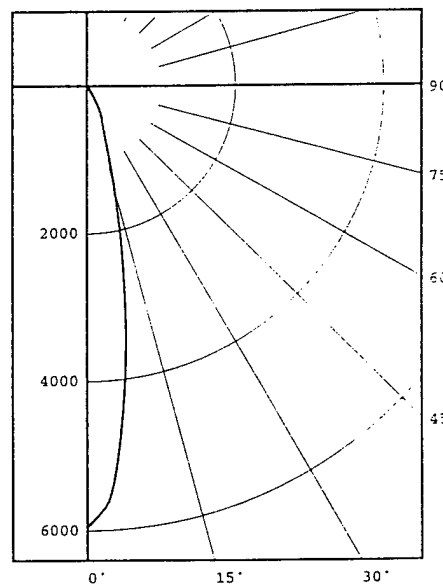
CIE TYPE - DIRECT

LUMINAIRE SPACING CRITERION = 0.3

LUMINOUS DIAMETER: 5.750

LUMINANCE DATA IN CANDELA/SQ M

ANGLE IN DEG	AVERAGE	MAXIMUM	MAX/AVG
45	3712.	58382.	15.7
55	1456.	35271.	24.3
65	0.	643.	0.0
75	0.	184.	0.0
85	0.	94.	0.0



Checked *S. Ludwig*
 Approved *R. B. ...*



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 PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

DATE: 8-25-1993

CANDELA DISTRIBUTION

0.0	0.0
0.0	5954
2.5	5686
5.0	4936
7.5	3949
10.0	2951
12.5	2083
15.0	1405
17.5	946
20.0	681
22.5	546
25.0	464
27.5	358
30.0	228
32.5	157
35.0	88
37.5	63
40.0	55
42.5	49
45.0	44
47.5	35
50.0	28
52.5	22
55.0	14
57.5	4
60.0	0
62.5	0
65.0	0
67.5	0
70.0	0
72.5	0
75.0	0
77.5	0
80.0	0
82.5	0
85.0	0
87.5	0
90.0	0

ZONAL LUMEN SUMMARY

0- 5	136.
5- 10	283.
10- 15	247.
15- 20	156.
20- 25	115.
25- 30	91.
30- 35	46.
35- 40	21.
40- 45	18.
45- 50	14.
50- 55	10.
55- 60	2.
60- 65	0.
65- 70	0.
70- 75	0.
75- 80	0.
80- 85	0.
85- 90	0.



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PREPARED FOR: U.S. ARMY CORPS OF ENGINEERS

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC	80				70				50			30			10			0	
	RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	71	71	71	71	70	70	70	70	66	66	66	64	64	64	61	61	61	60	
1	69	67	66	65	67	66	65	64	64	63	62	62	61	60	59	59	59	58	
2	66	64	62	61	65	63	61	60	61	60	59	59	58	57	58	57	56	55	
3	64	61	59	57	63	60	58	57	59	57	56	57	56	55	56	55	54	53	
4	62	59	56	54	61	58	56	54	57	55	53	56	54	53	55	53	52	51	
5	60	56	54	52	59	56	53	51	55	53	51	54	52	51	53	51	50	50	
6	58	54	52	50	57	54	51	49	53	51	49	52	50	49	51	50	49	48	
7	56	52	50	48	56	52	49	48	51	49	47	51	49	47	50	48	47	46	
8	55	51	48	46	54	50	48	46	50	47	46	49	47	46	49	47	46	45	
9	53	49	46	45	53	49	46	45	48	46	45	48	46	44	47	46	44	44	
10	52	48	45	43	51	47	45	43	47	45	43	47	45	43	46	44	43	42	

ALL CANDELA, LUMENS, LUMINANCE, COEFFICIENT OF UTILIZATION AND VCP VALUES IN THIS REPORT ARE BASED ON RELATIVE PHOTOMETRY WHICH ASSUMES A BALLAST FACTOR OF 1.000. ANY CALCULATIONS PREPARED FROM THESE DATA SHOULD INCLUDE AN APPROPRIATE BALLAST FACTOR.

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