LEVEL

19

LIGHTING STUDY

SECURITY SYSTEM MO' FICATIONS

AD A090157

DTIC
OCT 14 1980
C

80 8 26 124

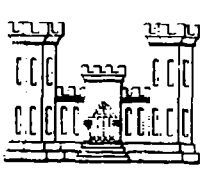
DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

(19)

LIGHTING STUDY

SECURITY SYSTEM MODIFICATIONS



(12) 66

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

(11) MAY 78

403 710

LIGHTING STUDY
SECURITY SYSTEM MODIFICATIONS

INDEX

LIGHTING STUDY
SECURITY SYSTEM MODIFICATIONS

LIST OF FIGURES AND TABLES

FIGURES

TABLES

REVISION
FEBRUARY 1978

STUDY OF SECURITY LIGHTING SYSTEM AND AUXILIARIES FOR SECURITY SYSTEM MODIFICATIONS AT VARIOUS SAC BASES

1. SCOPE:

The Air Force has been engaged in a program to provide upgraded security at its weapon's storage and aircraft alert facilities. As a part of the program, it was necessary to upgrade the lighting systems in these areas to meet the newer, more stringent requirements contained in AFR 207-1 issued in July 1975 (revised version of AFM 207-1). Lighting surveys of SAC bases in the Continental U. S. and overseas had revealed extensive deficiencies. Because of the large number of facilities and investment in materials involved it was concluded that a detailed lighting study should be made of various lighting schemes to determine the arrangement that would best meet the prescribed illumination requirements both photometrically and economically. The study would examine variables such as type of light source, pole spacing, mounting height, aiming angles, etc. Such a study was conducted by the Corps of Engineers and an initial report issued in December 1975. A set of definitive drawings based on the results of the study was issued in October 1976. They were utilized in the design and construction of upgraded systems at the various weapons storage areas (WSA's) and aircraft alert areas (AAA's or BAA's). The present security approach, however, is somewhat different than that in effect in December 1975. It has evolved through various changes, revisions, and refinements of criteria, security philosophy, and operating format. Current approach is noted in the following discussion.

2. TYPES OF FACILITIES INVOLVED - LIGHTING FORMAT:

There are two different types of areas which are being modified to provide greater security. One area is involved with storage of weapons and materials related to our national defense and the other has as its primary function to provide immediate reaction capability against an attack. The revised lighting is intended to provide an increased deterrent to intrusion sabotage, or hostile action, provide earlier and more reliable detection of such condition, and allow reaction personnel to cope more effectively with a threat.

2-1 Weapons Storage:

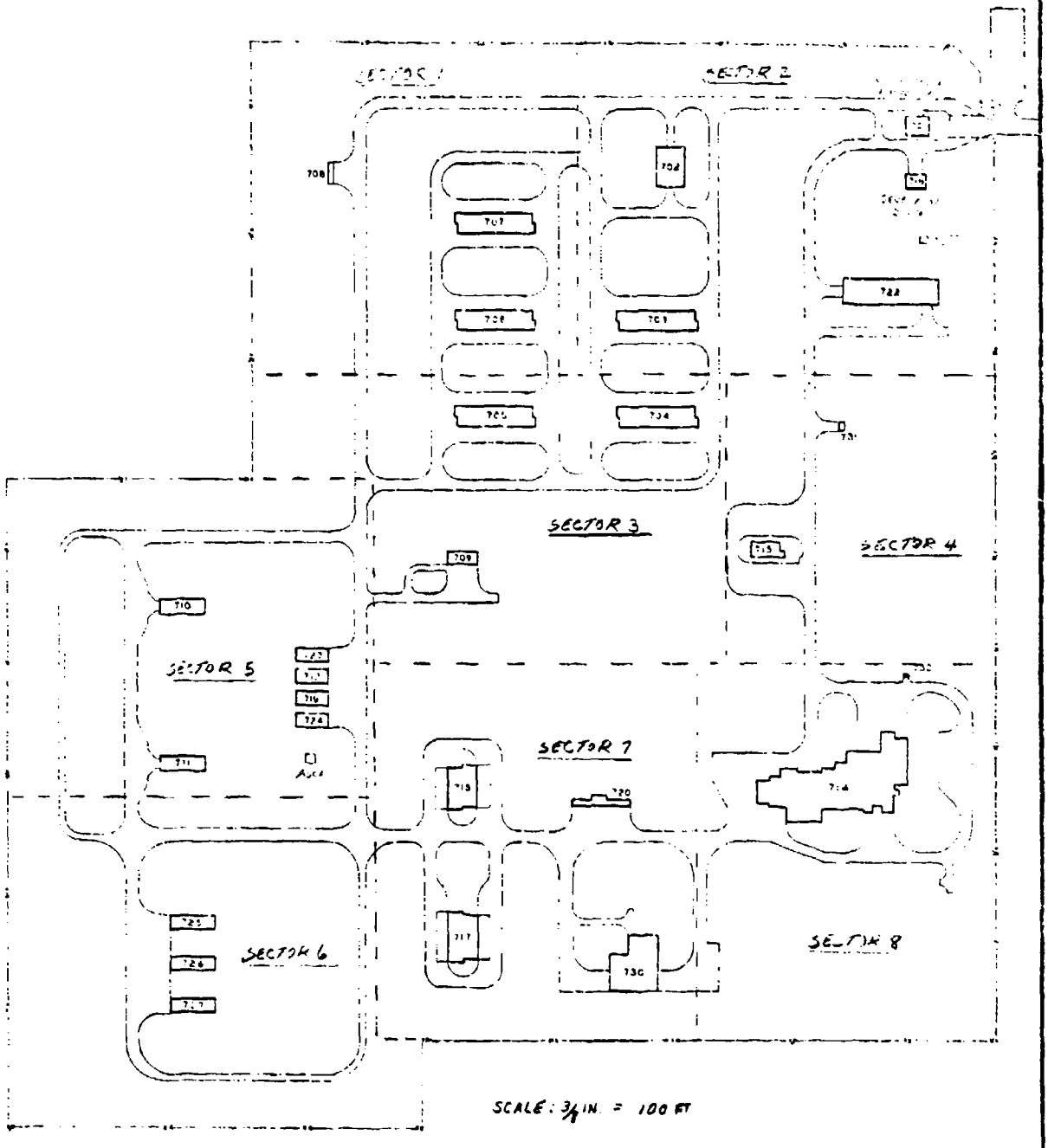
Areas used for weapons storage vary in size depending on the Base. Probably the largest is approximately 3000 feet by 2500 feet; one of the smaller, 300 feet by 1200 feet. A typical area, both in size and operation, is shown on Figure 1. At present most facilities have only a single fence. Future criteria will probably specify a double fence at some areas. Perimeter lighting will be directed outward and is intended to be energized continously during hours of darkness and reduced visibility. It will be switched, in no more than 2 segments, from the Master Surveillance and Control Facility ("MSCF" "Main Control Tower"). Area lighting will normally be off. It will be sectorized with controls at the MSCF. Controls will also be provided at the Entry Control Facility with over-ride capability by MSCF personnel. Guard personnel at the tower will be able to light up a specific location (sector) where there may be an intrusion or other problem. Towers range from 20-50 feet in height.

2-2 Aircraft Alert:

Aircraft alert areas at SAC bases are either of two types: the standard "SAC Christmas Tree" or the mass ramp type. See Figures 2 and 3 for typical layouts. Perimeter lighting will be similar to the format used at the Weapon's Storage Areas with the exception of the taxiway gap. Area lighting will be sectorized; nowever, for alert areas a center sector will be required with lights installed no closer than a envelope traced by a line 125 feet from hardstand paving. This required width of the center sector will range from 600 to 1200 feet for various bases. Typical will probably be 900 feet for the mass ramp type. For the Christmas Tree type shown in Fig. 3, it would range in width from 475 feet to 750 feet depending on distance selected for lateral spacing of poles.

2-3 Entry Control:

Each of the areas described above has a single entryway through which access is controlled. An entrapment area, enclosed by security fence, straddles the entrapment. Most areas will be subdivided into vehicle and personnel areas. Security police personnel will be stationed within Entry Control Buildings located within or adjacent to the entrapment area.



TYPICAL WEAPONS STORAGE AREA

FIGURE 1

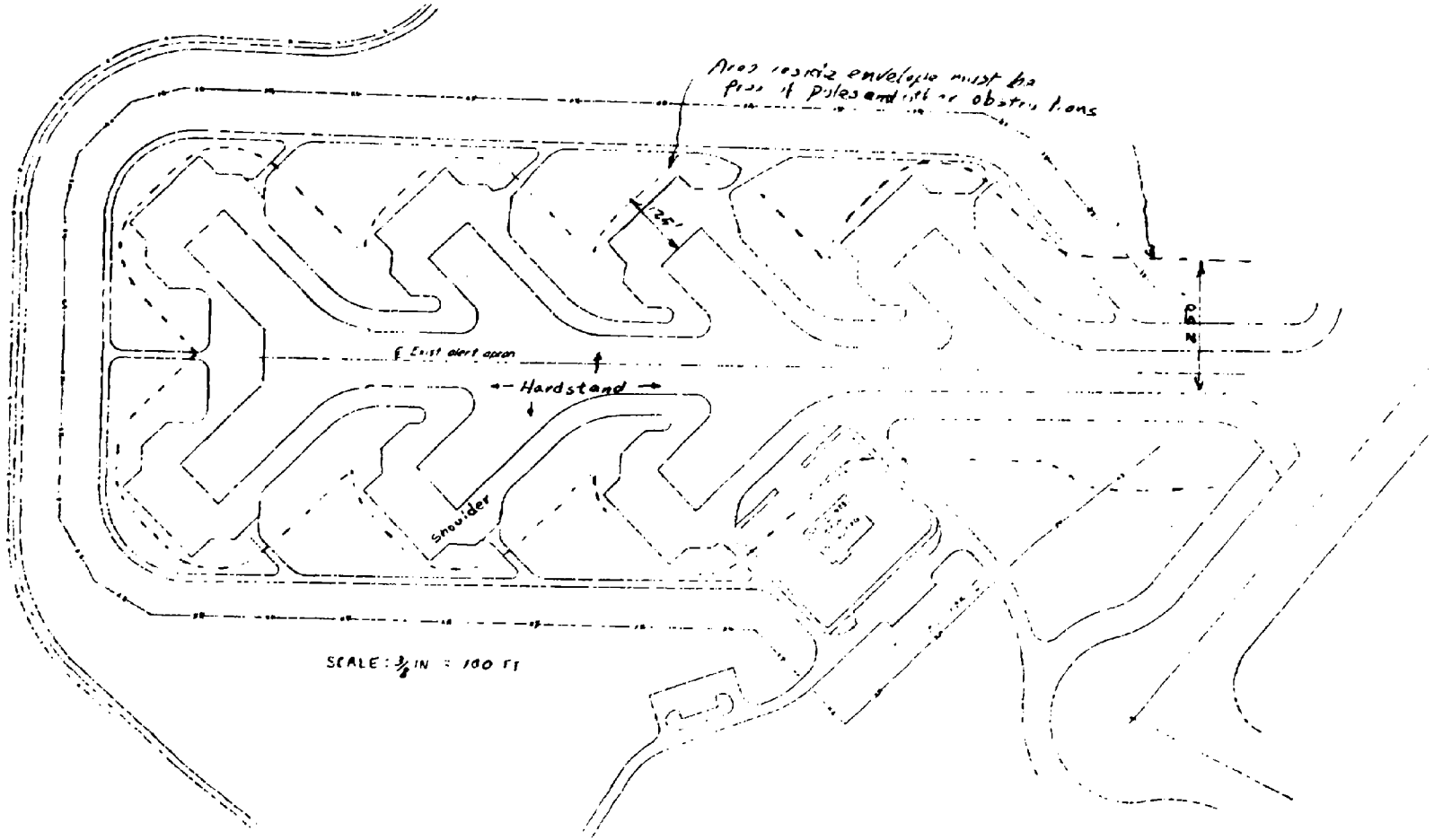
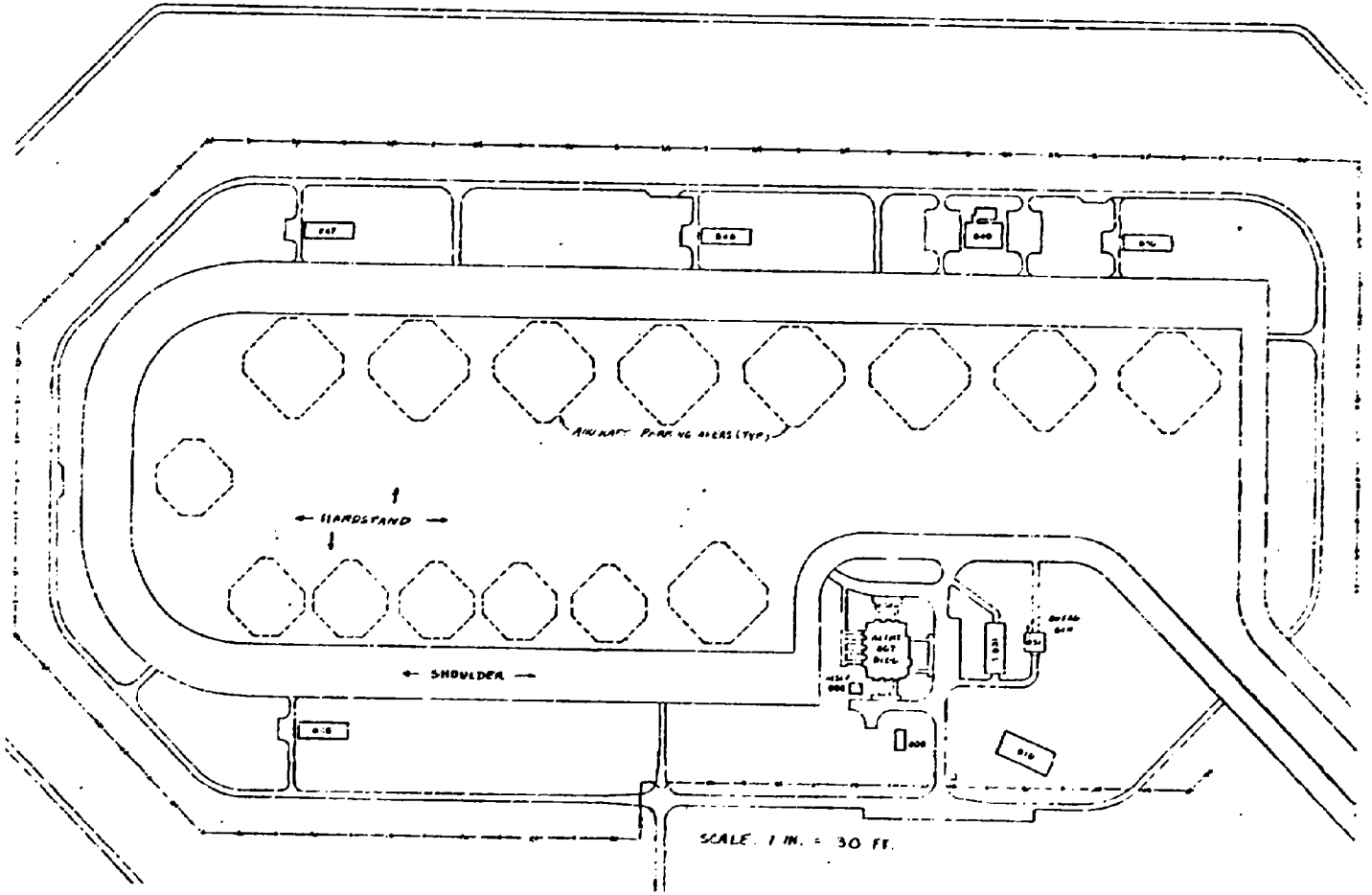


FIGURE 2

TYPICAL AIRCRAFT ALERT AREA - "CHRISTMAS TREE" TYPE



TYPICAL AIRCRAFT ALERT AREA – MASS RAMP TYPE

FIGURE 3

3. CRITERIA

3-1 Photometric Requirements:

3-1.1. Perimeter Lighting. For perimeter lighting, a strip from 10 feet inside the inner boundary fence to 30 feet beyond the outer fence must be lighted along the entire length of perimeter fencing. Minimum illumination required by Air Force criteria (AFR 207-1) in July 1975 was 2.0 footcandles, vertical, at the edge of the clear zone, 3 feet above ground and 2.0 footcandles, vertical, at each fence from ground level to 9 feet above above. A maximum of 1.0 footcandle, vertical (photometer perpendicular to the fence) was stipulated for a line, at ground level, 10 feet inside the inner fence. See Figure 4 for illustration. Previous criteria was 2.0 footcandles horizontal, at 6 inches up to 50 feet beyond the fence (derived from DOD 5210.41M (Confidential)). Under present criteria, the strip to be illuminated extends from the inner fence to the outer edge of the clear zone. A level of 2 horizontal (photometer aimed upward) footcandles average, at 6 inches above grade, is required at the time of initial installation. Degradation down to 65% is permissible (1.3 footcandles average, maintained). The uniformity of illumination must not exceed a ratio of 3 to 1. The luminaire is to be centered over the fence to minimize fence shadows.

3-1.2. Area Lighting. For area lighting it will be necessary to provide an arrangement such that there will be a mimimum of 0.4 footcandle of vertical illumination measured at 3 feet above ground throughout the area concerned. A value less than 0.4 footcandle at a particular point in a particular direction will not be considered a violation as long as the 0.4 f.c. measurement can be obtained at some other orientation. See figure 4. In 1975, the minimum value was 0.5 fc. Prior to that the requirement was 0.2 footcandles, horizontal, throughout the area, at the 6 inch level.

3-1.3. Entry Facility Lighting. Present policy stipulates use of a high pressure sodium light source installed in a roadway type of luminaire. A minimum of 2 footcandles of horizontally measured illumination is required within the entrapment area(s) at ground level (6 inches up is acceptable for measurement purposes). A minimum of 1.5 horizontal footcandles is necessary on the 30 foot clear zone in front of the exterior fence. An average level of 0.5 to 1.25 fc is desired for background lighting. The ECF lighting zone extends 25 feet from the ends of the gateway(s) and 25 feet behind the ECF building. The background lighting requirement applies to the exterior area(s) lying to the sides and behind the entrapment area.

3-1.4. Taxiway Gap Lighting. The minimum size taxiway gap will have dimensions of 425 ft across the taxiway by 60 ft. deep. The lighting zone will extend 15 feet farther (to a 75 ft depth) on the taxiway itself. The minimum acceptable illumination in the defined lighting zone is 1.5 vertical footcandles, obtained at any orientation from 0° to 360° horizontally in a plane 3 ft above ground.

3-2 Special Requirements and Limiting Factors.

The selection of a light source and specific layout arrangement was governed by certain special considerations. The impact of some of these factors will be analyzed elsewhere in this report. The following are some of the significant items:

3-2.1. Instant-On Fixtures. The area lighting will normally remain off (see Section 2). When circumstances call for one of the sectors to be lighted, it will be necessary that full illumination be provided almost immediately. For the subject facilities full illumination within five (5) seconds has been stipulated. The practical effect of this requirement is to eliminate all but the quartz iodine type of light source.

3-2.2. Instant Restrike. Perimeter lighting for both types of areas must provide continuous illumination at 100% of criteria levels during hours of darkness (see above). Unless UPS (Uninterruptible Power System) equipment is provided (or the requirement modified somewhat), this will require use of the quartz iodine lamp either entirely or to provide backup illumination during the restart interval of other lamp types.

3-2.3. Mounting Height. For perimeter lighting, Air Force policy in 1975 was that luminaire mounting not exceed 15 feet in height. Current policy allows 25 feet for single fence layouts and 35 feet maximum for double fence sites.

3-2.4. Clearance from Perimeter Fence. Lighting poles had to be set back at least 15 feet inside the inner fence under 1975 criteria. At present poles are to be placed approximately 3 feet back at WSA's, 6 feet at AAA's.

3-2.5. Airfield Clearances. Area lighting must be installed outside an area defined by an envelope of 125 feet from the limits of the hardstand paving per AFM 86-8. A clearance of 250 feet is required at taxiway areas (measured from far side of taxiway). In addition a 2000 foot approach zone is required along runways (1000 feet on both sides of the centerline). From the limit of that zone a 1 on 7 gradient is required. For more information, refer to the clearance layouts on Definitive Drawing AD 86-11-01, Sheets C-1 and C-4. No lighting or power poles can be higher than that envelope. These factors will limit pole location and heights at some facilities. The effect of jet blast is also to be considered relative to pole location.

3-2.6. Reliability. The type and arrangement of the lighting system has to be such that failure of one unit will not affect the rest of the system. The equipment must operate as intended irrespective of seasonal temperature variation and weather conditions.

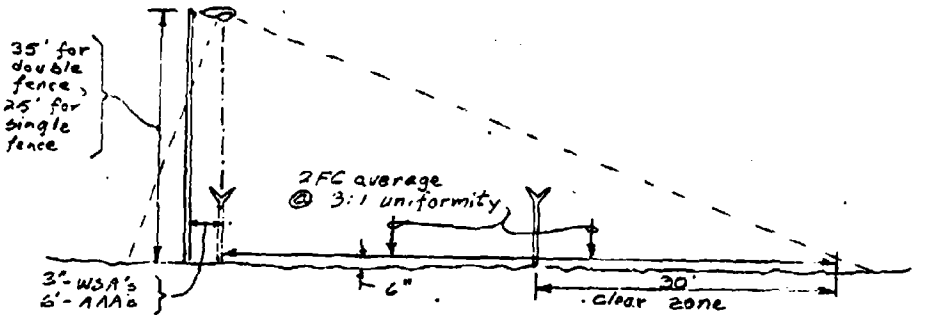
3-2.7. Hardening. Components which are essential to the functioning of security lighting (or other essential services) and which might be vulnerable to sabotage, must be hardened to prevent the breakdown of an entire system. Hardening is not required for components

mounted 15 feet or more above the ground. Generators will normally be housed in hardened concrete structures. Electrical distribution within 200 feet of the perimeter fencing should be underground. Pad-mounted transformers and lighting controls should be contained within hardened enclosures.

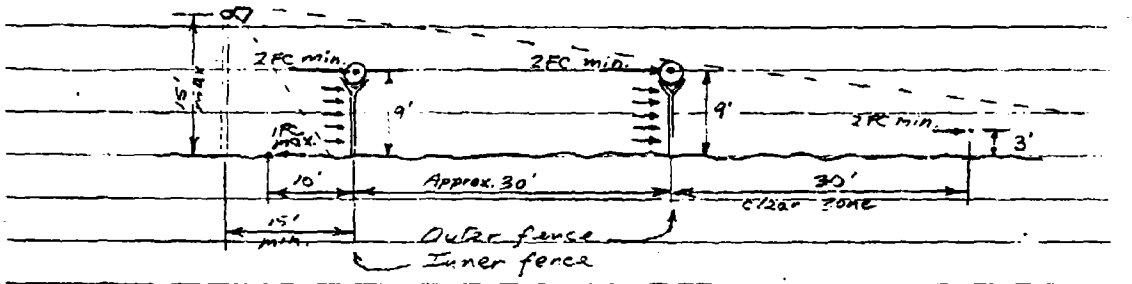
3-2.8. Backup Power. An alternate power source is necessary to replace commercial power during conventional outages or intentional sabotage to insure continuous operation of lighting and other security facilities. Automatic switching to full load capability on the line within 60 seconds maximum must be provided.

3-2.9. Sectorizing. As mentioned previously area lighting has to be divided into several individually controlled sectors. Each sector has to stand alone relative to establishing the basic format (number of luminaires per pole, horizontal aiming, pole spacing, distance between rows). However in placing the border of the sector, the illumination contribution from an adjacent sector can be included. This is acceptable on the basis that should the center of attention (intruder, etc.) shift to the edge of the sector, the adjacent sector lighting will be turned on.

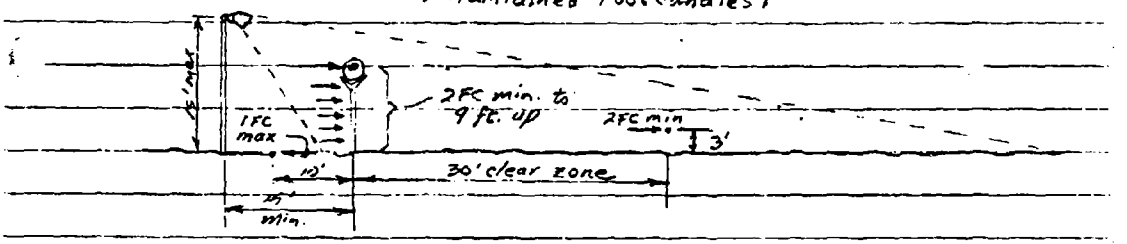
3-2.10. Visibility/Glare. The traditional approach for perimeter lighting has been to project glare toward an intruder approaching the secured area, while leaving reaction forces within in relative darkness. Initial designs in 1975 and 1976 followed this approach using high pressure floodlights. The present format, however, requires uniform illumination that will provide maximum visibility for viewing by TV surveillance systems (TV cameras typically will be aimed down the fenceline). A meeting at Eglin Air Force Base on 20-22 February 1977 established the roadway luminaire as the standard for perimeter lighting.



PERIMETER LIGHTING REQUIREMENTS - 1977
(Initial Footcandles)

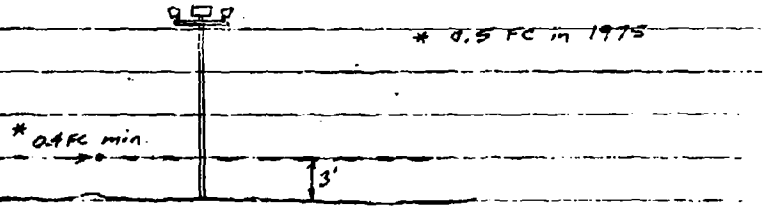


a. Double Fence Configuration
(Maintained Footcandles)



b. Single Fence Configuration
(Maintained footcandles)

PERIMETER LIGHTING REQUIREMENTS - 1975



Note: A reading of 0.4* footcandle on a photometer oriented in any direction from 0° to 360° in a horizontal plane 3 ft. above the ground will be considered to have fulfilled the criteria.

AREA LIGHTING REQUIREMENT
(Maintained footcandles)

FIGURE 4

4. BACKGROUND FOR THE STUDY:

4-1 General: The prescribed objective of the lighting study was that the most efficient arrangement both photometrically and economically be determined. The study was to proceed, initially, in an unconstrained mode, on the basis that all arrangements that might feasibly fulfill the objectives of the study be considered. The effect of varying such parameters as mounting height, luminaire orientation, aiming angle, quantity of luminaires, pole spacing, etc., were to be considered. The effects of constraints such as 15 foot mounting height limitation (perimeter lighting), clearances from taxiways or hardstands, instant start or restrike requirements, maximum of 1 footcandle spill light 10 feet inside perimeter fence, etc. were also to be considered. The economic penalty, if any, resulting from such constraint was to be identified.

4-2 Lighting Schemes Considered: To provide the illumination levels described in Section 3, a number of different schemes, as listed below, were evaluated. The low pressure sodium source was not one of the specified schemes in the original criteria, but was included here, with Air Force concurrence, since available literature indicated it was a lamp of very high efficiency.

4-2.1. Area Lighting:

a. Quartz Iodine Fixtures. Because of the instant start requirement and the relatively infrequent use (unlikely to total over 200 burning-hours over an entire year), there would be little gain in considering other types of lamps.

4-2.2. Perimeter Lighting:

a. Quartz Iodine Fixtures.

b. High Pressure Sodium (HPS) fixtures with supplemental means of insuring 100% illumination during restart interval (Provided by quartz fixtures serving as backup illumination until the H.P.S. can build up to full illumination output. Quartz units would automatically shut off at that point.)

c. H.P.S. with 75% backup illumination during the restrike interval.

d. H.P.S. with 50% backup illumination during the restrike interval.

e. H.P.S. plus an Uninterruptible Power System. The U.P.S. had to be of sufficient capacity to maintain service without a break to the H.P.S. lights for 15 minutes.

f. H.P.S. with spill light from Area lighting fixtures being utilized to provide backup illumination during the restrike interval.

g. Low Pressure Sodium (L.P.S.) fixtures with supplemental means (quartz iodine lamps) of providing 100% illumination during the interval required to return to full brillance.

h. L.P.S. with 75% backup illumination during the interval required to return to full brilliance.

i. L.P.S. with 50% backup illumination during the interval required for full brilliance to be restored.

j. L.P.S. plus U.P.S. of sufficient capacity to maintain uninterrupted service to the lights for 15 minutes.

k. L.P.S. with Area Lighting being switched on (by personnel at MSCF) to provide spill light as backup illumination while the UPS builds up again to rated light output

4-3 Light Sources Considered - Description:

4-3.1. General. The primary purpose of a light source is generation of light energy. The efficiency at which this end is achieved is expressed in lumens output per watts consumed (input). The maximum theoretical efficiency (luminous efficacy) of an ideal white source (one which radiates a constant output over the entire visible spectrum and none outside that spectrum) is 220 lumens per watt. If the input energy were to be radiated only as a monochromatic yellow green, at a wavelength of 5550 angstroms (the region of the spectrum most sensitive to the eye), the theoretical efficacy would be approximately 680 lumens per watt. The first electric lamps in the 1880s produced 2 lumens per watt. The modern low pressure sodium lamp achieves approximately 180 lumens per watt, the greatest achieved thus far in a commercially available lamp.

4-3.2. Incandescent Lamp. The incandescent lamp is the oldest lamp type presently in use. A tungsten filament serves as the light source although not very efficiently since only 10% of its output is usable light, the rest being primarily heat. The lumen efficiency can be increased slightly but at the cost of shorter life. The quartz iodine (tungsten halogen, tungsten halide) variation contains a halogen gas which tends to regenerate the tungsten thus increasing life. Quartz lamps find their greatest application for flood lighting where low initial cost and/or instant start requirements govern. A summary of this lamp's significant characteristics and a comparison with other sources is contained in Figure 5. A quartz lamp has negligible lumen depreciation over its operating life. The lamp is limited to operation in the horizontal position. See Figure 16.

4-3.3. Fluorescent Lamp. In fluorescent lamps, a ballast causes an arc to strike between cathodes. The arc causes mercury vapors under low pressure to emit ultraviolet radiation which causes fluorescent powders to generate visible light. These lamps have relatively long

life and low surface brightness (glare) with application for interior lighting primarily. Their poor beam control and instability during temperature changes limits their usefulness outdoors.

4-3.4. High Intensity Discharge (HID) Lamps. These lamps have a gaseous arc and operate under pressures and current densities sufficient to generate visible light from their arcs alone without additional additives. Like most discharge arc lamps, they have a negative resistance characteristic which requires a ballast to limit current to the lamp and supply the proper starting voltage. Mercury lamps have a quartz arc tube containing mercury for light generation, argon for starting, and in some lamps added phosphors for color improvement. Metal halide lamps contain iodide additives for better color rendition and greater light output. Both of these lamps suffer from comparatively long restart intervals. High pressure sodium lamps contain a ceramic arc tube with xenon gas added for starting. They have the advantage of a significantly higher lumen output and a relatively shorter restrike time. A characteristic common to HID lamps is the necessity for lamps to cool down and the pressure to drop before restrike can occur. This process must occur whenever the arc has been lost. A break in power as short as one cycle (16.67 milliseconds) or a sudden dip in line voltage (as small as 25% for HPS) can extinguish the arc. The cool down interval ranges from 20 minutes for metal halide lamps to 1-2 minutes for high pressure sodium depending on the manufacturer and the lamp size. The low pressure sodium lamp shares the negative resistance characteristic of HID lamps, however it performs somewhat differently because it operates at significantly lower vapor pressures. See subsection 4-3.6. for more details.

4-3.5. High Pressure Sodium (HPS) Lamp. HPS lamps were pioneered in the U.S by the General Electric Company in the mid 1960's and have found rapidly increasing acceptance as a result of the increased emphasis on energy conservation. Efficacy of the bare lamp alone extends to 130 lumens per watt in the larger sizes. Over 25% of its output energy is in the form of usable light. HPS lamps utilize a different ballast design than mercury or metal halide because of the high voltage high frequency starting pulse required. Warm-up time is approximately 5 minutes to full output. Operating pressure is lower than for a mercury vapor or metal halide lamp which, coupled with the different starting method, allows restrike times to be lower - approximately 1-2 minutes, 3 minutes maximum. HPS lamps have a characteristic golden-yellow output (yellow, orange, and red predominate). The lamps themselves are physically quite compact compared to other types of lamps and allow luminaire designs having excellent beam control. Lamps made by General Electric are limited to a vertical mounting position, either base up or base down. The vertical aiming can be adjusted up to approximately 90° from the design position; if aiming extends beyond that, part or all of the sodium amalgam may spill from its reservoir. The newest Westinghouse and Sylvania lamps can be operated in any position with apparently minimal effect on lamp life. In a HPS lamp operating voltage increases over its rated life. The extent of rise determines lamp life. When the required input voltage to the lamp exceeds the voltage supplied by the

ballast, the lamp will cycle on and off. At this point the lamp must be replaced. Extended operation in this mode (a maximum of 50 hours has been recommended) or operation without a lamp will cause damage to the ballast.

4-3.6. Low Pressure Sodium (LPS) Lamp.

a. History. The first practical LPS lamp was introduced commercially in this country in 1932. Efficacy then was 50 lumens per watt. Development effort here, however, on a lamp for outdoor use, soon faded and effort was concentrated instead on the mercury vapor source, plus, variations of the incandescent, and later others such as metal halide and HPS. On the other hand, in Europe the lamp came into wide use for applications such as roadway lighting. It has recently reentered the commercial lighting market in the United States. A partial listing of locations where LPS equipment has been installed and organizations that have studied LPS lighting is included in Attachment 8. Other articles and information on LPS is included in Attachments 5, 9, 10 11 and 12.

b. Description of Lamp Types. There are two types of lamps available: one manufactured by General Electric Company Ltd. (G.E.C.) of England (not affiliated with General Electric Company of the United States), the other made by N.V. Phillips Company of Eindhoven, the Netherlands. (Norelco is the primary outlet for Phillips Products in the U.S.). Presumably an essential difference between the two lamps is that the G.E.C. lamp is a constant wattage type with lumen output decreasing over life, the other a constant lumen type with the lamp absorbing a gradually increasing amount of input wattage over its rated life. On this basis, an engineering decision should involve evaluating the trade-off between lower light output or additional energy consumption. However, it has not been possible to verify that the difference is as significant as proponents of the G.E.C. lamp have indicated. In practice it appears that the lamp will experience some wattage increase although less than the Norelco lamp. The Norelco lamp apparently undergoes a slight increase in lumen output over its rated life.

c. Lamp Construction and Operation. Lamps are of the arc discharge type. The arc tube is constructed of borate glass (to resist attack by sodium) backed by lime glass (to seal out moisture). It contains sodium under a very low vapor pressure plus one or more starting gases such as neon, argon or xenon. As is characteristic of arc-discharge lamps, light output is dependent upon arc-temperature and vapor pressure. Ionization of the starting gases increases temperature in the tube causing the sodium to vaporize (at 90°C). Tube within a tube construction with a vacuum between insures excellent thermal insulation properties. Ambient temperatures between -10°C to 40°C have no practical effect on light output or starting. There are two different varieties of arc tubes - dimpled vs smooth construction. Dimpled lamps utilize indentations spaced along the tube serving as reservoirs of sodium to counterbalance the sodium migration characteristic which occurs toward the end of useful lamp life. Norelco lamps use this approach. G.E. of England utilizes a smooth tube with a heat reflecting film on the lamp jacket. Film thickness is tapered along the length of

the lamp to balance thermal and electrical gradients in the arc tube and thus maintain sodium vapor light output constant over rated lamp life. According to the ballast manufacturer, the two lamps should be completely interchangeable in any fixture without any adverse affect on either ballast or the lamp. See attachments 1 and 2 for literature on the lamps.

d. Starting and Restrike. Once the arc has been ignited, heat from the starting gas discharge begins to vaporize the sodium. The vaporization process continues for 7 to 15 minutes, depending on the particular lamp, until full light output is achieved. Restrike is almost immediate since the temperature and pressure have to drop only slightly to enable restrike to occur. The lower wattage lamps exhibit better characteristics than the larger units. A sample 35 watt luminaire from Quality Outdoor Lighting (G.E. of England lamp) tested in this office in September 1975 provided immediate (within 3 seconds) restrike and full illumination for power breaks up to 2 minutes duration. Total warmup time from cold start was 8 minutes. "Off" intervals from 2-4 minutes duration had fairly sharp dropoffs of illumination, which then leveled off until at a 15-minute interval conditions were equivalent to cold start. Tests made by Southern Division, Naval Facilities Engineering Command in September 1975 using 4-90W Verd-A-Ray fixtures showed average restrike times of approximately 2 minutes for a 30 second break in power. Representatives from North American Phillips and SEPCO Lighting have indicated immediate restrike for outages of up to 5 minutes duration. See Attachments 3 and 4. Test data on new 180 W lamps was received from the Los Angeles representative of Norelco in March 1977. After a power break of 1 second duration, 65% of the lamps reignited immediately, 85% within 2 minutes. Lumen output was 67% initially increasing to 87% of normal at 2 minutes. If the power interruption was a full minute in duration, 73% of the lamps reignited immediately, 100% at 1-3/4 minutes. Lumen output was 73% initially 102% at 2 minutes, settling down to normal (100%) after 5 minutes.

e. Color Rendition. Light from low pressure sodium lamps has a reddish coloration initially due to ionization of the neon starting gas. This changes to a monochromatic yellow at full output. This area of the visible spectrum is most sensitive to the human eye, which results in maximum efficiency in energy usage to achieve a given level of useful illumination. Objects viewed under this light will tend to lose their color quality; discrimination between red and orange, blue and green, etc. will be difficult other than as degrees of brightness or darkness. However, according to representatives of Quality Outdoor Lighting, addition of supplemental light from another wider spectrum source of one-fifteenth or more of the LPS illumination level will restore color quality. For roadway lighting, public acceptance after an initial adjustment period has apparently been relatively high. See Attachments 6 and 10 for results of opinion surveys.

f. Special Considerations. To maintain optimum light output and lamp life requires that the higher wattage (135,180W) luminaires

be mounted with the longitudinal axis not more than 20° from the horizontal. This assures more uniform operating temperature along the tube and minimizes concentration of sodium at one end.

g. Availability. Low pressure sodium lighting has only recently been reintroduced into this country and as yet is still relatively unknown. However, interest in this source is growing. Luminaires and ballasts are manufactured in the United States. Lamp stocks are maintained here, but lamps at present are still manufactured overseas. See Attachment 7 for addresses. Either type of LPS lamp can be operated in a given fixture; there may be some difference in lumen output or wattage drawn in a particular application, however.

4-3.7. Xenon. Two types of lamps are available, short arc ("compact arc") and long arc. The short arc lamp has found more commercial application than the long arc. These include use for search lights, projection lamps, studio lighting, optical instruments and display systems. The main application for the newer long arc lamp has been for sports lighting or similar configurations where poles have to be placed outside the area to be lighted. Short arc lamp enclosures operate under high internal pressures (10-50 atmospheres), whereas long arc lamps are subject to much lower (and safer) pressures of 1 atmosphere maximum. Short arc lamps utilize resistive or inductive ballasts; long arc lamps require only a starter. Starting voltage pulses are under 600V (line voltage) for the long arc unit vs. several thousand volts for short arc. Both lamps reproduce the spectral energy distribution of natural light with exceptional fidelty, better than any other artificial light source. Starting and restrike is essentially instantaneous (2 seconds). The long arc fixture is available without the instant start feature, restrike is 30-60 seconds. Efficacy of the long arc lamp is 20-27 lumens per watt. Short arc lamp efficacies range from 20 to over 50 lpw. The long arc fixture has the disadvantage of being heavy and bulky (265 lbs, 84 inches long for 20 kw unit). In the U.S. sources of long arc luminaires and lamps are limited to American Daylight Co. International of Phoenix, Arizona and EC & G Inc. of Salem, Massachusetts (lamps only). The short arc lamps and fixtures are more competitive with a variety of sources available.

4-4 Evaluation of Lamp Sources.

4-4.1. General. Each of the various lamp types has its own characteristic features which may be advantageous or disadvantageous, depending on the application. Comparative characteristics are shown in Figure 5. Table I contains a listing of lamp sizes and the nearest equivalent, based on relative lumens per watt, for other types. Specific factors which determined the selection of lamps for this application are discussed in the following paragraphs.

4-4.2. Cost. The incandescent units have the lowest initial cost, but are relatively high in energy consumption. The HPS and LPS conversely, have relatively high initial cost and very low operating cost. The highest initial cost ($2500 for a 20000 watt fixture) occurs with long arc xenon units.

4-4.3. Efficacy. The incandescent sources have the lowest lumen output at 12-23 lumens per watt. The highest efficacies are available from the the LPS sources, 183 lpw for the 180 lamp alone, 135-140 lumens per input watts to the luminaire The HPS source is next best at 140 lpw for the bare lamp, and 90-95 lpw for the lamp/luminaire assembly.

4-4.4. Lamp Characteristics. Comparative data on lamp mortality and lumen depreciation over life is shown in Figure 7 (also refer to Figure 8 and Attachment 4). It should be noted that lamp characteristics have been upgraded since this chart was compiled and that some lamps have slightly longer operating life or better mortality than indicated. For the purposes of this lighting study, it was assumed that group relamping would occur when 20% of the total lamps initially installed had been spot replaced (80% survival). Maintenance factors (dirt factor X lamp lumen depreciation) were determined, from manufacturers data, using the LLD corresponding to this point on the mortality curves. See table III for typical maintenance factors. The HPS lamp suffers a decline in lumen output over life which results in a change in efficacy from approximately 105 lpw initial to an average of 92 lpw. The LPS lamp has ballasts which are designed to compensate for the lumen degradation by increasing the wattage delivered to the lamp. The Phillips lamp will even show an increase in its lumen output. Power consumption by this lamp rises from 180 watts initial to approximately 240 watts at end of life. Change in efficacy drops from 150 lumens per watt (lpw) initial to an average of 136 lpw. Although firm data has been difficult to obtain, indications are that the G.E.C. lamp also has an increased energy consumption over its life, although of lesser degree, plus some decrease in lumen output. See Table II. In computer analysis, we have used figures of 40 watts and 10 watts respectively for the wattage rises projected at 20% mortality for the Phillips and G.E.C. lamps.

TABLE I - EQUIVALENT LAMP SIZES BY WATTAGE* (APPROX.)

Quartz or Incandescent	Fluorescent	Mercury Vapor	Metal Halide	High Pressure Sodium	Low Pressure Sodium
200	55/60	100	--	50	35
250	2x40	175	--	70	55
500	4x40	250	175	100	90
750	--	250/400	175	150	135
1,000	--	400	250	150/250	135
1,500	--	--	400	--	180
--	--	700	--	400	--
--	--	1,000	--	--	--
--	--	--	1,000	--	--
--	--	--	1,500	1,000	--

*The lamp sizes listed are based on the wattages of lamps alone, actual input wattage to fixtures may be higher than these nominal sizes due to ballast losses. Equivalency is determined from rated lumen output.

TABLE II - COMPARISON* OF HIGH PRESSURE AND LOW PRESSURE SODIUM FIXTURE CHARACTERISTICS OVER RATED LIFE

	LPS		HPS
	GEC	PHILLIPS	
Initial Lamp Wattage	180	180	395
Lamp Wattage at end of life	200	240	400
Ballast Loss (watts)	40	40	80
Total Input Watts - Initial	220	220	475
Total Input Watts - Final	240	280	480
Initial Lumens	33,000	33,000	50,000
End of Life Lumens	28,050	34,000	37,500
Efficacy Initial (Lum/W)	150	150	105
Efficacy - Final	117	121	78
Efficacy - Average	134	136	92

*These figures are based on available information. Operating experience on these lamps apparently has not been sufficient to publish firm detailed data, particularly for the GEC lamp. The figures represent averaged performance; individual lamps off the production line may perform somewhat better or worse than indicated.

TABLE III - MAINTENANCE FACTORS

TYPE OF LAMP	NECA* MF	RATED LIFE (50% Fail)	RELAMP (20% Fail	CORPS OF ENGINEERS LLD	DF	MF
Incandescent	0.75					
Quartz	0.85	2000	1600	0.95	0.85	0.81
Mercury Vapor (White)						
175-700W	0.70					
1000W	0.65					
M.V. (clear/color impr)						
175-700 W	0.75					
1000W	0.70					
Metal Halide	0.65					
High pressure Sodium	0.75					
250W Floodlight	---	15000	9500	0.85	0.85	0.72
250W Roadway	---	15000	9500	0.85	0.80	0.68
400W Roadway	---	20000	13000	0.85	0.80	0.68
Low Pressure Sodium						
180W Phillips	---	18000	14000	1.00	0.90	0.90
180W G.E.C.	---	18000	14000	0.85	0.95	0.81

*NECA data is taken from their "Electrical Design Guidelines" series.

4-4.5. Lumen Output vs Voltage Drop. For fluorescent and HID lamps lumen output is influenced primarily by ballast design. Ballasts are readily available which will limit changes in lumen output (or wattage) to ± 3% (or ± 5% some mfrs.) under a line voltage fluctuation of ± 10%. Standard incandescent and tungsten halide lamps, however, are very sensitive to line voltage variations from design operating voltage. A lamp operated at 5% below design voltage will deliver only 85% of the rated lumen output. Allowance for voltage drops in supply circuits will have to be made. See Figure 8. (Example: An area designed to a level of 0.47 footcandles minimum will yield 0.4 FC minimum if the actual voltage delivered to the lamp due to voltage drop in the line is 95% of rated lamp voltage.)

4-4.6. Color. Of the artificial light sources, the xenon lamps most nearly duplicate the color spectrum of sunlight. The output of incandescent lamps spans the entire light spectrum but tends to be strong at the red end. Fluorescent lamp output is spotty, tending toward the violet end of the spectrum, special natural spectrum lamps are available however. The HID sources also have irregular spectral distributions. The metal halide lamps generate a set of color components that most closely, of the HID sources, resembles natural light. The light energy from HPS sources is predominately yellow and yellow-orange plus some low intensity components of red and blue. The LPS lamps concentrate virtually all of their light energy in a monochromatic yellow component.

4-4.7. Visibility/Glare. Glare as perceived by an observer can be of two types, discomfort glare or disability glare ("veiling glare", "blinding glare"). If disability glare is present, the observer's visual performance will suffer. Discomfort glare will make an individual uncomfortable but will not necessarily interfere with visual perception or discrimination. Most of the factors having an influence on glare, such as reflector design, type and construction of lense or refractor, orientation or location of luminaires, are not inherent in the lamp itself. However compact, high output sources such as HPS will create some direct glare problems because of the relative brightness per unit area. Physically large lamps such as LPS or fluorescent appear less intense to the observer even for units equivalent in lumen output to the HPS. The luminance (photometric brightness) of a LPS lamp is approximately 65 candela (cd) per square inch, 2900 cd/sq. in for mercury vapor lamps, and 6500 cd/sq. in. for HPS (to obtain values in footlamberts multiply by 452). Some users are of the opinion that LPS permits more discrimination of objects than HPS; others report particularly good light penetration on heavy fog.

4-4.8. Warm-Up/Restrike. One of the greatest advantages of quartz iodine and other incandescent lamps is that they produce full illumination almost instantaneously when energized. Xenon and fluorescent lamps for most purposes, can also be considered to have instant start/restrike characteristics. Xenon's high cost and fluorescent's mediocre photometric

performance outdoors outweigh these advantages for most applications. The HID lamps such as mercury vapor and metal halide have relatively long restrike intervals of approximately 5 and 15 minutes respectively. Manufacturers of high pressure sodium utilize a high voltage starting pulse to cut this interval to approximately 1-1/2 minutes.

4-4.9. Load Characteristics. All of the lamps commonly used for outdoor lighting, except incandescent, use ballasts to control current to the lamp. Ballasts are available for each lamp type, in high power factor versions that will maintain power factor of the line at 90-95%. Power consumption by the ballast will be 15-25% of lamp wattage. Incandescent sources operate at 100% power factor and don't require ballasts; however there will be large inrush currents when tungsten filament lamps are energized. Although the current spikes are of short duration, they are high in magnitude (1500 to 1800% of normal operating current vs approximately 150% starting current for other types of lamps such as HPS). It is necessary that equipment serving incandescent lighting be fully rated for such duty - ie., contacts rated for tungsten filament loads, heavy duty lighting contactors, overcurrent devices, switches, etc.

4-4.10. Strobe Effect. This phenomenon results from the tendency of lamp output to follow the fluctuations of an alternating current wave form. It can cause moving objects to flicker and rotating machinery to appear to be at rest or turning slower than actual speed. The effect is most noticeable in an individual's peripheral vision rather than directly in front. For outdoor lighting it would tend to be a nuisance rather than a hazard. Stroboscopic effect is most pronounced with mercury vapor and some type of fluorescent lamps (or ballasts). HPS lamps are slightly less subject to it; metal halide lamps exhibit minimal effect. To counteract the effect, mercury and HPS lighting should be supplied by 3 phase power. The problem does not develop under incandescent lighting and apparently is minimal with low pressure sodium.

4-4.11. Safety and Environmental Considerations. Attention should be given to proper disposal of removed HID lamps. Sodium is somewhat volatile when exposed to water. Loose sodium should be neutralized before discarding. For recommended disposal procedures for LPS lamps, see Attachment 17 in Appendix A. There are no special hazards involved with disposal of HPS lamps other than what could be expected from careless handling of tubes. Mercury vapor lamps can cause harmful ultraviolet radiation burns if operated after the outer glass envelope has been broken. The required operating voltage of HID lamps tends to rise with age. When the ballast can no longer deliver sufficient voltage to maintain operation, mercury vapor and metal halide arcs will be extinguished. HPS ballasts will deliver a starting pulse to reignite, thus cycling on and off continuously.

4-4.12. TV Surveillance. Use of a closed circuit television system for outdoor surveillance requires that attention be given during design to the amount and type of lighting to be installed. If the light levels are too low, the camera is subject to image "burn-in" particularly if cameras are held in fixed positions. The result is that the particular image that remains on the TV monitor even though the scene in front of the camera may have changed. The spectral response of the light source also is a factor affecting the efficiency of the system. Since cameras are sensitive to average illumination, uniformity of lighting on the scene is important. Three types of tubes are generally available at present. The oldest is the antimony sulphide vidicon, the standard for the industry. It is most compatible with incandescent lighting; if other lamp types are employed, the relative illumination level must be increased to compensate (1.7 FC HPS equivalent to 1 FC incandescent, LPS 2 FC to 1 FC). The newer silicon vidicon is over 5 times more sensitive than the standard vidicon under incandescent lighting, almost 3 times when HPS is the source. The newest tube, the hetero-junction vidicon has a sensitivity ratio of 10:1 over the standard vidicon; 6:1 when using HPS lighting. The last tube, in addition to its better sensitivity for low light application, is more resistant to "blooming" (the brightest objects in a scene appear larger than actual size - the extent of the distortion being proportional to the relative brightness).

4-4.13. Restrictions on Mounting Position. For quartz iodine lamps, orientation of the longitudinal axis is critical. If the variation from horizon exceeds $\pm$ 4° lamp life will suffer appreciably. There are no restrictions in rotation about that axis other than insuring that floodlights aimed upward have been specifically designed for the extra heat load. Low pressure sodium lamps can be tilted up 20° maximum above horizontal and down to 90° below horizontal; however the base (socket end) of the lamp must serve as the pivot position not the opposite end. The most efficient operation and longest life will be obtained at or near horizontal particularly with the larger lamps (90 - 180W). High pressure sodium lamps manufactured by General Electric must be ordered in either "base up" or a "base down" versions. Lamps can be tilted 95° maximum from the vertical (to 5° above horizontal). If tilted beyond, the mercury sodium amalgam can spill out of its reservoir. Lamps of other manufacturers (except Westinghouse 1000 watt unit) may be operated in any burning position.

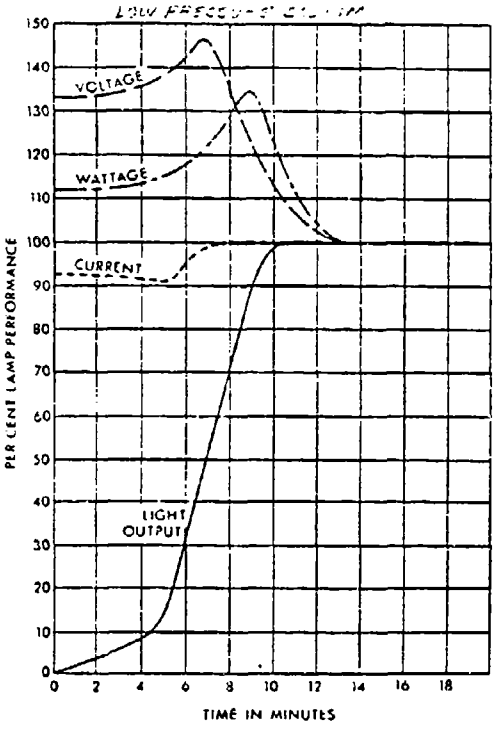
4-4.14. Miscellaneous Considerations. Low temperature operation has minimal effect on lumen output of most lamps but can interfere with starting. Low temperature ballasts are readily available for outdoor applications to compensate for temperature related starting difficulties (commonly rated at -20°F). Fluorescent lamps however do suffer significant lumen decrease as temperature drops. Large, long lamps such as fluorescent

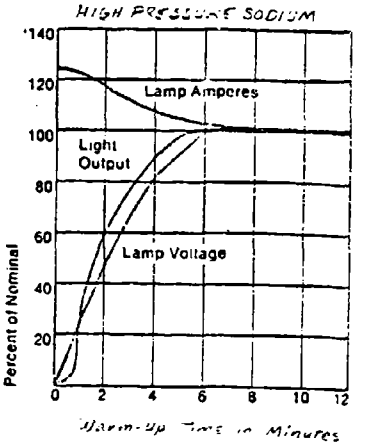
or LPS present problems in designing housings that will provide efficient beam control. LPS, primarily because of its high efficacy has been used in floodlights, whereas with fluorescent this nas not been done. Compact sources such as quartz and HPS are ideal for floodlighting applications. Manufacturing techiques employed in the production of incandescent and fluorescent lamps have been refined to the point that camp characteristics are quite uniform and are predictable with reasonable precision. With LPS and to a lesser extent, HPS there is more variance in performance parameters from one lamp to another off the production line. LPS lamps operate at relatively low temperatures (260°C/500°F) resulting in a minimum of breathing during fluctuations in ambient temperature; as a consequence these lamps have negligible dirt factors (0.90 to 0.95 typically). HPS lamps operate at comparatively higher temperatures (400°C/750°F) with poorer dirt factors (0.75-0.85). Some HPS floodlights and roadway units are available in filtered versions that are less subject to light degradation due to accumulations of dirt, film etc. on lenses, lamps and refractors (higher dirt factors, 0.85-0.90). The typical quartz lamp operates at temperatures exceeding 500°F.

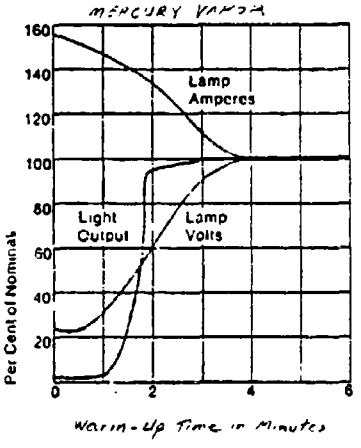
	INCANDESCENT		FLUORESCENT		HIGH INTENSITY DISCHARGE (HID)				
	Filament	Quartz Iodine	Cold Cathode	Heated Cathode	Xenon	Mercury Vapor	Metal Halide	High Press Sodium	Low Press. Sodium
Efficacy-lamp only (lumens/watt)	12-20	20-23	50-65	55-75	20-50	40-65	80-100	95-140	131-183
Wattages Available	5-5000	45-5000	20-75	4-220	15-30,000	175-3000	175-1500	50-1000	35-180
Ballast Loss (watts for size __)	----	----	30 (2-40W)	15 (2-40W)	----	45-65 (400W)	55 (400W)	55-82 (400W)	40 (180W)
Lamp Life (hours for size __)	750 (100W)	2000 (1500W)	9000 (40W)	20000 (40W)	1000 (500W)	24000 (100-400W)	15000 (400W)	20000 (400W)	18000 (180W)
Time Interval to Restrike	Immediate	Immediate	Immediate	Immediate	Immediate	3-6 min.	10-20 min.	2 min. or less	Immediate to 2 min.
Time to Full Output (Initial or Restrike)	Immediate	Immediate	Immediate	Immediate	Immediate	3-7 min.	3-5 min.	3-4 min.	8-15m start Immed. to 5m. restrike
Color Rendition	Very Good	Very Good	Fair to Good	Fair to Good	Excellent	Blue-Green	Good	Gold-Yellow	Monochrom. Yellow
Beam Control	Very Good	Good	Poor	Poor	Very Good	Fair	Good	Good	Fair
Lamp Size	Compact	Compact	Extended	Extended	Compact	Medium	Medium	Compact	Extended
Comparative Fixture Cost	1	3	2	4	9	5	6	7	8
Comparative Operating Cost	8	7	6	5	9	4	3	2	1
Low Temperature Operation	Very Good	Very Good	Fair	Fair	Good	Good	Good	Good	Good
Advantages	Low Initial Cost	Instant Start	Low Cost	Long Life	Color, Beam Control	Long Lamp Life	Color, Efficiency	Efficiency	L/Watt high, Good Maint. Factor
Disadvantages	Short Life	Low Efficiency	Shape	Shape	Large ballast, safety	Starting	Restrike, Safety	Starting, Glare	Color

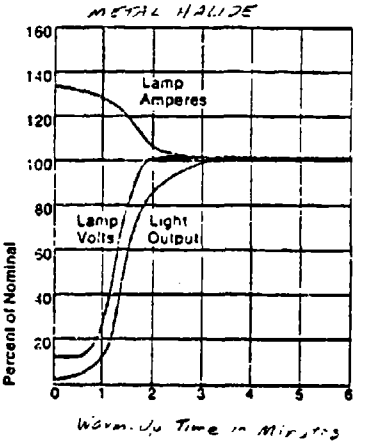
FIGURE 5

COMPARATIVE LAMP CHARACTERISTICS









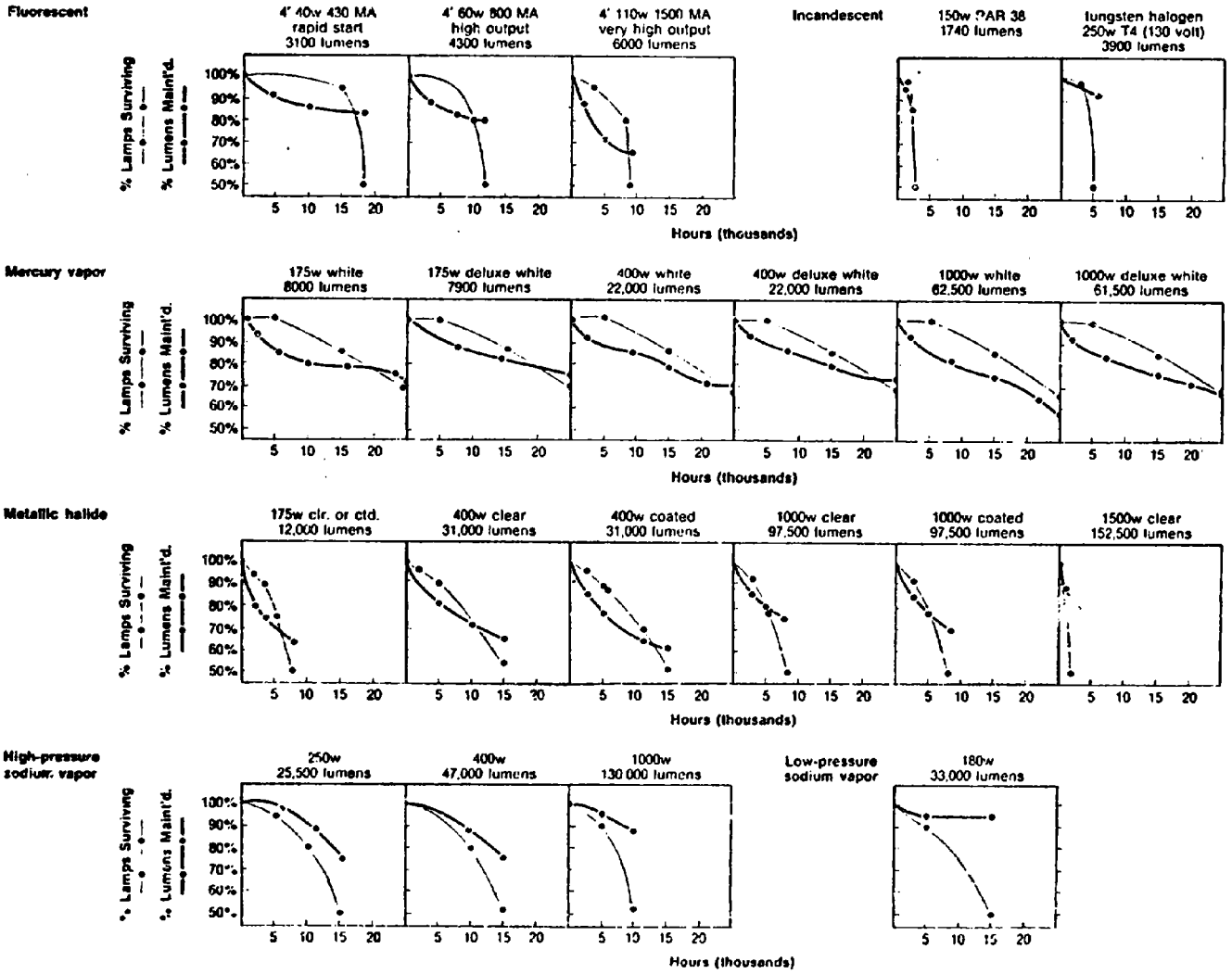
TYPICAL WARM UP TIMES ON INITIAL START

FOR H/I AND LPS LAMPS

Data from Illum. Engrg. Soc. & Westinghouse

FIGURE 5

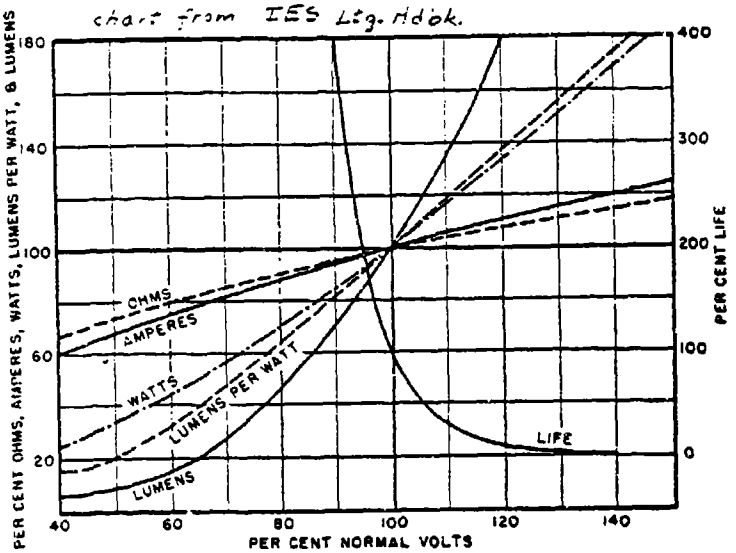
Lamp mortality and lumen depreciation



from N.E.C.A. Electrical Design Guidelines 24

Figure 7

chart from IES Lig. Hdbk.



$L_1 = L_2 \left(\frac{V_1}{V_2}\right)^k$

$LE_1 = LE_2 \left(\frac{V_2}{V_1}\right)^d$

$k \approx 3.4$

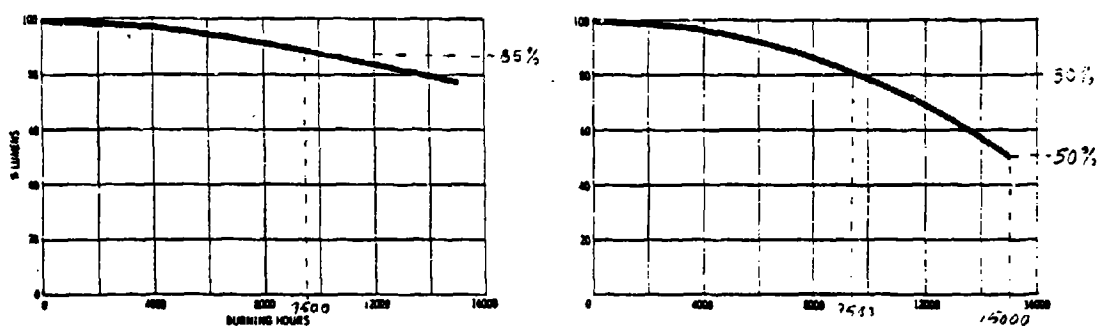
$d \approx 13$

V = voltage at lamp terminals

L = lumen output of lamp

LE = life expectancy of lamp

INCANDESCENT LAMP OPERATING CHARACTERISTICS



A. Lumen Maintenance

B. Lamp Mortality

From Graph B: Rated life = 15000 hours @ 50% mortality
Group Relamping Period = 9500 hours @ 20% mortality*

From Graph A: Lamp Lumen Depreciation (LLD) = 0.85 @ 9500 hours

* 20% lamp mortality was selected for this application.

LAMP CHARACTERISTICS - 250W HIGH PRESSURE SODIUM
(Lucalox # LU250) by Gen. Electric

LAMP PARAMETERS

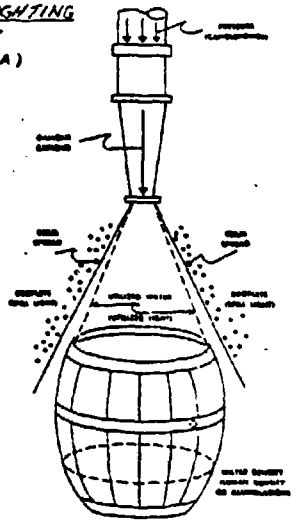
FIGURE 8

5. LIGHTING ANALYSIS:

5-1. Criteria. To properly evaluate the various potential lighting arrangements developed for each of the schemes described in Section 4, calculations of the footcandle output for each arrangement has to be made. The format specified in the original criteria was that computer printouts be provided to determine the extent to which each arrangement met the illumination criteria prescribed in Section 3. Calculations were to be based on the point by point method. Computer printouts were to show the calculated vertical or horizontal footcandle illumination at evenly spaced grid points throughout the defined area.

5-2. Lighting Theory. The unit "lumen" is used to identify the amount of light emitted from a light source. It represents the amount of luminous flux leaving the source. One lumen is defined as the flux contained within a unit solid angle emitted from a uniform point source of one candela. Illumination resulting from luminous flux falling on a surface is measured in footcandles. One lumen per square foot is numerically equivalent to one footcandle; one lumen per square meter is equivalent to one lux. One of the most significant factors in determining applicability of a particular luminaire to a specific task is its luminous intensity (candlepower) which is expressed as candela. This unit represents the intensity of the light source in a given direction. Intensities will have different values in different directions. The basis of most lighting calculations is the Inverse Square Law. It sets forth the following relationship: that the illumination at a point on a surface is directly proportional to the luminous intensity of the light in that direction and inversely proportional to the square of the distance from the source. This relationship is not valid for other than point sources, and for distances that are less than 5 times the largest dimension of the luminaire. See Figure 9 for additional information. Formulas, based on the Inverse Square Law, for computing illumination levels in vertical or horizontal footcandles are given in Figure 10. One determinant of quality lighting concerns its uniformity. Even illumination without dark areas or spots of high intensity light is the objective. The extent of variation is defined by the uniformity ratio, that is the average illumination (footcandles or lux) over a given area divided by the minimum value of illumination in that area.

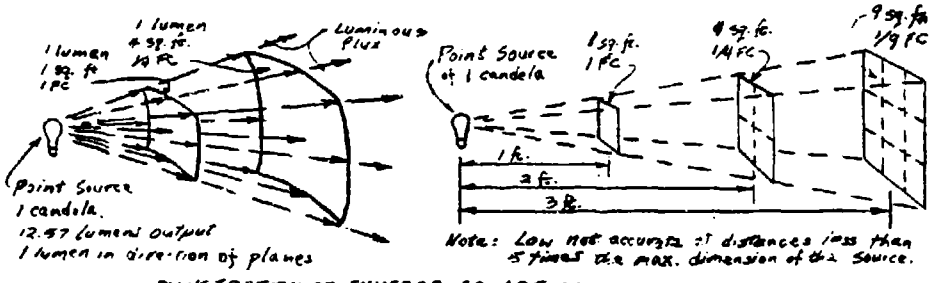
HYDRAULIC-LIGHTING ANALOGY (from NECA)



Corresponding Parameters

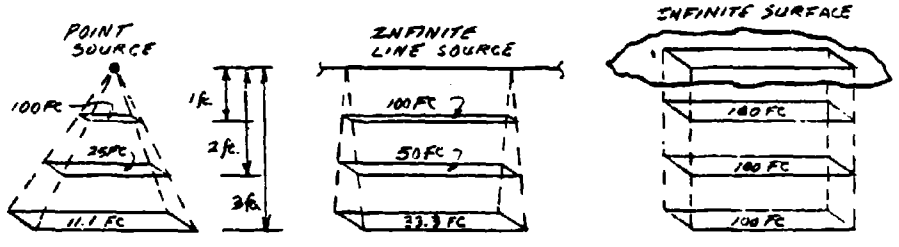
Hydraulic	Lighting
Nozzle	Luminaire
Gallons/Min	Lumens
Pressure	Candlepower
Beam Spread	Beam Spread
Droplets	Spin Light
Utilized Water	Utilized Light
Water Density (gallons/sq.ft.)	Lumen Density (lumens/sq.ft.)

One lumen uniformly distributed over one sq ft. of area produces an illumination level of one foot-candle.



Note: Law not accurate at distances less than 5 times the MAX. dimension of the source.

ILLUSTRATION OF INVERSE SQUARE LAW



Point Source: Illumination is inversely proportional to the square of the distance. Example: single luminaire

Line Source: Illumination is inversely proportional to the distance. Example: Row of fluorescent lamps

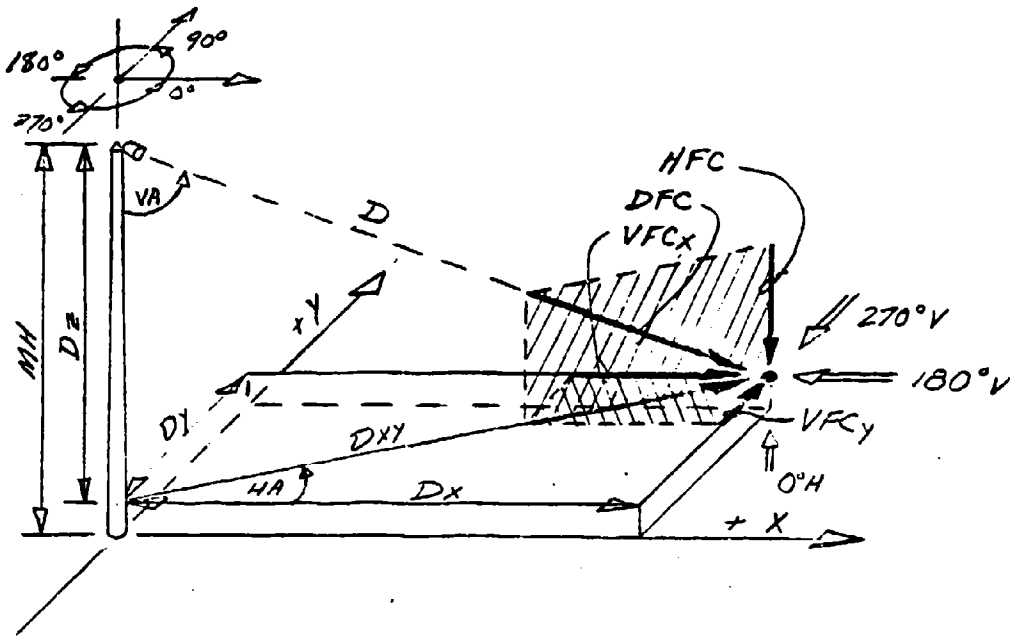
Surface Source: Illumination does not change with area. Example: Luminous ceiling

Note: Relationship is not accurate very near or extremely far from the source.

ILLUMINATION VS GEOMETRY OF THE SOURCE

BASIC LIGHTING RELATIONSHIPS

FIGURE 9



Definitions

D = Distance from luminaire to point (in ft)*

D_x, D_y, D_z = X, Y, and Z components of D

MH = Mounting height of luminaire (in ft)*

I = Intensity (candlepower) of the light source in a particular direction, in candelas

VFC, HFC, DFC = Illumination, in footcandles - vertical, horizontal, and direct, respectively

LLD = Lamp lumen depreciation

DF = Dirt factor

MF = Maintenance factor ($MF = LLD \times DF$)

⟸ Identifies the orientation at which specific illum. calculations or measurements are based

Basic Relationships

Inverse square law: $FC \sim I/D^2$

Distance: $D = (D_x^2 + D_y^2 + D_z^2)^{\frac{1}{2}}$

POINT TO POINT ILLUMINATION CALCULATIONS

FIGURE 10
Sheet 1 of 2

General Illumination Formulas **

$$HFC = \frac{I \cdot Dz \cdot MF}{(Dx^2 + Dy^2 + Dz^2)^{\frac{3}{2}}}$$

$$VFCy = \frac{I \cdot Dy \cdot MF}{(Dx^2 + Dy^2 + Dz^2)^{\frac{3}{2}}} = HFC \cdot \frac{Dy}{Dz}$$

$$VFCx = \frac{I \cdot Dx \cdot MF}{(Dx^2 + Dy^2 + Dz^2)^{\frac{3}{2}}} = HFC \cdot \frac{Dx}{Dz}$$

Illumination Formulas for 2 Dimensional Application **
(Dx = 0)

$$HFC = \frac{I \cdot Dz \cdot MF}{(Dy^2 + Dz^2)^{\frac{3}{2}}}$$

$$VFCy = \frac{I \cdot Dy \cdot MF}{(Dy^2 + Dz^2)^{\frac{3}{2}}} = HFC \cdot \frac{Dy}{Dz}$$

* If metric units (meters) are substituted, results of calculations will be in Lux (VLux, HLux, DLux). Values given in footcandles may be converted to Lux by applying a multiplier of 10.76. A multiplier of 0.3048 will convert values given in feet to the equivalent in meters.

** If illumination calculations are to be made at ground level, "HH" may be substituted for "Dz".

POINT TO POINT ILLUMINATION CALCULATIONS

FIGURE 10
Sheet 2 of 2

5-3 Illumination Calculations. The point by point method of calculating illumination has proved most accurate. Formulas for the point by point calculation technique are given in Figure 10. Illumination may be determined on a horizontal basis or for any orientation of a vertical basis. The general formula will be most commonly used since most applications will be 3-dimensional. In certain special applications the simplified 2-dimensional formulas could find use. The effect of degradation in light output due to lamp aging or contamination is accounted for by the maintenance factor. An adjustment could also be included that would compensate for lamp operation at other than rated voltage or at low ambient temperatures, if desired. When applying these formulas, the contributions from several sources to the illumination at a point may be added directly in the case of horizontal footcandles. When calculations are made on a vertical footcandle basis, it is necessary that all contributions be resolved into components at the same orientation such as 270°. This is analagous to conducting all footcandle measurements with the photometer pointed in the same direction - such as perpendicular to the plane of a fence or a pole line.

5-4 Characteristics of Horizontal and Vertical Illumination. There are some basic distinctions that should be kept in mind with respect to the different illumination characteristics of vertically and horizontally based lighting. A floodlight type of luminaire mounted relatively close to the ground will yield the maximum vertical illumination on a particular point. Readings of horizontal footcandles, however, will be very low and will tend to drop off to zero the greater the distance out from the pole. A floodlight mounted relatively high will result in a much stronger horizontal illumination component at the point. It can be seen, therefore, that for a horizontal footcandle requirement, high mast lighting would illuminate an area more efficiently and evenly with fewer poles than would be the case for low mounting heights. Mounting height considerations are discussed in paragraphs 9-1.1 and 9-3.1. One idiosyncrasy of basing criteria on vertical footcandle measurement is that the illumination at the pole under the luminaire will always measure zero, since the vertical footcandle component is zero. The eye of an observer may perceive a high level of illumination however, since the horizontal component could be very high.

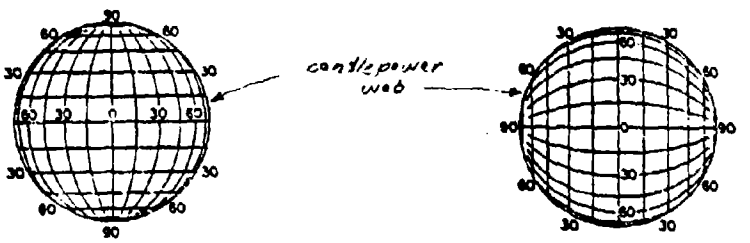
5-5 Candlepower Data.

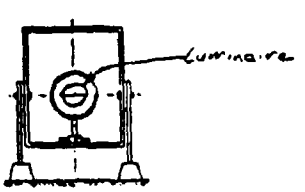
5-5.1. General. Because of the directional characteristic of light intensity, each luminaire will have its own distinctive candlepower distribution pattern somewhat like a fingerprint. The variation in characteristics of a particular model from one unit to the next off the assembly line will depend on the control that can be maintained over the various manufacturing processes. Since most lighting calculations do not require an extreme degree of precision, a photometric test made on one or two random units should be valid for all units of that particular model luminaire. Accuracy, including minor error due to midpoint interpolation of candlepower values, should be better than 5% in most cases. (The margin of error could possibly extend to 10% for some low pressure sodium luminaires. Operating voltage and temperature could have an effect in some cases - note 4-3.3 and 4-4.5).

Most manufacturers perform informal abbreviated tests during development of a prototype; once the decision has been made to go into production, one or more units are pulled off the assembly line and sent to a recognized testing laboratory for a formal test. Some of the larger manufacturers have their own in house test laboratories.

5-5.2. Test Procedure. Virtually all tests in this country are conducted in accordance with the procedures recommended by the Illuminating Engineering Society (IES) in their published standards. There are two recognized test configurations: one in which the polar axis (axis of rotation) is horizontal, the other in which the polar axis is vertical. The horizontal polar axis (HPA) test format is almost universally used for examining floodlights. The vertical polar axis (VPA) procedure is applied to roadway luminaires, fluorescent, high mast, and most wall mount units. Steps in the test procedures are illustrated in Figure 11. The smaller the increment at which readings are taken the more accurate the candlepower data will be. For narrow beam floodlights 1° intervals may be advisable. For wide beam floodlights, 10° intervals are preferred. IES recommends that mid-zone angles (5°, 15°, 25°, etc) be selected for taking measurements so that the data could be used in the computation of lumens by the zonal method without additional manipulation.

5-5.3. Data Format. Photometric data is available from manufacturers in a variety of formats. The most convenient, and the most accurate for computer calculations, is the raw test data in tabular form (similar to Figure 14 and sheet 3 of Figure 15). An example of the standard IES NEMA reporting format (floodlights and other horizontal polar axis units) is shown in Figure 12. Isocandela curves have been plotted from candlepower test data on the left half of the diagram respresenting the luminaire, lumens have been calculated and listed on the right half. These lumen figures may be converted to candelas by the technique given in Figure 13. The table of Figure 14 shows the lower half vertical angles as negative. Other organizations make the lower half positive while some identify vertical angles as "upper" or "lower". The isocandla chart portrayed on Figure 15, sheet 1 constitutes recommended IES reporting format for roadway luminaires. The plot of critical distribution values such as 1/2 maximum candlepower and maximum candlepower aids in identifying the beam distribution category to which the luminaire belongs. One shortcoming of data in the form of isocandela curves is that it can be difficult to interpolate values between curves with accuracy, particularly if a small scale graph is used. A single candlepower distribution curve, in a single plane will not be of value for point by point calculations unless the particular luminaire should happen to have symmetrical distribution such as IES type V. (Note: When requesting data from local representatives of luminaire manufacturers, it must be stressed that the data must be candlepower measured 3 dimensionally, in 4 or more planes. Since this data often has to be obtained from the factory, a better response can often be obtained by contacting the concern's lighting applications engineer direct.)

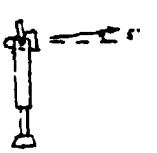




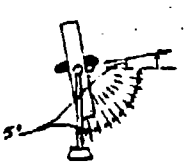
Goniometer Used With Luminaire Having A Vertical Axis Mounting

Goniometer Used With Luminaire Having A Horizontal Axis Mounting

Step 1 (Top View)



Step 1 (Side View)



Step 2 (Side View)

Step 2 (Top View)

For the first cycle, the luminaire is adjusted 5° (Step 1) and candlepower readings are then taken at the 5°, 15°, 25°, 35°, 45°, 55°, 65°, 75°, and 85° intervals about the other axis (Step 2). For the second cycle, the luminaire is set at 15° (Step 1) and Step 2 readings repeated. The angle notation shown is IES format.

PROCEDURE SPECIFIED BY ILLUMINATING ENGINEERING SOCIETY (IES) FOR CANDLEPOWER MEASUREMENTS

(10° H x 10° V zone format shown)

FIGURE 11

OUTDOOR LIGHTING DEPARTMENT
HENDERSONVILLE, N C
ISSUED BY H.J. Yeaman DATE 8-24-71

GENERAL ELECTRIC

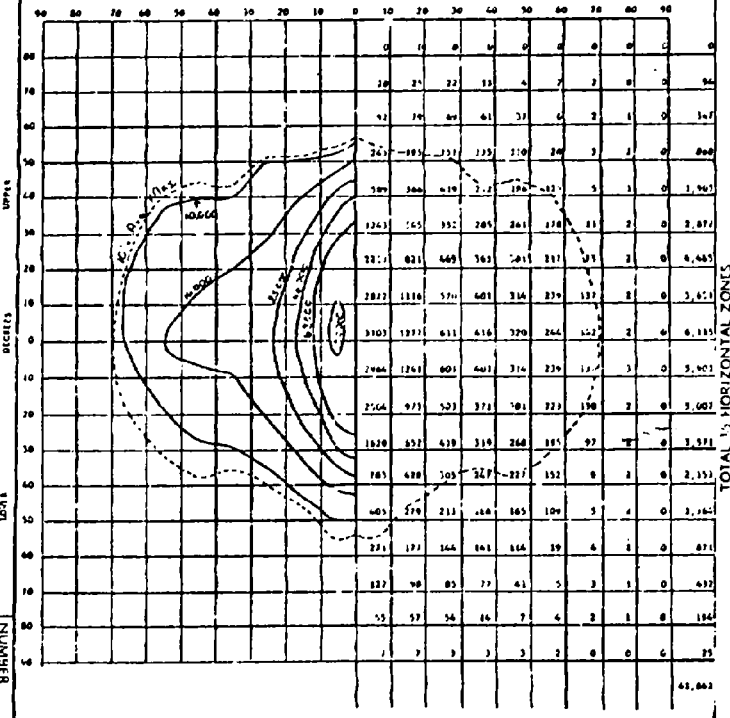
PHOTOMETRIC DATA

POLAR AXIS - HORIZONTAL

ISOCANDELA CURVE
AVG. LEFT AND RIGHT SIDES

LUMEN DISTRIBUTION
AVG. LEFT AND RIGHT SIDE

DEGREES

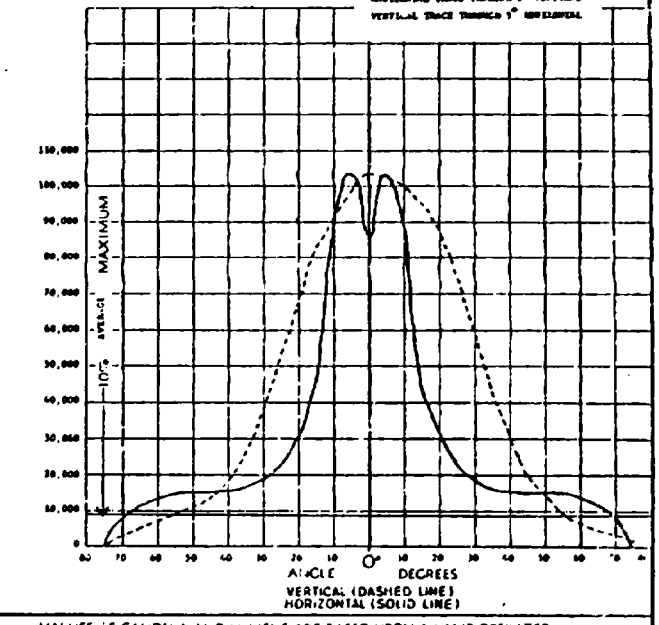


TOTAL OF VERTICAL ZONES

TOTAL ½ HORIZONTAL ZONES

CANDELA

CANDLE POWER TRACES

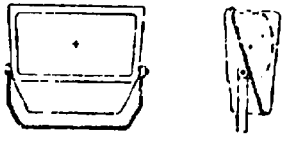


VALUES OF CANDELA AND LUMENS ARE BASED UPON A LAMP OPERATED AT ____ LUMENS IF THE DATA IS DESIRED FOR A DIFFERENT LAMP LUMEN RATING MULTIPLY ALL CANDELA AND LUMEN VALUES BY THE RATIO

DIFFERENT LAMP LUMEN RATING ÷ ____

SUMMARY	
BEAM SPREAD	[1952 method] [1971 method]
AVE MAX CP	
BEAM LUMENS	
BEAM EFFICIENCY	TOTAL EFFICIENCY %

THE BEAM SIZE IS DETERMINED BY THE AREA INCLUDED WITHIN THE ISOCANDELA CURVE WHICH IS 10% OF THE AVERAGE MAXIMUM CANDLEPOWER



FLOODLIGHT DESCRIPTION:

GENERAL ELECTRIC [illegible]
NARROW BEAM ETCHED REFLECTOR #235577-02
SOCKET POSITION 6
FLAT CLEAR BOROSILICATE GLASS

LAMP: 1000 WATT HIGH PRESSURE SODIUM
G. E. NO. LU1000/50 (LUCALOX)

NUMBER	REV NO
35-175335	01

NUMBER 35-175335 REV NO 01

PHOTOMETRIC DATA FOR FLOODLIGHT
STANDARD IES-NEMA REPORTING FORMAT

FORMAT 12

CONVERSION METHOD
LUMENS TO CANDLEPOWER

1. Basic formula: $CP = L/K_z$

(Based on zonal lumen method with photometric data in standard IES reporting format per FIGURE 12)

2. Zonal constant formulas:

$K_z = \frac{\phi \pi}{180}(\sin\theta_2 - \sin\theta_1)$ [general formula]

$K_z = \frac{2\pi\phi}{180}\sin P(\cos\theta_m)$ [shortcut method]

3. Definitions:

ϕ = interval of vertical zones, in degrees.

θ_1, θ_2 = limits of the particular horizontal interval in degrees.

P = ½ of the horizontal interval in degrees.

θ_m = the median angle for each horizontal interval calculated.

CP = candlepower, in candela

L = lumens.

4. Typical Multipliers:

$K_z = \frac{2\pi\phi}{180}\sin P\cos\theta_m = \frac{2\pi(4)}{180}\sin(2)\cos\theta_m.$

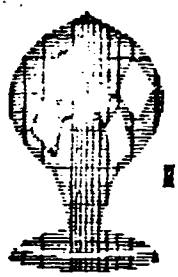
$= 0.004873 \cos\theta_m$ (4° vertical, 4° horizontal)
$= 0.007309 \cos\theta_m$ (6° vertical, 4° horizontal)
$= 0.01096 \cos\theta_m$ (6° vertical, 6° horizontal)
$= 0.01948 \cos\theta_m$ (8° vertical, 8° horizontal)
$= 0.03042 \cos\theta_m$ (10° vertical, 10° horizontal)

5. Example – Conversion constants for 10°V x 10°H:

θ_m	5	15	25	35	45	55	65	75	85
K_z	0.0303	0.0294	0.0276	0.0249	0.0215	0.0174	0.0129	0.0079	0.0023

All of the lumen values in the horizontal column, from 85° lower to 0° to 85° upper, would be divided by 0.0304, the 15° column by 0.0294, etc. (See FIGURE 12 ,

FIGURE 13



INDEPENDENT TESTING LABORATORIES, INC.

3386 Longhorn Road, Boulder, Colorado 80302

Phone 442-1255, Area Code 303

REPORT NO. 16969
DATE 8-6-73

SHEET 5 (SUPPLEMENTARY CP DATA)
AVERAGE OF RIGHT AND LEFT SIDES

PREPARED FOR KEENE CORP. STONCO LIGHTING . CAT. NO. CPH-1515, 1500W QUARTZ, NEMA 6 x 5 BEAM
POLAR AXIS HORIZONTAL

HORIZONTAL MIDZONE ANGLES →

VERTICAL MIDZONE ANG ↓	0.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
60.0	290.	301.	291.	270.	304.	219.	167.	130.	83.
52.0	580.	673.	693.	572.	1076.	663.	293.	227.	112.
44.0	4446.	4185.	2841.	2935.	2881.	1954.	842.	378.	144.
36.0	5703.	5380.	5272.	5064.	4105.	2979.	1544.	510.	177.
28.0	7395.	7103.	7025.	6619.	5596.	3961.	2123.	621.	209.
20.0	10488.	10080.	10155.	9368.	8101.	5482.	2743.	690.	239.
12.0	16723.	16092.	16043.	14394.	12209.	8016.	3691.	728.	259.
4.0	25858.	24649.	24433.	21261.	17277.	10482.	4316.	760.	265.
0.0	27018.	26052.	26028.	22613.	18681.	11576.	5099.	749.	265.
-4.0	25230.	24047.	23733.	20626.	16784.	10312.	4288.	780.	265.
-12.0	16337.	15704.	15620.	14070.	11915.	7893.	3704.	768.	260.
-20.0	10343.	9954.	9955.	9282.	8061.	5479.	2832.	709.	241.
-28.0	7250.	6936.	6894.	6579.	5619.	3973.	2138.	623.	211.
-36.0	5316.	5090.	5033.	4934.	3907.	2886.	1504.	507.	179.
-44.0	1933.	1566.	1771.	2776.	1361.	1786.	811.	368.	146.
-52.0	531.	547.	543.	520.	402.	607.	282.	207.	113.
-60.0	290.	300.	308.	309.	20.	203.	183.	122.	82.

ZONE FORMAT: 8° VERTICAL SPACING x 10° HORIZONTAL INTERVAL

FIGURE 14 PHOTOMETRIC DATA : CANDLEPOWER TABLE

ENVIRONMENTAL RESEARCH LABORATORIES

3410 E. HELM DRIVE, THUNDERBIRD INDUSTRIAL AIRPARK, SCOTTSDALE, ARIZONA 85260 TELEPHONE (602) 948-3471

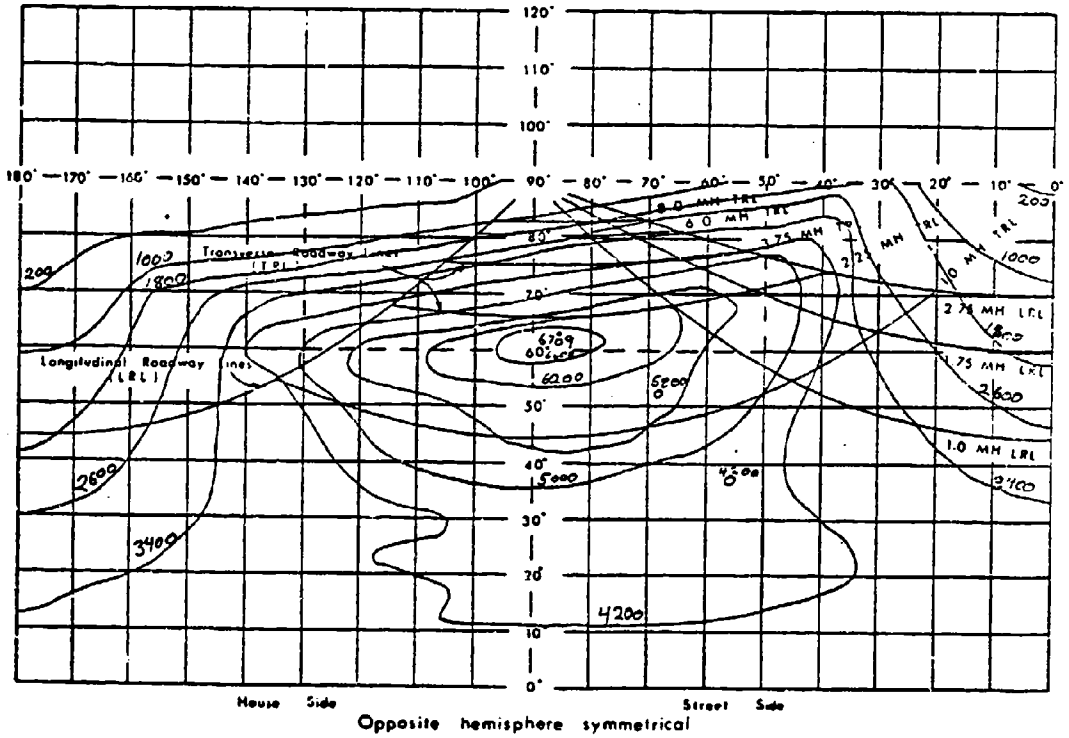
CERTIFIED TEST REPORT NO. ERL 1924

ITT LOW PRESSURE SODIUM LUMINAIRE, CAT. NO. 67-12184
UPPER LAMP POSITION
ONE 180 WATT LOW PRESSURE SODIUM LAMP, RATED 33,000 LUMENS

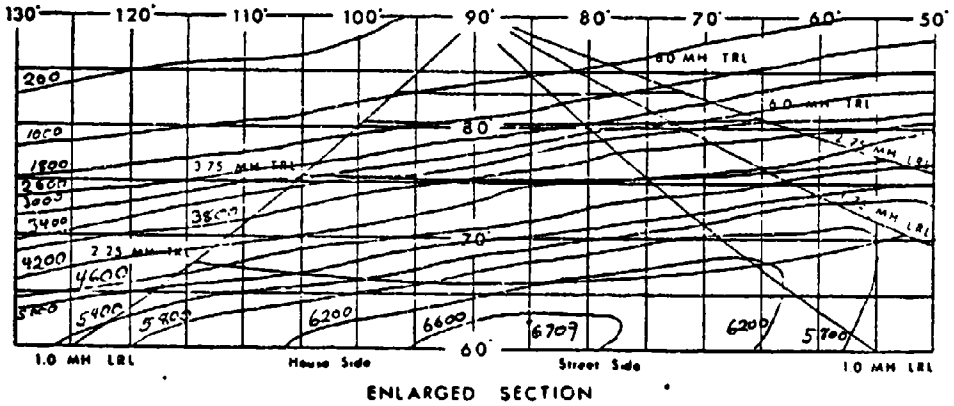
****** LUMINAIRE TILTED 10.00 DEGREES ******

POLAR AXIS: VERTICAL

ISOCANDELA CHART



Opposite hemisphere symmetrical



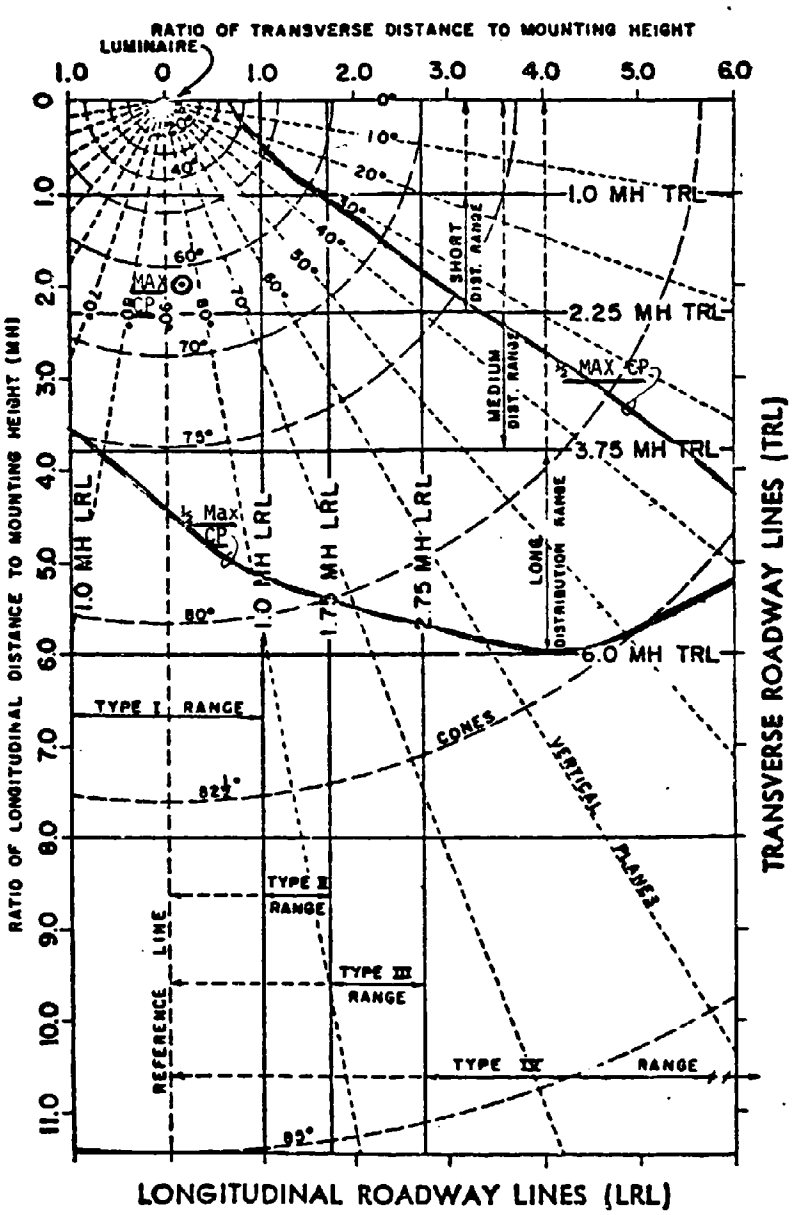
ENLARGED SECTION

PHOTOMETRIC DATA FOR ROADWAY LUMINAIRE

FIGURE 15
Sheet 1 of 3

ENVIRONMENTAL RESEARCH LABORATORIES

7410 E. HELM DRIVE, THUNDERBIRD INDUSTRIAL AIRPARK, SCOTTSDALE, ARIZONA 85260 TELEPHONE: (602) 948-3471



Test No. ERL1924 IES CLASSIFICATION : TYPE IV SHORT NON-CUTOFF

FIGURE 15
Sheet 2 of 3

ENVIRONMENTAL RESEARCH LABORATORIES INC.
7410 E. HELM DRIVE, THUNDERBIRD INDUSTRIAL AIRPARK
SCOTTSDALE, ARIZONA 85260.

CERTIFIED TEST REPORT NO. ERL 1924

ITT LOW PRESSURE SODIUM LUMINAIRE, CAT. NO. 67-12184
UPPER LAMP POSITION
ONE 180 WATT LOW PRESSURE SODIUM LAMP, RATED 33,000 LUMENS
****** LUMINAIRE TILTED 10.00 DEGREES ******
MEAN CANDLEPOWER IN STANDARD ZONES

HORIZONTAL ANGLES	VERTICAL ANGLES								
	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
5.	3849.	3842.	3726.	3356.	2787.	2036.	1462.	947.	376.
15.	3850.	3903.	3909.	3582.	3121.	2556.	2030.	1345.	700.
25.	3850.	4020.	4155.	3906.	3579.	3103.	2711.	2178.	1909.
35.	3856.	4125.	4299.	4163.	3811.	3619.	3600.	3551.	2745.
45.	3867.	4210.	4306.	4316.	4116.	4554.	4761.	5008.	2768.
55.	3875.	4263.	4324.	4326.	4805.	5388.	5758.	5167.	2564.
65.	3879.	4299.	4430.	4343.	5505.	5806.	6214.	4732.	2036.
75.	3877.	4321.	4439.	4531.	5854.	6145.	6330.	4374.	1548.
85.	3886.	4364.	4446.	4672.	5881.	6322.	6179.	3951.	1112.
95.	3809.	4265.	4423.	4724.	5870.	6398.	5986.	3692.	630.
105.	3883.	4109.	4318.	4572.	5634.	6245.	5660.	3094.	433.
115.	3866.	4044.	4182.	4277.	5179.	5848.	5212.	2593.	329.
125.	3839.	3964.	3990.	3889.	4469.	5142.	4797.	2179.	0.
135.	3804.	3872.	3782.	3631.	3724.	4100.	4251.	1770.	0.
145.	3781.	3737.	3600.	3394.	3128.	2977.	3313.	1445.	0.
155.	3756.	3587.	3290.	3012.	2652.	2228.	2027.	984.	0.
165.	3729.	3471.	3049.	2565.	2146.	1591.	954.	521.	0.
175.	3733.	3381.	2910.	2229.	1702.	1233.	592.	62.	0.

LUMENS IN STANDARD ZONES

HORIZONTAL ANGLES	VERTICAL ANGLES								
	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
5.	10.	30.	48.	58.	60.	51.	40.	28.	11.
15.	10.	31.	50.	62.	67.	64.	56.	40.	21.
25.	10.	32.	53.	68.	77.	77.	75.	64.	58.
35.	10.	33.	55.	72.	82.	90.	99.	104.	83.
45.	10.	33.	55.	75.	88.	113.	131.	147.	84.
55.	10.	34.	55.	75.	103.	134.	159.	152.	78.
65.	10.	34.	57.	76.	118.	145.	171.	139.	62.
75.	10.	34.	57.	79.	125.	153.	175.	129.	47.
85.	10.	34.	57.	81.	126.	157.	171.	116.	34.
95.	10.	34.	57.	82.	126.	159.	165.	109.	19.
105.	10.	32.	55.	80.	121.	156.	156.	91.	13.
115.	10.	32.	54.	74.	111.	146.	144.	76.	10.
125.	10.	31.	51.	68.	96.	128.	132.	64.	0.
135.	10.	31.	48.	63.	80.	102.	117.	52.	0.
145.	10.	30.	46.	59.	67.	74.	91.	42.	0.
155.	10.	28.	42.	52.	57.	55.	56.	29.	0.
165.	10.	27.	39.	45.	46.	40.	26.	15.	0.
175.	10.	27.	37.	39.	36.	31.	16.	2.	0.

FIGURE 15
Sheet 3 of 3

5-6 Luminaire Beam Distribution. Although there are applications where general, uncontrolled illumination is suitable, optimum performance in a given application is obtained when a lighting arrangement has been designed using a luminaire with precisely defined beam characteristics. Factors affecting beam control are the design of the reflector and the lens or refractor and the position of the lamp relative to these components. Effects of these factors for incandescent luminaires is illustrated in Figure 16. The industry has developed classification standards to identity specific beam categories. For projected beam units such as floodlights and searchlights there are seven defined NEMA Beam spreads from very narrow to very wide. Beam spread width is measured from the limits of the isocandela line corresponding to 10% of maximum candlepower. This method has been in effect since 1971. The 1952 IES method determined beam spread by measuring the isocandela line corresponding to 10% of the average maximum candlepower. Beam spread per the 1971 IES method is usually 2-5° less than that obtained with the 1952 method. NEMA beam types and the corresponding beam spreads in degrees is given in Figure 16. There is a different set of beam distribution categories applicable to some of the vertical polar axis luminaires such as roadway and high mast units. Illumination is classified according to the proportion of light directed to the front and to the sides of the luminaire and above a defined cutoff line. For street lighting applications, IES type III, medium, semicutoff is most commonly used. A general pattern in which illumination is equal in all directions (IES type V) is most suitable for high mast lighting and area lighting. The various categories are identified in Figures 17 and 18.

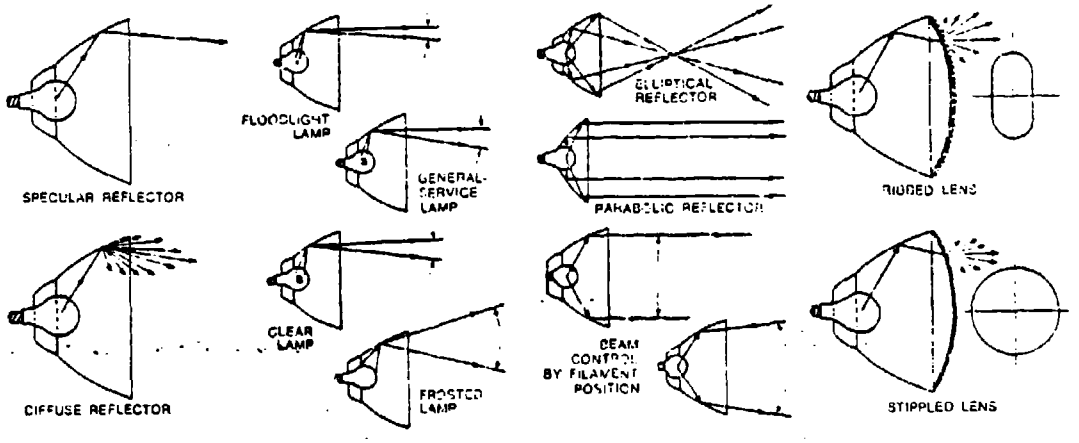
5-7 Effect of Distance on Illumination Level. Illumination on a point decreases significantly as the distance from the light source to the point is increased. The extent is determined by the inverse square law. The relationship is directly proportional for configurations involving a single pole and direct illumination (i.e. the footcandles in the direction of the ray(s) from the source to the point(s)). The theoretical curve (dashed line) of Figure 19 corresponds to this condition. The situation is more complex when several poles are involved and a component of illumination is considered. The solid curves on sheets 1 and 2 illustrate the relationships applicable at 4 different relative mounting heights. The figures shown for base mounting height and spacing apply to the computer trials used to develop the curves. The relationships between relative mounting height, spacing, and illumination, however, should be valid using any other reference figures. These curves could also be of use in determining the adjustment necessary to adopt the area lighting application curves (discussed in Section 9-2) to a revised illumination criteria value (i.e. 0.4 footcandle minimum to 0.3 or 0.5).

FLOODLIGHT LUMINAIRE TYPES

BEAM SPREAD DEGREES	NEMA TYPE	BEAM DESCRIPTION	MINIMUM BEAM EFFICIENCY, % INCANDESCENT TUNGSTEN-HALIDE	MINIMUM BEAM EFFICIENCY, % HIGH INTENSITY DISCHARGE
10 Up to 18	1	Very Narrow	38	—
18 Up to 29	2	Narrow	40	30
29 Up to 46	3	Medium Narrow	46	34
46 Up to 70	4	Medium	50	38
70 Up to 100	5	Medium Wide	54	42
100 Up to 130	6	Wide	56	46
130 and UP	7	Very Wide	60	50

Above from NEMA Standard FA1-1973
Example: A floodlight with a rectangular beam pattern such as 75° horizontal, 35° vertical, would be designated NEMA Type 5x3

ELEMENTS CONTROLLING BEAM SPREAD



FROM ACTUAL SPECIFYING ENGINEER, JULY 1972

FLOODLIGHTING DATA

FIGURE 16

IES "Type" classification

Type I: ½ maximum candela line enters the area on both sides of reference line (zero MH LRL) and remains within the area bounded by 1.0 MH LRL on both house and street sides in the **transverse zone of maximum candela.**

Type II: ½ maximum candela line does not cross the 1.75 MH LRL on the street side in the **transverse zone of maximum candela.**

Type III: ½ maximum candela line enters area bounded by the 1.75 MH LRL to the 2.75 MH LRL on the street side in the **transverse zone of maximum candela.**

Type IV: ½ maximum candela line crosses the 2.75 MH LRL in the **transverse zone of maximum candela.**

Type V: When the pattern has circular symmetry of candela distribution and is essentially the same at all lateral angles.

Control of Distribution Above Maximum Candlepower.

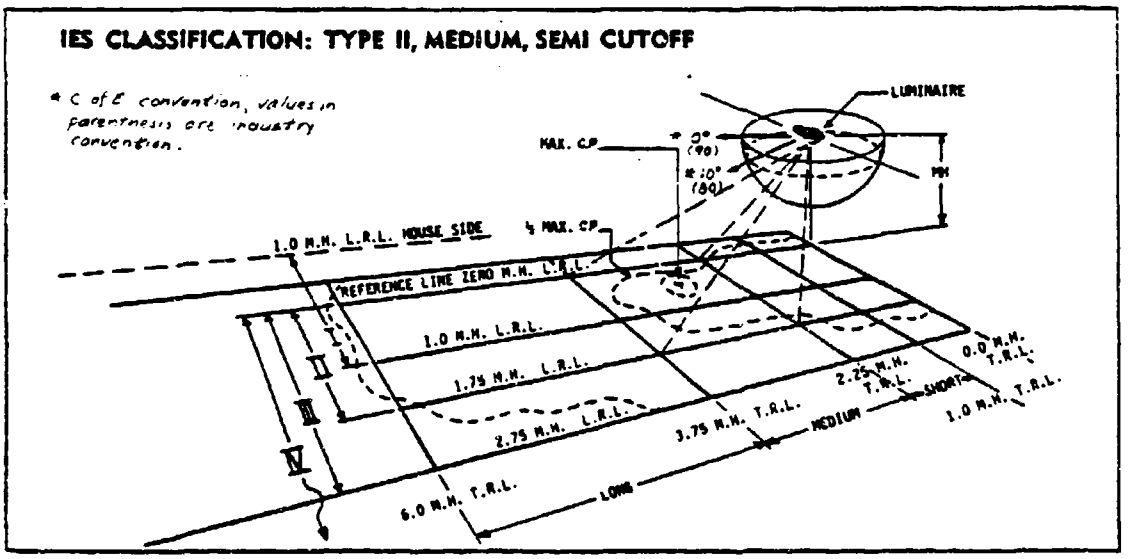
Cutoff. A luminaire light distribution is designated as cutoff when the candlepower per 1000 lamp lumens does not numerically exceed 25 (2½ per cent) at an angle of 90 degrees above nadir (horizontal), and 100 (10 per cent) at a vertical angle of 80 degrees above nadir. This applies to any lateral angle around the luminaire.

Semicutoff. A luminaire light distribution is designated as semicutoff when the candlepower per 1000 lamp lumens does not numerically exceed 50 (5 per cent) at an angle of 90 degrees above nadir (horizontal), and 200 (20 per cent) at a vertical angle of 80 degrees above nadir. This applies to any lateral angle around the luminaire.

Noncutoff. A luminaire light distribution is designated as noncutoff when there is no candlepower limitation in the zone above maximum candlepower.

TRL = Transverse Roadway Line
LRL = Longitudinal Roadway Line
candlepower (cp) = light intensity, in candelas.

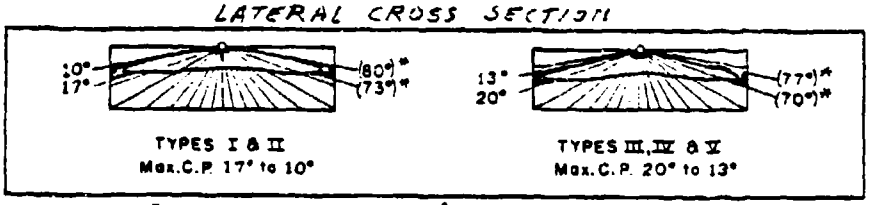
REFERENCES:
IES Lighting Handbook, 5th Edition
IES Std # RP-8 "American National Standard Practice for Roadway Lighting"
General Electric publication #GET3100S



BEAM DISTRIBUTION CLASSIFICATION: ROADWAY LIGHTING

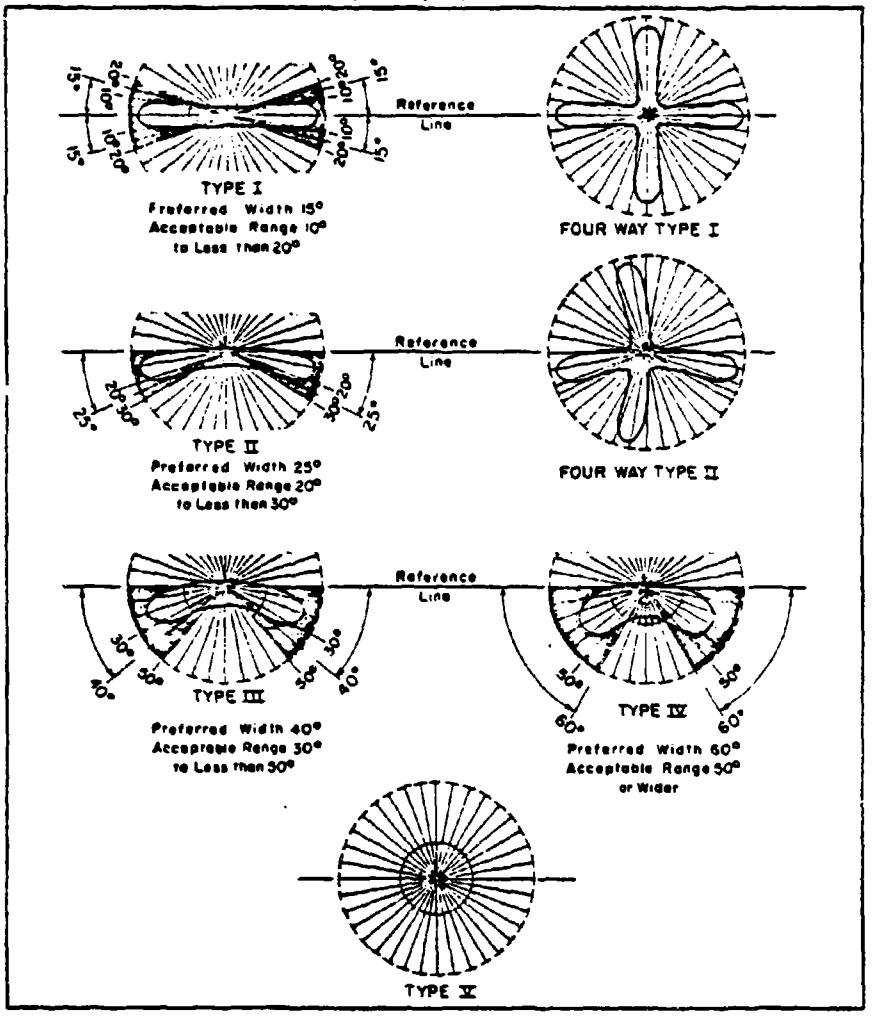
FIGURE 17

LATERAL CROSS SECTION



* Industry Convention for roadway luminaires

TOP VIEW



IES BEAM DISTRIBUTION PATTERNS - ROADWAY LIGHTING

FIGURE 18

ILLUMINATION VS DISTANCE
VERTICAL ILLUMINATION @ 270°
(3 ft. above ground)

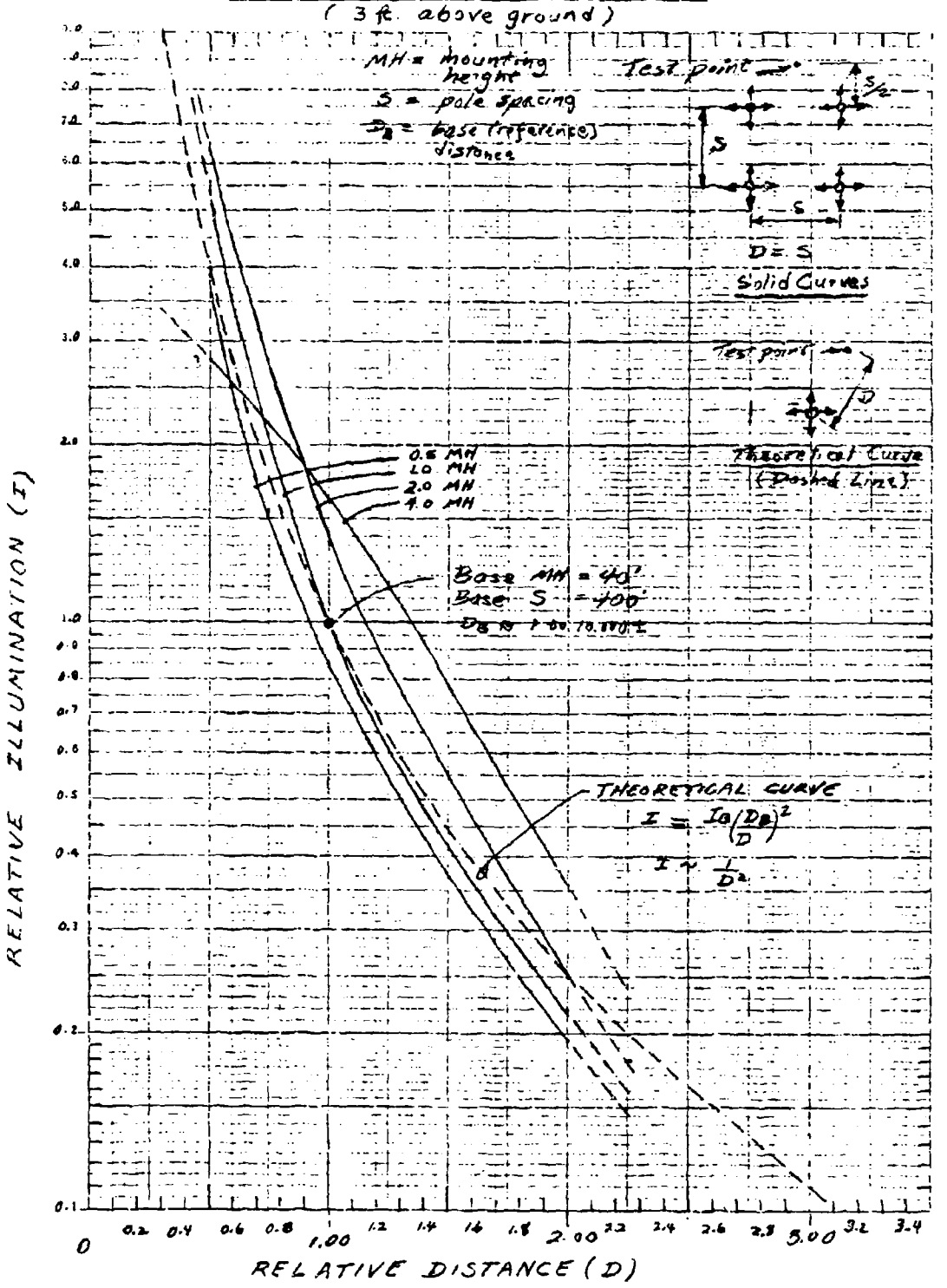


FIGURE 19
Sheet 1 of 2

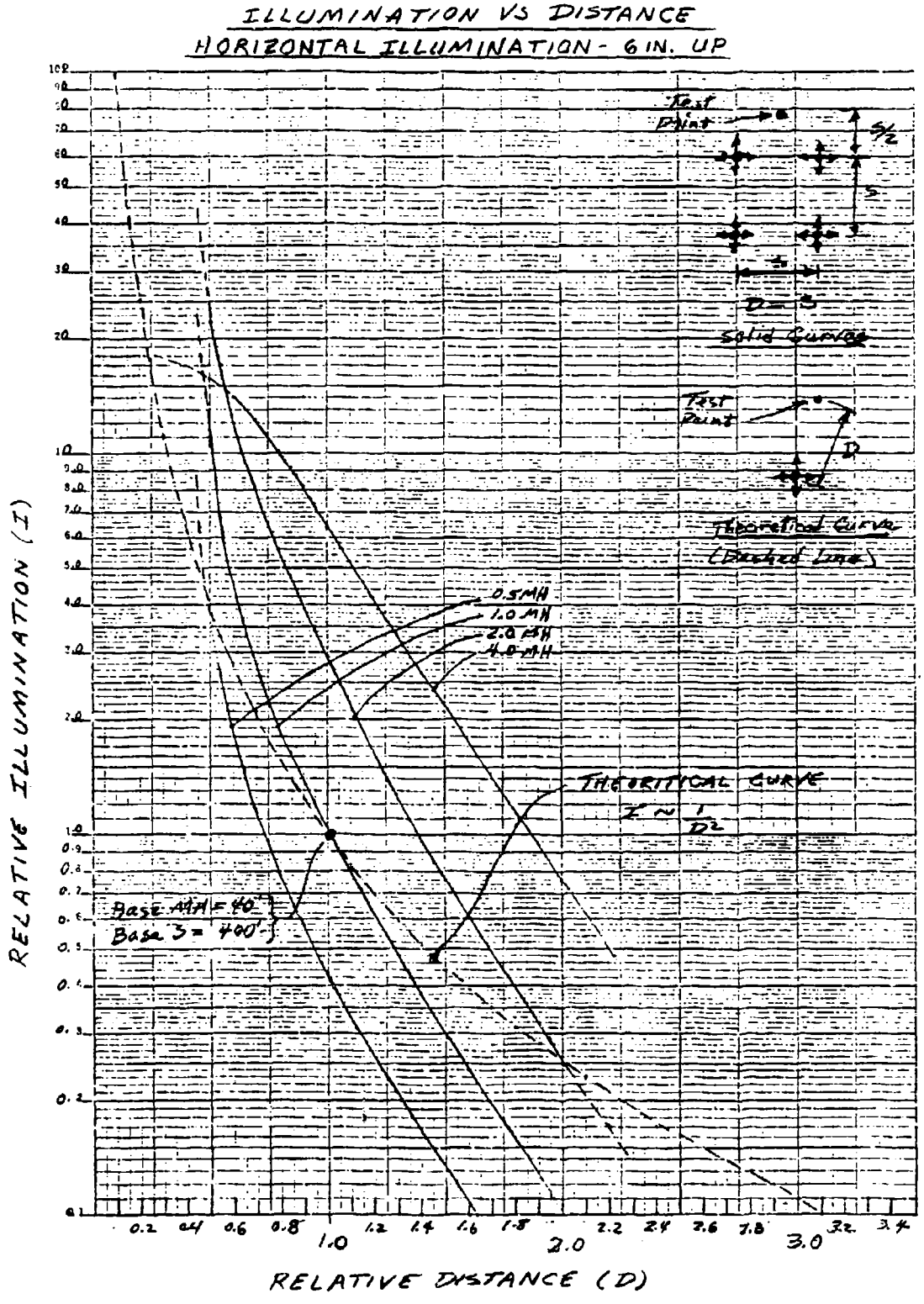


FIGURE 19
Sheet 2 of 2

5-8 Computer Format. The computerized lighting analysis performed for this study was based on point by point formulas similar to the format shown in Figure 10. Each lighting arrangement evaluated required entry of input data pertaining to the type, location, and quantity of luminaires to be used, the component of illumination to be calculated, and the configuration and location of the illumination grid to be printed out. An input sheet for the approved taxiway lighting configuration is examined on Sheet 3 of Figure 20. Sheets 1 and 2 list the steps involved in the computer calculation process. A printout of the complete program can be found in Appendix A, Attachment 13. To calculate the illumination at each point on the grid the contribution from each source has to be determined, resolved into components, and added to the subtotal. The most complex phase of this process involves determination of the light intensity applicable to each contribution. The appropriate pair of candlepower angles must be determined in each case by a technique employing direction cosines (Note Figure 21 and 22). As can be seen from Figure 22, the angles required and thus the value of intensity (candlepower) will be dependent on the type and orientation of the programmed luminaire. Candlepower data for a particular luminaire must first be entered and placed in storage. The computer will then copy the data into its memory whenever it is processing a trial in which that luminaire has been specified. The reference coordinate formats applicable for entering data are shown in Figure 23 for typical luminaires. A common format has been applied to both the horizontal polar axis and the vertical polar axis form of test data. The industry in contrast uses a distinct format for each of the two tests. The corresponding industry notation equivalent to the Corps of Engineers format is identified in the figure. Figure 23 also identifies the reference coordinates utilized when entering luminaire orientations. Appendix B contains a listing of all luminaires filed in computer storage to date, both by the computer identification code and by category. A copy of the actual candlepower data applicable to each luminaire is included. Because of the interpolation technique used, it is necessary that values be entered at the extreme candlepower angles for the vertical polar axis luminaires. This means that values at 0° and 360° horizontal have to be listed or that the entries at locations such as 355° and 5° have to be duplicated at -5° and 365°. The latter approach was usually taken for the luminaires listed in Appendix B. It is also necessary to enter a value at 90° vertical. Since this location corresponds to the polar region of the candlepower web, with the test procedure converging to a point, the value will be the same, or very nearly so, at all angular coordinates of 90° vertical from 0° horizontal to 90° horizontal.

SUMMARY OF PROCEDURE*

Step 1. The user enters input data. The luminaire identification code plus variables pertaining to location and orientation must be typed in per Section 2 on Sheet 3. One line of data must be entered for each luminaire used. The grid parameters selected for the illumination calculations must be entered per Section 3. Other input is noted in Section 1.

Step 2. The computer determines the location of the first point in the grid per the boundaries and increments specified in Step 1.

Step 3. Using direction cosines, the horizontal and vertical candlepower angles applicable to the specific point are computed for the first luminaire listed. The computer will select either a horizontal polar axis calculation format or a vertical polar axis format (See Figure 11) per the "H" or "V" code applicable to the particular luminaire.

Step 4. The computer then searches the candlepower table for the nearest listed angle above the horizontal angle determined in Step 3 and the nearest listed angle below. The two nearest spanning angles corresponding to the vertical angle of Step 3 are also located as a part of the same process.

Step 5. Applying an interpolation process to the four candlepower values of the Step 4 angles, the computer determines a relatively accurate approximation of the light intensity directed at the point.

Step 6. Direct illumination is calculated using the value of candlepower obtained in Step 5 and the luminaire parameters entered in Step 1. The direct value is resolved into either a horizontal footcandle component or an X or Y vertical FC component per the instructions entered in Step 1 for the first grid.

Step 7. The processes of Step 2 through Step 7 are repeated for the second luminaire and in turn for every luminaire that was entered in Step 1. The FC contribution from each liminaire is added to the value obtained in Step 6. The final result is placed in storage pending printout instructions.

Step 8. The procedure of Steps 2 through 8 is repeated for the second point on the grid and in turn for every other point in the grid. The process is initiated at the point having the lowest "X" and "Y" coordinates proceeding progressively to the point having the next highest value of "Y" coordinate. After the highest magnitude "Y"

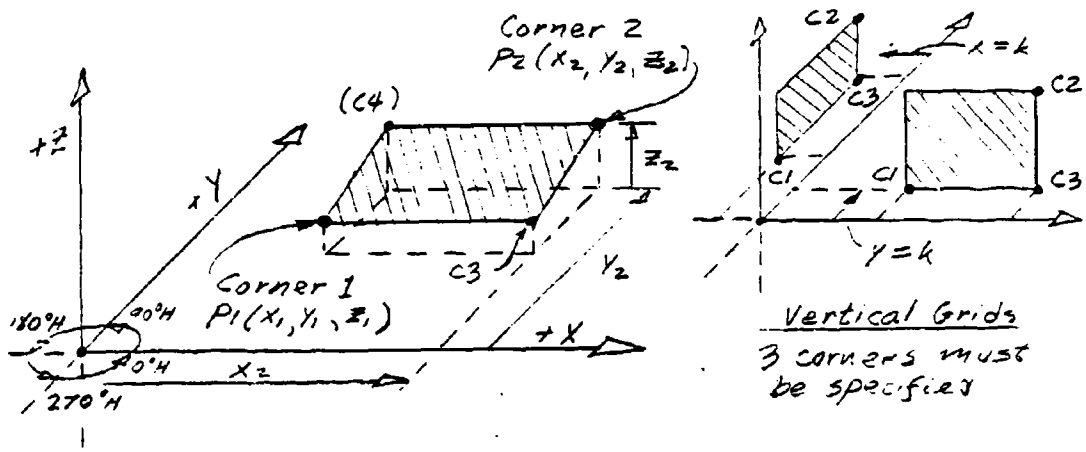
COMPUTERIZED LIGHTING ANALYSIS

Figure 20
Sheet 1 of 3

located has been processed, the calculation procedure shifts to the row having the second lowest "X" coordinate again proceeding from the point of lowest "Y" coordinate to the point of highest "Y" coordinate. Calculations are also made to determine the total footcandles on the grid, the average footcandles, and the uniformity ratio.

Step 9. The procedure of Steps 2-8 is repeated for the second grid and in turn for any other grids specified in Step 1.

*See Attachment 14 for a more detailed description of the computer analysis and the equipment used. A copy of the program itself constitutes Attachment 13.



ILLUMINATION GRID PARAMETERS
(Refer to Attach. 19 & 20 also)

NOTE: Corner 4 coordinates are computed automatically. For horizontal grids ($Z_1 = Z_2 = Z_3 = Z_4 = k$) only corners 1 and 2 need be entered, 3 and 4 will be calculated automatically.

COMPUTERIZED LIGHTING ANALYSIS

Figure 20
Sheet 2 of 3

INPUT LATA FORMAT
(See Layout on Fig 47)

1. GENERAL DATA - EXAMPLE AND KEY

```
00100                1          1
(Line No)     (Switch#1)  (Switch#2)  (Switch#3)  (Switch#4)  (Switch#5)  (Switch#6)
00110      TW18F     TAXI WAY GAP LIGHTING    061577
(L.N.)     ←(Test No)→ ←- - - - - - Descriptive data - title, date, etc - - - - - - - →
00120      V250S3MGE1       0.85        0.80        1.00
00130      H400HS44WE       0.85        0.85        1.00
00140      9999999999
(L.N.)     ←— (LC) —→ ←— (LLD) —→ ←— (DF) —→ ←— (LF) —→
```

LC-Luminaire identif. code
LLD-Lamp lumen depreciation
DF-Dirt factor
LF-Misc. lamp factor

2. LUMINAIRE LOCATION AND ORIENTATION

```
00170      H400HS44WE      30.00       0.00       20.00       94.00       85.00   Pole #1
00180      V250S3MGE1      30.00     475.00       25.00        0.00        0.00 }
00190      H400HS44WE      30.00     475.00       20.00      280.00       85.00 } Pole #2
00200      H400HS44WE      30.00     475.00       20.00      266.00       85.00 }
00210      9999999999
(L.N.)     ←— (LC) —→ ←(X coord)→ ←(Y coord)→ ←(Z coord)→ ←— (HA) —→ ←— (VA) —→
```

Note: HA = Horiz. aiming, VA = Vert. aiming. See Fig 23 for reference

3. GRID PARAMETERS (SEE SHEET 2)

```
00213  2        0.00     -20.00        .50       90.00      300.00        .50
00214           10          17          H         0.00        0.00       0.00      0.00  (Z=k)
00260  5        0.00      40.00       3.00       60.00      220.00       3.00
00270            7          10          V      270.00        0.00       0.00      0.00  (Z=k)
00340  9        0.00     240.00       0.00       90.00      240.00      50.00
00350           10          11          V      270.00       90.00     240.00      0.00  (Y=k)
00360 10       30.00       0.00       0.00       30.00      240.00      50.00
00370           13          11          V      270.00       30.00     240.00      0.00  (X=k)
00380      9999999999
(L.N.)(Grid#)← (X, Y, Z coordinates of Corner #1) →← - (Coordinates of Corner #2) - →
(L.N.)      (No of col's)(No of rows) (FCs-H or V)← (DR) -→← (Coordinates of Corner #3) →
```

Note: DR = Direction of photometer readings-always 0° for horizontal grids.
For H grids, X increment = $(X_2-X_1) \div (NC-1)$; Y inc = $(Y_2-Y_1) \div (NR-1)$ = 20 ft for Grid 5.
For V grid with Y=k, NC is spec'd in x's, NR in z's; for V grid with X=k, NC is spec'd in y's, NR in z's. The "9999999999" digits signify the end of a routine.

FIGURE 20
Sheet 3 of 3

CALCULATING CANDLEPOWER (CP) ANGLES USING DIRECTION COSINES

Given: $X_L = X$ distance of luminaire from reference axes.
$Y_L = Y$ " " " " " " "
$Z_L = Z$ " " " " " " "

$X_p = X$ " " point (P_1) " " "
$Y_p = Y$ " " " " " "
$Z_p = Z$ " " " " " "

θ_A = Horizontal aiming angle of luminaire.
σ_{CA} = Vertical " " " "

Find: Vertical cp angle, β_y - Vertical Polar Axis (VPA) test format.
Horizontal cp angle, γ_2 - Vertical Polar Axis test format.
Vertical cp angle, σ_z - Horizontal Polar Axis (HPA) test format.
Horizontal cp angle γ_1 - Horizontal Polar Axis test format

Procedure:

$X_1 = X_{P1} - X_L$
$Y_1 = Y_{P1} - Y_L$
$Z_1 = Z_{P1} - Z_L$

HPA: $\sigma_A = 90° - \sigma_{CA}$
VPA: $\sigma_A = \sigma_{CA}$

$X' = X_1 \cos\alpha_1 + Y_1 \cos\beta_1 + Z_1 \cos\gamma_1$
$Y' = X_1 \cos\alpha_2 + Y_1 \cos\beta_2 + Z_1 \cos\gamma_2$
$Z' = X_1 \cos\alpha_3 + Y_1 \cos\beta_3 + Z_1 \cos\gamma_3$

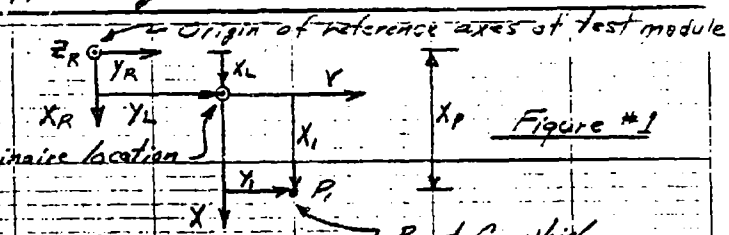


Figure #1

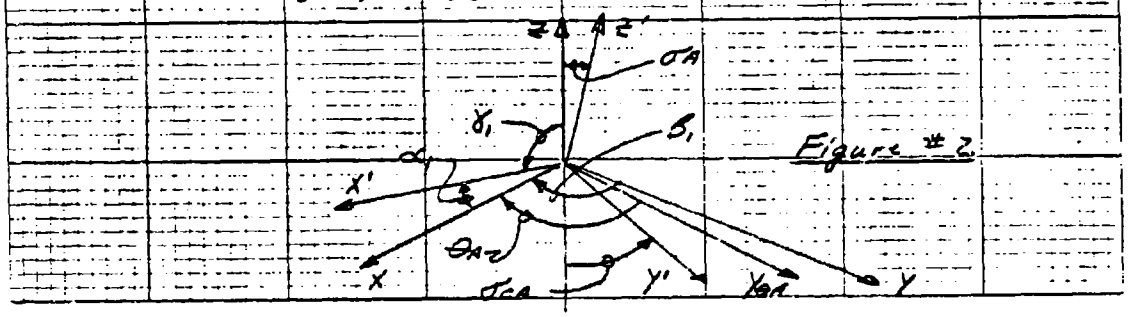


Figure #2

FIGURE 21
Sheet 1 of 4

$\alpha_1 = \theta_A - 90°$

$\beta_1 = \theta_A - 180°$

$\gamma_1 = 90°$

$X' = X_1 \cos(\theta_A - 90°) + Y_1 \cos(\theta_A - 180°) + Z_1 \cos(90°)$

$X' = \underline{X_1 \cos(\theta_A - 90°) + Y_1 \cos(\theta_A - 100°)}$

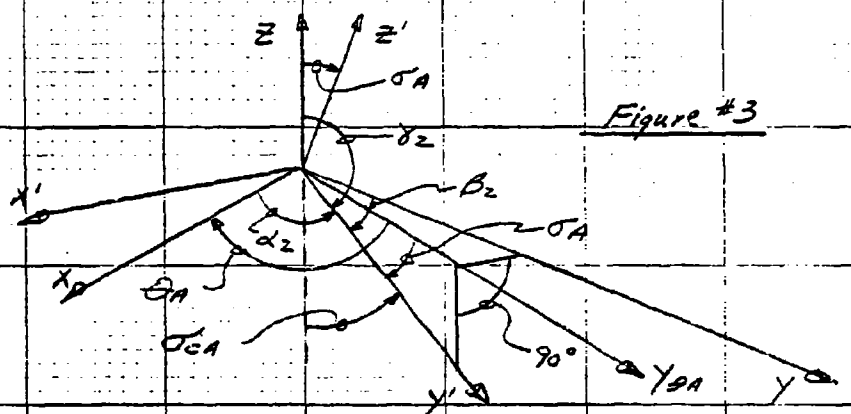


Figure #3

$\alpha_2 = \text{arc cos}\,[\cos(\theta_A)\cos(\sigma_A)]$

$\beta_2 = \text{arc cos}\,[\cos(\theta_A - 90°)\cos(\sigma_A)]$

$\gamma_2 = 90° + \sigma_A$

$Y' = X_1 \cos(\theta_A)\cos(\sigma_A) + Y_1 \cos(\theta_A - 90°)\cos(\sigma_A) + Z_1 \cos(90° + \sigma_A)$

$Y' = \underline{X_1 \cos(\theta_A)\cos(\sigma_A) + Y_1 \cos(\theta_A - 90°)\cos(\sigma_A) - Z_1 \sin(\sigma_A)}$

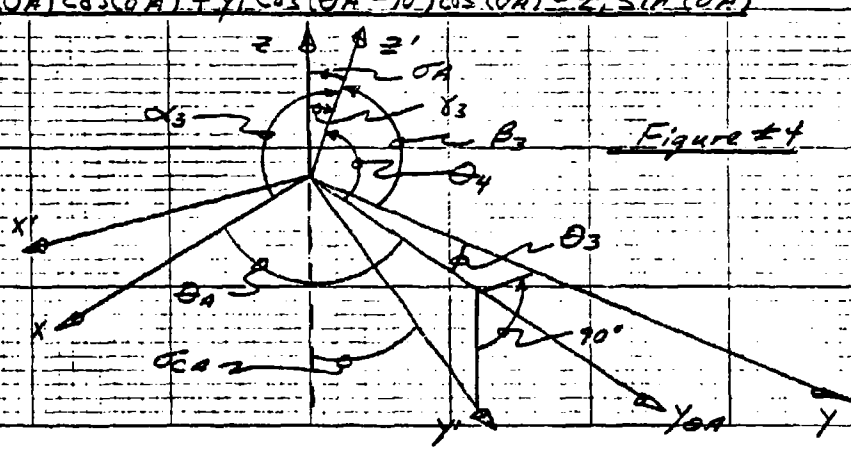


Figure #4

FIGURE 21
Sheet 2 of 4

$\theta_3 = \theta_A - 90°$ $\theta_4 = \sigma_A - 90°$

$\alpha_3 = \text{arc cos } [\cos(\theta_A)\cos(\theta_4)]$

$\alpha_3 = \text{arc cos } [\cos(\theta_A)\cos(\sigma_A - 90°)]$

$\beta_3 = \text{arc cos } [\cos(\theta_3)\cos(\theta_4)]$

$\beta_3 = \text{arc cos } [\cos(\theta_A - 90°)\cos(\sigma_A - 90°)]$

$\gamma_3 = \sigma_A$

$Z' = X_1\cos(\theta_A)\cos(\sigma_A - 90°) + Y_1\cos(\theta_A - 90°)\cos(\sigma_A - 90°) + Z_1\cos(\sigma_A)$

HPA FORMAT:

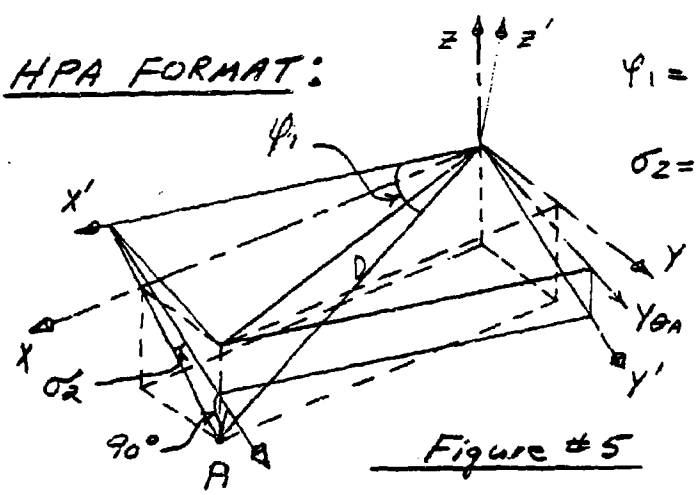


Figure #5

$\varphi_1 = \text{arc cos } \frac{X'}{D}$ (HCPL)

$\sigma_2 = \text{arc tan } \frac{Z'}{Y'}$ (VCPL)

(For 1st quadrant)

VPA FORMAT:

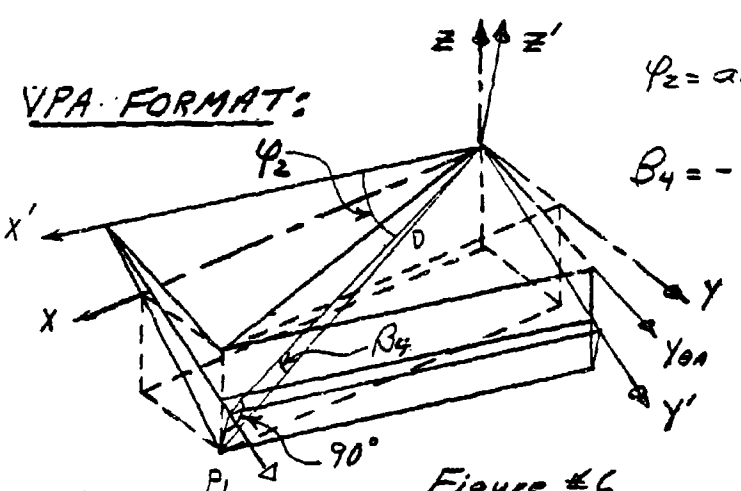


Figure #6

$\varphi_2 = \text{arc tan } \frac{Y'}{X'}$ (HCPL)

$\beta_4 = -\text{arc sin } \frac{Z'}{D}$ (VCPL)

(For 1st quadrant)

FIGURE 21
Sheet 3 of 4

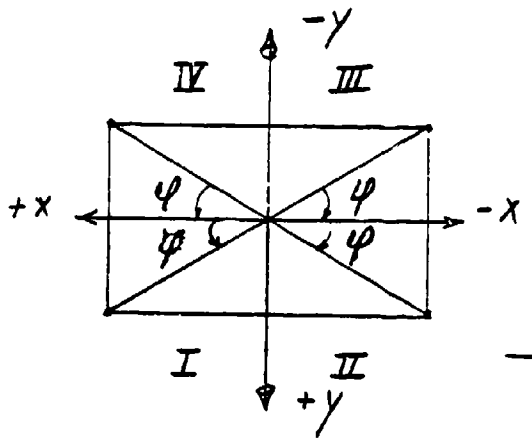


Figure #7

Quadrant

I : $X>0$ $Y>0$

Horizontal Angle = φ

II : $X<0$ $Y>0$

Horizontal Angle = $180° - \varphi$

III : $X<0$ $Y<0$

Horizontal Angle = $180° + \varphi$

IV : $X>0$ $Y<0$

Horizontal Angle = $360° - \varphi$

BASIC RELATIONSHIPS

$D = (X^2 + Y^2 + Z^2)^{1/2}$

Z = MH = mounting height

$\cos\gamma = \cos\sigma \cos\beta$.

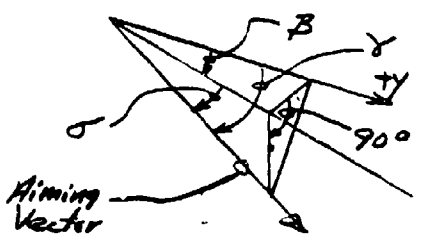
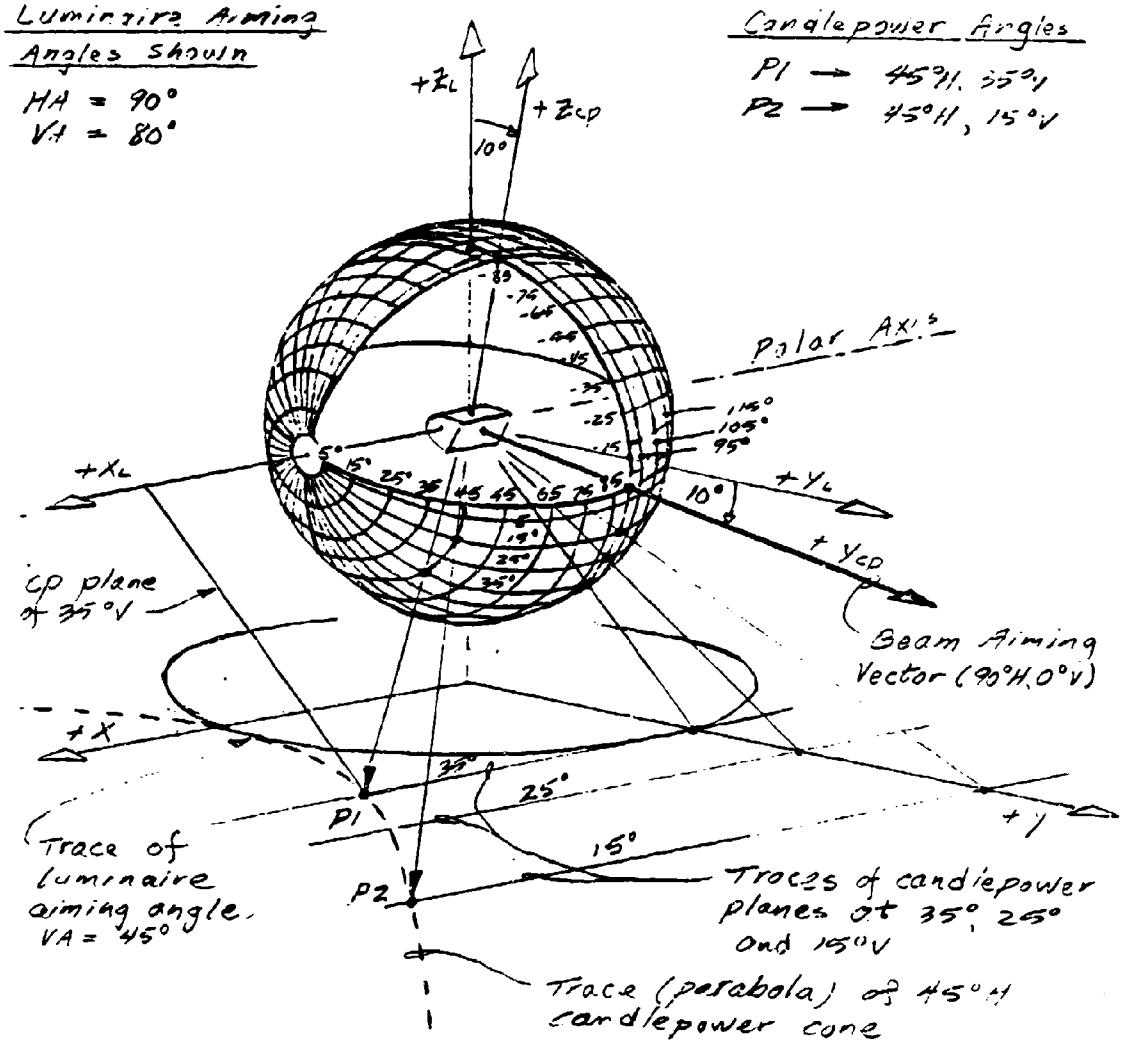


FIGURE 21
Sheet 4 of 4

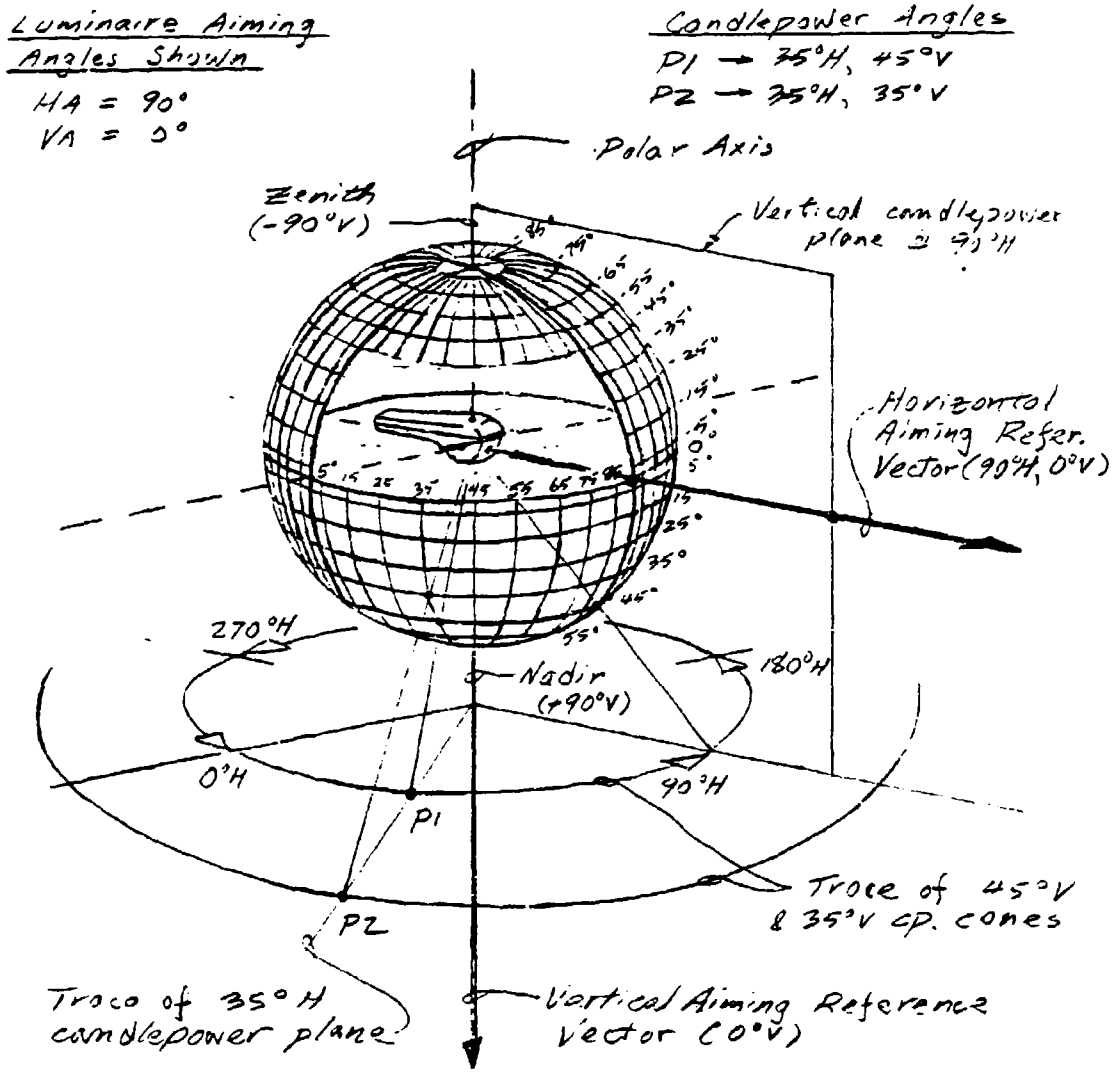
HORIZONTAL POLAR AXIS FORMAT



CANDLEPOWER ANGLE GEOMETRY

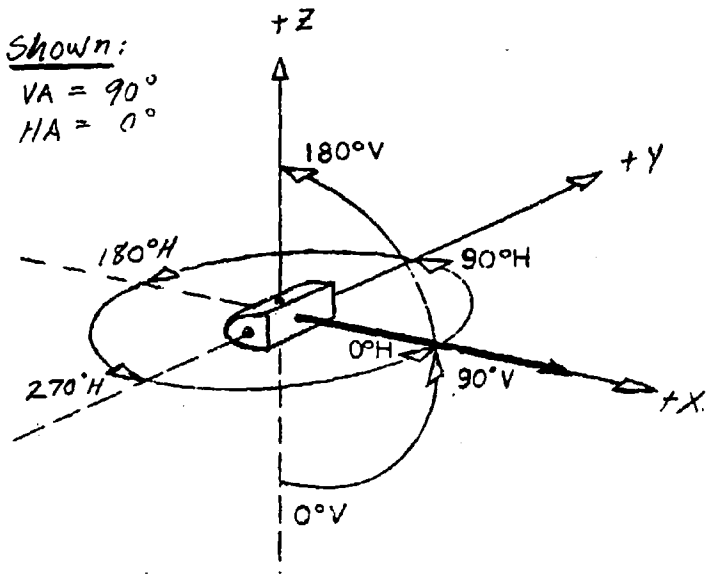
FIGURE 22
Sheet 1 of 2

VERTICAL POLAR AXIS FORMAT



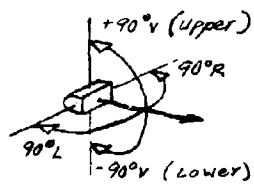
CANDLEPOWER ANGLE GEOMETRY

FIGURE 22
Sheet 2 of 2

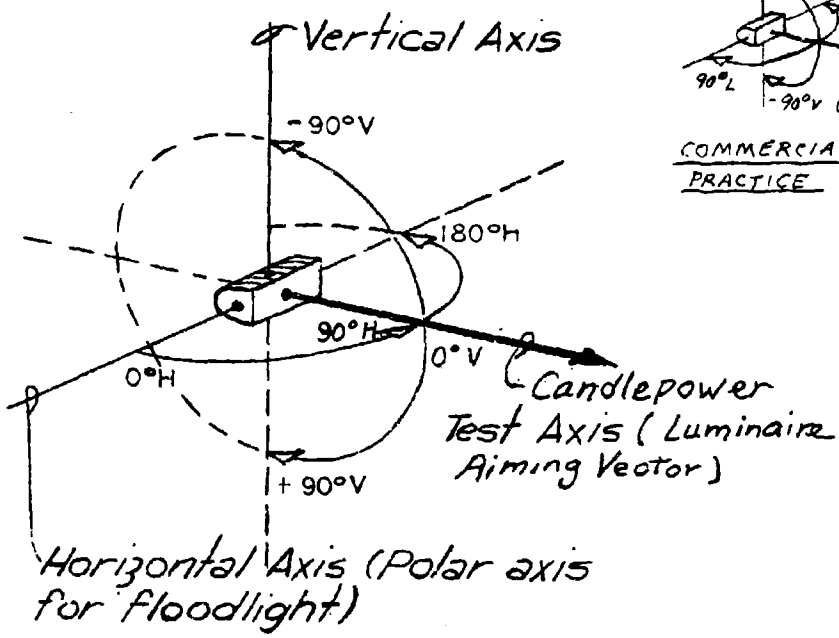


REFERENCE AXES FOR AIMING ANGLES

NO SCALE



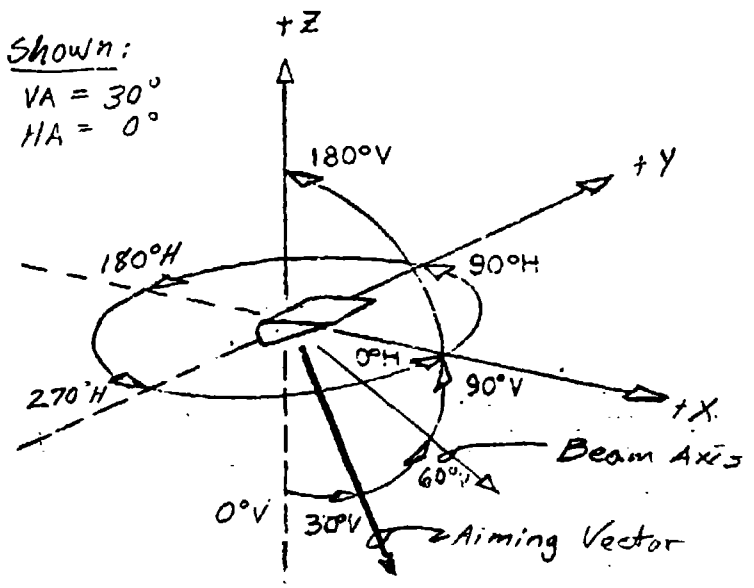
COMMERCIAL PRACTICE



REFERENCE AXES FOR CANDLE POWER DATA

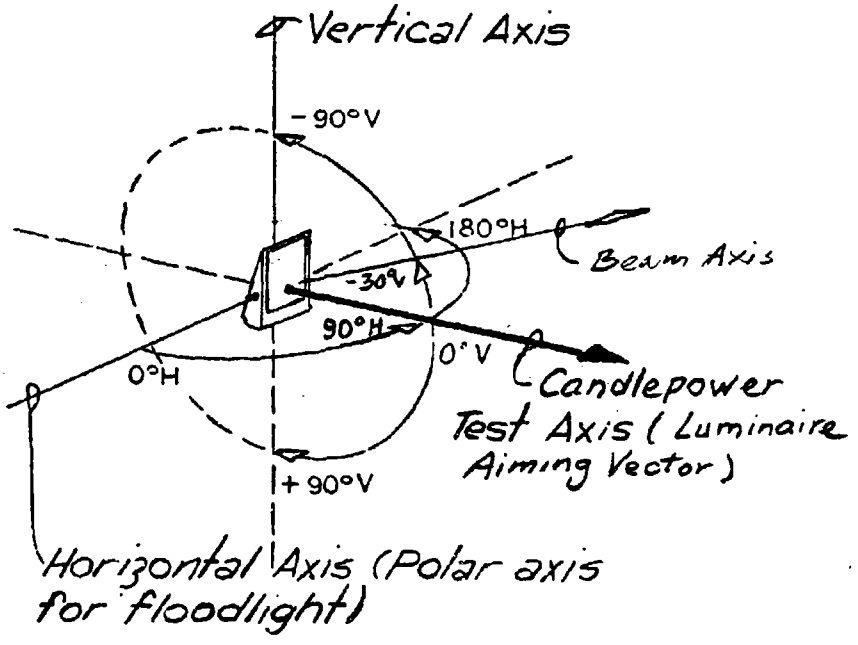
NO SCALE

FIGURE 23
sheet 1 of 3



REFERENCE AXES FOR AIMING ANGLES

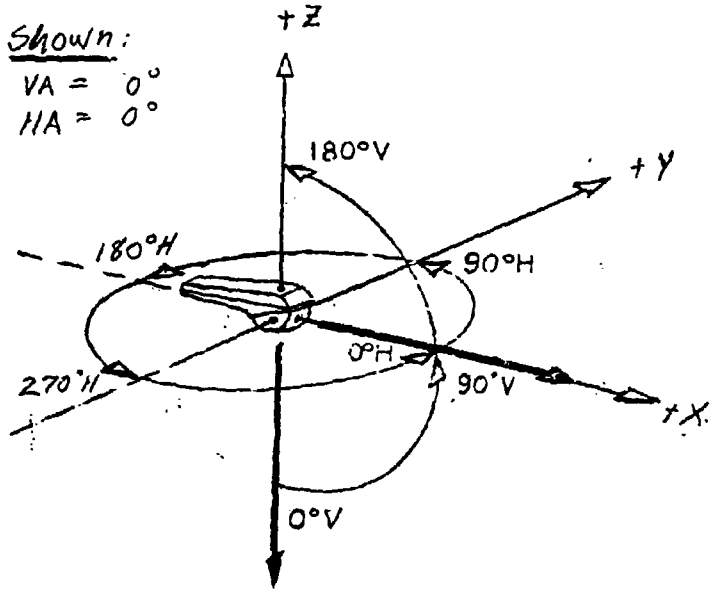
NO SCALE



REFERENCE AXES FOR CANDLE POWER DATA

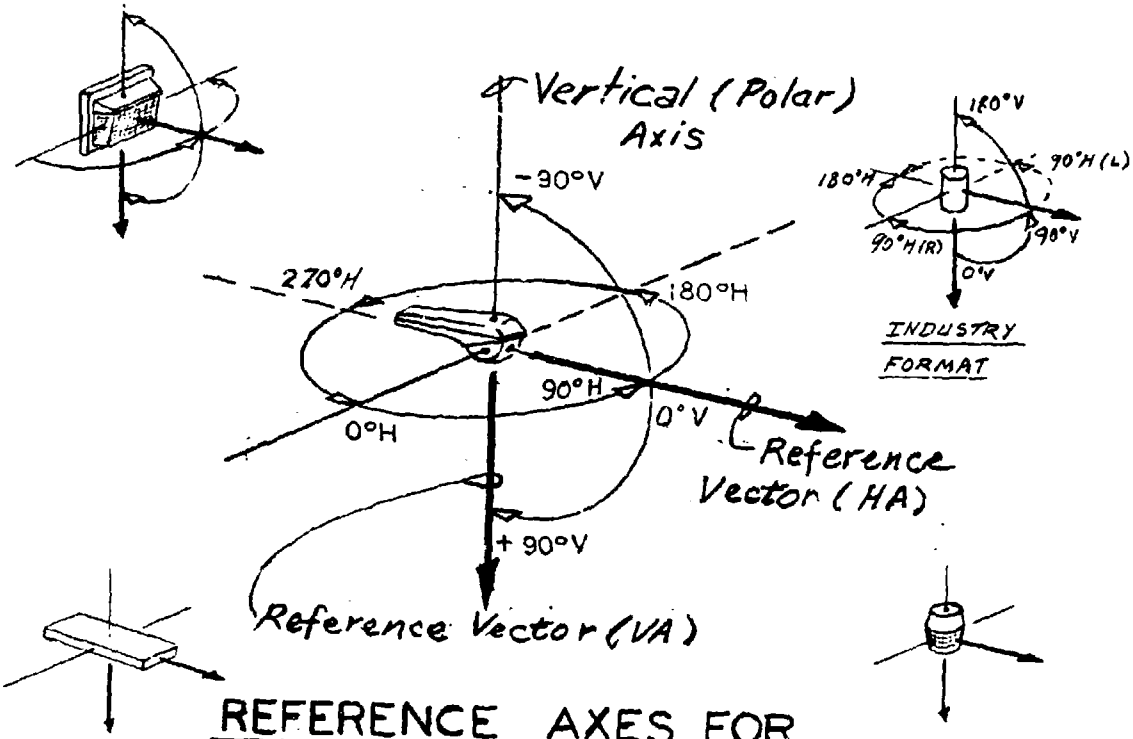
NO SCALE

FIGURE 23
Sheet 2 of 3



REFERENCE AXES FOR AIMING ANGLES

NO SCALE



REFERENCE AXES FOR CANDLE POWER DATA

NO SCALE

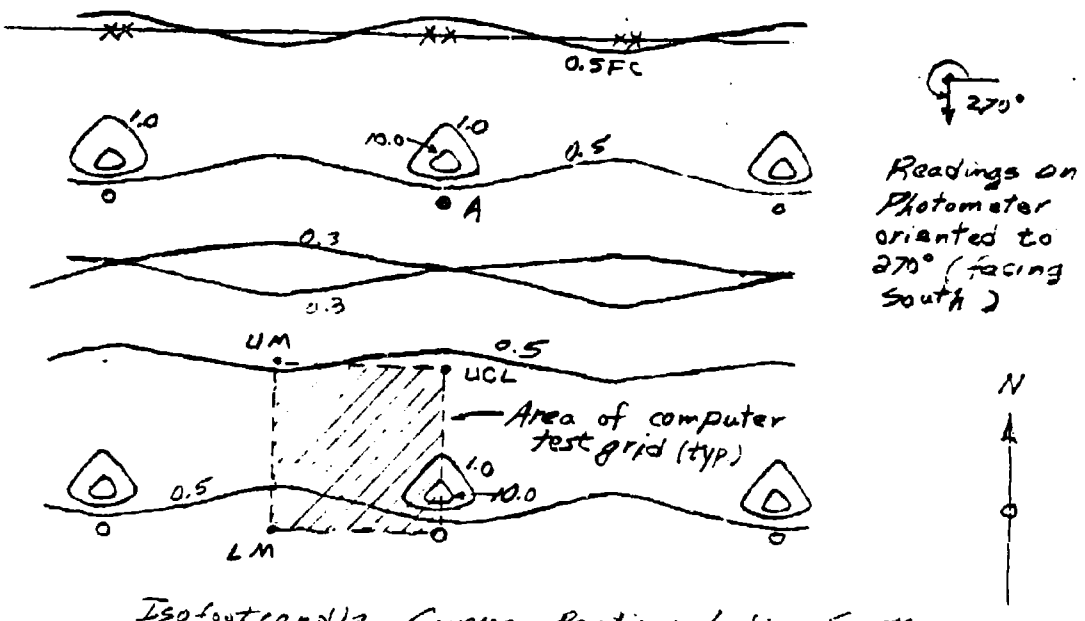
FIGURE 23
Sheet 3 of 3

5-9 The Modular Approach to Lighting Analysis. Computer aided evaluations of different lighting schemes, such as those examined in this study, can be performed using a modular approach.

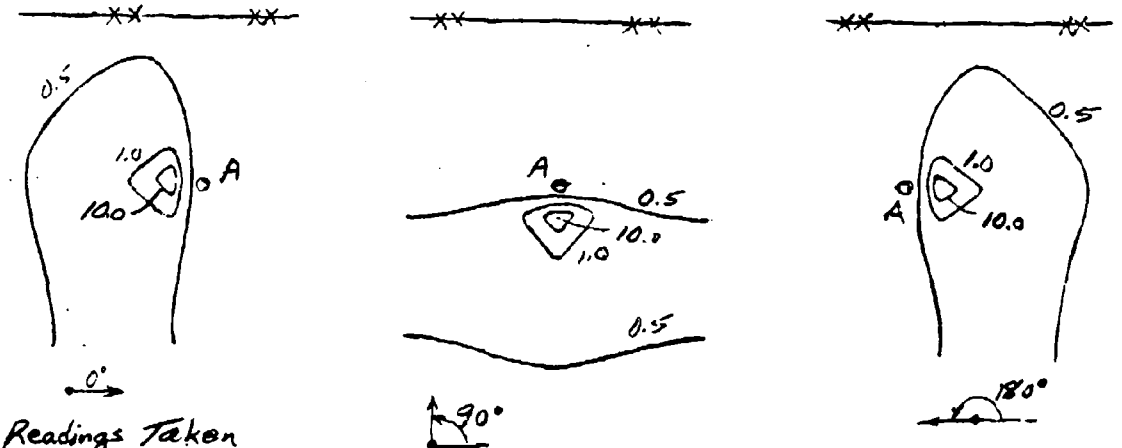
5-9.1. Single Row Format. In a pole line of infinite length, light distribution patterns around any one individual pole will be symmetrical and equal in magnitude to those around any other pole. Axes of symmetry will be the centerline at each pole (normal to the pole line) and the midline between any two poles. It is possible therefore to select one pair of poles and establish a test grid extending from one of the poles to the midline. Measurements can be taken within the test grid and if criteria minimums are satisfied for this grid, they will be met in all other grids. In performing a computer analysis a 6 pole module can be established with a test grid in the center. The critical points on the test grid are the upper midpoint (UM), the lower midpoint (LM), the upper centerline (UCL), and the pole. The upper midpoint is the weakest grid point for most configurations, the area under the pole usually will be comparatively strong. The 6 pole module approximates the infinite row configuration with sufficient accuracy for practically all applications. The additional contribution from an 8 pole module could add 1-2% to the illumination at the midpoint depending on the mounting weight, pole spacing, etc. For all practical purposes the characteristics of the 6 pole module are repeatable. It can be used, in building block style, to assemble a row of any length desired. Since essentially only one pole contributes to the illumination at the midpoint at the ends of a row, supplemental luminaires may be required unless there is an adjacent lighting sector that can contribute (Note discussion in Section 9-2 and Figure 36).

5-9.2. Area Lighting. For general area lighting an approach similar to the single row format can be employed. Assuming luminaires, in multiples of four, are equally spaced around a pole, the illumination patterns will be symmetrical in four directions. For vertical footcandle formats the distribution pattern will be directional (See Figure 24 for illustration). For a vertical footcandle format, the weakest point in the lighting module will be the upper midpoint of the test grid located at the center of the module. Changing module size from 4, to 6 or 8, to 9, and to 12 or 16 poles will have definite effects on the illumination at this point. Increasing the size beyond 16 poles will have minor effect on weak point illumination. A 12 pole module can be used, in building block style, to form an area of any size. Distribution patterns are symmetrical in all test grids, but those just inside the outside rows or columns will be slightly smaller in magnitude. The upper midpoints at the four corners will require supplementation (See Figure 37 for examples). The above relationships are valid for a vertical footcandle basis. If illumination were horizontally based, the weakest grids would be on the outside, the strongest grid would be the center one.

5-9.3. Evaluation of Data. An extensive number of computer trials were performed in the course of this study. Nearly all of the trials used in making comparative analysis utilized a 6 pole module if for a single row application and a 12 pole module for general area lighting. The three critical points (UM,LM,UCL) of the test grids were checked for adherence to criteria. Grids were computed in two formats - one, corresponding to the exact borders of the test grid, was utilized to determine the applicable uniformity ratio, for the second, an augmented version of the test grid, the printout data extended slightly beyond the test grid so that symmetry could be checked. The test grids, having relatively small increments between rows or columns of illumination points, served to delineate the isofootcandle patterns (see Figures 24, 25, & 26) characteristic of the particular configurations. A grid which encompased the entire module was also included in many trials. The row and column intervals in this instance were selected to correspond to the pole and critical point locations, or multiples thereof.



Isofootcandle Curves - Readings looking South



Readings Taken for 0° orientation of photometer (looking East)

Readings Taken Looking North (90°)

Photometer oriented at 180° (Facing West)

ISOFOOTCANDLE CURVES - VERTICAL FC BASIS

(Assuming Symmetrical Pole & Luminaire Layout)

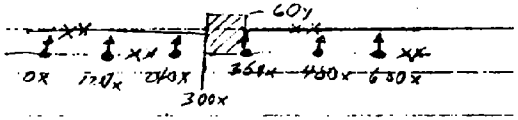
FIGURE 24

6. FOOTCANDLE PRINTOUTS OF TYPICAL ARRANGEMENTS. The methodology of the computerized calculations and format for entering input data were outlined in Fig. 20 and discussed in Section 5-8. The results of such calculations have been printed out in the form of illumination grids, such as shown in Figures 25 and 26. Figure 25 is an example of a perimeter lighting configuration. Each location on the grid can be identified in terms of a "X" and "Y" coordinate. The height of the grid plane in relation to ground level is defined by the "Z" coordinate. The figures at each point represent horizontal footcandles, maintained. Figure 26 provides an example of an area lighting printout. Each grid point represents vertical footcandles, maintained, for a 270° measurement basis. For convenience and consistency, the decimal point of each footcandle figure was selected as reference for spotting poles, delineating grids, and evaluating compliance with criteria.

T74A PER LTG--' 6-POLE) 1X400MPS SP120 MH35 -- (020678 78/02/06 09.18.01 PAGE 17

TEST GRID 4 COORDINATES OF CORNER 1 240.00 -25.00 .50
COORDINATES OF CORNER 2 370.00 110.00 .50
COORDINATES OF CORNER 3 370.00 -25.00 .50
COORDINATES OF CORNER 4 240.00 110.00 .50

Expl Watts = 480 ea
4KW/1000LF



		X 240.00	X 250.00	X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 370.00	
Y	30.00	2.0003	1.819-	1.8037	1.8135	2.0003	2.3575	3.2409	4.1685	4.3074	4.1685	30.00 Y
Z	.50											.50 Z
Y	25.00	1.9993	1.7745	1.7679	1.7745	1.9993	2.5286	3.3823	4.5376	4.8974	4.5375	25.00 Y
Z	.50											.50 Z
Y	20.00	1.8879	1.6733	1.6431	1.6733	1.8879	2.5426	3.3063	4.6483	5.2337	4.6482	20.00 Y
Z	.50											.50 Z
Y	15.00	1.7662	1.5205	1.4861	1.5205	1.7662	2.3443	3.2658	4.2983	5.2777	4.2982	15.00 Y
Z	.50											.50 Z
Y	10.00	1.6353	1.3602	1.3028	1.3602	1.6353	2.1769	3.0000	4.0160	5.0418	4.0159	10.00 Y
Z	.50											.50 Z
Y	5.00	1.5063	1.2111	1.1213	1.2042	1.4997	1.9873	2.5087	3.5251	4.5125	3.5250	5.00 Y
Z	.50											.50 Z
Y	0.00	1.3662	1.0827	1.0674	1.0827	1.3662	1.7580	2.0431	2.4735	2.9760	2.4734	0.00 Y
Z	.50											.50 Z
Y	-5.00	1.1877	.9301	.7940	.9301	1.1877	1.5574	1.8686	2.1248	2.3026	2.1247	-5.00 Y
Z	.50											.50 Z
Y	-10.00	1.0039	.7962	.7167	.7962	1.0039	1.3354	1.6019	1.8333	1.8664	1.8332	-10.00 Y
Z	.50											.50 Z
Y	-15.00	.8562	.6647	.6228	.6687	.8562	1.1341	1.3283	1.4628	1.5294	1.4627	-15.00 Y
Z	.50											.50 Z
Y	-20.00	.7080	.5529	.5149	.5529	.7080	.8910	1.0487	1.1641	1.2045	1.1640	-20.00 Y
Z	.50											.50 Z
Y	-25.00	.5560	.4498	.4154	.4488	.5560	.6746	.7982	.9004	.9308	.9004	-25.00 Y
Z	.50											.50 Z

TEST GRID

2.0 FC

1.0 FC

For 60 ft test grid: Avg. FC = 2.29 (3.36 Initial), Uniformity Ratio = 2.37
30 ft test grid: Avg. FC = 2.63 (3.47 Initial), Uniformity Ratio = 2.72
All values shown are horizontal footcandles, maintained, at 6 in. up
a maintenance factor of 0.68 (LLD = 0.85 x DF = .680)

FOOTCANDLE PRINTOUT
PERIMETER LIGHTING - DOUBLE FENCE
(See Attach 19 for complete run)

62

FIGURE 25
Sheet 1 of 2

[T74A] PER LTG--PF(6-POLE) 1X400HPS SP120 MH35 -- 1020678 78/02/06 09.18.01 PAGE 16

400w Roadway luminaire
Type IV, medium, non-cutoff
Westinghouse Cat #V26-SP6D-FEA
Photometric Test # 672241
Socket Position # M-A

TEST GRID 4 COORDINATES OF CORNER 1 240.00 -25.00 .50
COORDINATES OF CORNER 2 370.00 110.00 .50
COORDINATES OF CORNER 3 370.00 -25.00 .50
COORDINATES OF CORNER 4 240.00 110.00 .50

		X 240.00	X 250.00	X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 370.00	
Y	110.00	.2296	.2175	.2174	.2175	.2296	.2344	.2505	.2591	.2637	.2588	110.00 Y
Z	.50											.50 Z
Y	105.00	.2620	.2474	.2483	.2474	.2620	.2768	.2891	.3023	.3076	.3020	105.00 Y
Z	.50											.50 Z
Y	100.00	.2995	.2827	.2835	.2827	.2995	.3151	.3344	.3548	.3609	.3546	100.00 Y
Z	.50											.50 Z
Y	95.00	.3410	.3266	.3234	.3266	.3410	.3605	.3904	.4187	.4259	.4185	95.00 Y
Z	.50											.50 Z
Y	90.00	.3916	.3793	.3684	.3793	.3916	.4142	.4581	.5048	.5186	.5046	90.00 Y
Z	.50											.50 Z
Y	85.00	.4534	.4422	.4215	.4422	.4534	.4905	.5426	.6059	.6359	.6057	85.00 Y
Z	.50											.50 Z
Y	80.00	.5302	.5169	.5063	.5169	.5302	.5793	.6424	.7323	.7643	.7321	80.00 Y
Z	.50											.50 Z
Y	75.00	.6325	.6068	.6151	.6068	.6325	.6825	.7514	.8841	.9261	.8839	75.00 Y
Z	.50											.50 Z
Y	70.00	.7470	.7204	.7432	.7204	.7470	.8021	.8955	1.0573	1.1153	1.0572	70.00 Y
Z	.50											.50 Z
Y	65.00	.8749	.8689	.8836	.8689	.8749	.9459	1.0728	1.2728	1.3552	1.2727	65.00 Y
Z	.50											.50 Z
Y	60.00	1.0237	1.0211	1.0377	1.0211	1.0237	1.1203	1.2870	1.5459	1.6722	1.5457	60.00 Y
Z	.50											.50 Z
Y	55.00	1.2037	1.1814	1.1968	1.1814	1.2037	1.3205	1.5521	1.8474	2.0314	1.8472	55.00 Y
Z	.50											.50 Z
Y	50.00	1.3913	1.3607	1.3494	1.3607	1.3913	1.5583	1.8786	2.2230	2.4148	2.2229	50.00 Y
Z	.50											.50 Z
Y	45.00	1.5718	1.5190	1.5095	1.5190	1.5716	1.8314	2.3020	2.5968	2.7905	2.5967	45.00 Y
Z	.50											.50 Z
Y	40.00	1.7425	1.6668	1.6695	1.6668	1.7425	2.0928	2.6124	3.0298	3.2197	3.0297	40.00 Y
Z	.50											.50 Z
Y	35.00	1.9021	1.7973	1.7342	1.7973	1.9021	2.2407	2.9361	3.6046	3.7486	3.6045	35.00 Y
Z	.50											.50 Z

1.0 FC

TEST GRID

2.0 FC

62

FIGURE 25
sheet 2 of 2

TE3029 AL:HR(12-POLE) (END ADJ+4L) HX15000 S400 MH40 - (78/02/17 09.09.08 PAGE 24

TEST GRID 6 COORDINATES OF CORNER 1 400.00 400.00 3.00
COORDINATES OF CORNER 2 600.00 600.00 3.00
COORDINATES OF CORNER 3 600.00 400.00 3.00
COORDINATES OF CORNER 4 400.00 600.00 3.00

48AW + VRC 147A
→ 3.27 KW/A

800Y 600Y 400Y 200Y 0Y 0X 400X 800X 1200X

		X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	X 0.00	
Y 600.00		.5906	.6012	.5885	.5691	.5268	.4939	.4556	.4280	.4154	0.0000	0.00 Y
Z 3.00		UGL								UM		0.00 Z
Y 580.00		.7207	.7342	.7133	.6645	.6062	.5406	.4868	.4511	.4423	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 560.00		.9109	.9284	.8913	.7899	.6925	.5967	.5164	.4771	.4691	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 540.00		1.2033	1.2246	1.1497	.9743	.8023	.6474	.5478	.5034	.4826	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 520.00		1.7107	1.7120	1.5563	1.2190	.9229	.7076	.5810	.5052	.4911	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 500.00		2.6292	2.5754	2.1640	1.5572	1.0654	.7642	.5832	.5013	.4735	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 480.00		4.4092	4.0442	3.0307	1.8890	1.1862	.7805	.5870	.4737	.4457	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 460.00		6.6269	5.7370	3.8886	2.2275	1.2310	.7353	.5195	.4218	.3922	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 440.00		6.7975	5.9405	4.1240	2.1137	1.0534	.6091	.4257	.3457	.3240	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 420.00		3.2266	3.8826	2.7222	1.3705	.6591	.3998	.3011	.2585	.2466	0.0000	0.00 Y
Z 3.00												0.00 Z
Y 400.00		.1558	.1594	.1622	.1653	.1661	.1676	.1690	.1688	.1677	0.0000	0.00 Y
Z 3.00										ZM		0.00 Z

OUTDOOR LIGHTING - MULTI-ROW PRINTOUT OF TEST GRID
AREA LIGHTING (See Attach 20 for complete run)

1.0 FC
0.47 FC

VFC 270°

Luminaire = 1500 W quartz floodlight, Gen. Elect. Cat # C525G006
Photometric Test # 25-175785

FIGURE R6

7. ECONOMIC ANALYSIS OF PERIMETER LIGHTING FORMATS.

7-1 General. The approach to perimeter lighting used in 1975 prior to surveillance TV considerations, was based on glare projection toward the intruder. The floodlight type of luminaire was most compatible to that type of lighting philosophy. An extensive number of trial lighting configurations using floodlights were formulated and evaluated with the aid of the computer in 1975. Those configurations that satisfied photometric criteria were then analyzed economically, both individually and on a comparative basis, using a separate computer program. Results are discussed in Section 8. (Note: The lighting program used for these 1975 computer trials utilized a partially inaccurate technique for determining candlepower angles. The error would affect portions of the footcandle grids and this could change the total costs of individual schemes somewhat. However the adjustment would be proportionate in each case and could not affect the relative standing of any one scheme in the overall ecomomic comparison).

7-2 Factors Evaluated. All significant factors bearing on cost were considered both initial (materials and installation and annual (operating, maintenance and annual ownership). A 10 year life was assumed. These factors are described in the following paragraphs.

7-2.1. Initial Equipment Investment includes costs for luminaires, lamps, ballasts, poles and foundations and accessories, electrical distribution including controls, standby generators, and UPS (uninterruptible power supply) for some High and Low Pressure Sodium lighting arrangements.

Wood poles were selected for cost comparisons due to their relatively low cost. See Table IV for cost analysis (1975 figures).

TABLE IV
POLE SELECTION - 30' HIGH

Description	Alum.	Pt'd Steel	Gal'd Stl	Wood
Pole	473	312	332	70
Brackets	40	32	40	--
Crossarm & Brace	--	--	--	25
Foundation	50	50	50	--
Erection, Pole Luminaire	120	120	120	120
Painting	--	20	--	--
	683	534	542	215
Overhead & Profit	X1.3	X 1.3	X1.3	X1.3
	$888	$694	$704	$280

TABLE V

COST COMPARISON OF OVERHEAD PRIMARY ELECTRICAL VS UNDERGROUND PRIMARY ELECTRICAL

Based on 80 acre site with one mile of Electrical Distribution and two 300 KVA 3Ø transformers. (1975 figures)

Item	Unit Cost	Quantity Cost	Total Site Cost
Overhead System			
Overhead Primary electrical Distribution 4 #4/0 ACSR	$7.95/LF	$41,980	
3-100 KVA Pole Mtd Transformers	$4,200/Ea	$ 8,400	$50,380
Underground System			
Underground Primary Electrical Distribution 15KV, 3 #2 Copper with 1#2, 600 Volt Copper, Concrete Encased	$17.50/LF	$92,400	
300 KVA Pad Mtd Transformer With Hardening	$7,500/Ea	$15,000	$107,400

Underground primary and secondary distribution system was selected for security reasons. See Table V for relative costs of overhead and underground distribution. (Note: This analysis is based on secondary distribution in conduit. Subsequently it was decided that a direct burial cable system would be acceptable in lieu of the secondary duct system.) Distribution from point of automatic transfer is either underground or hardened.

Standby generators are sized to carry total connected load. In combination schemes with quartz and sodium, generators must be large enough to supply energy to both light sources during restrike period.

UPS system costs includes 15 minute battery backup and will supply power during standby generator startup period.

7-2.2. Initial Labor Estimates include contractor costs for installation of poles, luminaires, electrical distribution, generators, and UPS.

7-2.3. Illumination Calculations include pole spacing (ft.) and area (acres), maintenance factors used, design footcandles and unit cost per foot or acre. A utilization factor was not programmed in tests so is shown as 0.00.

7-2.4. Annual Cost include energy costs, generator fuel costs and replacement lamp costs. Also listed is total connected load and total KW/hr consumption per year.

7-2.5. Annual Maintenance includes costs for relamping, cleaning and general repair to all system components.

7-2.6. Annual Ownership and Operating Cost combines the initial cost on an annual basis with maintenance and operating costs. Also provided is a unit price per foot or acre.

7-3 Comparative Costs. Copies of the computer summary sheets have been provided to conveniently show relative costs between schemes (see Figure 27 or Appendix D, Sheets 1-6). They can be used to make the following pertinent comparison:

a. 100% quartz, single fence, schemes 1, 2, 3, 4, 5. Lowest relative cost is Scheme 1.

b. 100% H.P. sodium, single fence, schemes 6, 7, 8 and 9. Lowest relative cost is Scheme 8.

c. 100% L.P. sodium, single fence, schemes 10 through 17. Lowest relative cost is Scheme 10.

d. Single Fence. H.P. sodium without UPS (Scheme 18) versus L.P. sodium without UPS (Scheme 22) and 100% quartz (Scheme 1). Lowest relative cost is Scheme 22, low pressure sodium.

e. Single Fence. H.P. sodium with 100% quartz backup (Scheme 19), L.P. sodium with 100% quartz backup (Scheme 23) and 100% quartz (Scheme 1). Lowest relative cost is Scheme 19, high pressure sodium.

f. Schemes 26, 27, 28 compare 100% quartz, 100 HPS and 100% LPS with double fence layout. Lowest relative cost is Scheme 27, high pressure sodium.

7-4 Program Format. The summary sheet format shown in Figure 27 is a condensed version of the longer format used in the individual analysis (see Figure 29 for example). The key to the computer program used in the 1975 perimeter lighting analysis is shown in Figure 28. A modified version of this format is shown in Figure 30. This is a general format which could be used on any project. Figure 31 is a work sheet for use when entering data. Since the computer recognizes the input data only according to relative position, there must be an entry corresponding to each line, either in fractional or integer form. To instruct the computer to ignore a line item, the user must enter "000".

ECONOMIC COMPARISION

SINGLE FENCE

		PERIMETER LIGHTING SCHEME 1 100% QUARTZ	PERIMETER LIGHTING SCHEME 2 100% QUARTZ	PERIMETER LIGHTING SCHEME 3 100% QUARTZ	PERIMETER LIGHTING SCHEME 4 100% QUARTZ	PERIMETER LIGHTING SCHEME 5 100% QUARTZ
I.	INITIAL EQUIPMENT INVESTMENT					
1.	QUANTITY OF LUMINAIRES	268	320	134	160	345
3.	LUMINAIRE COST TOTAL	11256.00	17120.00	8710.00	10400.00	4485.00
4.	QUANTITY OF POLES	134	160	67	160	115
9.	POLE + FOUNDATION COST TOTAL	9380.00	11200.00	4690.00	11200.00	8050.00
14.	ELECTRICAL DISTRIBUTION	26400.00	66000.00	40200.00	48600.00	34500.00
14A.	STANDBY GENERATOR COST	22780.00	54400.00	34170.00	40800.00	29325.00
14C.	UPS COST	0.00	0.00	0.00	0.00	0.00
16.	TOTAL INIT EQUIP INCL LAMPS	73700.00	151200.00	89780.00	112800.00	80845.00
17.	RELATIVE INIT EQUIP INVESTMENT	1.31	2.68	1.59	2.00	1.44
II.	INITIAL LABOR ESTIMATES					
20.	NET LABOR, POLES + LUMINAIRES	36850.00	46400.00	20435.00	34400.00	38525.00
21.	LABOR ELECTRICAL DISTRIBUTION	20100.00	40000.00	30150.00	36000.00	25875.00
22.	TOTAL INITIAL LABOR	59630.00	100800.00	54605.00	77600.00	67450.00
23.	TOTAL INITIAL INVESTMENT	133330.00	252000.00	298785.00	344800.00	303095.00
24.	RELATIVE INITIAL INVESTMENT	1.00	1.89	2.24	2.59	2.27
IV.	ANNUAL COSTS					
31.	TOTAL SYSTEM KW	134.	320.	201.	240.	173.
33.	TOTAL ENERGY KWH/YEAR	536000.	1280000.	804000.	960000.	690000.
34.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37.	ANNUAL KWH COST	10720.00				
37D.	DIESEL FUEL COST	214.40	512.00	321.60	384.00	276.00
40.	REPLACEMENT LAMP COST	10452.00	13440.00	6030.00	7200.00	13455.00
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS					
44.	RELAMPING COST - LABOR	2680.00	3200.00	1340.00	1600.00	3450.00
47.	CLEANING COST - LABOR	0.00	0.00	0.00	0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	702.16	1467.20	877.70	1104.00	763.60
52.	TOTAL ANNUAL MAINTENANCE COST	3382.16	4667.20	2217.70	2704.00	4213.60
53.	ANNUAL OPERATING COST	24768.56	44219.20	24669.30	29488.00	31744.60
VI.	ANNUAL OWNERSHIP + OPERATING COST					
55.	FIXED OWNERSHIP COST	18438.13	35147.84	20217.25	24696.00	20477.82
56.	ANNUAL OWNERSHIP + OPING COST	43206.69	79367.04	44886.55	54184.00	52222.42
VII.	RELATIVE COSTS OF LIGHT					
59.	RELATIVE COST EXCLUDING FIXED	6.66	11.85	6.61	7.90	8.51
60.	RELATIVE TOTAL COST	2.90	5.33	3.01	3.77	3.51

COMPARATIVE COSTS - PERIMETER LIGHTING

FIGURE 27
Sheet 1 of 6

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

SINGLE FENCE

		PERIMETER LIGHTING SCHEME 6 100% HP SODIUM	PERIMETER LIGHTING SCHEME 7 100% HP SODIUM	PERIMETER LIGHTING SCHEME 8 100% HP SODIUM	PERIMETER LIGHTING SCHEME 9 100% HP SODIUM	PERIMETER LIGHTING SCHEME 10 100% LP SODIUM
I.	INITIAL EQUIPMENT INVESTMENT					
1.	QUANTITY OF LUMINAIRES	200	134	134	100	160
3.	LUMINAIRE COST TOTAL	78000.00	32160.00	32160.00	25000.00	43680.00
4.	QUANTITY OF POLES	200	134	67	100	80
9.	POLE + FOUNDATION COST TOTAL	88000.00	9380.00	4690.00	7000.00	5600.00
14.	ELECTRICAL DISTRIBUTION	14500.00	9715.00	9715.00	11500.00	5400.00
14A.	STANDBY GENERATOR COST	12325.00	8257.75	8257.75	9775.00	4760.00
14C.	UPS COST	43500.00	29145.00	29145.00	34500.00	16800.00
16.	TOTAL INIT EQUIP INCL LAMPS	243925.00	92677.75	89059.75	91675.00	79320.00
17.	RELATIVE INIT EQUIP INVESTMENT	4.33	1.65	1.58	1.63	1.41
II.	INITIAL LABOR ESTIMATES					
20.	NET LABOR, POLES + LUMINAIRES	44400.00	28810.00	18425.00	23000.00	17200.00
21.	LABOR ELECTRICAL DISTRIBUTION	10875.00	7286.25	7286.25	8625.00	4200.00
22.	TOTAL INITIAL LABOR	62525.00	40953.75	30568.75	37375.00	24200.00
23.	TOTAL INITIAL INVESTMENT	460950.00	288031.50	274028.50	283450.00	257020.00
24.	RELATIVE INITIAL INVESTMENT	3.46	2.16	2.06	2.13	1.93
IV.	ANNUAL COSTS					
31.	TOTAL SYSTEM KW	73.	49.	49.	58.	28.
33.	TOTAL ENERGY KWH/YEAR	290000.	194300.	194300.	230000.	112000.
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37.	ANNUAL KWH COST	5800.00				
37D.	DIESEL FUEL COST	116.00	77.72	77.72	92.00	44.80
40.	REPLACEMENT LAMP COST	3840.00	2031.16	2572.80	1440.00	921.60
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS					
44.	RELAMPING COST - LABOR	336.84	225.68	225.68	123.08	170.67
47.	CLEANING COST - LABOR	231.58	155.16	155.16	138.46	234.67
50.	PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	2363.25	886.58	839.68	877.75	764.40
52.	TOTAL ANNUAL MAINTENANCE COST	2931.67	1267.42	1220.52	1139.29	1149.73
53.	ANNUAL OPERATING COST	12687.67	7262.30	7757.04	7271.29	4376.13
VI.	ANNUAL OWNERSHIP + OPERATING COST					
55.	FIXED OWNERSHIP COST	42436.70	18404.83	16264.18	17771.30	14290.89
56.	ANNUAL OWNERSHIP + OPRING COST	55124.37	25667.13	24021.22	25042.59	18667.01
VII.	RELATIVE COSTS OF LIGHT					
59.	RELATIVE COST EXCLUDING FIXED	3.40	1.95	2.08	1.95	1.17
60.	RELATIVE TOTAL COST	2.70	1.72	1.61	1.68	1.25

FIGURE 27
SHEET 2 of 5

ECONOMIC COMPARISION

SINGLE FENCE

		PERIMETER LIGHTING SCHEME 11	PERIMETER LIGHTING SCHEME 12	PERIMETER LIGHTING SCHEME 13	PERIMETER LIGHTING SCHEME 14	PERIMETER LIGHTING SCHEME 15
I.	INITIAL EQUIPMENT INVESTMENT	100% LP SODIUM	100% LP SODIUM	100% LP SODIUM	100% LP SODIUM	100% LP SODIUM
1.	QUANTITY OF LUMINAIRES	160	134	134	134	201
3.	LUMINAIRE COST TOTAL	49280.00	48240.00	45426.00	48240.00	50250.00
4.	QUANTITY OF POLES	80	134	67	67	67
9.	POLE + FOUNDATION COST TOTAL	5600.00	9380.00	4690.00	4690.00	8710.00
14.	ELECTRICAL DISTRIBUTION	5600.00	8040.00	8040.00	9040.00	12060.00
14A.	STANDBY GENERATOR COST	4760.00	6834.00	6834.00	6834.00	10251.00
14C.	UPS COST	16800.00	24120.00	24120.00	24120.00	36180.00
16.	TOTAL INIT EQUIP INCL LAMPS	84920.00	101036.00	93532.00	96346.00	124084.00
17.	RELATIVE INIT EQUIP INVESTMENT	1.51	1.79	1.66	1.71	2.20
II.	INITIAL LABOR ESTIMATES					
20.	NET LABOR, POLES + LUMINAIRES	17200.00	30820.00	20435.00	20435.00	25929.00
21.	LABOR ELECTRICAL DISTRIBUTION	4200.00	6030.00	6030.00	6030.00	9045.00
22.	TOTAL INITIAL LABOR	24200.00	40870.00	30485.00	30485.00	41004.00
23.	TOTAL INITIAL INVESTMENT	263520.00	296306.00	278417.00	281231.00	319488
24.	RELATIVE INITIAL INVESTMENT	1.98	2.22	2.09	2.11	2
IV.	ANNUAL COSTS					
31.	TOTAL SYSTEM KW	28.	40.	40.	40.	40.
33.	TOTAL ENERGY KWH/YEAR	112000.	160800.	160800.	160800.	241200.
34.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37.	ANNUAL KWH COST	2240.00				
37D.	DIESEL FUEL COST	44.80	64.32	64.32	64.32	96.48
40.	REPLACEMENT LAMP COST	921.60	1415.04	1202.78	1415.04	2122.56
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS					
44.	RELAMPING COST - LABOR	170.67	142.93	110.77	142.93	214.40
47.	CLEANING COST - LABOR	234.67	196.53	196.53	196.53	294.80
50.	PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	820.40	966.14	891.10	919.24	1174.51
52.	TOTAL ANNUAL MAINTENANCE COST	1225.73	1305.61	1198.41	1258.71	1683.71
53.	ANNUAL OPERATING COST	4432.13	6000.97	5681.51	5954.07	8726.75
VI.	ANNUAL OWNERSHIP + OPERATING COST					
55.	FIXED OWNERSHIP COST	15086.08	19522.73	16982.49	17382.08	22500.61
56.	ANNUAL OWNERSHIP + OPERATING COST	19518.21	25523.69	22664.00	23336.14	31227.36
VII.	RELATIVE COSTS OF LIGHT					
59.	RELATIVE COST EXCLUDING FIXED	1.19	1.61	1.52	1.60	2.34
60.	RELATIVE TOTAL COST	1.31	1.71	1.52	1.57	2.10

FIGURE 27
Sheet 3 of 6

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

SINGLE FENCE

		PERIMETER LIGHTING SCHEME 16 100% LP SODIUM	PERIMETER LIGHTING SCHEME 17 100% LP SODIUM	PERIMETER LIGHTING SCHEME 18 HP SODIUM W/O UPS	PERIMETER LIGHTING SCHEME 19 HP SODIUM +100% Q	PERIMETER LIGHTING SCHEME 20 HPS + 75% Q
I.	INITIAL EQUIPMENT INVESTMENT					
1.	QUANTITY OF LUMINAIRES	115	160	134	268	268
3.	LUMINAIRE COST TOTAL	28750.00	40000.00	32160.00	40370.00	40870.00
4.	QUANTITY OF POLES	115	80	67	67	67
9.	POLE + FOUNDATION COST TOTAL	8050.00	5600.00	4690.00	4690.00	4690.00
14.	ELECTRICAL DISTRIBUTION	6900.00	9600.00	7772.00	47972.00	34572.00
14A.	STANDBY GENERATOR COST	5865.00	8160.00	6606.20	40776.20	29386.20
14C.	UPS COST	20700.00	28800.00	0.00	0.00	0.00
16.	TOTAL INIT EQUIP INCL LAMPS	74060.00	97440.00	56320.20	141410.20	116496.20
17.	RELATIVE INIT EQUIP INVESTMENT	1.31	1.73	1.00	2.51	2.07
II.	INITIAL LABOR ESTIMATES					
20.	NET LABOR, POLES + LUMINAIRES	26450.00	24400.00	18425.00	28475.00	28475.00
21.	LABOR ELECTRICAL DISTRIBUTION	5175.00	7200.00	5829.00	35979.00	25929.00
22.	TOTAL INITIAL LABOR	35075.00	36400.00	25031.20	69251.20	57861.20
23.	TOTAL INITIAL INVESTMENT	263535.00	288240.00	235751.40	210641.40	174347.40
24.	RELATIVE INITIAL INVESTMENT	1.98	2.16	1.77	1.58	1.31
V.	ANNUAL COSTS					
31.	TOTAL SYSTEM KW	35.	48.	39.	240.	173.
33.	TOTAL ENERGY KWH/YEAR	138000.	192000.	155440.	159460.	158120.
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37.	ANNUAL KWH COST	2760.00				
37A.	DIESEL FUEL COST	55.20	76.80	62.18	383.78	276.58
40.	REPLACEMENT LAMP COST	1214.40	1689.60	2572.80	2602.95	2600.94
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS					
44.	RELAMPING COST - LABOR	122.67	179.67	225.68	232.38	232.38
47.	CLEANING COST - LABOR	168.67	234.67	155.16	419.81	419.81
50.	PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	702.65	921.60	512.28	1343.08	1095.18
52.	TOTAL ANNUAL MAINTENANCE COST	993.99	1326.93	893.12	1995.27	1747.37
53.	ANNUAL OPERATING COST	5023.58	6933.33	6636.90	8171.20	7733.69
VI.	ANNUAL OWNERSHIP + OPERATING COST					
55.	FIXED OWNERSHIP COST	14958.28	18255.52	10828.83	28905.43	23767.87
56.	ANNUAL OWNERSHIP + OPRING COST	19981.86	25188.85	17465.73	37076.63	31501.56
VII.	RELATIVE COSTS OF LIGHT					
59.	RELATIVE COST EXCLUDING FIXED	1.35	1.86	1.78	2.19	2.07
60.	RELATIVE TOTAL COST	1.34	1.69	1.17	2.49	2.12

FIGURE 27
SHEET 4 OF 6

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

SINGLE FENCE

	PERIMETER LIGHTING SCHEME 21 HPS + 50% Q	PERIMETER LIGHTING SCHEME 22 LPS W/O UPS	PERIMETER LIGHTING SCHEME 23 LPS + 100% Q	PERIMETER LIGHTING SCHEME 24 LPS + 75% Q	PERIMETER LIGHTING SCHEME 25 LPS + 50% Q
I. INITIAL EQUIPMENT INVESTMENT					
1. QUANTITY OF LUMINAIRES	335	160	320	320	400
3. LUMINAIRE COST TOTAL	40602.00	43680.00	54080.00	54080.00	53760.00
4. QUANTITY OF POLES	67	80	80	80	80
9. POLE + FOUNDATION COST TOTAL	4490.00	5600.00	5600.00	5600.00	5600.00
14. ELECTRICAL DISTRIBUTION	27872.00	4480.00	52480.00	34440.00	29490.00
14A. STANDBY GENERATOR COST	23691.20	3808.00	44608.00	31008.00	24209.00
14C. UPS COST	0.00	0.00	0.00	0.00	0.00
16. TOTAL INIT EQUIP INCL LAMPS	104560.20	60449.00	162048.00	132249.00	119048.00
17. RELATIVE INIT EQUIP INVESTMENT	1.86	1.07	2.88	2.35	2.10
II. INITIAL LABOR ESTIMATES					
20. NET LABOR, POLES + LUMINAIRES	30485.00	17200.00	29200.00	29200.00	31600.00
21. LABOR ELECTRICAL DISTRIBUTION	20904.00	3360.00	39360.00	27360.00	21340.00
22. TOTAL INITIAL LABOR	54176.20	21008.00	73808.00	60208.00	55808.00
23. TOTAL INITIAL INVESTMENT	158736.40	158841.00	235856.00	192496.00	173856.00
24. RELATIVE INITIAL INVESTMENT	1.19	1.19	1.77	1.44	1
IV. ANNUAL COSTS					
31. TOTAL SYSTEM KW	139.	22.	262.	182.	142.
33. TOTAL ENERGY KWH/YEAR	157450.	89600.	94400.	92800.	92000.
36. DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37. ANNUAL KWH COST	3149.00				
37D. DIESEL FUEL COST	222.98	35.84	419.84	291.84	227.84
40. REPLACEMENT LAMP COST	2612.00	921.60	957.60	955.20	948.40
V. ANNUAL MAINTENANCE, LABOR + MATERIALS					
44. RELAMPING COST - LABOR	235.73	170.67	178.67	178.67	182.67
47. CLEANING COST - LABOR	552.13	234.67	550.67	550.67	708.67
50. PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51. REPLACEMENT PARTS, PAINT, ETC.	968.55	575.68	1567.68	1271.68	1120.48
52. TOTAL ANNUAL MAINTENANCE COST	1756.42	981.01	2297.01	2001.01	2011.81
53. ANNUAL OPERATING COST	7740.39	3730.45	5562.45	5104.05	5048.05
VI. ANNUAL OWNERSHIP + OPERATING COST					
55. FIXED OWNERSHIP COST	21446.46	11157.79	32741.79	26607.39	23835.55
56. ANNUAL OWNERSHIP + OPRING COST	29186.85	14888.25	38304.25	31711.45	28883.61
VII. RELATIVE COSTS OF LIGHT					
59. RELATIVE COST EXCLUDING FIXED	2.07	1.00	1.49	1.37	1.35
60. RELATIVE TOTAL COST	1.96	1.00	2.57	2.13	1.94

FIGURE 27
Sheet 5 of 6

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

DOUBLE FENCE

	PERIMETER LIGHTING SCHEME 26	PERIMETER LIGHTING SCHEME 27	PERIMETER LIGHTING SCHEME 28
I. INITIAL EQUIPMENT INVESTMENT	100% QUARTZ	100% HPS	100% LPS
1. QUANTITY OF LUMINAIRES	160	100	134
3. LUMINAIRE COST TOTAL	10400.00	25000.00	48240.00
4. QUANTITY OF POLES	160	100	134
9. POLE + FOUNDATION COST TOTAL	11200.00	7000.00	9380.00
14. ELECTRICAL DISTRIBUTION	48000.00	11500.00	8040.00
14A. STANDBY GENERATOR COST	40800.00	9775.00	6834.00
14C. UPS COST	0.00	34500.00	24120.00
16. TOTAL INIT EQUIP INCL LAMPS	112800.00	91675.00	101036.00
17. RELATIVE INIT EQUIP INVESTMENT	1.23	1.00	1.10
II. INITIAL LABOR ESTIMATES			
20. NET LABOR, POLES + LUMINAIRES	36800.00	23000.00	30820.00
21. LABOR ELECTRICAL DISTRIBUTION	36000.00	8625.00	6030.00
22. TOTAL INITIAL LABOR	77600.00	37375.00	40870.00
23. TOTAL INITIAL INVESTMENT	190400.00	129050.00	141906.00
24. RELATIVE INITIAL INVESTMENT	1.48	1.00	1.10
IV. ANNUAL COSTS			
31. TOTAL SYSTEM KW	240.	58.	40.
33. TOTAL ENERGY KWH/YEAR	960000.	230000.	160800.
36. DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37. ANNUAL KWH COST	19200.00		
37D. DIESEL FUEL COST	384.00	92.00	64.32
40. REPLACEMENT LAMP COST	7200.00	1440.00	1415.04
V. ANNUAL MAINTENANCE, LABOR + MATERIALS			
44. RELAMPING COST - LABOR	1600.00	123.06	142.93
47. CLEANING COST - LABOR	0.00	138.46	196.53
50. PAINTING COST - LABOR	0.00	0.00	0.00
51. REPLACEMENT PARTS, PAINT, ETC.	1104.00	877.75	966.14
52. TOTAL ANNUAL MAINTENANCE COST	2704.00	1139.29	1305.61
53. ANNUAL OPERATING COST	29488.00	7271.29	8000.97
VI. ANNUAL OWNERSHIP + OPERATING COST			
55. FIXED OWNERSHIP COST	26696.00	17771.30	19522.73
56. ANNUAL OWNERSHIP + OPRTING COST	56184.00	25042.59	25523.69
VII. RELATIVE COSTS OF LIGHT			
59. RELATIVE COST EXCLUDING FIXED	4.91	1.21	1.00
60. RELATIVE TOTAL COST	2.24	1.00	1.02

FIGURE 27
Sheet 6 of 6

7-5 Miscellaneous Considerations. The vertical footcandle based criteria used for the perimeter lighting in 1975 favored a low mounting height of approximately 4 ft. The cost savings of a 5-foot mounting height over the 15-foot mounting then called for was approximately $1.00 per linear foot. The interference with operations in adjacent areas and to pilots from glare due to the corresponding nigh (almost 90°) vertical aiming angle would have been significant however. All photometric and economic analysis is contingent on the time period used for the operational life of the lamps. The maintenance factor is in turn determined based on that period. For the security lighting application of this study group relamping was assumed when 20% of the total lamps would have been spot replaced. (Refer to Table III and Figure 8).

1975 PERIMETER LIGHTING
KEY TO PROGRAM FORMAT

I. INITIAL EQUIPMENT INVESTMENT

1. Quantity of luminaires	: Given
2. Luminaire cost each	: Given
3. Luminaire cost total	: 1 x 2 (Step 1 x Step 2)
4. Quantity of poles	: Given
5. Mounting Height	: Given
6. Pole and bracket cost each	: Given
7. Pole cost total	: 4 x 6
8. Foundation cost each	: Given
9. Pole and foundation cost total	: 4 x (6+8)
10. Quantity of lamps per luminaire	: Given
11. Quantity of lamps	: 1 x 10
12. Lamp cost each	: Given
13. Lamp cost total	: 11 x 12
14. Electrical distribution	: ($200)*x 31
14A. Cost of standby generator	: ($170)*x 31
14C. Cost of UPS (Uninterruptable Power Supply)	: ($750)*x 1 x30
15. Total Initial equipment less lamps	: 3+9+14+14A+14B+14C
16. Total initial equipment including lamps	: 15 + 13
17. Relative initial equipment investment	: 16/Lowest system value

II. INITIAL LABOR ESTIMATES

18. Pole erection and painting	: Given
19. Luminaire labor cost	: Given
20. Net labor, poles plus luminaires	: (4x18) + (1x19)
21. Electrical distribution, labor	: ($150)* x 31
21A. Labor cost, standby generator	: ($20)* x 31
21B. Labor cost, UPS	: ($100)* x 1 x 30
22. Total initial labor	: 20+21+21A+21B
23. Total initial investment equipment and labor	: 16 + 22
24. Relative initial investment	: 23/Lowest system value

Figure 28
Sheet 1 of 4

III. ILLUMINATION CALCULATIONS

25.	Spacing or area	: Given
26.	Utilization factor	: Calculated
27.	Maintenance factor (Percent lumen depreciation at time of group relamping x dirt factor.)	: Given
28.	Average maintained foot-candles per design criteria (Vertical for area lighting measured 3'-0" above ground level and approximately 2.0 FC Vertical average 3'-0" above ground level for boundary lighting.)	: Give = .5 FC or 2.0 FC
29.	Initial investment cost per lineal foot or acre (Either Step 23 or Step 25 x Step 4 will be entered into program depending on whether perimeter lighting (linear feet) or area lighting (acres) is being examined.)	: 23 : 25 x 4

IV. ANNUAL COSTS

	KW per liminaire	: Given
30.	KW per luminaire	: Given
30A.	KW for UPS power loss (25% x Step 30)	: Given
31.	Total system KW	: 1 x 30 + 30A
32.	Annual operation (4000 hrs for boundary lighting and 200 hours for area lighting. 4000 hours selected for boundary lighting compares favorably with the Air Force computer analysis (See Attach No. 16) of lighting required at 28 separate bases. The Air Force analysis averaged 4089 hours with full 2 FC horizontal illumination maintained under cloudy sky conditions. The 200 hours for area lighting is based on 5 percent of the hours of darkness and is estimated to be a maximum average figure and includes a weekly 30 minute test load on standby generators,	: Given

Figure 28
Sheet 2 of 4

daily operation and inspection tests, time for alerts, construction operations and loading and unloading operations.)

33. Total energy KWH per year	: 31 x 32
34. Energy cost per KWH ($0.02/per KWH is used for energy cost in this study. Present (Aug 75) average Air Force costs are $0.014 /KWH and expected to increase.)	: Given
35. Demand charge/KW/month	: Given
36. Demand charge per year	: 31 x 35 x (12 months)*
37. Annual KWH cost	: 33 x 34
37A. Diesel fuel cost/gal	: $0.40
37B. Fuel consumption rate Gal/KWH	: $0.08
37C. Diesel operating hrs/year (Estimate of weekly tests and emergency operation)	: 50
37D. Diesel fuel cost	: 31x37Ax37Bx37C
38. Group relamping period (From lamp curves where spot replacement approaches 20% or lumen depreciation drops 20% or more	: Given
38A. Rated lamp life, hours	: Given
38B. Portion lamps spot-replaced	: Given
39. Quantity replacement lamps	: 11 (1.0 + 38B) x 32/38
40. Replacement lamp cost	: 39 x 12

V. ANNUAL MAINTENANCE, LABOR & MATERIALS

41. Cost of labor $/manhour	: $10.00
42. Group relamping time naire (including cleani	: .3 manhour
42A. Spot relamping tim naire (including cleaning)	: .5 manhour
43. Group relamping/year/luminaire	: 32/38
43A. Spot relampings/year/luminaire	: 38B x 43
44. Relamping cost - labor	: 1x41x(42x43+42Ax43A)
45. Cleaning time/luminaire	: 0.2 manhour
46. Cleanings/year/luminaire (If negative, Step 46 = 0) (Assumes one annual cleaning. Where annual operating hours exceeds group lamp repalcement fixtures will only be cleaned at a time of group replacement.)	: 1.0 - 32/38

Figure 28
Sheet 3 of 4

47.	Cleaning cost - labor	: 1x41x45x46
48.	Painting time per pole	: Given
49.	Paintings/year/pole	: 0.2
50.	Painting cost - labor	: 4x41x48x49
51.	Replacement parts, paint, etc.	: 1% x 15
52.	Total annual maintenance	: 44+47+50+51
53.	Annual operating costs	: 36+37+37D+40+52
54.	Annual operating cost per Lineal Foot or acre	: 53/(25x4)

VI. ANNUAL OWNERSHIP & OPERATING COST

55. Fixed ownership cost : 14.2% x (15+22)

(Cost % = $\frac{i\ (1+i)n}{(i+i)n-1}$

i = interest at 7%

n = functional life at 10 years

Note: It is assumed lighting system will be obsolete in 10 years due to technical advances and/or change in mission. It is further assumed cost of salvage will equal salvage value.)

56. Annual Ownership and Operating Cost : 53+55

57. Annual Ownership and Operating Cost per linear foot or acre : 57/(25x4)

*All figures in the parenthesis identified by asterisks represent items which were calculated internally (in the computer program) and which would not appear in the actual printout.

Figure 28
Sheet 4 or 4

TYPICAL ECONOMIC ANALYSIS PRINTOUT
(Single Fence - Perimeter Lighting)

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 1
TEST 50 2X500W QUARTZ H100 V93
60 DEGREE AIMING
HORIZONTAL POSITION 60 135 DEGREES

		TOTAL FOR SYSTEM	2X500W QTZ Q500WMGE 60 FT SP 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	268	268
2.	LUMINAIRE COST EACH		42.00
3.	LUMINAIRE COST TOTAL	11256.00	11256.00
4.	QUANTITY OF POLES	134	134
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		9380.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	9380.00	9380.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		268
12.	LAMP COST EACH		13.00
13.	LAMP COST TOTAL	3484.00	3484.00
14.	ELECTRICAL DISTRIBUTION	26800.00	26800.00
14A.	STANDBY GENERATOR COST	22780.00	22780.00
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		70216.00
16.	TOTAL INIT EQUIP INCL LAMPS	73700.00	73700.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		60.00
20.	NET LABOR, POLES + LUMINAIRES	36850.00	36850.00
21.	LABOR ELECTRICAL DISTRIBUTION	20100.00	20100.00
21A.	LABOR STANDBY GENERATOR	2680.00	2680.00
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	59630.00	59630.00
23.	TOTAL INITIAL INVESTMENT	133330.00	133330.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		60.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.81
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~GE~~	16.58	16.58

FIGURE 29
SHEET 1 OF 2

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 1 — TEST 50 2X500W QUARTZ H100 V93; 60 DEGREE AIMING; HORIZONTAL POSITION 60 135 DEGREES

		TOTAL FOR SYSTEM	2X500W QTZ Q500WMGE 60 FT SP 15 FT MTG
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.50
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	134.	134.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	536000.	536000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	10720.00	10720.00
37D.	DIESEL FUEL COST	214.40	214.40
38.	GROUP RELAMPING PERIOD (HOURS)		1600.
38A.	RATED LAMP LIFE (HOURS)		2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		804.
40.	REPLACEMENT LAMP COST	10452.00	10452.00
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		2.50
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.5000
44.	RELAMPING COST - LABOR	2680.00	2680.00
46.	CLEANINGS/YEAR/LUMINAIRE		0.00
47.	CLEANING COST - LABOR	0.00	0.00
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	702.16	702.16
52.	TOTAL ANNUAL MAINTENANCE COST	3382.16	3382.16
53.	ANNUAL OPERATING COST	24768.56	24768.56
54.	ANNUAL OP'NG COST PER FT OR ~~ACRE~~	3.08	3.08
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	18438.13	18438.13
56.	ANNUAL OWNERSHIP + OP'NG COST	43206.69	43206.69
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	5.37	5.37

Non-applicable terminology has been crossed out in printout. The program was set up to print out either "per lineal foot" or "per acre" price dependent on whether input data (item III 25) is in feet (perimeter lighting) or square feet (area lighting)

FIGURE 29
SHEET 2 OF 2

E - Variable quantities or descriptive material to be entered by user for each run.

F - Fixed costs or quantities applicable to a specific project - to be entered on the initial run only.

▨ - Items or material which will be calculated or printed automatically by the computer

U.S. ARMY CORPS OF ENGINEERS • OMAHA DISTRI(

ECONOMIC COMPARISION

	TOTAL FOR SYSTEM	E
I. INITIAL EQUIPMENT INVESTMENT		
1. QUANTITY OF LUMINAIRES		E
2. LUMINAIRE COST EACH		
3. LUMINAIRE COST TOTAL		
4. QUANTITY OF POLES		E
5. MOUNTING HEIGHT		E
6. POLE + BRACKET COST EACH		
7. POLE COST TOTAL		
8. FOUNDATION COST EACH		E
9. POLE + FOUNDATION COST TOTAL		
10. QTY LAMPS PER LUMINAIRE		E
11. QUANTITY LAMPS		
12. LAMP COST EACH		E
13. LAMP COST TOTAL		
14. ELECTRICAL DISTRIBUTION		F
14A. STANDBY GENERATOR COST		F
14C. UPS COST		F
15. TOTAL INIT EQUIP LESS LAMPS		
16. TOTAL INIT EQUIP INCL LAMPS		
II. INITIAL LABOR ESTIMATES		
18. POLE ERECTION + PAINTING		E
19. LUMINAIRE LABOR		E
20. NET LABOR, POLES + LUMINAIRES		
21. LABOR ELECTRICAL DISTRIBUTION		F
21A. LABOR STANDBY GENERATOR		F
21B. LABOR UPS		F
22. TOTAL INITIAL LABOR		
23. TOTAL INITIAL INVESTMENT		
III. ILLUMINATION CALCULATIONS		
25. [SPACING] [OR AREA]		E
26. UTILIZATION FACTOR		E
27. MAINTENANCE FACTOR		E
28. DESIGN FOOTCANDLES		E
29. INIT COST PER [LINEAL FT] [OR ACRE]		

Cross out inapplicable term

COMPUTER PRINTOUT FORMAT

ECONOMIC ANALYSIS

FIGURE 30
Sheet 1 of

ECONOMIC COMPARISION

		TOTAL FOR SYSTEM		
IV.	**ANNUAL COSTS**			
30.	KW PER LUMINAIRE		E	
30A.	KW UPS POWER LOSS		E	
31.	TOTAL SYSTEM KW			
32.	ANNUAL OPERATION (HOURS)		E	
33.	TOTAL ENERGY KWH/YEAR			
34.	ENERGY COST PER KWH		E	
35.	DEMAND CHARGE/KW/MONTH		E	
36.	DEMAND CHARGE PER YEAR			
37.	ANNUAL KWH COST			
37A.	DIESEL FUEL COST/GAL			F
37B.	FUEL CONSUMPTION RATE (GAL/KWH)			F
37C.	DIESEL OPERATING HOURS/YEAR			F
37D.	DIESEL FUEL COST			
38.	GROUP RELAMPING PERIOD (HOURS)		E	
38A.	RATED LAMP LIFE (HOURS)		E	
38B.	PORTION OF LAMPS SPOT REPLACED		E	
39.	QUANTITY OF REPLACEMENT LAMPS			
40.	REPLACEMENT LAMP COST			
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**			
41.	COST OF LABOR ($/MANHOUR)			F
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE			
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE			
44.	RELAMPING COST - LABOR			
46.	CLEANINGS/YEAR/LUMINAIRE			
47.	CLEANING COST - LABOR			
48.	PAINTING TIME PER POLE		E	
50.	PAINTING COST - LABOR			
51.	REPLACEMENT PARTS, PAINT, ETC.			
52.	TOTAL ANNUAL MAINTENANCE COST			
53.	ANNUAL OPERATING COST			
54.	ANNUAL OPING COST PER FT OR ACRE			
VI.	**ANNUAL OWNERSHIP + OPERATING COST**			
55.	INTEREST RATE			F
56.	FUNCTIONAL LIFE			F
57.	FIXED OWNERSHIP COST			
58.	ANNUAL OWNERSHIP + OPING COST			
59.	TOTAL PER [LINEAL FOOT] [OR ACRE]			

Cross out inapplicable item

COMPUTER PRINTOUT FORMAT
ECONOMIC ANALYSIS

FIGURE 30
Sheet 2 of 2

INPUT SHEET ECONOMIC ANALYSIS

00100 SYS
00110 SYS
00120 SYS
00130 SYS
00140 COMP
00150 COMP
00160 COMP
00170 COMP
00180 NUMG-NUMBER OF GROUPS OF COMPONENTS
00190 I1-QUANTITY OF LUMINAIRES
00200 F2-LUMINAIRE COST EACH
00210 I4-QUANTITY OF POLES
00220 F5-MOUNTING HEIGHT
00230 F6-POLE + BRACKET COST
00240 F8-FOUNDATION COST
00250 I10-QUANTITY OF LAMPS PER LUMINAIRE
00260 F12-LAMP COST EACH
00270 F30-KW PER LUMINAIRE
00280 F30A-UPS POWER LOSS (OF LOAD KW)
00290 F18-POLE ERECTION + PAINTING
00300 F19-LUMINAIRE LABOR COST
00310 F25-SPACING OR AREA
00320 F26-UTILIZATION FACTOR
00330 F27-MAINTENANCE FACTOR
00340 F28-AVERAGE MAINTAINED FC
00350 F32-ANNUAL OPERATION *
00360 F34-ENERGY COST PER KWH
00370 F35-DEMAND CHARGE/KW/MONTH
00380 F38-GROUP RELAMPING PERIOD (HOURS)
00390 F38A-LAMP LIFE (HOURS)
00400 F38B-PORTION OF LAMPS SPOT REPLACED
00410 F48-PAINTING TIME PER POLE

83

FIGURE 31

8. RESULTS OF PERIMETER LIGHTING ANALYSIS. The perimeter lighting schemes outlined in Section 4-2.2 and 7-3 can be grouped in various ways and different aspects compared. Figure 32 represents a relative comparison of quartz, high pressure sodium and low pressure sodium systems on a per year basis. Figure 33 lists actual costs of each scheme on a 10 year basis. The figures it includes for the spill light configurations mentioned in paragraph 4-2.2 correspond to the HPS or LPS with UPS categories of Figure 32. Although this analysis was conducted using floodlights, the comparison would be valid, on a relative basis, to roadway configurations also.

8-1 Summary. The schemes analyzed can be grouped into four basic categories in summarizing results: quartz versus sodium vapor (high or low pressure) with UPS, with quartz backup, or without either UPS or quartz backup.

8-1.1. All Quartz System. This system has the largest annual ownership cost and consumes the most energy. Reliability of system is good. Outages would be limited to the time it takes for a standby generator to start up, approximately 25 seconds.

8-1.2. Sodium Vapor with UPS. This system has relatively low ownership and operating costs and power consumption. Reliability is good with no outages while the system is in operation. From a security standpoint this is the best system.

8-1.3. Sodium Vapor Without UPS or Quartz Backup. This system has the lowest annual operating and ownership costs and the lowest power consumption. Reliability is fair. With loss of commercial power, the H.P. sodium lamp will be out during standby generator start-up and will take up to 2 minutes for restrike. L.P. sodium will be back to full illumination in approximately 2 minutes. Area lighting could be turned on during restrike period to partially illuminate the boundary area by spill light. This system does not meet criteria time limit on outage. This arrangement is objectionable from a security standpoint since security personnel inside the secure area would not be in relative darkness compared to an intruder.

8-1.4. Sodium Vapor with Quartz Backup. This system has relatively high ownership and operating costs and low energy consumption. Reliability is good with outage only while standby power is starting, approximately 25 seconds.

8-2 Conclusions.

8-2.1. The 100% quartz system is the least desirable due to costs and energy use.

8-2.2. Sodium vapor with quartz backup costs more than the more reliable sodium with UPS system.

8-2.3. Sodium vapor without UPS, although the most attractive from a cost and energy use standpoint, does not however meet criteria relative to outage time. Temporary use of area lighting to furnish spill light would be objectionable from a security standpoint.

8-2.4. Sodium vapor with UPS meets the criteria without power outage, has relatively low cost and power consumption. This system has lowest cost if the system of paragraph 8-2.3. above can not be used.

8-2.5. The low pressure sodium light source for one fence and two fence configurations appears to be the best selection particularly in the light of rising energy costs. However a L.P. sodium system has the following disadvantages that are difficult to effectively evaluate:

a. A monochromatic light output that obliterates color rendition. The yellow light requires "some getting used to".

b. Although there are now a number of manufacturers of L.P. luminaires, (roadway, floodlights, etc.) in this country (see Attachment 7), major companies such as General Electric remain opposed to it.

c. The light source is large and precise beam control is more difficult to achieve compared to HPS and most other sources.

d. There is no known U.S. manufacturer of lamps. Lamps must be supplied from foreign sources. This has impact on "gold flow" and could affect availability under hot or cold war conditions.

e. Complete test data by independent testing laboratories was not available. The system is relatively new to the U.S. and sufficient field data is not available to substantiate all claims made by manufacturers' representatives.

8-3 Action Taken. The 1975 draft version of the lighting study recommended use of either high or low pressure sodium with UPS backup. The high pressure sodium version received subsequent Air Force approval. The low pressure sodium configuration, although somewhat lower in cost, was rejected because of possible lamp replacement problems due to the overseas source. The scheme consisting of high pressure sodium without UPS backup but using spill light from adjacent area lighting was determined to be unsatisfactory since there would be no light during generator start-up and then only partial illumination until the HPS source could build up to full lumen output. It was determined that the interior area should remain in darkness for security reasons.

COMPARISON OF PERIMETER LIGHTING-ONE YEAR BASIS

Scheme	Description	Relative Cost (order)	KW-HR Per Year	Energy Saving Per Year KW-HR	Annual Cost Ownership & Operating	Cost Savings Per Year One Site	Cost Savings Per Year 50 Sites
1	100% Quartz	2.90 (11)	536,000	0	42,207.00	00,000.00	000,000.00
8	HPS + UPS	1.61 (4)	194,000	342,000	24,021.00	19,186.00	959,300.00
10	LPS + UPS	1.25 (3)	112,000	424,000	18,667.00	24,540.00	1,227,000.00
18	HPS w/o UPS	1.17 (2)	155,000	381,000	17,466.00	25,741.00	1,287,050.00
22	LPS w/o UPS	1.00 (1)	90,000	476,000	14,888.00	28,319.00	1,415,950.00
19	HPS + 100% Q	2.49 (9)	159,000	377,000	37,077.00	6,130.00	306,500.00
20	HPS + 75% Q	2.12 (7)	158,000	378,000	31,502.00	11,705.00	585,250.00
21	HPS + 50% Q	1.96 (6)	157,000	379,000	29,187.00	14,020.00	701,000.00
23	LPS + 100% Q	2.57 (10)	64,000	412,000	38,304.00	4,903.00	245,150.00
24	LPS + 75% Q	2.13 (8)	93,000	443,000	31,711.00	11,496.00	574,800.00
25	LPS + 50% Q	1.94 (5)	92,000	444,000	28,884.00	14,323.00	716,150.00

FIGURE 32

COMPARISON OF PERIMETER LIGHTING - 10 YEAR BASIS

	A	B	C	D	E	F
CONFIGURATION	100% Q	HPS+UPS	HPS + 100% Q	HPS + 75% Q	HPS + 50% Q	HPS + AREA SPILL
OWNERSHIP COST PER SITE (AVE. 8,000 LF)	184,400	162,600	289,000	237,700	214,500	108,300
ELECTRICAL ENERGY COST - 10 YRS	107,200	38,900	31,900	31,600	31,500	31,100
RELAMPING COST - 10 YRS	131,300	28,000	28,400	28,300	28,500	28,000
MAINTENANCE COST - 10 YRS	9,200	10,700	21,500	17,400	17,400	7,300
TOTAL LIFE COST PER SITE	432,100	240,200	370,800	315,000	291,900	174,700
TOTAL 50 SITES FOR SAC ALERT AREAS & WEAPONS STORAGE AREAS - 10 YRS (400,000LF)	21.6 MIL	12.0 MIL	18.5 MIL	15.8 MIL	14.6 MIL	8.7 MIL
TOTAL SAVINGS - 10 YRS		9.6 MIL	3.1 MIL	5.8 MIL	7.0 MIL	12.9 MIL
(Relative Standing)	(11)	(4)	(9)	(7)	(6)	(2)

FIGURE 33
SHEET 1 of 2

COMPARISON OF PERIMETER LIGHTING - 10 YEAR BASIS

	G	H	I	J	K
CONFIGURATION	LPS+UPS	LPS + 100% Q	LPS + 75% Q	LPS + 50% Q	LPS + AREA SPILL
OWNERSHIP COST PER SITE (AVE. 8,000 LF)	142,900	324,400	266,100	238,400	111,600
ELECTRICAL ENERGY COST - 10 YRS	22,400	18,900	18,600	18,400	17,900
RELAMPING COST - 10 YRS	10,900	11,400	11,300	11,500	10,900
MAINTENANCE COST - 10 YRS	10,400	25,400	21,100	20,600	8,500
TOTAL LIFE COST PER SITE	186,600	383,100	317,100	288,900	148,900
TOTAL 50 SITES FOR SAC ALERT AREAS & WEAPONS STORAGE AREAS - 10 YRS (400,000 LF)	9.3 MIL	19.1 MIL	15.8 MIL	14.4 MIL	7.4 MIL
TOTAL SAVINGS - 10 YRS	12.3 MIL	2.5 MIL	5.8 MIL	7.2 MIL	14.2 MIL
(RELATIVE STANDING)	(3)	(10)	(7)	(5)	(1)

FIGURE 33
SHEET 2 of 2

9. DESIGN CONSIDERATIONS - FORMAT/OPTIMIZATION.

9-1 Area Lighting - Optimization.

9-1.1. Mounting Height. When illumination criteria is based on vertical footcandle (FC) measurement, and there are no constraints relative to vertical aiming of the luminaire or uniformity of illumination, the most efficient arrangement is to place the luminaire at the same height as the object, line, plane, etc that is to be illuminated per criteria. If there are constraints on vertical aiming (see below), raising the mounting height will increase the light projection in front of the pole line (i.e. a greater span can be illuminated to criteria levels). For most situations, 40 foot is a practical limit to luminaire placement. Above this height there is a pronounced escalation in cost of poles and maintenance ("cherry pickers" can't be used). Mounting heights over 40 feet are justified for applications such as center sector lighting where poles must be located outside the area that is to be lighted. The greater the distance that poles must be set back, the higher the mounting height should be. The alternative is increased energy cost due to a greater number of luminaires or higher installation cost for more poles. Ten year costs favor higher poles. The lighting uniformity ratio will also be improved by raising the mounting height (or by increasing the pole setback in the case of center sector lighting).

9-1.2. Vertical Aiming. As the discussion above indicates, the most efficient configuration for a vertical FC format is to mount floodlights at the same level as the object(s) to be illuminated while aiming the beam of the floodlight directly at the object. This is equivalent to aiming at the horizon and corresponds to 90° vertical in the aiming format (see Figure 23) used in the computer analysis. This aiming angle however will also project the maximum amount of glare and may interfere with the performance of pilots and Security Police personnel. The IES Lighting Handbook recommends a maximum vertical aiming angle of 60°. This will eliminate most of the glare objectionable to the observer while still allowing a reasonable extent of area to be illuminated.

9-1.3. Beam Pattern. Wide beam patterns, in both horizontal and vertical orientations, are most suitable for area lighting. Most commercially available wide beam 1500 W floodlights have NEMA 6x5 (see Figure 16) beams.

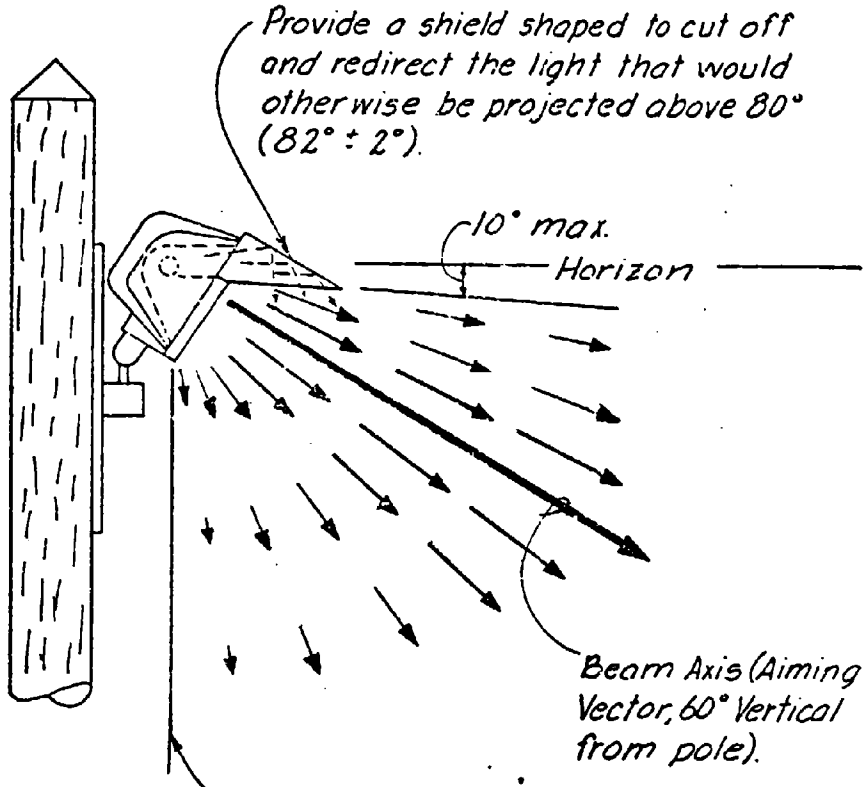
9-1.3.1. The vertical beam spread could range from 70° to 99° in width, although most 1500 W units available tend toward the higher figure (500 W units have narrower beams in most cases). Complete coverage is provided essentially from the pole to the horizon. Since a large portion of the light energy is above the beam axis, relatively wide pole spacing is possible

(see Fig. 34). A narrow vertical beam unit would concentrate the light, creating an intense "hot spot" at the 60° zone. Beam control on narrow beam units is achieved by means of highly polished (specular) reflectors which appear more intense to the observer and will thus generate more glare complaints. The wide beam reflector, however, has a diffuse surface making this floodlight inherently a lower glare unit (Note illustrations in Figure 16). Narrow vertical beam units, since they concentrate their light energy around the beam axis, are most suitable where narrow areas have to be lighted and vertical aiming can be over 75°. Taxiway gap lighting is an example of such an application. See Par. 9-6.

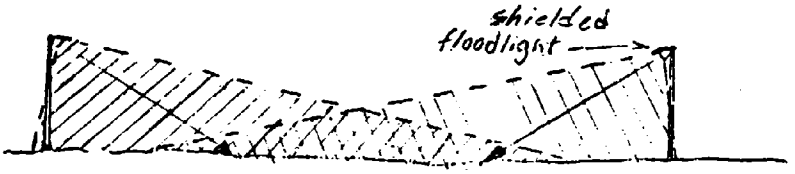
9-1.3.2. The horizontal beam spreads on most commercial units exceeds 120°. This rather wide spread permits 4 evenly spaced units to provide complete illumination around a pole with a relatively high degree of uniformity. If a spread of 90° or less is used there will be dark bands between adjacent luminaires. For this application, a minimum beam spread of 115° has been stipulated on definitive drawings. There are floodlights available in high pressure sodium versions with beam spans exceeding 140°. When used in high mast applications such as for interstate interchanges, the result has been an exceptionally uniform illumination without discernible weak spots.

9-1.4. Horizontal Aiming. A series of computerized tests were performed to determine which of various aiming formats provided the optimum results. When using wide beam units, it is most efficient to orientate 8, or 4, floodlights at 0°, 90°, 180°, and 270° around a pole (0° is referenced from the "X" axis which is aligned with the pole line). An arrangement using 8 evenly spaced (45° apart) is less efficient. A configuration having a pair of luminaires aimed 45°, 135°, 225° and 315°, horizontally will be the least efficient. To achieve optimum performance in area lighting an attempt should be made to create an essentially square light pattern around each pole. The corners of the "square" lie the greatest distance from the pole and will thus be the most difficult to illuminate. Selection of the "X" and "Y" axis for horizontal orientations of the floodlights enables contributions to be made from at least 2 units (4 & 8 luminaires per pole). It turns out that the candlepower intensity directed at the corner is stronger than that which could be obtained from a single floodlight aimed directly at the corner. Another factor which also tends to work against the second approach somewhat is that due to floodlight geometry the -7.8° plane intersects the corner vs the prime (or 0°) plane in the first approach. (See Figure 35). As indicated in par. 1-3.2. above, these advantages could not be obtained with narrow horizontal beam units. Six or eight aiming directions (and additional luminaires) would have to be employed vs the four directions used here. The above rules are applicable when light is to be projected in all directions from a pole. When light is to be projected in one direction away from a pole line, as in the case for center sector lighting, different formats must be used. (See Discussion below in par. 9-2.3. and single row application curves, Figure 40).

VERTICAL BEAM SPREAD CHARACTERISTICS



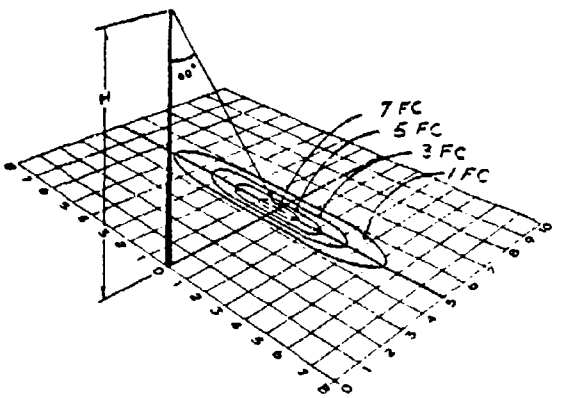
SHIELDING DETAIL



TYPICAL AREA LIGHTING CROSS SECTION

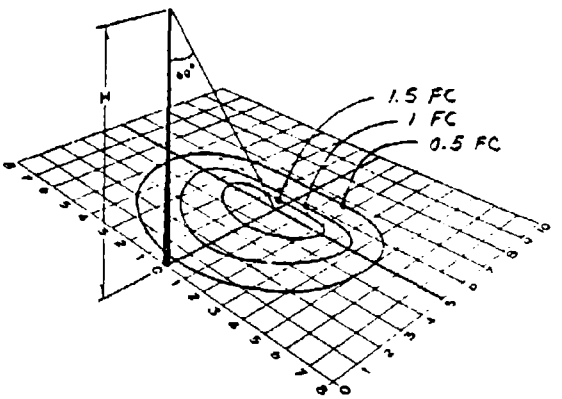
FIGURE 34
Sheet 1 of 2

1. NARROW
(30° H x 11° V)



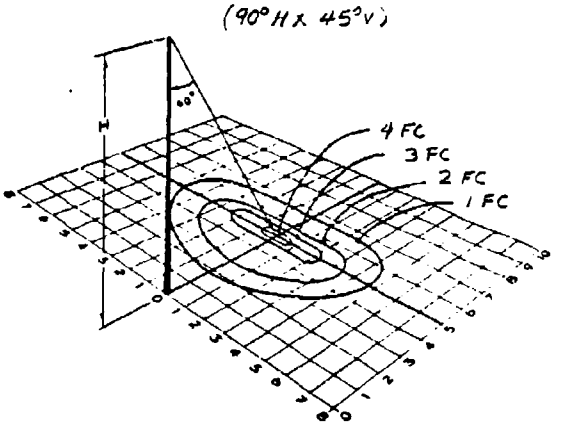
Max. illumination: 7 footcandles
Min. illumination: 1 footcandle
Ratio: 7:1

4. EXTRA-WIDE
(99° H x 53° V)

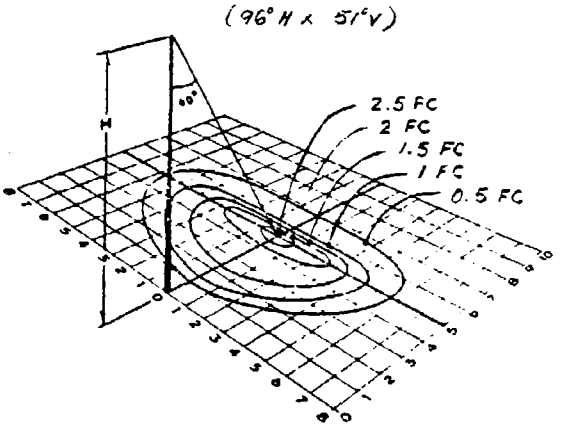


Max. illumination: 1.5 footcandles
Min. illumination: 0.5 footcandle
Ratio: 3:1

2. MEDIUM
(90° H x 45° V)



3. WIDE
(96° H x 51° V)

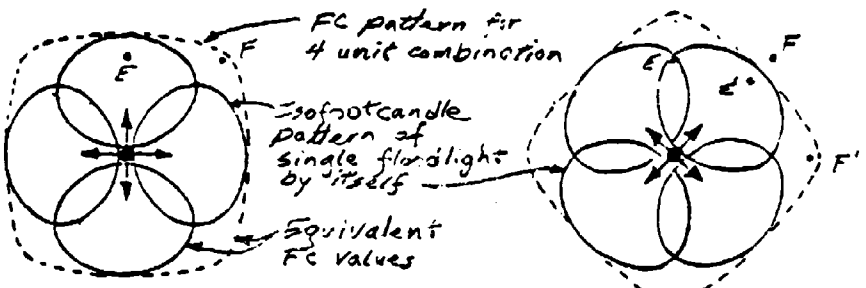


NOTE: The above isofootcandle curves are applicable to 500 w quartz floodlights mfrd by Sylvania Electric Products Co. (1850 series, catalog literature dated July 15, 1963). Mounting height is 30 ft.

Isofootcandle Curves - Wide vs. Narrow Beam Spread

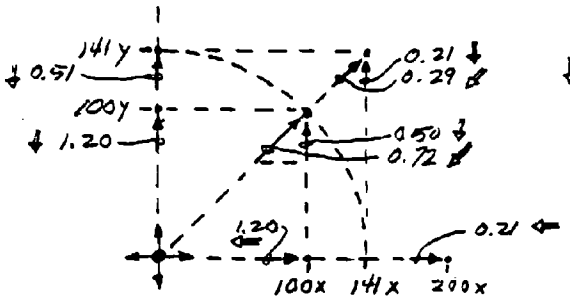
VERTICAL BEAM SPREAD CHARACTERISTICS.

FIGURE 34
Sheet 2 of 2



Footcandle Patterns

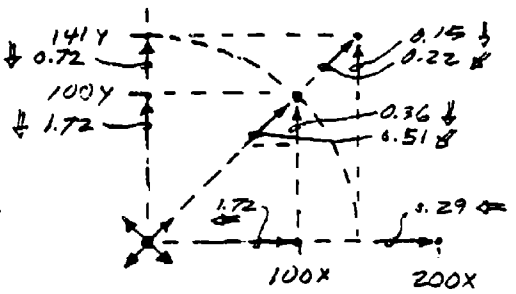
Footcandle Patterns



FC's at Specific Points

HORIZ. AIMING ALIGNED ON "X" and "Y" AXES

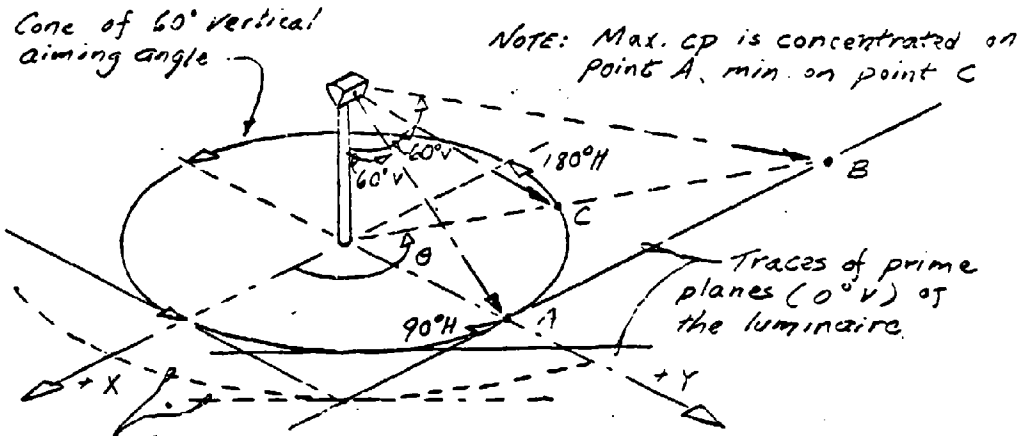
Computer Run: TE06



FC's at Specific Points

HORIZ. AIMING ALIGNED 45° from "X" - "Y" AXES

Computer Run: TE07



PHOTOMETRIC GEOMETRY OF FLOODLIGHT

FIGURE 35

9-1.5. Quantity of Luminaires Per Pole. From a purely photometric standpoint, increasing the number of poles (decreasing spacing between poles) will decrease the number of luminaires required for a given application. There would be savings in total wattage and thus energy costs. However those savings would be offset by higher installation costs besides the objectionable features of a "forest of poles". For this series of projects, the 8 luminaire per pole format was found to be most suitable for large square areas and most rectangular areas (i.e. multirow format). For long, somewhat narrow areas, the most efficient format, 4, 6, or 8 luminaires per pole, would depend on the dimensions of the particular area. Floodlights, for the purposes of this project, are availabe in one size commercially, 1500W. It is not feasible to adjust individual lamp wattages proportional to the dimensions of areas to be lighted. The 4 and 6 luminaire configurations, in some cases, may therefore be more efficient than 8 luminaires per pole. Where illumination is to be projected in one direction only and the pole must be set back from the area such as for center sector lighting, more than 8 luminaires may be required per pole. (See par 9-2.3.).

9-1.6. Shielding. Use of floodlights with wide vertical beam spreads will mean that in most cases there will be a small amount of spill light above the horizon. This stray light could interfere with pilots vision or could be a nuisance factor if residential areas are immediately adjacent. Glare shields such as detailed in Figure 34 will cut off light above 80° and redirect it downward.

9-1.7. Spacing vs Mounting Height. When designing area lighting around criteria given in terms of horizontal footcandles pole spacing should not, as a rule, be more than 4 times the luminaire mounting height. As this ratio is exceeded the number of luminaires required to maintain mimimum illumination will increase rapidly and uniformity of illumination (on horizontal FC basis) will become proportionately worse. When considered from a vertical FC basis, it is desirable to keep mounting height low relative to spacing. Uniformity, on a vertical FC basis, will be relatively good if the area immediately under the pole is discounted. Since the eye sees a combination of vertical and horizontal FC's, it is desirable to avoid extreme ratios with vertical FC formats also. A 10:1 ratio was the maximum obtained with the area lighting configuration used in this series of projects; 6:1 or 7:1 the more typical value.

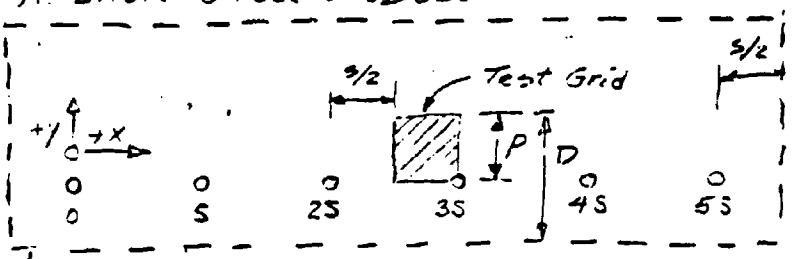
9-2 Area Lighting - Site Format.

9-2.1. General. All area lighting formats were developed using a 1500W quartz iodine floodlight with a NEMA 6x5 beam spread. If other beam spreads were substituted the formats described in this section would not, in most cases, remain valid without some modifications. The performance of the quartz lamp is extremely sensitive to fluctuations in line voltage. A lamp operating 5% below its design voltage will deliver only 85% of its rated lumen output. A configuration that would

yield 0.47 footcandles minimum under rated conditions would deliver 0.4 FC if there were 5% voltage drop in the supply line. The formats shown on the definitive drawings will provide the minimum illumination required by criteria while allowing a 5% maximum voltage drop in the circuits supplying the luminaires. Vertical aiming is 60° for all formats. The definitive site layouts and application curves assume use of a lamp having a 34400 lumen rating. Use of a lamp having a different rating would require that the curves be adjusted (per inverse square law of distance).

9-2.2. Single Row Configurations. Three distinct single row configurations have been detailed on sheets C8-C10A of the definitives for the convenience of the designer. See Figure 36 for a description of each type. The relatively wide spacing of the eight luminaire per pole configuration will illuminate a span 450 ft wide. The median 250 ft spacing of the six luminaire configuration will lighten a 420 ft. span, the narrow 200 ft. spacing of the four floodlight configuration will cover a 350 ft span. Mounting height is 40 ft in each case. A 6-pole module served as the basic format for computer analysis. It can be employed, in building block style, to form a row of any specific length necessary. The 50% spacing shown at each end of the module applies only if there will be another pole opposite to contribute half of the total illumination on the midpoint (S/2 from pole). At the ends of rows (or sectors if there is not another sector adjacent), therefore, supplemental luminaires must be installed to maintain the light level at criteria values. Figure 36 delineates the compensation required for sectors having 2,4, or 6 poles. If an adjacent sector could supply an "end" pole at the same spacing increment, the supplemental units could be omitted. Application curves (see Figures 39 and 40) have been prepared to assist in the selection of a lighting scheme for areas in which the above approaches might not be most efficient. Curves "B1, D1, B2," and D2" would be particularly well suited for applications where perimeter lighting and area lighting share common poles. Since illumination would be in one direction only, the lower set (180°-360°) of luminaires could be omitted - i.e. for Curve D1, delete units at 225° and 315°, retain those at 45° and 135°. All curves include an allowance for voltage drop not to exceed 5%.

A. BASIC 6 POLE MODULE



This basic module can be used to build up a row of any length desired. Supplemental floodlights must be installed on the end pole such as the compensated format shown below for individual sectors.

LEGEND

S = pole spacing (x direction)

S/2 = end zone (first width of FC test grid

P = projection (in "y" direction) of criteria illumination

D = 2P

MH = mounting ht ≥ 40 ft

HA = Horiz. Aiming

O = Pole w/ normal floodlight pattern

O = Pole with supplemental floodlight

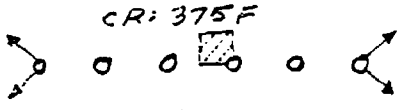
B NARROW SPACING

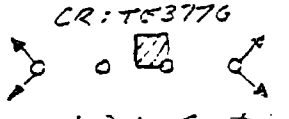
4 x 1500 W quarts

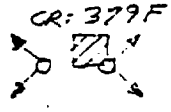
MH 41, S200, P175, D350

HA = 0, 90, 180, 270°

Basic CR: TE374C







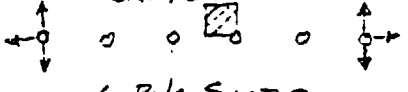
C. MEDIUM SPACING

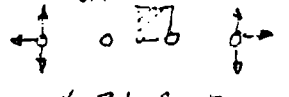
6 x 1500 W quarts

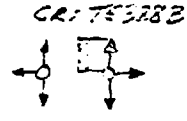
MH 43, S250, P210, D420

HA = 45, 90, 135, 225, 270, 315°

Basic Computer Run: TE383







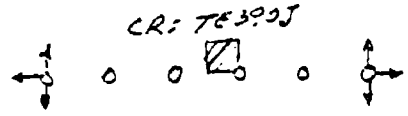
D. WIDE SPACING

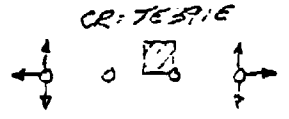
8 x 1500 W quarts

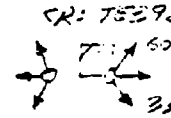
MH 49, S300, P225, D450

HA = 10, 80, 100, 170, 190, 260, 280, 350°

Basic Computer Run: TE390D







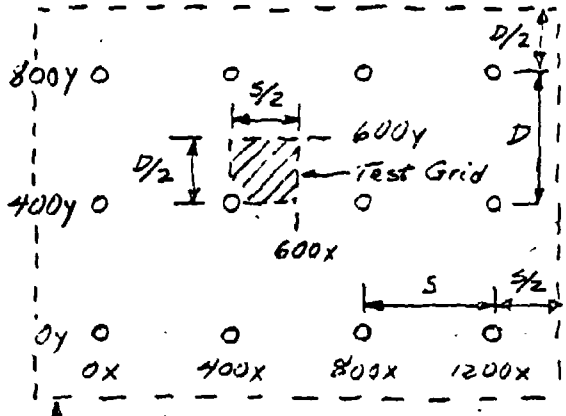
AREA LIGHTING - SINGLE ROW CONFIGURATIONS

Applic. Definitives: AD 71-03-02, SA C1-00A 97

FIGURE 36

9-2.3. Multirow Configurations. The eight luminaire format is the most suitable horizontal aiming arrangement for larger areas and was therefore used almost exclusively in computer analysis. A square spacing format (S=D) is most efficient economically for the wide beam, large area application. A 12 pole module was used in analysis of lighting configurations. Figure 37 contains the specifics of the various schemes used on Definitive Series AD 71-03-02, sheets C1-C3A. The maximum allowable pole spacing ranges from 340 ft for a 4 pole sector to 400 ft. for a 12-pole sector. Illumination at the corners of any sector standing alone will drop below criteria minimums and will require the addition of supplemental luminaires as indicated. This will not be necessary if there is an adjacent sector with a pole, positioned at the same spacing increment, that could contribute the required illumination. A standard spacing of 400 ft for sectors of 4-pole through 9-pole size can be maintained if a greater quantity of luminaires are installed per section "C" of Figure 37 to augment weak areas in the interior of the sectors. Mounting height is 40 ft in all cases. The application curves of Figure 41 can be used, at the designer's option, to select alternate spacing schemes than those depicted on the definitive drawings. These curves will maintain criteria illumination when the lamp is operated at 95% of rated voltage.

A. BASIC 12 POLE MODULE

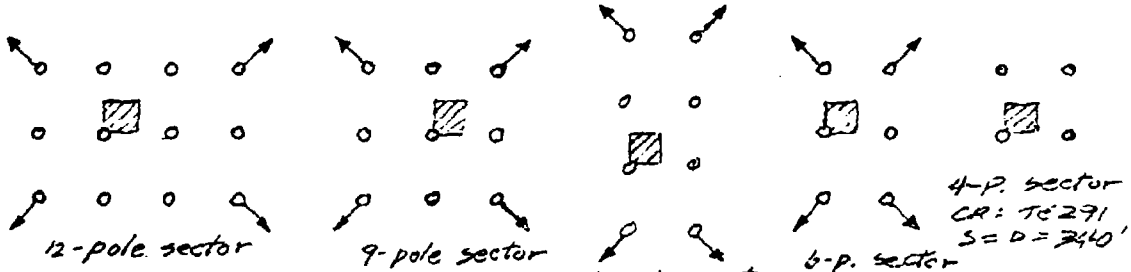


8 x 1500w Quartz Iodine
MH40, VA60
HA = 15, 75, 105, 165°
195, 255, 285, 345°

MH = mounting height = 40ft
S = pole spacing
D = distance between rows
HA = horizontal aiming
○ = pole with standard number of floodlights
○↖ = pole with additional supplemental floodlight.
CR = computer run

Modular area used in computer analysis. Compensated formats must be used for individual sectors. See below. Supplemental units may be omitted at any corners where there is an equivalent sector adjacent (see par. 9-2.3).

B INDIVIDUAL SECTORS - VARIABLE SPACINGS



12-pole sector
CR: 302B
S=D=400'

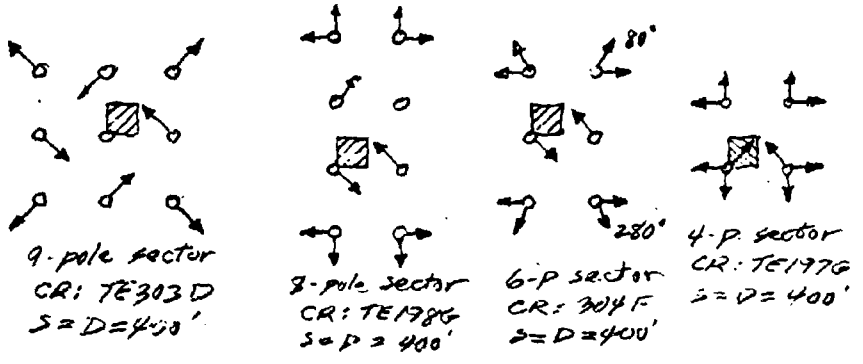
9-pole sector
CR: TE294A
S=D=380'

8-pole sector
CR: TE293A
S=D=360'

6-p. sector
CR: 292A
S=D=360'

4-p. sector
CR: TE291
S=D=340'

C. INDIVIDUAL SECTORS - ADJUSTED 400' SPACINGS

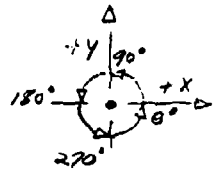


9-pole sector
CR: TE303D
S=D=400'

8-pole sector
CR: TE198G
S=D=400'

6-P sector
CR: 304F
S=D=400'

4-P sector
CR: TE197G
S=D=400'



COORDINATE SYSTEM REFERENCE

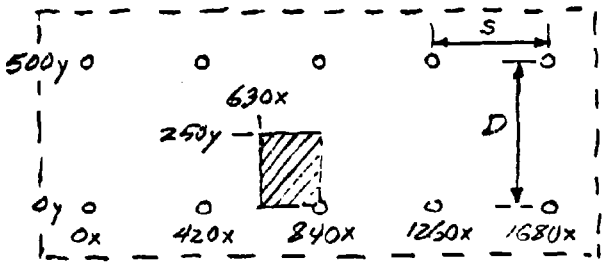
AREA LIGHTING - MULTIROW CONFIGURATIONS

Applicable Definitive: Series AD 71-03-02
Sheets C1-C3A

FIGURE 37

A. DOUBLE ROW – MEDIUM SPAN

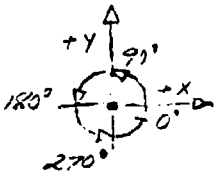
6 x 1500W quartz iodine
MH60, S420, VA60
D500, PS0, D'500
HA = 45x2, 80, 100, 135°x2.
225x2, 260, 280, 315°x2



Computer Run: TE355
No supplementation reqd at ends

LEGEND

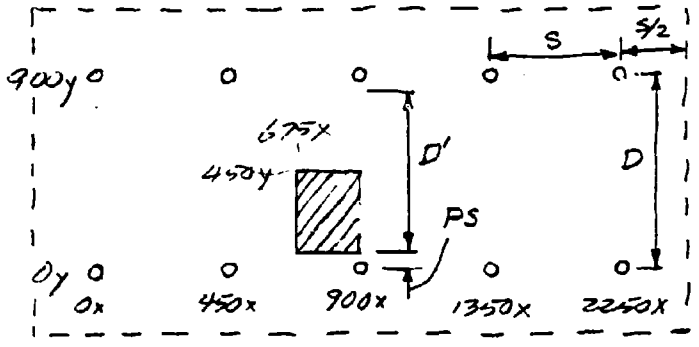
VA = Vertical aiming
HA = horizontal aiming
MH = mounting height
P = pole spacing
D = distance between rows
PS = distance pole line must be setback from edge of sector
D' = maximum allowable sector width
o = pole with standard floodlight formats
⊙ = pole with additional supplemental floodlights
CR = computer run



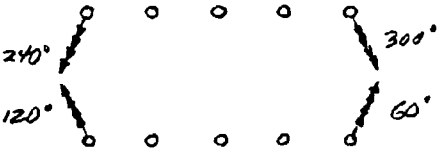
COORDINATE SYSTEM REFERENCE

B. DOUBLE ROW – WIDE SPAN

9 x 1500W quartz iodine
MH100, S450, VA60
D900, PS65, D'770
HA = 45, 90, (80, 100)x3, 135°
225, 270, (260, 280)x3, 315°



Computer Run: TE258



10 Pole Sector

CR: TE266

AREA LIGHTING - DOUBLE ROW CONFIGURATIONS
(CENTER SECTOR)

Applicable Definitives: AD 71-03-02, sh. C4-C7 100 FIGURE 58

9-2.4. Double Row Configurations. The double row area lighting configurations delineated on sheets C4-C7 of Definitive Series AD71-03-02 are intended to be applied to the center sector lighting of SAC "Christmas Tree" alert areas and to mass ramp alert areas. The medium span version (see Figure 38) is applicable to Christmas Tree ramps. Due to the ramp configuration poles have to spaced 420 ft apart laterally. When 6 luminaires are mounted at 60 ft. up, a 500 ft. wide span can be illuminated. No pole setback is necessary; the secror limit can he extended to the pole line. The wide span format applicable to the mass ramp has 9 floodlights mounted 100 ft up on structures spaced 450 ft apart laterally. The two rows are placed 900 ft. apart and require a 65 ft. pole setback (or 770 ft. maximum sector width) Supplemental units are required on the end poles of sectors having a large D:S ratio. Where this ratio is less than 1.2 to 1, as the Christmas tree application, supplemental floodlights can be omitted. The application curves of Figure 42 should provide a sufficient range of formats such that any alert configuration likely to be encountered should be covered. Eight horizontal aiming formats are available. The most efficient aiming angles in terms of the projection that can be achieved is 80° and 100° (260 and 280° for opposite row). If all units are grouped at these two angles however, there will be extensive criteria violations ("dark spots") near the pole lines, at the midpoint between poles. To keep these within acceptable limits at least one set of floodlights must be aimed at 45° and 135°. The number of pairs at these angles determines the extent to which the sector edges must be placed in front of the pole lines (pole setback). A family of curves has been prepared for 40,60, 80 and 100 ft. mounting heights. For a given spacing, the upper portion of a curve identifies corresponding maximum projection that the particular format will allow. The distance between the two rows can not exceed 2 x projection "P". The lower portion of the curve (A', B1', C1', etc) determines the pole setback required. The area enclosed by a set of curves exceeds criteria; a point lying outside fails to meet criteria, the extent of the violation being proportional to the distance from the curve(s). The above schemes all utilize the 1500 W quartz iodine lamp and permit 5% voltage drop to the lamp. A brief examination was made using a 20,000 watt long arc xenon source. It had equal or superior characteristics from a photometric basis, particularly color. Its high initial and replacement lamp cost however negated its photometric advantages to the extent that there was no real economic gain from its use. Applicable computer runs were "TEST335" and "TEST336."

9-2.5. Supplementation - Individual Luminaire. In designing area lighting there will be many instances requiring supplemental floodlights to adjust weak spots at ends or corners of sectors or around buildings or other obstructions. Sheet C13 of Definitive Series AD 71-03-02 contains isofootcandle curves of a single 1500W floodlight at 90° and 45° orientation for 180°, 225°, and 270° footcandle readings. These curves should be of assistance in determining location, number and orientation of supplemental units. The conversion graphs of Figures 43 and 44 can be utilized to adapt the isofootcandle curves to other mounting heights. The multiplier from Figure 43 should be applied to the footcandle values, the multiplier from Figure 44 to the longitudinal and transverse distance coordinates.

Eight Luminaires Per Pole	Four Luminaires Per Pole
 HA = 15, 75, 105, 165° 195, 255, 285, 345°	
 HA = (0, 90, 180, 270°) x 2	 HA = 0, 90, 180, 270°
 HA = (45, 135, 225, 315°) x 2	 HA = 45, 135, 225, 315°
 HA = (30, 150, 210, 330°) x 2	 HA = 30, 150, 210, 330°
 HA = (60, 120, 240, 300°) x 2	 HA = 60, 120, 240, 300°

Six Floodlights Per Pole

 HA = 45, 90, 135, 225, 270, 315°

 HA = 0, 45, 135, 180, 225, 315°

 HA = 15, 90, 165, 195, 270, 345°

 HA = 0, 75, 105, 180, 255, 285°

NOTE: Horiz. aiming format for double row configurations will be found on sheet 1 of FIGURE 42

HA = Horizontal aiming angle of individual luminaire. Reference (0°) line is the "x" axis. Angles are measured counterclockwise.

P = Projection - the max. distance from the pole line (in "y" direction) that the specified FC levels will be met.

S = Spacing (in "x" direction) between poles

D = Distance (in "y" direction) between rows of poles. "D" can't exceed "2P" without violating criteria.

Ps = Pole setback. The distance that the pole line must be set back from the area to be illuminated to insure that criteria illumination levels are met or, conversely, the min. distance that the border (of the area or sector) can be placed in front of the pole line without falling below criteria.

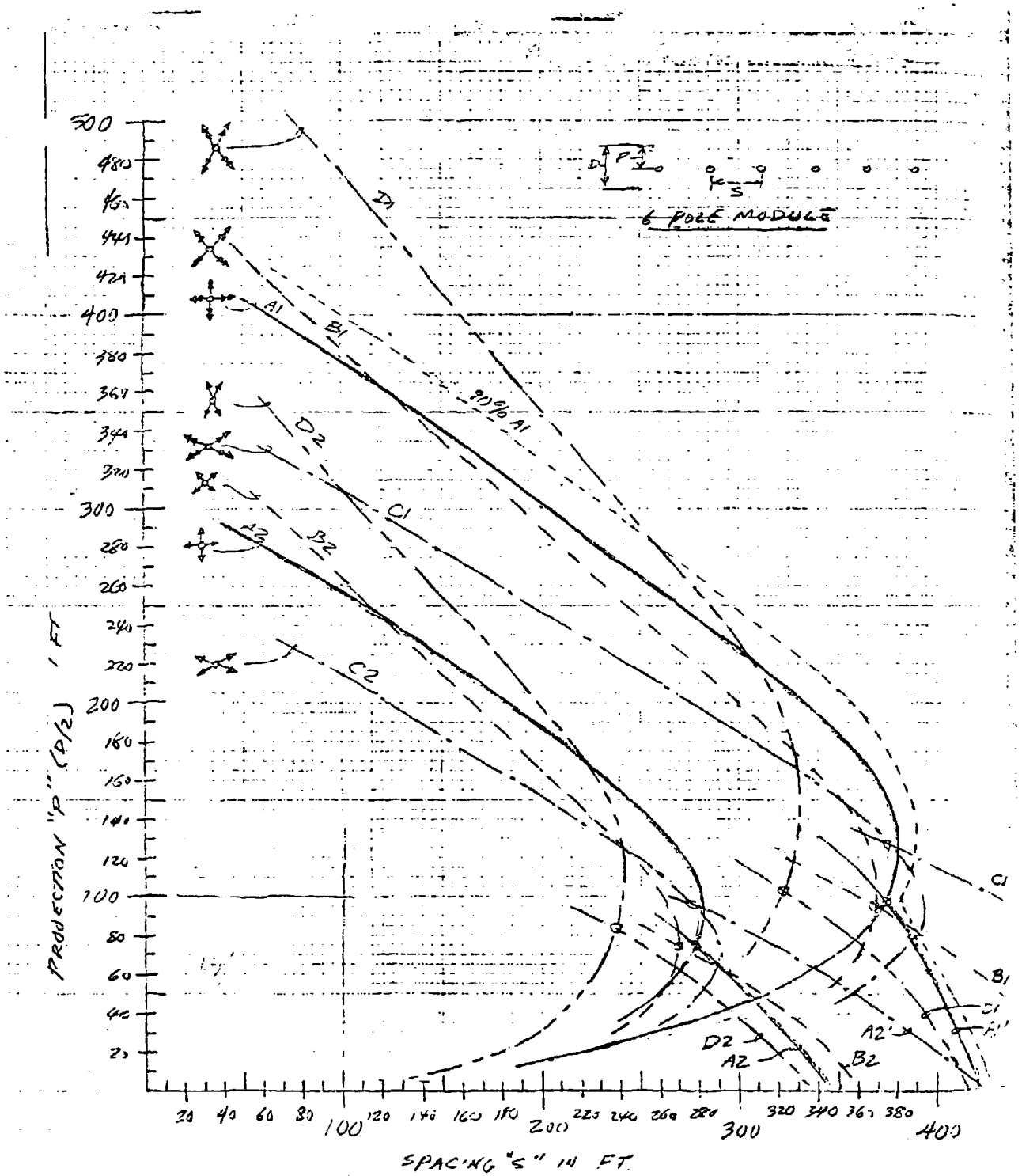
A / A' — Curve of projection vs. spacing for a specific FC. The plain letter(s) identify the relationship(s) that would apply when values measured at a 270° orientation are considered. The primed letter(s) corresponds to the relationships obtained on a 180° (or 0°) basis. The curves will yield the criteria minimum of a 1 vertical FC if total voltage drop from a rated voltage source does not exceed 5%.

90% C — Same as above except that deviations up to 10% below criteria for up to 5% of total no. of grid points are permitted.

KEY TO FORMAT - AREA LIGHTING APPLICATION CURVES

Applicable Definitives: AD 71-03-02, Sh C11-C13

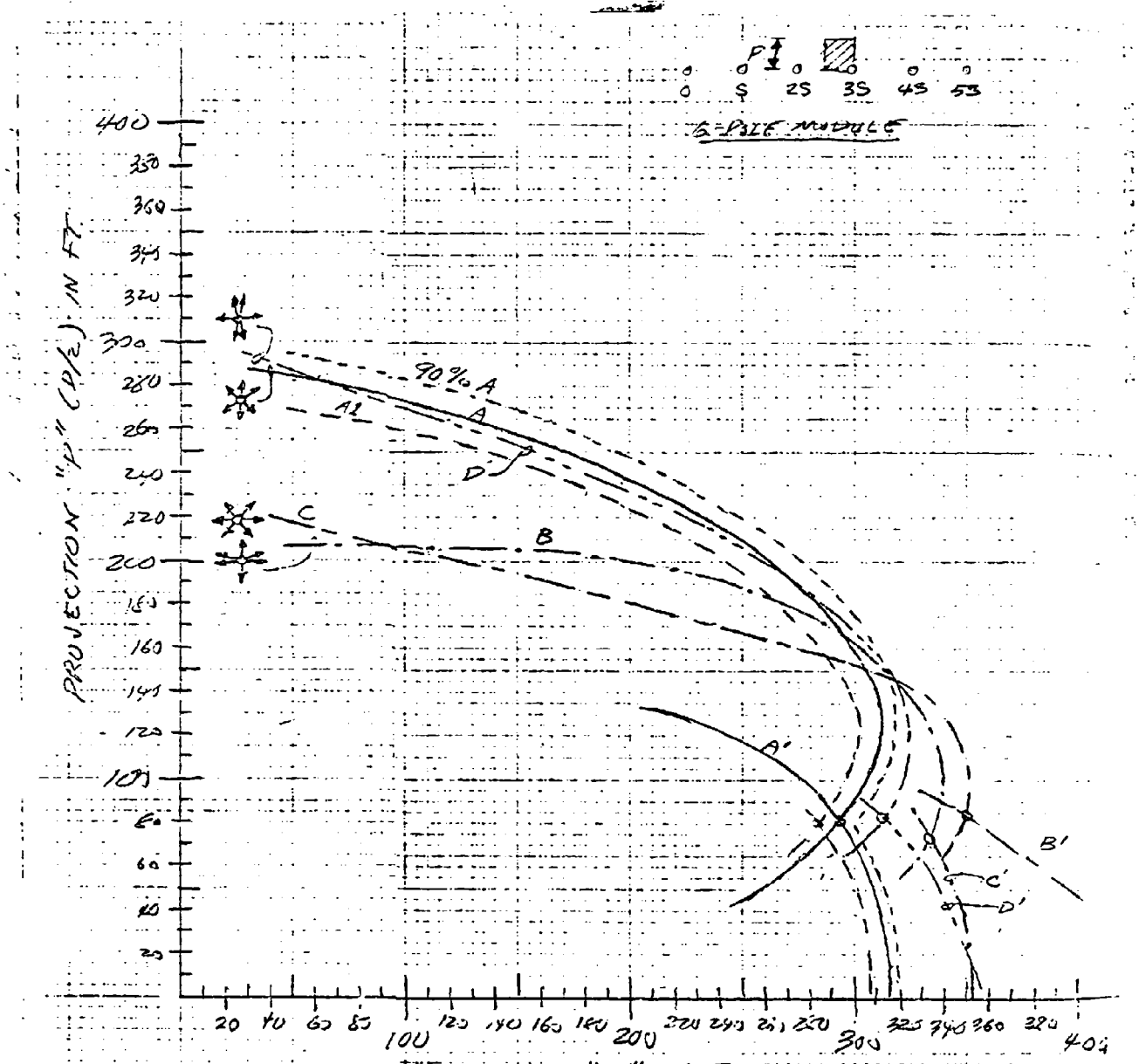
FIGURE 37



SINGLE ROW CURVES - 4 & 8 LUMINAIRE FORMATS

40 FT MOUNTING HEIGHT

FIGURE 40
SA 1 of 2



SINGLE ROW CURVES - LUMINAIRE FORMAT

40 FT MOUNTING HEIGHT

FIGURE 40
SH 2 of 2

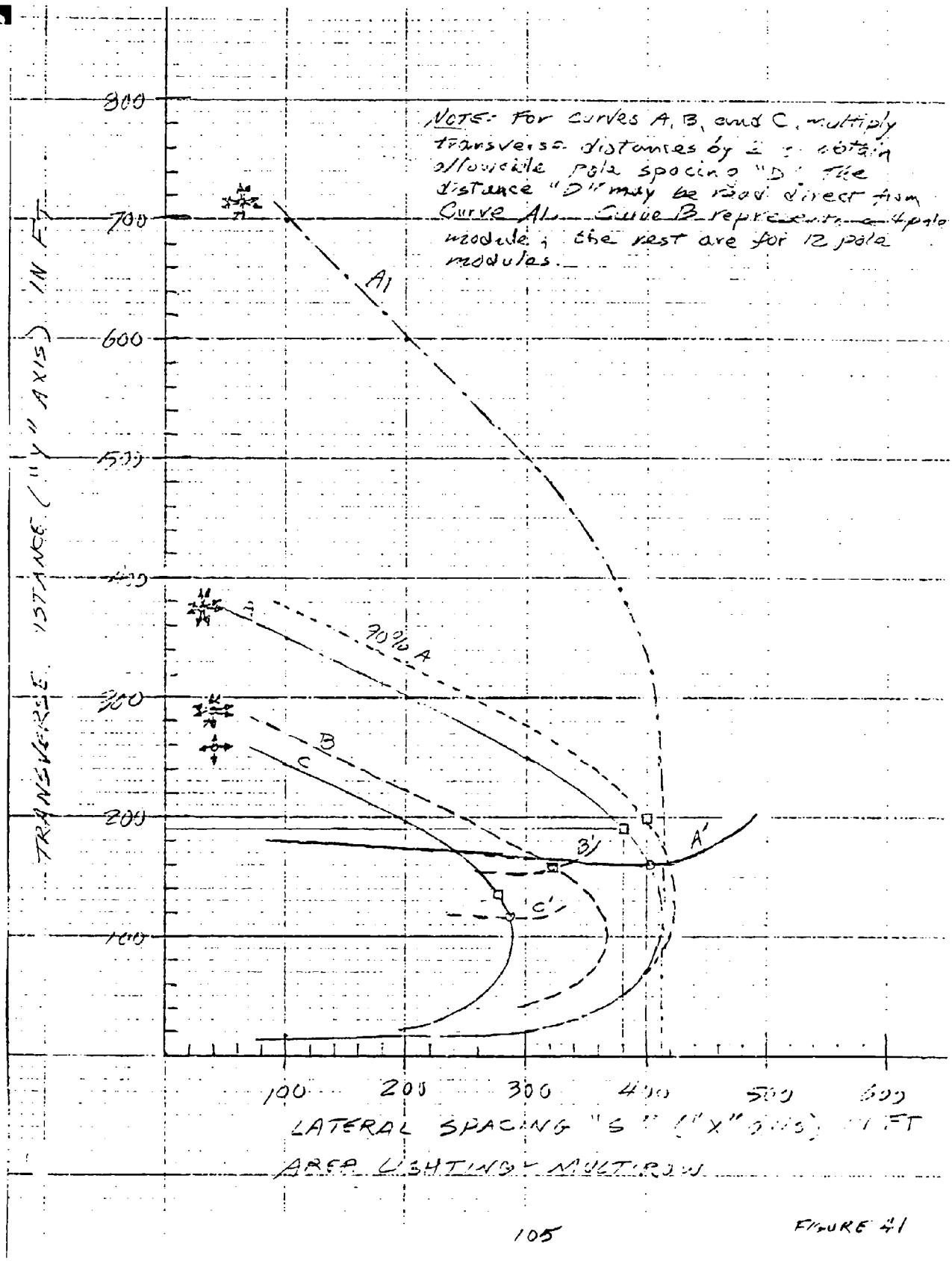
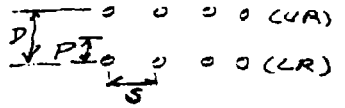

NOTE: For curves A, B, and C, multiply transverse distances by .7 to obtain allowable pole spacing "D". The distance "D" may be read direct from Curve A1. Curve B represents 4 pole modules; the rest are for 12 pole modules.
A1
70% A
B
C
B'
A'
C'
800
700
600
500
400
300
200
100
TRANSVERSE DISTANCE ("Y" AXIS) IN FT.
100
200
300
400
500
600
LATERAL SPACING "S" ("X" AXIS) IN FT.
AREA LIGHTING - MULTIPLE

FIGURE 41

AREA LTG - DOUBLE ROW (CENTER SECTION)

KEY TO CURVES



A. 

15 floodlights
HA = 45°, (60, 100) x 5, 90, 135
225, (260, 280) x 5, 270, 315

B1 

12 floodlights
HA = 45, (80, 100) x 5, 135 ← Lower Row (LR) of poles
225, (260, 280) x 5, 315 ← Upper Row (UR)

C1 
9 floodlights
HA = 45, (80, 100) x 3, 90, 135
225, (260, 280) x 3, 270, 315

D1 
6 floodlights
HA = 45, (80, 100) x 2, 135
225, (260, 280) x 2, 315

B2 
12 floodlights
HA = 45° x 2, (80°, 100°) x 4, 135° x 2
225° x 2, (260, 280) x 4, 315 x 2

C2 
9 floodlights
HA = (45, 80) x 2, 90, (100, 135) x 2
(225, 260) x 2, 270, (280 315) x 2

D2 
6 floodlights
HA = 45 x 2, 80, 100, 135 x 2
225 x 2, 260, 280, 315 x 2

D3 
6 floodlights
HA = (45, 135) x 3
(225, 315) x 3

-·—·—· } 270° ⇓ FC measurement
- - - - } 0° ⇒ FC measurement

FIGURE 42
SHEET 5

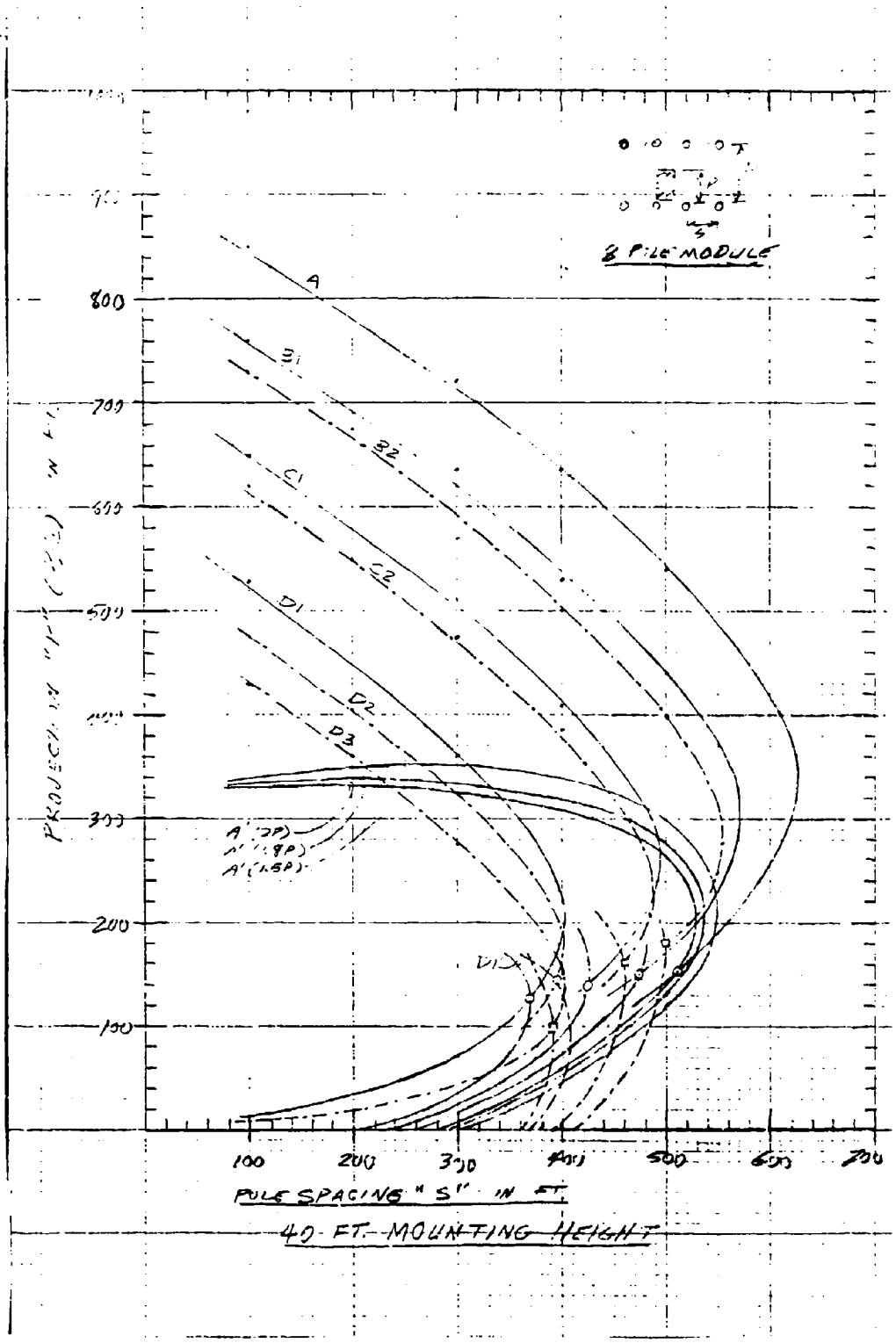


FIGURE 42
Sh 2 of 5

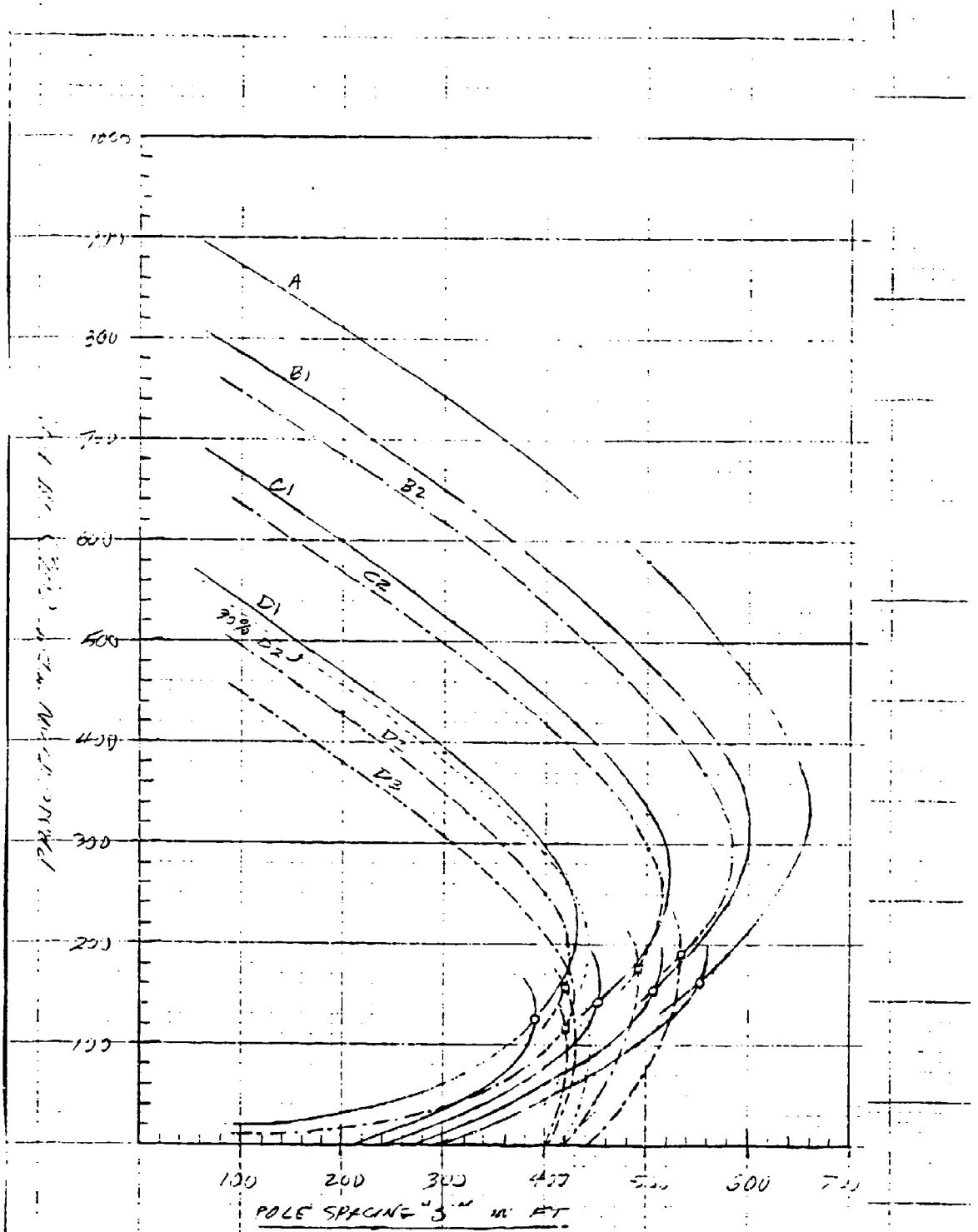


FIGURE 42
Sh. 3 of 5

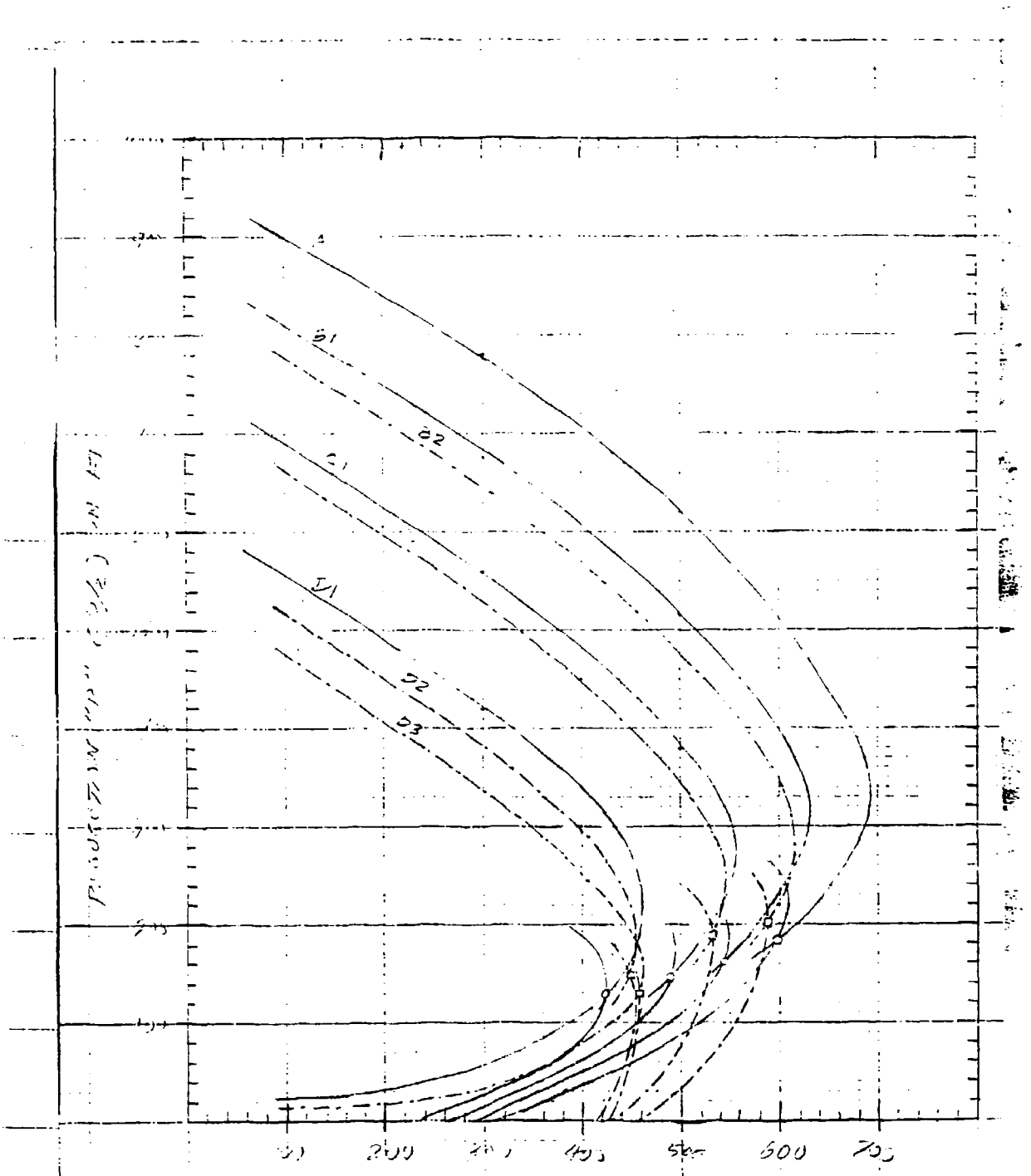


FIGURE 42

S. 11 - 45

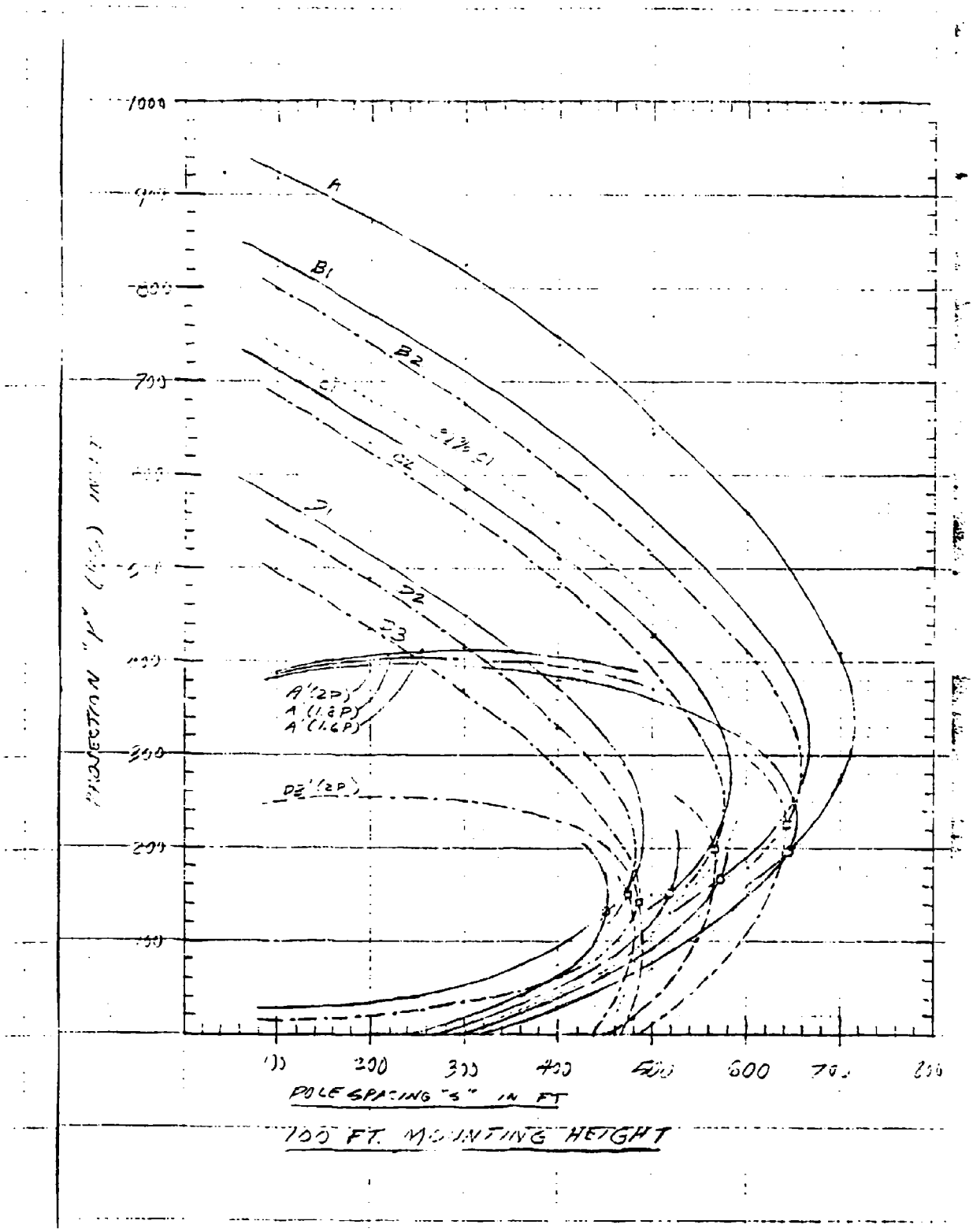
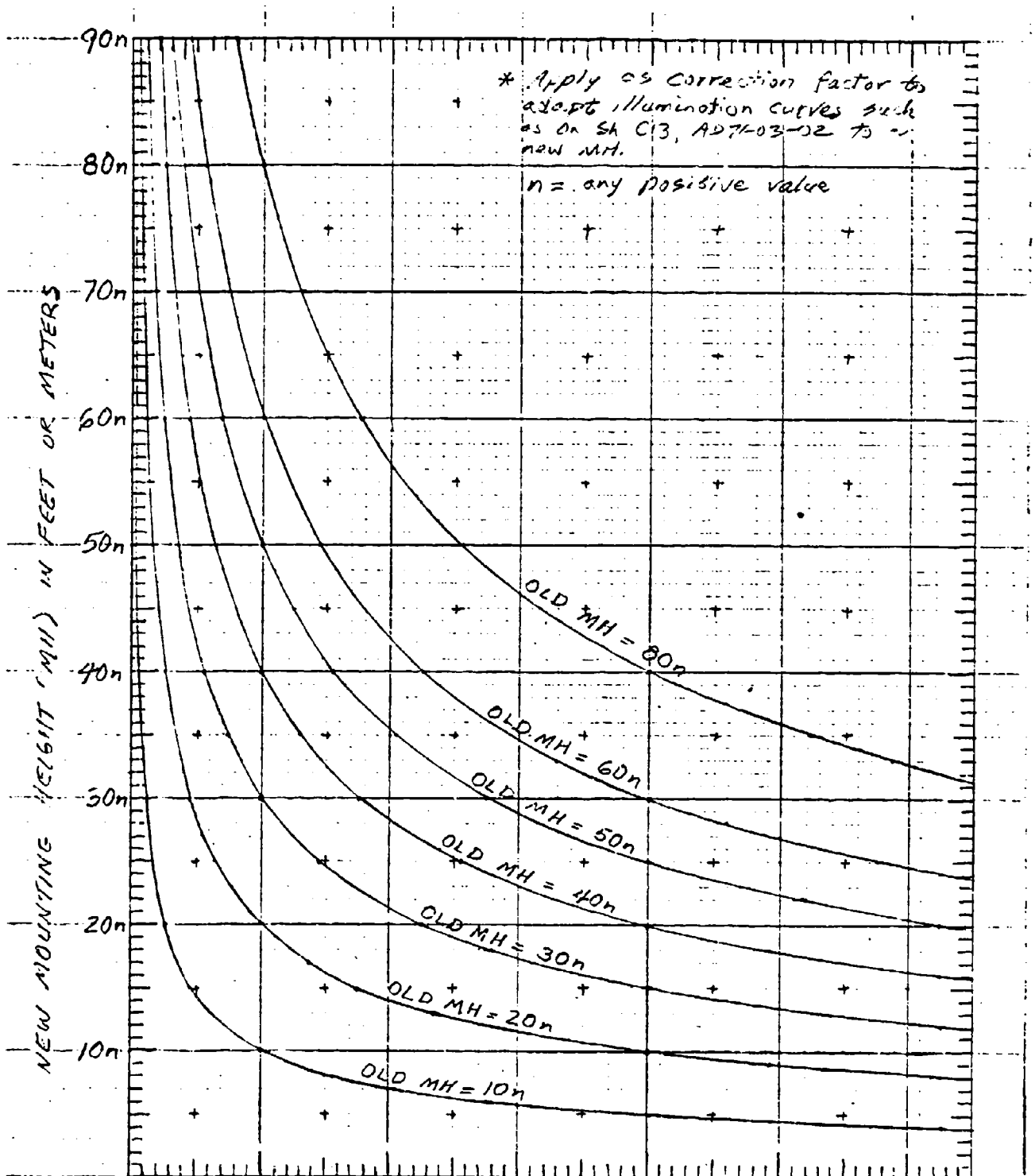


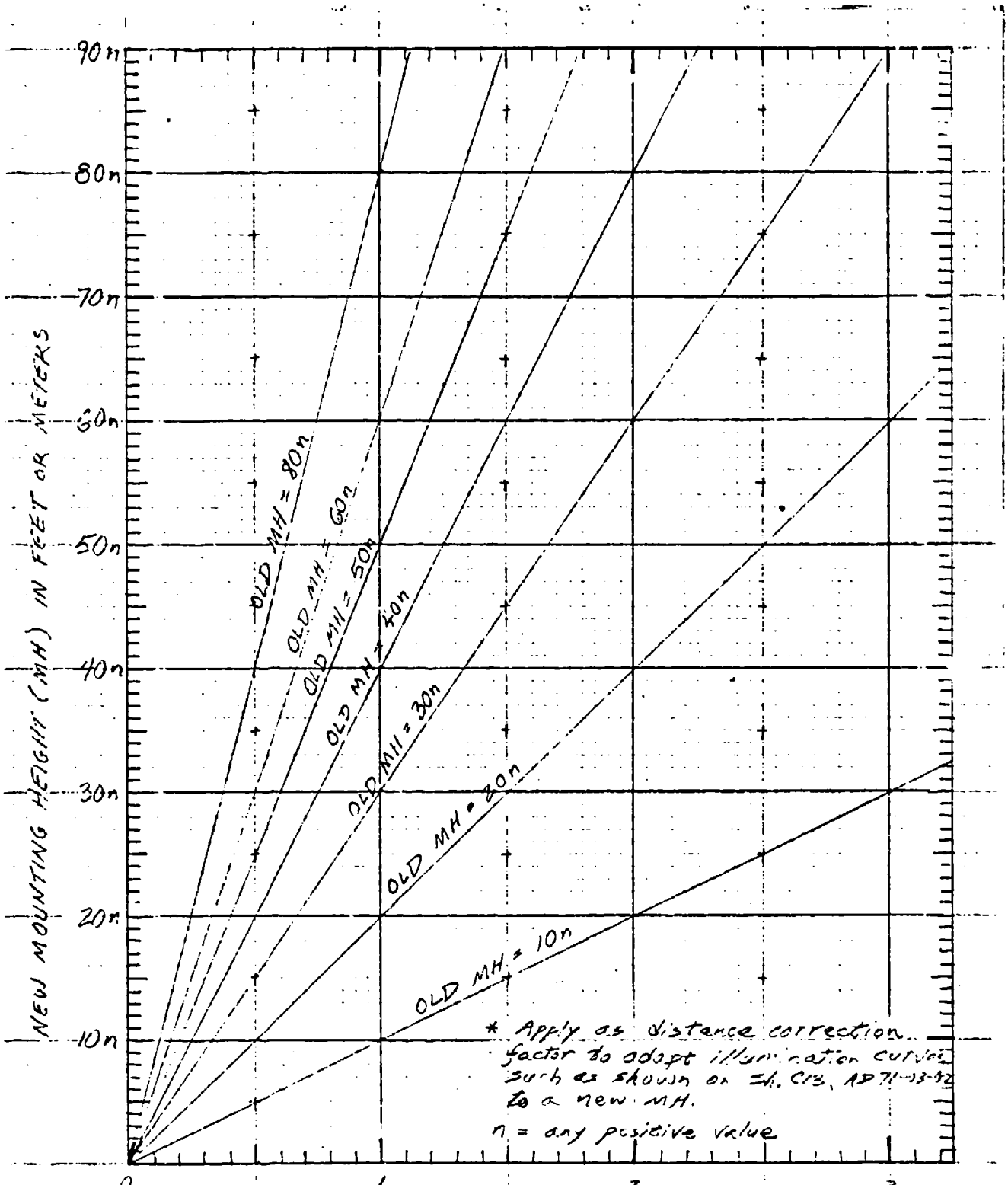
FIGURE 4
Sh 5 of 5



ILLUMINATION CONVERSION GRAPH

L1

FIGURE 43



DISTANCE CONVERSION GRAPH

FIGURE 44

9-3 Perimeter Lighting-Optumization.

9-3.1. Mounting Height. With fixed position luminaires such as the roadway fixtures and illumination criteria based on horizontal footcandle (FC) measurement, it is to the designer's advantage to mount lighting units as high as feasible. Raising mounting height improves uniformity of lighting; it also allows greater spacing between poles and/or a greater distance that can be illuminated in front of the pole line. Current Air Force policy limits the height of perimeter poles in WSA's and AAA's to 35 ft maximum above ground. Sensor cable is located along the perimeter of these areas. Security police feel that longer poles, being in close proximity to the buried sensor system, will transit much higher intensity wind generated vibrations to the sensors and lead to an unacceptable level of nuisance alarms. The most efficient mounting height under the vertical FC constraints of the 1975 criteria (see par. 3-1.1) was approximately four ft. The requirement that equipment below 15 ft. be hardened effectively set the mounting height at 15 ft. above ground, which was also the maximum permitted at that time. The maximum span that could be illuminated per criteria at the 25 ft. mounting height would be approximately 35 ft. using a type III luminaire and 45 ft. with an IES type IV distribution. To project far enough in front of the pole line to illuminate a 55-60 ft. deep span, such as was required for the double fence configuration, requires a type IV luminaire mounted at 35 ft. minimum.

9-3.2. Luminaire Aiming. The beam distribution characteristics of the roadway luminaires are such that optimum performance for most applications will be obtained when the luminaire is oriented perpendicular to the pole line ("X" axis). This orientation corresponds to 90° horizontal in Corps of Engineers aiming format. The roadway luminaire is intended to be used in a single position vertically (0° vertically in C of E aiming format). There are no built-in provisions for vertical aiming other than minor adjustments ($\pm$ 5°) to correct for pole misalignments. For the flocdlight configuration that formed the basis of the 1975 design the optimum vertical aiming angle was determined to be 70°. Horizontal aiming angles were extended as low as 40° for the first 250 W floodlight and as high as 140° for the second to achieve a 100 ft. minimum pole spacing. Under a vertical FC constraint these angles are practical limits to horizontal adjustment. Increasing the angle between the two floodlights would yield only a negligible increase in pole spacing whereas the span illuminated in front of the pole line would decrease significantly. A mathematical analysis of effects of varying floodlight parameters has been prepared by the Office of Science and Research, Headquarters, SAC (Attachment 21). The effect of relaxing the mounting height constraint from 15 ft. maximum to 35 ft. maximum and changing to a horizontal FC criteria basis (ie. WSA at Malmstrom AFB) is that pole spacing can be increased from 100 ft to 160 ft. while maintaining uniformity under 3:1.

9-3.3. Beam Pattern. Roadway luminaires utilize both specially designed reflectors and prismatic lenses to achieve precise beam control.

All of the IES beam distribution patterns, except the type V, project most of their light laterally rather than tranversely, making them ideal for street lighting applications. The IES type III medium, semicutoff distribution proved to be most suitable for the 30 ft. depth associated with single fence perimeter lighting. This pattern is also the most common type used in commercial applications. IES type IV medium distribution pattern projects a larger proportion of its light energy in front of the pole than a type III unit would. The type IV unit was found to be more suitable for lighting the 55-60 ft. security zones characteristic of double fence configurations. Floodlights such as used in the 1975 design project their light energy in one general direction. Illuminating a narrow band parallel to the pole presents more of a problem particularly if low mounting heights are required.

9-3.4. Fence Shadow, Glare, Spill Light. When the pole line is set back from the perimeter fence, a portion of the light energy transmitted is blocked by the fence fabric, posts, barbed tape, etc, creating shadows or at least a measurable loss of light. Some of the light is reflected back into the protected area. If luminaires are mounted close to the fence (15 ft or less) at low mounting heights, the reflected light from the fence segments nearest the pole can be bright enough that guard personnel will have difficulty in discerning objects outside the fence. Providing a dark coating on the fence fabric will overcome this problem. The fence shadow effect will result in a somewhat poorer uniformity ratio although not apparently of a magnitude as to seriously diminish the effectiveness of TV surveillance. Increasing pole setback will reduce the glare and contrast problems but increase the range of fence shadow. Raising the mounting height however decreases glare, poor contrast, and extent of fence shadow. Uniformity ratio improves also. The best location for the luminaire is with the lense mounted directly over the fence. Shadows due to the fence are virtually nonexistent while vision through the fence is unimpaired. The only glare is from the concertina (barbed tape spiralled on top of the fence). There will be some spill light into the protected area whether roadway luminaires or floodlights are installed. Floodlights would require corner shields to control backlight. Backlight from roadway luminaires can be controlled with shields installed behind the refractor or more simply, with tape placed on the inside of the refractor. It should be noted that footcandle measurements, taken on a vertical FC basis, will always be zero directly under a roadway luminaire whereas the illumination level will be quite high as measured on a horizontal FC basis (or as seen by the eye).

9-3.5. Miscellaneous. The prime factors governing selection of luminaire wattage and beam type are the depth of the security zone in conjunction with maxmimum uniformity ratio requirement of 3:1. The maximum pole spacing possible is dependent on the size and beam type of a particular luminaire. The 400 watt type IV unit performed

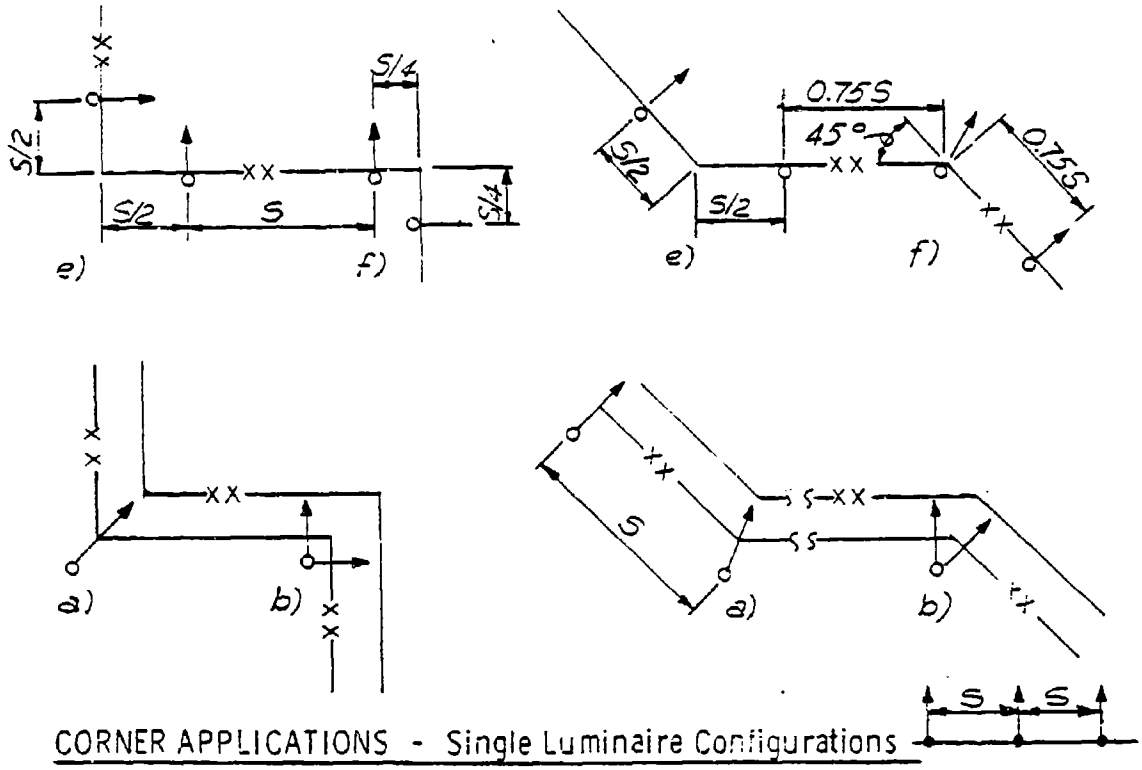
best for a double fence format with a security zone exceeding 50 ft. depth. The 250 watt, type III unit was more than adequate for the narrower 30 ft. zone of the single fence format, particularly at the somewhat conservative 100 ft. pole spacing.

9-4 Perimeter Lighting - Site Format.

9-4.1. Original Format. The 1975 design utilized two 250W high pressure sodium NEMA / x 5 floodlights mounted 15 ft. up on poles spaced 100 ft. apart for single fence lighting. Vertical aiming was 70°, horizontal 40° and 140°. The pole line was set back 20 ft. inside the perimeter fence. The double fence format was based on a single 400W, NEMA 7 x 6 aimed 90° horizontally, 65° vertically. Maximum pole spacing was 80 ft., pole setback 25 ft. Applicable definitives are series AD 71-03-01, sheets C1-C4.

9-4.2. Current Format - General. The present format represents a change in protective philisophy from glare projection toward the intruder to maximum visibility for closed circuit TV surveillance. Pole setback is influenced by the presence of the buried sensor system and the bases of TV cameras to be installed at a later date. Poles in WSA's should be approximately 3 ft. behind the perimeter fence and 6 ft. in AAA's. The luminaire must be centered over the (inner) fence and arm length adjusted as required. Computer tests were based on a 6 pole module which can be considerable repeatable for whatever length of perimeter fence may be involved. This procedure will give accurate results except at the ends of the fence and at corners. The format should be adjusted at corners per Figure 45. The illumination at the end of the pole line (at S/2) will be 1/2 of that between any two poles elsewhere, since at the end only one pole contributes to the total illumination. If it is desired to maintain the full spacing (S/2), a second luminaire, or a higher wattage luminaire, must be installed on the end pole.

9-4.3. Current Format - Single Fence. The zone to be illuminated under the single fence configuration is 30 ft. deep. A series of computer tests were made of various single fence configurations. The approved design utilizes a 250W high pressure sodium roadway luminaire having an IES type III, medium, semicutoff distribution and mounted 25 ft. above grade. Pole spacing is 100 feet. Luminaire aiming is 90° horizontal and 0° vertical. This format will yield an average horizontal footcandle level of 2.59 maintained at a uniformity of 2.92. This corresponds to 3.81 FC initial (maintenance factor = 0.68) vs the 2.0 FC required by criteria. Applicable definitives are series AD71-03-01, sheets C6 and C7. Applicable computer test is #T235B.



CORNER APPLICATIONS - Single Luminaire Configurations

a. Inside Corner = install one floodlight bisecting the angle of the fences.

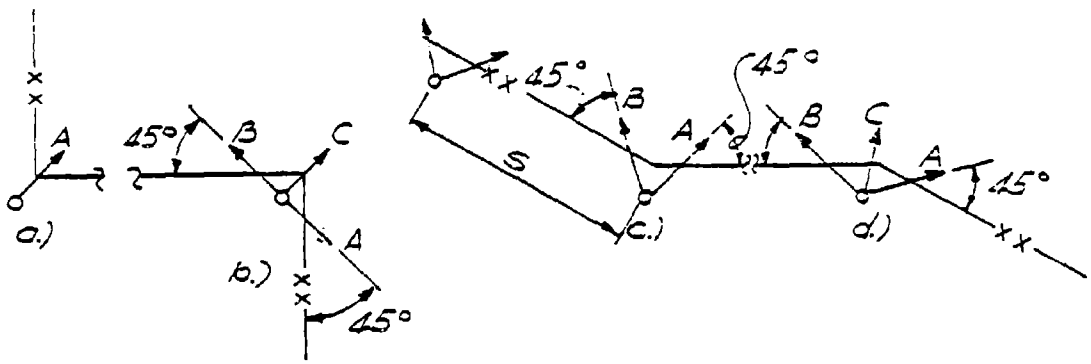
b. Outside Corner = install two floodlights, normal to the fence segment to the left and to the right of the pole, respectively.

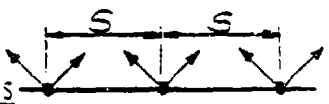
e. Inside corner - install one luminaire normal to each fence segment at 1/2 the standard spacing.

f. Outside corner - install one luminaire normal to each fence segment at 1/4 of the standard spacing for square corners; for octuse angles between 90° and 180° determine the spacing between 25% and 100% of the standard spacing that corresponds to the particular angle and install one luminaire bisecting the angle

CORNER APPLICATIONS - INTERIOR LIGHTING

FIGURE 45
Sheet 1 of 2





CORNER APPLICATIONS - Double Luminaire Configurations

a. Inside corner, right angle = install one floodlight bisecting the angle of the fences (also use for angles less than 90°).

b. Outside corner, right angle = install floodlights "A" & "B" at 45° angles with the fence and "C" bisecting the fence angle.

c. Inside corners, obtuse angle = install 2 floodlights at 45° angles to the fence (Note: arrangement 'a' may be used for angles up to 110°).

d. Outside corner, obtuse angle = install 2 floodlights at 45° angles with the fence and a 3rd ("C") bisecting the angle between these two floodlights ("A" & "B").

NOTE: The above or similar arrangements should be used at corners to insure minimum illumination levels will be provided. Spacing should not be less than indicated. Examples "a", "b", "c", and "d" are intended for floodlights or other luminaire type having a directed beam pattern that can be aimed as desired. Examples "c, d, e" and "f" are intended for roadway luminaires and similar units which distribute most of their illumination parallel to the pole line in both directions, and for which little or no adjustment in vertical aiming can be made. Roadway luminaires could be installed per examples "a" and "b"; however, there would be either more illumination than necessary in the clear zone ("b") or greater penetration of backlight inside the secure area ("a").

FIGURE 45
Sheet 2 of 2

9-4.4. Current Format - Double Fence. The security zone for the double fence configuration is typically 55 - 65 ft wide. It consists of a clear zone extending 30 ft. beyond the outer fence plus a 25 - 35 ft. separation between the inner and outer fences. The luminaire must be centered over the inner fence. The format shown on Definitive Series AD71-03-01, sheets C7 and C8 utilizes a 400W high pressure sodium luminaire having an IES type IV, medium, noncutoff distribution. The luminaire is mounted 35 ft. above grade (measured from ground level at inner fence) and aimed 90° horizontally, 0° vertically. Maximum allowable pole spacing is 120 ft. This format yields 2.63 average horizontal footcandles and a uniformity ratio of 2.72 over a 60 ft. deep security zone. The corresponding average FC level when initially installed would be 3.87 FC. The applicable computer run is #T74A.

9-5 ENTRY CONTROL FACILITY (ECF) LIGHTING.

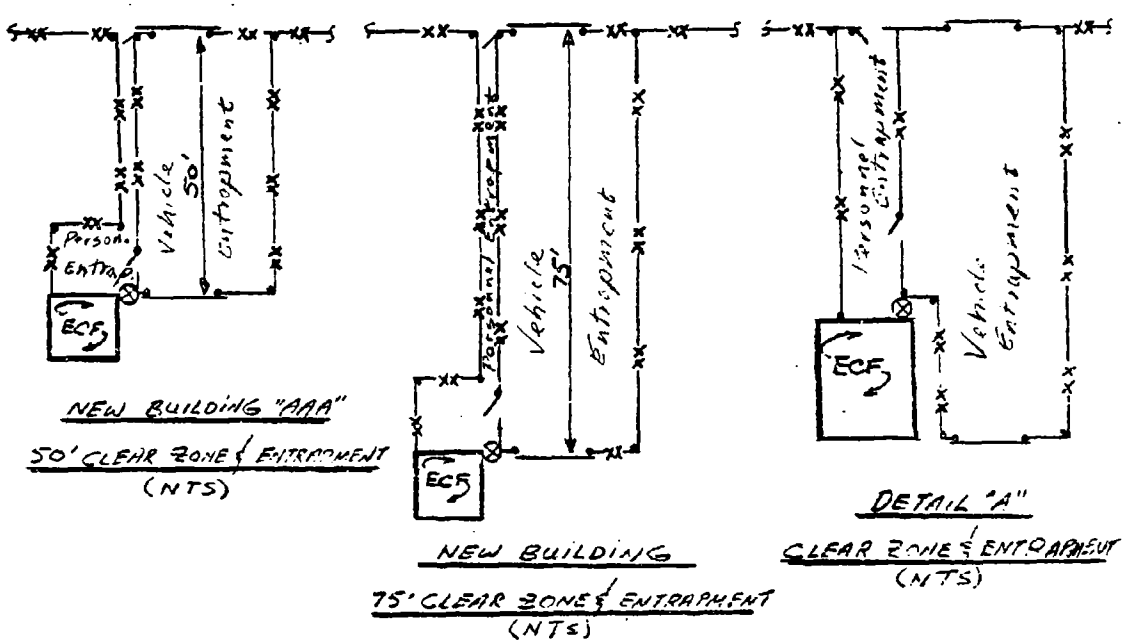
9-5.1. General Consideration. Entry facilities at WSA's and AAA's because of their special function and layout present unique design problems. Facilities at most WSA's are existing but show minimal standardization of layout. ECF's at some AAA's are existing, at others, the facilities are being built. As a result design essentially has to be implemented on a case by case basis. Areas of design to which a general optimized approach can be applied are limited. Since illumination criteria is on a horizontal footcandle basis, it is to the designers advantage to use the higher mounting heights of 35 or 40 ft. wherever feasible.

9-5.2. Site Format. A standardized entry control building design (Definitive Series AD27-05-02) has been developed for use of locations where no entry facility has previously been required or where an existing building is to be replaced. Two entry way configurations have been approved for use with the new building design - one having a 75 ft. deep vehicle entrapment area, the other with a 50 ft. deep area (see Figure 46). The first type of facility will be installed at weapons storage areas, the latter at alert areas. Sheets E2-E8 of Definitive Series AD 27-05-02 contain photometric data, application information, and lighting layouts pertaining to the above two types of areas. They also include as examples layouts for three different configurations of existing entry control facilities. Two acceptable lighting arrangements have been developed for each site layout - one based on high pressure sodium roadway luminaires having IES type III beam distributions, the other based on IES Type IV beam distributions. The lighting system is designed to be switched in three segments: entrapment lighting, background lighting (behind the building and outside the entrapment area), and building lighting.

9-5.3. Individual Luminaires. The footcandle distribution patterns characteristic of particular luminaires are shown on sheet E4 as an aid in selecting and locating luminaires at entry control facilities having configurations different than the examples shown. Isofootcandle curves are provided for 150 W, 250 W, and 400 W roadway luminaires having type III

JES

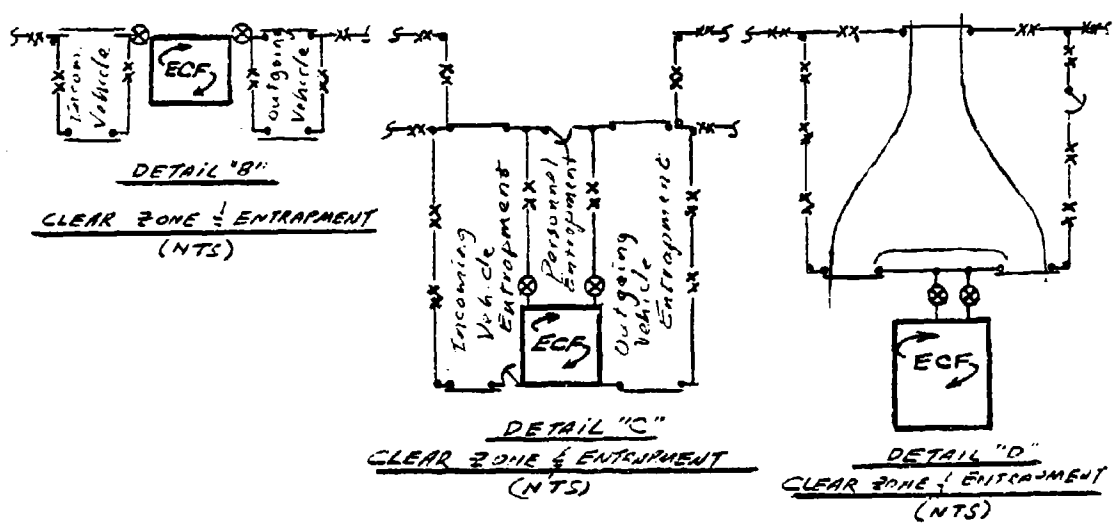
TYPICAL ECF SITE PLANS



NEW BUILDING "AAA"
50' CLEAR ZONE & ENTRAPMENT
(NTS)

NEW BUILDING
75' CLEAR ZONE & ENTRAPMENT
(NTS)

DETAIL "A"
CLEAR ZONE & ENTRAPMENT
(NTS)

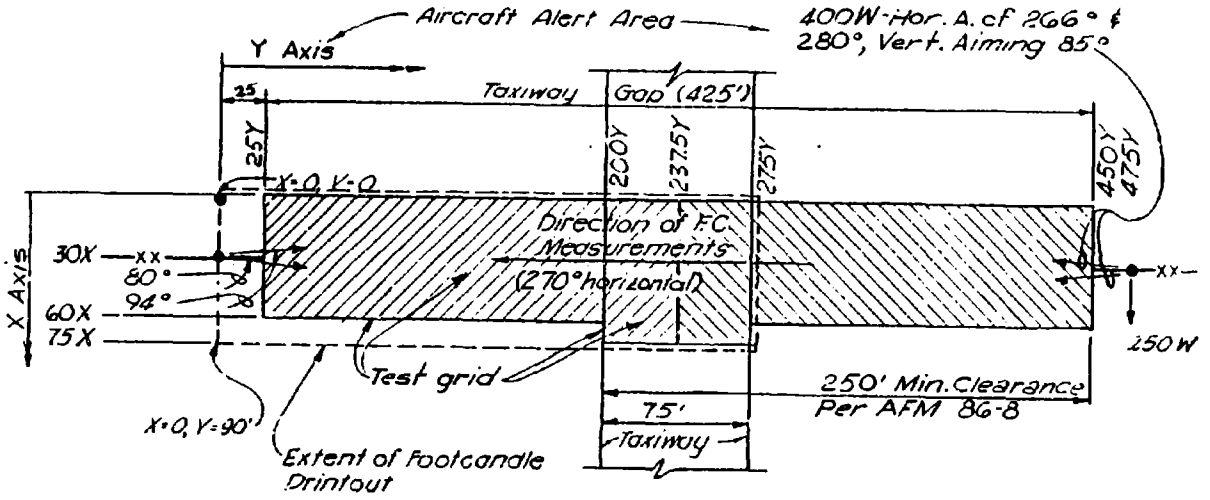


DETAIL "B"
CLEAR ZONE & ENTRAPMENT
(NTS)

DETAIL "C"
CLEAR ZONE & ENTRAPMENT
(NTS)

DETAIL "D"
CLEAR ZONE & ENTRAPMENT
(NTS)

FIGURE 46



TAXIWAY GAP
TYPICAL LIGHTING LAYOUT MODULE

Minimum lighting requirement in shaded area is 1.5 vertical foot candles (maintained) at 3 feet above grade. A measurement of 1.5 F.C. obtained at any orientation from 0^0 to 360^0 will be deemed to have satisfied the criteria.

Layout module meets minimum setback requirements of 250 feet from far edge of taxiways.

Lighting scheme shown on this sheet will satisfy criteria for a taxiway gap of up to 500 feet without adjusting horizontal or vertical aiming.

FIGURE 47

beam distribution and for 250 W and 400 W luminaires having type IV distribution. Given mounting height is 40 ft. Multipliers to apply to FC values are included if lower mounting heights should be desired. The type IV luminaires should be easier to manipulate in most cases.

9-6 TAXIWAY GAP LIGHTING

9-6.1. General Considerations. The gap in the perimeter fence across the taxiway of Aircraft Alert Areas presents a long narrow area to be illuminated. See Figure 47. Minimum criteria illumination levels have been established in terms of vertical footcandles. Under these constraints, narrow beam floodlights and relatively high aiming angles are appropriate.

9-6.2. Site Format. The minimum length of the gap across the taxiway gap is determined by the clearance criteria of AFM 86-8. No above grade structures are permissable in a 250 ft. wide band, measured from the far side of the taxiway. With a taxiway width of 75 ft this establishes a 425 ft. minimum taxiway gap. The depth of the area has been set at 75 ft. on the taxiway itself and 60 ft. for the remainder of the gap. The format illustrated on Sheet C5 of Definitive Series AD 71-03-01 will provide the criteria minimum illumination for gaps of up to 500 ft. This format utilizes two 400 W high pressure sodium floodlights having NEMA 4 x 4 beam spreads. They are mounted 20 ft. up on poles set back 25 ft. from the taxiway gap lighting zone. A relatively high vertical aiming angle of 85° is used. The two units on the right side (when looking out of the alert area) are aimed at 80° and 94° horizontally. The units on the opposite end of the gap are positioned at 266° and 280°. Provision for manual switching of taxiway lighting is included. Applicable computer trial numbers are TW18F and TW19D.

W. P. Shea, MROED-DC

D. L. Vollmer, MROED-DC

February 1978

APPENDIX A

MISCELLANEOUS ATTACHMENTS

LIST OF ATTACHMENTS

Item No.	SUBJECT
1.	Catalog Literature - Low Pressure Sodium Lamp Quality Outdoor Lighting.
2.	Catalog Literature - L.P.S. Lamp, North American Phillips Lighting Corp. (Norelco).
3.	Letter from Norelco Representative Concerning L.P.S. Lamp Restrike.
4.	Letter from SEPCO Lighting Representative Concerning L.P.S. Restrike and Lamp Mortality.
5.	Letter from Norelco Representative Concerning Chemicals Used in L.P.S. Lamp.
6.	Survey of Public Reaction to L.P.S. Lighting, City of Long Beach, California.
7.	Sources of L.P.S. Lighting Equipment
8.	Sample List of L.P.S. Installations and Studies.
9.	Article from Electrical Construction and Maintenance, January 1975: "Low Pressure Sodium Lamps: A Way to Conserve Energy"
10.	Article from Lighting Design and Application, April 1972: "A Second Look at Low Pressure Sodium".
11.	Article from Lighting Design and Application, December 1974: "Energy Conservation and Luminaire Dirt Depreciation".
12.	Article from Lighting Design and Application, April 1974: "Exterior Security Fence Lighting".
13.	Printout of Computer Program Used for Lighting Calculations
14.	Computer Program Abstract - Point to Point Lighting
15.	Printout of Computer Program Used for Economic Comparisons.
16.	Data on Night Lighting: Mean Daily and Annual Hours Required
17.	Disposal Instructions for Low Pressure Sodium Lamps
18.	Manufacturers Literature on Long Arc Xenon Lighting
19.	Printout of Computer Trial for a Selected Perimeter Lighting Configuration
20.	Printout of Computer Trial for a Selected Area Lighting Configuration
21.	Air Force Study of Optimization Techniques Applicable to Perimeter Lighting Using Floodlights

Advantages of Low Pressure Sodium

Developments and Improvements

The first practical LPS lamps, introduced commercially in 1932, produced about 50 lumens per watt. The development of glasses resistant to attack and discoloration by the sodium vapor, the re-design of the arc tubes, the development of new techniques and materials in reflecting the heat of the arc back into the arc; all have greatly improved the lamps. At present, the 180 watt lamp delivers approximately 183 lumens per watt and there is ample evidence that this will go higher.

Lamps of earlier design were limited in life because of sodium attack on glass and metal seals, glass absorbtion of the argon starting gas and the drift of the sodium to the cooler parts of the discharge tube. Modern lamps utilize a borate glass of special composition as a very thin, inner surface backed by lime glass to form the arc discharge tube. The borate glass withstands the attack by the sodium but would absorb moisture, hence the backing of lime glass. The borate glass does not discolor nor rapidly take up the argon gas. The present lamp life rating is 18,000 hours.

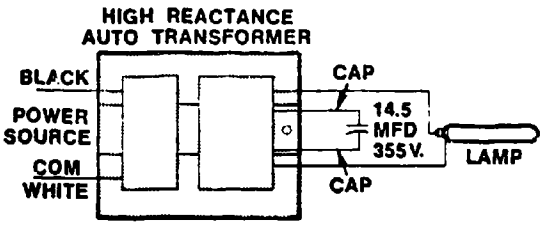
Older, U-shaped LPS lamps had the problem of sodium in the arc drifting away from the electrodes because the electrodes were much hotter than the remote end of the U-tube. The modern, smooth lamps have a tapered film of indium oxide on the inner surface of the outer glass tube. This film effectively equalizes the temperature, minimizes sodium drift and requires a smaller amount of sodium for lamp operation.

In this country, the earlier acceptance of the LPS lamps may have been slowed, in part due to the lack of American-made lamps. The earlier lamps, offered in commercial quantities, were made in England and Holland. They are now readily available here from stock through Quality Outdoor Lighting.

Technical development is increasing rapidly, especially in the field of illumination. Science has introduced a number of new light sources and, with computer aid, we have designed optical systems and luminaires for these new sources, providing our customers with new avenues of solving illumination problems on the streets and roads never before thought possible.

One of these new light sources is **Super-SOX** low pressure sodium lamp which is the most efficient light source known to man. It is presently playing an important role in increasing road safety, providing better area lighting and conserving energy.

The Facts . . . How It Works



Ballast Performance and Starting

The ignition in a **Super-SOX** low pressure sodium lamp is accomplished by means of gas discharge through a neon-argon gas mixture, in the inner arc tube, which also contains a quantity of free sodium. Because there is nothing to vaporize for ignition of the arc, these lamps are very reliable starters. The heat from the neon-argon discharge begins vaporizing the sodium, which continues to increase the light output, and after about 12 to 15 minutes the maximum output of the lamp is reached. Following start up from cold start, the lamp's light changes from red of the neon to yellow of the sodium discharge. Most importantly, if normal voltage is interrupted, there is very rapid restarting of the lamp when the line voltage is restored, because the temperature and pressure of the gas and sodium vapor needs little reduction to that required for re-start.

Thermal insulation is provided by the tube-within-a-tube construction of the LPS lamp and the evacuation of the air from the space between the tubes. This and the aid of the gas for the initiation of the arc, means that the ambient temperature has no practical effect on lamp starting. Also, this thermal insulation serves to make the operating lamp largely independent of the ambient temperature; the light output is essentially constant between −10°C (+14°F) and +40°C (+104 F).

The 260°C operating temperature of the surface of the arc tube is such that, if an interruption of the input voltage occurs, the arc temperature and pressure must reduce very little for the arc re-strike to take place. This minimal time for re-strike is a major safety feature in the use of the LPS lamps, avoiding an extended period without light.

The operating temperature of the surface of the arc tube is important for such tube whether it is a LPS lamp or a fluorescent, mercury, metal halide or high pressure sodium lamp. For any arc discharge lamp, the temperature of the coolest point on the arc tube controls the pressure of the vapor of the arc and that pressure, in turn, controls the amount of light which is developed by the arc. The tube of the LPS lamp operates at approximately 260°C (500°F) for maximum efficacy. Normally, this temperature is nearly uniform over the entire outer surface of the inner tube. This temperature is much lower than that for the mercury, metal halide and high pressure sodium lamps. The more

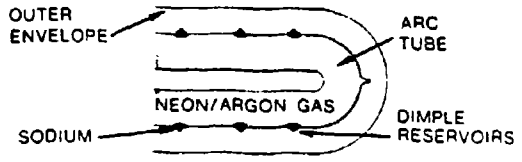
ATTACHMENT 1

moderate temperature of the LPS arc tube means that less infra-red energy is being released from the lamp and this limits any adverse heating effect on lamp sockets, wiring and other parts of the luminaire. Also, the result is a cleaner luminaire. (See report ERL-1102).

Ballasting requirements are similar to those for mercury or metal halide lamps, but the high voltage pulse or the helical heater coil required for high pressure sodium lamps is not needed for the LPS lamps. Therefore, the ballast design is simpler, with fewer maintenance problems and eliminates a possible source of radio interference.

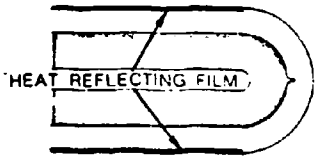
If there is under or over voltage on a LPS system, there will be a relatively flat response of light output of the lamps. This is due to the interaction of lamp current, voltage, power factor and efficacy, which results in only a modest decrease of light output with either a decrease or an increase in the system voltage.

Construction-Smooth vs. Dimpled Lamps



The dimpled lamps utilize indentations, spaced regularly along the outside of the inner, arc tube, as reservoirs for sodium. These serve to maintain the necessary level of sodium along the arc but require perhaps 10 to 20 times the amount used for the same size smooth lamp with film.

In the dimpled lamp reservoirs of sodium replenish the arc tube as the sodium vapor migrates. The reservoirs gradually empty during life. Although sodium migration is delayed it still occurs during the useful life of the lamp with a consequent fall in efficacy and, because arc voltage is higher in neon than in sodium, a progressive rise in lamp watts. A 180 watt lamp at 20,000 hours consumes 247 watts.



In **Super SOX** lamps the heat reflecting film on the jacket, although only light wavelengths thick, has a carefully designed and critically controlled change in thickness along the length of the lamp. This exactly balances the thermal and electrical gradients in the arc tube and maintains full sodium vapor light output along the tube throughout life. No significant watts rise through life and a more reliable life through eliminating the possibility of glass cracks at dimple stress points. A 180 watt **Super SOX** lamp at 20,000 hours consumes 187 watts.

High Luminous Efficacy and Lumen Maintenance

The **Super-SOX**, low pressure sodium lamp, produces up to 183 lumens per watt, which is considerably higher than either the clear mercury (57 lpw), metal halide (100 lpw) or the high pressure sodium (140 lpw) light sources of large size. The LPS life rating of 18,000 hours compares favorably with other sources, exceeding that for metal halide and for most sizes of the high pressure sodium lamps.

Super-SOX low pressure sodium lamp light output remains remarkably close to published ratings. Any decrease is modest and gradual over the life of the lamp. Lumen maintenance is 95% approx.

Color and Light

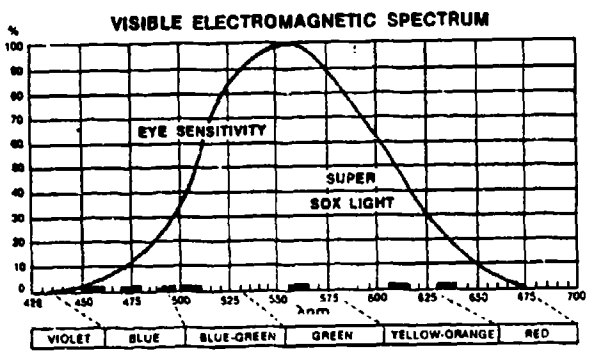
Within the very wide limits of the radiant energy spectrum, there is the comparatively narrow band of frequencies (380 to 760 nanometers) representing light energy. Any reference made to "color" or to a specific color is an indication of a specific wavelength, or a combination of wavelengths, within the range of light energy. Such wavelengths of light then enable us to see the color and brightness of an object or surface. Materials within the surface of an object or its finish, such as the pigments in a paint, reflect the selected wavelengths out of the light reaching the object. The limitation is that the wavelength desired must be in the light reaching the object if we are to have good color rendition.

The LPS lamp, with all of its light output energy in very narrow wavelength bands near the center of the visible range, does not provide light for good color discrimination and there will be distortion of colors other than yellow.

The facts are that the spectral response characteristic of the human eye is such that maximum response is for light of approximately 555 nanometers in wavelength and the LPS light is largely in very narrow wavelength bands at 589 and 589.6 nanometers. The difficulty has been to attempt to link and interpret these facts.

Electrically, the benefits of the narrow band widths means that the energy is utilized where it will do the most good: in a narrow energy band to which the eye is extremely sensitive. The monochromatic yellow light and the high level of luminance prove most compatible, for example, with a television surveillance system. It does not provide for distinguishing colors or facial features, but it does offer good clarity and picture detail.

The sensation that we call color and light is our psychological interpretation of certain portions of the electro-magnetic spectrum.



Spectral Emission Characteristics of High Intensity Discharge Sources

(Infra-red not included)

Principal Lines (Nanometers)

Mercury: 334.2, 365-366.3, 390.6, 404.7-407.8, 433.9, 434.7, 435.8, 491.6, 546.1, 577-579.

Scandium: 390, 436, 474, 508, 672

Sodium: 466, 498, 570, 584, 598, 614, 630-650

The visible radiation from the sodium lamp is yellow and largely monochromatic, consisting almost entirely of two special lines at 589.0 and 589.6 Nanometers. This closely corresponds to the peak response of the human eye (560.0 NM). Therefore, all light is produced in the most efficient area of eye response—the color amplifies contrast and is restful to the eye.

There have been claims and counter-claims but conservatively it appears that the very narrow band of LPS color has its advantages for roadway and area lighting. It may be argued that, in the case of relatively low level illumination, seeing deals largely with luminances and contrast—not with color.

A factor in the maintenance of lighting equipment is that a yellow light will attract a smaller number of insects than a white light of equal candlepower and a lower candlepower will attract fewer insects. Therefore, the LPS lamp, with low luminance and yellow color, is to be preferred.

Luminance

The arc tube luminance (photometric brightness) of the **Super-SOX** low pressure sodium lamp is 10 cd/cm², an extremely low value compared with 450 cd/cm² for the clear, high intensity mercury lamps and 1,000 cd/cm² for the clear, high pressure sodium lamps. This results in a low-glare source for the LPS and permits maximum visual capabilities.

Light control of present luminaires for LPS lamps is such that there is considerable light delivered to the roadway shoulders and median strips. Motorists have been very much aware of this and a majority, in a Chicago survey, have expressed approval. A majority of the motorists were reported to like the amount of light, the lower glare and the visibility of the signs and lane-separating stripes. Many motorists express pleasure in the "golden glow" of the LPS light and many feel that the signs located along the roadway are more attention-getting than when lighted with mercury lamps.

It is reported that mercury lighting installations must have 90% higher levels of illumination than sodium light for the same visibility distance. Results of investigations comparing the apparent brightness of light color on the perceptibility and on the glare and brightness impressions of the road user can be summarized by the comparison of high pressure mercury, phosphor-coated lamps with that of sodium lamps: a) Both from visibility test on existing lighting installations and in an open-air laboratory, as from threshold value measurements indoors, it has been found that in order to obtain the same visibility, the luminance of the background with improved color mercury lighting must be at least 1.5 times higher than with sodium light; b) The luminance of the luminaire in the direction of the eye of the road user may be almost 1.5 times higher with sodium light than with improved color mercury lighting without increase in discomfort glare; and c) For the same impression of road surface brightness for the road user, the road surface luminance with color improved mercury lighting must be 3 to 4 times higher than for sodium light.

Super-SOX luminaires result in lower cost for many street and area installations because of the higher efficacy of the LPS lamps, fewer luminaires and poles and reduced installation, owning and operating costs. The combination of the **Super-SOX** lamp and luminaire provides better illumination uniformity on both wet and dry road surfaces.

Traffic Guidance and Security

The additional light which LPS luminaires distribute to roadway shoulders makes it easier for the motorist to distinguish the location of entrances and exits. The distinctive color of the LPS is being used successfully to distinguish major intersections or entire sections of roadway, such as by-pass arteries around a city. The color is also very distinctive in use as security lighting, delineating an outline or area and discouraging intrusion and vandalism.

SUPER SOX PERFORMANCE

Production of light

The passage of an electric current through the vapor of sodium metal causes the sodium atoms to emit the well-known yellow light characteristic of sodium discharge.

Starting and operation

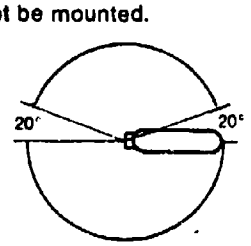
When a sodium lamp is first switched on the normal mains voltage is not sufficient to cause a discharge between the electrodes, and the control gear is designed so that a sufficiently high voltage, up to 550 volts, is available. As the lamp runs up, the arc voltage after rising slightly is reduced to a value where the nominal lamp wattage is achieved. At the instant of starting, the discharge takes place in the argon gas which in turn initiates a discharge in the neon gas with which the arc tube is also filled. The heat developed by the discharge in the neon gas gradually vaporizes the sodium metal.

Fast restarts

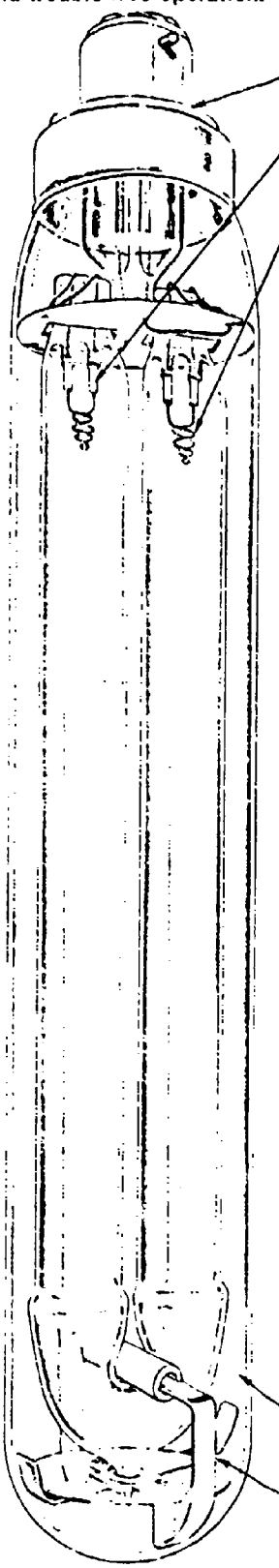
SuperSOX lamps restart faster than any other type lamp. Start immediately on switching and runs up quickly to full brightness. Starts and runs at any temperature as low as —58°F. Restarts immediately at restoration of power, even if only momentary break. **Super SOX** lamps are relatively insensitive to marked variations in power supply.

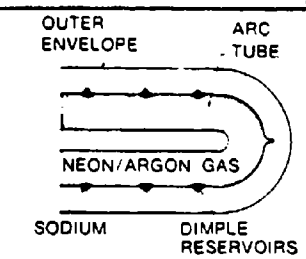
Operating position

The shaded portion of the diagram shows the position in which the lamp **must not** be mounted.



Super SOX lamps made differently for longer life, higher lumen output and trouble free operation.

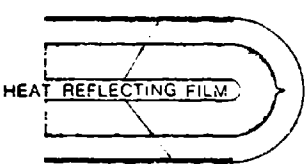




DIMPLE CONSTRUCTION

In the dimpled lamp reservoirs of sodium replenish the arc tube as the sodium vapor migrates.

The reservoirs gradually empty during life. Although sodium migration is delayed it still occurs during the useful life of the lamp with a consequent fall in efficacy and, because arc voltage is higher in ne than in sodium, a progressive ris lamp watts. A 180 watt lamp at 20,000 hours consumes 247 watts.



TAPERED FILM CONSTRUCTION

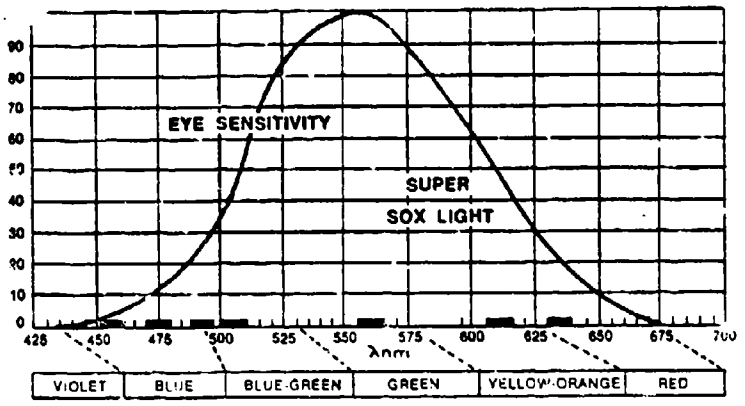
In Super SOX lamps the heat reflecting film on the jacket, although only light wavelengths thick, has a carefully designed and critically controlled change in thickness along the length of the lamp. This exactly balances the thermal and electrical gradients in the arc tube and maintains full sodium vapor light output along the tube throughout life. No significant watts rise through life and a more reliable life through eliminating the possibility of glass cracks at dimple stress points. A 180 watt Super SOX lamp at 20,000 hours consumes 187 watts.

1-4

COLOR AND LIGHT

The sensation that we call color and light is our psychological interpretation of certain portions of the electro-magnetic spectrum.

VISIBLE ELECTROMAGNETIC SPECTRUM



Spectral Emission Characteristics of High Intensity Discharge Sources

(Infra-red not included)

Principal Lines (Nanometers)

Mercury: 334.2, 365-366.3, 390.6, 404.7-407.8, 433.9, 434.7, 435.8, 491.6, 546.1, 577-579.

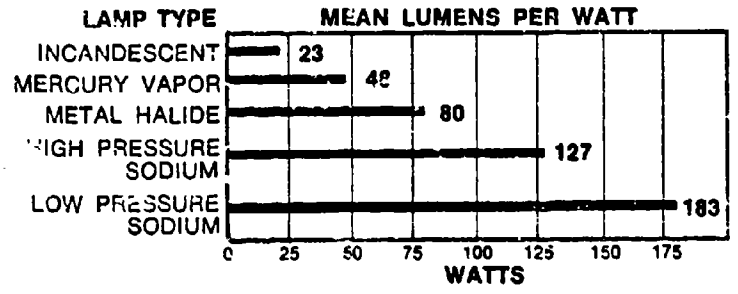
Scandium: 390, 436, 474, 508, 672

Sodium: 466, 498, 570, 584, 598, 614, 630-650

The visible radiation from the sodium lamp is yellow and largely monochromatic, consisting almost entirely of two special lines at 589.0 and 589.6 Nanometers. This closely corresponds to the peak response of the human eye (560.0 NM). Therefore, all light is produced in the most efficient area of eye response—the color amplifies contrast and is restful to the eye.

HIGHEST LUMENS PER WATT

No matter what anyone else tells you, the low pressure sodium **Super SOX** lamp is the most efficient light source known to man. None of the recent advantages in the field of high pressure discharge lamp has reduced the importance of the low pressure sodium lamp as the supreme source in applications where the highest possible luminous efficacy is the decisive factor influencing choice. The **Super SOX** low pressure sodium lamps are up to eight times more efficient than incandescent. They are four times more efficient than mercury vapor lamps. Up to two and one half times more efficient than metal halide lamps and even 46% more efficient than high pressure sodium lamps, the second most efficient light source made by man.



LIFE

A satisfactory life and the absence of early failures is a primary characteristic of **Super SOX** sodium lamps. Ultimate failure generally results from exhaustion of the emissive materials and to a secondary degree from absorption by the glass of the argon gas. The rated average life of all types of sodium lamps is 18,000 hours. Lumen maintenance is 95% approx.

WATTS

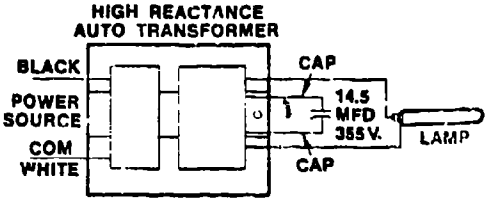
The lamp watts through life for a **Super SOX** tapered film lamp produces a constant wattage operation whereas other types of lamps exhibit a marked rise in watts during life.

CONSTRUCTION

Not all Sox lamps are of similar construction. The new **Super SOX** low pressure sodium lamp is an entirely new concept in which the conventional dimple type construction has been eliminated. The new lamp utilizes a coating on the outer glass envelope with a heat reflecting film relatively thick at the U bend end and tapering off to almost one third as thick at the electrode end. The film has the property of absorbing almost no visible light, so there is no reduction in light output. Also with all the sodium initially at the U bend end, much closer control of lamp is possible. This produces a maintained brightness over the whole lighting length of the lamp life.

BALLAST DESIGN

Trouble free operation, long lamp life, simple ballast design. When you vary the line voltage ±10% your wattage output will vary only ±4%.



Dual wattage ballast design.
55 watt ballast will also operate a 35 watt lamp.
180 watt ballast will also operate a 135 watt lamp.

SUPER SOX COST SAVINGS

Here's how three different lamps compare in efficiency, power consumption and lighting cost. (Based on the industry average of 54 lighting fixtures per mile of interstate highway.)

When comparing three different light sources in efficiency, power consumption, and lumen output, based on the industry average of 54 luminaires per mile of interstate highway, converting to low pressure sodium would save over $1,000.00 per mile per year in operating lamp cost and over 50,000 Kilowatts per mile per year.

Lamp Type	Number of Fixtures	Efficiency Lumens/ Watt	KW Consumed/ Mile	Annual Lamp Operating Costs*
low pressure sodium (SOX 180W)	54	183	9.72	$ 850.00
high pressure sodium (400W)	54	117	21.5	$1,890.00
mercury vapor (400W)	54	54	21.5	$1,890.00

*In dollars per mile.

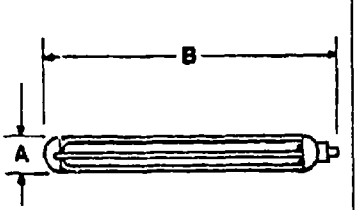
Ordering Information

Super SOX L.P.S. Lamp Information

Lamp Watts	Bulb	Base Design Bayonet	Ordering Abbreviation	Rated Aver. Life, Hrs.	Approximate: Lumens Initial	Lumens Mean	Description See below
35	T-16	B.C.	SOX 35	18000—	4600	4508	1, 2, 3, 4, 5, 6, 7, 8, 9 and 10
55	T-16	B.C.	SOX 55	18000—	7650	7497	
90	T-21	B.C.	SOX 90	18000—	12750	12495	
135	T-21	B.C.	SOX 135	18000—	22000	21560	
180	T-21	B.C.	SOX 180	18000—	33000	32340	

Dimensions

A Bulb Dia.	Light Center Length	B Max. Overall Length	Std. Pkg. Qty.
2⅛	6¾	12¹³⁄₁₆	12
2⅛	9	16¾	12
2¹⁵⁄₁₆	11	20¾	6
2¹⁵⁄₁₆	16	30½	6
2¹⁵⁄₁₆	22⅝	44⅛	3



1. Rated average life is the life obtained on the average, from large representative groups of lamps in laboratory tests under controlled conditions at 5 or more burning hours per start. It is based on survival of at least 50% of the lamps and allows for individual lamps, or groups of lamps, to vary considerably from the average.
2. Performance may not be satisfactory unless operated within specified burning positions. See operating position page 8.
3. Starting supply voltage must be held to 10 volts of rated line voltage.
4. Lamps will start down to −58°F.
5. Suggested maximum capacity temperature: 210°C.
6. Requires a ballast specified or approved for Sox lamps. 35 watt ballast will also operate 55 watt lamp. 135 watt ballast will also operate 180 watt lamp.
7. Color: not on Black Body Locus but monochromatic at 3,896 nm.
8. C.I.E. chromaticity: x = .575 y = .425
9. Warm-up time: 50% full 7 minutes; 100% 15 minutes.
10. ELECTRICAL CHARACTERISTICS:

Nominal lamp watts:	35W.	55W.	90W.	135W.	180W.
Nominal lamp volts:	70	109	112	164	240
Nominal lamp current (amps):	0.6	0.6	0.95	0.95	0.91
Starting line current less than line operating current:					
Nominal lamp starting volts R.M.S.:	390	410	420	520	600

... there's no substitute for Quality
Quality Outdoor Lighting • Northbrook, Illinois 60062 • (312) 498-6540

Printed in U.S.A. 7-6

Norelco®
SOX

LOW PRESSURE SODIUM LAMPS FROM NORTH AMERICAN PHILIPS.

The modern generation of low pressure sodium lamps (SOX) incorporates more than forty years of research and development in lamp technology.

With efficiencies up to 183 lumens per watt; SOX are the most economic lamps available in the world for public and industrial applications. Coupled with this technological breakthrough in efficiency, SOX lamps maintain their initial lumen output throughout a rated life of 18,000 hours.

All SOX lamps are of similar construction. A borate coated, sodium resistant "U-Bend" discharge tube is enclosed in an integral vacuum jacket. This vacuum jacket is internally coated with indium oxide to maintain optimum operating temperatures. (See figure No. 1)

The spectral light output of a SOX lamp (589.0 nm.) closely corresponds to the peak response of the human eye (560.0 nm.). This feature of low pressure sodium lamps economically creates improved nighttime visibility. (See figure No. 2)

Whereas some lamps are limited in their applications due to weather conditions, SOX lamps ignite and operate normally irregardless of ambient temperatures. No rise in ignition voltage or loss in light output is ever experienced by the influence of temperature variations.

FEATURES

- **Highest Efficiency of Any Commercially Available Lamp (Max. of 183 Lumens Per Watt)**
- **Optimum Lumen Maintenance (100%)**
- **Long, Reliable Life (90% Survival at 10M Hours)**
- **Low Current Operation**
- Low Surface Brightness
- Low Operating Temperature
- No UV Output
- Non-Insect Attracting
- High Performance in Fog/Mist Conditions
- Sodium is a Non-Polluting Element
- Suitable for Operation with Photo Control
- Overall Reduction in Maintenance Costs

APPLICATIONS

- Highway Lighting
- Traffic Intersections
- Railway Yards, Harbors, and Docks
- Railway Crossings
- Pedestrian Crossings
- Flood Lighting
- Industrial Lighting
- Quarries and Mines
- Specialized Quality Control Applications
- Shipyards
- Tunnels and Underpasses
- Security Lighting

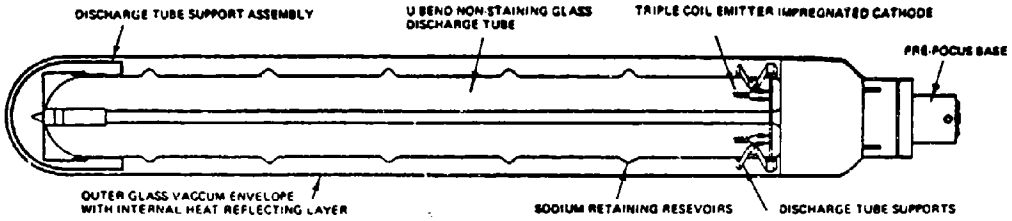
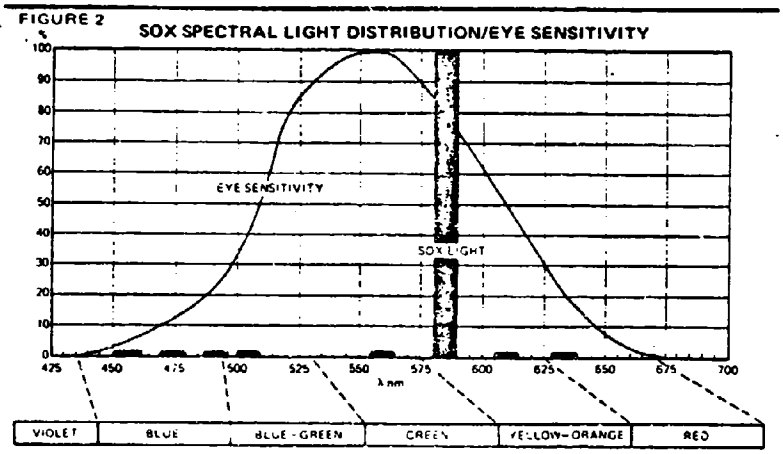


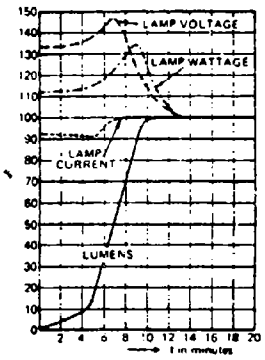
FIGURE 1

FIGURE 2

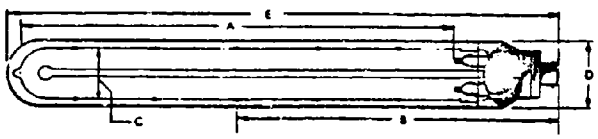
SOX SPECTRAL LIGHT DISTRIBUTION/EYE SENSITIVITY



LAMP PERFORMANCE DURING STARTING PERIOD

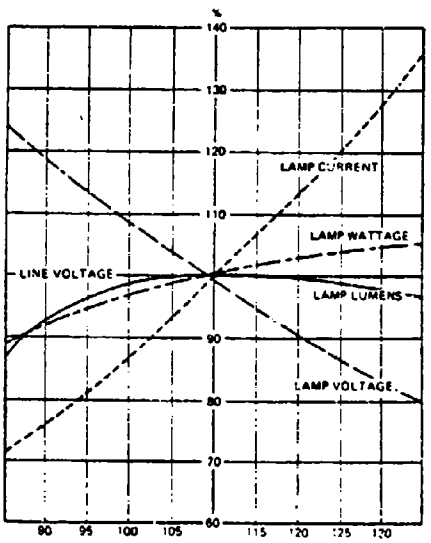


APPROXIMATE DIMENSIONS OF LAMPS



Lamp type	35 W	55 W	90 W	135 W	180 W
A (in)	7 9/16	12	15 7/8	25 7/16	38
B (in)	7 1/4	9 9/16	11 1/2	18 3/8	23
C (in)	1 7/16	1 7/16	1 13/16	1 13/16	1 13/16
D max. (in)	2 1/8	2 1/8	2 11/16	2 11/16	2 11/16
E max. (in)	12 3/16	16 3/4	20 3/4	30 1/2	44 1/8

EFFECT OF LINE VOLTAGE VARIATION ON SOX LAMP PERFORMANCE



CHARACTERISTICS OF SOX LAMPS

Lamp designation	Starting voltage V	Lamp voltage V	Lamp current A	Luminous flux 1) lm	Starting luminance cd/cm²	Starting period 2) min	Weight
SOX 35 W	380	70	0.600	4650	10	7	8 oz
SOX 55 W	410	105	0.980	7700	10	7	13 lbs
SOX 90 W	420	115	0.940	12500	10	9	1 lb 3 oz
SOX 135 W	575	160	0.950	21500	10	9	1 lb 14 oz
SOX 180 W	575	245	0.910	33000	10	9	2 lb 6 oz

1) After 100 burning hours
2) The number of minutes after which the lamp has reached 80% of the max. luminous flux.

ORDERING AND PACKAGE DATA

Lamp designation	Zip code	Ordering abbreviation	Packing unit Qty	Weight lbs	Dimensions in			Volume ft³
SOX 35 W	AW 21	SOX 35	9	11	12 3/4	12 3/4	18 1/8	1.73
SOX 55 W	AW 22	SOX 55	9	15	12 3/4	12 3/4	22	2.08
SOX 90 W	AW 23	SOX 90	9	22	14	14	26 3/16	2.98
SOX 135 W	AW 24	SOX 135	9	29	14	14	39 3/16	4.41
SOX 180 W	AW 25	SOX 180	9	44	16 9/16	16 15/16	53 3/4	8.11

SOX LAMP LIFE WATT CONSUMPTIONS

LAMP	HOURS 100	2000	5000	10,000	18,000
SOX 35 W	36 W	37 W	36 W	41 W	44 W
SOX 55 W	53 W	57 W	58 W	65 W	62 W
SOX 90 W	90 W	93 W	100 W	116 W	122 W
SOX 135 W	130 W	140 W	149 W	173 W	178 W
SOX 180 W	176 W	187 W	211 W	220 W	241 W

August 15, 1975

Mr. R. S. Bruns
P.O. Box 05456
Greenville, South Carolina 29606

Dear Mr. Bruns,

Re: Security Lighting/Charleston, S.C. Naval Facility

I have contacted our Laboratories with a view to obtaining more specific data regarding the hot re-ignition characteristics of low pressure sodium lamps but as mentioned, this will take some time to obtain. Based on experience, I would advise the following in the interim:

1. 35 and 55 watt lamps will re-ignite immediately following a power drop-out with a reliability factor of plus 95%.

2. 90, 135 and 180 watt lamps will re-ignite immediately following a power drop-out with a reliability factor of plus 75%.

3. Lamps that do not re-ignite immediately will strike within a maximum of 2 minutes.

4. The amount of light produced when lamps re-ignite will be dependent upon the duration of outage. In general if power is restored within 30 seconds, those lamps which re-ignite immediately will produce 90% plus of their maximum light output.

5. Normal "run-up" time for a cold lamp to full output will be a maximum of 10 minutes.

Recently I had the occasion to visit a 224 floodlight installation (SOX 180W lamps in SNF027 fixtures) at Port Elizabeth, N.J. In the course of our inspection power was cut and restored in approximately five minutes. All lamps visible from our point of viewing re-struck immediately and with sufficient output to

Letter from representative of North American Philips Lighting Corp.

ATTACHMENT 3 3-1

make work in the area possible.

The enclosed literature covers the range of Norelco low pressure sodium lamps and fixtures; but, should you have specific questions please don't hesitate before contacting me. Because of the nature of the project you are working on, and in order to minimize delays in communication, it is felt that we can best serve you directly from Hightstown, rather than via our Atlanta Office.

I would call your particular attention to the enclosed documentation on the catenary system of lighting. Based on your advise I would suggest this would be the most economic and light technically correct approach to adopt.

When and if you feel a meeting with yourself and/or the Naval engineers is required, arrangements can be made to suit your convenience.

Personally I look forward to hearing from you and working with you to resolve this highly interesting lighting project.

Yours sincerely,

Robert A. Lewis
Corporate Commercial Engineer

RL:dm
Enclosures

cc: A. L. Merken
J. A. Donmoyer
R. Ricchiuti (For Information Only)

1 2 8
(Navy)

July 31, 1975

Department of the Navy
Southern Division
Naval Facilities Engineering Command
2144 Melbourne St.
P.O. Box 10068
Charleston, S.C. 29411

Code 404
(C.T. Paysinger)

Subject: Series 4000 Luminaire for Low Pressure Sodium

Gentlemen:

Enclosed is the information which you requested on our Series 4000 Low Pressure Sodium Luminaire. Our catalog sheet describes the fixture size, material, beam spreads and other construction features. The candlepower distribution curves provide the information on maximum candlepower, lumen efficiency and other photometric data.

The lamp information is provided on the North American Phillips (lamp manufacturer) Lamp Data Sheet. This sheet provides lamp sizes, dimensions, lumen output, power consumption thru lamp life. The lamp has a rated life of 18,000 hours with 90% survival at 10,000 hours. The lamp lumen maintenance is 100% over life of the lamp. This burning position for the 90 watt, 135 watt, and 180 watt lamps is horizontal plus or minus 20% of horizontal.

The latest information from the lamp manufacturer is that 90% of the lamps will restrike immediately with interruptions up to 5 minutes. The other 10% will take up to 58 seconds to restrike. If the line voltage is 10% less than ballast rating the restrike times will be the same but the lumen output will be less than full intensity and will take time to come back to normal full intensity.

ATTACHMENT 4 c,

I hope that we have provided all of the answers to your questions. If not, or if you have further questions please let me know. At this time I would also like to offer any assistance that we can provide in helping to layout any project that you have or review your designs.

Very truly yours,

SEPCO LIGHTING DIVISION
Connecticut International Corp.

Frank Locke
Sales Engineer

FL/bak

NORTH AMERICAN PHILIPS
LIGHTING CORPORATION

HIGHTSTOWN, NEW JERSEY 08520

TELEPHONE: (609) 448-4000

February 4, 1975

Mr. Richard Anderson
NAPLC
255 W. Carob Street
Compton, California 90220

Dear Mr. Anderson

With reference to questions raised by the Bechtal Corporation I would confirm the following points relating to sodium lamps.

Low pressure sodium vapor lamps (SOX) supplied by the North American Philips Lighting Corporation do not contain mercury in any form. The only elements present in the lamp discharge tube are sodium and a small quantity of neon-argon mixture (99%-1%), the function of which is to initiate the discharge. The tungsten electrodes are impregnated with a rare earth oxide to assist in ignition.

Conversely, high pressure sodium lamps contain sodium in the form of a sodium - mercury amalgam. In this case, xenon is normally used as a "starter gas."

SOX lamps can be safely employed in lighting installations where there are severe restrictions on the presence of mercury such as in proximity to nuclear reactors.

With kind regards,

Yours sincerely,

Robert A. Lewis
Corporate Commercial Engineer
Discharge Lamps & Fixtures

RAL/sv
cc: G. Gedney
L. Pintak
B. Yates

ATTACHMENT 5 5-1

Survey results

SURVEY OF PUBLIC REACTION TO LOW PRESSURE SODIUM LIGHTING. CITY OF LONG BEACH, CALIFORNIA

Residential Test Installation

Replacement of 175W mercury vapor with 55W LPS

Public response:

1.	Do you approve of the new light fixtures in appearance?	85% Yes
2.	Do you find the new light color objectionable?	74% No
3.	Do you prefer the previous mercury vapor lights?	72% No
4.	Is visibility as good with the new lights?	76% Yes
5.	Even if there were some objection to the new type lights, do you feel the energy saving justifies the installations?	89% Yes

Power consumption reduced by 70%

Business Street/Shopping Center Installation

Replacement of 700W mercury vapor with 180W LPS

Public response:

1.	Do you approve of the new lights in appearance?	96% Yes
2.	Do you find the new light color objectionable?	88% No
3.	Do you prefer previous mercury vapors	80% No
4.	If your customers have made comments on the new lights, have they been generally favorable?	81% Yes
5.	Even if there were some objection to the new type lights, do you feel the energy saving justifies the installations?	92% Yes
6.	Do you feel the new type lights have affected business in the shopping center?	92% No change or favorably

Lighting levels up approximately 10% and power consumption has been reduced by 74%.

ATTACH. 6

SOURCES OF LOW PRESSURE SODIUM LIGHTING EQUIPMENT

A. Luminaires

1. Architectural Area Lighting Co.
   Subsidiary of LCA Corp.
   13901-13 South Carmenita Rd.
   Sante Fe Springs, CA 90670

2. American Electric ITT
   Southhaven, MS 38671

3. Benjamin Electric Mfg. Co.
   P. O. Box 180
   Spartan, TN 38583

4. Devine Lighting
   Division of LCA
   4546 East 11th St.
   Kansas City, MO 64127

5. Guth Lighting
   Division of Sola Basic
   P. O. Box 7079
   St. Louis, MO 63177

6. J.H. Spaulding Co.
   Division of LCA/Whiteway
   3731 Dirr Street
   Cincinnati, OH 34223

7. Lustra Lighting Corp.
   180 Manor Road
   East Rutherford, NJ 07073

8. Natale Machine & Tool Co.
   Broad St. & 13th St.
   Carlstadt, NJ 07072
   (35W Floodlight only at present)

9. North American Philips (Norelco)
   Lighting Corporation
   Hightstown, NJ 08520

10. Omega-Lite
    3715 Woodmont
    Toledo, OH 43613

11. Quality Outdoor Lighting
    3535 Commercial
    Northbrook, IL 60062

12. Red Dot Lighting
    L E Mason Co.
    98 Business Street
    Boston, MA 02136

13. Sepco Lighting Division
    Connecticut International Corp.
    9 Britton Road
    Bloomfield, CT 06002

14. Streetlighting Equipment Company
    3123 61st Street
    Woodside, NY 11377

15. Stonco Lighting Division
    Keene Corporation
    2345 Vauxhall Road
    Union, NJ 07083

16. Trimblehouse Corp.
    P. O. Box 726
    Norcross, GA 30071

17. Verd-A-Ray Corp.
    615 Front Street
    Toledo, OH 43605
    (Services as marketing arm
    of Norelco)

18. Voight Lighting Industries, Inc.
    135 Fort Lee Rd.
    Leonia, NJ 07605

B. Ballasts*

Advance Transformer Co.
2950 Western Ave.
Chicago, IL 60618
(Norelco lamps)

Jefferson Electric Co.
Division of Litton Systems, Inc.
Bellwood, IL 60104
(GEC lamps)

C. Lamps*

General Electric Co. Ltd. of England
(Available from Quality Outdoor Ltg.)

Phillips Corporation of Holland
(Available from other companies listed under "A".)

*NOTE: Lamps are readily interchangeable. There is no adverse effect on either ballasts or luminaires.

SAMPLE LIST OF LOW PRESSURE SODIUM INSTALLATIONS AND STUDIES

A. Installations of L.P.S. Lighting.

Elizabeth Port Authority Marine Terminal
New Jersey - 224 Norelco 180W units

State of Illinois, Division of Highways
Expressway Lighting on Interstate 55
1971, 180W units replaced 400W mercury vapor

Hawthorne, California
Roadway Lighting, November 1974
135W Norelco

Parking Lot, Penn Harris Motor Inn
Camp Hill, Pennsylvania

New York City
Highway Lighting, 1971

Energy Research & Development Administration
(ERDA), Germantown, Maryland
Roadway & Parking Lot Lighting
135W Units, June 1975

B. Organizations that have Studied L.P.S. Lighting.

Navy Public Works Center
Code 423
P. O. Box 113
San Diego, Calif. 92136

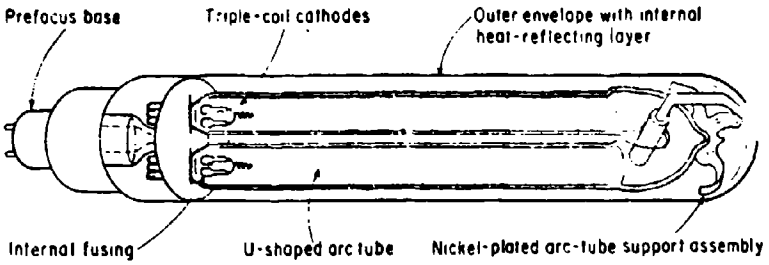
Southern Division
Naval Facilities Engineering Command
P. O. Box 10068
Charleston, S. Carolina 29411

LPS being considered for Naval Air Stations at Charleston, S.C. and Jacksonville, Florida)

C. Miscellaneous - Other Reported Installations or Studies.

Robbins AFB
A.F. Logistics Command
Chicago Naval Air Station
Bronx Whitestone Bridge, New York City - 1974
Port Elizabeth, New Jersey

Attachment #8



CONSTRUCTION FEATURES of typical U-shaped LPS lamp. Overall length of a 180-watt lamp is 44 in., and its diameter is almost 3 in.

Low-pressure-sodium lamps: a way to conserve energy

Improvements in lamp design and concern over rising fuel costs have stimulated a renewed interest in this unique source of light.

By WILLIAM A. WEIBEL
Lighting Consultant, P.E., F.I.E.S.

THE SPOTLIGHT has centered on the development of the high-pressure-sodium lamp during the past decade; however, steady progress was also being made in improving the efficiency and usefulness of the *low-pressure*-sodium (LPS) lamp, which first appeared during the early 1930s.

The importance today of cutting energy wherever possible has stimulated new interest in the LPS lamp. This article is intended to review its characteristics, principle of operation, construction, and possible uses.

Characteristics and operation

Light is produced in the LPS lamp by the passage of an electric current through sodium vapor. The principle is very similar to that of other high-intensity discharge sources (mercury-vapor, metal-halide, high-pressure-sodium); however, the LPS lamp differs in essential details of operation and light-output characteristics that make it unique.

As with other arc-discharge lamps, light output of the LPS lamp is critically dependent upon the arc-temperature and vapor pressure. Initially, the lamp utilizes one or more starting gases (neon, argon, xenon and helium) within the discharge tube to initiate an ionization path for the current flow, since sodium is in solid form below 98C and has a very low vapor pressure. As ionization and temperature increase, the sodium vaporizes. Initially, the light has the characteristic red color of neon; but as temperature and pressure increase and the sodium vaporizes fully, the color changes to yellow.

Starting time of the LPS lamp is 10 to 15 minutes, depending upon lamp type, size, and application. It is not affected by ambient temperatures between -50C and +40C, and when the lamp reaches full output, ambient temperatures have an insignificant effect on operating characteristics because of the insulation provided by the vacuum within the space between the discharge tube and the outer bulb.

A relatively low temperature of 270C is maintained in the discharge tube while the lamp is operating. Because of this, the restart period of the LPS lamp after a power interruption is only about one minute—the time for temperature and pressure to decrease to starting conditions. (Other discharge lamp types, such as mercury, with much higher operating temperature and pressure, have a restart time of three to seven minutes.)

Most higher-wattage LPS lamps should be operated with the major, longitudinal axis of the lamp at or within 20 deg of the horizontal. This positioning assures a more uniform temperature in the discharge tube and distribution of the sodium for optimum light output and lamp life.

The output of the LPS lamp is concentrated almost completely in two narrow bands of wavelength, at 589.0 and 589.6 nanometers* (yellow region). Since other wavelengths in the visible region of the electromagnetic spectrum essential for good color rendition are lacking, colors other than yellow that are present in an object will appear distorted under the LPS lamp. However, this monochromatic light emission occurs very near to the most-sensitive point of response (555 nanometers) of the human eye. This means a very high utilization of muscular and nervous energy involved in a seeing task is achieved, and electrical energy usage for a given level of illumination is maximized.

The efficacy* of the LPS lamp varies from 131 to 183 lumens per watt (lpw), depending upon the wattage (see Table 1). Efficacies of other familiar light sources are compared in Table 2. (The 1000-watt size was chosen for these other sources because the efficacies of these lamps is highest at this wattage.)

The early LPS lamps had a low 50 lpw efficacy. Present values indicate that considerable progress has been made in design and construction

*A nanometer is a unit of wavelength equal to one-millionth of a millimeter

*The efficacy of an electric lamp is the ratio of emitted luminous flux to power input, expressed in lumens per watt.

ATTACHMENT 9 177

Table 1. Low-pressure-sodium lamp characteristics*

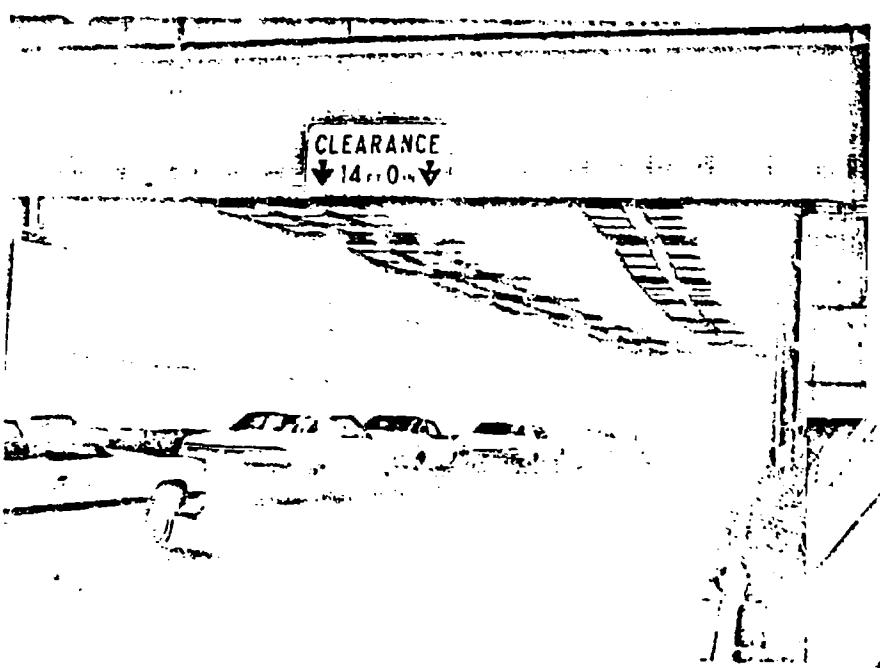
Lamp rating (watts)	Bulb length (in.)	Bulb diameter (in.)	Initial output (lumens)	Luminous efficacy (lpw)
35	12¼	2⅛	4,600	131
55	16¾	2⅛	7,700	140
90	20¾	2 11/16	12,750	142
135	30½	2 11/16	22,000	163
180	44	2 11/16	33,000	183

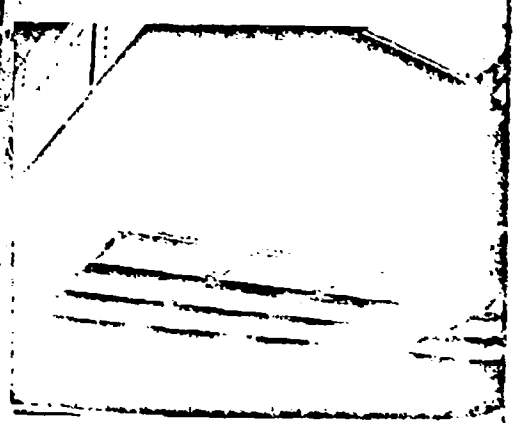
*Composite of presently available U-tube lamps with a life rating of 18,000 hours.

Table 2. Selected lamp type efficacies

Lamp type	Rating (watts)*	Output (lumens)	Efficacy (lpw)
Incandescent, PS-52	1,000	23,000	23
Mercury, clear, BT-56	1,000	57,000	57
Fluorescent, 1500 ma	215	16,000	74
Metal halide, BT-56	1,000	100,000	100
High-pressure sodium, T-18	1,000	140,000	140
Low-pressure sodium, T-21	180	33,000	183

*Wattages were chosen to show highest efficacies of each lamp type.





TUNNEL ILLUMINATION used to provide visual transition or adaptation from full daylight is typical application of low-pressure-sodium lamps. The criterion for this test installation in Philadelphia, Pa., was 1000 fc at the entrance, accomplished by using 51-by-26-in luminaires ceiling-mounted in five rows for 500 ft inside the tunnel. Temporary wall of plywood panels at left separates traffic lanes to insure accurate light measurements. Closeup (right) shows mirror-finished reflectors each carrying either two 180-watt lamps or one 180- and one 90-watt lamp. A glass lens seals the lamp enclosure.

Further improvements can be expected with refined heat conservation procedures, and efficacies of 200 lpw and higher could soon be a reality.

Construction

The accompanying drawing shows the construction of low-pressure-sodium lamps available in this country. (The LPS lamp is not manufactured in the United States; it is imported from Europe.) The lamp is characterized by a relatively long arc tube that is doubled back on itself to achieve convenient dimensions for a luminaire enclosure. (A linear, non-U-shaped lamp is also produced and used in Europe.)

The LPS lamp shown has a large-diameter arc tube and a two-pin, single-bayonet-type base at one end. In some types of lamps the sodium metal is distributed through the discharge tube using dimples or reservoirs spaced along the length of the tube. These reservoirs, which act as cold spots, keep the sodium in the proper location for a continuous discharge. Another type of lamp accomplishes the distribution of sodium by use of a tapered, invisible, heat-reflecting film deposit of indium oxide on the inside surface of the outer jacket which acts as a reflector to the infrared heat radiation emitted by the arc. This helps maintain the required 270C surface temperature of the arc tube by turning back the heat energy that otherwise would be dissipated by the lamp.

Sodium vapor is exceedingly reactive at high temperatures and chemically attacks most glasses, especially those which contain silica. Resulting

Table 3. LPS lamp ballast characteristics*

Lamp rating (watts)	Input voltage (volts)	Input wattage (watts)	Starting voltage (volts)	Ballast weight (lbs)
35	240/120	60	390	7
	480	60	390	6
55	240/120	80	410	7
	480	80	410	6
90	240/120	125	420	10
	277	125	420	10
	480	125	420	10
135	240/120	178	575	16
135	277	178	575	16
	480	178	575	16
180	240/120	220	600	16
	277	220	600	16
	480	220	600	16

*Typical of presently available ballasts for single U-tube lamps, built-in for power-factor correction to 90% or above.

reduction of light output and actual disintegration of the arc tube caused a great deal of trouble in the past. However, special types of glass with silica largely replaced by boric oxide (to resist the sodium vapor) and laminated with lime-soda glass (to resist moisture) are now used to provide better stability of arc-tube materials.

Another early problem, the tendency of the glass to absorb argon during operation of the lamp, has been overcome with advancements in glass technology.

Ballasts

The LPS lamp, as other electric discharge lamps, requires the use of auxiliary electrical controls (ballasts) to supply necessary starting voltage and to limit operating current. This control of current is necessary because the electrical impedance of an arc discharge decreases with an increase of arc temperature, and the lamp could rapidly draw more current until it destroyed itself.

Electrically, LPS ballasts are similar to those used with mercury and metal-halide lamps and do not require the special high-voltage pulse required to start most of the high-pressure-sodium lamps. This simplifies the ballast design and improves the possibilities for trouble-free operation.

The minimum starting voltage ranges from 480 to 650 volts, depending on lamp size. Most ballasts used are the high-reactance transformer type, but lamps using reactor ballasts are satisfactory for a 480-volt supply circuit, since they receive the required voltage level in the starting pulse. The high-reactance ballast has better voltage regulation and a higher power factor than the reactor type, and in a case where a choice is available, it is generally preferred. Some lamp types using reactor ballasts increase their wattage requirements as they age, so that the electrical distribution system must be sized for the lamp's end-of-life requirements which can be 40 per cent higher than the initial lamp wattage rating.

Ballast total input wattage ranges from 60 to 220 watts, depending on lamp size. As lamp and ballast wattage increases, there is a significant improvement in ballast efficiency, with a greater percentage of the ballast input watts appearing as lamp watts. See Table 3.

Luminaires

Several manufacturers have complete lines of luminaires for outdoor application of LPS lamps, and other firms are developing models or contemplating entering the market. The luminaire housing used today is normally an aluminum, one-piece casting or an extrusion cut to length with end castings secured by continuous welding. Housings may have a baked enamel finish on the inside and outside surfaces. The lens is of glass or plastic (which is possible because of the relatively low operating temperature of the lamp), with either a flat or deep bowl configuration. Gasketing for the enclosure is ozone-resisting neoprene, pure wool (treated to resist moisture and heat) or an equivalent material.

The luminaire optical system, depending on the light distribution desired, may have a reflector and refractor combination or just a reflector with a clear, flat, enclosure cover. Units are available with either a cutoff, semicutoff or noncutoff light distribution, depending on optical system and lamp position within the housing. One luminaire, for example, has a lamphold[illegible] mounting which is adjustable in three vertical positions for a choice of candlepower distributions.

Applications

The decidedly yellow color of the LPS lamp limits its application. However, based on extensive studies of its use for roadway lighting, light from the lamp gives the impression of greater brightness (for a given road surface luminance, for example) and provides greater visual acuity, greater speed of perception, and less discomfort glare than other popular roadway lighting systems.

At roadway intersections or pedestrian crossings, the lamp color can serve as a sign of caution to the motorist. In Europe, the LPS source is used for bypass roadways around large metropolitan areas, while mercury lamps light ramps and feeder roads. This provides an effective "color-coding" of such bypass roads, making their location and configuration readily discernible at a considerable distance.

Other applications where color discrimination is not an essential factor but where high efficacy, low wattage and other factors influencing system cost, installation, and maintenance can be of real and continued value include pedestrian crossings, bridges, railway crossings, tunnels and underpasses, shipyards, docks, industrial yards, quarries, mines, railroad yards, and large construction sites. Continuing concern for the optimization of electrical energy requires careful consideration to the possible use of the low-pressure-sodium lamp for applications such as these.

A Second Look At Low-Pressure Sodium

R. Stark and H. Cossyphas

An indirect roadblock to improved night visibility on expressways and at major intersections is the general assumption that advancements in this area would logically result in rising electrical energy costs. This impediment, and more practical demands for improved night visibility, prompted the State of Illinois Division of Highways to experiment with low-pressure sodium lighting along a one-mile stretch of heavily trafficked interstate highway. To the authors' best knowledge, this is the first major expressway installation of high-efficacy low-pressure sodium lamps in the United States.

Stevenson Expressway, a six-lane divided highway and a major Chicago artery, was undistinguishable with regard to lighting from other major interstates feeding metropolitan areas—until one year ago. At that time, an experimental one-mile long lighting installation of low-pressure sodium lamps became operable as the initial phase of a research program sponsored by the State of Illinois Division of Highways.

Stevenson Expressway, U. S. Interstate 55, was chosen as the site of the experiment since it lends itself easily to the evaluation of a lighting system under foggy or smoggy conditions. Prior to the experimental installation, mercury luminaires were used on the entire length of the road.

Because of cost considerations, the experiment was restricted to existing light standards and their locations. The 400-watt mercury luminaires simply were replaced with 180-watt tubular U-shaped low-pressure sodium units. The standards are set 14 feet back from the edge of the pavement, and are spaced at 150 feet. They are equipped with 12-foot mast arms which provide a 34-foot mounting height (Figure 1).

Both luminaires, mercury and low-pressure sodium, (Figure 2) met the IES categorization for medium vertical distribution, Type III lateral distribution, and semi-cutoff vertical control.

Performance data from the experiment were gathered to compare and evaluate the low-pressure sodi-

The Authors: Mr. Stark is a Registered Professional Engineer working as regional electrical engineer with the State of Illinois Dept. of Transportation, and a past chairman of the IES Roadway Lighting Committee. Mr Cossyphas is a Registered Professional Engineer working as special studies engineer with the State of Illinois Dept. of Transportation.

ATTACHMENT 10 p. 1

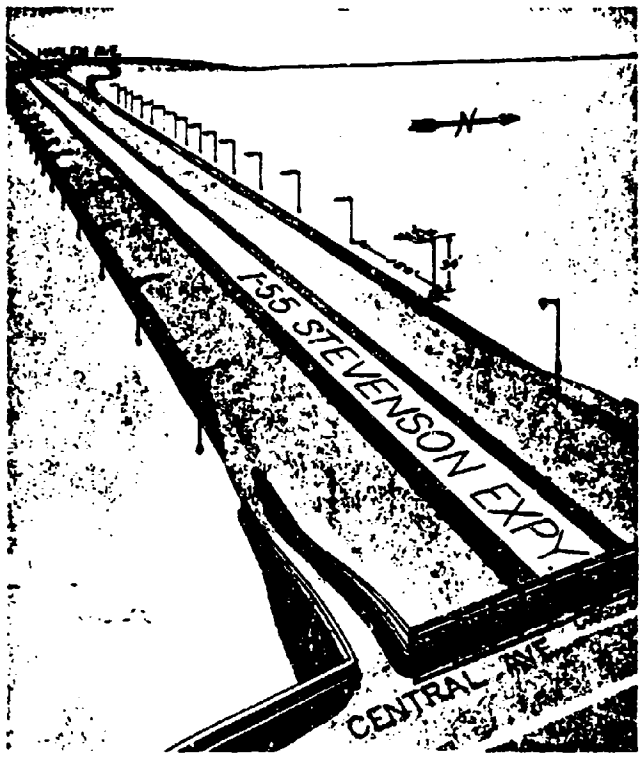


Figure 1.

um and mercury installations in terms of:

Average Horizontal Illumination
Average Vertical Illumination
Uniformity of Illumination
Glare
Color Rendering
Sign and Delineation Visibility
Efficacy and Efficiency
Maintenance
Economics
Safety
Public Reaction and Preference

Photometric measurements from both sources were obtained by an illumination recorder. Instrumentation and operation of the recorder have been documented in previous studies.[1,2]

Horizontal illumination readings were taken with the sensing photocell mounted on the roof of a passenger vehicle, approximately five feet above the pavement. The sensing photocell was also mounted on the back side of the rear bumper, about one and one-half feet above the pavement, for vertical illumination readings. The test vehicle was driven at an approximate speed of 45 mph.

Portions of the strip chart outputs of the illumination recorder are illustrated in Figures 3 through 10, representing horizontal and vertical illumination levels for two eastbound lanes and two westbound lanes. These charts show readings for the same 1200-foot long expressway stretch. Results of the strip chart recorder outputs made possible the necessary calculations for average illumination, mean deviation, uniformity ratio, and uniformity of illumination.[3]

These results are represented in

Table I—Photometric Results

COMPONENT		Horizontal						Vertical					
DIRECTION		Eastbound			Westbound			Eastbound			Westbound		
LANE NO.		1	2	3	1	2	3	1	2	3	1	2	3
Mercury Vapor	$\bar{E}$.	.66	1.12	1.07	.69	1.1	1.07	0.58	0.65	0.60	0.56	0.61	0.58
	M.D.	0.248	0.485	0.446	0.21	0.474	0.445	0.175	0.218	0.215	0.174	0.214	0.212
	U.R.	1.7	2.38	2.85	1.68	2.40	2.81	1.45	1.62	2.	1.47	1.6	2.1
	U.I.	62.4	56.8	58.5	69.5	57.0	58.4	69.9	66.5	64.1	69.	65.	63.5
Low Pressure Sodium	$\bar{E}$.	1.02	1.58	2.32	1.04	1.61	2.34	0.75	0.95	1.06	.74	.93	1.02
	M.D.	0.175	0.517	1.137	0.171	0.645	1.198	0.098	0 225	0.315	0.092	0.222	0.313
	U.R.	1.22	1.7	2.5	1.2	1.7	2.5	1.87	1.9	1.77	1.89	2.05	1.8
	U.I.	82.6	62.3	51.1	83.6	59.9	48.9	87.	76.4	70.3	87.6	76.2	69.4

Table I for convenient comparison of the two systems. It should be noted, however, that mercury lighting measurements were taken after the luminaires had been operating for 9000 hours without any washing maintenance for nine months preceding the experiment. Under this condition, one would expect the light flux output of the luminaires to depreciate by at least 20 per cent. Increases in horizontal illumination levels were much more significant for lane No. 3 than for any of the other lanes. Increases in illumination levels for all lanes would have been more consistent if the low-pressure sodium luminaires were uptilted by approximately five degrees from the horizontal plane. This adjustment could not be provided, however, because of design characteristics of the luminaire model used in the experiment.

High light flux densities were observed on the shoulder and house side of the expressway, eliminating transverse transitional adaptation difficulties. This increase in the width of the motorists' field of view is believed to enhance a feeling of security by alleviating the fear of seclusion, usually suggested by lighting systems that do not illuminate areas adjacent to the roadway, or which over-emphasize optical guidance. Results of disability[4] and discomfort[5] glares calculated for both systems are shown in Table II.

Table II—Glare-Contributions

	Mercury			Low-Pressure Sodium		
Lane	1	2	3	1	2	3
Disability (DVB in fl.)	.0397	.0854	.102	.0645	.117	.161
Discomfort (Avg. number)		7.112			7.058	

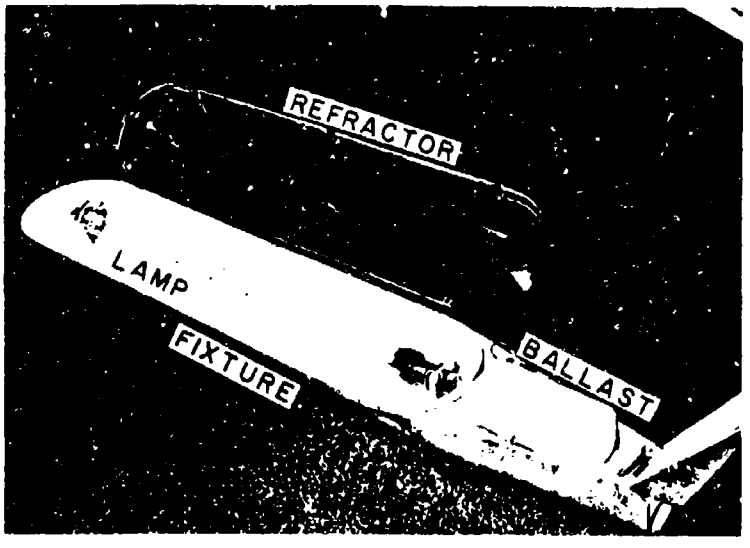


Figure 2. Low-pressure sodium luminaire.

Disability glare for the low-pressure sodium installation is considerably higher than that of the mercury system. (See Table II.) However, the resultant difference of loss in contrast between the two systems would not exceed five per cent in favor of the mercury system for any lane, even assuming equal illumination levels for both systems. It also is noted that the two systems offered numerically equivalent discomfort glare values. Of the two luminaires used in this experiment, the low-pressure sodium unit exhibits better discomfort glare control than mercury at comparable illumination levels.

A reduction in headlight glare from opposing traffic also was achieved by this installation. The increase in ambient illumination levels resulted in glare reduction from the headlights.

For multiple input information driving tasks, previous studies have shown that the effectiveness of highway signs depends on the target value technique employed.[6] A sign may fulfill the legibility criteria, but it remains ineffective unless it is actually read. It was observed that the yellow environment provided by the low-pressure sodium installation enhanced the noticeability of overhead directional signs lighted with fluorescent sources. The color contrast between the sign and the environment served as an attention gaining technique. The photometric characteristics of the illuminated signs were not otherwise

Motorists' Questionnaire

The State of Illinois, Department of Public Works and Buildings, is interested in your opinion concerning the low-pressure sodium lighting installation (yellowish lights), extending for one mile east of Harlem Avenue on the Stevenson Expressway.

Please answer only those questions which are clear to you; do not answer any questions on which you have no definite opinions.

1. How would you rank this lighting system in comparison to the lighting on the rest of the expressway, i.e., conventional lighting?

   Better—73% As Good—21% Worse—6%

2. Do you feel that this system provides more light on the road than the conventional system?

   Yes—81% No—5% Same as the Conventional —14%

3. Do you feel that this system offers more even light, i.e., less dark and bright spots on the pavement than the conventional lighting?

   Yes—89% No—5% Same as the Conventional —6%

4. Are the overhead signs more visible under this system than under conventional lighting?

   Yes—55% No—20% Same as the Conventional —25%

5. Are the signs located on the side of the road more visible under this system than under conventional lighting?

   Yes—54% No—20% Same as the Conventional —26%

6. Are the lane separating stripes more visible than under conventional lighting?

   Yes—66% No—16% Same as the Conventional —18%

7. Do these lights cause more glare than the other lights on the expressway?

   Yes—10% No—86% Same as the Conventional —4%

8. Is the true color of other vehicles on the road seen better under this system than under the conventional system?

   Yes—38% No—41% Same as the Conventional —21%

9. Can you see more of the ground adjacent to the road with this system than with the conventional system?

   Yes—78% No—8% Same as the Conventional —14%

10. Do you like this system?

    Yes—84% No—8% No Preference—8%

11. What do you like most about this system?

    Color—8% Amount of Light—26% Glare—9%
    Evenness of Light—30% General Visibility—27%

12. What do you dislike about this system?

    Color—55% Amount of Light—8% Glare—16%
    Evenness of Light—2% General Visibility—19%

13. If your answers above do not favor this lighting system, do you feel that your attitude might change by knowing that it costs less than conventional lighting?

    Yes—30% No—70%

14. Use this space for special comments, if any.

Please place this questionnaire in the attached self-addressed and post stamped envelope and mail it at your earliest convenience.

Your cooperation is highly appreciated by the division of highways.

affected. The visibility of the unlighted roadway signs appeared to be somewhat improved by the low-pressure sodium light due to the increase of light flux in the house side of the road. The lane separating delineation stripes were enhanced under this system because of the improved color rendering of the pavement and stripes themselves.

In the area of true (daylight) color rendering, the low-pressure sodium installation appeared inferior to the mercury system, as anticipated. Low-pressure sodium emits monochromatic luminous flux at a wavelength of 585 nm. No other appreciable radiation is emitted in the visible spectrum. Consequently, all colors—except yellow—appear distorted.

The high efficacy of the low-pressure sodium lamp, 175 lumens per watt, results in considerable savings in power and materials. In this experimental installation, the illumination levels were increased while the power consumption was decreased to half of its previous level.

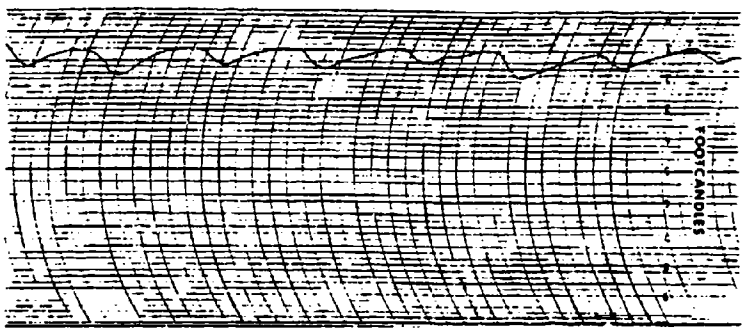


Figure 3. Eastbound lane No. 3, mercury installation.

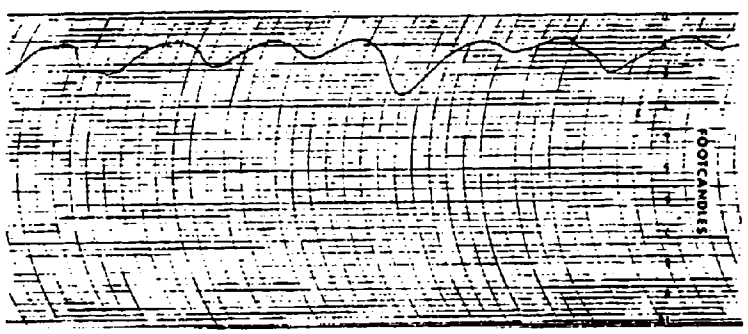


Figure 4. Eastbound lane No. 3, low-pressure sodium installation.

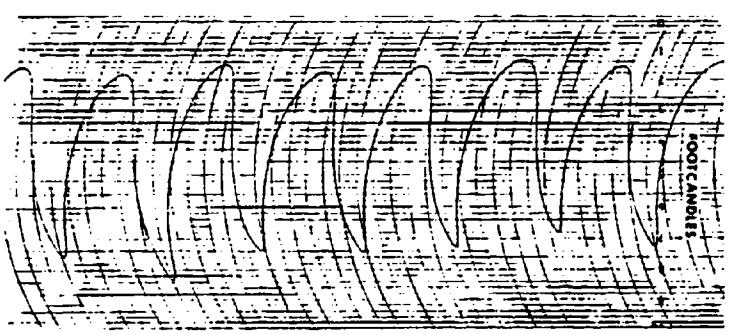


Figure 5. Westbound lane No. 1, mercury installation.

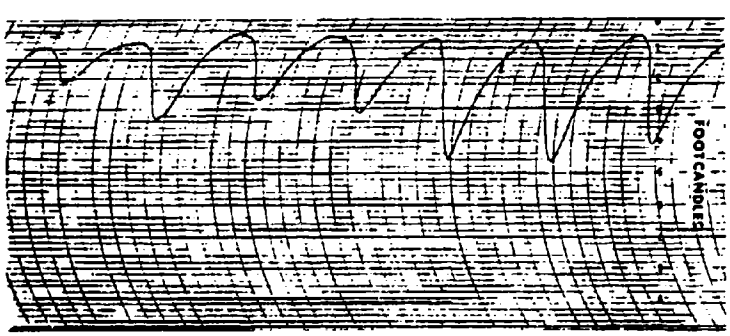


Figure 6. Westbound lane No. 1, low-pressure sodium installation.

A dollar per footcandle economic analysis obviously favors low-pressure sodium systems due to lower power consumption, smaller wiring, and, possibly, larger spacings. Such a method, however, may not be entirely meaningful.

The low-pressure sodium units on Stevenson Expressway have been in operation for approximately one year. Consequently, no conclusions can be drawn regarding their maintenance. The manufacturer claims 50 per cent mortality* at 18,000 hours under normal operation cycles, and no light flux depreciation during the lamp life.

To determine the acceptance of the system by the general public, questionnaires were distributed to motorists of diverse driving backgrounds, including police officers, truck drivers, and lighting specialists. Results from the questionnaires were based on a population sample of 165.

*96 per cent survival at 10,000 hours under laboratory conditions.

10 - 5

While the results of the sampling were not statistically analyzed with regard to the representativeness of the population and possible reactive influences affecting replies, it can be safely stated that the opinions received were decidedly favorable to low-pressure sodium over mercury, with the obvious exception of color rendering. Interestingly, of those individuals who generally did not favor the low-pressure sodium installation, some 70 per cent refused to be swayed in their convictions—even if the system would cost considerably less than conventional lighting.

Further experimentation with low-pressure sodium lighting by the Illinois Division of Highways is likely, so that the effects of these installations on accident rates may be studied and verified statistically.

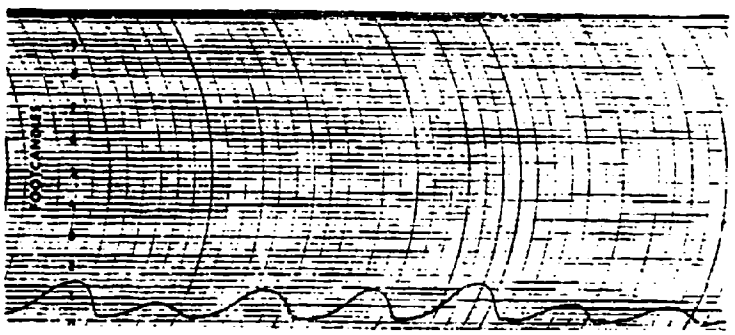


Figure 7. Eastbound lane No. 2, mercury installation.

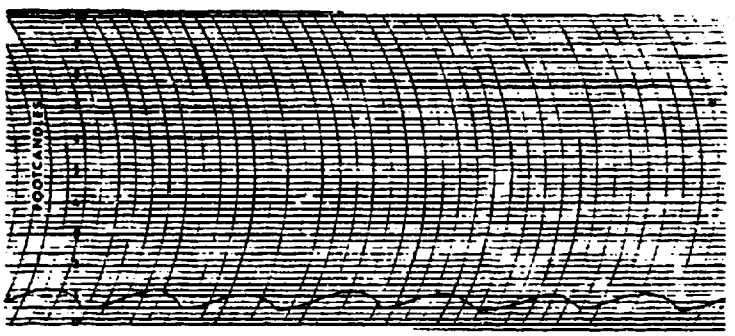


Figure 8. Eastbound lane No. 2, low-pressure sodium installation.

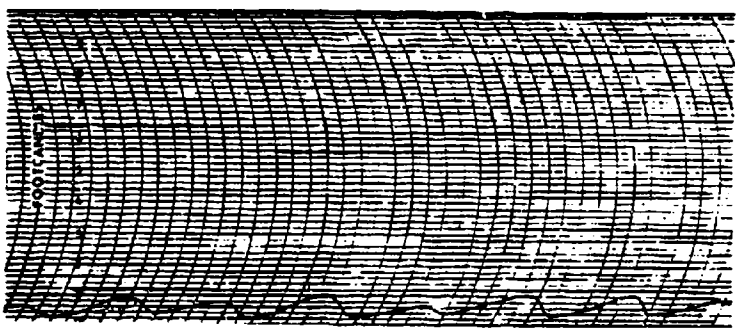
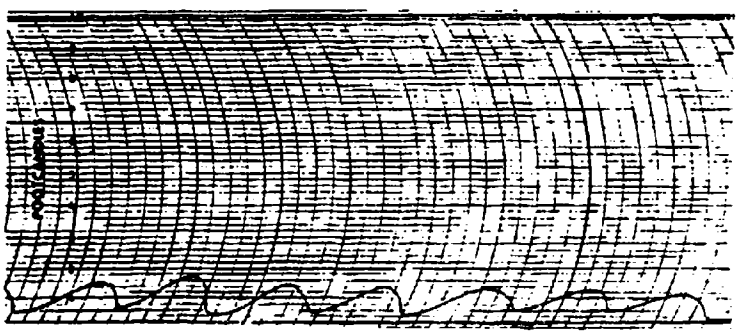


Figure 9. Westbound lane No. 3, mercury installation.



References

1. Cossyphas, H. and Stark, R., "Evaluation of an Experimental High Mount Illumination Technique For Expressway Interchanges," ILLUMINATING ENGINEERING, Vol. 66, February 1971, pp. 84-86.
2. State of Illinois, Department of Public Works and Buildings, Division of Highways, Electrical Bureau, Interim Report: Evaluation of High-Mount Area Lighting at the I-94 and I-80 Expressway Interchange, Chicago, Ill., April 1970.
3. LeVere, R. and Mahler, E., "Uniformity of Illumination," ILLUMINATING ENGINEERING, Vol. 65, April 1970, p. 211.
4. Fowle, A. W. and Kaercher, R. L., "Effective Control of Glare," ILLUMINATING ENGINEERING, May 1962, pp. 336-348.
5. deBoer, J. B. and Schreuder, D. A., "Glare as a Criterion for Quality in Street Lighting," *Transaction of the Illuminating Engineering Society* (London), Vol. 32, No. 2, 1967, pp. 117-135.
6. Forbes, T. W., Snyder, T. E., and Pain, R. F., "Traffic Sign Requirements," Highway Research Record, Number 70. Night Visibility 1963 and

Energy conservation and luminaire dirt depreciation

A comparison of a mercury and a low-pressure sodium luminaire in terms of the effect of dust collection on luminous intensity

Perry Romano

In these days of energy conservation, it is important to reexamine the light loss factors that rob us of the full amount of light required for seeing tasks. One of the most important factors is luminaire dirt depreciation (LDD), the result of dust and dirt collecting on lamp and luminaire surfaces. This collection will progressively absorb the vital energy that is then lost as useful light on the work surfaces.

To combat this factor, it is necessary to determine how the lamp type, size, and the luminaire design affect the collection of dust and dirt and to what degree the luminaire is limited in its operation. This information will be valuable in luminaire design and application.

To gain new data on LDD, two different types of sources were tested in roadway luminaires. Each luminaire was given a complete photometric test when clean and was tested again after having been operated in a dust chamber. The tests were made independently at a nationally recognized test laboratory in accordance with IES recommended procedures. Tests were based on 60-plane photometry, with vertical increments of 2.5 degrees from 50 degrees to 90 degrees. Test distance exceeded 25 feet.

A 180-watt low-pressure sodium lamp (LPS) [1], rated 33,000 lumens, was tested in a roadway luminaire with a clear acrylic molded cover. A 400-watt, H400A33-1, clear mercury lamp (H), rated 19,667 lumens, was tested in a roadway luminaire (cobra-head) with an aluminum reflector and a glass refractor. Thermocouples were attached to the two luminaires in selected places, and one was suspended in the ambient air within each luminaire.

The accelerated tests in the dust chamber [2] cycled the luminaires in increments of two hours on and two hours off. It was found that the luminaires reached close to their maximum temperatures in two hours and cooled again to approximately ambient temperature in the next two-hour period. This cycling caused the luminaires to "breathe" as if

The author national sales manager, **Quality Outdoor Lighting**, Northbrook, Ill. **Dr. Ian Lewin** of Environmental Research Laboratories conducted the testing described in this article, and **William Weibel** served as a consultant. Both are contributing editors to *LD&A*

[1]

ATTACHMENT II "-1

they had been in normal operation for a period of approximately 210 days.

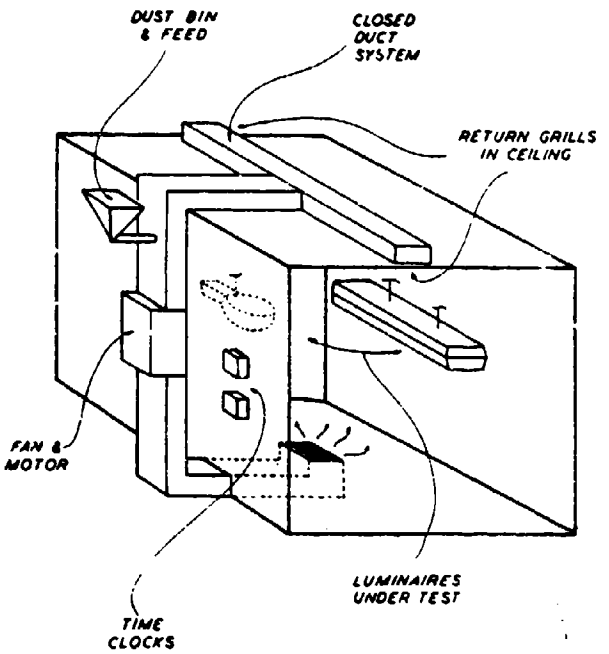
The dust chamber was an 8-foot by 8-foot by 8-foot room with a closed loop circulation ventilation system, with the one supply register located in the center of the floor. Dust was fed automatically into the return side of the fan, within the closed loop, and circulated. The dust used was the standard of air conditioning air filter manufacturers and consisted of a ratio of 90:10 of extremely fine desert silt and lampblack.

The photometric tests, after the accelerated dust collection, showed only a slight reduction in efficiency for the LPS luminaire, but there was a significant decrease for the H luminaire [**Table 1**].

The spacing of luminaires along a roadway and their mounting height are essential elements in system design. Such spacing and mounting are dependent on luminaire luminous-intensity distribution. The dust tests showed the extent to which luminaire luminous-intensity distribution was affected adversely by dust collection [**Table 2**]. Again, the data show the better performance of the LPS luminaire and emphasize the importance of LDD in luminaire and system design.

A reduction in candlepower is to be expected for both luminaires, because the dust collection on lamp and light control surfaces not only absorbs light, but acts as an added diffuser, scattering it in a less effective pattern. It is interesting, too, that the lateral plane of maximum candlepower was shifted 2.5 degrees by the collection of dust, changing the IES classification for the H luminaire from type III, medium, to type II, short. The classification of the LPS luminaire was unchanged from type III, short.

In the design of a lighting system, there is the question of the amount of light that will be delivered to the workplane, both initially and after



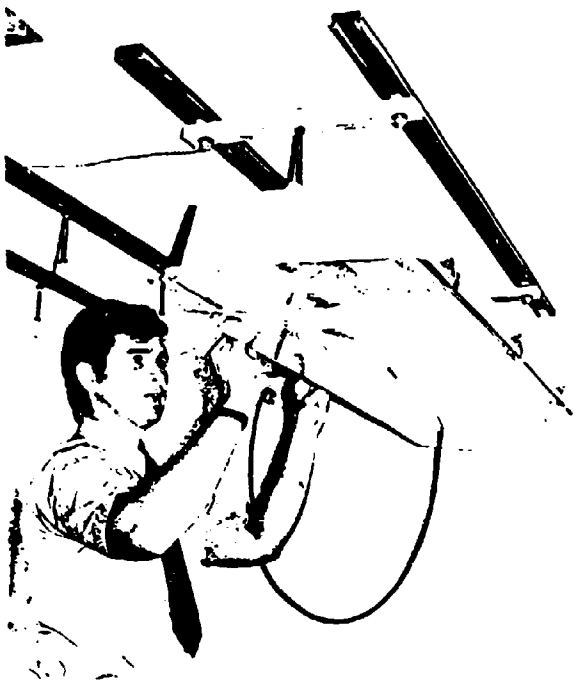
[2]

Table 1. Luminaire efficiency (per cent)

Luminaire	Clean	Dirty	Decrease
LPS	79.7	78.4	1.63
H	78.9	67.7	14.20

Table 2. Maximum luminous intensity in candelas

Luminaire	Clean	Dirty	Decrease (per cent)
LPS	9448	8550	9.50
H	9650	7850	18.65



[3]

depreciation. A useful factor in estimating the design quantity of light is the coefficient of utilization, the ratio of the lumens reaching the workplane to that of the total lumens leaving the lamp or lamps of the luminaire. Table 3 illustrates the affect of LDD on the coefficients of the two luminaires tested. It is apparent that the LPS luminaire was little affected by dust collection, but the H luminaire had considerable reduction in its ability to deliver quantities of light to the roadway.

The LPS luminaire has the additional advantage of a light source of much higher efficacy (lumens of light output per watt of lamp electrical input), higher total lumens, and lower wattage than the H luminaire. Lamp efficacy for the LPS is 183 lpw and for the H is 49.2 lpw, a ratio of 3.73 to 1. The higher efficacy of the LPS lamp and the lower LDD of its luminaire mean that much greater amounts of light can be delivered to the roadway from each LPS luminaire.

The higher operating temperature of the higher wattage H luminaire causes it to "breathe more deeply" and thus draw more dust into its optical system. Both luminaires were gasketed and the LPS luminaire had a larger volume of air enclosed in its optical system, but its much lower operating temperature enabled its gasketing to limit effectively the LDD. Also, the lower operating temperature of the LPS luminaire can be expected to act favorably on the life of luminaire components.

To summarize, the LPS luminaire outperformed the H luminaire in these tests and is the superior luminaire with regard to maintenance of luminous intensity,. efficiency, and coefficients of utilization. These advantages, as well as the lower wattage and the higher light output and efficacy of the LPS lamp, are valuable in these continuing days of energy conservation. □

Table 3. Coefficients of utilization—street side

	LPS luminaire			H luminaire		
Ratio*	Clean	Dirty	Per cent decrease	Clean	Dirty	Per cent decrease
0.5	0.169	0.167	1.2	0.170	0.146	14.1
1.0	0.274	0.271	1.1	0.377	0.309	18.0
1.5	0.329	0.325	1.2	0.477	0.391	18.0
2.0	0.358	0.353	1.4	0.523	0.431	17.6
2.5	0.374	0.369	1.3	0.549	0.453	17.5
3.0	0.384	0.378	1.6	0.563	0.465	17.4
3.5	0.391	0.385	1.5	0.573	0.474	17.3
4.0	0.394	0.389	1.3	0.578	0.478	17.3
5.0	0.398	0.393	1.3	0.585	0.485	17.1
Total	0.404	0.401	0.7	0.605	0.504	16.7

* Ratio: transverse width of street to luminaire mounting height.

SECURITY

Exterior security fence lighting

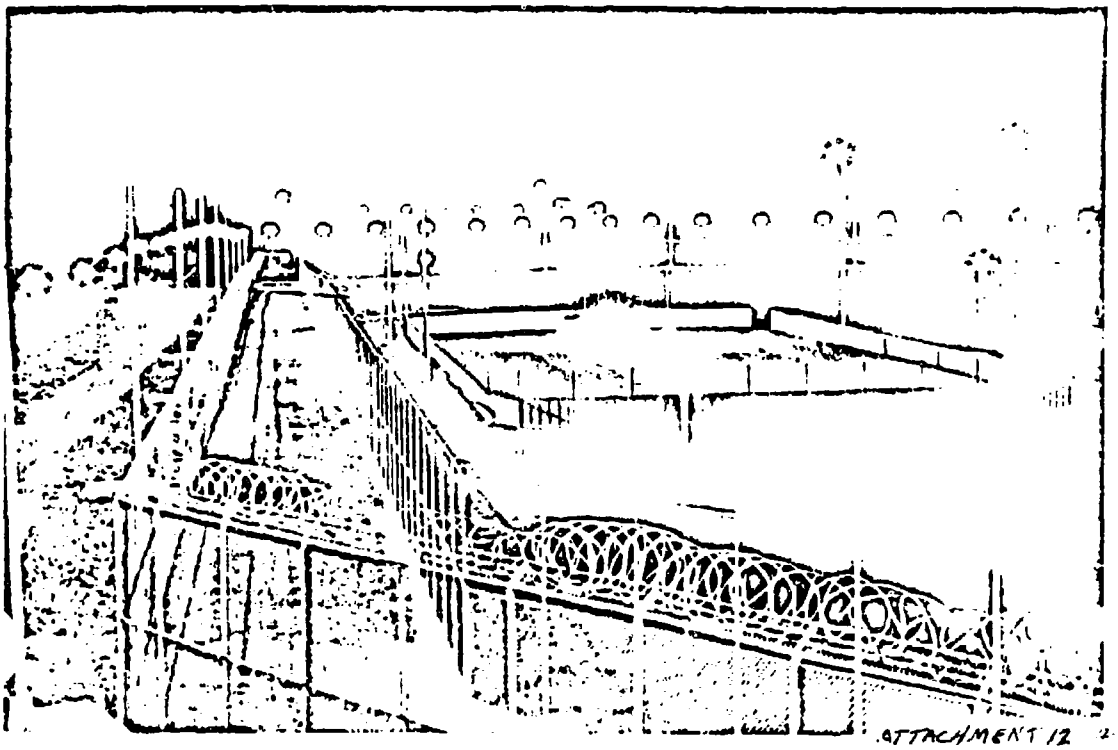
Low-pressure sodium sources for the exterior lighting of maximum security institutions have the advantages of high luminous efficacy, low arc-tube luminance, monochromatic light that offers a psychological and visual deterrent to inmates, and reliable starting characteristics

R. E. Jennings, P.E.

The author heads Illumination Engineering, Dept. of Public Works, Ottawa, Canada

Social unrest at many penal institutions in both the United States and Canada over the past few years has resulted in tremendous interest in the application of new security and detection systems. It has also created a need for improvement in existing security lighting systems. This challenge can be met today because research and development in the field of illumination have provided new design criteria as well as new products.

[1]



ATTACHMENT 12

high-intensity light sources and luminaires enable us to design lighting systems to improve the visual performance of the security staff.

This article analyzes and describes the effects of the more important factors that must be considered in designing an exterior security fence lighting system. We compare a previously installed system at a maximum security institution with a new system that has been designed with these several factors in mind.

Historically, early research concerned itself with the performance characteristics of human vision and established the fact that visual performance was not only dependent on the level of illumination of the visual task but also involved the four fundamental factors in vision: luminance, size, contrast and exposure duration. More recent research has shown that visual performance also depends on other physical properties of the luminous environment created by the lighting installation.

Level of illumination, vision factors, layout and the intensity of distribution of a light source, differences in task and background chromaticities, and psychological variables—all are interrelated and must be carefully considered in our effort to maximize visual performances in a normal environment.

A penal institution, however, cannot be considered a normal environment. Additional factors related to patterns of ocular search and scanning, as well as visual information processing, must be considered in designing exterior security fence lighting systems to assist in achieving maximum visual performance by the security staff under conditions of actual visual work.

The pattern of ocular search and scanning, as in the case of a security guard, may involve steadily fixating a suspicious area for several seconds or minutes or scanning a larger area. He may glance away from a suspicious point momentarily or he may institute an ocular scan of some other area. If the task surround has areas of luminance different from that of the task luminance, movements of the line of sight about the environment will produce losses in visual sensitivity due to transient adaptive effects.

Training, motivation, and fatigue are other factors that affect the visual performance of a security officer in the performance of his duties. It is not within the scope of this article to include a detailed description of all such factors, nor is it intended to detail methods and measurements required to establish such values. Studying and evaluating such factors as relative contrast sensitivity (RCS), contrast rendering factor (CRF), disability glare factor (DGF), and the transient adaptation factor (TAF) will ensure achieving maximum visual performance. The evaluation of the four aspects of illuminance environment as expressed by RCS, CRF, DGF, and TAF represents a considerable advancement over older methods that evaluated visual performance solely in terms of the quantity of illuminance.

Existing perimeter lighting

Double chain-link fences located 20 feet apart are usually installed around the perimeter of a maximum security institution. Strands of barbed wire are installed at the top of the 14-foot fence. During exercise periods, inmates are not permitted to approach to within 15 feet of the inner fence.

Exterior fence lighting systems installed in recently constructed institutions consist of 20-foot aluminum standards spaced 100 feet apart, and located approximately 5 feet outside an exterior fence on which is mounted a post-top incandescent luminaire rated at 370 watts, providing an IES Type 1 light distribution. This is a poor choice of luminaire, because it does not provide either the level of illumination or the quality of lighting required for this application. It also requires considerable maintenance.

The proposed lighting system, in addition to providing good uniformity and quality of lighting, offers adequate illuminance in four major areas:

- Between security fences.
- On the face of the inner security fence to a height of 5 feet from ground level.
- Fifteen-foot "no man's land" on compound side of inner fence.
- Leading away from the exterior fence.

The system should provide a maintained level of illuminance of 4.5 footcandles over the prescribed area, with a uniformity of no less than 1.25 to 1.0 over the area.

New lighting system

Our first concern in considering criteria for the design of this new exterior security fence lighting system was the selection of the light source. After a thorough investigation, we chose a low-pressure sodium lamp (LPS).

High luminous efficacy

The SOX 135-watt low-pressure sodium lamp chosen produces 159 lumens/watt, which is considerably higher than either clear mercury, metal halides, or high-pressure sodium light sources of the same rating. Its life rating of 15,000 hours compares favorably with other sources.

This meets our first design criterion: namely, to use minimum electrical input wattage to produce optimal illumination levels over a defined area. This was a very important consideration in our effort to conserve electrical energy. It was also an important consideration when the perimeter fence lighting system is supplied by standby power.

Lamp brightness

The arc tube luminance of the LPS lamp is 10 cd/cm^2—an extremely low value compared to values of 450 cd/cm^2 for clear high-intensity mercury lamps and 1000 cd/cm^2 for clear high-pressure sodium lamps.

This also met another design criterion: to avoid direct glare in the field of view of guards located in watchtowers, as well as those on foot patrol. It should permit scanning the area between fences with maximum visual capability.

Monochromatic yellow light

The output of a low-pressure sodium lamp is a virtually monochromatic yellow light (a doublet of 589 and 589.6 nm), which is very close to the eye's 555-nm peak sensitivity. Electrically, the benefits of the narrow bandwidth mean that energy is utilized where it will do the most good—in a narrow energy band to which the eye is extremely sensitive.

The monochromatic yellow light and the high level of illuminance prove most compatible when a television surveillance system is installed. It does not permit distinguishing colors or facial features, but it does offer good clarity and picture detail. And it results in increased visual acuity.

Historically, we have grown accustomed to interpret the color yellow as an indication of caution or danger: for example, yellow traffic lights and flashing roadway construction signs. I believe that it is quite possible that this yellow band of light around the perimeter of a maximum security satellite will prove to be a psychological as well as a visual deterrent to inmates contemplating escape.

Reliable starting

The ignition in an LPS lamp is by means of a gas discharge through a neon-argon gas mixture. Because there is nothing to vaporize to initiate the arc, these lamps are very reliable starters. The heat from the neon-argon discharge begins vaporizing the sodium, which increasingly contributes to the light output until, after about 12 to 15 minutes following start-up from cold start, the lamp's light is sodium yellow.

Most important, when normal power fails, the lamp provides instant restarting when the diesel generator comes on line, because the gas and sodium mixture is still hot.

Other advantages

- The lumen output of the LPS lamp remains unchanged throughout its life, which is rated 15,000 hours on 5-hour starts.
- Luminous output is within 5 per cent at −40°C.
- With reactor ballast, the lamp maintains luminous output within 6 per cent and lamp wattage within 8 per cent of nominal—with 20 per cent fluctuation in line voltage.

The luminaire selected for this application uses one 135-watt LPS lamp and produces a symmetrical twin-beam candlepower distribution for maximum reduction of contrast losses and discomfort glare. It has a maximum luminous intensity of 318.5 cd/100 lm, at an angle of 50° from nadir. The geometric configuration of the fence in relation to poles and mounting height of these luminaires is such that this beam of maximum intensity strikes the face of the inner fence 3 to 5 feet above ground level. This is the critical cutting zone for inmates attempting to escape.

The system chosen for lighting the exterior fence is an axially suspended catenary system. The design is based on the use of 30-foot octagonal steel poles with transformer type bases. Luminaires are mounted at 26 feet on 33-foot centers, with each span of the main suspension cable being terminated at each consecutive pole. Ballasts and fuses for three luminaires are located in these bases. Each span is individually wired.

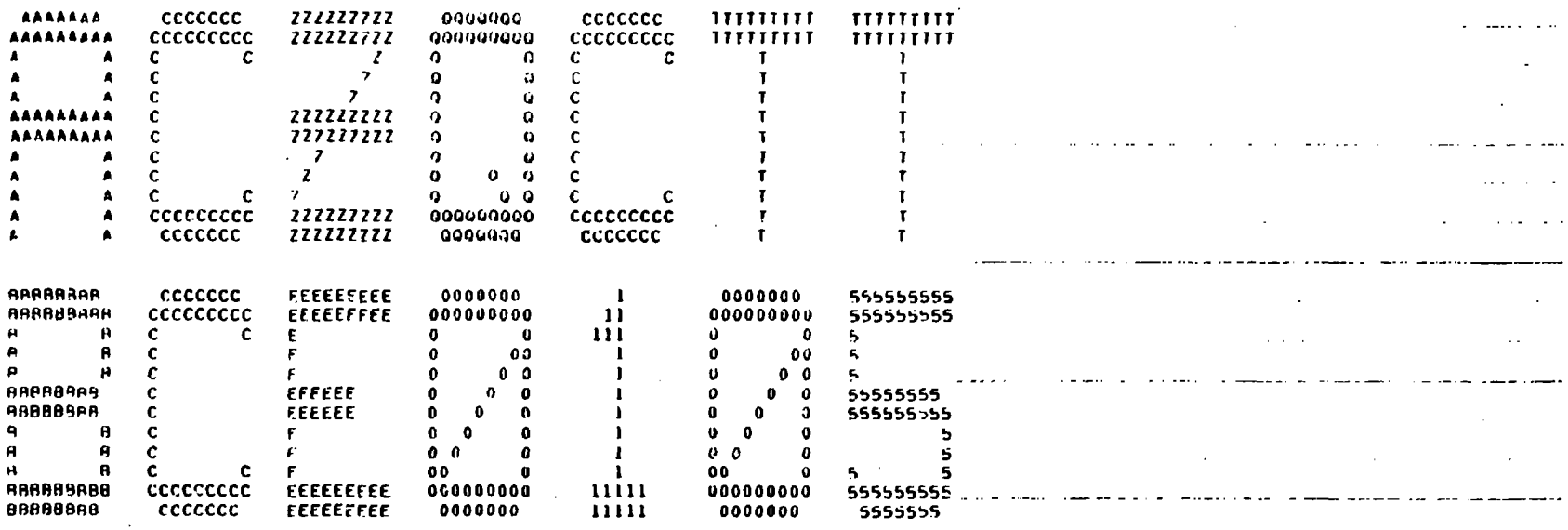
To avoid increasing costs, we explored the possibility of using the existing underground duct and cable system. Because each 135-watt luminaire draws only 0.95 ampere and there are three luminaires per section for a total of 405 watts (as compared to the existing 370 watt luminaires), it was possible to employ the existing wiring system.

The existing concrete bases were not strong enough to accept the new steel poles; however, rather than replace these, we cut the tops off, diamond drilled new holes for the new anchor bolts, and installed a concrete "collar" to provide the required strength. This avoided breaking into the existing underground duct system and exposing it to moisture and other possible injury.

Field tests have proven that the new security fence lighting system has exceeded the design calculations and has provided a visual environment in accordance with all the factors previously stated. The system has been installed at three maximum security institutions to date and the security staff has reported a definite improvement in visual performance, particularly during periods of intense fog. Uniformity is excellent and has permitted removal of the coils of barbed wire placed at ground level between the fences. □

2-21-78
Lighting Study Comp Ln Progr

HDR SYSTEMS INC. COMPUTING SERVICES. JOB NAME = ACZQCTT
NOS 1.2-452 OPERATING SYSTEM USER = BCE0105
JOB ORIGIN = KI200.
JOBCARD NAME = JOB



ATTACHMENT 13
13-1

```
      C-POINT TO POINT LIGHTING CALCULATIONS 712MIC2120
      C
      C-OMAHA DISTRICT, U.S. ARMY CORPS OF ENGINEERS
      C-DATE SEPTEMBER 1975
      C
      C-AUTHOR M.E. FLETCHER
      C
      C-DEFINITIONS OF ARRAYS AND ELEMENTS
      C
      C   ARRAY CPH(90)
      C     PURPOSE-HOLDS THE VALUES OF HORIZONTAL ANGLES FOR THE CANDLEPOWER
      C       TABLE.
      C
      C   ARRAY CPV(40)
      C     PURPOSE-HOLDS THE VALUES OF VERTICAL ANGLES FOR THE CANDLEPOWER
      C       TABLE.
      C
      C   ARRAY CP(90,40)
      C     PURPOSE-HOLDS THE CANDLEPOWER ARRAY IN MEMORY FOR THE CURRENT
      C       LUMINAIRE.
      C     1ST SUBSCRIPT
      C       1-60 VALUES IN THE HORIZONTAL DIRECTION
      C     2ND SUBSCRIPT
      C       1-40 VALUES IN THE VERTICAL DIRECTION
      C
      C   ARRAY-POST(150,6)
      C     PURPOSE-A LIST OF THE INDIVIDUAL LUMINAIRES, THEIR POSITIONS AND
      C       AND AIMING, TO BE CONSIDERED IN THE CALCULATIONS.
      C     1ST SUBSCRIPT
      C       1-150 DIFFERENT LUMINAIRE POSITIONS
      C     2ND SUBSCRIPT
      C       1 THE SUBSCRIPT OF THE ENTRY IN THE ANDEX1 ARRAY FOR THE
      C         LUMINAIRE WITH THE SAME LUMID
      C       2 THE X-COORDINATE OF THE LUMINAIRE>S POSITION
      C       3 THE Y-COORDINATE OF THE LUMINAIRE>S POSITION
      C       4 THE Z-COORDINATE OF THE LUMINAIRE>S POSITION
      C       5 THE HORIZONTAL ANGLE OF THE LUMINAIRE>S AIM.  HORIZONTAL
      C         ANGLES ARE MEASURED COUNTERCLOCKWISE FROM THE POSITIVE
      C         X-AXIS
      C       6 THE VERTICAL ANGLE OF THE LUMINAIRE>S AIM
      C
      C   ARRAY-TGRID(30,30,4)
      C     PURPOSE-HOLDS THE COORDINATES AND FOOTCANDLES OF POINTS ON THE
      C       TEST GRID FOR WHICH ILLUMINATION IS COMPUTED.
      C     1ST SUBSCRIPT
      C       1-30 X-COORDINATES TO BE PRINTED ACROSS THE TOP OF THE PAGE
      C     2ND SUBSCRIPT
      C       1-30 Y-COORDINATES TO BE PRINTED DOWN THE PAGE
      C     3RD SUBSCRIPT
      C       1 X-COORDINATE OF THE POINT
      C       2 Y-COORDINATE OF THE POINT
      C       3 Z-COORDINATE OF THE POINT
      C       4 THE ILLUMINATION AT THE POINT
      C
      C   ARRAY-IPID(15)
      C     PURPOSE-HOLDS A 60 CHARACTER PROJECT    NTIFICATION WHICH IS
      C       PRINTED AT THE TOP OF EACH PAGE OF OUTPUT
```

```
      C
      C-ARRAYS AND CONSTANT DATA
            PROGRAM RTPLT(INPUT,OUTPUT,TAPE1,TAPE99=INPUT)
            COMMON /T2V/ CPH(50),CPV(40),CP(50,40),HV,FID,NH,NV
            COMMON /T2V/ CM(6,4)
            COMMON /GRD/ POST(150,6)
            COMMON /GRD/ TGRID(30,30,4),NUMX,NUMYZ
            COMMON /PID/ IPID(15),IPAGE,LINLIM,LINE
            COMMON /CON/ PI,DEGRAD,RADDEG,PID2
            COMMON /DIR/ UID(10),DLAMPT(10),DDIPTT(10),OTHECT(10)
            COMMON /XYZ/ COSXX,COSXY,COSXZ,COSYX,COSYY,COSYZ,COSZX,COSZY,COSZZ
            COMMON /DEV/ IDEV1,IDEV2,IDEV3,IDEV4,IDEV5,IDEV6
            COMMON /ISW/ ISW1,ISW2,ISW3,ISW4,ISW5,ISW6
            COMMON /INX/ ANDEX1(200),INDEX1(800)
            DATA PI/3.1415926535897/
            DATA F9/99999999./
            1  A A9/10H9999999999/, SPACES/10H          /
            1  A IYES/1/,INO/0/
            DATA IPAGE,LINLIM/0,55/
            DEGRAD = PI/180.
            RADDEG = 180./PI
            PID2 = PI/2.
            PIX2 = 2.*PI
            PIX3 = 3.*PI
            PIX1P5 = 1.5*PI
            PIX2P5 = 2.5*PI
            IM = 0
            IDEV1 = 1
            IDEV2 = 4P
      C-READ PROGRAM CONTROLS
        100 READ(IDEV2,110) ITYPE,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6
        110 FORMAT(A5,5X,6I10)
            IF(EOF(IDEV2)) 900,115
        115 CONTINUE
      C-READ PROJECT IDENTIFICATION
        200 READ(IDEV2,210) ITYPE,IPID
        210 FORMAT(A5,5X,15A4)
            IF(EOF(IDEV2)) 900,215
      C-PRINT PROGRAM CONTROLS
        215 CALL PAGE
            PRINT 220, ISW1,ISW2,ISW3,ISW4,ISW5,ISW6
        220 FORMAT(10X,"ISW1 =",I3,"  1=PRINT CANDLEPOWER TABLES          "/
           2       10X,"ISW2 =",I3,"  1=DISK DIRECTORY PRINT             "/
           3       10X,"ISW3 =",I3,"  1=PRINT EACH POINT AFTER CALCULATION"/
           4       10X,"ISW4 =",I3,"  1=PRINT + ZERO GRID AFTER EACH LIGHT"/
           5       10X,"ISW5 =",I3,"  1=PRINT ALL CANDLEPOWER TABLES      "/
           6       10X,"ISW6 =",I3,"  1=USE TS PAGE CHANGES               "/)
            PRINT 230,IDEV1,IDEV2,IDEV3,IDEV4,IDEV5,IDEV6
        230 FORMAT(10X,"IDEV1 =",I3,"  CANDLEPOWER TABLES                 "/
           2       10X,"IDEV2 =",I3,"  DESIGN INPUT                      "/
           3       10X,"IDEV3 =",I3,"                                    "/
           4       10X,"IDEV4 =",I3,"                                    "/
           5       10X,"IDEV5 =",I3,"                                    "/
           6       10X,"IDEV6 =",I3,"                                    "/)
      C-SECTION TO INITIALIZE CANDLEPOWER FILES
            CALL OPENMS(IDEV1,INDEX1,800,0)
            CALL READMS(IDEV1,ANDEX1,200,1)
```

```
      NUMLUM = ANDEX1(200)
C-SECTION TO PRINT DISK DIRECTORY
      IF(ISW2 .GT. 0) CALL DRPRNT
C-SECTION TO PRINT ALL CANDLEPOWER TABLES
      IF(ISW5 .LT. 1) GO TO 250
      DO 240 IA = 1,NUMLUM
  240 CALL CPPRNT(IA)
      GO TO 900
  250 CONTINUE
C-DEPRECIATION FACTORS
  300 DO 310 I = 1,10
      UID(I) = SPACES
      DLAMPT(I) = 1.
      DDIRTT(I) = 1.
      OTHFCT(I) = 1.
  310 CONTINUE
      NUMUSE = 0
      PRINT 320
  320 FORMAT(' ')
      PRINT 330
  330 FORMAT(10X,"INPUT DATA - DEPRECIATION FACTORS")
      PRINT 320
      PRINT 340
  340 FORMAT(10X,"LUMID       DLAMP       DDIRT       OTHFC")
      PRINT 350
  350 FORMAT(10X,4("----------  "))
  360 READ(IDEV2,370) ITYPE,AID,DLAMP,DDIRT,OTHFC
  370 FORMAT(A5,5X,A10,3F10.0)
      IF(AID .EQ. 49) GO TO 500
C----TEST FOR NOT CURRENTLY IN DEPRECIATION FACTOR TABLE
      DO 380 IA = 1,NUMUSE
      IF(AID .EQ. UID(IA)) GO TO 390
  380 CONTINUE
      GO TO 410
  390 PRINT 400, AID
  400 FORMAT(10X,"ERROR-   ",A10," DEPRECIATION FACTORS PREVIOUSLY",
     2    " GIVEN")
      GO TO 360
C----TEST FOR LUMINAIRE IN MASTER FILE
  410 DO 420 IA = 1,NUMLUM
      IF(AID .EQ. ANDEX1(IA)) GO TO 440
  420 CONTINUE
      IERR1 = TYES
      PRINT 430, AID
  430 FORMAT(10X,"ERROR-   ",A10," NOT IN CANDLEPOWER FILE")
      GO TO 360
C----SECTION TO MAKE ENTRY IN DIRECTORY
  440 NUMUSE = NUMUSE + 1
      UID(NUMUSE) = AID
      DLAMPT(NUMUSE) = DLAMP
      DDIRTT(NUMUSE) = DDIRT
      OTHFCT(NUMUSE) = OTHFC
      PRINT 450, AID,DLAMP,DDIRT,OTHFC
  450 FORMAT(10X,A10,3F12.4)
      GO TO 360
C-READ LUMINAIRE POSITION AND ORIENTATION
  500 NUMIT = 0
```

```
            IERR2 = TNO
      510 READ(IDEV2,520) ITYPE,AID,X,Y,Z,H,V
      520 FORMAT(A5,5X,A10,5F10.0)
175         IF(EOF(IDEV2)) 900,525
      525 IF(AID .EQ. AS) GO TO 560
      C-SEARCH DIRECTORY OF LUMINAIRE TYPES FOR A MATCH
            DO 530 IA = 1,NUMLUM
            IF(AID .EQ. ANDEX(IA)) GO TO 540
180   530 CONTINUE
            PRINT 532, AID
      532 FORMAT(10X,"ERROR-   ",A10,"NOT IN CANDLEPOWER FILE")
            IERR2 = IYES
      540 DO 542 IB = 1,NUMUSE
185         IF(AID .EQ. UID(IB)) GO TO 550
      542 CONTINUE
            IERR2 = IYES
            PRINT 544, AID
      544 FORMAT(10X,"ERROR-   ",A10," NO DEPRECIATION FACTORS ENTERED")
190         GO TO 510
      C-STORE DATA IN ARRAY POST WITH ANGLES CONVERTED TO RADIANS
      550 F = IA
            NUNIT = NUNIT + 1
            POST(NUNIT,1) = F
195         POST(NUNIT,2) = X
            POST(NUNIT,3) = Y
            POST(NUNIT,4) = Z
            POST(NUNIT,5) = H * DEGRAD
            POST(NUNIT,6) = V * DEGRAD
200         CALL PSPRNT(NUNIT)
            GO TO 510
      560 IF((IERR1 .EQ. IYES) .OR. (IERR2 .EQ. IYES)) GO TO 900
      C-PRINT CANDLEPOWER TABLES OF THE LUMINAIRES USED
            IF(ISW1 .LT. 1) GO TO 600
205         DO 570 IA = 1,NUMUSE
            DO 570 IB = 1,NUMLUM
            IF(UID(IA) .EQ. ANDEX(IB)) CALL CPPRNT(IB)
      570 CONTINUE
            ISW1 = 0
210   C-READ DATA FOR TEST GRID
      600 IGRID = 0
      610 READ(IDEV2,620) ITYPE,XGRID1,YGRID1,ZGRID1,XGRID2,YGRID2,ZGRID2
      620 FORMAT(A4,6X,6F10.0)
            IF(XGRID1 .GT. 99) GO TO 500
215         IGRID = IGRID + 1
            CALL PAGE
            PRINT 630, IGRID,XGRID1,YGRID1,ZGRID1,XGRID2,YGRID2,ZGRID2
      630 FORMAT(10X,"TEST GRID POSITION AND SIZE - TEST GRID", I3//
           1    10X,"XGRID1    YGRID1    ZGRID1    XGRID2    YGRID2    ",
220        2    "ZGRID2"/10X,6("-------   ")/7X,6F10.2)
            READ(IDEV2,640) ITYPE,NUMX,NUMYZ,ICOMP,HMETER,
           1    XGRID3,YGRID3,ZGRID3
      640 FORMAT(A4,6X,2I10,9X,A1,4F10.0)
            IF(NUMX .GT. 30) NUMX = 30
225         IF(NUMYZ .GT. 30) NUMYZ = 30
            PRINT 650, NUMX,NUMYZ,ICOMP,HMETER,XGRID3,YGRID3,ZGRID3
      650 FORMAT(//10X,"NUMX      NUMYZ     ICOMP     HMETER    XGRID3    ",
           1    "YGRID3    ZGRID3"/, 10X, 7("-------   ")/
```

```
                2    7X,2F10.4,9X,F1.4,F10.2)
230             RMETER = RMETER * DEGRAD
                DO 660 I = 1,30
                DO 660 J = 1,30
                DO 660 K = 1,4
              660 TGRID(I,J,K) = 0.
235         C-CALCULATE THE COORDINATES OF THE TEST GRID POINTS
                IF((XGRID3 .NE. 0.) .OR. (YGRID3 .NE. 0.) .OR. (ZGRID3
               1    .NE. 0.)) GO TO 670
                XGRID3 = XGRID2
                YGRID3 = YGRID1
240             ZGRID3 = ZGRID1
              670 CONTINUE
                XGRID4 = XGRID1 + XGRID2 - XGRID3
                YGRID4 = YGRID1 + YGRID2 - YGRID3
                ZGRID4 = ZGRID1 + ZGRID2 - ZGRID3
245             I = 1
                C2 = NUMYZ
                DO 680 J = 1,NUMYZ
                C1 = J - 1
                C2 = C2 - 1.
250             C3 = C1 + C2
                TGRID(I,J,1) = (C2*XGRID1 + C1*XGRID4)/C3
                TGRID(I,J,2) = (C2*YGRID1 + C1*YGRID4)/C3
                TGRID(I,J,3) = (C2*ZGRID1 + C1*ZGRID4)/C3
              680 CONTINUE
255             C2 = NUMX - 2
                C3 = C2 + 1.
                DX = (C2*XGRID1 + XGRID3)/C3 - XGRID1
                DY = (C2*YGRID1 + YGRID3)/C3 - YGRID1
                DZ = (C2*ZGRID1 + ZGRID3)/C3 - ZGRID1
260             DO 690 I = 2,NUMX
                DO 690 J = 1,NUMYZ
                TGRID(I,J,1) = TGRID(I-1,J,1) + DX
                TGRID(I,J,2) = TGRID(I-1,J,2) + DY
                TGRID(I,J,3) = TGRID(I-1,J,3) + DZ
265           690 CONTINUE
            C-CALCULATE ILLUMINATION AT POINTS ON THE TEST GRID
              700 DO 770 LIGHT = 1, NUNIT
                NHEAD = 1
                IL = POST(LIGHT,1)
270             XL = POST(LIGHT,2)
                YL = POST(LIGHT,3)
                ZL = POST(LIGHT,4)
                HL = POST(LIGHT,5)
                VL = POST(LIGHT,6)
275             DO 710 IA = 1,NUMUSE
                IF(NID(IA) .EQ. ANDEX1(IL)) GO TO 712
              710 CONTINUE
                PRINT 544, ANDEX1(IL)
                GO TO 900
280           712 DLAMPT = DLAMPT(IA)
                DDIRT = DDIRTT(IA)
                OTHFC = OTHFCT(IA)
                IF(IL  .EQ. IM ) GO TO 720
                CALL RANIN(IL)
285             POLAR = HV
```

```
      720 IM  = IL
          HLD = HL*RADDEG
          VLD = VL*RADDEG
          IF(ISW3.GT.0) CALL PAGE
290       IF(ISW3.GT.0) PRINT 725, LIGHT,XL,YL,ZL,HLD,VLD,IL
      725 FORMAT(10X, "LIGHT", I3, 3X, " (", 3F8.2, ")", 2F8.2, I8)
          LINE = LINE + 1
          NHEAD = 1
C-ADJUST VERTICAL AIMING ANGLE
295       IF(POLAR .EQ. IHV) GO TO 730
C-----FOR A FLOODLIGHT (HORIZONTAL POLAR AXIS)
          VLC = PI - VL
          GO TO 734
C-----FOR A ROADWAY LUMINAIRE (VERTICAL POLAR AXIS)
300       IF(VL .GT. PID2) GO TO 732
      730 VLC = PID2 - VL
          GO TO 734
      732 VLC = PIX2P5 - VL
      734 CONTINUE
305   C-POINT CALCULATION LOOPS
          DO 760 IX = 1,NUMX
          DO 760 IYZ = 1,NUMYZ
          XG = TGRID(IX,IYZ,1)
          YG = TGRID(IX,IYZ,2)
310       ZG = TGRID(IX,IYZ,3)
          X = XG - XL
          Y = YG - YL
          Z = ZG - ZL
C-COMPUTE DISTANCES AND ANGLES TO POINT IN MAIN COORDINATE SYSTEM
315       R = SQRT(X*X + Y*Y + Z*Z)
          RH = SQRT(X*X + Y*Y)
          HXY = ATANSP(X,Y)
          COSZP = Z/R
          IF(R .NE. 0.) GO TO 735
320           FC = 9999999999.
              GO TO 750
      735     CONTINUE
C-SELECT CALCULATIONS DEPENDING ON POLAR AXIS
          IF(POLAR .EQ. IHV) GO TO 736
325   C-----FOR A FLOODLIGHT LUMINAIRE
          CALL COSFLD(HL,VLC)
          XC = COSXX*X + COSXY*Y + COSXZ*Z
          YC = COSYX*X + COSYY*Y + COSYZ*Z
          ZC = COSZX*X + COSZY*Y + COSZZ*Z
330       VC = ACOS(ZC/R)
          COSH = 1.
          SINVC = SIN(VC)
          IF(SINVC .NE. 0.) COSH = XC/(R*SINVC)
          IF(COSH .GT. 1.) COSH = 1.
335       IF(COSH .LT. -1.) COSH = -1.
          HC = ACOS(COSH)
          IF(YC .LT. 0.) HC = PIX2 - HC
          H = PI - VC
          IF((XC .LE. 0.) .AND. (ZC .GT. 0.)) H = PI + VC
340       IF((XC .LT. 0.) .AND. (ZC .LE. 0.)) H = PI + VC
          V = -HC
          IF(YC .LT. 0.) V = PIX2 - HC
```

```
                V = -V
                GO TO 738
      C-----FOR A ROADWAY LUMINAIRE
        736 CALL COSROD(HL,VLC)
                XC = COSXX*X + COSXY*Y + COSXZ*Z
                YC = COSYX*X + COSYY*Y + COSYZ*Z
                ZC = COSZX*X + COSZY*Y + COSZZ*Z
                VC = ACOS(ZC/R)
                COSH = 1.
                SINVC = SIN(VC)
                IF(SINVC .NE. 0.) COSH = XC/(R*SINVC)
                IF(COSH .GT. 1.) COSH = 1.
                IF(COSH .LT. -1.) COSH = -1.
                HC = ACOS(COSH)
      C         HCP = HC * RADDEG
      C         VCP = VC * RADDEG
      C         IF(ISW3 .GT. 0.) PRINT 780, XC,YC,ZC,HCP,VCP
      C 780 FORMAT(10X, 5F10.2)
                IF(YC .LT. 0.) HC = PIX2 - HC
                H = HC + PID2
                IF(H .GT. PIX2) H = H - PIX2
                V = VC - PID2
        738 CONTINUE
      C-PERFORM CANDLEPOWER TABLE LOOK UP
                CALL INTRVL(H,V,CPL)
                HTABLE = H * RADDEG
                VTABLE = V * RADDEG
                FC = CPL * DLAMP * DDIRT * OTHFC/(R * R)
      C-SELECT HORIZONTAL OR VERTICAL FOOTCANDLES
                IF(ICOMP .EQ. IHV) GO TO 748
                IF(ICOMP .EQ. IHO) GO TO 750
      C-COMPUTE HORIZONTAL FOOTCANDLES (LIGHT METER VERTICAL UPWARD)
                FC = FC * ABS(COSZP)
                GO TO 750
      C-COMPUTE VERTICAL FOOTCANDLES (LIGHT METER HORIZONTAL AT ANGLE HMETER)
        748 FC = FC * RH/R
                HXYIRO = HXY + PI
                IF(HXYIRO .GT. PIX2) HXYIRO = HXYIRO - PIX2
                HV = HXYIRO - HMETER
                COSHV = COS(HV)
                FC = FC * COSHV
                IF(COSHV .LT. 0.) FC = 0.
      C-ACCUMULATE FOOTCANDLES
        750 TGRID(IX,IYZ,4) = TGRID(IX,IYZ,4) + FC
                HXY = HXY * RADDEG
                IF(ISW3.GT.0) CALL PTPRNT(IX,IYZ,XG,YG,ZG,HXY,HTABLE,VTABLE,CPL,R,
               1 RH,FC,NHEAD)
        760 CONTINUE
                IF(ISW4.EQ.0) GO TO 770
                CALL GRPRNT(IGRID,XGRID1,YGRID1,ZGRID1,
               1     XGRID2,YGRID2,ZGRID2,XGRID3,YGRID3,ZGRID3,
               2     XGRID4,YGRID4,ZGRID4)
                DO 768 J = 1,30
                DO 768 I = 1,30
        768 TGRID(I,J,4) = 0.
        770 CONTINUE
      C-PRINT RESULTS
```

```
400               CALL AVPUNT
                  CALL GRPRNT(IGRID,XGRID1,YGRID1,ZGRID1,XGRID2,YGRID2,ZGRID2,
                 1     XGRID3,YGRID3,ZGRID3,XGRID4,YGRID4,ZGRID4)
              C-GO BACK FOR NEXT GRID
                  GO TO 610
405             900 CONTINUE
                  CALL CLOSMS(IDEV1)
                  REWIND IDEV2
                  CALL DATE(PDATE)
                  CALL TIME(PTIME)
410               PRINT 910, PDATE, PTIME
                910 FORMAT(//10X,"END OF RUN   ",2(A9,1X))
                  STOP
                  END
```

```
      C-SUBROUTINE FOR PRINTING LUMINAIRE POSITION AND AIMING
            SUBROUTINE PSPRNT(NUNIT)
            COMMON /END/ POST(150,5)
            COMMON /PID/ IPID(15),IPAGE,LINLIM,LINE
            COMMON /CON/ PI,DEGRAD,RADDEG,PI02
            COMMON /DIR/ UID(10),DLAMPT(10),ODIRTT(10),OTHECT(10)
            DATA IFIRST/0/
            IF(IFIRST .EQ. 0) GO TO 110
            IF(LINE.LT.LINLIM) GO TO 200
          110 CALL PAGE
            IFIRST = 7999999
            PRINT 130
          130 FORMAT(10X,"LUMINAIRE POSITION AND AIMING DATA")
            PRINT 140
          140 FORMAT(10X,"UNIT   LUMINAIRE",43X,"HORZ          VERT")
            PRINT 150
          150 FORMAT(10X,"NO      IDCODE        X-COORD       Y-COORD       Z-COORD
           1      ANGLE         ANGLE")
            PRINT 160
          160 FORMAT(10X, "-----", 5("   ----------"))
            LINE = LINE + 5
      C-PRINT ONE LINE CORRESPONDING TO UNIT
          200 H = POST(NUNIT,5) * RADDEG
            V = POST(NUNIT,6) * RADDEG
            ITYPE = POST(NUNIT,1)
            PRINT 210,NUNIT,UID(ITYPE),(POST(NUNIT,J),J=2,4),H,V
          210 FORMAT(10X,I4,3X,A10,5F13.2)
            LINE = LINE + 1
            RETURN
            END
```

```
      SUBROUTINE GRPRNT     73/74   OPT=2                FTN 4.6+452      78/02/21. 14.57.14      PA      1
      
    1       C-THIS SUBROUTINE PRINTS THE TEST GRID OF FOOTCANDLE VALUES
                SUBROUTINE GRPRNT(IGRID,XGRID1,YGRID1,ZGRID1,XGRID2,YGRID2,ZGRID2,
                1     XGRID3,YGRID3,ZGRID3,XGRID4,YGRID4,ZGRID4)
                COMMON /GRD/ TGRID(30,30,4),NUMX,NUMYZ
    5           COMMON /PID/ IPID(15),IPAGE,LINLIM,LINE
            C-INITIALIZE
                IX1 = -9
                IX2 = 0
            C-MAIN LOOP
   10         100 IX1 = IX1 + 10
                IX2 = IX2 + 10
                LINE = 999999
                IF((IX1 .GT. NUMX) .AND. (IYZ .GE. NUMYZ)) GO TO 300
                IYZ = 0
   15         110 IYZ = IYZ + 1
                IF(IYZ .GT. NUMYZ) GO TO 100
                IF(IX2.LT.NUMX) GO TO 115
                NX1 = NUMX + 1
                DO 114 IX = NX1,IX2
   20           TGRID(IX,IYZ,4) = 0.
                TGRID(IX,IYZ,1) = 0.
              114 CONTINUE
              115 CONTINUE
                IF(LINE .LE. LINLIM) GO TO 200
   25       C-CHANGE PAGE AND PRINT HEADING
                CALL PAGE
                PRINT 120
              120 FORMAT(1H )
                PRINT 130, IGRID,XGRID1,YGRID1,ZGRID1
   30         130 FORMAT(10X,"TEST GRID",I3,3X,"COORDINATES OF CORNER 1",3F13.2)
                PRINT 140, XGRID2,YGRID2,ZGRID2,XGRID3,YGRID3,ZGRID3,
               1     XGRID4,YGRID4,ZGRID4
              140 FORMAT(25X, "COORDINATES OF CORNER 2",3F13.2,
                1      /25X, "COORDINATES OF CORNER 3",3F13.2,
   35           2      /25X, "COORDINATES OF CORNER 4",3F13.2)
                PRINT 120
                PRINT 150
              150 FORMAT(14X, 10("        X"))
                PRINT 155, (TGRID(IX,IYZ,1),IX=IX1,IX2)
   40         155 FORMAT(14X, 10F9.2)
                PRINT 160
              160 FORMAT(14X, 10("  --------"))
                LINE = LINE + 4
            C-PRINT FOOTCANDLES
   45         200 JYZ = NUMYZ + 1 - IYZ
                PRINT 210, TGRID(IX1,JYZ,2),(TGRID(IX,JYZ,4),IX=IX1,IX2),
               1 TGRID(IX2,JYZ,2)
              210 FORMAT(10X, "Y", F8.2, 10F9.4, F8.2, " Y")
                PRINT 220, TGRID(IX1,JYZ,3),TGRID(IX2,JYZ,3)
   50         220 FORMAT(10X, "Z", F8.2, 90X, F8.2, " Z")
                PRINT 120
                LINE = LINE + 3
                GO TO 110
            C-END OF GRID PRINT
   55         300 CONTINUE
                RETURN
                END
```

```
SUBROUTINE INT2V      73/74   OPT=2                    FTN 4.6+452      78/02/21. 14.57.14      PAGE  1

      C-SUBROUTINE FOR TWO-DIMENSIONAL INTERPOLATION
            SUBROUTINE INT2V (XBAR,YBAR,VAL)
            COMMON /T2V/ X(40),Y(40),TBL(40,40),MV,FILO,NX,NY
            COMMON /T2V/ CM(6,4)
            NN=0
            JX=NX-1
            JY=NY-1
            DO 1 IX=1,JX
            IF (XBAR.EQ.X(IX)) GO TO 4
            IF ((XBAR.GT.X(IX)).AND.(XBAR.LT.X(IX+1))) GO TO 3
          1 CONTINUE
            IX = NX
            XIF = XBAR - X(IX)
            IF(ABS(XIF) .LT. .1) XIF = 0.
            IF(XIF) 2,4,2
          2 VAL=0.
            RETURN
          3 NN=1
          4 DO 5 IY=1,JY
            IF(YBAR.EQ.Y(IY)) GO TO 7
            IF ((YBAR.GT.Y(IY)).AND.(YBAR.LT.Y(IY+1))) GO TO 6
          5 CONTINUE
            IY = NY
            YIF = YBAR - Y(IY)
            IF(ABS(YIF) .LT. .1) YIF = 0.
            IF(YIF) 2,7,2
          6 NN=NN+2
          7 IF (NN) 2,8,9
          8 VAL=TBL(IX,IY)
            RETURN
          9 TEMP1=(XBAR-X(IX))/(X(IX+1)-X(IX))
            IF (NN-1) 2,10,11
         10 VAL=TBL(IX,IY)+TEMP1*(TBL(IX+1,IY)-TBL(IX,IY))
            RETURN
         11 TEMP2=(YBAR-Y(IY))/(Y(IY+1)-Y(IY))
            IF (NN-2) 2,12,13
         12 VAL=0.
            IF(TBL(IX,IY).NE.0.)VAL=TBL(IX,IY)+TEMP2*(TBL(IX,IY+1)/TBL(IX,IY))
            RETURN
         13 TEMP3=TBL(IX,IY)+TEMP1*(TBL(IX+1,IY)-TBL(IX,IY))
            TEMP4=TBL(IX,IY+1)+TEMP1*(TBL(IX+1,IY+1)-TBL(IX,IY+1))
            TEMP5=(YBAR-Y(IY))/(Y(IY+1)-Y(IY))
            TVAL1=TEMP3+TEMP5*(TEMP4-TEMP3)
            VAL =TVAL1
            RETURN
            END
```

```
      C-THIS FUNCTION CALCULATES INVERSE TANGENTS SUCH THAT 0 =ATANSP =2*PI
            FUNCTION ATANSP(X,Y)
            COMMON /CONV/ PI,DEGRAD,RADDEG,PI02
            IF((X.EQ.0.).AND.(Y.EQ.0.)) GO TO 10
            IF((X.EQ.0.).AND.(Y.GE.0.)) GO TO 20
            IF((X.EQ.0.).AND.(Y.LT.0.)) GO TO 30
            IF((X.GT.0.).AND.(Y.GE.0.)) GO TO 40
            IF((X.LT.0.).AND.(Y.GE.0.)) GO TO 50
            IF((X.LT.0.).AND.(Y.LT.0.)) GO TO 50
            IF((X.GT.0.).AND.(Y.LT.0.)) GO TO 60
            PRINT 5
          5 FORMAT(10X, "ERROR-ATANSP")
         10 ATANSP = 0.
            GO TO 70
         20 ATANSP = PI02
            GO TO 70
         30 ATANSP = 3.*PI/2.
            GO TO 70
         40 ATANSP = ATAN(Y/X)
            GO TO 70
         50 ATANSP = PI+ATAN(Y/X)
            GO TO 70
         60 ATANSP = 2.*PI + ATAN(Y/X)
         70 RETURN
            END
```

15-15

```
      C-THIS SUBROUTINE PRINTS POINTS, ONE PER CALL
            SUBROUTINE PTPRNT(IX,IYZ,XG,YG,ZG,HXY,H,V,CPL,R,RH,FC,NHEAD)
            COMMON /PID/ IPID(15),IPAGE,LINLIM,LINE
            IF(NHEAD .GT. 0) PRINT 110
            IF(LINE .LT. LINLIM) GO TO 120
            CALL PAGE
            PRINT 110
        110 FORMAT(/23X," X Y Z HXY H V
           1  CP R RH FC")
            LINE = LINE + 2
        120 PRINT 130, IX,IYZ,XG,YG,ZG,HXY,H,V,CPL,R,RH,FC
        130 FORMAT(10X,"GRID ",2I3," (",3F8.2,")",6F8.2,F16.8)
            LINE = LINE + 1
            NHEAD = 0
            RETURN
            END
```

```
      C-DIRECTION COSINES FOR HORIZONTAL POLAR AXIS
            SUBROUTINE COSFLD(H,V)
            COMMON /CON/ PI,DEGRAD,RADDEG,PID2
            COMMON /XYZ/ COSXX,COSXY,COSXZ,COSYX,COSYY,COSYZ,COSZX,COSZY,COSZZ
            SINV = SIN(V)
            SINH = SIN(H)
            COSV = COS(V)
            COSH = COS(H)
            PID2V = PID2 + V
            SPID2V = SIN(PID2V)
            CPID2V = COS(PID2V)
      C-DIRECTION COSINES FOR X-AXIS
            COSXX = SINV * COSH
            COSXY = SINV * SINH
            COSXZ = COSV
      C-DIRECTION COSINES FOR Y-AXIS
            COSYX = SPID2V * COSH
            COSYY = SPID2V * SINH
            COSYZ = CPID2V
      C-DIRECTION COSINES FOR Z-AXIS
            COSZX = -SINH
            COSZY = COSH
            COSZZ = 0.
            RETURN
            END
```

```
SUBROUTINE COSROD     73/74   OPT=2                FTN 4.6+452     78/02/21. 14.57.14     PAGE     1

      C-DIRECTION COSINES FOR VERTICAL POLAR AXIS
            SUBROUTINE COSROD(H,V)
            COMMON /COM/ PI,DEG,RAD,RADDEG,PID2
            COMMON /XYZ/ COSXX,COSXY,COSXZ,COSYX,COSYY,COSYZ,COSZX,COSZY,COSZZ
            SINV = SIN(V)
            SINH = SIN(H)
            COSV = COS(V)
            COSH = COS(H)
            VPID2 = V + PID2
            SVPID2 = SIN(VPID2)
            CVPID2 = COS(VPID2)
      C-DIRECTION COSINES FOR X-AXIS
            COSXX = SINV * COSH
            COSXY = SINV * SINH
            COSXZ = COSV
      C-DIRECTION COSINES FOR Y-AXIS
            COSYX = -SINH
            COSYY = COSH
            COSYZ = 0.
      C-DIRECTION COSINES FOR Z-AXIS
            COSZX = SVPID2 * COSH
            COSZY = SVPID2 * SINH
            COSZZ = CVPID2
            RETURN
            END
```

```
      SUBROUTINE AVPRNT     73/74   OPT=2                    FTN 4.6+452        78/02/21. 14.57.14        PA        1

    1           C-SUBROUTINE FOR CALCULATING          RMIN  RATIO
                      SUBROUTINE AVPRNT
                      COMMON /GRID/ FGRID(30,30,4),NUMX,NUMYZ
                      FCT = 0.
    5                 FCMIN = 999999999.
                      FCMAX = -999999999.
                      DO 110 I = 1,NUMX
                      DO 110 J = 1,NUMYZ
                      FCG = FGRID(I,J,4)
   10                 IF(FCG .LT. FCMIN) FCMIN = FCG
                      IF(FCG .GT. FCMAX) FCMAX = FCG
                      FCT = FCT + FCG
                  110 CONTINUE
                      PTS = NUMX * NUMYZ
   15                 PRINT 120, FCT, PTS
                  120 FORMAT(//10X,"TOTAL FOOTCANDLES   =", F15.10
                     1        /10X,"NUMBER OF POINTS    =", F15.10)
                      FCA = FCT/PTS
                      UNI = 0.
   20                 IF(FCMIN .NE. 0.) UNI = FCA/FCMIN
                      PRINT 130, FCA, UNI
                  130 FORMAT(//10X,"AVERAGE FOOTCANDLES =", F15.10
                     1        /10X,"UNIFORMITY RATIO    =", F15.10)
                      PRINT 140, FCMAX, FCMIN
   25                 FORMAT(//10X,"MAXIMUM FOOTCANDLES =", F15.10
                     1        /10X,"MINIMUM FOOTCANDLES =", F15.10)
                      RETURN
                      END
```

```
      C-DISK DIRECTORY PRINT
            SU ROUTINE ORPRNT
            COMMON /PIO/ IPIOLIS),IPAGE,LINLIM,LINE
            COMMON /IDX/ ANDEX1(200), INDEX1(800)
            NUMLUM = ANDEX1(200)
            IA1 = -3
  100       CALL PAGE
            PRINT 110
  110       FORMAT(/)
            PRINT 120
  120       FORMAT(10X,4("NO. LUMID        "))
            PRINT 130
  130       FORMAT(10X,4("--- ----------  "))
            LINE = LINE + 3
  140       IF(LINE .GT. LINLIM) GO TO 100
            IA1 = IA1 + 4
            IF(IA1 .GT. NUMLUM) GO TO 9990
            IA2 = IA1 + 3
            IF(IA2 .GT. NUMLUM) IA2 = NUMLUM
            PRINT 150, (IA,ANDEX1(IA),IA=IA1,IA2)
  150       FORMAT(10X,4(I3,1X,A10,2X))
            LINE = LINE + 1
            GO TO 140
 9990       RETURN
            END
```

```
      C-SUBROUTINE FOR CHANGING PAGES AND RESETING LINE COUNTER
            SUBROUTINE PAGE
            COMMON /PID/ IPID(15),IPAGE,LINLIM,LINE
            COMMON /ISW/ ISW1,ISW2,ISW3,ISW4,ISW5,ISW6
            DATA ITOP/76568/, IDEL/7674H/, IFLAG/0/
            IF(IFLAG .GT. 0) GO TO 80
            IFLAG = 1
            CALL DATE(PDATE)
            CALL TIME(PTIME)
         80 CONTINUE
            IPAGE = IPAGE + 1
            IF(ISW6 .NE. 0) PRINT 90, ITOP,(IDEL,IA=1,51)
         90 FORMAT(52R2)
            PRINT 100
        100 FORMAT(1H1)
            PRINT 110, IPID,PDATE,PTIME,IPAGE
        110 FORMAT(/   10X,15A4,20X,2(A2,1X,),," PAGE",I5/)
            LINE = 4
            RETURN
            END
```

```
      C-RETRIEVES A SPECIFIED CANDLEPOWER TABLE FROM MASS STORAGE
            SUBROUTINE RANIN(ITABLE)
            COMMON /T2V/ CPH(90),CPV(90),CP(90,40),HV,FID,NH,NV
            COMMON /T2V/ CM(5,-)
            COMMON /DEV/ IDEV1,IDEV2,IDEV3,IDEV4,IDEV5,IDEV6
            COMMON /IDX/ INDEX1(200),INDEX1(800)
            DIMENSION CPID(3500),CMID(28)
            EQUIVALENCE (CP,CPID),(HV,CMID)
            HV = 1H$
            FID = 10H$$$$$$$$$$
            NH = 0
            NV = 0
            DO 110 JA = 1,40
            CP(JA) = 0.
            DO 110 IA = 1,90
          110 CP(IA,JA) = 0.
            DO 120 IA = 1,90
          120 CPH(IA) = 0.
            CALL RANREC(ITABLE,1,IREC)
            CALL READMS(IDEV1,CMID,28,IREC)
            CALL RANREC(ITABLE,2,IREC)
            CALL READMS(IDEV1,CPH,NH,IREC)
            CALL RANREC(ITABLE,3,IREC)
            CALL READMS(IDEV1,CPV,NV,IREC)
            NHNV = NH*NV
            CALL RANREC(ITABLE,4,IREC)
            CALL READMS(IDEV1,CPID,NHNV,IREC)
            IA = NHNV + 1
            JA = NV + 1
            DO 210 JA = 1,NV
            JB = JB - 1
            IB = NH + 1
            DO 210 IC = 1,NH
            IA = IA - 1
            IB = IB - 1
            CP(IB,JB) = CPID(IA)
            IF(IA .GT. NH) CPID(IA) = 0.
          210 CONTINUE
            RETURN
            END
```

```
      SUBROUTINE CPPRNT     73/74   OPT=2                    FTN 4.6+452        78/02/21. 14.57.14        PAGE     1

 1          C-THIS SUBROUTINE PRINTS THE CANDLEPOWER TABLE FOR A LUMINAIRE
                SUBROUTINE CPPRNT(ITABLE)
                COMMON /T2VZ/ CPH(30),CPV(40),CP(90,40),HV,FID,NH,NV
                COMMON /T2V/ C4(6,4)
 5              COMMON /PID/ IPID(15),IPAGE,LINLIM,LINE
                COMMON /CON/ PI,DEGRAD,RADDEG,PID2
                DIMENSION H(30),V(40),ICP(10)
                CALL RANIN(ITABLE)
                DO 110 IA = 1,NH
10            110 H(IA) = CPH(IA) * RADDEG
                DO 120 JA = 1,NV
              120 V(JA) = CPV(JA) * RADDEG
                JR = 0
          C-CHANGE PAGE AND PRINT HEADINGS
15            210 CALL PAGE
                PRINT 220, FID,ITABLE
              220 FORMAT(10X,"CANDLEPOWER TABLE - LUMINAIRE CODE: ",
             2    A10,1X,"TABLE NO.",I4)
                DO 230 IA = 1,4
20            230 PRINT 240, (C4(IA,JA),IA=1,6)
              240 FORMAT(10X,6A10)
                PRINT 250
              250 FORMAT(1H )
                PRINT 260, HV,NH,NV
25            260 FORMAT(10X,"HORZ. ANGLES",2X,"(",A1,2I5,")")
                LINE = LINE + 7
                IA1 = 1
                IA2 = 9
                IF(IA2 .GT. NH) IA2 = NH
30              PRINT 270, (H(IA),IA=IA1,IA2)
                LINE = LINE + 1
              270 FORMAT(16X,9F6.1)
                IA1 = 0
              280 IA1 = IA1 + 10
35              IF(IA1 .GT. NH) GO TO 310
                IA2 = IA1 + 9
                IF(IA2 .GT. NH) IA2 = NH
                PRINT 290, (H(IA),IA=IA1,IA2)
                LINE = LINE + 1
40            290 FORMAT(10X,10F6.1)
                GO TO 280
          C-PRINT BODY OF TABLE
              310 PRINT 320
              320 FORMAT(5X,"VERT.")
45              LINE = LINE + 1
              330 IF((LINE .GT. LINLIM) .AND. (JR .LT. NV)) GO TO 210
                JR = JR + 1
                IF(JR .GT. NV) GO TO 9900
                IA1 = 1
50              IA2 = 9
                IF(IA2 .GT. NH) IA2 = NH
                IR2 = 0
                DO 339 IA = IA1,IA2
                IR2 = IR2 + 1
55            339 ICP(IR2) = CP(IA,JR)
                PRINT 340, V(JR),(ICP(IR),IR=1,IR2)
                LINE = LINE + 2
```

```
      340 FORMAT(/4X,66.1,5X,91A)
          IA1 = 0
60    350 IA1 = IA1 + 10
          IF(IA1 .GT. NH) GO TO 330
          IA2 = IA1 + 9
          IF(IA2 .GT. NH) IA2 = NH
          IH2 = 0
65        DO 359 IH = IA1,IA2
          IH2 = IH2 + 1
      359 ICP(IH2) = CP(IA,JH)
          PRINT 360, (ICP(IH),IH=1,IH2)
          LINE = LINE + 1
70    360 FORMAT(10X,10(A))
          GO TO 350
     9990 RETURN
          END
```

```
SUBROUTINE RANREC      73/74   OPT=2                FTN 4.6+452      78/02/21. 14.57.14      Pa      1

1           C-SUBROUTINE FOR COMPUTING COC RECORD NUMBER
                SUBROUTINE RANREC(IG,IT,IR)
                IR = 4*(IG-1) +IT + 1
                RETURN
5               END
```

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO
Point to Point Lighting	712X602120

PREPARING AGENCY
U.S. Army Corps of Engineers, Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
M.E. Fletcher	Sep 75 Mar 77	REV 1	PROD

A. PURPOSE OF PROGRAM

The program analyzes the design of a lighting installation to determine the amount of illumination it gives. The program permits analysis of an installation having many luminaires. The luminaires may be a mixture of many different types.

B. PROGRAM SPECIFICATIONS

1. Language - FORTRAN IV

2. Size: 28.042K Words

C. METHODS

The program performs lighting calculations by the point to point method. The candlepower data for many different luminaires has been previously stored on random access disk. When calculations are being for a particular luminaire the candlepower table for that luminaire is placed in memory. The horizontal component, or vertical component, or direct illumination may be selected for output.

D. EQUIPMENT DETAILS

1. Computer: CDC 6600

2. Peripherals: 1-Card Reader
1-Printer
1-Random Access Disk

E. INPUT - OUTPUT

INPUT: Usually a permanent file created for timesharing terminal by using the text editor.

OUTPUT: Runs are submitted from the timesharing terminal, and output returned at the remote batch terminal.

F. ADDITIONAL REMARKS

POINT TO POINT LIGHTING 712C2120

*****

1. IDENTIFICATION.
Program name: Point To Point Lighting
Program number: 712X6C2120
Original: September 1975
Revision: 1 - March 1977. This revision changed the method of specifying the test grid. It also incorporates other changes and improvements necessary for the program to operate in a combination timesharing and remote batch system.

2. PURPOSE. The program analyzes the design of a lighting installation to determine the amount of illumination it gives. The design is described to the program by giving the coordinates of each luminaire. The origin of the coordinate system is completely arbitrary. It may be chosen wherever convenient. The output of the program is a printout of a grid of illumination (footcandle) values. The grid is specified by giving the coordinates of two corners.

3. ENTERING CANDLEPOWER DATA. Refer to Figure 3, card type 50. In order to test a given luminaire with this program the candlepower data for the luminaire must be obtained and entered into the computer. For use with this program candlepower data must be in the form of a two-dimensional table; one dimension being the number of horizontal angles, the other dimension being the number of vertical angles.

3.1. The candlepower data is first entered into a sequential file which has a format of one record (card) per point. The program will later transfer the data to a random access file. The first 9 characters of a record are ignored by the program, and may be used for sequence numbers or other information at the discretion of the user. Character 10 must contain either an H or V. This indicates to the program how the photometry of the fixture was performed, i.e. was the polar axis horizontal or vertical (polar axes will be discussed later). Columns 11-20 contain the LUMID. Columns 21-30 contain the horizontal angle. Columns 31-40 contain the vertical angle. Columns 41-50 contain the candlepower value.

3.2. The cards must be arranged so the the angles are in

ascending order with the vertical angles changing the fastest. The resulting file has a group of cards with the same horizontal angle, and with the vertical angles increasing from the smallest to the largest. This group is then followed by another group with the next larger horizontal angle, and a repetition of the vertical angles. The pattern is followed until all data for the luminaire has been entered.

3.3. Since photometric data is given in terms of horizontal and vertical angles a polar coordinate system is implied. It is very important to determine if the photometry was performed with a horizontal or a vertical polar axis. Consider for a minute the standard right-handed XYZ coordinate system. Polar coordinates in such a system are given by r, theta, and phi. It is not necessary to specify the coordinate r for a candlepower table. Theta is the angle with the positive Z-axis. Phi is the angle with the positive X-axis. Let r = 1 unit so that we are considering a unit vector with some direction designated by theta and phi. If phi is held constant at some value, and theta is varied from 0.0 to 360.0 degrees then the tip of the unit vector will trace a great circle on a sphere of radius 1. This corresponds to a line of longitude of the surface of the earth. If theta instead of phi is held constant, and phi is varied from 0.0 to 360.0 degrees then the tip of the unit vector will trace a circle smaller than a great circle unless theta is exactly 90.0 degrees. These circles correspond to lines of latitude on the earth.

3.4. The program defines the Z-axis as the polar axis of an XYZ-coordinate system. When preparing to enter candlepower data it is necessary to determine whether the polar axis was horizontal or vertical when the photometric tests were made. This determines whether the horizontal angles in the candlepower table are measuring lattitude or longitude. If that question is answered for horizontal angles then it is automatically answered for vertical angles.

3.5. In general for floodlight type luminaires it will be found that the photometric data was taken with the polar axis horizontal. This means that the

candlepower data should be coded with an H.

3.6. In general for roadway type luminaires it will be found that the photometric data was taken with the polar axis vertical. This means that the candlepower data should be coded with a V.

3.7. For entering candlepower data certain conventions have been adopted which do not necessarily conform to standard mathematical usage.

3.8. For a luminaire coded as H, generally a floodlight luminaire, the following convention has been adopted: For horizontal angles the zero reference is taken 90 degrees to the left of the central part of the beam when looking at the face of the luminaire. Most floodlights have a bracket which permits tilting in the vertical direction. A ray with a horizontal angle of 0.0 degrees would come out the right hand shaft of the vertical tilt mechanism when looking at the luminaire from behind. For vertical angles the zero reference is taken at the central part of the beam. Angles below the center of the beam are positive, and become increasingly more positive as the rotation down from the center of beam increases. Angles above the center of the beam are negative, and become increasingly more negative as the rotation up from the center of the beam increases.

3.9. For a luminaire coded a V, generally a roadway luminaire, the following convention has been adopted: Draw a line from the mounting bracket out through the center of the luminaire. The zero reference for horizontal angles is on a line through the center of the luminaire, perpendicular to the bracket-luminaire line, and to the right when looking at the luminaire from behind. A point on the bracket-luminaire line on the opposite side from the bracket would have a horizontal angle of 90.0 degrees. The zero reference for vertical angles is a horizontal plane through the center of the luminaire. A point in this plane has a vertical angle of 0.0 degrees. A point directly beneath the luminaire has vertical angle of positive 90.0 degrees. The point directly beneath a roadway luminaire is ambiguous as far as the horizontal angle is concerned. This point has been arbitrarily

assigned a horizontal angle of zero degrees.

3.10. Please note that these horizontal angles, as well as the angles used for entering the zonal cavity data, do not apply to aiming angles and to other angles to be discussed later. They are not necessarily consistent with manufacturer's data sheets either. Some manual conversion of angles must usually be made before the candlepower data is entered. There is no single inclusive procedure that applies to all luminaires so manufacturers publish data that will be found presented in many different ways.

3.11. A special case which needs to be mentioned is that of a roadway luminaire that emits light at the horizontal angles from 0 to 180 degrees. The candlepower table for this type of luminaire must include columns for both 0 and 180 degrees. This is required to make the two-dimensional interpolation routine work properly.

4. ENTERING DEPRECIATION FACTORS. Refer to Figure 4, Data type 40. The amount of light a given luminaire will put out when it is new and clean is greater than it will be after some time has passed. For design purposes it is usually desired to predict the performance of the lighting system under the worst possible conditions. In most cases the worst possible conditions would be just before lamp replacement and just before cleaning. The program predicts a decrease in light by applying multipliers to the candlepower of the luminaire. The multipliers are decimal fractions in the range 0.0<FACTOR<=1.0.

4.1. The program allows for three factors. One is for lamp aging. One is for dirt accumulation. The last factor is for anything else that needs to be considered such as a lamp with a different lumen rating than the lamp used in the photometric tests.

Data definitions:

CPL = The candlepower of the luminaire with no depreciation factors applied. CPL is interpolated from the nearest values in the previously entered candlepower table.

DOINT = The depreciation factor due to the

accumulation of dirt on the luminaire.

DLAMP = The depreciation factor due to aging of the lamp.

OTHFC = Any other factor which must considered, and will change light output.

Computation: CPL * DLAMP * DDIRT * OTHFC

5. ENTERING LUMINAIRE POSITION AND AIMING. Refer to Figure 2, card type 60. The exact position of each luminaire as well its aiming angles must be entered. The positions that are entered are the positions of the center of each luminaire. In addition to the X and Y coordinates, the Z-coordinate or height of the luminaire must be given. The Z-coordinate would normally be the pole height. A situation where the Z-coordinate would not be the pole height would be in the case of a roadway luminaire mounted on an arm with upward slant. The increased height due to slant must be included. The actual height above ground of the luminaire is the correct figure in all cases.

5.1. The location of the origin of the coordinate system is completely relative. The user simply has to make sure that all coordinates that he enters are consistent with the system that he is using. When the program computes the amount of light falling on a certain point the coordinates involved are subtracted, and the program operates with the differences.

Data Definitions:

XL, YL, ZL = The coordinates of the luminaire.

XG, YG, ZG = The coordinates of the point on the test grid.

Computation:
X = XG - XL
Y = YG - YL
Z = ZG - ZL

5.2. Aiming angles must also be entered. The system of coordinates used by the program is a standard right-hand XYZ-coordinate system. The Z-axis is

defined as being vertical. The horizontal aiming angle is measured from the positive X-axis. It can go all the way around from 0.0 to 360.0 degrees. Negative values are not allowed. The vertical aiming angle is measured from the negative Z-axis. This is contrary to the standard system which measures from the positive Z-axis. The result is that a vertical angle of 0.0 degrees indicates a light aimed straight down.

5.3. Before vertical angles are used in further calculations they are changed to other values. The translation depends upon whether the luminaire has been coded as H or V. For a luminaire coded as H (floodlight) vertical angles in the range 0.0 to 180.0 are changed to 180.0 to 0.0. This effectively switches the zero reference to the positive Z-axis. For a luminaire coded as V (roadway) vertical angles in the range 0.0 to 90.0 is changed to 90.0 to 0.0, and the range 90.0 through 180.0 is changed to 360.0 to 270.0.

6. ENTERING THE TEST GRID. Refer to Figure 2, card types 70 and 80. A test grid is defined as the network of points for which the amount of light is to be computed. The program is capable of processing as many test grids in one run as required. The specification of a test grid consists of a sequence of two cards defining a rectangular area. The sequence is repeated as often as necessary. It is sometimes useful to make a test grid covering a large area, and then to make another test grid covering a smaller area within the larger area.

6.1. A test grid is defined by giving the XYZ-coordinates of two points. The points are at opposite corners of a rectangular area. The area is the space for which the amount of light is to be computed. A geometric fact is that three points are required to define a plane. In the case of a horizontal plane (and tilted planes where the line from point 1 to 3 is parallel to the X-axis) the program will pick the third point automatically. Otherwise it is necessary to give the coordinates of the third point.

6.2. The rules the program uses to pick point 3 are as follows:

XGRID3 = XGRID2
YGRID3 = YGRID1
ZGRID3 = ZGRID1

With the above information the program calculates the coordinates of the fourth corner and all the remaining points of the test grid. The coordinates of the four corners are printed to help in interpreting the results.

6.3. When the test grid is printed out the positions of the corners on the paper are as follows: Corner 1 is lower left. Corner 2 is upper right. Corner 3 is lower right. Corner 4 is upper left.

6.4. The first card specifying the test grid is for the XYZ-coordinates of corner 1 and corner 2. The second card is for the number of X-points, the number of YZ-points, the selection of horizontal or vertical components or direct, the angle or the light meter for vertical components, and the XYZ-coordinates of corner 3.

7. METHODS: The following paragraphs discuss in detail the mathematical procedures the programs uses. Only enough detail was included to make the major points understandable. For more detail refer to the program listing itself.

8. After the input data discussed above is complete the program proceeds to calculate illumination at points on the test grid by the point to point method. This means that the distance and angles to a point on the test grid are determined, the candlepower looked up in the table, and the calculation made. The procedure is repeated once for each point on the test grid for each luminaire. The following formula will determine the exact number of times the procedure is carried out. Data definition:

NUNIT = the number of luminaires

NUMX = the number of X-points on the test grid

NUMYZ = the number of YZ-points on the test grid

IGRID = the total number of test grids to be processed

LOOPS = the number of time the procedure is performed

Computation: LOOPS = NUNIT * NUMX * NUMYZ * IGRID

9. At the beginning of the point to point calculation loop the program selects a particular luminaire. The aiming angles are adjusted as discussed above. Then it selects a particular point on the test grid. The luminaire and point selected depend on the number of times the program has been around the loop.

10. After the aiming angles have been adjusted the next item of business is calculation of the X, Y, and Z distances to the point. This is done by subtracting the coordinates of the test grid point and the luminaire. The XYZ-distances are used to calculate some other basic values. Data definition:

    R = the straight line distance from the luminaire to the point

    RH = the component of R in the horizontal plane

    HXY = the horizontal angle from the luminaire to the point in the main system

    COSZP = the cosine of the angle of the luminaire's ray with a vertical line

    Computation:
    R = SQRT(X*X + Y*Y + Z*Z)
    RH = SQRT(X*X + Y*Y)
    HXY = ATANSP(X,Y)
    COSZP = Z/R

11. After computation of R and the other basic items the program branches depending on whether the luminaire has a horizontal or vertical polar axis. The next step in either branch is calculation of direction cosines.

11.1. For a floodlight luminaire coded as H: A coordinate system is established about the luminaire. The polar axis (Z-axis) of the system is fixed in a horizontal position. Note below that COSZZ = 0. This fixes the Z-axis as parallel to the XY-plane but still allows it to rotate. The central part of the beam is aimed along the Y-axis. The direction cosines of the angles of the axes of the luminaire's

system with the axes of the main system are computed. Data definition:

H = horizontal aiming angle

V = vertical aiming angle

PID2 = pi/2 or 90.0 degrees

COSXX, COSXY, COSXZ = the cosines of the luminaire's X-axis with the main system's axes

COSYX, COSYY, COSYZ = the cosines of the luminaire's Y-axis with the main system's axes

COSZX, COSZY, COSZZ = the cosines of the luminaire's Z-axis with the main system's axes

Computation:
C-DIRECTION COSINES FOR X-AXIS
COSXX = SIN(V) * COS(H)
COSXY = SIN(V) * SIN(H)
COSXZ = COS(V)
C-DIRECTION COSINES FOR Y-AXIS
COSYX = SIN(PID2 + V) * COS(H)
COSYY = SIN(PID2 + V) * SIN(H)
COSYZ = COS(PID2 + V)
C-DIRECTION COSINES FOR Z-AXIS
COSZX = -SIN(H)
COSZY = COS(H)
COSZZ = 0.

11.2. For a roadway luminaire coded as V: A coordinate system is established about the luminaire. The polar axis (Z-axis) of the system is vertical. The central beam of the luminaire is aimed along the negative Z-axis. Computation of direction cosines:

C-DIRECTION COSINES FOR X-AXIS
COSXX = SIN(V) * COS(H)
COSXY = SIN(V) * SIN(H)
COSXZ = COS(V)
C-DIRECTION COSINES FOR Y-AXIS
COSYX = -SIN(H)
COSYY = COS(H)
COSYZ = 0.
C-DIRECTION COSINES FOR Z-AXIS
COSZX = SIN(V-PID2) * COS(H)

```
COSZY = SIN(V-PID2) * SIN(H)
COSZZ = COS(V-PID2)
```

12. After calculation of the appropriate set of direction cosines the coordinates of the test grid point in the luminaire's system are computed. The formula used is the standard one for rotation of coordinates in three dimensions. Data definition:

    XC, YC, ZC = the coordinates of the test grid point in the lights system

    Computation:

```
XC = COSXX*X + COSXY*Y + COSXZ*Z
YC = COSYX*X + COSYY*Y + COSYZ*Z
ZC = COSZX*X + COSZY*Y + COSZZ*Z
```

13. Once the coordinates in the luminaire's system have been computed they can be used to obtain the horizontal and vertical angles in the luminaire's system. Data definition:

    VC = the vertical angle in the luminaire's system

    HC = the horizontal angle in the luminaire's system

    Computation:

```
VC = ACOS(ZC/R)
COSH = 1.
SINVC = SIN(VC)
IF(SINVC .NE.  0.) COSH = XC/(R*SINVC)
IF(COSH .GT.  1.) COSH = 1.
IF(COSH .LT.  -1.) COSH = -1.
HC = ACOS(COSH)
IF(YC .LT.  0.) HC = PIX2 - HC
```

    The purpose of the last IF statement is to allow the horizontal angle to cover the full range from 0.0 to 360.0 degrees. This is necessary since ACOS repeats on the range from 0.0 to 180.0 degrees.

14. After the angles have been computed in the luminaire's system further manipulation is still required before we have the angles necessary to reference the candlepower table. Different manipulations are performed depending on whether the luminaire is coded as H or V.

14.1. For a floodlight luminaire coded as H: The vertical

angle VC is turned into the horizontal angle H. H is used for the candlepower table look up. This change is necessary since the polar axis (Z-axis) of the luminaire's coordinate is horizontal. The horizontal angle HC is turned into the vertical angle V. Data definition:

PI = pi = 3.1416592

Computation:
```
H = PI - VC
IF((XC .LE.  0.) .AND.  (ZC .GT.  0.)) H = PI + VC
IF((XC .LT.  0.) .AND.  (ZC .LE.  0.)) H = PI + VC
V = -HC
IF(YC .LT.  0.) V = PIX2 - HC
V = -V
```

14.2. For a roadway luminaire coded as V: The vertical angle VC is turned into the vertical angle V, but the zero reference is switched from the positive Z-axis to the XY-plane. The horizontal angle HC is turned into the horizontal angle H. The 90.0 degrees added has the effect of making the line directly in front of the luminaire 90.0 degrees.

Computation:
```
H = HC + PID2
IF(H .GT.  PIX2) H = H - PIX2
V = VC - PID2
```

15. After the necessary angles have been computed the next step is the same for both types of luminaires. The step is to perform a table look up in the candlepower table using the horizontal and vertical angles H and V. Since there will not usually be an entry in the table at the exact angles needed it is necessary to perform a two-dimensional interpolation. In the program the whole buisness is accomplisned by a subroutine called INT2V.

16. The interpolation proceeds in three steps. First a candlepower value is interpolated using the horizontal angles bracketing the point and the candlepower values at the nearest vertical angle below the point. Then another interpolation is performed using the candlepower values at the nearest vertical angle above the point. Then using the two candlepower values just obtained a value is interpolated using the vertical

angles bracketing the point. The result of the last interpolation is the final value of candlepower. It is used to calculate footcandles.

17. Computation of illumination:

FC = CPL * DLAMP * DDIRT * OTHFC/(R*R)

It is standard practice to resolve FC (footcandles) into either a horizontal or vertical component. This is necessary so that light from a number of different sources can be added.

17.1. For horizontal components. Data definition:

COSZP = the cosine of the angle of the luminaire's ray with a vertical line

Computation: FC = FC * ABS(COSZP)

17.2. For vertical components. Data definition:

HXY180 = the reverse of the horizontal angle from the luminaire to the point in the main system

HMETER = the angle the light meter is aimed

Computation:
```
FC = FC * RH/R
HXY180 = HXY + PI
IF(HXY180 .GT.  PIX2) HXY180 = HXY180 - PIX2
HV = HXY180 - HMETER
COSHV = COS(HV)
FC = FC * COSHV
IF(COSHV .LT.  0.) FC = 0.
```

18. The final value for the illumination (FC) obtained is added to the test grid point. The program then goes on to the next point. The program continues to go through the loop until it has done all the points and all the luminaires. Then the test grid is printed.

19. DESCRIPTION OF INPUT: The illustrations on the following pages show how input should be prepared. The term "card" is used loosely since the program can run either with card input or with input from a timesharing terminal. One line of typing on a terminal is equivalent to one card.

19.1. Formats are shown in the illustrations. The proper type of data must be typed in each field according to the field's format. If a mistake is made in the type of data in the field the program will abort. I format is for integer data. The data for an I field should be typed right justified without a decimal point. F format is for decimal numbers. The data for F fields should be typed right justified with a decimal point. A format is for alphabetic data. The data for A fields should be left justified. The particular columns allotted for the various data fields are shown by the illustrations.

19.2. Three types of cards require special attention. After the required number of these cards are entered there must be a kissoff. A kissoff card has all 9's from column 11 to column 20. The card types that require a kissoff are: luminaire depreciation factors, luminaire positions, test grid specifications.

19.3. An actual data set is reproduced in Figure 1 with comments.

```
00100 9999          1                          1 ← SWITCHES
00105       PADMIN1
00110       V10CHSGGE          1.00     1.00      1.00 ←DEPRECIATION FACTORS
00120       9999999999 ← KISSOFF                    LUMINAIRE POSITION ↷
00130       V10CHSGGE          0.00     0.00     20.00      0.00      0.00 ↷
00140       9999999999 ← KISSOFF                    TEST GRID SPECIFICATION ↷
00150            -10.00       -10.00     0.00     10.00     10.00      0.00 }↷
00160                 S            S        H      0.00
00170       9999999999 ← KISSOFF
*
```

FIGURE 1 - INPUT PREPARED ON A TIMESHARING TERMINAL

5. PUNCHED CARD FORMAT—MULTIPLE

DATE: MARCH 1977 | JOB NUMBER: 712-MIC2-120 | PROGRAMMER: M.E. TONER

TITLE: POINT TO POINT LIGHTING

SOURCE: FIGURE 2 - DESIGN DATA INPUT FORMAT

A-16

CARD TYPE 10 - PROGRAM CONTROL

NOTE: ALL SWITCHES READ BY I10 FORMAT 1 = ON, 0 = OFF.

[1|0]

ITYPE		ISW1	ISW2	ISW3	ISW4	ISW5	ISW6
		PRINT CANDLE-POWER TABLE	DISK DIRECTORY PRINT	PRINT EACH POINT AFTER CALCULATION	PRINT GRID AFTER EACH LIGHT	PRINT EACH CANDLEPOWER CARD	READ SEQUENTIAL CANDLEPOWER FILE

CARD TYPE 30 - PROJECT IDENTIFICATION

[3|0]

ITYPE		IPID
		(60 CHARACTERS ALPHANUMERIC) 15A4

CARD TYPE 40 - LUMINAIRE IDENTIFICATION & DEPRECIATION FACTORS

[4|0]

ITYPE		LUMID	DLAMP	DDIRT	OTHFC
		LUMINAIRE IDENTIFICATION 2A4, A2	LAMP LUMEN DEPRECIATION F10.0	LUMINAIRE DIRT DEPRECIATION F10.0	ANY OTHER FACTOR F10.0

CARD TYPE 60 - LUMINAIRE POSITION AND ORIENTATION

[6|0]

ITYPE		LUMID F10.0	XLUM F10.0	YLUM F10.0	ZLUM F10.0	HLUM F10.0	VLUM F10.0

CARD TYPE 70 - TEST GRID SPECIFICATION

[7|0]

ITYPE		XGRID1 F10.0	YGRID1 F10.0	ZGRID1 F10.0	XGRID2 F10.0	YGRID2 F10.0	ZGRID2 F10.0

CARD TYPE 80 - TEST GRID SPECIFICATION

[8|0]

ITYPE		NUMX I10	NUMYZ I10	H, V, D (COMP, AI)	HMETER F10.0	XGRID3 F10.0	YGRID3 F10.0	ZGRID3 F10.0

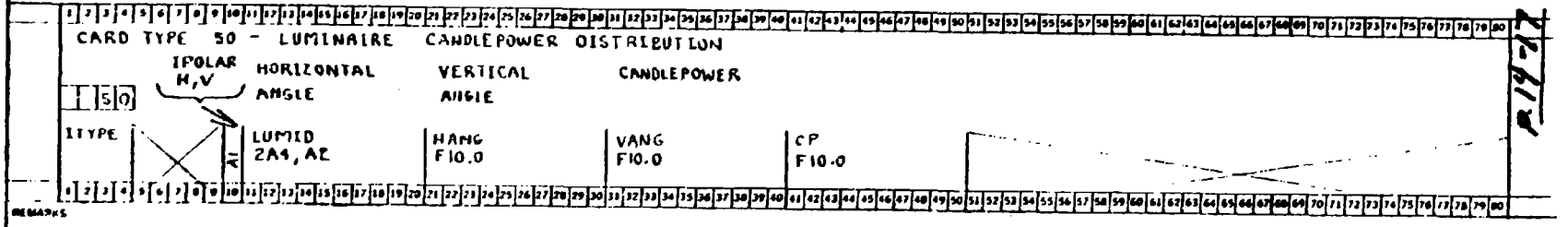
REMARKS

PUNCHED CARD FORMAT—MULTIPLE

DATE: MARCH 1977 | JOB NUMBER: 712-M1C2-120 | PROGRAMMER: M.E. FLETCHER

TITLE: POINT TO POINT LIGHTING

SOURCE: FIGURE 3 - CANDLEPOWER INPUT FORMAT



REMARKS

1918a

NOTES:

1. IN THIS REVISION OF THE PROGRAM CANDLEPOWER DATA IS READ FROM EITHER TAPE 1 OR TAPE 2 DEPENDING ON THE VALUE SWITCH 6.

2. IF SWITCH 6 IS OFF (ZERO), WHICH IS THE NORMAL MODE, CANDLEPOWER DATA IS READ FROM TAPE 1. TAPE 1 IS A BINARY, RANDOM ACCESS FILE. IT IS NOT POSSIBLE TO MAKE ANY CHANGES THIS FILE EXCEPT FOR A TOTAL RE-CREATION.

3. IF SWITCH 6 IS ON (ONE) CANDLEPOWER DATA IS READ FROM TAPE 2 AND WRITTEN TO TAPE 1. TAPE 2 IS A BCD FILE FORMATED AS SHOWN ABOVE. IT CAN CHANGED WITH THE TEXT EDITOR (COMPOSE) OR OTHER PROGRAMS. IT COULD ALSO BE PUNCHED INTO CARDS OR READ FROM CARDS.

4. ON HDR'S SYSTEM A PERMANENT FILE CALLED CANDLE1 IS MAINTAINED. CANDLE1 IS ASSIGNED TO TAPE 2. ANOTHER PERMANENT FILE CANDLER IS ASSIGNED TO TAPE 1. THERE IS A PROCEDURE FILE, LIGHT1R, WHICH CAN BE SUBMITTED TO TRANSFER THE CANDLEPOWER DATA FROM CANDLE1 TO CANDLER.

5. THE SEQUENTIAL CANDLEPOWER FILE MUST END WITH A KISSOFF (9999999999) IN COLUMNS 11-20. THIS IS THE FILE CANDLE1 ON TAPE2.

```
C
  /LIST
C 00010 C-U.S. ARMY CORPS OF ENGINEERS
  00020 C-OMAHA DISTRICT
  00030 C
C 00040 C-OUTDOOR LIGHTING ECONOMIC COMPARISON, 712MIC2130
  00050 C-AUTHOR:  M. E. FLETCHER
  00060 C-DATE:  OCTOBER 1975
C 00070 C*
  00080       PROGRAM ECON1(TAPE1,OUTPUT,TAPE2=OUTPUT)
  00090       COMMON /EQP/ F2(6),F3(6),F5(6),F7(6),F8(6),F9(6),
C 00100      1F12(6),F13(6),F14(6),F14A(6),F14C(6),F15(6),
  00110      2F16(6),F6(6),I1(6),I4(6),I10(6),I11(6)
  00120       COMMON /LAB/ F18(6),F19(6),F20(6),F21(6),F21A(6),F21B(6),F22(6),
C 00130      1F23(6)
  00140       COMMON /ILL/ F25(6),F26(6),F27(6),F28(6),F28A(6),F29(6),F29A(6)
  00150       COMMON /CST/ F30(6),F30A(6),F31(6),F32(6),F33(6),F34(6),
C 00160      1F35(6),F36(6),F37(6),F37D(6),F38(6),F38A(6),F38B(6),F39(6),F40(6)
  00170       COMMON /MNT/ F43(6),F43A(6),F44(6),F46(6),F47(6),F48(6),F50(6),
  00180      1F51(6),F52(6),F53(6),F54(6),F54A(6)
C 00190       COMMON /ANN/ F55(6),F56(6),F57(6),F57A(6),F58(6)
  00200       COMMON /TOT/ I1T(30),F3T(30),I4T(30),F7T(30),F9T(30),F13T(30),
  00210      1 F14T(30),F14AT(30),F14CT(30),F15T(30),F16T(30),F20T(30),F21T(30),
C 00220      2 F23T(30),F33T(30),F31T(30),F37T(30),F37DT(30),F40T(30),F44T(30),
  00230      3 F47T(30),F50T(30),F51T(30),F52T(30),F53T(30),F55T(30),F56T(30),
  00240      4 F22T(30),F21AT(30),F21BT(30),F38T(30),F38AT(30),F29T(30),F17(30),F24(30),
C 00250      5 F59C(30),F59(30),F60(30),F54T(30),F58T(30)
  00260       COMMON /HED/ HEAD(5,4),SYSCOL(130),DESCRI(5,120),ISYS
  00270       COMMON /DEV/ IDEV1
C 00280 C-DEVICE CODES
  00290       IDEV1 = 1
  00300       REWIND IDEV1
C 00310       ISYS = 0
  00320       SPACES = 10H
  00330       HEAD(1,1) = SPACES
C 00340       HEAD(1,2) = SPACES
  00350       HEAD(1,3) = 10H TOTAL FOR
  00360       HEAD(1,4) = 10H SYSTEM
C 00370 C-READ HEADING FOR SIDE BY SIDE COMPARISION
  00380   100 ISYS = ISYS + 1
  00390       CALL ZERO
C 00400       J = (ISYS - 1) * 4
  00410       DO 120 K = 1,4
  00420       J = J + 1
C 00430       READ(IDEV1,110) SYSCOL(J),(DESCRI(I,J),I=1,5)
  00440   110 FORMAT(10X,6A10)
  00450       IF(EOF(IDEV1)) 4000,120
C 00460   120 CONTINUE
  00470 C-READ DATA FOR COLUMN HEADERS
  00480       DO 140 IL=1,4
C 00490       READ(IDEV1,130) (HEAD(IG,IL),IG=2,5)
  00500   130 FORMAT(10X,6A10)
```

PRINTOUT OF COMPUTER PROGRAM USED FOR ECONOMIC COMPARISONS

ATTACHMENT 15

```
00510       IF(EOF(IDEV1)) 9999,140
00520   140 CONTINUE
00530 C-READ THE NUMBER OF COMPONENT GROUPS FOR THIS SYSTEM
00540       READ(IDEV1,150) NUMG
00550   150 FORMAT(10X,I10)
00560 C
00570 C-1. INITIAL EQUIPMENT INVESTMENT
00580 C
00590       CALL PAGE(1)
00600       PRINT 190
00610   190 FORMAT(/10X,'1.  INITIAL EQUIPMENT INVESTMENT'//)
00620 C-1. QUANTITY OF LUMINAIRES
00630   200 READ(IDEV1,210) I1
00640   210 FORMAT(10X,6I10)
00650       CALL ITOTER(I1,I1T(ISYS))
00660       PRINT 240, I1T(ISYS),(I1(IG),IG=1,NUMG)
00670   240 FORMAT(10X,'     1.  QUANTITY OF LUMINAIRES          ',5I14)
00680 C-2. LUMINAIRE COST EACH
00690       READ(IDEV1,250) F2
00700   250 FORMAT(10X,6F10.0)
00710       PRINT 260, (F2(IG),IG=1,NUMG)
00720   260 FORMAT(10X,'     2.  LUMINAIRE COST EACH             ',14X,4F14.2)
00730 C-3. LUMINAIRE COST TOTAL
00740       DO 270 IG=1,NUMG
00750       FI = I1(IG)
00760       F3(IG) = FI*F2(IG)
00770   270 CONTINUE
00780       CALL FTOTER(F3,F3T(ISYS))
00790       PRINT 280, F3T(ISYS),(F3(IG),IG=1,NUMG)
00800   280 FORMAT(10X,'     3.  LUMINAIRE COST TOTAL            ',5F14.2)
00810 C-4. QUANTITY OF POLES
00820       READ(IDEV1,210) I4
00830       CALL ITOTER(I4,I4T(ISYS))
00840       PRINT 290, I4T(ISYS),(I4(IG),IG=1,NUMG)
00850   290 FORMAT(10X,'     4.  QUANTITY OF POLES               ',5I14)
00860 C-5. MOUNTING HEIGHT
00870       READ(IDEV1,250) F5
00880       PRINT 300, (F5(IG),IG=1,NUMG)
00890   300 FORMAT(10X,'     5.  MOUNTING HEIGHT                 ',14X,4F14.2)
00900 C-6. POLE + BRACKET COST
00910       READ(IDEV1,250) F6
00920       PRINT 310, (F6(IG),IG=1,NUMG)
00930   310 FORMAT(10X,'     6.  POLE + BRACKET COST EACH        ',14X,4F14.2)
00940 C-7. POLE COST TOTAL
00950       DO 320 IG=1,NUMG
00960       FI4 = I4(IG)
00970       F7(IG) = FI4*F6(IG)
00980   320 CONTINUE
00990       CALL FTOTER(F7,F7T(ISYS))
01000       PRINT 330, (F7(IG),IG=1,NUMG)
01010   330 FORMAT(10X,'     7.  POLE COST TOTAL                 '14X,4F14.2)
01020 C-8. FOUNDATION COST EACH
01030       READ(IDEV1,250) F8
01040       PRINT 340, (F8(IG),IG=1,NUMG)
01050   340 FORMAT(10X,'     8.  FOUNDATION COST EACH            ',14X,4F14.2)
01060 C-9. POLE + FOUNDATION COST TOTAL
01070       DO 350 IG=1,NUMG
01080       FI4 = I4(IG)
01090       F9(IG) = FI4*(F6(IG)+F8(IG))
01100   350 CONTINUE
01110       CALL FTOTER(F9,F9T(ISYS))
01120       PRINT 360, F9T(ISYS),(F9(IG),IG=1,NUMG)
01130   360 FORMAT(10X,'     9.  POLE + FOUNDATION COST TOTAL    ',5F14.2)
01140 C-10. QUANTITY LAMPS PER LUMINAIRE
01150       READ(IDEV1,210) I10
01160       PRINT 370, (I10(IG),IG=1,NUMG)
```

```
01170    370 FORMAT(10X,'   10.  QTY LAMPS PER LUMINAIRE          ',14X,4I14)
C 01180 C-11. QUANTITY LAMPS
01190       DO 380 IG=1,NUMG
01200       I11(IG) = I1(IG)*I10(IG)
01210    380 CONTINUE
01220       PRINT 390, (I11(IG),IG=1,NUMG)
01230    390 FORMAT(10X,'   11.  QUANTITY LAMPS                 ',14X,4I14)
01240 C-12. LAMP COST EACH
01250       READ(IDEV1,250) F12
01260       PRINT 400, (F12(IG),IG=1,NUMG)
01270    400 FORMAT(10X,'   12.  LAMP COST EACH                 ',14X,4F14.2)
01280 C-13. LAMP COST TOTAL
01290       DO 410 IG=1,NUMG
01300       F11 = I11(IG)
01310       F13(IG) = F11*F12(IG)
01320    410 CONTINUE
01330       CALL FTOTER(F13,F13T(ISYS))
01340       PRINT 420, F13T(ISYS),(F13(IG),IG=1,NUMG)
01350    420 FORMAT(10X,'   13.  LAMP COST TOTAL                ',5F14.2)
01360 C-14.  ELECTRICAL DISTRIBUTION
01370       READ(IDEV1,250) F30
01380       READ(IDEV1,250) F30A
01390       DO 430 IG=1,NUMG
01400       F1 = I1(IG)
01410       F31(IG) = F1*(F30(IG)+F30A(IG)*F30(IG))
01420       F14(IG) = 200.*F31(IG)
01430    430 CONTINUE
01440       CALL FTOTER(F14,F14T(ISYS))
01450       PRINT 435, F14T(ISYS),(F14(IG),IG=1,NUMG)
01460    435 FORMAT(10X,'   14.  ELECTRICAL DISTRIBUTION          ',5F14.2)
01470 C-14A. STANDBY GENERATOR COST
01480       DO 440 IG=1,NUMG
01490       F14A(IG) = 170.*F31(IG)
01500    440 CONTINUE
01510       CALL FTOTER(F14A,F14AT(ISYS))
01520       PRINT 445, F14AT(ISYS),(F14A(IG),IG=1,NUMG)
01530    445 FORMAT(10X,'  14A.  STANDBY GENERATOR COST          ',5F14.2)
01540 C-14C. UPS COST
01550       DO 450 IG=1,NUMG
01560       F11 = I1(IG)
01570       F14C(IL) = 0.
01580       IF(F30A(IG).GT.0.) F14C(IG) = 750.*F11*F30(IG)
01590    450 CONTINUE
01600       CALL FTOTER(F14C,F14CT(ISYS))
01610       PRINT 460, F14CT(ISYS),(F14C(IG),IG=1,NUMG)
01620    460 FORMAT(10X,'  14C.  UPS COST                       ',5F14.2)
01630 C-15. TOTAL INITIAL EQUIPMENT LESS LAMPS
01640       DO 470 IG=1,NUMG
01650       F15(IG) = F3(IG)+F9(IG)+F14(IG)+F14A(IG)+F14C(IG)
01660    470 CONTINUE
01670       CALL FTOTER(F15,F15T(ISYS))
01680       PRINT 480, (F15(IG),IG=1,NUMG)
01690    480 FORMAT(10X,'   15.  TOTAL INIT EQUIP LESS LAMPS     ',14X,4F14.2)
01700 C-16. TOTAL INITIAL EQUIPMENT INCLUDING LAMPS
01710       DO 490 IG=1,NUMG
01720       F16(IG) = F13(IG)+F15(IG)
01730    490 CONTINUE
01740       CALL FTOTER(F16,F16T(ISYS))
01750       PRINT 500, F16T(ISYS),(F16(IG),IG=1,NUMG)
01760    500 FORMAT(10X,'   16.  TOTAL INIT EQUIP INCL LAMPS     ',5F14.2)
01770 C
01780 C-II. INITIAL LABOR ESTIMATES
01790 C
01800       PRINT 1190
01810   1190 FORMAT(//10X,'II.  INITIAL LABOR ESTIMATES'/)
01820 C-18. POLE ERECTION + PAINTING
```

```
      READ(IDEV1,250) F18
      PRINT 1200, (F18(IG),IG=1,NUMG)
 1200 FORMAT(10X,'   18.  POLE ERECTION + PAINTING          ',14X,4F14.2)
C-19. LUMINAIRE
      READ(IDEV1,250) F19
      PRINT 1210, (F19(IG),IG=1,NUMG)
 1210 FORMAT(10X,'   19.  LUMINAIRE LABOR                   ',14X,4F14.2)
C-20. NET LABOR, POLES + LUMINAIRES
      DO 1220 IG=1,NUMG
      F4 = I4(IG)
      F1 = I1(IG)
      F20(IG) = F4*F18(IG) + F1*F19(IG)
 1220 CONTINUE
      CALL FTOTER(F20,F20T(ISYS))
      PRINT 1230, F20T(ISYS),(F20(IG),IG=1,NUMG)
 1230 FORMAT(10X,'   20.  NET LABOR, POLES + LUMINAIRES    ',5F14.2)
C-21. ELECTRICAL DISTRIBUTION
      DO 1240 IG=1,NUMG
      F21(IG) = 150.*F31(IG)
 1240 CONTINUE
      CALL FTOTER(F21,F21T(ISYS))
      PRINT 1250, F21T(ISYS),(F21(IG),IG=1,NUMG)
 1250 FORMAT(10X,'   21.  LABOR ELECTRICAL DISTRIBUTION    ',5F14.2)
C-21A. LABOR STANDBY GENERATOR
      DO 1260 IG=1,NUMG
      F21A(IG) = 20.*F31(IG)
 1260 CONTINUE
      CALL FTOTER(F21A,F21AT(ISYS))
      PRINT 1270, F21AT(ISYS),(F21A(IG),IG=1,NUMG)
 1270 FORMAT(10X,'  21A.  LABOR STANDBY GENERATOR          ',5F14.2)
C-21B. LABOR UPS
      DO 1280 IG=1,NUMG
      FII = II(IG)
      F21B(IG) = 0.
      IF(F30A(IG).GT.0.) F21B(IG) = 100.*FII*F30(IG)
 1280 CONTINUE
      CALL FTOTER(F21B,F21BT(ISYS))
      PRINT 1290, F21BT(ISYS),(F21B(IG),IG=1,NUMG)
 1290 FORMAT(10X,'  21B.  LABOR UPS                       ',5F14.2)
C-22. TOTAL INITIAL LABOR
      DO 1300 IG=1,NUMG
      F22(IG) = F20(IG) + F21(IG) + F21A(IG) + F21B(IG)
 1300 CONTINUE
      CALL FTOTER(F22,F22T(ISYS))
      PRINT 1310, F22T(ISYS),(F22(IG),IG=1,NUMG)
 1310 FORMAT(10X,'   22.  TOTAL INITIAL LABOR              ',5F14.2)
C-23. TOTAL INITIAL INVESTMENT
      DO 1320 IG=1,NUMG
      F23(IG) = F16(IG)+F22(IG)
 1320 CONTINUE
      CALL FTOTER(F23,F23T(ISYS))
      PRINT 1330, F23T(ISYS),(F23(IG),IG=1,NUMG)
 1330 FORMAT(10X,'   23.  TOTAL INITIAL INVESTMENT         ',5F14.2)
C
C-III. ILLUMINATION CALCUALTIONS
C
      PRINT 1790
 1790 FORMAT(//10X,'III.  ILLUMINATION CALCULATIONS'//)
C-25. SPACING OR AREA
      READ(IDEV1,250) F25
      PRINT 1800, (F25(IG),IG=1,NUMG)
 1800 FORMAT(10X,'   25.  SPACING OR AREA                  ',14X,4F14.2)
C-26. UTILIZATION FACTOR
      READ(IDEV1,250) F26
      PRINT 1810, (F26(IG),IG=1,NUMG)
 1810 FORMAT(10X,'   26.  UTILIZATION FACTOR               ',14X,4F14.2)
```

```
C-27. MAINTENANCE FACTOR
      READ(IDEV1,250) F27
      PRINT 1820, (F27(IG),IG=1,NUMG)
1820  FORMAT(10X,'  27.  MAINTENANCE FACTOR          ',14X,4F14.2)
C-28. DESIGN FOOTCANDLES
      READ(IDEV1,250) F28
      PRINT 1830, (F28(IG),IG=1,NUMG)
1830  FORMAT(10X,'  28.  DESIGN FOOTCANDLES          ',14X,4F14.2)
C-29. COST PER LINEAL FOOT OR ACRE
      DO 1840 IG=1,NUMG
      F4 = I4(IG)
      IF(F4 .EQ. 0.) F4 = I4(1)
      F29(IG) = F23(IG)/(F25(IG)*F4)
      CALL FTOTER(F29,F29T(ISYS))
1840  CONTINUE
      PRINT 1850, F29T(ISYS),(F29(IG),IG=1,NUMG)
1850  FORMAT(10X,'  29.  INIT COST PER LINEAL FT OR ACRE ',4F14.2)
C
C-IV. ANNUAL COSTS
C
      CALL PAGE(1)
      PRINT 2390
2390  FORMAT(/10X,'IV.  ANNUAL COSTS',/)
C-30. KW PER LUMINAIRE
      PRINT 2400, (F30(IG),IG=1,NUMG)
2400  FORMAT(10X,'  30.  KW PER LUMINAIRE          ',14X,4F14.2)
C-30A. KW UPS POWER LOSS
      DO 2410 IG=1,NUMG
      F1 = I1(IG)
      F30A(IG) = F1*F30(IG)*F30A(IG)
2410  CONTINUE
      PRINT 2420, (F30A(IG),IG=1,NUMG)
2420  FORMAT(10X,'  30A.  KW UPS POWER LOSS          ',14X,4F14.2)
C-31. TOTAL SYSTEM KW
      CALL FTOTER(F31,F31T(ISYS))
      PRINT 2430, F31T(ISYS),(F31(IG),IG=1,NUMG)
2430  FORMAT(10X,'  31.  TOTAL SYSTEM KW          ',5F14.0)
C-32. ANNUAL OPERATION
      READ(IDEV1,250) F32
      PRINT 2440, (F32(IG),IG=1,NUMG)
2440  FORMAT(10X,'  32.  ANNUAL OPERATION (HOURS)  ',14X,4F14.0)
C-33. TOTAL ENERGY KWH/YEAR
      DO 2450 IG=1,NUMG
      F33(IG) = F31(IG)*F32(IG)
2450  CONTINUE
      CALL FTOTER(F33,F33T(ISYS))
      PRINT 2460, F33T(ISYS),(F33(IG),IG=1,NUMG)
2460  FORMAT(10X,'  33.  TOTAL ENERGY KWH/YEAR      ',5F14.0)
C-34. ENERGY COST PER KWH
      READ(IDEV1,250) F34
      PRINT 2470, (F34(IG),IG=1,NUMG)
2470  FORMAT(10X,'  34.  ENERGY COST PER KWH        ',14X,4F14.4)
C-35. DEMAND CHARGE/KW/MONTH
      READ(IDEV1,250) F35
      PRINT 2480, (F35(IG),IG=1,NUMG)
2480  FORMAT(10X,'  35.  DEMAND CHARGE/KW/MONTH     ',14X,4F14.4)
C-36. DEMAND CHARGE PER YEAR
      DO 2490 IG=1,NUMG
      F36(IG) = F31(IG)*F35(IG)*12.
2490  CONTINUE
      CALL FTOTER(F36,F36T(ISYS))
      PRINT 2500, F36T(ISYS),(F36(IG),IG=1,NUMG)
2500  FORMAT(10X,'  36.  DEMAND CHARGE PER YEAR    ',5F14.2)
C-37. ANNUAL KWH COST
      DO 2510 IG=1,NUMG
      F37(IG) = F33(IG)*F34(IG)
```

```
 2510 CONTINUE
      CALL FTOTER(F37,F37T(ISYS))
      PRINT 2520, F37T(ISYS),(F37(IG),IG=1,NUMG)
 2520 FORMAT(10X,'  37.  ANNUAL KWH COST                    ',5F14.2)
C-37D. DIESEL FUEL COST
      DO 2530 IG=1,NUMG
      F37D(IG) = F31(IG)*.40*.08*50.
 2530 CONTINUE
      CALL FTOTER(F37D,F37DT(ISYS))
      PRINT 2540, F37DT(ISYS),(F37D(IG),IG=1,NUMG)
 2540 FORMAT(10X,'  37D.  DIESEL FUEL COST                  ',5F14.2)
C-38. GROUP RELAMPING PERIOD
      READ(IDEV1,250) F38
      PRINT 2550, (F38(IG),IG=1,NUMG)
 2550 FORMAT(10X,'  38.  GROUP RELAMPING PERIOD (HOURS)  ',14X,4F14.0)
C-38A. LAMP LIFE (SPOT REPLACEMENT ONLY)
      READ(IDEV1,250) F38A
      PRINT 2560, (F38A(IG),IG=1,NUMG)
 2560 FORMAT(10X,'  38A.  RATED LAMP LIFE (HOURS)        ',14X,4F14.0)
C-38B. PORTION OF LAMPS SPOT REPLACED
      READ(IDEV1,250) F38B
      PRINT 2570, (F38B(IG),IG=1,NUMG)
 2570 FORMAT(10X,'  38B.  PORTION OF LAMPS SPOT REPLACED  ',14X,4F14.2)
C-39. QUANTITY OF REPLACEMENT LAMPS
      DO 2580 IG=1,NUMG
      F11 = I11(IG)
      F39(IG)   = (F11*(1.+F38B(IG))*F32(IG)/F38(IG))
 2580 CONTINUE
      PRINT 2590, (F39(IG),IG=1,NUMG)
 2590 FORMAT(10X,'  39.  QUANTITY OF REPLACEMENT LAMPS  ',14X,4F14.0)
C-40. REPLACEMENT LAMP COST
      DO 2600 IG=1,NUMG
      F40(IG) = F39(IG) * F12(IG)
 2600 CONTINUE
      CALL FTOTER(F40,F40T(ISYS))
      PRINT 2610, F40T(ISYS),(F40(IG),IG=1,NUMG)
 2610 FORMAT(10X,'  40.  REPLACEMENT LAMP COST            ',5F14.2)
C
C-V. ANNUAL MAINTENANCE, LABOR + MATERIALS
C
      PRINT 2615
 2615 FORMAT(//10X,'V.  ANNUAL MAINTENANCE, LABOR + MATERIALS'/)
C-43. GROUP RELAMPINGS/YEAR/LUMINAIRE
      DO 2620 IG=1,NUMG
      F43(IG) = F32(IG)/F38(IG)
 2620 CONTINUE
      PRINT 2630, (F43(IG),IG=1,NUMG)
 2630 FORMAT(10X,'  43.  GROUP RELAMPINGS/YEAR/LUMINAIRE  ',14X,4F14.2)
C-43A. SPOT RELAMPINGS/YEAR/LUMINAIRE
      DO 2640 IG=1,NUMG
      F43A(IG) = F38B(IG)*F43(IG)
 2640 CONTINUE
      PRINT 2650, (F43A(IG),IG=1,NUMG)
 2650 FORMAT(10X,'  43A.  SPOT RELAMPINGS/YEAR/LUMINAIRE  ',14X,4F14.4)
C-44. RELAMPING COST-LABOR
      DO 2660 IG=1,NUMG
      F1 = I1(IG)
      F44(IG) = F1*10.*(.3*F43(IG)+.5*F43A(IG))
 2660 CONTINUE
      CALL FTOTER(F44,F44T(ISYS))
      PRINT 2670, F44T(ISYS),(F44(IG),IG=1,NUMG)
 2670 FORMAT(10X,'  44.  RELAMPING COST - LABOR          ',5F14.2)
C-46. CLEANINGS/YEAR/LUMINAIRE
      DO 2680 IG=1,NUMG
      F46(IG) = 1.-F32(IG)/F38(IG)
      IF(F46(IG).LT.0.) F46(IG)=0.
```

```
03810  2680 CONTINUE
C 03820      PRINT 2690, (F46(IG),IG=1,NUMG)
03830  2690 FORMAT(10X,'   46.  CLEANINGS/YEAR/LUMINAIRE          ',14X,4F14.2)
03840 C-47. CLEANING COST - LABOR
● 03850      DO 2700 IG=1,NUMG
03860      F1 = I1(IG)
03870      F47(IG) = F1*10.*.2*F46(IG)
● 03880  2700 CONTINUE
03890      CALL FTOTER(F47,F47T(ISYS))
03900      PRINT 2710, F47T(ISYS),(F47(IG),IG=1,NUMG)
C 03910  2710 FORMAT(10X,'   47.  CLEANING COST - LABOR          ',5F14.2)
03920 C-48. PAINTING TIME PER POLE
03930      READ(IDEVI,250) F48
C 03940      PRINT 2720, (F48(IG),IG=1,NUMG)
03950  2720 FORMAT(10X,'   48.  PAINTING TIME PER POLE          ',14X,4F14.2)
03960 C-50. PAINTING COST - LABOR
C 03970      DO 2730 IG=1,NUMG
03980      F4 = I4(IG)
03990      F50(IG) = F4*10.*F48(IG)*.2
C 04000  2730 CONTINUE
04010      CALL FTOTER(F50,F50T(ISYS))
04020      PRINT 2740, F50T(ISYS),(F50(IG),IG=1,NUMG)
C 04030  2740 FORMAT(10X,'   50.  PAINTING COST - LABOR          ',5F14.2)
04040 C-51. REPLACEMENT PARTS, PAINT, ETC.
04050      DO 2750 IG=1,NUMG
C 04060      F51(IG) = .01*F15(IG)
04070  2750 CONTINUE
04080      CALL FTOTER(F51,F51T(ISYS))
C 04090      PRINT 2760, F51T(ISYS),(F51(IG),IG=1,NUMG)
04100  2760 FORMAT(10X,'   51.  REPLACEMENT PARTS, PAINT, ETC.  ',5F14.2)
04110 C-52. TOTAL ANNUAL MAINTENANCE
C 04120      DO 2770 IG=1,NUMG
04130      F52(IG) = F44(IG)+F47(IG)+F50(IG)+F51(IG)
04140  2770 CONTINUE
C 04150      CALL FTOTER(F52,F52T(ISYS))
04160      PRINT 2780, F52T(ISYS),(F52(IG),IG=1,NUMG)
04170  2780 FORMAT(10X,'   52.  TOTAL ANNUAL MAINTENANCE COST   ',5F14.2)
C 04180 C-53. TOTAL ANNUAL MAINTENANCE
04190      DO 2790 IG=1,NUMG
04200      F53(IG) = F36(IG)+F37(IG)+F37D(IG)+F4C(IG)+F52(IG)
C 04210  2790 CONTINUE
04220      CALL FTOTER(F53,F53T(ISYS))
04230      PRINT 2800, F53T(ISYS),(F53(IG),IG=1,NUMG)
C 04240  2800 FORMAT(10X,'   53.  ANNUAL OPERATING COST          ',5F14.2)
04250 C-54. ANNUAL OP'NG COST PER FT OR ACRE
04260      DO 2810 IG = 1,NUMG
C 04270      F4 = I4(IG)
04280      IF(F4 .EQ. 0) F4 = I4(1)
04290      F54(IG) = F53(IG)/(F25(IG)*F4)
C 04300  2810 CONTINUE
04310      CALL FTOTER(F54,F54T(ISYS))
04320      PRINT 2820, F54T(ISYS),(F54(IG),IG=1,NUMG)
C 04330  2820 FORMAT(10X,40H   54.  ANNUAL OP'NG COST PER FT OR ACRE,5F14.2)
04340 C
04350 C-VI. ANNUAL OWNERSHIP
● 04360 C
04370      PRINT 3500
04380  3500 FORMAT(//10X,'VI.  ANNUAL OWNERSHIP + OPERATING COST '//)
● 04390 C-55. FIXED OWNERSHIP COST
04400      DO 3510 IG=1,NUMG
04410      F55(IG) = .142*(F15(IG)+F22(IG))
● 04420  3510 CONTINUE
04430      CALL FTOTER(F55,F55T(ISYS))
04440      PRINT 3520, F55T(ISYS),(F55(IG),IG=1,NUMG)
● 04450  3520 FORMAT(10X,'   55.  FIXED OWNERSHIP COST          ',5F14.2)
04460 C-56. ANNUAL OWNERSHIP + OPERATING COST
```

```
04470          DO 3530 IG=1,NUMG
04480          F56(IG) = F53(IG)+F55(IG)
04490    3530 CONTINUE
04500          CALL FTOTER(F56,F56T(ISYS))
04510          PRINT 3540, F56T(ISYS),(F56(IG),IG=1,NUMG)
04520    3540 FORMAT(10X,40H   56.  ANNUAL OWNERSHIP + OPERATING COST  ,5F14.2)
04530 C-58. TOTAL PER LINEAL FOOT OR ACRE
04540          DO 3550 IG = 1,NUMG
04550          F4 = I4(IG)
04560          IF(F4 .EQ. 0) F4 = I4(1)
04570          F58(IG) = F56(IG)/(F25(IG)*F4)
04580    3550 CONTINUE
04590          CALL FTOTER(F58,F58T(ISYS))
04600          PRINT 3560, F58T(ISYS),(F58(IG),IG=1,NUMG)
04610    3560 FORMAT(10X,'   58.  TOTAL PER LINEAL FOOT OR ACRE   ',5F14.2)
04620          GO TO 100
04630 C
04640 C-COMPARISION OF SYSTEMS
04650 C
04660    4000 IS1 = 4 * ISYS - 3
04670          DO 4005 IS = IS1,ISYS
04680    4005 SYSCOL(I) = SPACES
04690          ISYS = ISYS - 1
04700          IS1 = -4
04710          K = 0
04720 C-START OF MAIN COMPARISION LOOP
04730    4010 IS1 = IS1 + 5
04740          IS2 = IS1 + 4
04750          IF(IS1.GT.ISYS) GO TO 9999
04760          IF(IS2.GT.ISYS) IS2 = ISYS
04770          DO 4020 I = 1,5
04780          DO 4020 J = 1,4
04790          K = K + 1
04800          HEAD(I,J) = SYSCOL(K)
04810    4020 CONTINUE
04820          CALL PAGE(2)
04830 C
04840 C-1. INITIAL EQUIPMENT INVESTMENT
04850 C
04860          PRINT 190
04870 C-1. QUANTITY OF LUMINAIRES
04880          PRINT  240, (I1T(IS),IS=IS1,IS2)
04890 C-3. LUMINAIRE COST TOTAL
04900          PRINT 280, (F3T(IS),IS=IS1,IS2)
04910 C-4. QUANTITY OF POLES
04920          PRINT 290, (I4T(IS),IS=IS1,IS2)
04930 C-9. POLE + FOUNDATION COST TOTAL
04940          PRINT 360, (F9T(IS),IS=IS1,IS2)
04950 C-14. ELECTRICAL DISTRIBUTION
04960          PRINT 435, (F14T(IS),IS=IS1,IS2)
04970 C-14A. STANDBY GENERATOR COST
04980          PRINT 445, (F14AT(IS),IS=IS1,IS2)
04990 C-14C. UPS COST
05000          PRINT 460, (F14CT(IS),IS=IS1,IS2)
05010 C-16. TOTAL INIT EQUIP INCL LAMPS
05020          PRINT 500, (F16T(IS),IS=IS1,IS2)
05030 C-17. RELATIVE INIT EQUIP INVESTMENT
05040          CMIN = 9999999999.
05050          DO 4030 IS = 1,ISYS
05060          IF(CMIN .GT. F16T(IS)) CMIN = F16T(IS)
05070    4030 CONTINUE
05080          DO 4040 IS = 1,ISYS
05090          F17(IS) = F16T(IS)/CMIN
05100    4040 CONTINUE
05110          PRINT 4050, (F17(IS),IS=IS1,IS2)
05120    4050 FORMAT(10X,'   17.  RELATIVE INIT EQUIP INVESTMENT ',5F14.2)
```

```
05130 C
05140 C-II. INITIAL LABOR ESTIMATES
05150 C
05160       PRINT 1190
05170 C-20. NET LABOR, POLES + LUMINAIRES
05180       PRINT 1230, (F20T(IS),IS=IS1,IS2)
05190 C-21. LABOR ELECTRICAL DISTRIBUTION
05200       PRINT 1250, (F21T(IS), IS=IS1,IS2)
05210 C-22. TOTAL INITIAL LABOR
05220       PRINT 1310, (F22T(IS),IS=IS1,IS2)
05230 C-23. TOTAL INITIAL INVESTMENT
05240       PRINT 1330, (F23T(IS),IS=IS1,IS2)
05250 C-24. RELATIVE INITIAL INVESTMENT
05260       CMIN = 9999999999.
05270       DO 4060 IS=1,ISYS
05280       IF(CMIN.GT.F23T(IS)) CMIN = F23T(IS)
05290  4060 CONTINUE
05300       DO 4070 IS=1,ISYS
05310       F24(IS) = F23T(IS)/CMIN
05320  4070 CONTINUE
05330       PRINT 4080, (F24(IS),IS=IS1,IS2)
05340  4080 FORMAT(10X,'  24. RELATIVE INITIAL INVESTMENT     ',5F14.2)
05350 C,
05360 C-IV. ANNUAL COSTS
05370 C
05380       PRINT 2390
05390 C-31. TOTAL SYSTEM KW
05400       PRINT 2430, (F31T(IS),IS=IS1,IS2)
05410 C-33. TOTAL ENERGY KWH/YEAR
05420       PRINT 2460, (F33T(IS),IS=IS1,IS2)
05430 C-36.. DEMAND CHARGE PER YEAR
05440       PRINT 2500, (F36T(IS),IS=IS1,IS2)
05450 C-37. ANNUAL KWH COST
05460       PRINT 2520, (F37T(IS),IS=IS1,IS29)
05470 C-37D. DIESEL FUEL COST
05480       PRINT 2540, (F37DT(IS),IS=IS1,IS2)
05490 C-40. REPLACEMENT COST
05500       PRINT 2610, (F40T(IS),IS=IS1,IS2)
05510 C
05520 C-V. ANNUAL MAINTENANCE, LABOR & MATERIALS
05530 C
05540       PRINT 2615
05550 C-44. RELAMPING COST - LABOR
05560       PRINT 2670, (F44T(IS),IS=IS1,IS2)
05570 C-47. CLEANING COST - LABOR
05580       PRINT 2710, (F47T(IS),IS=IS1,IS2)
05590 C-50. PAINTING COST - LABOR
05600       PRINT 2740, (F50T(IS),IS=IS1,IS2)
05610 C-51. REPLACEMENT PARTS, PAINT, ETC.
05620       PRINT 2760, (F51T(IS),IS=IS1,IS2)
05630 C-52. TOTAL ANNUAL MAINTENANCE COST
05640       PRINT 2780, (F52T(IS),IS=IS1,IS2)
05650 C-53. ANNUAL OPERATING COST
05660       PRINT 2800, (F53T(IS),IS=IS1,IS2)
05670 C
05680 C-VI. ANNUAL OWNERSHIP + OPERATING COST
05690 C
05700       PRINT 3500
05710 C-55. FIXED OWNERSHIP COST
05720       PRINT 3520, (F55T(IS),IS=IS1,IS2)
05730 C-56. ANNUAL OWNERSHIP + OPERATING COST
05740       PRINT 3540, (F56T(IS),IS=IS1,IS2)
05750 C
05760 C-VII. RELATIVE COSTS OF LIGHT
05770 C
05780       PRINT 4100
```

```
05790  4100 FORMAT(//10X,'VII.  RELATIVE COSTS OF LIGHT          ')
05800 C-59. RELATIVE COSTS EXCLUDING FIXED
05810       CMIN = 999999999.
05820       DO 4110 IS = 1,ISYS
05830       F59C(IS) = F56T(IS) - F55T(IS)
05840       IF(F59C(IS) .LT. CMIN) CMIN = F59C(IS)
05850  4110 CONTINUE
05860       DO 4120 IS = 1,ISYS
05870       F59(IS) = F59C(IS)/CMIN
05880  4120 CONTINUE
05890       PRINT 4130, (F59(IS),IS=IS1,IS2)
05900  4130 FORMAT(10X,'   59.  RELATIVE COST EXCLUDING FIXED   ',5F14.2)
05910 C-60. RELATIVE TOTAL COST
05920       CMIN = 9999999999.
05930       DO 4140 IS = 1, ISYS
05940       IF(F56T(IS) .LT. CMIN) CMIN = F56T(IS)
05950  4140 CONTINUE
05960       DO 4150 IS = 1,ISYS
05970       F60(IS) = F56T(IS)/CMIN
05980  4150 CONTINUE
05990       PRINT 4160, (F60(IS),IS=IS1,IS2)
06000  4160 FORMAT(10X,'   60.  RELATIVE TOTAL COST              ',5F14.2)
06010       GO TO 4010
06020  9999 CONTINUE
06030       ITOP = 7656B
06040       NULL = 7600B
06050       PRINT 9998, ITOP
06060  9998 FORMAT(10R2)
06070       REWIND IDEV1
06080       STOP
06090       END
06100 C-THIS SUBROUTINE FINDS THE TOTAL OF AN INTEGER ARRAY OF 6 ELEMENTS
06110       SUBROUTINE ITOTER(I,ITOTAL)
06120       DIMENSION I(6)
06130       ITOTAL = I(1)+I(2)+I(3)+I(4)+I(5)+I(6)
06140       RETURN
06150       END
06160 C-THIS SUBROUTINE FINDS THE TOTAL OF A REAL ARRAY OF 6 ELEMENTS
06170       SUBROUTINE FTOTER(F,TOTAL)
06180       DIMENSION F(6)
06190       TOTAL = F(1)+F(2)+F(3)+F(4)+F(5)+F(6)
06200       RETURN
06210       END
06220 C-THIS SUBROUTINE CHANGES PAGES AND PRINTS THE HEADING
06230       SUBROUTINE PAGE(IFLAG)
06240       COMMON /HED/ HEAD(5,4),SYSCOL(130),DESCRI(5,120),ISYS
06250       COMMON /DEV/ IDEV1
06260       DATA IPAGE/0/
06270       IPAGE = IPAGE + 1
06280       ITOP = 7656B
06290       NULL =7600B
06300       PRINT 90,ITOP
06310    90 FORMAT(10R2)
06320       PRINT 100, IPAGE
06330   100 FORMAT(1H1,40X,'U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT',
06340      1 27X,'PAGE',I4)
06350       PRINT 110
06360   110 FORMAT(/53X,'ECONOMIC COMPARISION')
06370 C-PRINT COLUMN HEADING FOR SIDE BY SIDE, AND DESCRIPTION
06380       IF(IFLAG .GT. 1) GO TO 240
06390       PRINT 210
06400   210 FORMAT(1H )
06410       J = (ISYS - 1) * 4
06420       DO 230 K = 1,4
06430       J = J + 1
06440       PRINT 220, SYSCOL(J),(DESCRI(I,J),I=1,5)
```

```
06450    220 FORMAT(10X,A10,10X,5A10)
06460    230 CONTINUE
06470    240 CONTINUE
06480 C-PRINT COLUMN HEADINGS FOR COMPONENT GROUPS
06490        PRINT 120, (HEAD(IG,1),IG=1,5)
06500    120 FORMAT(/50X,5(4X,A10))
06510        PRINT 130, (HEAD(IG,2),IG=1,5)
06520    130 FORMAT(50X,5(4X,A10))
06530        PRINT 140, (HEAD(IG,3),IG=1,5)
06540    140 FORMAT(50X,5(4X,A10))
06550        PRINT 150, (HEAD(IG,4),IG=1,5)
06560    150 FORMAT(50X,5(4X,A10))
06570        RETURN
06580        END
06590 C-SUBROUTINE FOR ZEROING ARRAYS
06600        SUBROUTINE ZERO
06610        COMMON /EQP/ FEQP(84),IEQP(24)
06620        COMMON /LAB/ FLAB(42)
06630        COMMON /ILL/ FILL(42)
06640        COMMON /CST/ FCST(90)
06650        COMMON /MNT/ FMNT(72)
06660        COMMON /ANN/ FANN(30)
06670        DO 110 I=1,84
06680    110 FEQP(I) = 0.
06690        DO 120 I=1,24
06700    120 IEQP(I) = 0
06710        DO 130 I=1,42
06720    130 FLAB(I) = 0.
06730        DO 140 I=1,42
06740    140 FILL(I) = 0.
06750        DO 150 I=1,90
06760    150 FCST(I) = 0.
06770        DO 160 I=1,72
06780    160 FMNT(I) = 0.
06790        DO 170 I=1,30
06800    170 FANN(I) = 30 → 0.
06810        RETURN
06820        END
/
```

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS STRATEGIC AIR COMMAND
OFFUTT AIR FORCE BASE, NEBRASKA, 68113

REPLY TO ATTN OF: DOWA (Maj Newcomb, 2681) 26 August 1975

SUBJECT: Illumination Data for Giant Lock

TO: DEEA

1. Reference: Conference between Major Newcomb-DOWA and Mr. Gano-DEEA on 8 August 1975.

2. The mean daily and annual required lighting times for 28 bases is contained in attachment 1.

3. The lighting time was computed for a threshold illumination value of 2 footcandles (fc). The illumination on a flat surface is 42 fc when the upper limb of the sun appears (or disappears) at the horizon. The morning and evening civil twilight periods (sun below horizon .8-6°) were considered in order to obtain the required lighting time for an illumination threshold value of 2 fc.

4. Little is known about the relationship between cloud conditions and illumination during the twilight period. The daylight assumption that the average illumination on a flat surface is reduced 50% by "average" cloud conditions was used. This assumption required a sun depression angle of 3.5° below the horizon in order to reduce the illumination on a flat surface to 2 fc. (A "clear sky" assumption would have required a depression angle of 4° which decreases the required lighting time by 4 minutes.)

5. The approximate required lighting time for the threshold illumination values of 1 and 5 fc can be obtained from the values in attachment 1 as follows:

a. For 1 fc; subtract 4 minutes from the mean daily required lighting time.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

DATA ON NIGHT-SITTING: MEAN DAILY and ANNUAL HOURS

Peace . . . . is our Profession

ATTACHMENT 16 16-1

b. For 5 fc; add 10 minutes to the mean daily required lighting time.

Dean D. Bartlett

DEAN D. BARTLETT, Lt Col, USAF
Chief, Plans Division
Directorate of Weather
Deputy Chief of Staff, Operations

1 Atch
Required Lighting
Times for 28 Bases

Figure underlined hours and minutes per year light is required.
Figure circled is hours and minutes per day lighting is required.

34-121.5

BEALE	CIVIL TWILIGHT	1/2 = 1.5° ADJ	SUNRISE	SUNSET	1/2 = 1.5° ADJ	CIVIL TWILIGHT	TIME LIGHTING REQ
DFC	0652	0704	0721	1646	1705	1717	839
JUN	0408	0421	0440	1935	1954	2007	507
ANN			4015+ 200-45=		4215' 45"		673 (11'13")
KINGFISH 46.5-84.5							
DFC	0745	0759	0819	1650	1720	1738	879
JUN	0405	0421	0440	2035	2059	2115	442
ANN			4015+ 6-05=		4021' 05"		660.5 (11'01")
PARGO 46-101							
DFC	0752	0809	0834	1653	1721	1739	888
JUN	0402	0419	0440	2057	2114	2130	435
ANN			3650+ 340-00=		3990' 40"		656.5 (10'56")
[illegible]							
DFC	0659	0714	0736	1601	1623	1637	877
JUN	0311	0327	0352	1952	2016	2032	431
ANN			3650+ 328-30=		3978' 30"		654 (10'54")
LINGCOD 47-66							
DFC	0640	0654	0714	1545	1607	1621	889
JUN	0300	0316	0336	1930	1955	2011	439
ANN			4015+ 24-30=		4039' 26"		664 (11'04")

MAC FORM JAN 86 36c PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE GENERAL PURPOSE WORK SHEET

← 16 → 16

ANDERSON	CIVIL TWILIGHT	ILL = 2 FT ABV	SUNRISE	SUNSET	ILL = 2 FT ABV	CIVIL TWILIGHT	TIME LIGHTING REQ
JAN	0625	0634	0648	1815	1829	1838	725
FEB	0620	0628	0641	1827	1840	1849	708
MAR	0603	0612	0625	1831	1844	1853	688
APR	0543	0551	0604	1834	1847	1856	664
MAY	0530	0539	0553	1841	1854	1904	645
JUN	0530	0540	0554	1850	1903	1913	637
JUL	0539	0548	0602	1851	1905	1914	643
AUG	0546	0555	0608	1839	1852	1901	663
SEP	0548	0556	0609	1818	1831	1839	685
OCT	0550	0559	0612	1758	1811	1820	708
NOV	0600	0609	0622	1750	1803	1812	726
DEC	0615	0614	0638	1758	1812	1821	727
TOTAL			4015+	146-00 =	4161' 00"		4854.5 11'24"
365 121.5 MEAN							
DAY	0648	0700	0717	1657	1702	1709	238
NIGHT	0414	0426	0445	1930	1949	2002	517
TOTAL			4015+	103-25 =	4118'25"		4777.5 11'17"

MAC FORM 36c JAN 91 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

GENERAL PURPOSE WORK SHEET

36 – 98.5

← 16 → 16

SHIPPARD	CIVIL TWILIGHT	ILL = [illegible]	SUNRISE	SUNSET	ILL = [illegible]	CIVIL TWILIGHT	TIME LIGHTING REQ
DFO	0708	0719	0735	1726	1744	1757	815
JAX	0454	0506	0523	1958	2010	2018	536
MIA			4015 + 91-15 =		4106' 15"		675.5 11'15"
40.5-43.5 [illegible]							
[illegible]	0726	0742	0807	1657	1713	1723	869
[illegible]	0413	0427	0449	2021	2044	2059	463
[illegible]			4015 + 36-30 =		4051' 30"		666 11'06"
36 – [illegible]							
[illegible]	0638	0650	0707	1649	1707	1719	823
[illegible]	0413	0425	0443	1920	1944	2000	521
[illegible]			4015 + 73 =		4088' 00"		672 11'12"
[illegible]							
[illegible]	0644	0656	0713	1648	1705	1717	831
[illegible]	0411	0423	0442	1926	1945	1957	518
[illegible]			4015 + 85-10 =		4100' 10"		674.5 11'14"
33.5 – [illegible]							
[illegible]	0627	0638	0654	1649	1706	1718	812
[illegible]	0415	0427	0444	1907	1926	1939	541
[illegible]			4015 + 103-25 =		4118' 25"		676.5 11'17"

MAC FORM JAN 87 36c PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE GENERAL PURPOSE WORK SHEET

	← L				→ L		
MARCH	CIVIL TWILIGHT	ILL = 2 STARS	SUNRISE	SUNSET	ILL = 2 STARS	CIVIL TWILIGHT	TIME LIGHTING REQ
DEC	0622	0633	0650	1644	1701	1712	812
JAN	0409	0421	0438	1903	1920	1932	541
ANN			4015 + 97.20 =		4112' 20"		676.5 11'16"
PER 03-71							
DEC	0640	0653	0712	1611	1631	1645	862
JAN	0328	0342	0404	1926	1949	2002	473
ANN			4015 + 42-35 =		4057' 35"		667.5 11'07"
PER 04-73.5 PGH							
DEC	0654	0708	0728	1617	1637	1651	871
JAN	0332	0347	0409	1943	2005	2020	462
ANN			4015 + 36-30 =		4051' 30"		666.5 11'06"
WI 03-93							
DEC	0704	0714	0729	1656	1713	1725	841
JAN	0416	0430	0450	1942	1956	2015	514
ANN			4015 + 103.25 =		4118' 25"		677.5 11'17"
PER 04-103							
DEC	0652	0705	0725	1616	1636	1650	869
JAN	0333	0447	0459	1960	2001	2015	526
ANN			4015 + 225-5 =		4240' 05"		697.5 11'37"

7-91

MAC FORM 36c JAN 00 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE GENERAL PURPOSE WORK SHEET

GRAND FORKS

MONTH	CIVIL TWILIGHT	ILL = 2 FT CD	SUNRISE	SUNSET	ILL = 2 ft cd	CIVIL TWILIGHT	TIME LIGHTING REQ.
JAN	736	750	810	512	533	547	14 17
FEB	655	708	726	601	619	633	12 49
MAR	600	613	631	643	701	714	11 12
APR	456	509	529	728	748	802	9 21
MAY	406	421	444	809	832	847	7 49
JUN	348	405	430	833	858	914	7 07
JULY	413	429	452	819	841	858	7 48
AUG	459	512	532	732	752	806	9 20
SEP	543	555	614	630	649	701	11 06
OCT	626	638	657	530	549	602	12 36
NOV	710	724	744	446	506	521	14 03
DEC	740	0755	817	439	0501	515	14:54
ANN	—	—	—	—	—	—	11:01
			4015+	6 - 5 =	4021'05"		

325-93

BASE	CIVIL TWILIGHT	ILL = 3 FT ABV	SUNRISE	SUNSET	ILL = 3 FT ABV	CIVIL TWILIGHT	TIME LIGHTING REQ
DIA	0646	0656	0712	1713	1733	1746	803
JAX	0440	0451	0508	1925	1943	1955	548
[illegible]			4015 + 91-15 =		4106' 15"		675.5 11'15"
33-97.5							
[illegible]							
[illegible]	0702	0712	0728	1727	1745	1757	807
[illegible]	0506	0512	0522	1941	1959	2011	553
[illegible]			4015 + 121-40 =		4136' 40"		680 11'20"
47.5-111							
[illegible]							
[illegible]	0734	0748	0810	16360	1657	1711	891
[illegible]	0345	0402	0427	2026	2046	2107	436
[illegible]			4015 + 18-15 =		4033' 15"		663.5 11'03"
[illegible]							
[illegible]	0657	0703	0722	1634	1653	1706	850
[illegible]	0354	0407	0427	1936	1956	2010	691
[illegible]			4015 + 60-50 =		4075' 50"		670.5 11'16"
[illegible]							
[illegible]	0700	0713	0732	1632	1651	1705	862
[illegible]	0349	0403	0425	1947	2008	2023	675
[illegible]			4015 + 48.40 =		4063' 40"		668.5 1'08"

GENERAL PURPOSE WORK SHEET

32.5-100

← 16 → 16

DYE'S	CIVIL TWILIGHT	ILLUMINATED	SUNRISE	SUNSET	ILLUMINATED	CIVIL TWILIGHT	TIME
DEC	0711	0721	0737	1738	1755	1806	806
JUN	0506	0515	0532	1949	2007	2019	548
FEB			4015 + 103 - 25 =		4118' 25"		677 11'17"
MAR 40.5-87.5							
DEC	0657	0710	0730	1605	1627	1641	883
JAN	0320	0335	0357	1946	2010	2026	445
FEB			4015 + 24 - 20 =		4039' 20"		664 11'04"
MAR 28-50.5							
NOV	0651	0700	0717	1739	1755	1805	785
OCT	0508	0518	0536	1929	1945	1956	573
SEP			4015 + 115 - 35 =		4130' 35"		679 11'19"
AUG							
JUL	0705	0716	0732	1733	1749	1800	807
JUN	0458	0510	0527	1945	2002	2014	548
APR			4015 + 103 - 25 =		4118' 25"		677.5 11'17"
SEP MAR JUNE							
DEC	0648	0700	0717	1703	1720	1731	820
JAN	0427	0439	0457	1930	1948	2000	531
FEB			4015 + 91 - 15 =		4106' 15"		675.5 11'15"

6-91

MAC FORM JAN 68 36c PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE GENERAL PURPOSE WORK SHEET

SODIUM LAMPS

To avoid local accumulation of sodium, which is found partly in a liquid condition when these lamps are in operation, and which may cause damage to the lamp, it must be mounted within the limits of the operating position as indicated in the figure.

Warning: Sodium lamps are perfectly safe when handled with care, but contain a small quantity of sodium, a substance which developes heat when in contact with moisture.
Therefore the following precautions should be taken:

a. The lamp must be stored and shipped enclosed in its original packing.

b. Care should be taken to dispose of discarded lamps, in such a manner as to obviate the risk of fire. One such way is as follows: the lamps (not more than twenty at one time), should first be broken into small pieces in a dry atmosphere, and placed in a dry bucket of ample capacity. The container should then be taken into the open air, and half filled with water by means of a rubber hose, the operator standing at a safe distance.
After a few minutes, the sodium will be rendered harmless.

CAUTION NOTICE PACKED WITH PHILIPS LPS LAMPS

G.E.C. **Sodium lamps**

TYPE SOI/H (Integral)
SLI/H (Linear)
SOX (SUPERSOX)

Allow the lamp to cool before removing.

Use on A.C. only in circuit with control gear complying with the appropriate I.E.C. specification.

Sodium lamps are perfectly safe when handled with reasonable care but they contain a small quantity of metallic sodium, a substance which develops heat in contact with moisture, and therefore the following precautions must be taken.

Packing, Shipping and Storing. Sodium lamps must be packed shipped and stored completely enclosed in the wrapping provided.

They must not be sent by Post.

Disposal of burnt-out Lamps. When lamps are discarded care should be taken to obviate the risk of fire. The Lamps (of which not more than 20 should be dealt with at one time) should first be broken into small pieces in a dry atmosphere and transferred to a dry bucket or other container of ample capacity. The container should then be taken into the open air and half filled with water by means of a hose. The operator should stand at a safe distance during the process. After a few minutes the metallic sodium contained in the lamps will be rendered harmless and these may then be disposed of in the ordinary way.

XL 328

CAUTION NOTICE PACKED WITH G.E.C. LPS LAMPS

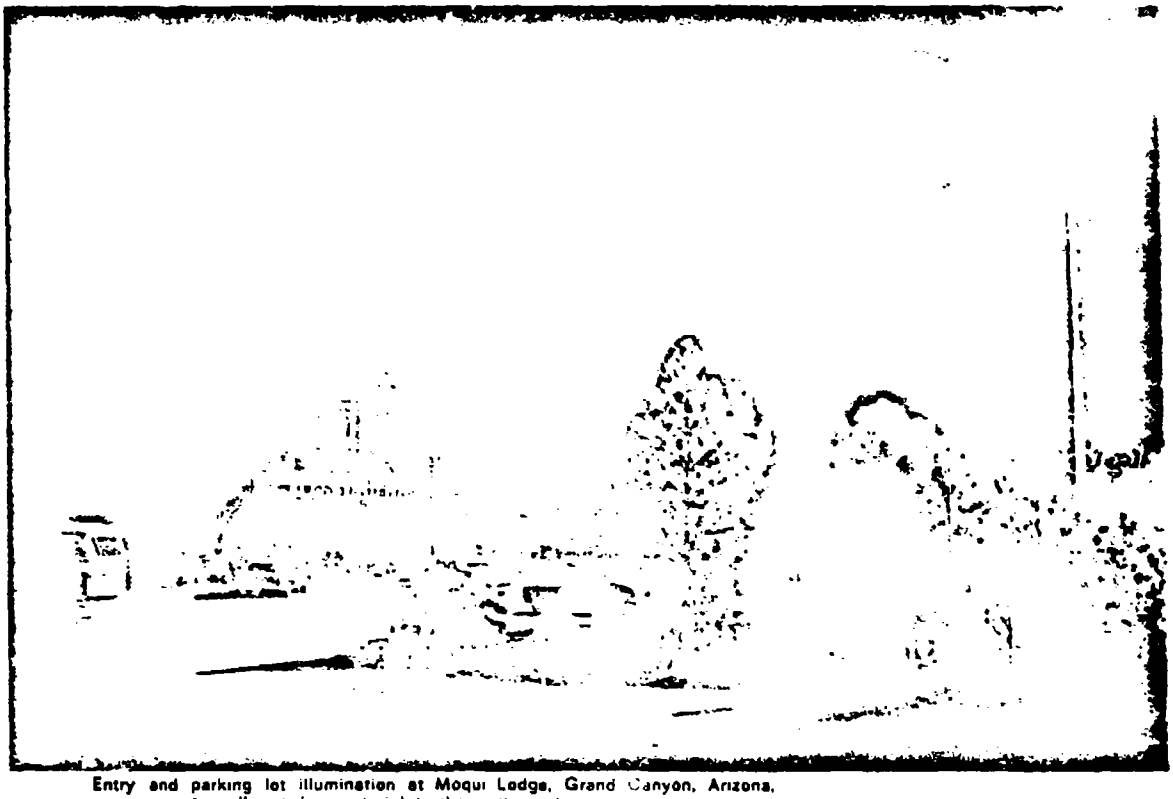
DISPOSAL INSTRUCTIONS FOR L.P.S. LAMPS

ATTACHMENT 17

AMERICAN DAYLIGHT CO.

Long-Arc Xenon

Wide Area Lighting



Entry and parking lot illumination at Moqui Lodge, Grand Canyon, Arizona, serves guests well, yet does not violate the rustic environment.

HIGH LUMEN OUTPUT

INSTANT START, RESTART

FEWER UNITS

LONG LIFE, DAYLIGHT QUALITY

BETTER DISTRIBUTION

SAFE, EASY TO SERVICE

ATTACHMENT 18
P 18-1

Long-Arc Xenon

ENGINEERED WIDE-AREA LIGHTING

As with any engineering problem, wide-area lighting is best achieved by providing the fewest fixtures and the lowest installation and maintenance costs necessary to do the job well. American Daylight's long-arc xenon meets these design criteria:

Fewer Units and Poles

Long-arc xenon luminaires have a visual horizontal beam spread of 150°. This very broad beam spread, matched with 20,000 watts of lighting power, provides an even coverage of an area with far fewer poles than any conventional lighting system. This results in savings in installation, equipment and maintenance costs. Architectural design is also enhanced.

Natural Daylight Quality

Xenon discharge lamps are the only available source that can be used for large area lighting that will faithfully reproduce the spectral distribution of natural daylight. This color quality provides excellent visual acuity, especially important where movement and distance must be judged, as in sports and activities involving machinery. If an object or area is distorted by predominantly yellow, blue or green light sources, then usually more light is required for identification. The use of xenon equipment reflects the colors to which the eye is most accustomed—in daylight.

High Maintained Lamp and Fixture Efficiency.

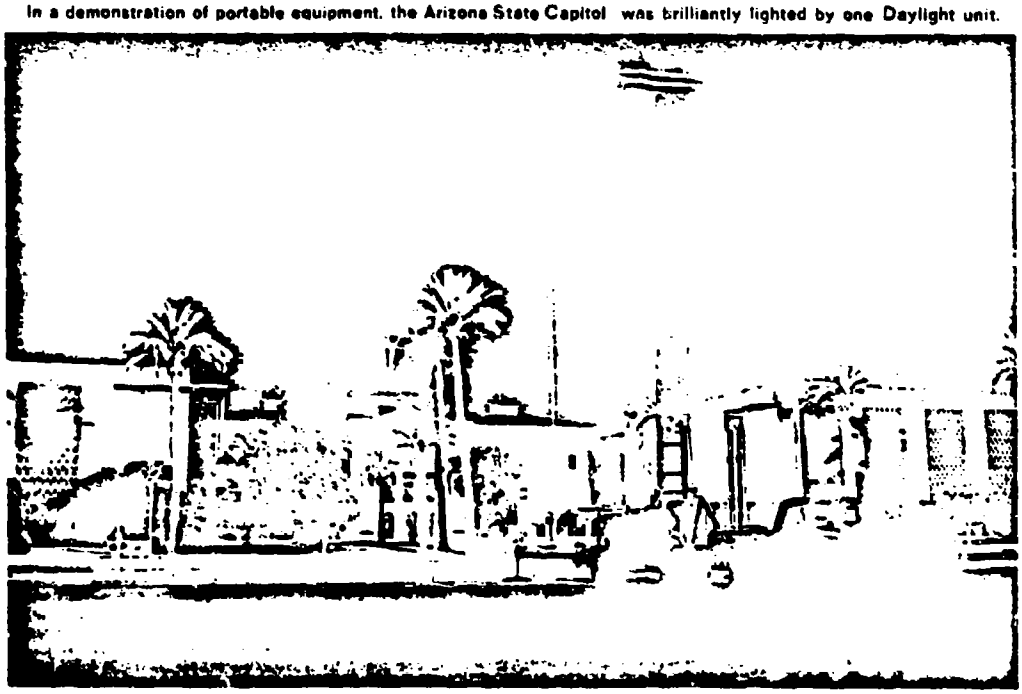
The use of long linear lamps positioned correctly within a parabola reflector provides very high fixture efficiency—over 70%. Many conventional luminaires have efficiencies of less than 50%. The xenon lamp maintains light output at 90% or better throughout the entire life of the lamp. Many discharge lamps will lose their output by as much as 60% at near end of life.

Reliable Quality

The American Daylight Company has over 12 years of experience and expertise in the manufacture of their lighting products. Their continued efforts in quality control, manufacture, and equipment performance has gained them confidence and respect.

The American Daylight long-arc xenon lighting equipment is the only equipment that can meet the total design requirements above.

In a demonstration of portable equipment, the Arizona State Capitol was brilliantly lighted by one Daylight unit.



ATTACH
18-2

provides daylight

GENERAL INFORMATION

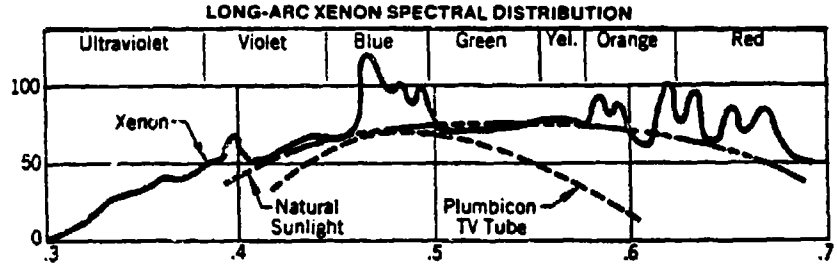
The long-arc lamps are filled with xenon, an inert gas, in a special ultra-violet absorbing quartz envelope and at a pressure of less than one atmosphere. (An important safety factor when handling them.)

Lamps are ignited instantly by a starter circuit which then drops off the line and the lamp continues to operate without aid of ballast and at unity power factor. Because there is no ballast, the lamp will ignite and operate in sub-freezing or tropical temperatures without additional starting or operating aids.

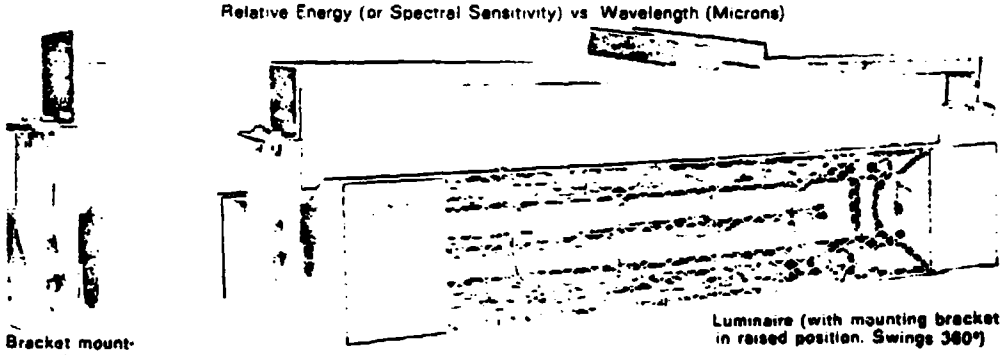
Instant re-strike (optional) capability becomes important in those applications where a momentary power interruption could cause panic, collisions of moving equipment, or delay of sporting events due to the time required by conventional discharge lamps to restrike.

Xenon lamps, with the spectral distribution very similar to natural daylight (6,500° Kelvin), is ideal for pick-up by the Plumbicon TV tube, and therefore offers the most desirable artificial lighting source for color film and TV camera pickup.

LONG-ARC XENON SPECTRAL DISTRIBUTION



Relative Energy (or Spectral Sensitivity) vs Wavelength (Microns)



Bracket mounting detail.

Luminaire (with mounting bracket in raised position. Swings 360°)

MOUNTING BRACKETS

MB-M (4" OD metal pole, clamp type)
MB-W (8" to 12" OD wood pole, clamp type with through-the-pole bolts)

LUMINAIRE SPECIFICATIONS

	Luminaire Model Numbers				
	ADC-16/208	ADC-20/220	ADC-20/240	ADC-20/265	ADC-20/277
Voltage	208	220	240	265	277
Power — Watts(100%, PF)	16,000	20,000	20,000	20,000	20,000
Initial Lamp Lumens	400,000	500,000	500,000	500,000	500,000
Horiz & Vert Beam Spread Medium	N/A	150° x 30°	150° x 30°	150° x 30°	150° x 30°
Wide	150° x 50°	150° x 50°	150° x 50°	150° x 50°	150° x 50°
Weight	190 lbs	200 lbs	200 lbs	200 lbs	200 lbs
Weight with bracket	195 lbs	265 lbs	265 lbs	265 lbs	265 lbs
Overall length	72"	84½"	84½"	84½"	84½"
Overall depth	19½"	19½"	19½"	19½"	19½"
Overall height	13½"	13½"	13½"	13½"	13½"

ATTACH
18-3

quality light..!

LAMP SPECIFICATIONS

	Lamp Model Numbers				
	L-16/208	L-20/220	L-20/240	L-20/265	L-20/277
Power (Watts)	16,000	20,000	20,000	20,000	20,000
Voltage	208	220	240	265	277
Current (Amps)	77	90.9	83.3	75.5	72.5
Initial Lamp Lumens	400,000	500,000	500,000	500,000	500,000
Light Color Temp (Kelvin)	6,500°	6,500°	6,500°	6,500°	6,500°
Lamp Ignition	Instant	Instant	Instant	Instant	Instant
Restrike Ignition*	Instant	Instant	Instant	Instant	Instant
Overall Length	60"	74"	74"	74"	74"
Diameter of Lamp Envelope	1-3/8"	1-3/8"	1-3/8"	1-3/8"	1-3/8"

*Optional

Lamp is warranted for 12 months, prorated monthly. Expected lamp life in excess of 10,000 hours.

COMPARATIVE CHARACTERSTICS OF FLOODLIGHTING EQUIPMENT

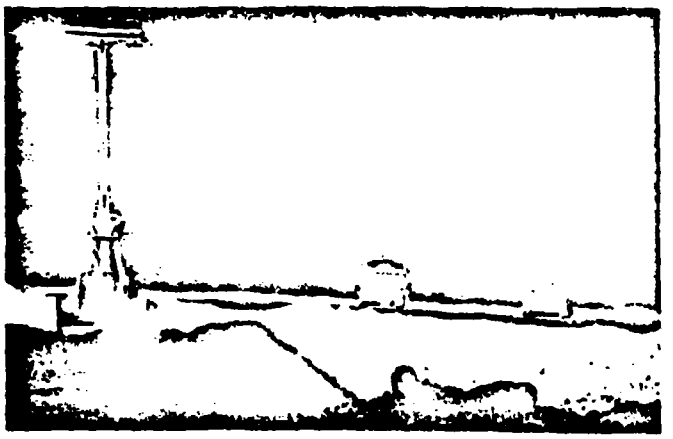
Flood Light Type	Mfr's Model	Power Req'd	Start-up Time	Re-strike Time	Maintained Fixture Efficiency (MFE)[1]	Maintained Lumens Per Watt (MLPW)[2]	Units req'd to equal 20,000 W of Long-arc Xenon	Color Quality
1500-W Tungsten Halogen	Westinghouse WQF-1500	1500 W	Instant	Instant	9,809 Lumens	6.5	30.0	Good
1100-W Phosphor Mercury	Wide-Lite F-1001-D	1100 W	5-7 Min	8-12 min	17,511 Lumens	15.9	17.0	Fair to Good
1300-W Metal-Halide	GE "Power Spot	1100 W 1100 W	3-5 min	10-15 min.	25,272 Lumens	23.0	12.0	Varies — usually good
16,000-W Long-Arc Xenon	Daylight ADC-16	16,000 W	Instant	Instant (Optional)	240,312 Lumens	15.0	1.25	Excellent
20,000-W Long-Arc Xenon	Daylight ADC-20	20,000	Instant	Instant (Optional)	300,390 Lumens	15.0	1	Excellent

[1]PR = Power input (to ballast if applicable)

[2]MFE = (Lamp lumen output at 60% rated life) x (fixture efficiency) x (maintenance factor)

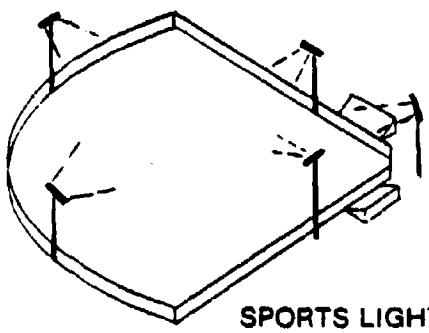
[3]MLPW = $\frac{MFE}{PR}$

Optional features: Bullet proof units • Front glass cover • Explosion-proof units
Specifications subject to change without notice



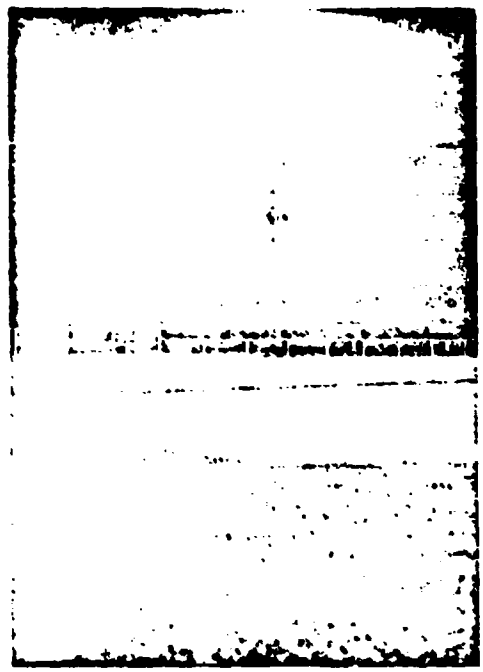
One American Daylight unit at "C" Dump, Duval Mine, Sahuarita, Arizona, eliminated need for eight previous lights and two flagmen.

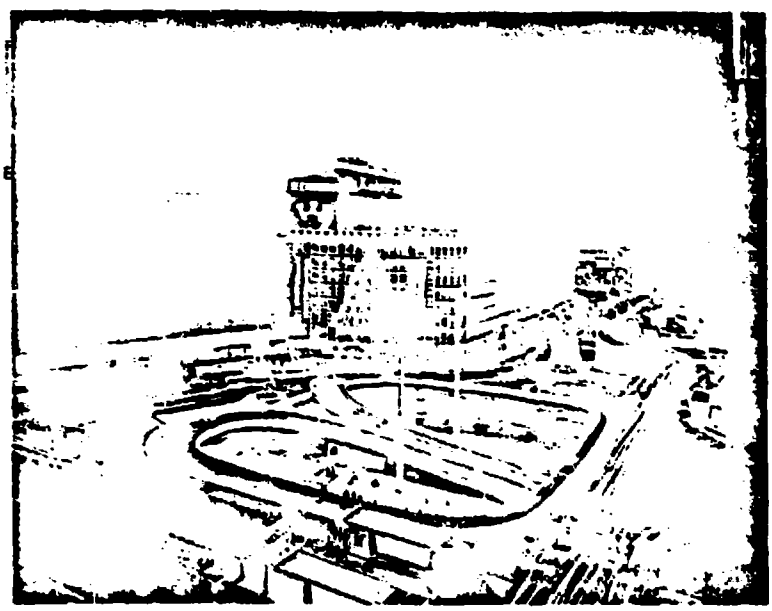
ATTACH.
18-4



SPORTS LIGHTING

Baseball, football, tennis and other sports are excellent applications for Daylight Xenon equipment. The strong vertical beam spread allows the players and spectators to "follow" the ball at all times instead of its disappearing and reappearing, as with most conventional lighting systems. In Plant City, Florida, 30 footcandles on the infield and 15 footcandles on the outfield were achieved by using only five poles instead of the conventional eight poles. This represented a great saving in installation and maintenance cost. The superior color quality of the xenon source causes players and uniforms to appear more natural, and enhances judgment of distances, speed, etc. Light quality and uninterrupted service are special advantages for television coverage of sporting events, and often may be an inducement to such coverage.

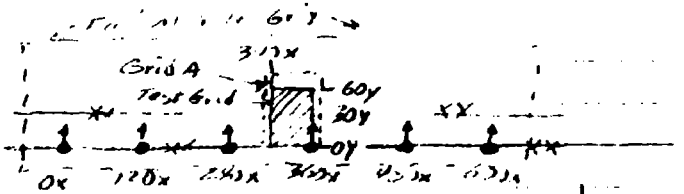




Japanese cities are noted for their exciting night life. Long-arc xenon, widely used there, gives night shoppers and motorists the confidence and safety of brilliant, daylight quality light.

ATTACH.
18-5

```
00100                    I      I
00110      T74A     PER LTG--DF(A=20LF) 1X400WPS SP120  MH35 -- (020678)
00120      V400S4XXF1      0.25      0.00      1.00
00130      9999999999
00140      V400S4XXF1      0.00      0.00     30.00     90.00      0.00
00150      V400S4XXF1    120.00      0.00     30.00     90.00      0.00
00160      V400S4XXF1    240.00      0.00     30.00     90.00      0.00
00170      V400S4XXF1    360.00      0.00     30.00     90.00      0.00
00180      V400S4XXF1    480.00      0.00     30.00     90.00      0.00
00190      V400S4XXF1    600.00      0.00     30.00     90.00      0.00
00200      9999999999
00210    1   -120.00     -30.00      0.50    120.00    120.00      0.50      0.00   } FMG - HEC
00220             15         11         H      0.00      0.00      0.00            }
00230    2   -120.00     -30.00      3.00    120.00    120.00      3.00      0.00   } FMG - VFC
00240             15         11         V    270.00      0.00      0.00            }
00250    3   -120.00     -30.00      3.00    120.00    120.00      3.00      0.00   } FMG - VFC
00260             15         11         V    390.00      0.00      0.00            }
00270    4    280.00     -25.00      0.50    370.00    110.00      0.50      0.00   } GA - HMC
00280             10         24         H      0.00      0.00      0.00            }
00290    5    300.00       0.00      0.50    360.00     60.00      0.50      0.00   } 30'TG - HFC
00300              7          7         H      0.00      0.00      0.00            }
00310    6    300.00       0.00      0.50    360.00     60.00      0.50      0.00   } 60'16 HFC
00320              7         13         H      0.00      0.00      0.00            }
00330    7    300.00       0.00     -5.50    360.00     60.00     -5.50      0.00   } 60'16 HFC (equiv 10.41'MH)
00340              7         13         H      0.00      0.00      0.00            }
00350    8    280.00      60.00      0.00    370.00     60.00    130.00      0.00   } Vertical Grid @ y = 60' HFC
00360             10         14         H      0.00    370.00     60.00            }
00370    9    300.00     -30.00      0.00    300.00    140.00    130.00      0.00   } Vertical Grid @ x = 300' HFC
00380             18         14         H      0.00    300.00    140.00            }
00390      9999999999
```



PERIMETER LIGHTING - DUSK TO DAWN

FENCE

ATTACHMENT A
A-1

```
T74A     PER LTG--DF(6-POLE) 1X400MPS SP120  WH35 -  (020678                    78/02/06  09.18.01  PAGE

ISW1 =  1  1=PRINT CANDLEPOWER TABLES
ISW2 =  1  1=DISK DIRECTORY PRINT
ISW3 =  0  1=PRINT EACH POINT AFTER CALCULATION
ISW4 =  0  1=PRINT + ZERO GRID AFTER EACH LIGHT
ISW5 =  0  1=PRINT ALL CANDLEPOWER TABLES
ISW6 =  0  1=USE TS PAGE CHANGES

IDEV1 =  1  CANDLEPOWER TABLES
IDEV2 = 99  DESIGN INPUT
IDEV3 =  0
IDEV4 =  0
IDEV5 =  0
IDEV6 =  0
```

NO.	LUMID	NO.	LUMID	NO.	LUMID	NO.	LUMID
1	H15CC656F2	2	H500 656F2	3	V2505 3M4E1	4	V1801 4SAE1
5	V1801 4MAF2	6	H15C 65L41	7	H15C 65N01	8	V35W 4MH01
9	V55W 4SN01	10	H10C S76C41	11	V1505 4LLA1	12	H15C 656E3
13	H501 55N01	14	H150 76A01	15	H10C S76U1	16	H10C S76C42
17	H400S64C41	18	V10C S76C41	19	H20W S76A01	20	H300 656E1
21	H400S76SY1	22	H250S76EF1	23	H15C 656E1	24	H400S76X51
25	H300 56W6F	26	H400 55N01	27	H250S75WE1	28	H400S22H01
29	H250S76GF1	30	V400S25EF1	31	V10C 5W6E1	32	H10C S65H01
33	V25C S3W6F2	34	V250 S4WF1	35	V250S3MWE1	36	V400S4MWF1
37	V400S3W5F1	38	V150 33W6F1	39	H15C 64L41	40	H15C 626F1
41	H15C 646F1	42	H15C 45WE1	43	H15C 622S2	44	H400S76CH1
45	H400S7U6F1	46	H400 644EF1	47	H400S55UE1	48	H400S52SE1
49	H400S45SF1	50	H135 75SF1	51	H90L S75GF1	52	H16WL75SE1
53	H250S53WF1	54	H10C S76W11	55	V1H0L 6WL1	56	V400S4LAE1
57	H400S67C41	58	H250S66H01	59	V10C S65401	60	V250 34LAE1
61	H400S65WF1	62	H15C 65U64	63	V2505 3MGE1	64	V1601 4S0U1
65	V1H0L 4MLU1	66	H500 65L41				

INPUT DATA - DEPRECIATION FACTORS

LUMID	DLAMP	POINT	OTHEC
V400S4MWF1	.0500	.1000	1.0000

List of luminaires having conflicting wattage data in storage

LUMINAIRE POSITION AND AIMING DATA

UNIT NO	LUMINAIRE IDCODE	X-COORD	Y-COORD	Z-COORD	HORZ ANGLE	VERT ANGLE
1	OPS	0.00	0.00	35.00	90.00	0.00
2	OPS	120.00	0.00	35.00	90.00	0.00
3	OPS	240.00	0.00	35.00	90.00	0.00
4	OPS	360.00	0.00	35.00	90.00	0.00
5	OPS	480.00	0.00	35.00	90.00	0.00
6	OPS	600.00	0.00	35.00	90.00	0.00

CANDLEPOWER TABLE - LUMINAIRE CODE: V400S4M4E1 TABLE NO. 36

HORZ. ANGLES (V 35 17)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
VERT.									
-35.0		125	150	145	140	135	125	130	135	150
	175	175	150	135	130	125	135	140	145	150
	125	100	90	70	40	0	0	0	0	0
	0	0	0	40	70	90	100	125	150	
-25.0		250	270	275	280	285	275	275	280	310
	375	375	310	290	275	275	285	280	275	270
	250	230	200	180	175	160	105	90	40	40
	90	105	160	175	180	200	230	250	270	
-15.0		375	405	420	410	450	430	420	425	410
	490	490	410	425	420	430	450	410	420	405
	375	355	350	345	380	390	320	260	180	180
	260	320	390	380	345	350	355	375	405	
-5.0		500	600	700	750	775	850	780	750	875
	1060	1060	875	750	740	450	775	750	700	600
	500	500	550	575	600	550	450	400	360	360
	400	450	550	600	575	550	500	500	640	
5.0		750	1000	1750	2250	3100	3750	2200	1675	1900
	2200	2200	1900	1875	2200	3750	3100	2250	1750	1000
	750	775	810	840	825	750	650	625	600	600
	625	650	750	825	840	810	775	750	1000	
10.0		835	1250	3750	9500	17000	13000	4400	3400	3000
	3300	3300	3000	3400	4400	13000	17000	9500	3750	1250
	835	825	860	950	1000	940	900	775	750	750
	775	900	840	1000	950	860	825	835	1250	
15.0		1125	2600	17000	33500	30000	16000	10200	5200	4350
	4100	4100	4350	5200	10200	16000	30000	33500	17000	2600
	1125	1020	1000	1175	1275	950	900	950	925	925
	950	900	950	1275	1175	1000	1020	1125	2600	
20.0		2200	7000	20000	27000	24000	17500	10000	7500	6650
	7000	7000	6650	7500	10000	17500	24000	27000	20000	7000
	2230	1560	1500	1550	1550	1125	1050	1125	1125	1125
	1125	1050	1125	1550	1550	1500	1560	2200	7000	
25.0		2300	7000	14000	18000	18000	14500	10500	9200	9200
	12500	12500	9200	9200	10500	14500	18000	18000	14000	7000
	4300	2500	2250	2100	1850	1350	1400	1450	1500	1500
	1450	1400	1350	1850	2100	2250	2500	4300	7	

SE-616

CANDLEPOWER TABLE - LUMINAIRE CODE: V400S4MWE1 TABLE NO. 36

HORZ. ANGLES (V 3A 17)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
VERT.									
30.0		5575	8000	11000	14000	14500	13000	12500	12500	13750
	16000	16000	13750	12500	12500	13000	14500	14000	11000	8000
	5575	5000	4025	2600	2100	1875	1800	1875	1925	1925
	1875	1800	1875	2100	2600	4025	5000	5575	8000	
35.0		6800	8200	9200	10200	12700	12500	14500	16000	16500
	17800	17800	16500	16000	14500	12500	12700	10200	9200	8200
	6800	5575	4900	3700	2800	2450	2400	2450	2475	2475
	2450	2400	2450	2800	3700	4900	5575	6800	8200	
45.0		6800	7600	8300	9300	11250	12500	14500	17000	17200
	16800	16400	17200	17000	14500	12500	11250	9300	8300	7600
	6800	5400	5250	4400	3700	3100	2900	2825	2700	2700
	2825	2900	3100	3700	4400	5250	5900	6800	7600	
55.0		5600	5750	7600	8400	9700	10400	12250	14000	14750
	15000	15000	14750	14000	12250	10400	9700	8400	7600	5750
	5600	5150	4750	4300	3900	3450	3250	3100	3000	3000
	3100	3250	3450	3900	4300	4750	5150	5600	5750	
65.0		4750	4900	5500	7800	8500	9000	9500	10500	11250
	12000	12000	11250	10500	9500	9000	8500	7800	5500	4900
	4750	4650	4300	4300	3950	3850	3600	3425	3350	3350
	3425	3600	3850	3950	4100	4300	4650	4750	4900	
75.0		4650	4825	5200	6500	7200	7700	8300	8600	9200
	9500	9500	9200	8600	8300	7700	7200	6500	5200	4825
	4650	4475	4200	4100	4000	3850	3750	3700	3650	3650
	3700	3750	3850	4000	4100	4200	4475	4650	4825	
85.0		4950	4950	5150	5500	6000	6300	6600	7000	7200
	7300	7300	7200	7000	6600	6300	6000	5500	5150	4950
	4900	4760	4650	4525	4450	4400	4350	4300	4270	4270
	4300	4350	4400	4450	4525	4650	4760	4900	4950	
90.0		5100	5100	5100	5100	5100	5100	5100	5100	5100
	5100	5100	5100	5100	5100	5100	5100	5100	2805	5100
	5100	5100	5100	5100	5100	5100	5100	5100	5100	5100
	5100	5100	5100	5100	5100	5100	5100	5100	5100	

TEST GRID POSITION AND SIZE - TEST GRID 1

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
-120.00	-30.00	.50	720.00	120.00	.50

NUMX	NUMYZ	ICOMP	DMETER	XGRID3	YGRID3	ZGRID3
15	11	-	0.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 181.81290887190
NUMBER OF POINTS = 165.0000000000

AVERAGE FOOTCANDLES = 1.101290965
UNIFORMITY RATIO = 77.96043298434

MAXIMUM FOOTCANDLES = 5.2776914764
MINIMUM FOOTCANDLES = .0141340467

TEST GRID 1 COORDINATES OF CORNER 1 -120.00 -30.00 .50
COORDINATES OF CORNER 2 720.00 120.00 .50
COORDINATES OF CORNER 3 720.00 -30.00 .50
COORDINATES OF CORNER 4 -120.00 120.00 .50

		X -120.00	X -60.00	X 0.00	X 60.00	X 120.00	X 180.00	X 240.00	X 300.00	X 360.00	X 420.00	
Y	120.00	.0715	.0937	.1282	.1340	.1908	.1641	.1979	.1659	.1979	.1641	120.00 Y
Z	.50											.50 Z
Y	105.00	.1030	.1249	.2063	.2165	.3010	.2466	.3076	.2483	.3076	.2466	105.00 Y
Z	.50											.50 Z
Y	90.00	.1544	.1949	.3658	.3389	.5125	.3669	.5186	.3684	.5186	.3669	90.00 Y
Z	.50											.50 Z
Y	75.00	.2101	.3082	.7176	.5889	.9210	.6138	.9261	.6151	.9261	.6138	75.00 Y
Z	.50											.50 Z
Y	60.00	.2732	.5195	1.4003	1.0147	1.6693	1.0366	1.6722	1.0377	1.6722	1.0366	60.00 Y
Z	.50											.50 Z
Y	45.00	.2666	.7553	2.5252	1.4920	2.7873	1.5086	2.7905	1.5095	2.7905	1.5086	45.00 Y
Z	.50											.50 Z
Y	30.00	.1904	.9024	4.1282	1.7911	4.3051	1.8030	4.3074	1.8037	4.3074	1.8030	30.00 Y
Z	.50											.50 Z
Y	15.00	.0783	.7435	5.2005	1.4802	5.2761	1.4855	5.2777	1.4861	5.2777	1.4855	15.00 Y
Z	.50											.50 Z
Y	0.00	.0317	.4544	2.9453	.9630	2.9745	.9674	2.9760	.9679	2.9760	.9674	0.00 Y
Z	.50											.50 Z
Y	-15.00	.0172	.3118	1.5131	.6191	1.5281	.6223	1.5294	.6228	1.5294	.6223	-15.00 Y
Z	.50											.50 Z
Y	-30.00	.0141	.1641	.7063	.3239	.7194	.3270	.7195	.3274	.7195	.3270	-30.00 Y
Z	.50											.50 Z

FMG HFC

8-61

TEST GRID 1 COORDINATES OF CORNER 1 -120.00 -30.00 .50
COORDINATES OF CORNER 2 720.00 120.00 .50
COORDINATES OF CORNER 3 720.00 -30.00 .50
COORDINATES OF CORNER 4 -120.00 120.00 .50

		X 480.00	X 540.00	X 600.00	X 660.00	X 720.00	X 0.00	X -0.00	X 0.00	X 0.00	X 0.00	
Y	120.00	.1904	.1340	.1282	.0837	.0715	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	105.00	.3010	.2145	.2063	.1249	.1030	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	90.00	.5125	.3349	.3658	.1849	.1544	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	75.00	.9210	.5289	.7176	.3082	.2181	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	60.00	1.6683	1.0147	1.4003	.5195	.2732	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	45.00	2.7873	1.4920	2.5252	.7553	.2666	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	30.00	4.3051	1.7911	4.1282	.9024	.1804	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	15.00	5.2761	1.4802	5.2005	.7435	.0783	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	0.00	4.9745	.9630	4.9453	.4844	.0317	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	-15.00	1.5281	.6191	1.5131	.3118	.0172	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	-30.00	.7184	.3439	.7063	.1641	.0141	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z

TEST GRID POSITION AND SIZE - TEST GRID 2

XGRID1	YGRID1	ZGRID1	YGRID2	XGRID2	ZGRID2
-120.00	-30.00	3.00	720.00	120.00	3.00

NUMX	NUMYZ	ICOMP	XMETER	XGRID3	YGRID3	ZGRID3
15	11	V	270.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 169.6166315215
NUMBER OF POINTS = 165.0000000000

AVERAGE FOOTCANDLES = 1.0284674638
UNIFORMITY RATIO = 0.0000000000

MAXIMUM FOOTCANDLES = 4.2671242940
MINIMUM FOOTCANDLES = 0.0000000000

TEST GRID 2 COORDINATES OF CORNER 1 -120.00 -30.00 3.00
COORDINATES OF CORNER 2 720.00 120.00 3.00
COORDINATES OF CORNER 3 720.00 -30.00 3.00
COORDINATES OF CORNER 4 -120.00 120.00 3.00

		X -120.00	X -60.00	X 0.00	X 60.00	X 120.00	X 180.00	X 240.00	X 300.00	X 360.00	X 420.00	
Y	120.00	.2392	.2949	.4131	.4273	.6186	.5193	.6398	.5244	.6398	.5193	120.00 Y
Z	3.00											3.00 Z
Y	105.00	.2939	.3612	.5761	.6325	.8473	.7136	.8649	.7179	.8649	.7136	105.00 Y
Z	3.00											3.00 Z
Y	90.00	.3705	.4506	.8445	.8890	1.1970	.9541	1.2109	.9576	1.2109	.9541	90.00 Y
Z	3.00											3.00 Z
Y	75.00	.4085	.6731	1.3882	1.2928	1.7836	1.3408	1.7935	1.3433	1.7935	1.3408	75.00 Y
Z	3.00											3.00 Z
Y	60.00	.4111	.9700	2.3120	1.9055	2.7144	1.9361	2.7207	1.9379	2.7207	1.9361	60.00 Y
Z	3.00											3.00 Z
Y	45.00	.3027	1.1132	3.5303	2.2084	3.8275	2.2239	3.8314	2.2251	3.8314	2.2239	45.00 Y
Z	3.00											3.00 Z
Y	30.00	.1438	.8836	4.1243	1.7544	4.2652	1.7658	4.2671	1.7664	4.2671	1.7658	30.00 Y
Z	3.00											3.00 Z
Y	15.00	.0299	.3479	2.8107	.7332	2.8395	.7352	2.8402	.7345	2.8402	.7352	15.00 Y
Z	3.00											3.00 Z
Y	0.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	3.00											3.00 Z
Y	-15.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-15.00 Y
Z	3.00											3.00 Z
Y	-30.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-30.00 Y
Z	3.00											3.00 Z

FMG - VFG

TEST GRID 2 COORDINATES OF CORNER 1 -120.00 -30.00 3.00
COORDINATES OF CORNER 2 720.00 120.00 3.00
COORDINATES OF CORNER 3 720.00 -30.00 3.00
COORDINATES OF CORNER 4 -120.00 120.00 3.00

		X 480.00	X 540.00	X 600.00	X 660.00	X 720.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	120.00	.6186	.4[illegible]3	.4067	.2649	.2327	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	105.00	.8473	.6[illegible]2[illegible]	.5761	.3612	.2939	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	90.00	1.1970	.98[illegible]	.8445	.4806	.3705	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	75.00	1.7836	1.2928	1.3482	.6731	.4085	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	60.00	2.7144	1.9955	2.3120	.9700	.4111	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	45.00	3.8275	2.2064	3.5303	1.1132	.3027	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	30.00	~~4.2652~~	~~1.7584~~	~~4.1243~~	XX.8936	.1438	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	15.00	2.8395	.7332	2.8107	.3479	.0299	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	0.00	0000	.0000	.0000	XX.0000	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-15.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-30.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID POSITION AND SIZE - TEST GRID 3

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
-120.00	-30.00	3.00	120.00	120.00	3.00

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
15	11	Y	100.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 80.303401464 9
NUMBER OF POINTS = 165.0000000000

AVERAGE FOOTCANDLES = .4866897058
UNIFORMITY RATIO = 0.0000000000

MAXIMUM FOOTCANDLES = 1.810213694 6
MINIMUM FOOTCANDLES = 0.0000000000

79-13

TEST GRID 3 COORDINATES OF CORNER 1 -120.00 -30.00 3.00
COORDINATES OF CORNER 2 120.00 120.00 3.00
COORDINATES OF CORNER 3 120.00 -30.00 3.00
COORDINATES OF CORNER 4 -120.00 120.00 3.00

		X -120.00	X -60.00	X 0.00	X 60.00	X 120.00	X 180.00	X 240.00	X 300.00	X 360.00	X 420.00	
Y	120.00	0.0000	0.0000	.0000	.0414	.2040	.2205	.2504	.2373	.2588	.2431	120.00 Y
Z	3.00											3.00 Z
Y	105.00	0.0000	0.0000	.0000	.1552	.3104	.2951	.3525	.3114	.3608	.3170	105.00 Y
Z	3.00											3.00 Z
Y	90.00	0.0000	0.0000	.0000	.2724	.4704	.4037	.5093	.4188	.5172	.4241	90.00 Y
Z	3.00											3.00 Z
Y	75.00	0.0000	0.0000	.0000	.4959	.6330	.6120	.6663	.6256	.6737	.6305	75.00 Y
Z	3.00											3.00 Z
Y	60.00	0.0000	0.0000	.0000	.9356	.8052	1.0284	.8319	1.0406	.8386	1.0450	60.00 Y
Z	3.00											3.00 Z
Y	45.00	0.0000	0.0000	.0000	1.4603	.7929	1.5232	.8151	1.5336	.8210	1.5376	45.00 Y
Z	3.00											3.00 Z
Y	30.00	0.0000	0.0000	.0000	1.7496	.5639	1.7949	.5805	1.8032	.5856	1.8068	30.00 Y
Z	3.00											3.00 Z
Y	15.00	0.0000	0.0000	.0000	1.4612	.2301	1.4860	.2425	1.4934	.2474	1.4968	15.00 Y
Z	3.00											3.00 Z
Y	0.00	0.0000	0.0000	.0000	.8238	.0749	.8450	.0899	.8517	.0943	.8550	0.00 Y
Z	3.00											3.00 Z
Y	-15.00	0.0000	0.0000	.0000	.4547	.0456	.4756	.0552	.4817	.0594	.4848	-15.00 Y
Z	3.00											3.00 Z
Y	-30.00	0.0000	0.0000	.0000	.2370	.0395	.2530	.0484	.2586	.0523	.2615	-30.00 Y
Z	3.00											3.00 Z

: MG - VFC
180° ⇐

TEST GRID 3 COORDINATES OF CORNER 1 -120.00 -30.00 3.00
COORDINATES OF CORNER 2 720.00 120.00 3.00
COORDINATES OF CORNER 3 720.00 -30.00 3.00
COORDINATES OF CORNER 4 -120.00 120.00 3.00

		X 480.00	X 540.00	X 600.00	X 660.00	X 720.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	120.00	.2629	.2461	.2453	.2480	.2647	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	105.00	.3647	.3199	.3670	.3216	.3683	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	90.00	.5209	.4268	.5230	.4284	.5243	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	75.00	.6771	.6330	.6790	.6345	.6803	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	60.00	.8417	1.0473	.8435	1.0487	.8447	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	45.00	.8238	1.5397	.8255	1.5411	.8267	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	30.00	.5893	1.8089	.5899	1.8102	.5910	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	15.00	.2499	1.4988	.2515	1.5001	.2526	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	0.00	.0959	.8569	.0985	.8582	.0995	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-15.00	.0617	.4866	.0632	.4878	.0642	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-30.00	.0545	.2632	.0559	.2644	.0569	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID POSITION AND SIZE - TEST GRID 4

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
280.00	-25.00	.80	370.00	110.00	.80

NUMX	NUMYZ	ICOMP	GMETER	XGRID3	YGRID3	ZGRID3
10	28	4	0.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 397.39866925232
NUMBER OF POINTS = 280.00000000000

AVERAGE FOOTCANDLES = 1.4210667590
UNIFORMITY RATIO = 6.5367601814

MAXIMUM FOOTCANDLES = 5.2776914764
MINIMUM FOOTCANDLES = .21739461901

TEST GRID 4 COORDINATES OF CORNER 1 280.00 -25.00 .50
COORDINATES OF CORNER 2 370.00 110.00 .50
COORDINATES OF CORNER 3 370.00 -25.00 .50
COORDINATES OF CORNER 4 280.00 110.00 .50

		X 280.00	X 290.00	X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 370.00	
Y	110.00	.2296	.2175	.2174	.2175	.2296	.2394	.2505	.2591	.2637	.2588	110.00 Y
Z	.50											.50 Z
Y	105.00	.2620	.2474	.2483	.2474	.2620	.2768	.2891	.3023	.3076	.3020	105.00 Y
Z	.50											.50 Z
Y	100.00	.2995	.2827	.2835	.2827	.2995	.3151	.3344	.3548	.3609	.3546	100.00 Y
Z	.50											.50 Z
Y	95.00	.3410	.3266	.3234	.3266	.3410	.3605	.3904	.4187	.4259	.4185	95.00 Y
Z	.50											.50 Z
Y	90.00	.3916	.3793	.3684	.3793	.3916	.4142	.4581	.5048	.5136	.5046	90.00 Y
Z	.50											.50 Z
Y	85.00	.4534	.4422	.4215	.4422	.4534	.4905	.5426	.6059	.6359	.6057	85.00 Y
Z	.50											.50 Z
Y	80.00	.5302	.5169	.5063	.5169	.5302	.5793	.6424	.7323	.7643	.7321	80.00 Y
Z	.50											.50 Z
Y	75.00	.6325	.6068	.6151	.6068	.6325	.6825	.7514	.8841	.9261	.8839	75.00 Y
Z	.50											.50 Z
Y	70.00	.7470	.7204	.7432	.7204	.7470	.8021	.8955	1.0573	1.1153	1.0572	70.00 Y
Z	.50											.50 Z
Y	65.00	.8749	.8689	.8836	.8689	.8749	.9459	1.0728	1.2728	1.3552	1.2727	65.00 Y
Z	.50											.50 Z
Y	60.00	1.0237	1.0211	1.0377	1.0211	1.0237	1.1203	1.2878	1.5459	1.6722	1.5457	60.00 Y
Z	.50											.50 Z
Y	55.00	1.2037	1.1814	1.1908	1.1814	1.2037	1.3205	1.5521	1.8474	2.0214	1.8472	55.00 Y
Z	.50											.50 Z
Y	50.00	1.3913	1.3507	1.3494	1.3607	1.3913	1.5583	1.8788	2.2230	2.4148	2.2228	50.00 Y
Z	.50											.50 Z
Y	45.00	1.5718	1.5190	1.5095	1.5190	1.5718	1.8314	2.3028	2.5968	2.7985	2.5967	45.00 Y
Z	.50											.50 Z
Y	40.00	1.7425	1.6668	1.6495	1.6668	1.7425	2.0928	2.6124	3.0298	3.2197	3.0297	40.00 Y
Z	.50											.50 Z
Y	35.00	1.9021	1.7973	1.7342	1.7973	1.9021	2.2407	2.9361	3.6046	3.7486	3.6045	35.00 Y
	.50											.50 Z

1.0 FC

2.0 FC

L1-4

TEST GRID 4 COORDINATES OF CORNER 1 240.00 -25.00 .50
COORDINATES OF CORNER 2 370.00 110.00 .50
COORDINATES OF CORNER 3 370.00 -25.00 .50
COORDINATES OF CORNER 4 240.00 110.00 .50

		X 240.00	X 250.00	X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 370.00	
Y	30.00	2.0003	1.8195	1.8037	1.8195	2.0003	2.3575	3.2409	4.1485	4.3074	4.1485	30.00 Y
Z	.50											.50 Z
Y	25.00	1.9993	1.7745	1.7674	1.7745	1.9993	2.5286	3.3823	4.5376	4.8974	4.5375	25.00 Y
Z	.50											.50 Z
Y	20.00	1.8879	1.6733	1.6431	1.6733	1.8879	2.5426	3.3063	4.6443	5.2337	4.6442	20.00 Y
Z	.50											.50 Z
Y	15.00	1.7662	1.5205	1.4861	1.5205	1.7662	2.3443	3.2658	4.2983	5.2777	4.2982	15.00 Y
Z	.50											.50 Z
Y	10.00	1.6353	1.3682	1.3028	1.3602	1.6353	2.1769	3.0600	4.0160	5.0414	4.0159	10.00 Y
Z	.50											.50 Z
Y	5.00	1.5063	1.2111	1.1213	1.2042	1.4997	1.9873	2.5087	3.5251	4.5125	3.5250	5.00 Y
Z	.50											.50 Z
Y	0.00	1.3662	1.0827	.9674	1.0827	1.3662	1.7580	2.0431	2.4735	2.8760	2.4734	0.00 Y
Z	.50											.50 Z
Y	-5.00	1.1877	.9301	.7940	.9301	1.1877	1.5574	1.8686	2.1248	2.3026	2.1247	-5.00 Y
Z	.50											.50 Z
Y	-10.00	1.0039	.7962	.7167	.7962	1.0039	1.3354	1.6019	1.8333	1.8664	1.8332	-10.00 Y
Z	.50											.50 Z
Y	-15.00	.8562	.6647	.6228	.6687	.8562	1.1341	1.3283	1.4628	1.5294	1.4627	-15.00 Y
Z	.50											.50 Z
Y	-20.00	.7080	.5529	.5149	.5529	.7080	.8910	1.0487	1.1641	1.2045	1.1640	-20.00 Y
Z	.50											.50 Z
Y	-25.00	.5560	.4448	.4154	.4488	.5560	.6746	.7982	.9004	.9308	.9004	-25.00 Y
Z	.50											.50 Z

TEST GRID POSITION AND SIZE - TEST GRID 5

YGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
300.00	0.00	.50	360.00	30.00	.50

NUMX	NUMYZ	ICOMD	METER	XGRID3	YGRID3	ZGRID3
7	7	M	0.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 129.05757293H5
NUMBER OF POINTS = 49.0000000000

AVERAGE FOOTCANDLES = 2.633H2H3192
UNIFORMITY RATIO = 2.721[599469

See Next Page

MAXIMUM FOOTCANDLES = 5.2776914764
MINIMUM FOOTCANDLES = .9679063593

TEST GRID 5 COORDINATES OF CORNER 1 300.00 0.00 .50
COORDINATES OF CORNER 2 360.00 30.00 .50
COORDINATES OF CORNER 3 360.00 0.00 .50
COORDINATES OF CORNER 4 300.00 30.00 .50

		X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 0.00	X 0.00	X 0.00	
Y	30.00	1.8037	1.8195	2.0803	2.3475	3.2409	4.1485	4.3074	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	25.00	1.7670	1.7745	1.9993	2.5286	3.3823	4.5376	4.8974	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	20.00	1.6431	1.6733	1.8879	2.5426	3.3063	4.6463	5.2337	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	15.00	1.4661	1.5205	1.7662	2.3443	3.2658	4.2983	5.2777	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	10.00	1.3028	1.3602	1.6353	2.1769	3.0600	4.0160	5.0418	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	5.00	1.1213	1.2042	1.4997	1.9673	2.8087	3.5251	4.5125	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	0.00	.9679	1.0427	1.3662	1.7580	2.0431	2.4735	2.9760	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z

30' deep Test Grid (uniformity ratios) HEC

02-61

TEST GRID POSITION AND SIZE - TEST GRID 8

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
300.00	0.00	.50	360.00	60.00	.50

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
7	13	4	0.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 208.3573751279
NUMBER OF POINTS = 91.0000000000

AVERAGE FOOTCANDLES = 2.2896414849
UNIFORMITY RATIO = 2.3655609481

See Next Page

MAXIMUM FOOTCANDLES = 5.2776414764
MINIMUM FOOTCANDLES = .9679063593

TEST GRID 6 COORDINATES OF CORNER 1 300.00 0.00 .50
COORDINATES OF CORNER 2 360.00 60.00 .50
COORDINATES OF CORNER 3 360.00 0.00 .50
COORDINATES OF CORNER 4 300.00 60.00 .50

		X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 0.00	X 0.00	X 0.00	
Y	60.00	1.0377	1.0211	1.0237	1.1203	1.2870	1.5459	1.6722	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	55.00	1.1908	1.1814	1.2037	1.3205	1.5521	1.8474	2.0214	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	50.00	1.3494	1.3607	1.3913	1.5583	1.8788	2.2230	2.4148	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	45.00	1.5095	1.5190	1.5718	1.8314	2.3020	2.5968	2.7905	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	40.00	1.6495	1.6668	1.7425	2.0928	2.6124	3.0298	3.2197	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	35.00	1.7342	1.7973	1.9021	2.2407	2.9361	3.6046	3.7486	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	30.00	1.8037	1.8195	2.0003	2.3575	3.2409	4.1485	4.3074	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	25.00	1.7670	1.7745	1.9993	2.5286	3.3823	4.5376	4.8974	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	20.00	1.6431	1.6733	1.8879	2.5426	3.3063	4.6483	5.2337	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	15.00	1.4861	1.5205	1.7662	2.3443	3.2658	4.2983	5.2777	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	10.00	1.3028	1.3402	1.6353	2.1769	3.0600	4.0160	5.0418	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	5.00	1.1213	1.2042	1.4947	1.9673	2.5087	3.5251	4.5125	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z
Y	0.00	.9879	1.0827	1.3662	1.7580	2.0431	2.4735	2.9760	0.0000	0.0000	0.0000	0.00 Y
Z	.50											0.00 Z

22-61

60' deep Test Grid - HPF

TEST GRID POSITION AND SIZE - TEST GRID 7

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
300.00	0.00	-5.50	360.00	60.00	-5.50

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
7	13	4	0.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 198.2650220341
NUMBER OF POINTS = 91.0000000000

AVERAGE FOOTCANDLES = 2.0698463960
UNIFORMITY RATIO = 1.9698869710

MAXIMUM FOOTCANDLES = 4.0093280762
MINIMUM FOOTCANDLES = 1.0502371592

TEST GRID 7 COORDINATES OF CORNER 1 300.00 0.00 -5.50
COORDINATES OF CORNER 2 360.00 60.00 -5.50
COORDINATES OF CORNER 3 360.00 0.00 -5.50
COORDINATES OF CORNER 4 300.00 60.00 -5.50

		X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 0.00	X 0.00	X 0.00	
Y	60.00	1.0502	1.0773	1.1717	1.3459	1.5790	1.7987	1.8921	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	55.00	1.1767	1.2033	1.3254	1.5501	1.8508	2.0628	2.1732	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	50.00	1.3051	1.3212	1.4654	1.7780	2.1049	2.3219	2.4120	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	45.00	1.4320	1.4381	1.5855	1.9502	2.3791	2.6174	2.6997	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	40.00	1.5215	1.5464	1.6677	2.0861	2.6432	2.9989	3.0373	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	35.00	1.5573	1.6407	1.7732	2.1813	2.8785	3.3160	3.3791	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	30.00	1.5728	1.6960	1.8469	2.2479	2.9314	3.5749	3.7318	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	25.00	1.5123	1.5297	1.8321	2.2961	2.9064	3.7011	3.9579	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	20.00	1.4230	1.4693	1.7297	2.2311	2.7386	3.5779	4.0093	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	15.00	1.3381	1.4009	1.6258	2.0632	2.6871	3.4570	3.9346	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	10.00	1.2643	1.3274	1.5212	1.9071	2.4967	3.0541	3.6666	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	5.00	1.1858	1.2421	1.4180	1.6450	1.8737	2.6208	3.2742	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z
Y	0.00	1.0836	1.1321	1.3156	1.4476	1.6118	1.9233	2.2234	0.0000	0.0000	0.0000	0.00 Y
Z	-5.50											0.00 Z

60 ft loop test grid - equivalent
to setting mounting height at 40 ft.

TEST GRID POSITION AND SIZE - TEST GRID H

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
280.00	60.00	0.00	370.00	60.00	130.00

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
10	14	H	0.00	370.00	60.00	0.00

TOTAL FOOTCANDLES = 24.8752909049
NUMBER OF POINTS = 140.0000000000

AVERAGE FOOTCANDLES = .1776806493
UNIFORMITY RATIO = 63.1761768383

MAXIMUM FOOTCANDLES = 1.7102531606
MINIMUM FOOTCANDLES = .0028124628

TEST GRID A COORDINATES OF CORNER 1 280.00 60.00 0.00
COORDINATES OF CORNER 2 370.00 60.00 130.00
COORDINATES OF CORNER 3 370.00 60.00 0.00
COORDINATES OF CORNER 4 280.00 60.00 130.00

		X 280.00	X 290.00	X 300.00	X 310.00	X 320.00	X 330.00	X 340.00	X 350.00	X 360.00	X 370.00	
Y 60.00		.0050	.0050	.0050	.0050	.0050	.0050	.0049	.0049	.0028	.0048	60.00 Y
Z 130.00												130.00 Z
Y 60.00		.0052	.0052	.0052	.0052	.0052	.0053	.0053	.0079	.0079	.0078	60.00 Y
Z 120.00												120.00 Z
Y 60.00		.0054	.0054	.0054	.0054	.0054	.0086	.0089	.0090	.0090	.0089	60.00 Y
Z 110.00												110.00 Z
Y 60.00		.0097	.0054	.0054	.0054	.0097	.0099	.0099	.0099	.0099	.0098	60.00 Y
Z 100.00												100.00 Z
Y 60.00		.0110	.0111	.0165	.0111	.0110	.0109	.0107	.0105	.0104	.0105	60.00 Y
Z 90.00												90.00 Z
Y 60.00		.0207	.0210	.0210	.0210	.0207	.0202	.0109	.0106	.0104	.0105	60.00 Y
Z 80.00												80.00 Z
Y 60.00		.0245	.0243	.0241	.0243	.0245	.0248	.0257	.0277	.0290	.0277	60.00 Y
Z 70.00												70.00 Z
Y 60.00		.0253	.0243	.0240	.0243	.0253	.0266	.0282	.0319	.0342	.0318	60.00 Y
Z 60.00												60.00 Z
Y 60.00		.0233	.0230	.0233	.0230	.0233	.0243	.0257	.0286	.0307	.0286	60.00 Y
Z 50.00												50.00 Z
Y 60.00		.0142	.0149	.0160	.0149	.0142	.0144	.0162	.0192	.0209	.0192	60.00 Y
Z 40.00												40.00 Z
Y 60.00		.0292	.0335	.0381	.0335	.0292	.0292	.0317	.0367	.0399	.0367	60.00 Y
Z 30.00												30.00 Z
Y 60.00		.2915	.3621	.4214	.3621	.2915	.2433	.2148	.2104	.2111	.2103	60.00 Y
Z 20.00												20.00 Z
Y 60.00		.7853	.8630	.8271	.8630	.7853	.7095	.6673	.7236	.7924	.7235	60.00 Y
Z 10.00												10.00 Z
Y 60.00		1.0370	1.0236	1.0392	1.0236	1.0370	1.1398	1.3157	1.5793	1.7103	1.5791	60.00 Y
Z 0.00												0.00 Z

Vertical Grid @ Y = 60 ft (parallel to plane of fence(s) or to plane of pole line)

TEST GRID POSITION AND SIZE - TEST GRID 9

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
300.00	-30.00	0.00	300.00	140.00	130.00

NUMX	NUMYZ	ICOMP	HEIGHT	XGRID3	YGRID3	ZGRID3
18	14	4	0.00	300.00	140.00	0.00

TOTAL FOOTCANDLES = 36.10458777540
NUMBER OF POINTS = 252.0000000000

AVERAGE FOOTCANDLES = .1432698254
UNIFORMITY RATIO = 42.19661111057

MAXIMUM FOOTCANDLES = 2.401800049
MINIMUM FOOTCANDLES = .0033952438

T74A PER LTG--OF(6-POLE) 1X400HPS SP120 MH35 (020678 78/02/06 09.18.01 PAGE 27

TEST GRID 9 COORDINATES OF CORNER 1 300.00 -30.00 0.00
COORDINATES OF CORNER 2 300.00 140.00 130.00
COORDINATES OF CORNER 3 300.00 140.00 0.00
COORDINATES OF CORNER 4 300.00 -30.00 130.00

(-30y) (0y) (20y) (40y) (60y)

	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	
Y -30.00	.0045	.0047	.0048	.0049	.0051	.0051	.0051	.0051	.0050	.0050	60.00 Y
Z 130.00											130.00 Z
Y -30.00	.0048	.0049	.0051	.0052	.0053	.0054	.0054	.0053	.0053	.0052	60.00 Y
Z 120.00											120.00 Z
Y -30.00	.0050	.0051	.0053	.0054	.0055	.0056	.0056	.0055	.0055	.0054	60.00 Y
Z 110.00											110.00 Z
Y -30.00	.0050	.0051	.0053	.0055	.0056	.0056	.0056	.0056	.0055	.0054	60.00 Y
Z 100.00											100.00 Z
Y -30.00	.0048	.0050	.0052	.0053	.0054	.0055	.0055	.0054	.0054	.0165	60.00 Y
Z 90.00											90.00 Z
Y -30.00	.0151	.0046	.0048	.0050	.0051	.0052	.0232	.0232	.0224	.0210	60.00 Y
Z 80.00											80.00 Z
Y -30.00	.0225	.0256	.0288	.0322	.0336	.0329	.0316	.0298	.0271	.0241	60.00 Y
Z 70.00											70.00 Z
Y -30.00	.0278	.0319	.0362	.0396	.0407	.0389	.0357	.0329	.0284	.0240	60.00 Y
Z 60.00											60.00 Z
Y -30.00	.0271	.0304	.0339	.0374	.0389	.0373	.0340	.0310	.0270	.0233	60.00 Y
Z 50.00											50.00 Z
Y -30.00	.0136	.0149	.0161	.0183	.0209	.0217	.0207	.0193	.0178	.0134	60.00 Y
Z 40.00											40.00 Z
Y -30.00	.0187	.0215	.0235	.0281	.0405	.0509	.0520	.0513	.0452	.0246	60.00 Y
Z 30.00											30.00 Z
Y -30.00	.0629	.0740	.0880	.1506	.6259	1.2709	1.4044	1.0816	.6756	.4212	60.00 Y
Z 20.00											20.00 Z
Y -30.00	.1508	.2015	.3233	.6442	1.3875	2.1924	2.4008	1.9613	1.3702	.8271	60.00 Y
Z 10.00											10.00 Z
Y -30.00	.3409	.5371	.7375	.9801	1.3004	1.6219	1.7859	1.6410	1.3412	1.0392	60.00 Y
Z 0.00											0.00 Z

Vertical Grid @ X = 300' (perpendicular to plane of the pole line).

TEST GRID 9 COORDINATES OF CORNER 1 300.00 -30.00 0.00
COORDINATES OF CORNER 2 300.00 140.00 130.00
COORDINATES OF CORNER 3 300.00 140.00 0.00
COORDINATES OF CORNER 4 300.00 -30.00 130.00

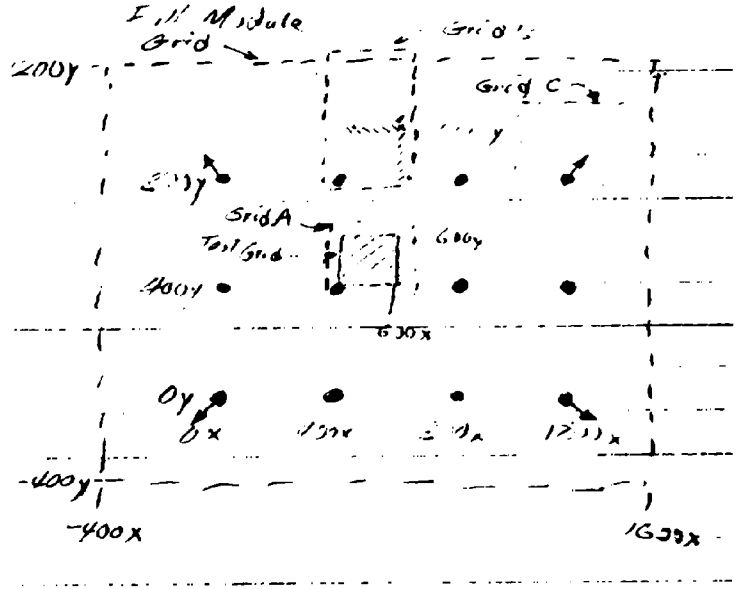
(70Y) (110Y)

	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 300.00	X 0.00	X 0.00	
Y 70.00 Z 130.00	.0049	.0046	.0047	.0046	.0044	.0043	.0082	.0081	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 120.00	.0051	.0050	.0048	.0047	.0094	.0094	.0092	.0040	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 110.00	.0052	.0051	.0110	.0111	.0110	.0107	.0102	.0097	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 100.00	.0052	.0133	.0132	.0128	.0123	.0116	.0109	.0102	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 90.00	.0165	.0159	.0151	.0141	.0132	.0122	.0113	.0103	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 80.00	.0197	.0181	.0165	.0150	.0136	.0123	.0111	.0100	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 70.00	.0214	.0188	.0166	.0146	.0130	.0116	.0106	.0097	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 60.00	.0203	.0180	.0158	.0139	.0123	.0108	.0096	.0087	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 50.00	.0192	.0159	.0134	.0114	.0098	.0085	.0075	.0068	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 40.00	.0121	.0092	.0073	.0061	.0051	.0044	.0038	.0034	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 30.00	.0246	.0162	.0116	.0092	.0075	.0062	.0053	.0046	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 20.00	.2176	.1093	.0628	.0453	.0340	.0264	.0213	.0179	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 10.00	.5484	.3452	.2143	.1445	.1029	.0774	.0606	.0491	0.0000	0.0000	0.00 Y 0.00 Z
Y 70.00 Z 0.00	.7498	.5143	.3740	.2892	.2229	.1713	.1332	.1080	0.0000	0.0000	0.00 Y 0.00 Z

END OF RUN 78/02/06 09.18.46

```
     FULL  DAYFILE.  78/02/04. 09.18.47.*09.17.52* PAGE    1
09.   52.JOB.TI320.
09.17.53.ACCOUNT.*CFB(A).*.
09.17.53.COMMENT.?120212012
09.17.53.COMMENT.CHARGE THIS JOH FOR PRINTING ONL
09.17.53.*
09.17.54.ATTACH(TAPE1=CANDLEN/M=R)
09.17.54.REQUEST(TAPE2=LIGHTIT)
09.17.55.REWIND(TAPE1.TAPE2)
09.17.55.CHARGE(LIGHTIT)
09.17.55.COPYSHF(TAPE2.OUTPUT)
09.17.56. END OF INFORMATION ENCOUNTERED.
09.17.56.REWIND(TAPE2)
09.17.56.REQUEST(LIGHTIO)
09.17.58.DEL(70000)
09.17.59.LIGHTIO(TAPE2)
09.18.01.  CM(WA+1 = 522464. LOADER USED  66600H
09.18.46.     STOP
09.18.46.     20.27H CP SECONDS EXECUTION TIME
09.18.46.DEL(10000)
09.18.47.RETURN(TAPE1.TAPE2.LIGHTIO)
09.18.47.CTIME      21.481 SECS.
09.18.47.DAYFILE.
```

```
00100 0000          1          1
00110       TF302A   4L:4W(12-POLE) (FWD 10)x(1) 4X15030  5400  MH40 - (021778)
00120       H150(65 F2          0.95          0.00          1.00
00130       0000000000
00500       H150(65 F2          0.00          0.00         40.00         20.00         60.00
00520       H150(65 F2          0.00          0.00         40.00         35.00         60.00
00530       H150(65 F2          0.00          0.00         40.00         70.00         60.00
00540       H150(65 F2          0.00          0.00         40.00        105.00         60.00
00550       H150(65 F2          0.00          0.00         40.00        140.00         60.00
00560       H150(65 F2          0.00          0.00         40.00        175.00         60.00
00570       H150(65 F2          0.00          0.00         40.00        210.00         60.00
00580       H150(65 F2          0.00          0.00         40.00        245.00         60.00
00590       H150(65 F2          0.00          0.00         40.00        280.00         60.00
00600       H150(65 F2        400.00          0.00         40.00         15.00         60.00
00610       H150(65 F2        400.00          0.00         40.00         70.00         60.00
00620       H150(65 F2        400.00          0.00         40.00        105.00         60.00
00630       H150(65 F2        400.00          0.00         40.00        140.00         60.00
00640       H150(65 F2        400.00          0.00         40.00        175.00         60.00
00650       H150(65 F2        400.00          0.00         40.00        210.00         60.00
00660       H150(65 F2        400.00          0.00         40.00        245.00         60.00
00670       H150(65 F2        400.00          0.00         40.00        280.00         60.00
00680       H150(65 F2        800.00          0.00         40.00         15.00         60.00
00690       H150(65 F2        800.00          0.00         40.00         70.00         60.00
00700       H150(65 F2        800.00          0.00         40.00        105.00         60.00
00710       H150(65 F2        800.00          0.00         40.00        140.00         60.00
00720       H150(65 F2        800.00          0.00         40.00        175.00         60.00
00730       H150(65 F2        800.00          0.00         40.00        210.00         60.00
00740       H150(65 F2        800.00          0.00         40.00        245.00         60.00
00750       H150(65 F2        800.00          0.00         40.00        280.00         60.00
00760       H150(65 F2       1200.00          0.00         40.00         15.00         60.00
00770       H150(65 F2       1200.00          0.00         40.00         70.00         60.00
00780       H150(65 F2       1200.00          0.00         40.00        105.00         60.00
00790       H150(65 F2       1200.00          0.00         40.00        140.00         60.00
00800       H150(65 F2       1200.00          0.00         40.00        175.00         60.00
00810       H150(65 F2       1200.00          0.00         40.00        210.00         60.00
00820       H150(65 F2       1200.00          0.00         40.00        245.00         60.00
00830       H150(65 F2       1200.00          0.00         40.00        280.00         60.00
00840       H150(65 F2       1200.00          0.00         40.00        315.00         60.00
00860       H150(65 F2          0.00        400.00         40.00         15.00         60.00
00870       H150(65 F2          0.00        400.00         40.00         70.00         60.00
00880       H150(65 F2          0.00        400.00         40.00        105.00         60.00
00890       H150(65 F2          0.00        400.00         40.00        140.00         60.00
00900       H150(65 F2          0.00        400.00         40.00        175.00         60.00
00910       H150(65 F2          0.00        400.00         40.00        210.00         60.00
00920       H150(65 F2          0.00        400.00         40.00        245.00         60.00
00930       H150(65 F2          0.00        400.00         40.00        280.00         60.00
00940       H150(65 F2        400.00        400.00         40.00         15.00         60.00
00950       H150(65 F2        400.00        400.00         40.00         70.00         60.00
00960       H150(65 F2        400.00        400.00         40.00        105.00         60.00
00970       H150(65 F2        400.00        400.00         40.00        140.00         60.00
00980       H150(65 F2        400.00        400.00         40.00        175.00         60.00
00990       H150(65 F2        400.00        400.00         40.00        210.00         60.00
01000       H150(65 F2        400.00        400.00         40.00        245.00         60.00
```



● = 8 - 150 W floods per pole

= Normal pattern plus 1 150W supplemental unit

90°
180° 0°
270°
Horiz. Aiming Convention

⇩ = Photometer Direction of Readings

ATTACHMENT 20
20-1

01010	H15C065GE2	400.00	400.00	40.00	345.00	60.00
01020	H15C065GE2	800.00	400.00	40.00	15.00	60.00
01030	H15C065GE2	800.00	400.00	40.00	75.00	60.00
01040	H15C065GE2	800.00	400.00	40.00	105.00	60.00
01050	H15C065GE2	800.00	400.00	40.00	165.00	60.00
01060	H15C065GE2	800.00	400.00	40.00	195.00	60.00
01070	H15C065GE2	800.00	400.00	40.00	255.00	60.00
01080	H15C065GE2	800.00	400.00	40.00	285.00	60.00
01090	H15C065GE2	800.00	400.00	40.00	345.00	60.00
01100	H15C065GE2	1200.00	400.00	40.00	15.00	60.00
01110	H15C065GE2	1200.00	400.00	40.00	75.00	60.00
01120	H15C065GE2	1200.00	400.00	40.00	105.00	60.00
01130	H15C065GE2	1200.00	400.00	40.00	165.00	60.00
01140	H15C065GE2	1200.00	400.00	40.00	195.00	60.00
01150	H15C065GE2	1200.00	400.00	40.00	255.00	60.00
01160	H15C065GE2	1200.00	400.00	40.00	285.00	60.00
01170	H15C065GE2	1200.00	400.00	40.00	345.00	60.00
01180	H15C065GE2	0.00	800.00	40.00	135.00	60.00
01200	H15C065GE2	0.00	800.00	40.00	15.00	60.00
01210	H15C065GE2	0.00	800.00	40.00	75.00	60.00
01220	H15C065GE2	0.00	800.00	40.00	105.00	60.00
01230	H15C065GE2	0.00	800.00	40.00	165.00	60.00
01240	H15C065GE2	0.00	800.00	40.00	195.00	60.00
01250	H15C065GE2	0.00	800.00	40.00	255.00	60.00
01260	H15C065GE2	0.00	800.00	40.00	285.00	60.00
01270	H15C065GE2	0.00	800.00	40.00	345.00	60.00
01280	H15C065GE2	400.00	800.00	40.00	15.00	60.00
01290	H15C065GE2	400.00	800.00	40.00	75.00	60.00
01300	H15C065GE2	400.00	800.00	40.00	105.00	60.00
01310	H15C065GE2	400.00	800.00	40.00	165.00	60.00
01320	H15C065GE2	400.00	800.00	40.00	195.00	60.00
01330	H15C065GE2	400.00	800.00	40.00	255.00	60.00
01340	H15C065GE2	400.00	800.00	40.00	285.00	60.00
01350	H15C065GE2	400.00	800.00	40.00	345.00	60.00
01360	H15C065GE2	800.00	800.00	40.00	15.00	60.00
01370	H15C065GE2	800.00	800.00	40.00	75.00	60.00
01380	H15C065GE2	800.00	800.00	40.00	105.00	60.00
01390	H15C065GE2	800.00	800.00	40.00	165.00	60.00
01400	H15C065GE2	800.00	800.00	40.00	195.00	60.00
01410	H15C065GE2	800.00	800.00	40.00	255.00	60.00
01420	H15C065GE2	800.00	800.00	40.00	285.00	60.00
01430	H15C065GE2	800.00	800.00	40.00	345.00	60.00
01440	H15C065GE2	1200.00	800.00	40.00	15.00	60.00
01450	H15C065GE2	1200.00	800.00	40.00	75.00	60.00
01460	H15C065GE2	1200.00	800.00	40.00	105.00	60.00
01470	H15C065GE2	1200.00	800.00	40.00	165.00	60.00
01480	H15C065GE2	1200.00	800.00	40.00	195.00	60.00
01490	H15C065GE2	1200.00	800.00	40.00	255.00	60.00
01500	H15C065GE2	1200.00	800.00	40.00	285.00	60.00

Luminaire H15CQ65GE2:
General Electric Cat # C525G306
1510W Quartz iodine floodlight
NEMA 6x5 beam pattern

2-82

```
01510      MISC(65-F2   1200.00    400.00     40.00     345.00     50.00
01520      MISC(65-F2   1200.00    400.00     40.00      65.00     50.00
01540      9999999999
02000  1     -400.00    -400.00       3.00   1600.00   1200.00      3.00
02010              11           V     270.00      0.00      0.00      0.00
02020  2     -400.00    -400.00       3.00   1600.00   1200.00      3.00
02030              11           V     180.00      0.00      0.00      0.00
02040  3     -400.00    -400.00       0.50   1600.00   1200.00      0.50
02050              11           V       0.00      0.00      0.00      0.00
02054  4     -400.00    -400.00       3.00   1600.00   1200.00      3.00
02056              11           V     225.00      0.00      0.00      0.00
02060  5      375.00     350.00       3.00    700.00    640.00      3.00
02070              14           V     270.00      0.00      0.00      0.00
02080  6      400.00     400.00       3.00    600.00    600.00      3.00
02090               9           V     270.00      0.00      0.00      0.00
02100  7      375.00     350.00       3.00    700.00    640.00      3.00
02110              14           V     150.00      0.00      0.00      0.00
02120  8      375.00     350.00       0.50    700.00    640.00      0.50
02130              14           V       0.00      0.00      0.00      0.00
02140  9      400.00     750.00       3.00    625.00   1320.00      3.00
02150              10           V     270.00      0.00      0.00      0.00
02160  10     400.00    1000.00       0.00    600.00   1000.00    120.00
02170               9           V     270.00    600.00   1000.00      0.00
02180  11     400.00     750.00       0.00    600.00   1040.00    120.00
02190              14           V       0.00    600.00   1040.00      0.00
02200  12    1100.00     750.00       3.00   1575.00   1040.00      3.00
02210              20           V     270.00      0.00      0.00      0.00
02220      9999999999
```

FMG - VFC 270° ⇓

FMG - VFC 180° ⇐

FMG - HFC

FMG - VFC 225° ⇙

GA" - VFC 270° ⇓

TG - VFC 270° ⇓

GA - VFC 150° ⇐

GA - HFC

GB - VFC 270° ⇓

Vertical Grid - VFC 270° ⇓
@ Y = 1000'

Vertical Grid VFC 0° ⇒
@ X = 600'

GC - VFC 270° ⇓

```
TF302R   *LISTING(12-MOLE) (END SINGLE PASS00)  S400  0440 = (        78/02/17  09.09.09  PAGE     1

ISW1 =  1  1=PRINT CANDLEPOWER TABLES
ISW2 =  1  1=DISK DIRECTORY PRINT
ISW3 =  0  1=PRINT EACH POINT AFTER CALCULATION
ISW4 =  0  1=PRINT + ZERO GRID AFTER EACH LIGHT
ISW5 =  0  1=PRINT ALL CANDLEPOWER TABLES
ISW6 =  0  1=USE TS PAGE CHANGES

IOEV1 =  1  CANDLEPOWER TABLES
IOEV2 = 99  VERSION INPUT
IOEV3 =  0
IOEV4 =  0
IOEV5 =  0
IOEV6 =  0
```

E 02

NO.	LUMID	NO.	LUMID	NO.	LUMID	NO.	LUMID
1	H15C065GE3	2	H500065GE2	3	V250S3M1E1	4	V180L4S4E1
5	V180L4M4E2	6	H15C065L01	7	H15C065401	8	V35WL4MN01
9	V55W045N01	10	H10C576CH1	11	V150S4LL01	12	H15C0656E2
13	H40C565N01	14	H180176E01	15	H10C575F01	16	H10C576CH2
17	H400564CH1	18	V10C576CH1	19	H20X576B01	20	H300065GE1
21	H400576SY1	22	H250576EE1	23	H15C066GE1	24	H400S75XE1
25	H300056WG2	26	H400S55F01	27	H250S75WE1	28	H400S22H01
29	H250S76GE1	30	V400S[illegible]6E1	31	V10C550GE1	32	H10C565H01
33	V250S3WGE2	34	V250S[illegible]WE1	35	V250S3MWE1	36	V400S4M4E1
37	V400[illegible]3WG1	38	V150S3W6E1	39	H15C064L01	40	H15C062GE1
41	H15C[illegible]46E1	42	H15C[illegible]56E1	43	H15C062GE2	44	H400S76CH1
45	H400S76SE1	46	H400S44SE1	47	H400S55XE1	48	H400S625E1
49	H400S62SSE1	50	H135L75SE1	51	H40L575SE1	52	H180L75SE1
53	H250S65WE1	54	H10C576WE1	55	V1H0L6WVL1	56	V400S4LAE1
57	H400S67CH1	58	H250S66H01	59	V10C565H01	60	V250S4LAE1
61	H400S65WE1	62	H15C065GE4	63	V250S3M6E1	64	V180L4S0U1
65	V1H0L4MLU1	66	H500055L01	67	V180L4M4E1	68	V180L4S0U2

INPUT Data - DEPRECIATION FACTORS

LUMID	DLAMP	DOIPT	OTHER
H15C065GE2	.9500	.8500	1.0000

20-04

LUMINAIRE POSITION AND AIMING DATA

UNIT NO	LUMINAIRE IDCODE	X-COORD	Y-COORD	Z-COORD	HORZ ANGLE	VERT ANGLE
1	DP5	0.00	0.00	40.00	225.00	60.00
2	DP5	0.00	0.00	40.00	15.00	60.00
3	DP5	0.00	0.00	40.00	75.00	60.00
4	DP5	0.00	0.00	40.00	105.00	60.00
5	DP5	0.00	0.00	40.00	165.00	60.00
6	DP5	0.00	0.00	40.00	195.00	60.00
7	DP5	0.00	0.00	40.00	255.00	60.00
8	DP5	0.00	0.00	40.00	285.00	60.00
9	DP5	0.00	0.00	40.00	345.00	60.00
10	DP5	400.00	0.00	40.00	15.00	60.00
11	DP5	400.00	0.00	40.00	75.00	60.00
12	DP5	400.00	0.00	40.00	105.00	60.00
13	DP5	400.00	0.00	40.00	165.00	60.00
14	DP5	400.00	0.00	40.00	195.00	60.00
15	DP5	400.00	0.00	40.00	255.00	60.00
16	DP5	400.00	0.00	40.00	285.00	60.00
17	DP5	400.00	0.00	40.00	345.00	60.00
18	DP5	800.00	0.00	40.00	15.00	60.00
19	DP5	800.00	0.00	40.00	75.00	60.00
20	DP5	800.00	0.00	40.00	105.00	60.00
21	DP5	800.00	0.00	40.00	165.00	60.00
22	DP5	800.00	0.00	40.00	195.00	60.00
23	DP5	800.00	0.00	40.00	255.00	60.00
24	DP5	800.00	0.00	40.00	285.00	60.00
25	DP5	800.00	0.00	40.00	345.00	60.00
26	DP5	1200.00	0.00	40.00	15.00	60.00
27	DP5	1200.00	0.00	40.00	75.00	60.00
28	DP5	1200.00	0.00	40.00	105.00	60.00
29	DP5	1200.00	0.00	40.00	165.00	60.00
30	DP5	1200.00	0.00	40.00	195.00	60.00
31	DP5	1200.00	0.00	40.00	255.00	60.00
32	DP5	1200.00	0.00	40.00	285.00	60.00
33	DP5	1200.00	0.00	40.00	345.00	60.00
34	DP5	1200.00	0.00	40.00	315.00	60.00
35	DP5	0.00	400.00	40.00	15.00	60.00
36	DP5	0.00	400.00	40.00	75.00	60.00
37	DP5	0.00	400.00	40.00	105.00	60.00
38	DP5	0.00	400.00	40.00	165.00	60.00
39	DP5	0.00	400.00	40.00	195.00	60.00
40	DP5	0.00	400.00	40.00	255.00	60.00
41	DP5	0.00	400.00	40.00	285.00	60.00
42	DP5	0.00	400.00	40.00	345.00	60.00
43	DP5	400.00	400.00	40.00	15.00	60.00
44	DP5	400.00	400.00	40.00	75.00	60.00
45	DP5	400.00	400.00	40.00	105.00	60.00

20-5

LUMINAIRE POSITION AND AIMING DATA

UNIT NO	LUMINAIRE TYCODE	X-COORD	Y-COORD	Z-COORD	HORZ ANGLE	VERT ANGLE
46	OPS	400.00	400.00	40.00	165.00	60.00
47	OPS	400.00	400.00	40.00	195.00	60.00
48	OPS	400.00	400.00	40.00	255.00	60.00
49	OPS	400.00	400.00	40.00	285.00	60.00
50	OPS	400.00	400.00	40.00	345.00	60.00
51	OPS	800.00	400.00	40.00	15.00	60.00
52	OPS	800.00	400.00	40.00	75.00	60.00
53	OPS	800.00	400.00	40.00	105.00	60.00
54	OPS	800.00	400.00	40.00	165.00	60.00
55	OPS	800.00	400.00	40.00	195.00	60.00
56	OPS	800.00	400.00	40.00	255.00	60.00
57	OPS	800.00	400.00	40.00	285.00	60.00
58	OPS	800.00	400.00	40.00	345.00	60.00
59	OPS	1200.00	400.00	40.00	15.00	60.00
60	OPS	1200.00	400.00	40.00	75.00	60.00
61	OPS	1200.00	400.00	40.00	105.00	60.00
62	OPS	1200.00	400.00	40.00	165.00	60.00
63	OPS	1200.00	400.00	40.00	195.00	60.00
64	OPS	1200.00	400.00	40.00	255.00	60.00
65	OPS	1200.00	400.00	40.00	285.00	60.00
66	OPS	1200.00	400.00	40.00	345.00	60.00
67	OPS	0.00	800.00	40.00	135.00	60.00
68	OPS	0.00	800.00	40.00	15.00	60.00
69	OPS	0.00	800.00	40.00	75.00	60.00
70	OPS	0.00	800.00	40.00	105.00	60.00
71	OPS	0.00	800.00	40.00	165.00	60.00
72	OPS	0.00	800.00	40.00	195.00	60.00
73	OPS	0.00	800.00	40.00	255.00	60.00
74	OPS	0.00	800.00	40.00	285.00	60.00
75	OPS	0.00	800.00	40.00	345.00	60.00
76	OPS	400.00	800.00	40.00	15.00	60.00
77	OPS	400.00	800.00	40.00	75.00	60.00
78	OPS	400.00	800.00	40.00	105.00	60.00
79	OPS	400.00	800.00	40.00	165.00	60.00
80	OPS	400.00	800.00	40.00	195.00	60.00
81	OPS	400.00	800.00	40.00	255.00	60.00
82	OPS	400.00	800.00	40.00	285.00	60.00
83	OPS	400.00	800.00	40.00	345.00	60.00
84	OPS	800.00	800.00	40.00	15.00	60.00
85	OPS	800.00	800.00	40.00	75.00	60.00
86	OPS	800.00	800.00	40.00	105.00	60.00
87	OPS	800.00	800.00	40.00	165.00	60.00
88	OPS	800.00	800.00	40.00	195.00	60.00
89	OPS	800.00	800.00	40.00	255.00	60.00
90	OPS	800.00	800.00	40.00	285.00	60.00

2-82

LUMINAIRE POSITION AND AIMING DATA

UNIT NO	LUMINAIRE IDCODE	X-COORD	Y-COORD	Z-COORD	HORZ ANGLE	VERT ANGLE
91	005	800.00	400.00	40.00	345.00	60.00
92	005	1200.00	400.00	40.00	15.00	60.00
93	005	1200.00	800.00	40.00	75.00	60.00
94	005	1200.00	800.00	40.00	105.00	60.00
95	005	1200.00	800.00	40.00	165.00	60.00
96	005	1200.00	800.00	40.00	195.00	60.00
97	005	1200.00	800.00	40.00	255.00	60.00
98	005	1200.00	800.00	40.00	285.00	60.00
99	005	1200.00	800.00	40.00	345.00	60.00
100	005	1200.00	800.00	40.00	45.00	60.00

CANDLEPOWER TABLE - LUMINAIRE CODE: H15C0653E2 TABLE NO. 12

HORZ. ANGLES (H 18 19)

VERT.	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
-68.0	0	0	69	103	172	241	275	275	334
	334	275	275	241	172	103	69	0	0
-60.0	69	69	103	172	241	275	344	344	413
	413	344	344	275	241	172	103	69	69
-52.0	69	103	172	241	275	344	413	413	447
	447	413	413	344	275	241	172	103	69
-44.0	138	550	1410	2477	3440	3764	4369	4094	4575
	4575	4094	4369	3764	3440	2477	1410	550	138
-36.0	241	963	2236	3440	4541	4850	5538	5263	5814
	5814	5263	5538	4850	4541	3440	2236	963	241
-28.0	413	1376	2993	4782	6020	6536	7396	7086	7878
	7878	7086	7396	6536	6020	4782	2993	1376	413
-20.0	516	1720	4059	6467	8256	9288	10458	10354	11180
	11180	10354	10458	9288	8256	6467	4059	1720	516
-12.0	482	1995	5022	8462	11490	13554	15446	15377	16478
	16478	15377	15446	13554	11490	8462	5022	1995	482
-4.0	585	2546	6605	11627	15962	18954	21844	21741	23323
	23323	21741	21844	18954	15962	11627	6605	2546	585
4.0	516	2408	6605	11352	15755	18886	21810	21913	23667
	23667	21913	21810	18886	15755	11352	6605	2408	516
12.0	516	2167	5470	8944	11937	13966	15962	15962	16994
	16994	15962	15962	13966	11937	8944	5470	2167	516
20.0	447	1720	4094	6605	8566	9598	10870	10733	11455
	11455	10733	10870	9598	8566	6605	4094	1720	447
28.0	378	1410	3098	4919	6192	6777	7774	7465	8153
	8153	7465	7774	6777	6192	4919	3098	1410	378
36.0	241	1032	2167	3574	4644	4988	5745	5401	6054
	6054	5401	5745	4988	4644	3578	2167	1032	241

CANDLEPOWER TABLE - LUMINAIRE CODE: HISCH65GE2 TABLE NO. 12

VERT.	HORZ. ANGLES (H 1H 1H) 22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
44.0	172	550	1479	2546	3612	3853	4472	4162	3990
	3990	4162	4472	3853	3612	2546	1479	550	172
52.0	69	103	172	241	275	344	413	413	516
	516	413	413	344	275	241	172	103	69
60.0	69	69	103	172	241	275	344	334	447
	447	334	344	275	241	172	103	69	69
68.0	0	0	69	103	172	241	275	275	413
	413	275	275	241	172	103	69	0	0

TEST GRID POSITION AND SIZE - TEST GRID 1

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
-400.00	-400.00	3.00	1600.00	1200.00	3.00

NUMX	NUMYZ	TCOMP	HMETER	XGRID3	YGRID3	ZGRID3
11	9	Y	270.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 17.5815909544
NUMBER OF POINTS = 99.0000000000

AVERAGE FOOTCANDLES = .1775918278
UNIFORMITY RATIO = 0.0000000000

MAXIMUM FOOTCANDLES = .7162238576
MINIMUM FOOTCANDLES = 0.0000000000

20-10

TEST GRID 1 COORDINATES OF CORNER 1 -400.00 -400.00 3.00
COORDINATES OF CORNER 2 1600.00 1200.00 3.00
COORDINATES OF CORNER 3 1600.00 -400.00 3.00
COORDINATES OF CORNER 4 -400.00 1200.00 3.00

	X -400.00	X -200.00	X 0.00	X 200.00	X 400.00	X 600.00	X 800.00	X 1000.00	X 1200.00	X 1400.00	
Y 1200.00	.1033	.1783	.2242	.2369	.2407	.2559	.2408	.2387	.2242	.1782	1200.00 Y
Z 3.00											3.00 Z
Y 1000.00	.1134	.3161	.7159	.4354	.6300	.4562	.6298	.4354	.7162	.3160	1000.00 Y
Z 3.00											3.00 Z
Y 800.00	.0701	.1267	.1717	.2099	.2120	.2266	.2120	.2098	.1716	.1264	800.00 Y
Z 3.00											3.00 Z
Y 600.00	.0765	.2182	.5378	.3546	.5996	.4154	.5904	.3946	.5381	.2182	600.00 Y
Z 3.00											3.00 Z
Y 400.00	.0426	.0899	.1270	.1559	.1558	.1677	.1558	.1565	.1270	.0896	400.00 Y
Z 3.00											3.00 Z
Y 200.00	.0409	.1443	.4687	.3132	.5016	.3220	.5016	.3132	.4687	.1643	200.00 Y
Z 3.00											3.00 Z
Y 0.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z 3.00											3.00 Z
Y -200.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-200.00 Y
Z 3.00											3.00 Z
Y -400.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-400.00 Y
Z 3.00											3.00 Z

full mobile grid - V... 2...

11-82

TEST GRID 1 COORDINATES OF CORNER 1 -400.00 -400.00 3.00
COORDINATES OF CORNER 2 1600.00 1200.00 3.00
COORDINATES OF CORNER 3 1600.00 -400.00 3.00
COORDINATES OF CORNER 4 -400.00 1200.00 3.00

	X 1600.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00
Y 1200.00 Z 3.00	.1033	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 1000.00 Z 3.00	.1142	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 800.00 Z 3.00	.0700	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 600.00 Z 3.00	.0768	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 400.00 Z 3.00	.0424	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 200.00 Z 3.00	.0418	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 0.00 Z 3.00	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y -200.00 Z 3.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y -400.00 Z 3.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z

TF3029 ALIMR(12-POLE) (END ADJ+4L) 6X15000 S400 MH40 = (78/02/17 09.09.08 PAGE 11

TEST GRID POSITION AND SIZE - TEST GRID 2

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
-400.00	-400.00	3.00	1200.00	1200.00	3.00

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
11	9	V	100.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 18.082818181485
NUMBER OF POINTS = 99.0000000000

AVERAGE FOOTCANDLES = .1825656630H
UNIFORMITY RATIO = 0.0000000000

MAXIMUM FOOTCANDLES = .7241478185
MINIMUM FOOTCANDLES = 0.0000000000

41-02

TEST GRID 2 COORDINATES OF CORNER 1 -400.00 -400.00 3.00
COORDINATES OF CORNER 2 1600.00 1200.00 3.00
COORDINATES OF CORNER 3 1600.00 -400.00 3.00
COORDINATES OF CORNER 4 -400.00 1200.00 3.00

	X -400.00	X -200.00	X 0.00	X 200.00	X 400.00	X 600.00	X 800.00	X 1000.00	X 1200.00	X 1400.00	
Y 1200.00	0.0000	0.0000	.0000	.0403	.0415	.0743	.0672	.0947	.0832	.1228	1200.00 Y
Z 3.00											3.00 Z
Y 1000.00	0.0000	0.0000	.0000	.1634	.0883	.2151	.1226	.2400	.1414	.3251	1000.00 Y
Z 3.00											3.00 Z
Y 800.00	0.0000	0.0000	.0000	.4673	.1245	.5332	.1655	.5618	.1065	.7238	800.00 Y
Z 3.00											3.00 Z
Y 600.00	0.0000	0.0000	.0000	.3108	.1526	.3412	.2006	.4235	.2235	.4407	600.00 Y
Z 3.00											3.00 Z
Y 400.00	0.0000	0.0000	.0000	.4969	.1482	.5778	.1974	.6109	.2208	.6282	400.00 Y
Z 3.00											3.00 Z
Y 200.00	0.0000	0.0000	.0000	.3108	.1522	.3412	.2005	.4235	.2235	.4407	200.00 Y
Z 3.00											3.00 Z
Y 0.00	0.0000	0.0000	.0000	.4673	.1245	.5335	.1655	.5622	.1866	.7241	0.00 Y
Z 3.00											3.00 Z
Y -200.00	0.0000	0.0000	.0000	.1634	.0879	.2151	.1225	.2400	.1413	.3252	-200.00 Y
Z 3.00											3.00 Z
Y -400.00	0.0000	0.0000	.0000	.0413	.0415	.0747	.0672	.0950	.0833	.1231	-400.00 Y
Z 3.00											3.00 Z

FMG - VFC
1E10 4

X1-02

TEST GRID 2 COORDINATES OF CORNER 1 -600.00 -400.00 3.00
COORDINATES OF CORNER 2 1600.00 1200.00 3.00
COORDINATES OF CORNER 3 1600.00 -400.00 3.00
COORDINATES OF CORNER 4 -600.00 1200.00 3.00

		X 1600.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	1200.00	.1040	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	1000.00	.1635	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	800.00	.2274	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	600.00	.2368	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	400.00	.2341	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	200.00	.2386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	0.00	.2275	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-200.00	.1835	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-400.00	.1041	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

51-02

TEST GRID POSITION AND SIZE - TEST GRID)

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
-600.00	-400.00	.50	1600.00	1200.00	.50

NMAX	NUMYZ	ICOMP	SMETER	XGRID3	YGRID3	ZGRID3
11	9	0	0.00	6.00	0.00	0.00

TOTAL FOOTCANDLES = 29.24404453439
NUMBER OF POINTS = 99.00000000000

AVERAGE FOOTCANDLES = .2953944777
UNIFORMITY RATIO = 39.16636643393

MAXIMUM FOOTCANDLES = 1.941442433
MINIMUM FOOTCANDLES = .0077496529

TEST GRID 3 COORDINATES OF CORNER 1 -400.00 -400.00 .50
COORDINATES OF CORNER 2 1600.00 1200.00 .50
COORDINATES OF CORNER 3 1600.00 -400.00 .50
COORDINATES OF CORNER 4 -400.00 1200.00 .50

	X -400.00	X -200.00	X 0.00	X 200.00	X 400.00	X 600.00	X 800.00	X 1000.00	X 1200.00	X 1400.00	
Y 1200.00 Z .50	.0077	.0146	.0186	.0193	.0194	.0207	.0194	.0194	.0186	.0146	1200.00 Y .50 Z
Y 1000.00 Z .50	.0145	.0519	.1310	.0703	.1096	.0728	.1095	.0703	.1311	.0519	1000.00 Y .50 Z
Y 800.00 Z .50	.0184	.1309	1@9484	.1959	1@7465	.1992	1@7465	.1959	1@9484	.1309	800.00 Y .50 Z
Y 600.00 Z .50	.0149	.0698	.1955	.1320	.2101	.1361	.2100	.1320	.1955	.0698	600.00 Y .50 Z
Y 400.00 Z .50	.0184	.1083	1@7452	.2090	1@7593	.2130	1@7593	.2090	1@7452	.1083	400.00 Y .50 Z
Y 200.00 Z .50	.0198	.0698	.1955	.1320	.2100	.1461	.2101	.1320	.1955	.0698	200.00 Y .50 Z
Y 0.00 Z .50	.0184	.1309	1@9484	.1959	1@7465	.1992	1@7465	.1959	1@9484	.1309	0.00 Y .50 Z
Y -200.00 Z .50	.0145	.0519	.1311	.0703	.1095	.0728	.1096	.0703	.1310	.0519	-200.00 Y .50 Z
Y -400.00 Z .50	.0077	.0146	.0186	.0194	.0194	.0207	.0194	.0193	.0186	.0146	-400.00 Y .50 Z

EMG - HFC

20-12

TEST GRID 3 COORDINATES OF CORNER 1 -400.00 -400.00 .50
COORDINATES OF CORNER 2 1600.00 1200.00 .50
COORDINATES OF CORNER 3 1600.00 -400.00 .50
COORDINATES OF CORNER 4 -400.00 1200.00 .50

	X 1600.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y 1200.00	.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y 1000.00	.0145	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y 800.00	.0184	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y 600.00	.0188	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y 400.00	.0184	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y 200.00	.0169	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y 0.00	.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y -200.00	.0145	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z
Y -400.00	.0077	0.0000	0.0000	0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z .50											0.00 Z

8-02

TEST GRID POSITION AND SIZE - TEST GRID -

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
-400.00	-400.00	3.00	1600.00	1200.00	3.00

NUMX	NUMYZ	ICOMP	DMETER	XGRID3	YGRID3	ZGRID3
11	9	9	22-.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 19.1470749227
NUMBER OF POINTS = 99.0000000000

AVERAGE FOOTCANDLES = .1934008578
UNIFORMITY RATIO = 0.0000000000

MAXIMUM FOOTCANDLES = .6064117163
MINIMUM FOOTCANDLES = 0.0000000000

20-19

TEST GRID 4 COORDINATES OF CORNER 1 -400.00 -400.00 3.00
COORDINATES OF CORNER 2 1600.00 1200.00 3.00
COORDINATES OF CORNER 3 1600.00 -400.00 3.00
COORDINATES OF CORNER 4 -400.00 1200.00 3.00

	X -400.00	X -200.00	X 0.00	X 200.00	X 400.00	X 600.00	X 800.00	X 1000.00	X 1200.00	X 1400.00	
Y 1200.00	.0102	.0544	.1099	.1397	.1574	.1862	.1885	.2065	.2174	.2128	1200.00 Y
Z 3.00											3.00 Z
Y 1000.00	.0107	.0250	.4500	.2788	.4573	.3384	.4941	.3620	.6064	.4534	1000.00 Y
Z 3.00											3.00 Z
Y 800.00	.0053	.0360	.0792	.4282	.2000	.4931	.2394	.5181	.2532	.6014	800.00 Y
Z 3.00											3.00 Z
Y 600.00	.0053	.0159	.3330	.2545	.4573	.3255	.4969	.3519	.5100	.3497	600.00 Y
Z 4.00											3.00 Z
Y 400.00	.0000	.0242	.0605	.3999	.1653	.4568	.2000	.4802	.2166	.4682	400.00 Y
Z 3.00											3.00 Z
Y 200.00	0.0000	.0000	.3029	.2118	.3999	.2595	.4283	.2788	.4422	.2893	200.00 Y
Z 3.00											3.00 Z
Y 0.00	0.0000	0.0000	0.0000	.3029	.0605	.3331	.0792	.3469	.0998	.4585	0.00 Y
Z 4.00											3.00 Z
Y -200.00	0.0000	0.0000	0.0000	0.0000	.0242	.0159	.0361	.0250	.0437	.0315	-200.00 Y
Z 3.00											3.00 Z
Y -400.00	0.0000	0.0000	0.0000	0.0000	0.0000	.0055	.0053	.0109	.0103	.0154	-400.00 Y
Z 3.00											3.00 Z

20-20

TEST GRID 4 COORDINATES OF CORNER 1 -400.00 -400.00 3.00
COORDINATES OF CORNER 2 1200.00 1200.00 3.00
COORDINATES OF CORNER 3 1600.00 -400.00 3.00
COORDINATES OF CORNER 4 -400.00 1200.00 3.00

	X 1600.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y 1200.00	.1501	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y 1000.00	.2105	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y 800.00	.2103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y 600.00	.1928	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y 400.00	.1655	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y 200.00	.1496	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y 0.00	.1167	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y -200.00	.0599	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z
Y -400.00	.0143	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z 3.00											0.00 Z

12-21

TEST GRID POSITION AND SIZE - TEST GRID 5

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
375.00	380.00	3.00	700.00	640.00	3.00

NUMX	NUMY	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
14	14	V	270.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 187.6641427985
NUMBER OF POINTS = 196.0000000000

AVERAGE FOOTCANDLES = .9574701163
UNIFORMITY RATIO = 6.1[illegible]4426116

MAXIMUM FOOTCANDLES = 6.7975445889
MINIMUM FOOTCANDLES = .1558016528

P-22

TEST PATH 5 COORDINATES OF CORNER 1 375.00 380.00 3.00
COORDINATES OF CORNER 2 700.00 640.00 3.00
COORDINATES OF CORNER 3 700.00 380.00 3.00
COORDINATES OF CORNER 4 375.00 640.00 3.00

	X 375.00	X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	
Y 640.00	.4341	.4395	.4426	.4418	.4350	.4233	.4045	.3923	.3794	.3764	640.00 Y
Z 3.00											3.00 Z
Y 620.00	.5045	.5015	.5073	.5040	.4454	.4703	.4513	.4230	.4031	.3960	620.00 Y
Z 3.00											3.00 Z
Y 600.00	.5934	.5906	.6012	.5885	.5691	.5268	.4939	.4556	.4280	.4154	600.00 Y
Z 3.00											3.00 Z
Y 580.00	.7313	.7207	.7342	.7133	.6645	.6062	.5406	.4868	.4511	.4423	580.00 Y
Z 3.00											3.00 Z
Y 560.00	.9259	.9109	.9284	.8913	.7999	.6925	.5967	.5154	.4771	.4691	560.00 Y
Z 3.00											3.00 Z
Y 540.00	1.2220	1.2033	1.2246	1.1497	.9743	.8023	.6474	.5478	.5034	.4824	540.00 Y
Z 3.00											3.00 Z
Y 520.00	1.7127	1.7107	1.7120	1.5563	1.2198	.9229	.7076	.5810	.5052	.4911	520.00 Y
Z 3.00											3.00 Z
Y 500.00	2.5764	2.6392	2.5754	2.1640	1.5572	1.0554	.7642	.5832	.5013	.4735	500.00 Y
Z 3.00											3.00 Z
Y 480.00	4.0406	4.0092	4.0442	3.0307	1.8890	1.1862	.7805	.5670	.4737	.4457	480.00 Y
Z 3.00											3.00 Z
Y 460.00	5.7335	6.0269	5.7370	3.8886	2.2275	1.2310	.7353	.5145	.4218	.3922	460.00 Y
Z 3.00											3.00 Z
Y 440.00	5.9569	6.1975	5.9605	4.1240	2.1137	1.0534	.6091	.4257	.3457	.3240	440.00 Y
Z 3.00											3.00 Z
Y 420.00	3.8788	3.2266	3.8826	2.7222	1.3705	.6591	.3998	.3011	.2585	.2466	420.00 Y
Z 3.00											3.00 Z
Y 400.00	.1561	.1558	.1549	.1622	.1653	.1661	.1676	.1690	.1688	.1677	400.00 Y
Z 3.00											3.00 Z
Y 380.00	.1683	.1684	.1723	.1746	.1776	.1784	.1793	.1806	.1805	.1797	380.00 Y
Z 3.00											3.00 Z

Test Grid Limits

UCL

1.0 PC

LCL

Grid "A"

* Val corresponding to 5% Voltage dr. in supply circuit to lamp

TEST GRID 5 COORDINATES OF CORNER 1 375.00 380.00 3.00
COORDINATES OF CORNER 2 700.00 640.00 3.00
COORDINATES OF CORNER 3 700.00 380.00 3.00
COORDINATES OF CORNER 4 375.00 640.00 3.00

	X 625.00	X 650.00	X 675.00	X 700.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y 640.00 Z 3.00	.3794	.3983	.4045	.4233	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 620.00 Z 3.00	.4031	.4186	.4451	.4685	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 600.00 Z 3.00	.4288	.4556	.4849	.5251	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 580.00 Z 3.00	.4511	.4845	.5310	.5969	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 560.00 Z 3.00	.4742	.5140	.5948	.6819	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 540.00 Z 3.00	.5005	.5478	.6474	.8023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 520.00 Z 3.00	.5109	.5810	.7076	.9226	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 500.00 Z 3.00	.5058	.5908	.7640	1.0562	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 480.00 Z 3.00	.4737	.5731	.7601	1.1870	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 460.00 Z 3.00	.4215	.5192	.7431	1.2319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 440.00 Z 3.00	.3454	.4254	.6102	1.0575	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 420.00 Z 3.00	.2586	.3018	.3996	.6593	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 400.00 Z 3.00	.1688	.1707	.1691	.1661	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 380.00 Z 3.00	.1823	.1427	.1613	.1784	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z

TEST GRID POSITION AND SIZE - TEST GRID 6

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
400.00	400.00	3.00	600.00	600.00	3.00

NUMX	NUMYZ	ICOMP	XMETER	XGRID3	YGRID3	ZGRID3
9	11	V	270.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 120.4654446126
NUMBER OF POINTS = 99.0000000000

VFC
② 270°

AVERAGE FOOTCANDLES = 1.2166226729
UNIFORMITY RATIO = 7.8100755074

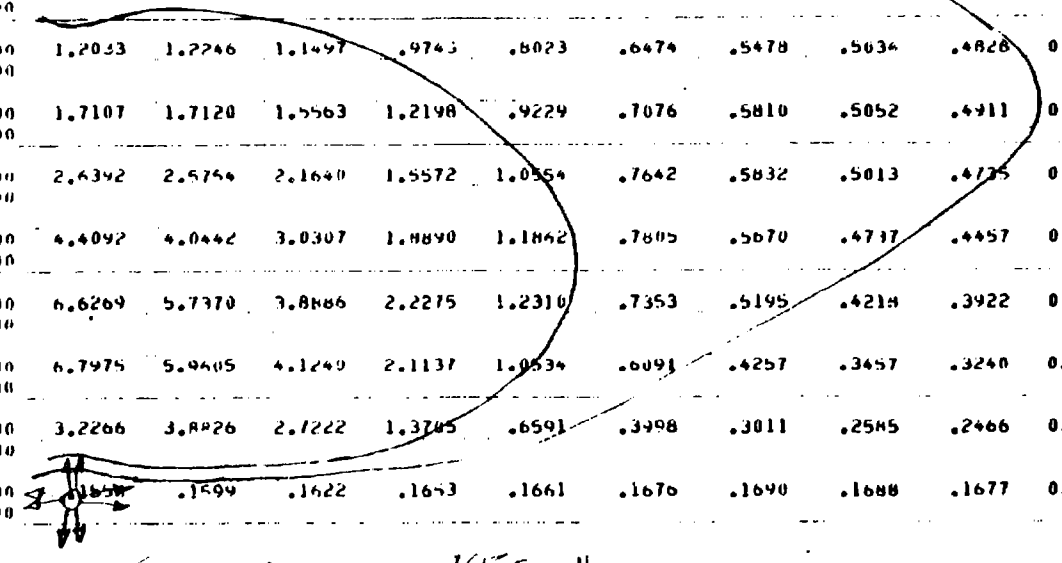
MAXIMUM FOOTCANDLES = 6.7975445869
MINIMUM FOOTCANDLES = .1558016528

Note: Uniformity would be much lower if both the 270° grid and the 180° grid (G7) were considered together.

52-02

TEST GRID 6 COORDINATES OF CORNER 1 400.00 400.00 3.00
COORDINATES OF CORNER 2 600.00 600.00 3.00
COORDINATES OF CORNER 3 600.00 400.00 3.00
COORDINATES OF CORNER 4 400.00 600.00 3.00

		X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	X 0.00	
Y	600.00	.5906	.6012	.5845	.5691	.5268	.4939	.4556	.4240	.4154	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	580.00	.7207	.7342	.7133	.6845	.6062	.5406	.4868	.4511	.4423	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	560.00	.9109	.9284	.8913	.7899	.6925	.5967	.5164	.4771	.4691	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	540.00	1.2033	1.2246	1.1497	.9743	.8023	.6474	.5478	.5034	.4828	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	520.00	1.7107	1.7120	1.5563	1.2198	.9229	.7076	.5810	.5052	.4911	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	500.00	2.6342	2.5764	2.1640	1.5572	1.0554	.7642	.5832	.5013	.4775	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	480.00	4.4092	4.0442	3.0307	1.8890	1.1842	.7805	.5870	.4737	.4457	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	460.00	6.6269	5.7370	3.8886	2.2275	1.2310	.7353	.5195	.4218	.3922	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	440.00	6.7975	5.9405	4.1249	2.1137	1.0534	.6091	.4257	.3457	.3240	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	420.00	3.2286	3.8826	2.7222	1.3705	.6591	.3998	.3011	.2585	.2466	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	400.00	.1550	.1599	.1622	.1653	.1661	.1676	.1690	.1688	.1677	0.0000	0.00 Y
Z	3.00											0.00 Z



TEST GRID - VIEW 270°

TEST GRID POSITION AND SIZE - TEST GRID 7

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
375.00	340.00	3.00	700.00	640.00	3.00

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
14	14	V	1.00.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 148.0863964493
NUMBER OF POINTS = 196.0000000000

AVERAGE FOOTCANDLES = .8575530349
UNIFORMITY RATIO = 5.7850664038

MAXIMUM FOOTCANDLES = 7.1562211739
MINIMUM FOOTCANDLES = .1482361549

77-02

TEST GRID 7 COORDINATES OF CORNER 1 375.00 380.00 3.00
COORDINATES OF CORNER 2 700.00 640.00 3.00
COORDINATES OF CORNER 3 700.00 380.00 3.00
COORDINATES OF CORNER 4 375.00 640.00 3.00

	X 375.00	X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	
Y 640.00	.1659	.1518	.2879	.4109	.4876	.5191	.5186	.4858	.4488	.4151	640.00 Y
Z 3.00											3.00 Z
Y 620.00	.1672	.1523	.2592	.3566	.4323	.4691	.4777	.4628	.4284	.3978	620.00 Y
Z 3.00											3.00 Z
Y 600.00	.1680	.1526	.2502	.3403	.4156	.4529	.4608	.4547	.4268	.3917	600.00 Y
Z 3.00											3.00 Z
Y 580.00	.1694	.1545	.2604	.3592	.4351	.4763	.4826	.4629	.4320	.4016	580.00 Y
Z 3.00											1.00 Z
Y 560.00	.1726	.1578	.2925	.4160	.4932	.5315	.5246	.4889	.4549	.4286	560.00 Y
Z 3.00											1.00 Z
Y 540.00	.1738	.1581	.3569	.5240	.6169	.6344	.5965	.5419	.4961	.4634	540.00 Y
Z 3.00											1.00 Z
Y 520.00	.1727	.1572	.4848	.7477	.8270	.7939	.7084	.6271	.5395	.4757	520.00 Y
Z 3.00											1.00 Z
Y 500.00	.1714	.1554	.7618	1.1616	1.2043	1.0418	.8775	.7138	.6018	.5077	500.00 Y
Z 3.00											1.00 Z
Y 480.00	.1712	.1551	1.3689	1.9493	1.7708	1.4199	1.1489	.8241	.6812	.5648	480.00 Y
Z 3.00											1.00 Z
Y 460.00	.1703	.1543	2.4766	3.2575	2.7283	1.9139	1.2989	.9459	.7193	.5664	460.00 Y
Z 3.00											1.00 Z
Y 440.00	.1656	.1503	3.7748	5.1019	3.8020	2.3541	1.4917	1.0249	.7447	.5811	440.00 Y
Z 3.00											1.00 Z
Y 420.00	.1643	.1488	4.8017	6.6449	4.6667	2.6041	1.5627	1.0519	.7611	.5847	420.00 Y
Z 3.00											1.00 Z
Y 400.00	.1644	.1482	4.2267	7.1562	4.8964	2.6284	1.5482	1.0293	.7498	.5778	400.00 Y
Z 3.00											1.00 Z
Y 380.00	.1673	.1512	4.0040	6.5510	4.6685	2.6013	1.5574	1.0526	.7623	.5858	380.00 Y
Z 3.00											1.00 Z

0.47 1.0 FS

Grid "A" - VFC, -180°

TEST GRID 7 COORDINATES OF CORNER 1 375.00 380.00 3.00
COORDINATES OF CORNER 2 700.00 440.00 3.00
COORDINATES OF CORNER 3 700.00 380.00 3.00
COORDINATES OF CORNER 4 375.00 440.00 3.00

		X 625.00	X 650.00	X 675.00	X 700.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	640.00	.3772	.3438	.3147	.2836	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	620.00	.3679	.3401	.3137	.2850	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	600.00	.3663	.3412	.3146	.2858	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	580.00	.3717	.3405	.3144	.2884	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	560.00	.3806	.3477	.3188	.2909	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	540.00	.3999	.3586	.3265	.2942	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	520.00	.4195	.3703	.3334	.2944	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	500.00	.4398	.3845	.3388	.3019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	480.00	.4580	.3928	.3414	.3016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	460.00	.4642	.3936	.3453	.3049	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	440.00	.4731	.3997	.3467	.3045	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	420.00	.4719	.3926	.3393	.2993	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	400.00	.4709	.3996	.3453	.3030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	380.00	.4739	.4000	.3456	.3034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID POSITION AND SIZE - TEST GRID H

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
375.00	380.00	.50	700.00	640.00	.50

NMAX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
14	14	H	0.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 166.378[illegible]319426
NUMBER OF POINTS = 196.0000000000

AVERAGE FOOTCANDLES = .0484721[illegible]15
UNIFORMITY RATIO = 6.237143[illegible]497

MAXIMUM FOOTCANDLES = 6.234037[illegible]38
MINIMUM FOOTCANDLES = .1366[illegible]073

TEST GRID "A" COORDINATES OF CORNER 1 375.00 380.00 .50
COORDINATES OF CORNER 2 700.00 640.00 .50
COORDINATES OF CORNER 3 700.00 380.00 .50
COORDINATES OF CORNER 4 375.00 640.00 .50

	X 375.00	X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	
Y 640.00 Z .50	.2761	.2721	.2767	.2675	.2404	.2098	.1845	.1618	.1489	.1467	640.00 Y .50 Z
Y 620.00 Z .50	.2275	.2238	.2280	.2225	.2092	.1888	.1719	.1543	.1427	.1389	620.00 Y .50 Z
Y 600.00 Z .50	.2136	.2101	.2140	.2091	.1991	.1818	.1667	.1529	.1413	.1361	600.00 Y .50 Z
Y 580.00 Z .50	.2285	.2248	.2290	.2233	.2100	.1918	.1722	.1551	.1438	.1400	580.00 Y .50 Z
Y 560.00 Z .50	.2783	.2740	.2786	.2693	.2425	.2140	.1870	.1638	.1518	.1489	560.00 Y .50 Z
Y 540.00 Z .50	.3816	.3754	.3821	.3612	.3102	.2583	.2106	.1796	.1651	.1582	540.00 Y .50 Z
Y 520.00 Z .50	.5927	.5956	.5916	.5401	.4284	.3238	.2499	.2046	.1793	.1716	520.00 Y .50 Z
Y 500.00 Z .50	1.0415	1.0719	1.0400	.8773	.6304	.4236	.3057	.2332	.1955	.1837	500.00 Y .50 Z
Y 480.00 Z .50	1.9601	2.1161	1.9602	1.4844	.9351	.5760	.3744	.2619	.2132	.1989	480.00 Y .50 Z
Y 460.00 Z .50	3.4661	4.0543	3.4663	2.4269	1.4307	.7889	.4464	.2958	.2289	.2093	460.00 Y .50 Z
Y 440.00 Z .50	4.9917	5.5934	4.9921	3.7012	1.9875	.9603	.5064	.3177	.2371	.2152	440.00 Y .50 Z
Y 420.00 Z .50	6.2336	5.0105	6.2340	4.4954	2.3808	1.0606	.5285	.3267	.2398	.2163	420.00 Y .50 Z
Y 400.00 Z .50	5.1771	4.0593	5.1775	4.8839	2.4747	1.0729	.5257	.3180	.2357	.2130	400.00 Y .50 Z
Y 380.00 Z .50	6.2336	5.0104	6.2340	4.4952	2.3805	1.0585	.5259	.3237	.2397	.2163	380.00 Y .50 Z

Grid "A" HFC

TEST GRID A COORDINATES OF CORNER 1 375.00 380.00 .50
COORDINATES OF CORNER 2 700.00 640.00 .50
COORDINATES OF CORNER 3 700.00 380.00 .50
COORDINATES OF CORNER 4 375.00 640.00 .50

	X 625.00	X 650.00	X 675.00	X 700.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y 640.00 Z .50	.1496	.1617	.1850	.2119	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 620.00 Z .50	.1427	.1541	.1712	.1908	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 600.00 Z .50	.1413	.1529	.1667	.1818	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 580.00 Z .50	.1436	.1554	.1729	.1898	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 560.00 Z .50	.1510	.1639	.1865	.2118	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 540.00 Z .50	.1646	.1803	.2106	.2543	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 520.00 Z .50	.1797	.2046	.2499	.3238	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 500.00 Z .50	.1976	.2332	.3057	.4236	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 480.00 Z .50	.2129	.2650	.3743	.5780	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 460.00 Z .50	.2286	.2955	.4509	.7889	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 440.00 Z .50	.2368	.3174	.5074	.9633	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 420.00 Z .50	.2397	.3237	.5259	1.0585	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 400.00 Z .50	.2357	.3180	.5257	1.0729	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z
Y 380.00 Z .50	.2348	.3267	.5285	1.0606	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y 0.00 Z

20-92

TEST GRID POSITION AND SIZE - TEST GRID 4

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
400.00	760.00	3.00	625.00	1320.00	3.00

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
10	28	V	270.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 180.6067054014
NUMBER OF POINTS = 280.0000000000

AVERAGE FOOTCANDLES = .6450239479
UNIFORMITY RATIO = 3.6112047055

MAXIMUM FOOTCANDLES = 6.8495731643
MINIMUM FOOTCANDLES = .1786173868

TEST GRID 9 COORDINATES OF CORNER 1 400.00 780.00 3.00
COORDINATES OF CORNER 2 525.00 1320.00 3.00
COORDINATES OF CORNER 3 625.00 780.00 3.00
COORDINATES OF CORNER 4 400.00 1320.00 3.00

	X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	Y 625.00	
Y 1320.00 Z 3.00	.1786	.1809	.1827	.1839	.1852	.1863	.1869	.1883	.1890	.1882	1320.00 Y 3.00 Z
Y 1300.00 Z 3.00	.1871	.1900	.1913	.1929	.1944	.1948	.1962	.1978	.1983	.1978	1300.00 Y 3.00 Z
Y 1280.00 Z 3.00	.1959	.1993	.2003	.2026	.2044	.2053	.2066	.2079	.2082	.2079	1280.00 Y 3.00 Z
Y 1260.00 Z 3.00	.2055	.2091	.2113	.2133	.2152	.2169	.2185	.2188	.2188	.2185	1260.00 Y 3.00 Z
Y 1240.00 Z 3.00	.2160	.2199	.2224	.2248	.2269	.2291	.2311	.2305	.2299	.2302	1240.00 Y 3.00 Z
Y 1220.00 Z 3.00	.2276	.2320	.2351	.2386	.2396	.2423	.2443	.2433	.2426	.2431	1220.00 Y 3.00 Z
Y 1200.00 Z 3.00	.2407	.2461	.2491	.2529	.2545	.2564	.2580	.2575	.2559	.2573	1200.00 Y 3.00 Z
Y 1180.00 Z 3.00	.2565	.2618	.2647	.2687	.2701	.2714	.2730	.2726	.2716	.2741	1180.00 Y 3.00 Z
Y 1160.00 Z 3.00	.2747	.2801	.2824	.2857	.2871	.2903	.2891	.2882	.2885	.2906	1160.00 Y 3.00 Z
Y 1140.00 Z 3.00	.2954	.3010	.3033	.3044	.3067	.3093	.3061	.3055	.3087	.3076	1140.00 Y 3.00 Z
Y 1120.00 Z 3.00	.3230	.3253	.3271	.3268	.3289	.3299	.3274	.3251	.3273	.3273	1120.00 Y 3.00 Z
Y 1100.00 Z 3.00	.3506	.3537	.3557	.3538	.3546	.3520	.3484	.3502	.3473	.3474	1100.00 Y 3.00 Z
Y 1080.00 Z 3.00	.3847	.3871	.3894	.3869	.3851	.3769	.3718	.3724	.3680	.3695	1080.00 Y 3.00 Z
Y 1060.00 Z 3.00	.4258	.4277	.4298	.4255	.4243	.4068	.4014	.3949	.3923	.3917	1060.00 Y 3.00 Z
Y 1040.00 Z 3.00	.4764	.4798	.4792	.4726	.4609	.4421	.4301	.4174	.4149	.4174	1040.00 Y 3.00 Z
Y 1020.00 Z 3.00	.5396	.5459	.5426	.5342	.5092	.4902	.4621	.4424	.4354	.4426	1020.00 Y 3.00 Z

20.34

GRID 9
VPC
270°

TEST GRID 9 COORDINATES OF CORNER 1 400.00 780.00 3.00
COORDINATES OF CORNER 2 625.00 1320.00 3.00
COORDINATES OF CORNER 3 625.00 780.00 3.00
COORDINATES OF CORNER 4 400.00 1320.00 3.00

	X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	X 625.00	
Y 1000.00	.6300	.6441	.6281	.6092	.5871	.5342	.4981	.4687	.4562	.4689	1000.00 Y
Z 3.00											3.00 Z
Y 980.00	.7613	.7754	.7547	.7060	.6478	.5824	.5288	.4932	.4847	.4934	980.00 Y
Z 3.00											3.00 Z
Y 960.00	.9529	.9711	.9342	.8331	.7356	.6400	.5598	.5207	.5131	.5181	960.00 Y
Z 3.00											3.00 Z
Y 940.00	1.2468	1.2487	1.1941	1.0191	.8469	.6923	.5928	.5488	.5281	.5466	940.00 Y
Z 3.00											3.00 Z
Y 920.00	1.7557	1.7578	1.6824	1.2662	.9695	.7541	.6278	.5523	.5382	.5580	920.00 Y
Z 3.00											3.00 Z
Y 900.00	2.6858	2.6227	2.2117	1.6054	1.1038	.8126	.6320	.5502	.5223	.5547	900.00 Y
Z 3.00											3.00 Z
Y 880.00	4.4575	4.0933	3.0801	1.9391	1.2365	.8309	.6176	.5244	.4964	.5244	880.00 Y
Z 3.00											3.00 Z
Y 860.00	6.6771	5.7879	3.9399	2.2795	1.2833	.7881	.5723	.4744	.4448	.4741	860.00 Y
Z 3.00											3.00 Z
Y 840.00	6.8496	6.0134	4.1774	2.1678	1.1077	.6640	.4806	.4004	.3786	.4008	840.00 Y
Z 3.00											3.00 Z
Y 820.00	3.2806	3.9375	2.7777	1.4267	.7149	.4569	.3583	.3156	.3033	.3154	820.00 Y
Z 3.00											3.00 Z
Y 800.00	.2120	.2170	.2200	.2237	.2252	.2271	.2286	.2281	.2266	.2279	800.00 Y
Z 3.00											3.00 Z
Y 780.00	.2269	.2318	.2347	.2386	.2399	.2412	.2427	.2423	.2413	.2439	780.00 Y
Z 3.00											3.00 Z

20-45

TEST GRID POSITION AND SIZE - TEST GRID 10

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
400.00	1000.00	0.00	600.00	1000.00	120.00

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
9	13	V	270.00	600.00	1000.00	0.00

TOTAL FOOTCANDLES = 41.639957166
NUMBER OF POINTS = 117.000000000

AVERAGE FOOTCANDLES = .3558971583
UNIFORMITY RATIO = 2.550682609

MAXIMUM FOOTCANDLES = .6617005065
MINIMUM FOOTCANDLES = .1395294531

96-02

TEST GRID 10 COORDINATES OF CORNER 1 400.00 1000.00 0.00
COORDINATES OF CORNER 2 600.00 1000.00 120.00
COORDINATES OF CORNER 3 600.00 1000.00 0.00
COORDINATES OF CORNER 4 400.00 1000.00 120.00

	X 400.00	X 425.00	X 450.00	X 475.00	X 500.00	X 525.00	X 550.00	X 575.00	X 600.00	X 0.00	
Y 1000.00	.1395	.1423	.1474	.1504	.1525	.1546	.1538	.1587	.1602	0.0000	0.00 Y
Z 120.00											0.00 Z
Y 1000.00	.1801	.1804	.1779	.1750	.1757	.1786	.1873	.1901	.1905	0.0000	0.00 Y
Z 110.00											0.00 Z
Y 1000.00	.2332	.2321	.2241	.2179	.2117	.2173	.2221	.2210	.2204	0.0000	0.00 Y
Z 100.00											0.00 Z
Y 1000.00	.2919	.2893	.2734	.2618	.2569	.2568	.2550	.2452	.2406	0.0000	0.00 Y
Z 90.00											0.00 Z
Y 1000.00	.3279	.3266	.3113	.3071	.2970	.2905	.2798	.2680	.2623	0.0000	0.00 Y
Z 80.00											0.00 Z
Y 1000.00	.3571	.3578	.3475	.3433	.3256	.3150	.3019	.2894	.2832	0.0000	0.00 Y
Z 70.00											0.00 Z
Y 1000.00	.3855	.3917	.3845	.3767	.3545	.3424	.3258	.3132	.3070	0.0000	0.00 Y
Z 60.00											0.00 Z
Y 1000.00	.4256	.4318	.4259	.4144	.3891	.3747	.3536	.3395	.3324	0.0000	0.00 Y
Z 50.00											0.00 Z
Y 1000.00	.4643	.4715	.4641	.4525	.4243	.4077	.3826	.3656	.3569	0.0000	0.00 Y
Z 40.00											0.00 Z
Y 1000.00	.4838	.4954	.4885	.4772	.4454	.4258	.3980	.3800	.3701	0.0000	0.00 Y
Z 30.00											0.00 Z
Y 1000.00	.5346	.5464	.5387	.5261	.4898	.4658	.4343	.4130	.4015	0.0000	0.00 Y
Z 20.00											0.00 Z
Y 1000.00	.5940	.5981	.5869	.5734	.5345	.5046	.4649	.4460	.4336	0.0000	0.00 Y
Z 10.00											0.00 Z
Y 1000.00	.6496	.6617	.6499	.6268	.5817	.5462	.5079	.4789	.4659	0.0000	0.00 Y
Z 0.00											0.00 Z

20-37

Vertical Grid @ Y = 1000 ft ; VFC @ 270° ⇓
(parallel to plane of "X" - "Z" coordinates)

TEST GRID POSITION AND SIZE - TEST GRID 11

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
600.00	760.00	0.00	600.00	1040.00	120.00

NUMX	NUMYZ	ICOMP	HMETER	XGRID3	YGRID3	ZGRID3
14	13	V	0.00	600.00	1040.00	0.00

TOTAL FOOTCANDLES = 41.5466864100
NUMBER OF POINTS = 182.0000000000

AVERAGE FOOTCANDLES = .2282773979
UNIFORMITY RATIO = 3.3902341243

MAXIMUM FOOTCANDLES = .5665816257
MINIMUM FOOTCANDLES = .0673338152

TEST GRID 11 COORDINATES OF CORNER 1 600.00 780.00 0.00
COORDINATES OF CORNER 2 600.00 1040.00 120.00
COORDINATES OF CORNER 3 600.00 1040.00 0.00
COORDINATES OF CORNER 4 600.00 780.00 120.00

		(780Y) X 600.00	(800Y) X 600.00	X 600.00	(840Y) X 600.00	X 600.00	(880Y) X 600.00	X 600.00	(920Y) X 600.00	X 600.00	(960Y) X 600.00	
Y	780.00	.0804	.0772	.0754	.0766	.0766	.0752	.0735	.0717	.0693	.0685	960.00 Y
Z	120.00											120.00 Z
Y	780.00	.1174	.1150	.1118	.1055	.0995	.0936	.0907	.0876	.0892	.0898	960.00 Y
Z	110.00											110.00 Z
Y	780.00	.1677	.1654	.1617	.1506	.1403	.1305	.1197	.1186	.1176	.1131	960.00 Y
Z	100.00											100.00 Z
Y	780.00	.2237	.2214	.2171	.1994	.1837	.1707	.1601	.1534	.1462	.1346	960.00 Y
Z	90.00											90.00 Z
Y	780.00	.2580	.2544	.2510	.2343	.2203	.2107	.1949	.1831	.1680	.1498	960.00 Y
Z	80.00											80.00 Z
Y	780.00	.2856	.2804	.2780	.2653	.2530	.2402	.2182	.2022	.1851	.1642	960.00 Y
Z	70.00											70.00 Z
Y	780.00	.3123	.3055	.3074	.2981	.2845	.2668	.2409	.2238	.2026	.1789	960.00 Y
Z	60.00											60.00 Z
Y	780.00	.3486	.3424	.3446	.3346	.3188	.2979	.2690	.2464	.2233	.1965	960.00 Y
Z	50.00											50.00 Z
Y	780.00	.3838	.3779	.3814	.3702	.3528	.3303	.2982	.2718	.2459	.2145	960.00 Y
Z	40.00											40.00 Z
Y	780.00	.4041	.3976	.4026	.3954	.3775	.3536	.3181	.2884	.2592	.2261	960.00 Y
Z	30.00											30.00 Z
Y	780.00	.4510	.4444	.4506	.4418	.4222	.3956	.3554	.3266	.2867	.2498	960.00 Y
Z	20.00											20.00 Z
Y	780.00	.5069	.5004	.4954	.4860	.4653	.4360	.3923	.3575	.3124	.2716	960.00 Y
Z	10.00											10.00 Z
Y	780.00	.5666	.5516	.5543	.5436	.5190	.4820	.4321	.3917	.3395	.2954	960.00 Y
Z	0.00											0.00 Z

20-37

Vertical grid @ x = 600 ft ; VFC @ 0° =>
(parallel to plane of Y "Z" coordinates)

TEST GRID II

COORDINATES OF CORNER 1	600.00	780.00	0.00
COORDINATES OF CORNER 2	600.00	1040.00	120.00
COORDINATES OF CORNER 3	600.00	1040.00	0.00
COORDINATES OF CORNER 4	600.00	780.00	120.00

(980y)x (1000y)x x (1040y)x

		600.00	600.00	600.00	600.00	0.00	0.00	0.00	0.00	0.00	0.00	
Y	980.00	.0701	.0499	.0490	.0673	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	120.00											0.00 Z
Y	980.00	.0878	.0648	.0617	.0746	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	110.00											0.00 Z
Y	980.00	.1065	.0805	.0750	.0677	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	100.00											0.00 Z
Y	980.00	.1194	.1093	.1017	.0952	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	90.00											0.00 Z
Y	980.00	.1329	.1199	.1108	.1029	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	80.00											0.00 Z
Y	980.00	.1451	.1301	.1193	.1099	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	70.00											0.00 Z
Y	980.00	.1584	.1417	.1293	.1184	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	60.00											0.00 Z
Y	980.00	.1733	.1541	.1398	.1273	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	50.00											0.00 Z
Y	980.00	.1881	.1661	.1502	.1363	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	40.00											0.00 Z
Y	980.00	.1971	.1728	.1556	.1405	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	30.00											0.00 Z
Y	980.00	.2160	.1893	.1688	.1517	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	20.00											0.00 Z
Y	980.00	.2348	.2041	.1821	.1631	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	10.00											0.00 Z
Y	980.00	.2532	.2199	.1952	.1742	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

CX-02

TEST GRID POSITION AND SIZE - TEST GRID 12

XGRID1	YGRID1	ZGRID1	XGRID2	YGRID2	ZGRID2
1100.00	760.00	3.00	1575.00	1040.00	3.00

NUMX	NUMYZ	ICOMP	HEIGHT	XGRID3	YGRID3	ZGRID3
20	14	V	270.00	0.00	0.00	0.00

TOTAL FOOTCANDLES = 258.1510044435
NUMBER OF POINTS = 280.0000000000

AVERAGE FOOTCANDLES = .9219678732
UNIFORMITY RATIO = 12.1637884559

MAXIMUM FOOTCANDLES = 8.6652705842
MINIMUM FOOTCANDLES = .3757911121

TEST GRID 12 COORDINATES OF CORNER 1 1100.00 780.00 3.00
COORDINATES OF CORNER 2 1575.00 1040.00 3.00
COORDINATES OF CORNER 3 1575.00 780.00 3.00
COORDINATES OF CORNER 4 1100.00 1040.00 3.00

	X 1100.00	X 1125.00	X 1150.00	X 1175.00	X 1200.00	X 1225.00	X 1250.00	X 1275.00	X 1300.00	X 1325.00	
Y 1040.00	.4334	.4515	.4734	.4947	.5100	.5177	.5095	.4880	.4572	.4118	1040.00 Y
Z 3.00											3.00 Z
Y 1020.00	.4784	.5137	.5412	.5745	.5957	.6105	.5972	.5694	.5218	.4666	1020.00 Y
Z 3.00											3.00 Z
Y 1000.00	.5371	.5900	.6341	.6867	.7162	.7427	.7191	.6747	.5973	.5206	1000.00 Y
Z 3.00											3.00 Z
Y 980.00	.6119	.6880	.7678	.8449	.8906	.9313	.8958	.8156	.7038	.5844	980.00 Y
Z 3.00											3.00 Z
Y 960.00	.6984	.8104	.9528	1.0776	1.1469	1.2054	1.1484	1.0005	.8254	.6659	960.00 Y
Z 3.00											3.00 Z
Y 940.00	.8126	.9794	1.2106	1.4312	1.5546	1.6246	1.5174	1.2541	.9847	.7506	940.00 Y
Z 3.00											3.00 Z
Y 920.00	.9356	1.2447	1.6162	1.9865	2.2567	2.3261	2.0939	1.5905	1.1694	.8481	920.00 Y
Z 3.00											3.00 Z
Y 900.00	1.0719	1.5778	2.2127	2.9174	3.4911	3.5977	2.9469	2.0651	1.3656	.9210	900.00 Y
Z 3.00											3.00 Z
Y 880.00	1.2054	1.9070	3.0813	4.3863	5.7063	5.7107	4.1567	2.5643	1.5459	.9471	880.00 Y
Z 3.00											3.00 Z
Y 860.00	1.2532	2.2458	3.9121	6.0782	8.2322	8.2575	5.5759	3.0394	1.5993	.9083	860.00 Y
Z 3.00											3.00 Z
Y 840.00	1.0817	2.1353	4.1383	6.2198	8.4083	8.6853	5.9647	2.9283	1.3925	.7399	840.00 Y
Z 3.00											3.00 Z
Y 820.00	.6871	1.3962	2.7428	3.9172	4.3390	5.4495	3.8542	1.8499	.8434	.4606	820.00 Y
Z 3.00											3.00 Z
Y 800.00	.1973	.1926	.1857	.1771	.1716	.1702	.1659	.1621	.1560	.1507	800.00 Y
Z 3.00											3.00 Z
Y 780.00	.2111	.2060	.1990	.1898	.1846	.1834	.1789	.1746	.1672	.1611	780.00 Y
Z 3.00											3.00 Z

Grid "C" V+C @ 270°

TEST GRID 12 COORDINATES OF CORNER 1 1100.00 780.00 3.00
COORDINATES OF CORNER 2 1575.00 1040.00 3.00
COORDINATES OF CORNER 3 1575.00 780.00 3.00
COORDINATES OF CORNER 4 1100.00 1040.00 3.00

	X 1350.00	X 1375.00	X 1400.00	X 1425.00	X 1450.00	X 1475.00	X 1500.00	X 1525.00	X 1550.00	X 1575.00	
Y 1040.00	.3687	.3245	.2861	.2498	.2242	.1967	.1754	.1564	.1400	.1265	1040.00 Y
Z 3.00											3.00 Z
Y 1020.00	.4031	.3499	.3014	.2604	.2295	.2019	.1761	.1570	.1408	.1277	1020.00 Y
Z 3.00											3.00 Z
Y 1000.00	.4426	.3765	.3150	.2733	.2366	.2030	.1782	.1580	.1411	.1271	1000.00 Y
Z 3.00											3.00 Z
Y 980.00	.4845	.3952	.3342	.2835	.2393	.2052	.1792	.1579	.1407	.1255	980.00 Y
Z 3.00											3.00 Z
Y 960.00	.5247	.4235	.3497	.2862	.2407	.2061	.1782	.1561	.1387	.1233	960.00 Y
Z 3.00											3.00 Z
Y 940.00	.5710	.4500	.3543	.2891	.2408	.2032	.1755	.1535	.1352	.1199	940.00 Y
Z 3.00											3.00 Z
Y 920.00	.6175	.4564	.3573	.2865	.2355	.1980	.1693	.1480	.1300	.1149	920.00 Y
Z 3.00											3.00 Z
Y 900.00	.6273	.4597	.3489	.2764	.2246	.1878	.1615	.1401	.1232	.1091	900.00 Y
Z 3.00											3.00 Z
Y 880.00	.6222	.4419	.3278	.2554	.2067	.1734	.1499	.1309	.1154	.1032	880.00 Y
Z 3.00											3.00 Z
Y 860.00	.5735	.3933	.2883	.2247	.1848	.1568	.1379	.1214	.1077	.0968	860.00 Y
Z 3.00											3.00 Z
Y 840.00	.4583	.3163	.2366	.1916	.1617	.1412	.1243	.1103	.0992	.0894	840.00 Y
Z 3.00											3.00 Z
Y 820.00	.3048	.2266	.1823	.1546	.1370	.1223	.1100	.0994	.0905	.0825	820.00 Y
Z 3.00											3.00 Z
Y 800.00	.1430	.1354	.1266	.1183	.1130	.1049	.0966	.0895	.0823	.0758	800.00 Y
Z 3.00											3.00 Z
Y 780.00	.1533	.1432	.1337	.1271	.1176	.1083	.0997	.0915	.0838	.0770	780.00 Y
Z 3.00											3.00 Z

```
    FULL  DAYFILE.  78/02/17. 09.34.55.*09.08.55* PAGE    1

09.08.55.JOB,T1320.
09.08.56.ACCOUNT,HCE0101,,.
09.08.56.COMMENT,712C212012
09.08.56.COMMENT,CHARGE THIS JOB FOR PRINTING ONL
09.08.56.Y
09.08.58.ATTACH(TAPE1=CANOGA/M=R)
09.08.59.SET(TAPE2=LIGHTIT)
09.09.00.REWIND(TAPE1,TAPE2)
09.09.01.PURGE(LIGHTIT)
09.09.01.COPYSBF(TAPE2,OUTPUT)
09.09.01. END OF INFORMATION ENCOUNTERED.
09.09.02.REWIND(TAPE2)
09.09.02.SET(LIGHTID)
09.09.03.SEL(70000)
09.09.03.LIGHTID(TAPE2)
09.09.09.  CM(MAX) = 522464, LOADER USED  66600B
09.34.54.    STOP
09.34.54.    427.05] CP SECONDS EXECUTION TIME
09.34.54.SEL(10000)
09.34.54.RETURN(TAPE1,TAPE2,LIGHTID)
09.34.55.CTIME     428.646 SECS.
09.34.55.DAYFILE.
```

11-02

SAC-NR-76-02

PERIMETER LIGHTING PROBLEM -- METHODOLOGY

RICHARD A. JOURDAN AND FRANCIS J. O'MEARA

14 OCTOBER 1976

OFFICE OF SCIENCE AND RESEARCH (NR)
HEADQUARTERS STRATEGIC AIR COMMAND
OFFUTT AIR FORCE BASE, NEBRASKA 68113

ATTACHMENT 21
P 21-1

PREFACE

Perimeter lighting of a guarded area is used as a nighttime aid in the detection and prevention of unauthorized entry. Because of increased energy costs, it is important to design these lighting systems to meet specified illumination levels at near minimum operating costs as well as at low acquisition costs.

The analysis was conducted in response to a request from the Design and Construction Management Division under the Deputy Chief of Staff, Engineering and Services (CINCSAC/DE), of Headquarters, Strategic Air Command, U. S. Air Force.

The objective of the analysis was to explore methodology for determining luminaire location, height, and aiming direction parameters for use in cost comparisons. This analysis was directed at a practical solution to the perimeter lighting problem and does not employ sophisticated mathematical methods such as nonlinear optimization techniques. Basic assumptions required for simplified computations are analyzed in the report, and mathematical formulations of the perimeter lighting problem are given in the report annexes.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PERIMETER LIGHTING PROBLEM -- METHODOLOGY

1. BACKGROUND

a. The electrical lighting systems which provide perimeter lighting for security purposes at numerous DoD installations are to be redesigned. A detailed study is underway to derive "lighting arrangements that would best meet the prescribed illumination requirements, both photometrically and economically." The U.S. Army Engineer District, Omaha, Corps of Engineers, has produced a draft study[1] fully describing the parameters of the problem and preliminary results from which the above quoted objective is abstracted.

b. CINCSAC/DE has requested NR to explore methodology to address perimeter lighting within the following ground rules:

(1) The constraint of minimum light inside the fence would be dealt with by shielding and thus need not be addressed.

(2) The lighting solution can be examined with respect to a straight fence (effect of corners negligible.)

(3) Target for solution should be within one to two percent.

(4) Solutions for a pole height of 15 feet and below should be addressed first.

(5) Adaptation to a fixed pole height of 15 feet should be examined later.

(6) Only the case of the single fence should be addressed.

(7) The purpose of assistance is to examine methodology only.

(8) The problem of area lighting, also treated in the draft study, was not at this time included in the NR task.

c. Two complementary approaches to the problem were taken. The first approach examined the problem analytically to uncover any general considerations of importance and to reduce, if possible, the number of variables that had to be examined. The second approach developed computational methods, short of complex nonlinear optimization techniques, to calculate the near-best solution over at least some of the critical

---

[1] Draft Lighting Study Security Systems Modifications, U.S. Army Engineer District, Omaha, Corps of Engineers, Omaha, Nebraska, December 1975

incident light performance factors. ANNEX A provides formulas for calculating incident light, and ANNEX C provides an interpolation method for deriving precise angular luminaire output.

2. SIMPLIFIED GEOMETRY

a. In order to simplify the analysis, all angles are defined in terms of their horizontal and vertical component angles. There are three types of angles considered: offset angles, luminaire aiming angles, and luminaire candle power angles. These are defined for a luminaire, a luminaire pole line, and a constraint line parallel to the pole line along which lighting requirements must be satisfied. (See Figure 1.)

(1) Horizontal Offset Angle θ

The angle formed by a line from the luminaire and perpendicular to a constraint line and a line from the luminaire to a point of interest on the constraint line, as projected on a plane parallel to the ground.

(2) Horizontal Aiming Angle θ_A

The angle formed by a line from the luminaire and perpendicular to a constraint line and a line from the luminaire in the direction that the luminaire aiming vector is pointed, as projected on a plane parallel to the ground.

(3) Horizontal Beam Angle θ_L

The angle formed by the luminaire aiming vector and a line from the luminaire to a point of interest on the constraint line, as projected on a plane parallel to the ground. The luminaire aiming vector is normally in the direction of greatest luminaire candle power intensity.

b. From the above definition, it follows that

$$\theta_L = \theta - \theta_A \qquad \text{----------} \qquad (1)$$

c. Luminaire candle power is defined in terms of luminaire beam angles. Let $F(\theta_L, \gamma_L)$ denote the luminaire candle power for a luminaire horizontal beam angle of θ_L and a luminaire vertical beam angle of γ_L. Using Equation (1) above, we can derive luminaire candle power in the offset direction of interest

$$f(\theta, \gamma) = F(\theta - \theta_A, \gamma - \gamma_A) \qquad \text{----------} \qquad (2)$$

GEOMETRY OF ANGLES ON THE

HORIZONTAL PLANE

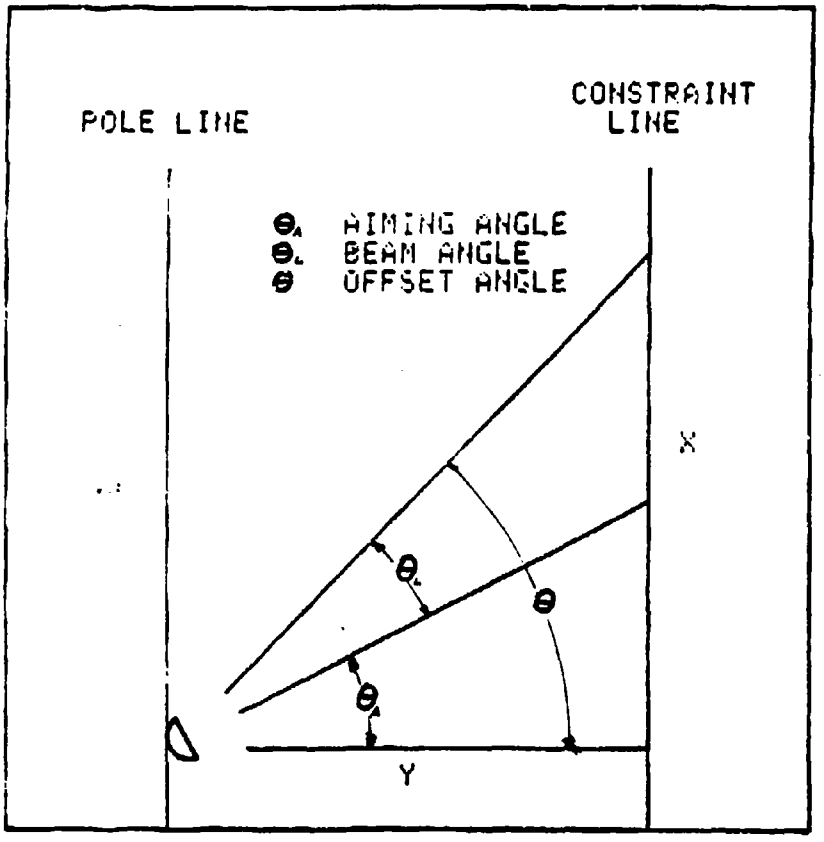


FIGURE 1

d. When we consider only the effects of candle power in the horizontal plane for a luminaire with horizontal aiming angle equal to zero, Equation (2) is simplified

$$f(\theta) = F(\theta) \qquad \text{----------} \qquad (3)$$

so that the luminaire candle power in the horizontal offset direction of interest can be expressed directly in terms of the luminaire candle power.

e. We can now write a simplified equation of foot candles incident to the vertical surface through the constraint line as a function of horizontal offset angle. Let $I(\theta)$ denote the component of luminaire candle power incident to the vertical constraint surface and $g(\theta)$ denote foot candles. Then,

$$g(\theta) = \frac{f(\theta) \cdot I(\theta)}{d^2} \qquad \text{----------} \qquad (4)$$

where

$$d = y \sec \theta \qquad \text{----------} \qquad (5)$$

and

$$I(\theta) = \cos \theta \qquad \text{----------} \qquad (6)$$

so that

$$g(\theta) = \frac{f(\theta) \cos^3 \theta}{y^2} \qquad \text{----------} \qquad (7)$$

f. The constraint lines run parallel to the fence and line of lighting poles. The constraint lines, lighting pole line and distance constraints are shown in Figure 2.

g. Analogous definitions can be made for vertical offset angle γ, vertical aiming angle γ_A and vertical beam angle γ_L. Most of the following discussions are in terms of horizontal angles. Hence, detailed definitions of vertical angles are omitted here.

3. MAXIMUM POLE SPACING

a. There are certain discrete combinations of lighting equipments that can be compared in the lighting problem. These consist of luminaire type/luminaire wattage and number of luminaires on a lighting

PERIMETER LIGHTING

GEOMETRIC CONSTRAINTS

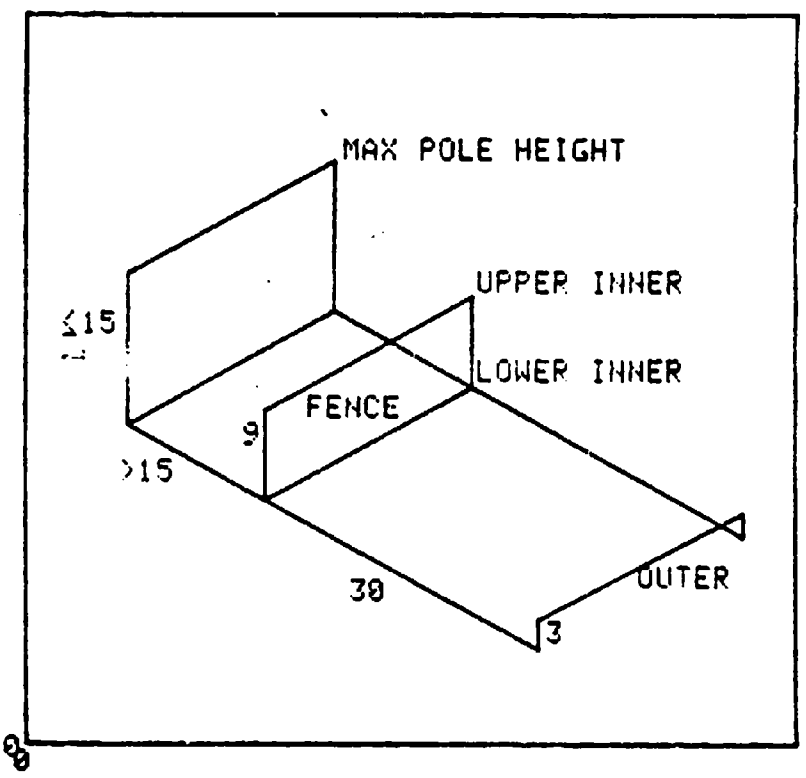


FIGURE 2

pole. Let us define these combinations as luminaire configurations. There are also luminaire arrangements describing where the luminaires are located and pointed. These variables are continuous and include distance the lighting poles are behind the fence and are apart, the height of the luminaires on the pole, and the angle the luminaires are aimed. Let us define these as arrangement variables.

b. Pole spacing is defined as the distance between poles such that lighting requirements are met everywhere along the constraint lines. For instance, if the lighting requirement was satisfied at horizontal offset distances out to a hundred feet except for an interval between 40 and 50 feet, the pole spacing would be 40 feet. In order to insure that this definition was met, a procedure was adopted to test the lighting requirements by incrementing offset distance successively from zero offset to larger offsets.

c. A luminaire configuration can have a multitude of arrangements. For any two arrangements that meet the lighting requirements, the lower cost arrangement is the one that has the larger pole spacing. It should be noted that this principle is independent of the cost of pole installation. From this principle our efforts were directed in finding a method for deriving a maximum pole spacing arrangement for a luminaire configuration. Once this methodology is obtained, a best arrangement solution can be obtained for each luminaire configuration. The installation and 10-year operating cost of each luminaire configuration can then be computed directly and compared.

d. By this procedure, cost factors can be applied after the search for the best lighting arrangement, greatly simplifying the problem.

4. MEASURE OF LIGHTING EFFICIENCY

a. The luminaire candle power required to satisfy the lighting constraints depends on luminaire distance and direction to the vertical surface along the constraint. Writing the equation for incident foot candles defined in paragraph 2e, we have

$$g(\theta) = \frac{f(\theta)\cos^3\theta}{y^2} \qquad \text{----------} \qquad (8)$$

Setting $g(\theta) = C$, a particular constraint requirement, and solving for $f(\theta)$, we have

$$f(\theta) = \frac{C \cdot y^2}{\cos^3\theta} \qquad \text{----------} \qquad (9)$$

2'-1

b. The candle power required to satisfy a constraint in constant foot candles increases with offset angle θ as shown below

$$R(\theta) \sim \frac{1}{\cos^3 \theta} \qquad \text{----------} \qquad (10)$$

The pole spacing achieved for a given pole distance and offset angle is proportional to tan θ:

$$P(\theta) \sim \tan \theta \qquad \text{----------} \qquad (11)$$

A measure of lighting efficiency is the pole spacing achieved per required candle power:

$$M(\theta) \sim P(\theta)/R(\theta) \qquad \text{----------} \qquad (12)$$

Substituting Equations (10) and (11) in Equation (12), we get

$$M(\theta) \sim \tan \theta \cos^3 \theta \qquad \text{----------} \qquad (13)$$

c. The graph of Equation (13) is given in Figure 3. Lighting efficiency peaks at a horizontal offset angle of about 35^0. This suggests that adding light intensity until the constraint is met at approximately 35^0 is efficient. Adding light intensity to meet the constraint beyond 35^0 is inefficient. (See Figure 3.) Since luminaire wattages are discrete values, it is not always possible to satisfy the constraint near 35^0. The most efficient use of lighting would then be the discrete value of lighting available that yields the highest value or is closest to the peak.

d. Equation (13) should not be used for calculating pole spacing. Its use is restricted, being affected by beam pattern, wattage cost, discrete wattages, aiming angle, etc. However, it is given to provide some objective guidance to what is intuitively apparent, i.e., it is wasteful to over-illuminate in the center in an effort to extend the offset.

Note: The most efficient pole spacing in terms of our restrictive measure can be derived by setting $M'\theta = 0$, solving for θ, and then converting from offset angle θ to pole distance $2Y \tan \theta$.

$$M(\theta) = \cos^3 \theta \tan \theta$$

$$M'(\theta) = \cos^3 \theta - 2 \sin^2 \cos \theta = 0$$

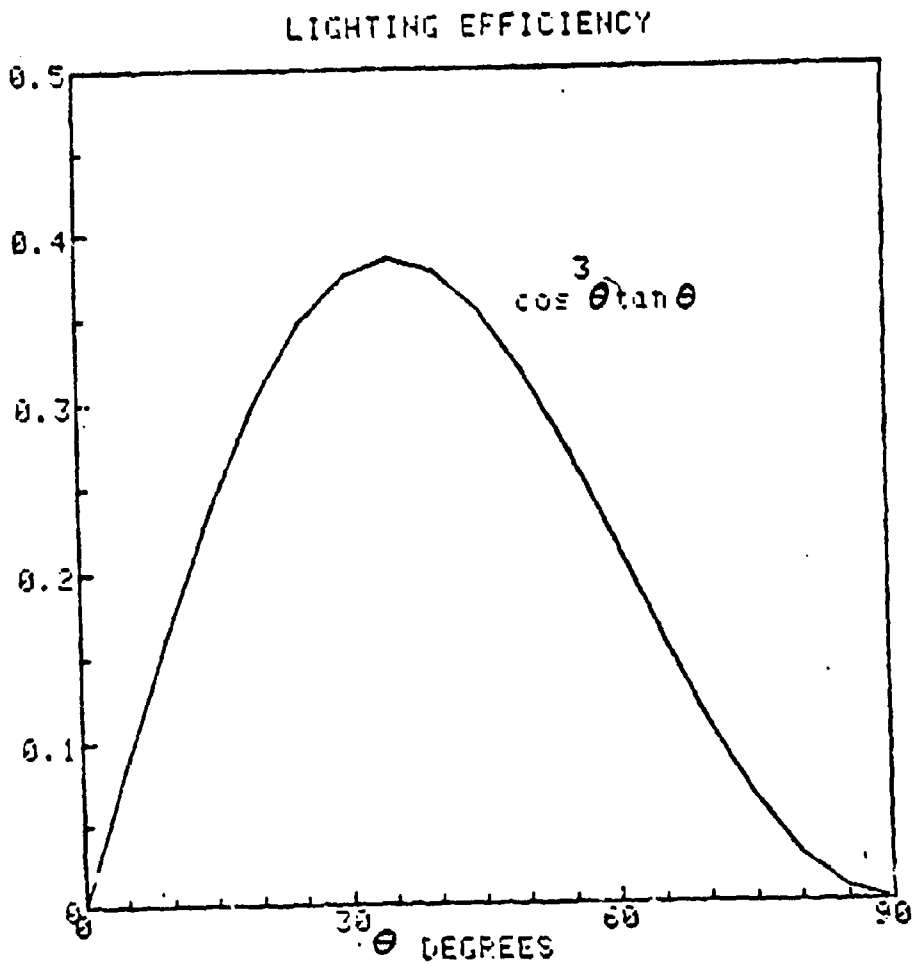

LIGHTING EFFICIENCY
0.5
0.4
0.3
0.2
0.1
0
30
60
90
θ DEGREES
cos³θtanθ

FIGURE 3

Substituting $1 - \sin^2 \theta$ for $\cos^2 \theta$ we have,

$$\sin^2 \theta = 1/3$$

$$\theta = 35^0\ 16'$$

$$2\ Y \tan \theta = 1.155\ y.$$

Hence, maximum lighting efficiency is achieved when pole spacing is slightly greater than pole distance to the lighting constraint.

5. WHEN TO ADD LUMINAIRES

The last section suggests that it sometimes might be more efficient to add luminaires than to increase pole spacing. As indicated, this would be when the incident light from a single luminaire yielded a very small pole spacing. A guide for adding luminaires can be obtained directly by comparing the incident light from one luminaire at an offset X, to that of two luminaires at an offset 2X, and to that of three luminaires at an offset 3X, etc. There is a range of offset X for which the greatest incident light is provided by 1 luminaire, 2 luminaires, 3 luminaires, etc. The smaller the offset X achieved by one luminaire, the greater the number of luminaires are required to provide the maximum pole spacing. Figure 4 illustrates this fact for 1 through 4 luminaires. The solid portion of each curve depicts when and how many luminaires would yield the greatest pole spacing per luminaire. For very narrow angle luminaires, it might be impractical to add luminaires. However, for any luminaire we can at least deduce the general rule that luminaires should not be added if the pole space achieved by a single luminaire is greater than the pole distance Y.

6. LIGHTING PARAMETERS

a. So far we have examined pole spacing as a measure of lighting performance. We have considered its relation to efficiency and luminaire power in a general way taking into consideration the effect of distance and incident angle. We shall next examine the lighting parameters. These are summarized in Table I.

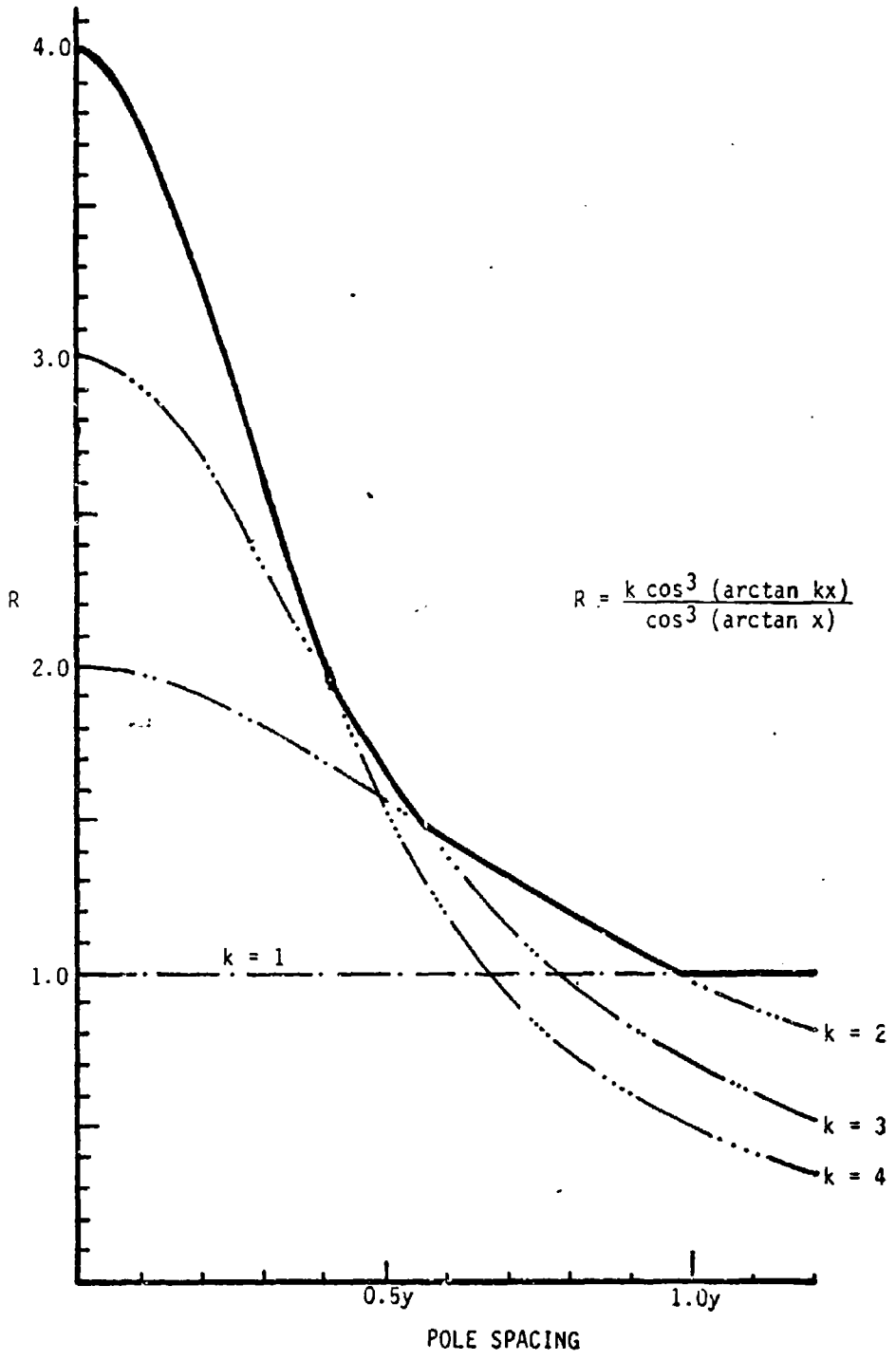


Figure 4. Greatest Pole Spacing Per Luminaire

21-11

TABLE I

MAXIMUM POLE SPACING PARAMETERS

Configuration Parameters	Arrangement Parameters	Requirement Parameters
Luminaire Type/Wattage	Independent	Outer Constraint
Number of Luminaires	Pole Height Z	Upper Inner Constraint
	Pole Distance Y	
	Vertical Aim	Lower Inner Constraint
	Horizontal Aim (Multi-Luminaires)	
	Dependent	
	Vertical Beam Angle	
	Horizontal Beam Angle	

b. Configuration Parameters

There are 25 luminaires to examine. Several luminaires of the same type can be used at the same time. If combinations of one, two, and three luminaires are considered, there would be 75 configurations to examine. The configurations must be examined separately. They are discrete parameters in the search process.

c. Arrangement Parameters

These are continuous parameters and when considered simultaneously, offer efficiencies in the search process. It is desirable to simplify the manner in which the lighting arrangements are evaluated. There are four independent lighting arrangement parameters; namely, pole height, pole distance Y, vertical aim, and horizontal aim for multi-luminaire configurations. Given any lighting arrangement and measurement point along a constraint, the vertical and horizontal beam angles can be determined, and thus these are defined as dependent variables necessary for the computation of incident light.

d. Requirement Parameters

Lighting requirements must be met along each of the constraint lines. The requirements are considered as parameters in the computer program. First, they are subject to changes in criteria. Second, they might be adjusted to account for additional factors. For instance, if one introduced dirt accumulation as a factor, it could be treated as a degrade factor in calculating illumination, but it could also be treated as an increased illumination requirement.

7. FIXING POLE HEIGHT

a. A pole height of three feet would yield the maximum foot candles at the outer constraint as a function of pole height. However, this pole height is not good for satisfying the inner constraints. The vertical offset angle to the upper inner constraint would be much greater than to the lower inner constraint. The inner constraints could be more equally satisfied by raising the pole height. A good solution would be obtained by fixing pole height so that the luminaire could be aimed midway between the two inner constraint heights.

b. A measure of the fractional loss of illumination as a function of pole height is given in Equation (14):

$$L(Z-H) = 1 - \cos^3 \left(\arctan \left((Z-H)/\sqrt{X^2+Y^2}\right)\right) \quad \text{----------} \quad (14)$$

where

X is offset distance

Y is pole distance

Z is pole height

H is constraint height

and

Z-H is height of lighting pole above or below the constraint.

By definition, when Z-H equals zero, we have no fractional loss in illumination at the constraint.

The relative effect of pole height on the fractional loss of illumination on the inner constraints versus the outer constraint was examined using Equation (14). Figures 5, 6, and 7 display results for minimum pole distance, zero offset; increased pole distance, zero offset; and minimum pole distance, increased offset. In each case the effect of pole height on the inner constraints were proportionately much greater than on the outer constraint. It is concluded that in general more is gained by adjusting pole height to 4.5 feet which is optimum for the inner constraints than lost by adjusting pole height higher than 3.0 feet which is optimum for the outer constraint. In a specific case where the inner constraints are easily satisfied whereas the outer constraint is not, there still

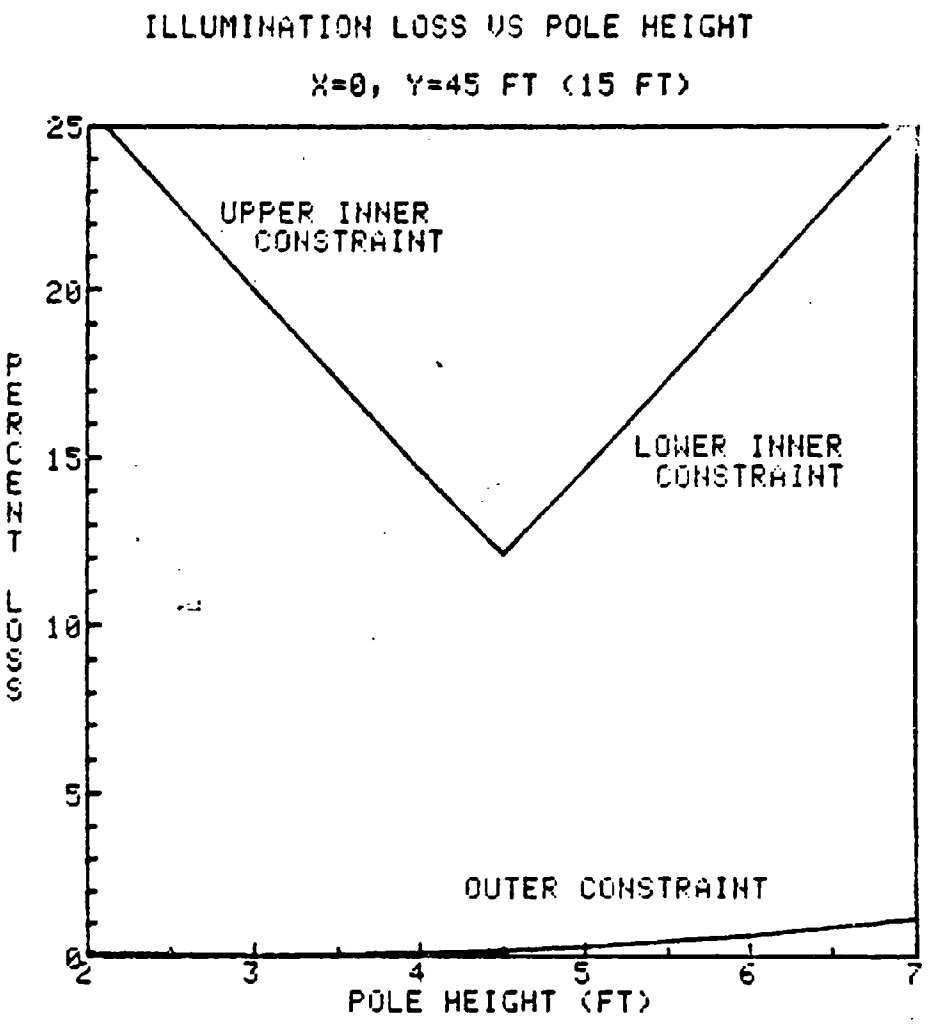


FIGURE 5

21-17

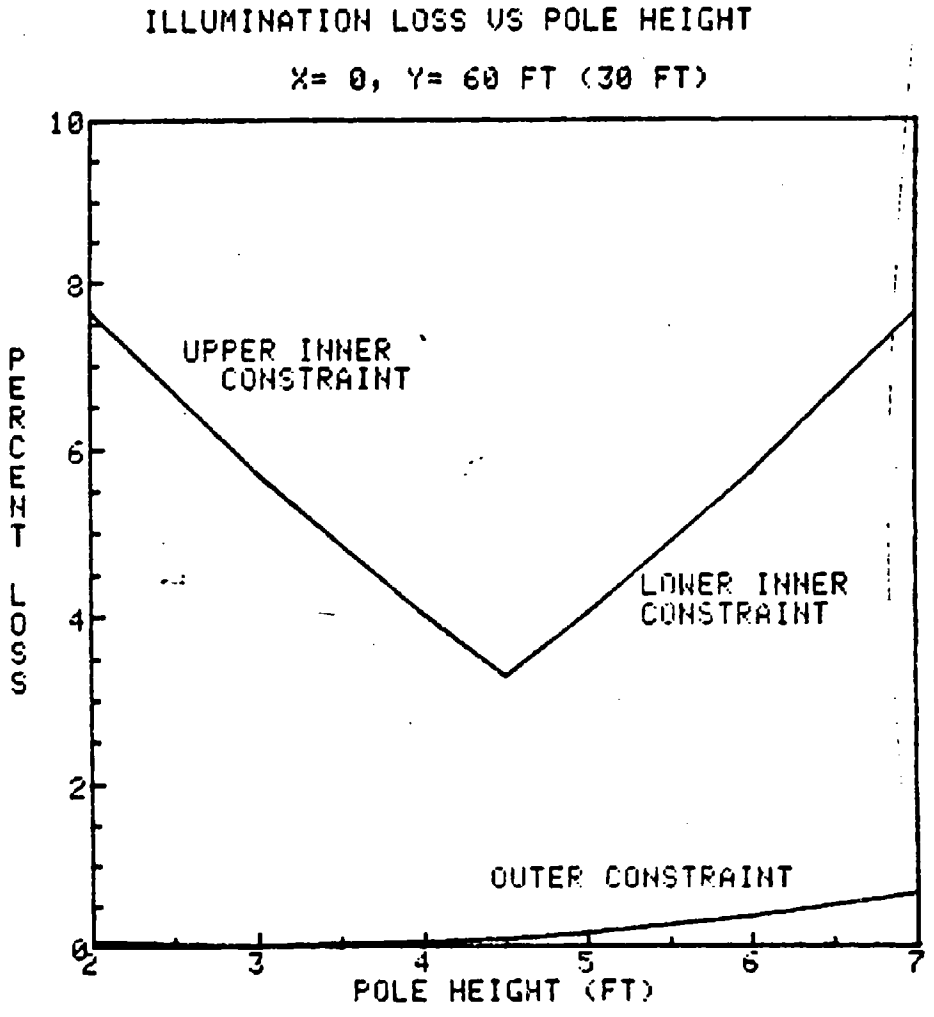

ILLUMINATION LOSS VS POLE HEIGHT
X= 0, Y= 60 FT (30 FT)
PERCENT LOSS
10
8
6
4
2
0
UPPER INNER CONSTRAINT
LOWER INNER CONSTRAINT
OUTER CONSTRAINT
2
3
4
5
6
7
POLE HEIGHT (FT)

FIGURE 6

21-1

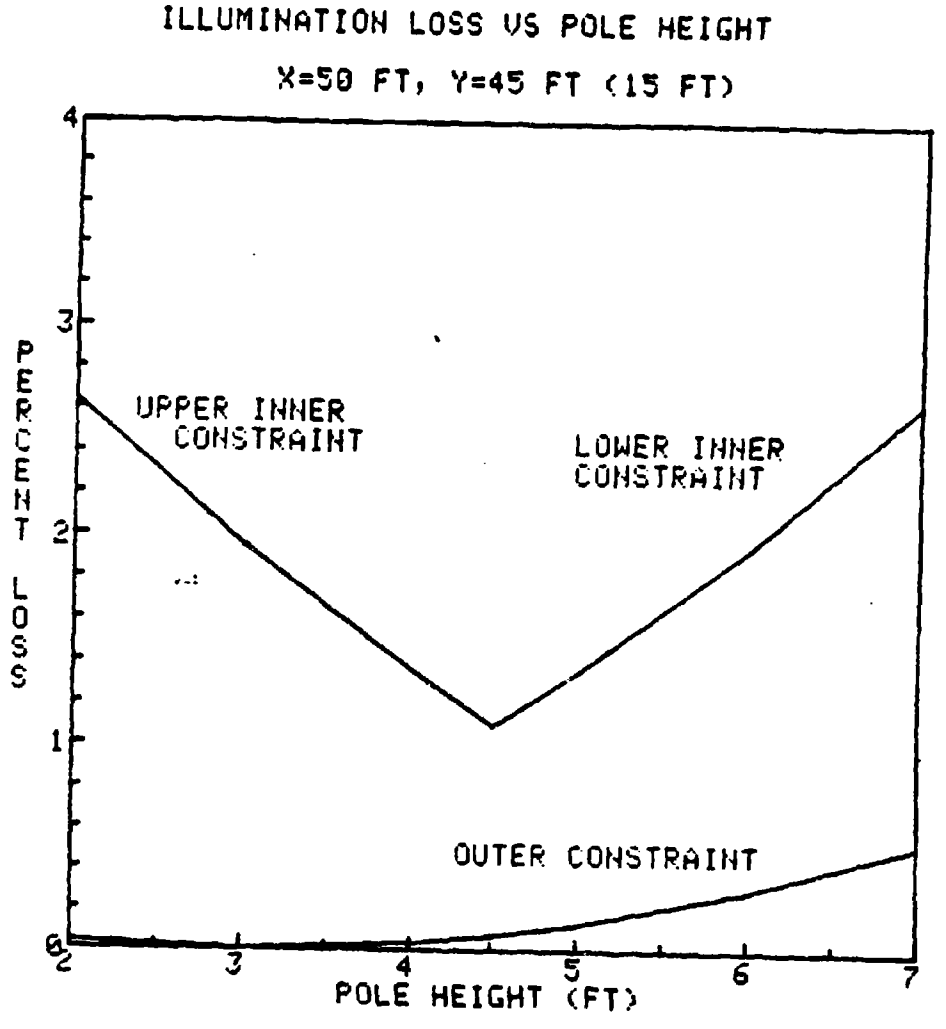


FIGURE 7

21-13

would be less than a one percent loss of illumination. The effect of this loss of illumination would have even a smaller effect on pole spacing.

c. By fixing pole height to 4.5 feet, we have effectively eliminated one of the independent arrangement parameters that have to be searched. This leaves only arrangements of pole distance, vertical aim and horizontal aim to be searched. Assuming we were going to search each arrangement parameter n times, the deletion of one parameter would reduce the search from n^4 combinations to n^3 combinations, a substantial reduction.

8. INNER CONSTRAINTS

a. The inner constraints are far more sensitive to the horizontal offset angle because they require a far greater offset angle than for the outer constraint to achieve the same offset distance. Figure 8 illustrates the worst case when the lighting pole is the minimum distance (15 ft) behind the fence. This difference becomes less crucial the further the lighting pole is moved back. It was soon discovered after some computer searches that the inner constraint was overriding for many luminaire types, especially those with narrow beam patterns. The searches consisted of moving the lighting pole back reducing the pole spacing achieved for the outer constraint, at the same time increasing the pole spacing achieved for the inner constraint until they became the same. It became evident that the use of multiple beams at plus and minus horizontal aiming angles could greatly improve results for narrow beams against the inner constraints.

b. An algorithm was devised for determining the maximum pole spacing over the constraints. Let us denote the maximum pole spacing for a given constraint as "P.S.". Then the maximum pole spacing for all constraints will be the least valued P.S. Let us denote this as "Min. P.S.". The Min. P.S. should be computed for the lighting pole 15 feet behind the fence. Then the distance should be increased a small amount and the Min. P.S. should be re-computed. If it does not increase, there is no need to test for greater distances behind the fence and the desired Min. P.S. is obtained. After repeating this process for vertical and horizontal aiming angles, the greatest Min. P.S. is obtained. (See Paragraph 12 for flow chart.)

9. MULTIPLE LUMINAIRE CONFIGURATIONS

a. An additional dimension of search, as compared to the single luminaire configuration, is required when evaluating two and three

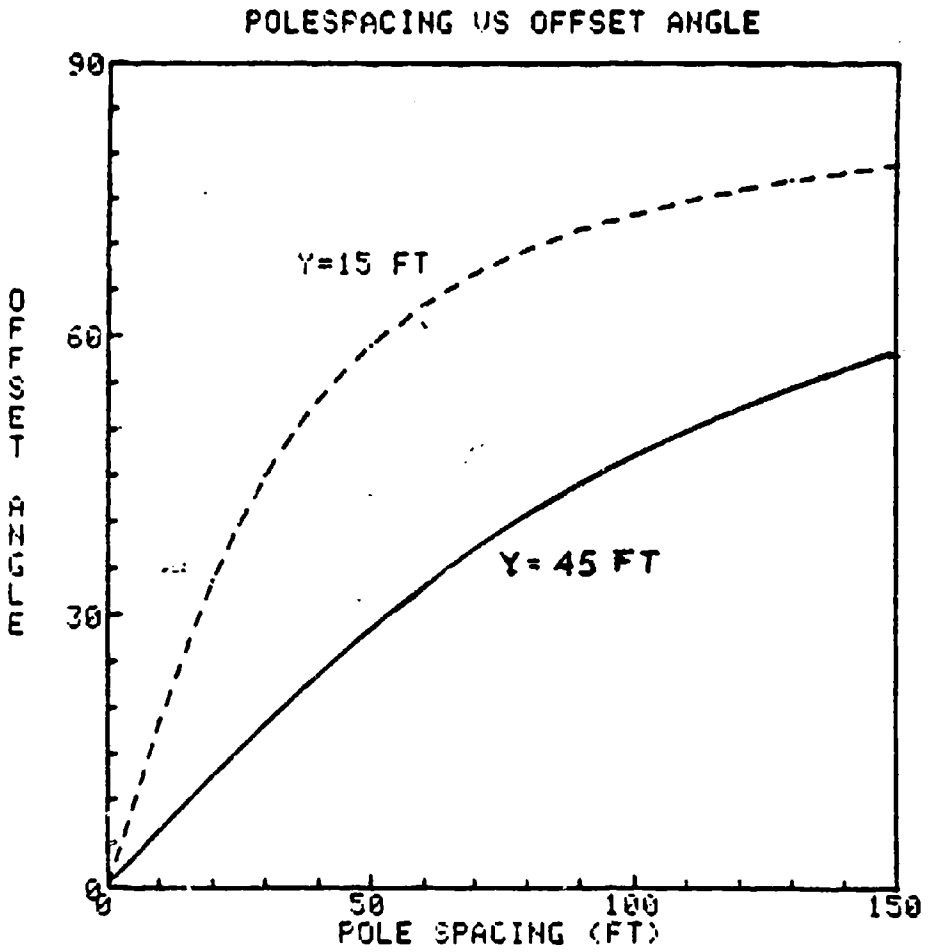

POLESPACING VS OFFSET ANGLE
90
60
30
0
OFFSET ANGLE
Y=15 FT
Y= 45 FT
0
50
100
150
POLE SPACING (FT)

FIGURE 8

luminaire configurations. In the two-luminaire configurations, a search of greater and greater plus and minus horizontal aiming angles would be needed until the maximum pole spacing was reached. The three-luminaire configurations would involve the same search procedures as in the two-luminaire case, except that a third luminaire with zero horizontal aiming angles would be added.

b. Multiple luminaire configurations can be examined as a single luminaire by rotating their beam patterns the amount of their horizontal aiming angle and adding.

10. ADDING LIGHT FROM ADJACENT POLES

a. So far we have introduced the concept of pole spacing as a measure of lighting performance (paragraphs 1-5) and have considered the lighting parameters and possible simplifications in their use (paragraphs 6-9). We now wish to return to pole spacing and two crucial issues involved in adding light from adjacent poles.

b. Criteria of One-half the Required Incident Light

(1) We have derived the maximum horizontal offset from a lighting pole for which the required incident light is obtained, and called this distance one-half pole spacing. Assume this is the left hand pole of adjacent poles. Then, incident light from the right hand pole would add to that of the left. This means that less than the required amount of incident light would have to be supplied by the left hand light and "pole spacing" could be increased accordingly. It is logical to assume that the adjacent poles can be moved apart until exactly one-half of the required light is supplied by each pole. The new pole space distance, based on adjacent poles, would be equivalent to the one-pole case derived for one-half the required incident light. This yields a very neat solution for the two-pole case and can easily be generalized to additional poles to the left and right. However, implicit in this simplified solution, is the assumption that if lighting requirements are satisfied exactly in the middle of two poles, it is satisfied everywhere else between the poles. This is only true if the incident lighting function is decreasing in a linear or concave-up fashion. Figure 9 illustrates this relation. The absolute value of the increase in illumination from the nearer light as one approaches it (here shown as Δ_R) is always greater than the decrease in illumination from the farther light (here shown as Δ_L), from which one is receding. The sum of the two lights (here shown as $I_L + I_R$) is always greater than or equal to the required incident light C.

(2) Foot candle functions, f (θ), are generally the opposite, concave-down. For example, if f (θ) = cos θ along the horizontal

CONDITION FOR MINIMUM LIGHT
MIDWAY BETWEEN POLES

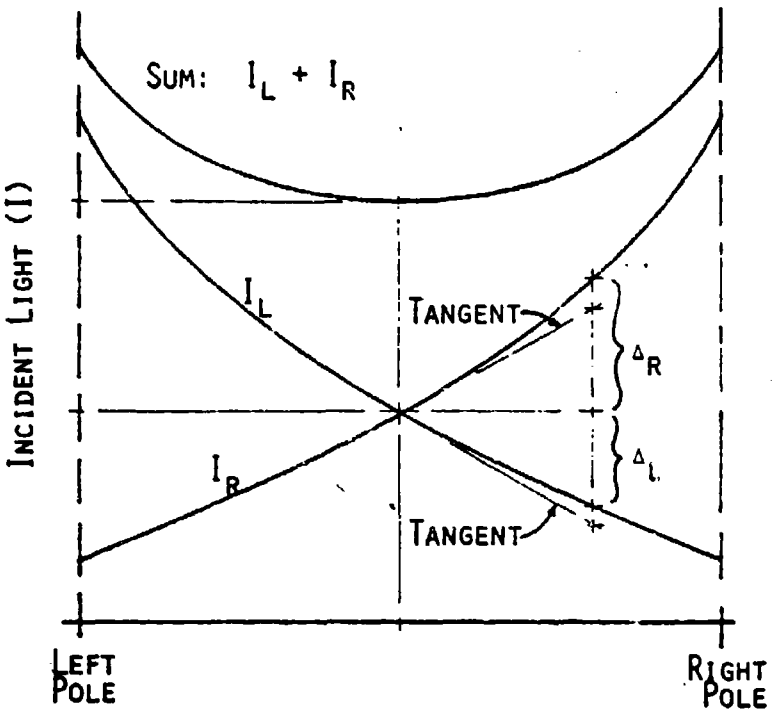


FIGURE 9

beam, it would never be concave-up. However, we should not rely on intuition. Since the foot candle function, f (θ), is multiplied by $\cos^3 \theta$ in the incident light equation, it is more likely to be transformed into a concave-up function. Let us see when this is true using the incident light equation:

$$g(\theta) = \frac{f(\theta) \cos^3 \theta}{y^2} \qquad \text{----------} \qquad (15)$$

Assume f (θ) = K, and compute the rate of change of the slope of g (θ), equivalent to its second derivative

$$g'(\theta) = \frac{-3K}{y^2} \cos^2 \theta \sin \theta \qquad \text{----------} \qquad (16)$$

and

$$g''(\theta) = \frac{-3K}{y^2} \cos^3 \theta - 2 \cos \theta \sin^2 \theta \qquad \text{----------} \qquad (17)$$

Solving for $g''(\theta) = 0$, we get $\tan^2 \theta = 0.5$ and $\theta = 35^0\ 26'$.

(3) A plot of $g''(\theta)$ is given in Figure 10. The rate of change of the incident light function $\cos^3 \theta$ changes from positive to negative at $35^0\ 26'$ and is a maximum negative rate at about 60^0. The greater the negative rate of change of a function, the greater is the extent that it is concave-up.

(4) When f (θ) is moderately concave-down, the situation is even improved. For example, when, as we stated before, f (θ) = cos θ the inflection point is equal to 30^0.

(5) The only case of concern appears to be when f (θ) drops off very rapidly to zero. The pole spacing would have to be reduced until the one-pole case provided the full lighting requirement. The lighting input tables could be adjusted to denote exactly where a drop-off occurred. However, it might be simpler to compute the sum of the left and right light sources when the one-pole source provides less than 1.0 of the incident light requirement.

c. Additional Light from Distant Poles

(1) Previous discussion has been based on measuring incident light from the immediate pole (left or right) to the mid-pole

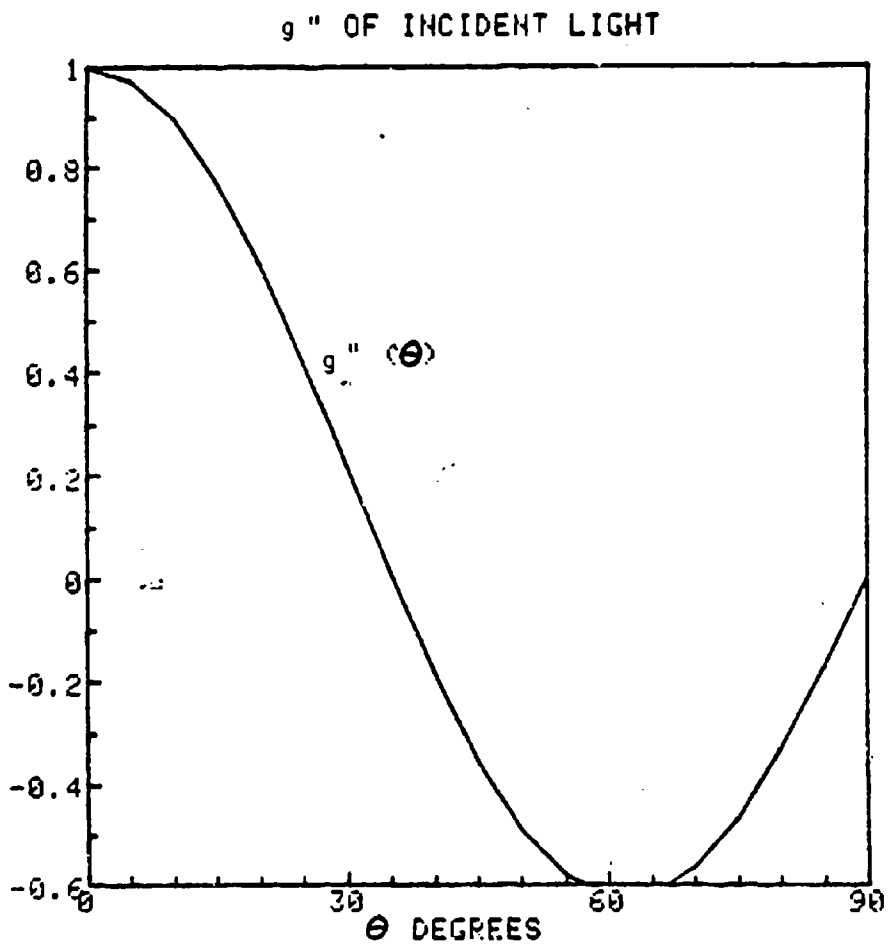


FIGURE 10

position along the constraint. An offset distance x was used to denote this distance to the first pole. Additional incident light is supplied to the mid-pole distance from more distant poles. The offset distance to the mid-pole position as a function of the kth distant pole is given by

$$x_k = (2k-1)\,x \qquad \text{----------} \qquad (18)$$

The general equation of incident light is given by

$$I = F(\theta,\gamma) \cdot \frac{y}{d} \cdot \frac{1}{d^2} \qquad \text{----------} \qquad (19)$$

where $F(\theta,\gamma)$ is luminaire foot candles

$\frac{y}{d}$ is component of incident light on the vertical surface of the constraint

d is distance

Substituting x, y, and z into the distance equation and using Equation (19), the incident light obtained from the kth pole is given by

$$I_k = F(\theta,\gamma)\; y \cdot \left[((2k-1)\,x)^2 + y^2 + z^2\right]^{-3/2} \qquad \text{-----} \qquad (20)$$

By substituting a constant for $F(\theta,\gamma)$ in Equation (20), we can determine the proportion of incident light provided by the kth pole independent of the luminaire foot candle pattern. This allows the summation of I_k terms.

Let $A_n = \sum_{k=1}^{n} I_k$ for all significant terms of I_k,

such that $I_{k>n} < .001$.

Then, the error for using only m pairs of poles is given by

$$E_m = (A_n - \sum_{k=1}^{m} I_k)/A_n \qquad \text{----------} \qquad (21)$$

2·2.

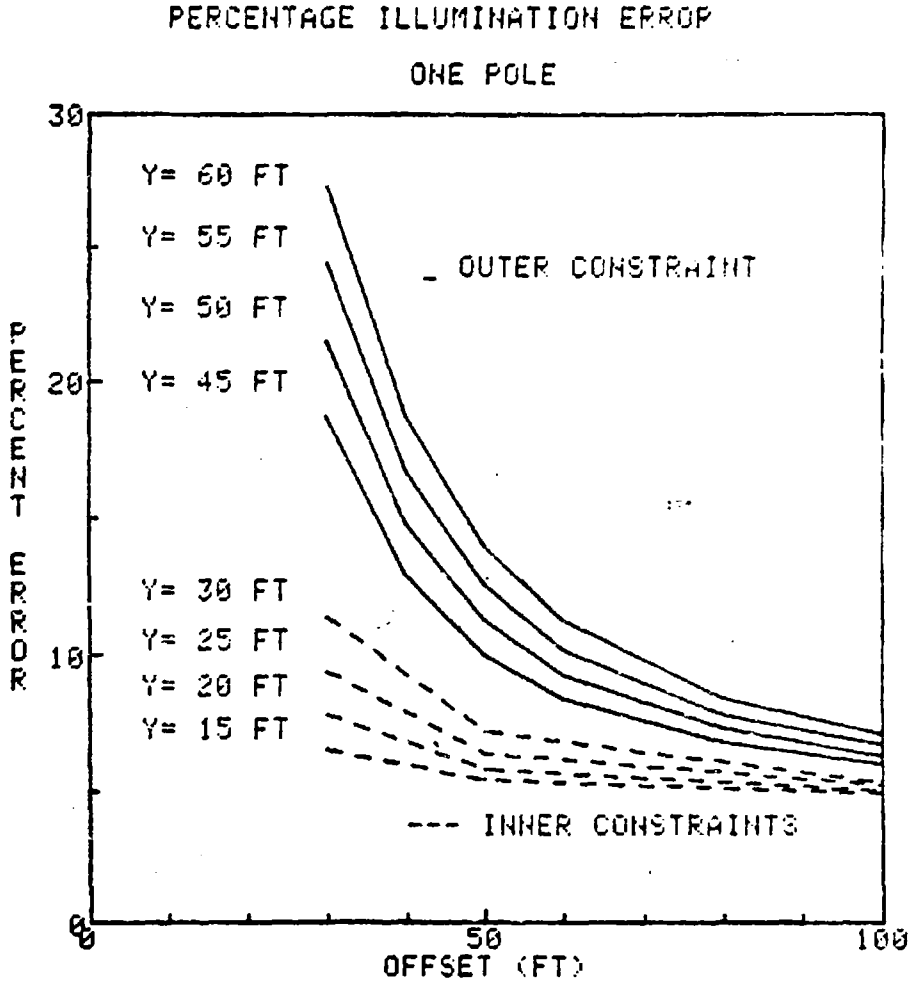

PERCENTAGE ILLUMINATION ERROR
ONE POLE
30
20
10
0
PERCENT ERROR
Y= 60 FT
Y= 55 FT
Y= 50 FT
Y= 45 FT
Y= 30 FT
Y= 25 FT
Y= 20 FT
Y= 15 FT
OUTER CONSTRAINT
INNER CONSTRAINTS
0
50
100
OFFSET (FT)

FIGURE 11

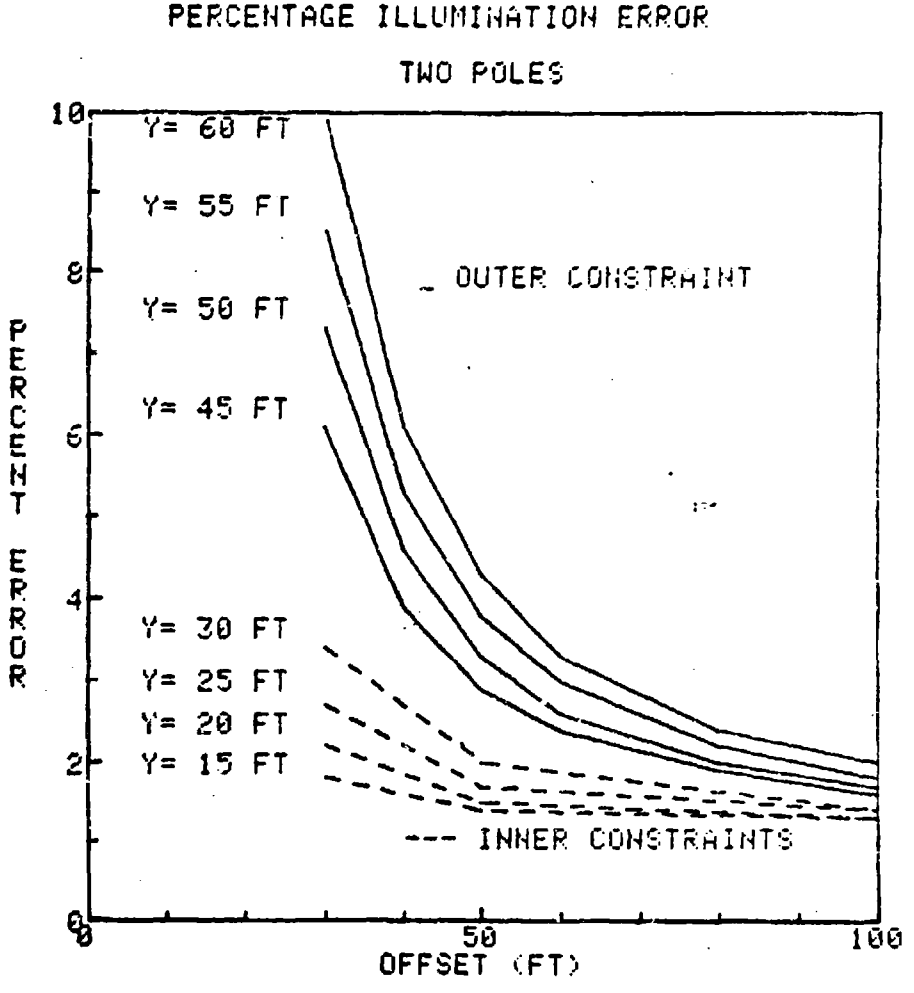


FIGURE 12

21-28

PERCENTAGE ILLUMINATION ERROR

THREE POLES

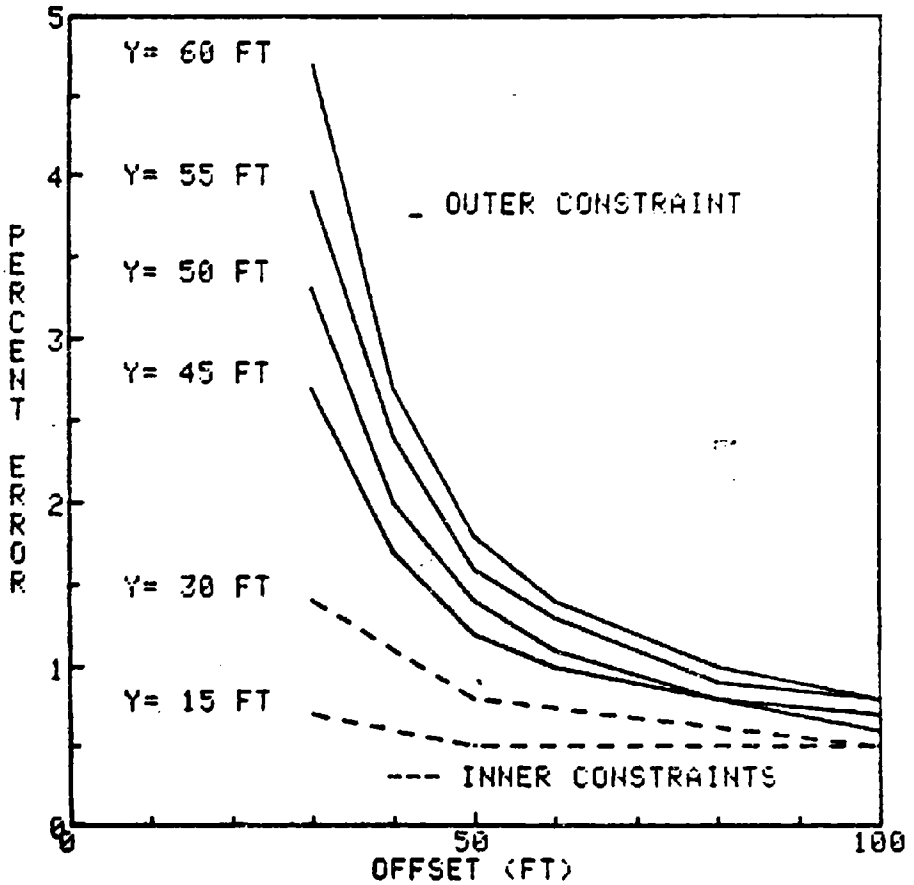


FIGURE 13

21-29

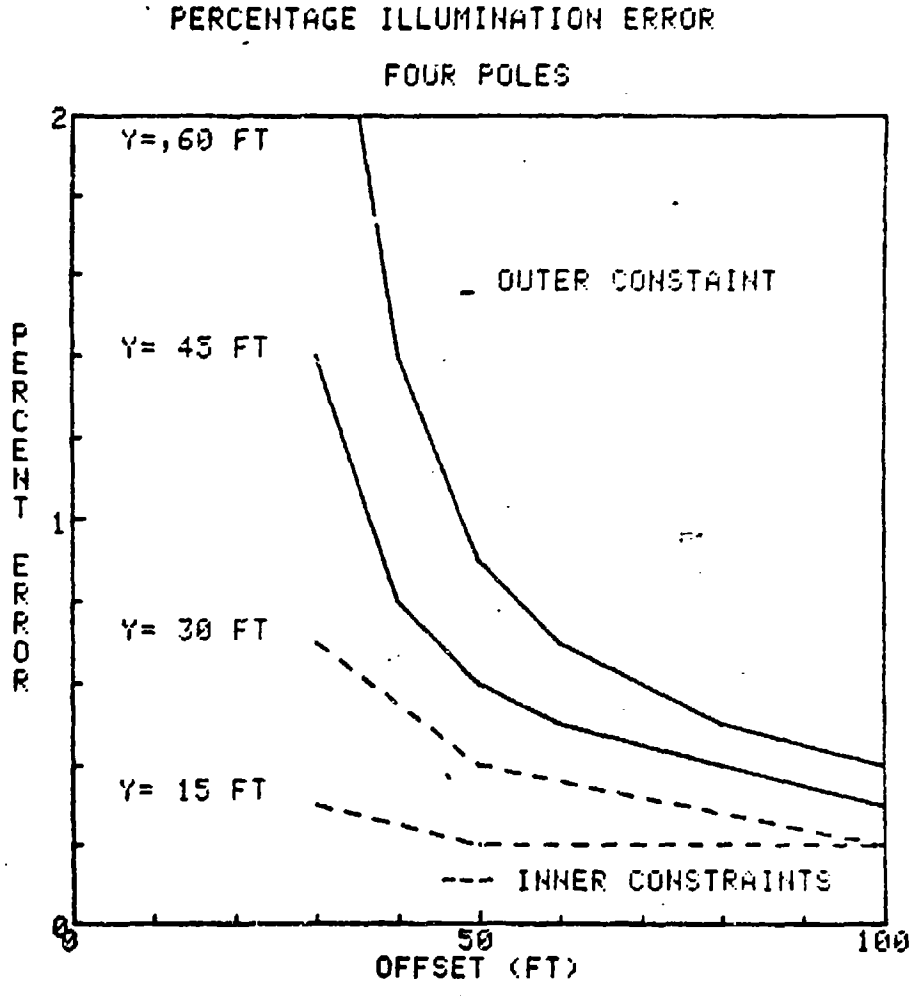


FIGURE 14

21-31

(2) Figures 11 through 14 show the upper bound of the error when using, respectively, one, two, three, and four pairs of poles in computing incident light. The errors are given for both outer and inner constraints. The errors for the outer constraints are relatively greater than those for the inner constraints. In general, the error for the inner constraints using k poles approximates the error for outer constraints using k plus one pole. In every case the error rises sharply for small offset distances. However, as we have shown before, when the measure of pole spacing is small, it is better to add luminaires on each pole. In practice we are only interested in solutions that yield large pole spacings. The offsets for these cases are in fact much greater than 30 feet. Further, the error in pole spacing is proportionately less than the error in incident light. As was shown in paragraph 4, the greater the pole spacing the less efficient it is to add light (similarly to account for more light.)

(3) On the basis of the error analysis, it seems that using three pairs of poles for the outer constraint and two pairs of poles for the inner constraint would yield satisfactory results. The final decision should be based on the required accuracy, uncertainty in other factors, and computer parameters.

11. FIFTEEN-FOOT POLE HEIGHT CONSTRAINT

a. Luminaires do not require expensive hardening if they are mounted at a height of fifteen feet or above. The money saved in not hardening must be compared to the money lost due to a more expensive lighting arrangement. This can be done by comparing minimum-cost lighting arrangements between pole height mounting below fifteen feet and at fifteen feet. The fifteen-foot pole height constraint does, indeed, cause a large decrease in pole spacing compared to the unconstrained pole height case. This is due to the increased angles of incidence at the outer constraint and lower inner constraint. (See Figure 15 for incident angles γ_1 and γ_2.) Secondly, a greater spread in the luminaire's vertical beam is required to illuminate the constraints. (See Figure 15 for the angle difference γ_3.) This does not explain the entire problem because now the outer constraint is not between the two inner constraints, and if the highest intensity part of the luminaire beam is pointed at it, a relatively less intense beam will be directed at the lower inner constraint.

b. The methodological problems fortunately are not so much aggravated. Just as before, a search over the vertical aiming angle arrangement parameter is required. In this case, more search steps will be required and better interpolation of the vertical beam may

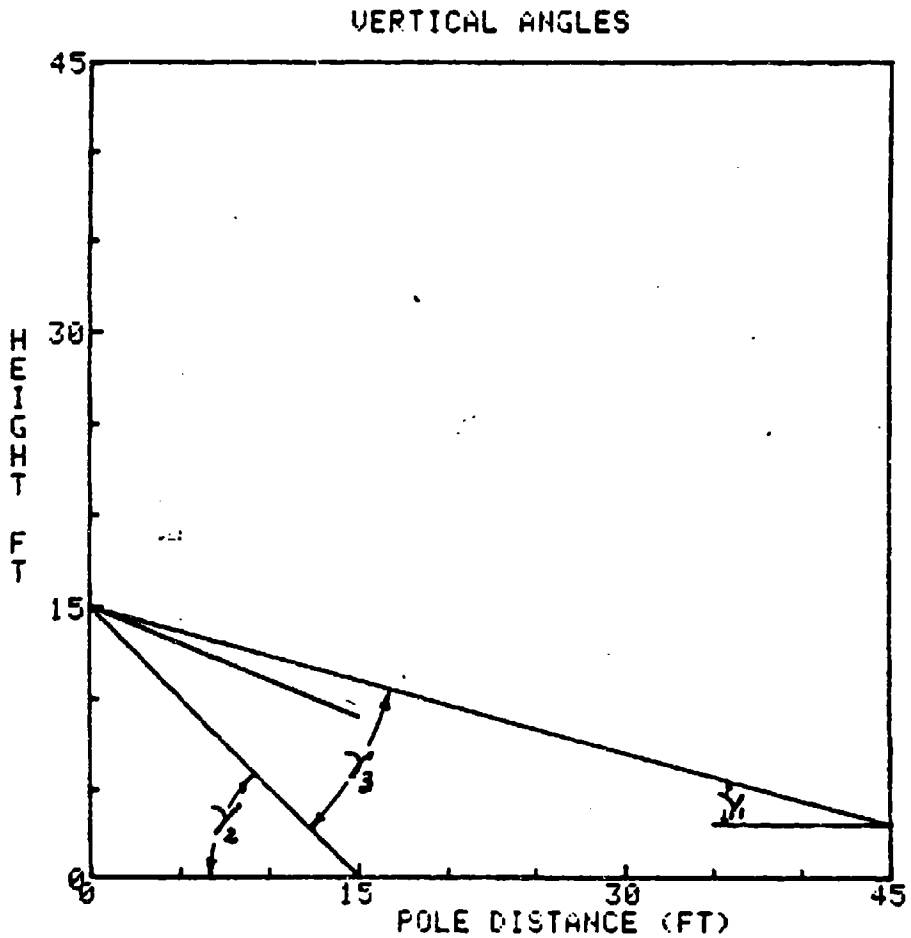

VERTICAL ANGLES
45
30
15
0
HEIGHT FT
0
15
30
45
POLE DISTANCE (FT)
γ1
γ2
γ3

FIGURE 15

be required because the solution will be more sensitive to the vertical angle parameter. On the other hand, the search should be simpler because the upper inner constraint can be ignored.

c. Another possible solution would be to use more than one luminaire aimed at different vertical angles. For instance, one luminaire could be aimed towards the lower inner constraint and another towards the outer constraint. Similar procedures for varying luminaire vertical aiming angles could be adopted as derived for varying luminaire horizontal aiming angles.

d. A natural extension of the above solution would be to use luminaires with a combination of horizontal and vertical aiming angles. This solution is so complicated that it should be considered only after practical experience is obtained on the simpler luminaire configurations.

e. The solution for the fifteen-foot pole height is more complicated than for the fixed 4.5 foot pole height. Additional procedures for the fifteen-foot pole height should be attempted only after those for the simpler case have been checked out.

12. SUMMARY OF BASIC PROCEDURES

a. Analytic considerations have been described in this report for basing the design of a computer search routine for determining near low cost lighting arrangements that satisfy perimeter lighting requirements. Maximum lighting pole spacing has been suggested as the measure for comparing lighting arrangements between luminaire configurations. This greatly simplifies the problem because lighting performance measures and installation and operating cost factors are derived sequentially.

b. Our analysis was restricted to investigating procedures for deriving maximum pole spacing. The following assumptions for reducing the magnitude of computations were analyzed. An asterisk denotes when a computer test for reduced computation is suggested.

(1) Multi-Luminaire Configurations

Multi-luminaire configurations are most likely needed to improve the pole spacing for the inner constraints. These configurations are not likely to improve the solution for the outer constraint unless the maximum pole spacing for one luminaire is less than about the pole distance.

(2) Fixing Pole Height

One arrangement parameter can be eliminated by fixing pole height to the mid-height of the inner constraints.

(3) Inner Versus Outer Constraint*

Further increases in pole distance to achieve greater maximum pole spacing does not have to be considered when the maximum pole spacing achieved for all constraints decreases with an increase in pole spacing.

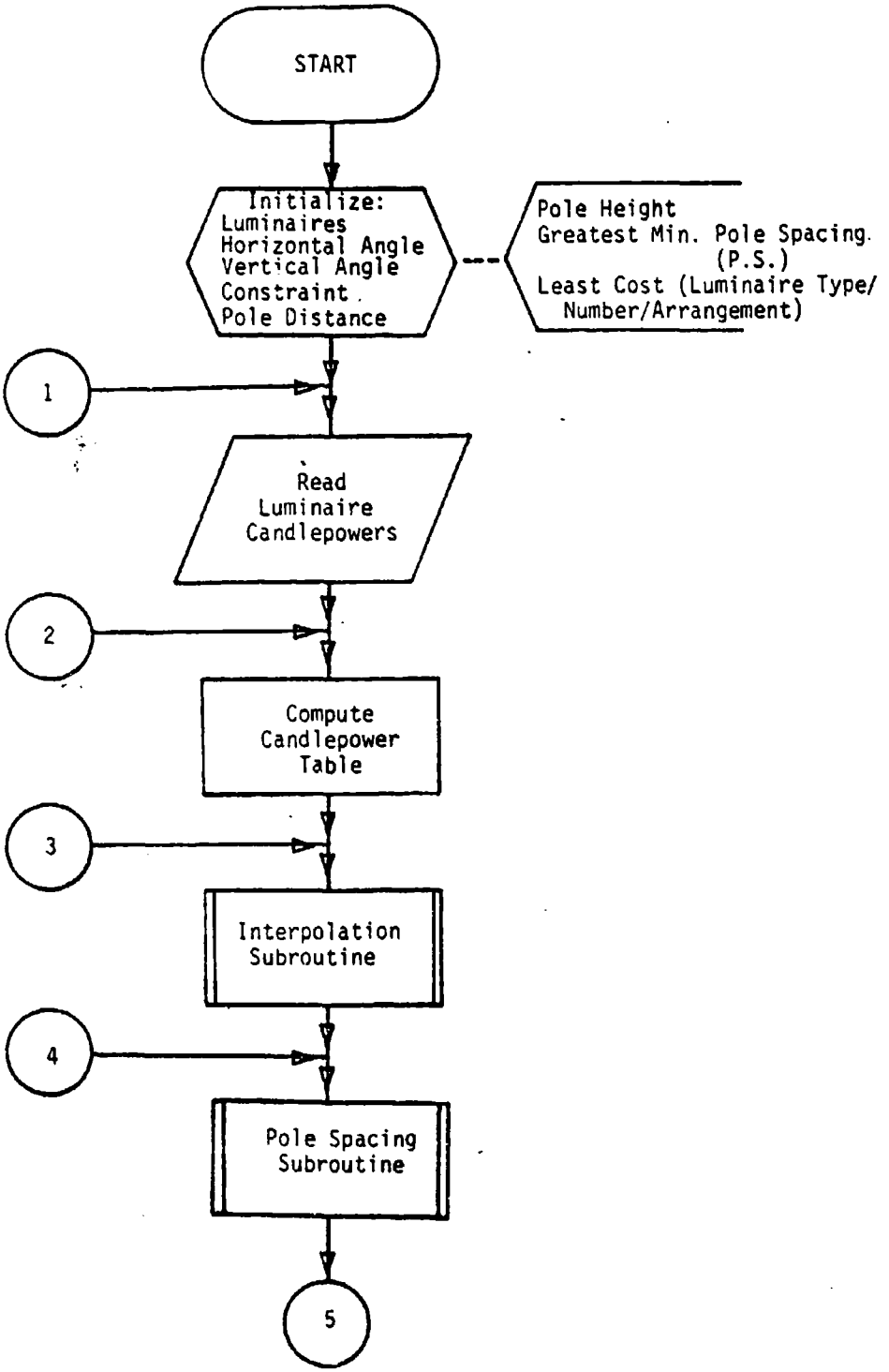
(4) One-Half Requirement*

In general, the maximum pole spacing is achieved when either the left hand or right hand lighting sources provide 0.5 of the lighting requirement (incident lighting function concave-up). For an exact solution, the sum of the left and right hand lighting sources needs to satisfy 1.0 of the lighting requirement. This sum should first be checked for a pole spacing based on either left hand or right hand poles providing 0.5 of lighting requirement. If this fails, the sum should successively be checked for smaller pole spacings. A solution must occur when either left hand or right hand lighting sources provide 1.0 of the lighting requirement.

(5) Lighting from Beyond Adjacent Poles

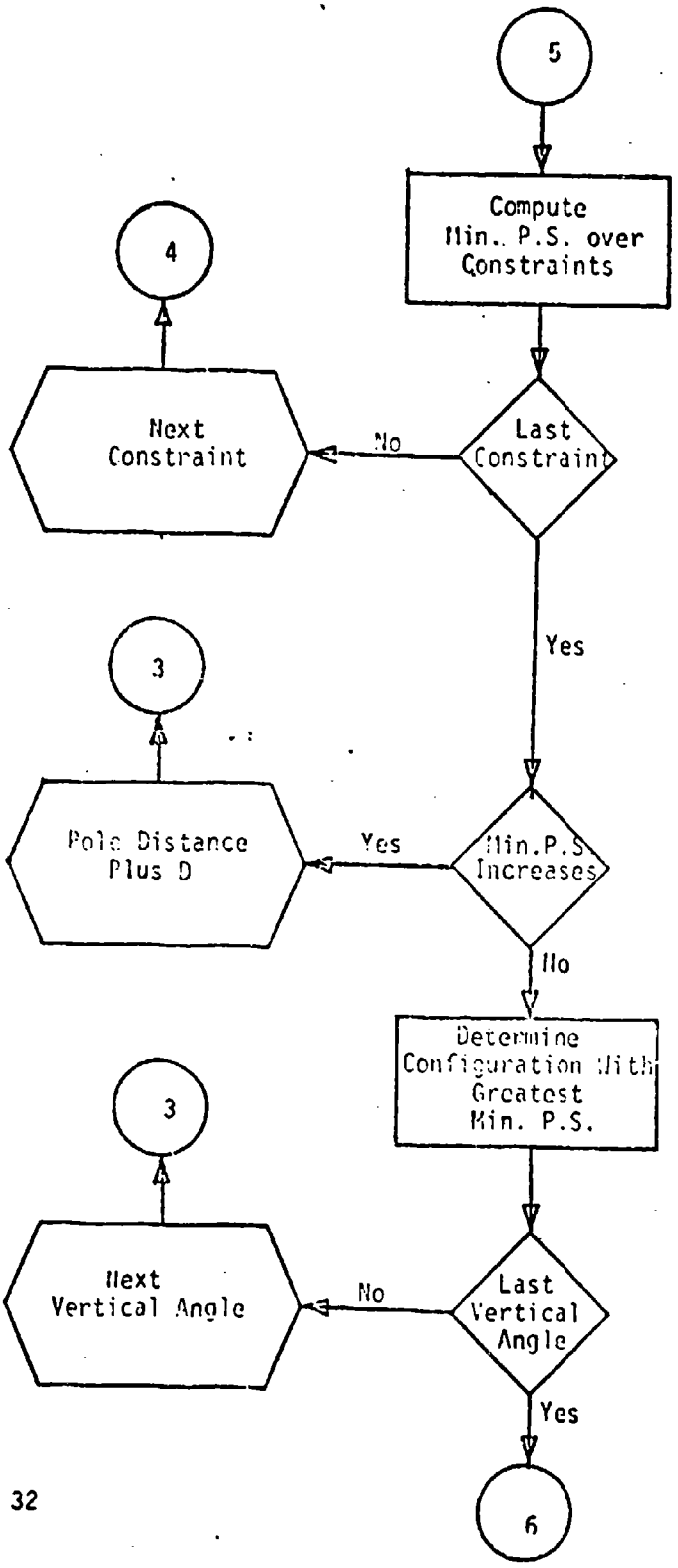
A good approximation of the total incident light from luminaires along the pole line can be derived by using three poles for the outer constraint and two poles for the inner constraints. The sums for these poles can easily be computed by changing only the x term in the incident light equations. When the offset distance is x feet for the first pole, it will be $3x$ feet for the second pole, and $5x$ feet for the third pole.

c. A flow diagram (Flow Charts 1a, 1b, and 1c) is given below incorporating the basic assumptions developed in this report, but omitting computational details.



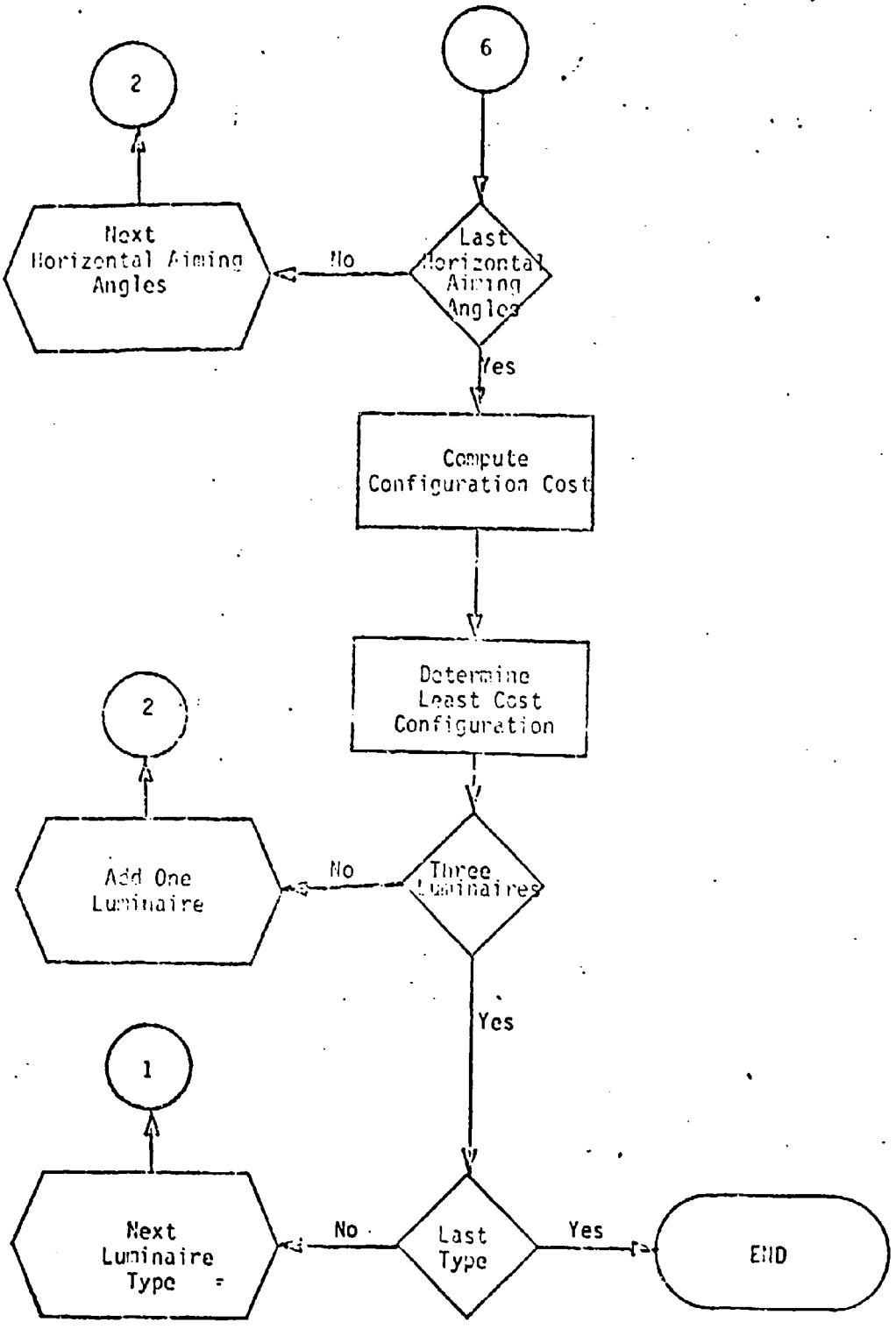
FLOW CHART 1a

21 35



FLOW CHART 1b

21-36



FLOW CHART 1c 21-37

ANNEX A

MATHEMATICAL FORMULATION OF THE PERIMETER LIGHTING PROBLEM

For detailed numerical analysis, the perimeter lighting problem has been reformulated in vector notation. This simplifies the mathematics used in the computer program to investigate the changing of parameters. Points have been located in an x, y, z coordinate system with origin at the base of the pole. The x-axis is parallel to the fence. The y-axis is normal to the plane containing the fence. The z-axis is normal to the ground plane. What this simply means is that pole spacing is measured along the x-axis, distance constraints among the pole, fence and boundary are measured on the y-axis, and height is measured on the z-axis. The following figure will help explain the three axes and the geometric or vector relationships below:

x = 1/2 pole spacing (ft)

y_1 = distance from pole to fence (ft)

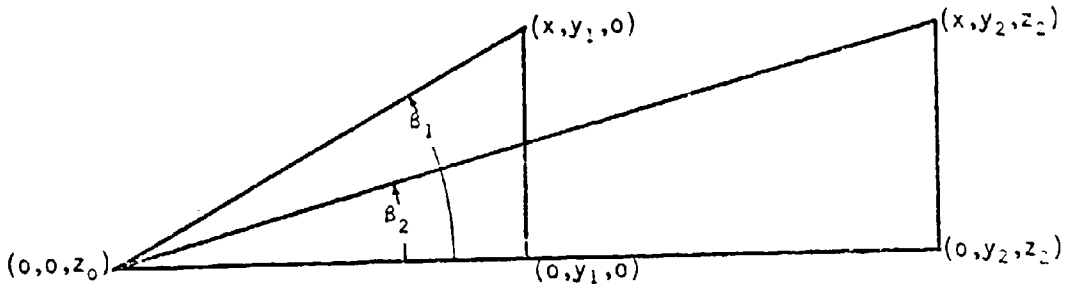
y_2 = distance from pole to boundary (ft)

z_o = height of luminaire on pole (ft)

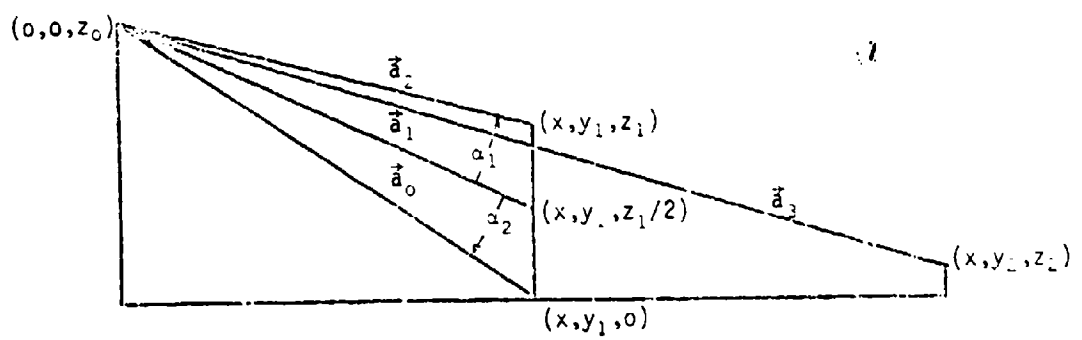
z_1 = height of fence (ft)

z_2 = height of boundary measurement (ft)

PLAN VIEW



PROFILE VIEW



Pole Fence Boundary

Figure 1. Geometry of the Perimeter Lighting Problem

The following vectors are defined from the luminaire to

POINT 0: Bottom of fence (x ft down fence)

$$\vec{a}_o = (x,y_1,0) - (0,0,z_o) = (x,y_1,-z_o)$$

$$d_o = |\vec{a}_o| = \sqrt{x^2+y_1^2+z_o^2}$$

$$= \sqrt{x^2+b_o} \quad \text{where} \quad b_o = y_1^2+z_o^2$$

POINT 1: Middle of fence (x ft down fence)

$$\vec{a}_1 = (x,y_1,z_1/2) - (0,0,z_o) = (x,y_1,z_1/2-z_o)$$

$$d_1 = |\vec{a}_1| = \sqrt{x^2+y_1^2+(z_1/2-z_o)^2}$$

$$= \sqrt{x^2+b_1} \quad \text{where} \quad b_1 = y_1^2+(z_1/2-z_o)^2$$

POINT 2: Top of fence (x ft down fence)

$$\vec{a}_2 = (x,y_1,z_1) - (0,0,z_o) = (x,y_1,z_1-z_o)$$

$$d_2 = |\vec{a}_2| = \sqrt{x^2+y_1^2+(z_1-z_o)^2}$$

$$= \sqrt{x^2+b_2} \quad \text{where} \quad b_2 = y_1^2+(z_1-z_o)^2$$

POINT 3: Boundary (x ft down fence)

$$\vec{a}_3 = (x,y_2,z_2) - (0,0,z_o) = (x_1,y_2,z_2-z_o)$$

$$d_3 = |\vec{a}_3| = \sqrt{x^2+y_2^2+(z_2-z_o)^2}$$

$$= \sqrt{x^2+b_3} \quad \text{where} \quad b_3 = y_2^2+(z_2-z_o)^2.$$

The vertical angles α_1 and α_2 can be calculated as follows:

$$\alpha_1 = \cos^{-1}\left(\frac{\vec{a}_1 \cdot \vec{a}_2}{|\vec{a}_1|\,|\vec{a}_2|}\right) = \cos^{-1}\left(\frac{x^2+b_4}{d_1 d_2}\right)$$

where $b_4 = y_1^2+(z_1-z_o)(z_1/2-z_o)$

$$\alpha_2 = \cos^{-1}\left(\frac{\vec{a}_o \cdot \vec{a}_1}{|\vec{a}_o|\,|\vec{a}_1|}\right) = \cos^{-1}\left(\frac{x^2+b_5}{d_o d_1}\right)$$

where $b_5 = y_1^2-z_o(z_1/2-z_o)$.

The horizontal angles β_1 and β_2 can be calculated as follows:

$$\beta_1 = \cos^{-1}\left(\frac{y_1^2+z_o^2}{d_o\sqrt{b_o}}\right) = \cos^{-1}\left(\frac{b_o}{d_o\sqrt{b_o}}\right) = \cos^{-1}\left(\frac{\sqrt{b_o}}{d_o}\right)$$

$$\beta_2 = \cos^{-1}\left(\frac{y_2^2+(z_2-z_o)^2}{d_3\sqrt{b_3}}\right) = \cos^{-1}\left(\frac{b_3}{d_3\sqrt{b_3}}\right) = \cos^{-1}\left(\frac{\sqrt{b_3}}{d_3}\right)$$

Let V be the vertical aiming angle of the luminaire and let F (h,v) be the interpolated output of the luminaire for a horizontal angle (h) and a vertical angle (v). The incident light at Points 0 through 3 may now be calculated as follows:

$$L_o = F(90-\beta_1, V-\alpha_2)\left(\frac{1}{d_o^2}\right)\left(\frac{y_1}{\sqrt{b_o}}\right)\left(\frac{\sqrt{b_o}}{d_o}\right) = \frac{y_1 F(90-\beta_1, V-\alpha_2)}{d_o^3}$$

$$L_1 = F(90-\beta_1, V)\left(\frac{1}{d_1^2}\right)\left(\frac{y_1}{\sqrt{b_1}}\right)\left(\frac{\sqrt{b_1}}{d_1}\right) = \frac{y_1 F(90-\beta_1, V)}{d_1^3}$$

$$L_2 = F(90-\beta_1, V+\alpha_1)\left(\frac{1}{d_2^2}\right)\left(\frac{y_1}{\sqrt{b_2}}\right)\left(\frac{\sqrt{b_2}}{d_2}\right) = \frac{y_1 F(90-\beta_1, V+\alpha_1)}{d_2^3}$$

$$L_3 = F(90-\beta_2, V)\left(\frac{1}{d_3^2}\right)\left(\frac{y_2}{\sqrt{b_3}}\right)\left(\frac{\sqrt{b_3}}{d_3}\right) = \frac{y_2 F(90-\beta_2, V)}{d_3^3}$$

Horizontal Correction

Vertical Correction

Distance Correction

ANNEX B

BIVARIATE INTERPOLATION FORMULA

TO OBTAIN F(h,v) FROM TABLE T(H,V)

Let T(H,V) be a bivariate table of luminaire output with H and V being tabulated over the values:

H: 90 to 270 degrees

V: -90 to +90 degrees.

Let $r = \frac{h-H_o}{H_1-H_o}$ where $H_1 < h \leq H_o$

$s = \frac{v-V_o}{V_1-V_o}$ where $V_o < v \leq V_1$.

$$F(h,v) = (1-r)(1-s)T(H_o,V_o) + r(1-s)T(H_1,V_o) + (1-r)sT(H_o,V_1) + rsT(H_1,V_1).$$

This formula would yield exact results if F(h,v) were of the form $A + Bh + Cv + Dhv$.

APPENDIX B

CANDLEPOWER TABLES

LUMINAIRE INDEX
January 1978

	Computer Code	C.P. File No.*	Fixture No.**	Actual Lamp Lumens	PHOTOMETRIC SOURCE DATA			
					I.D. No.	Type***	Test Date	Test Lumens
1.	H90LS65NO1	13	1	12500	-	Isocandela Diagram	Approx. 1974	12500
2.	H90LS75SE1	51	2	12500	-	Isocandela Curves	Approx. 1976	12500
3.	H135L75SE1	50	20	21500	-	Isocandela Curves	Approx. 1976	21500
4.	H180L75SE1	52	3	33000	-	Isocandela Curves	Approx. 1976	33000
5.	H180L76NO1	14	4	33000	-	Isocandela Diagram	Approx. 1974	33000
6.	H250S65WE1	53	21	50000	630743	Lumen Chart	10-13-72	47000
7.	H250S66HU1	58	22	25500	HP-00444	Isocandela/ Lumen Chart	11-21-75	25500
8.	H250S75WE1	27	23	25500	ERL 1832	C.P. Table	5-17-76	25500
9.	H250S76GE1	29	24	25500	35-175448	Isocandela/ Lumen Chart	8-29-72	1000
10.	H250S76WE1	22	25	25500	630386	Isocandela/ Lumen Chart	5-22-69	44000
11.	H300P56WGE	25	302	3840	-	C.P. Curves	Approx. 1966	3840
12.	H300Q65GE1	20	80	5950	35-174254	Prorate of 500w (See#27)	3-17-64	10500
13.	H400S22HU1	28	26	50000	TRH-11162 -29-P	Isocandela/ Lumen Chart	9-16-71	47000
14.	H400S44WE1	46	27	50000	672246	Lumen Chart	6-10-75	47000
15.	H400S55HU1	26	28	50000	TRH-11162 -33-P	Isocandela/ Lumen Chart	9-21-71	47000
16.	H400S55WE1	47	29	50000	672247	Lumen Chart	6-10-75	47000
17.	H400S62SE1	48	30	50000	-	Isocandela Curves	Approx. 1976	50000
18.	H400S64CH1	17	305	50000	4577-A	Isocandela/ Lumen Chart	8-14-74	50000
19.	H400S65SE1	49	31	50000	-	Isocandela Curves	Approx. 1976	50000
20.	H400S65WE1	61	32	50000	630743	Lumen Chart	10-13-72	47000

LUMINAIRE INDEX
January 1978

	Computer Code	C.P. File No.*	Fixture No.**	Actual Lamp Lumens	PHOTOMETRIC SOURCE DATA			
					I.D. No.	Type***	Test Date	Test Lumens
21.	H400S67CH1	57	33	50000	45611	C.P. Table (Comp. P.O.)	Approx. 1973	50000
22.	H400S76CH1	44	34	50000	45543	C.P. Table (Comp. P.O.)	Approx. 1973	50000
23.	H400S76GE1	45	35	50000	35-176201	Isocandela/ Lumen Chart	12-15-76	1000
24.	H400S76SY1	21	36	50000	4440	C.P./Lumen Table	6-22-76	50000
25.	H400S76WE1	24	37	50000	630386	Isocandela/ Lumen Chart	5-22-69	44000
26.	H500Q55LA1	66	81	10500	-	Isocandela/ Lumen Chart	Approx. 1967	10500
27.	H500Q65GE2	2	82	10500	35-174254	Isocandela/ Lumen Chart	3-17-64	10500
28.	H10CS65HO1	32	38	140000	27189-P	Isocandela Curves	Approx. 1975	140000
29.	H10CS76CH1	10	39	140000	45803	C.P. Table (Comp. P.O.)	Approx. 1970	130000
30.	H10CS76CH2	16	307	130000	4531-A	Isocandela/ Lumen Chart	11-19-73	130000
31.	H10CS76HU1	15	40	140000	HP-00429	Isocandela/ Lumen Chart	Approx. 1976	140000
32.	H10CS76WI1	54	41	130000	-	Isocandela/ Lumen Chart	-	130000
33.	H15CQ62GE1	40	83	33000	35-174257	Isocandela/ Lumen Chart	4-16-64	33000
34.	H15CQ62GE2	43	84	33000	35-175783	Isocandela/ Lumen Chart	11-13-74	1000
35.	H15CQ64LA1	39	85	33000	-	Isocandela/ Lumen Chart	Approx. 1966	33000
36.	H15CQ64GE1	41	86	33000	35-175784	Isocandela/ Lumen Chart	11-13-74	1000
37.	H15CQ65GE1	42	88	33000	35-175785	Isocandela/ Lumen Chart	11-13-74	1000
38.	H15CQ65GE2	12	89	34400	35-175785	Isocandela/ Lumen Chart	11-13-74	1000
39.	H15CQ65GE3	1	90	34400	5785	C.P. Table (Comp. P.O.)	11-13-74	1000
40.	H15CQ65GE4	62	91	34400	35-175785	Isocandela/ Lumen Chart	11-13-74	1000
41.	H15CQ65HU1	7	92	34400	HP-00392	Isocandela/ Lumen Chart	Approx. 1975	35800
42.	H15CQ65LA1	6	87	34400	-	Isocandela/ Lumen Chart	Approx. 1968	33000

LUMINAIRE INDEX
January 1978

	Computer Code	C.P. File No.*	Fixture No.**	Actual Lamp Lumens	PHOTOMETRIC SOURCE DATA			
					I.D. No.	Type***	Test Date	Test Lumens
43.	H15CQ66GE1	23	93	33000	35-174259	Isocandela/ Lumen Chart	3-17-64	33000
44.	H20MX76AD1	19	308	500000	ERL 1563	C.P./Lumen Table	11-6-75	500000
45.	V35WL4MNO1	8	300	4800	ERL 2080	C.P. Table	1-18-77	4800
46.	V55WL4SNO1	9	301	8000	ERL2081A	C.P. Table	1-17-77	8000
47.	V150S3MGE1	38	120	16000	5693	C.P. Table (Comp. P.O.)	3-21-77	100000
48.	V150S4LLA1	11	303	16000	JB-6	C.P. Table	9-16-77	16000
49.	V180L4SAE1	4	103	33000	ERL 1924	C.P. Table	9-16-76	33000
50.	V180L4MAE1	67	100	33000	ERL 1933	C.P. Table	9-14-76	33000
51.	V180L4MAE2	5	101	33000	ERL 1934	C.P. Table	9-17-76	33000
52.	V180L4MLU1	65	102	33000	2634	Isocandela Diagram	Approx. 1975	33000
53.	V180L4SQU1	64	104	32000	17218	C.P. Table (Comp. P.O.)	1-24-74	32000
54.	V180L4SQU2	68	105	33000	17218	C.P. Table (Comp. P.O.)	1-24-74	32000
55.	V180LGWVL1	55	304	33000	429986	Lumen Chart	11-14-74	7700(55W)
56.	V250S3MAE1	3	121	25500	25-37	Isocandela Diagram	10-14-75	25500
57.	V250S3MGE1	63	122	25500	5819	C.P. Table (Comp. P.O.)	3-21-77	100000
58.	V250S3MGE2	33	123	25500	35-175135	Isocandela Diagram	4-28-70	25000
59.	V250S3MWE1	35	124	25500	672303	Isocandela Diagram	12-6-74	1000
60.	V250S4MWE1	34	126	25500	672316	Isocandela Diagram	12-23-74	1000
61.	V250S4LAE1	60	125	25500	I-2351	C.P. Table (Comp. P.O.)	Approx. 10-1-75	25500
62.	V400S2SGE1	30	127	(Test Luminaire-C.P. Table obtained from Alabama Highway Department)				
63.	V400S3MGE1	37	128	50000	5819	C.P. Table (Comp. P.O.)	3-21-77	100000

LUMINAIRE INDEX
January 1978

	Computer Code	C.P. File No.*	Fix-ture No.**	Actual Lamp Lumens	PHOTOMETRIC SOURCE DATA			
					I.D. No.	Type***	Test Date	Test Lumens
64.	V400S4LAE1	56	129	50000	I-2350	C.P. Table (Comp. P.O.)	Approx. 10-1-75	50000
65.	V400S4MWE1	36	130	50000	672241	Isocandela Diagram	1-4-74	1000
66.	V10CS5MGE1	31	306	130000	35-175227	C.P. Graph	3-16-73	130000
67.	V10CS65HO1	59	42	140000	27189-P	C.P. Table (Comp. P.O.)	Approx. 1975	140000
68.	V10CS76CH1	18	43	140000	45803	C.P. Table (Comp. P.O.)	Approx. 1970	130000

* The Candlepower File Number identifies the Corps of Engineers data file (computer printout) associated with a specific luminaire. (See p. B14)

** See "LUMINAIRE IDENTIFICATION GUIDE".

*** C.P. = Candlepower
P.O. = Printout
Comp. = Computer

NOTES:

1. The computer codes are in general alphanumeric order; wattage symbols appear in the order of the wattage represented rather than strict numeral order (i.e. "V55W..." before "V150..." and "H10C..." after H500...").

2. All manipulations involving these luminaires must be referenced from the photometric test position. Floodlights are normally positioned with the lens face 90° from the aiming vector (i.e. normal to it) per sheet 1 of Figure 23. A floodlight tested by the VPA format (no. 67) will have the plane of the lens positioned at 0°. In this position the plane of the lens is normal to the vertical aiming reference vector. See Sheet 3 of Figure 23. The beam axis of the General Electric Versaflood I (#9) is positioned 25° above the candlepower test axis (lens 115° from test axis). The longitudinal axis of the Interstate luminaires (Nos. 61 and 64) is tilted 30° from the horizontal aiming reference vector (sheet 3 of Figure 23).

KEY TO LUMINAIRE COMPUTER CODES

Sample Codes	{	H	15C	Q	75	GE	2
	{	V	180	L	4M	AE	1
Position --		A	B	C	D	E	F

Position A: Photometric Test Format. Use "H" for horizontal polar axis, "V" for vertical polar axis.

Position B: Nominal wattage. "C" is equivalent to "00", "M" to "000". The "W" (used in a few codes) represents watts.

Position C: Type of Source. "Q" indicates quartz iodine, "I" incandescent "F" fluorescent, "M" mercury vapor, "H" metal halide, "S" high pressure sodium, "L" low pressure sodium and "X" long arc xenon. An exception is "90LS" (pos. A and B combined) which denotes 90 watt low pressure sodium.

Position D: Beam distribution type: A numeral pair such as "65" refers to a NEMA Type 6x5 floodlight beam. A numeral-letter combination signifies an IES type of distribution pattern - i.e. "3M" is used for a unit having an IES Type III, medium, semicutoff distribution.

Position E: Manufacturer. "AE" is shorthand for American Electric Div. of ITT, "HO" for Holophane Lighting, "AD" for American Daylight Co, etc.

Position F: Differentiation Symbol. The numeral "1" signifies the particular luminaire was the first of that type to have photometric data entered into the computer data storage file. If data for an upgraded model, or different test data for the same unit is entered, the next consecutive numeral (or letter) is used.

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
		A. FLOODLIGHTS (1-99)	
		Low Pressure Sodium (1-19)	
1.	H90LS65NO1 (H90LS65NO) (H90HS65NO)	Norelco 09302 -	Rectangular Flood/SNF-026 90W. L.P.S./SOX90 NEMA 6x5 (120°Hx100°V)
2.	H90LS75SE1 (H90LS75SE)	Sepco Floodlighting 4000-90 NA	Rectang. Flood/Series 4000 90W. L.P.S./SOX90 NEMA 7x5 (140°Hx90°V)
3.	H180L75SE1 (H180LS75SE)	Sepco Floodlighting 4000-180 NA	Rectang. Flood/Series 4000 180W. L.P.S./SOX180 NEMA 7x5 (150°Hx90°V)
4.	H180L76NO1 (H180LS76NO) (H180HS76NO)	Norelco 09304 -	Rectang. Flood/SNF-027 180 W. L.P.S./SOX180 NEMA 7x6 (140°Hx110°V)

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
	High Pressure Sodium (20-49)		
20.	H135L75SE1 (H135LS75SE)	Sepco Floodlighting 4000-135 NA	Rectangular Flood/Series 4000 135W. H.P.S./SOX135 NEMA 7x5 (144°Hx90°V)
21.	H250S65WE1 (H250HS65WE)	Westinghouse R4G-SNGE-65A NA	Rectangular Flood/MRF-250 250W. H.P.S./C250 NEMA 6x5 (129.6°Hx99.0°V)
22.	H250S66HU1 (H250HS66HU)	Hubbell MGS-0250S-624 NA	Circular Flood/Magnuliter II 250W. H.P.S./LU250/BD NEMA 6x6 (127.9°Hx112.0°V)
23.	H250S75WE1 (H250HS75WE)	Westinghouse R4G-SNGE-75A-277 NA	Rectangular Flood/MRF 250 250W. H.P.S./C250 NEMA 7x5 (130.8°Hx90.6°V)
24.	H250S76GE1 (H250HS76GE)	General Electric C875G504 3	Asymmetric Flood/Versaflood I Luminaire 250 W. H.P.S./LU250/BD NEMA 7x6 (139°Hx120°V)
25.	H250S76WE1 (H250HS76WE)	Westinghouse R4G-SNGE-76A-277 NA	Rectangular Flood/MRF 250 250W. H.P.S./C250 NEMA 7x6 (144°Hx109°V)
26.	H400S22HU1 (H400HS22HU)	Hubbell 3245-277HS NA	Circular Flood/Marinelite Series 3000 400W. H.P.S./LU400/BD NEMA 2x2 (24.5°Hx23.5°V)
27.	H400S44WE1 (H400HS44WE)	Westinghouse DHG-SPGE-44A-277 NA	Circular Flood/DL-400 400W. H.P.S./C400 NEMA 4x4 (54.2°Hx54°V)
28.	H400S55HU1 (H400HS55HU)	Hubbell 3545-277HS NA	Circular Flood/Marinelite Series 3000 400W. H.P.S./LU400/BD NEMA 5x5 (90°Hx86.5°V)
29.	H400S55WE1 (H400HS55WE)	Westinghouse DHG-SPGE-55A-277 NA	Circular Flood/DL-400 400 W. H.P.S./C400 NEMA 5x5 (86.1°Hx86.2°V)
30.	H400S62SE1 (H400HS62SE)	Sepco Floodlighting 7000-990-400HPS NA	Rectangular Flood/Series 7000 400W. H.P.S./LU400/BU NEMA 6x2 (105°Hx23°V)
31.	H400S65SE1 (H400HS65SE)	Sepco Floodlighting 7000-90120-400HPS NA	Rect. Flood/Series 7000 400W. H.P.S./LU400/BD NEMA 6x5 (120°Hx90°V)

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
32.	H400S65WE1 (H400HS65WE) (H400HS76WE)	Westinghouse R4G-SPGE-65A-277 NA	Rectangular Flood/MRF 400 400W. H.P.S./C400 NEMA 6x5 (129.6°Hx99.0°V)
33.	H400S67CH1 (H400HS67CH)	Crouse-Hinds 48334 NA	Rectangular Flood/MV/MA Series 400W. H.P.S./C400 NEMA 6x7 (125°Hx142°V)
34.	H400S76CH1 (H400SGRCH1)	Crouse-Hinds GALR-4LEC7 NA	Asymmetric Flood/GAL Series 400W. H.P.S./LU400/BU NEMA 7x6
35.	H400S76GE1	General Electric C539G507 B-2	Rectangular Flood/P400C 400W. H.P.S./LU400/BD NEMA 7x6 (144°Hx112°V)
36.	H400S76SY1 (H400HS76SY)	Sylvania HDF400-561 NA	Rectangular Flood/Batwing Series 400W. H.P.S./LU-400 NEMA 7x6 (137.3°Hx101.4°V)
37.	H400S76WE1 (H400HS76WE)	Westinghouse R4G-SPGE-76A-277 NA	Rectangular Flood/MRF 400 400W. H.P.S./C400 NEMA 7x6 (144°Hx109°V)
38.	H10CS65HO1 (H10CHS65HO) (HS1000WMHO)	Holophane 855-277 NA	Same as No. 42 but with C.P. data in Horizontal Polar Axis (HPA) format.
39.	H10CS76CH1 (HPS1000RCH)	Crouse Hinds GALR-10LEC7 NA	Asymmetric Flood/GAL Series 1000W. H.P.S./LU1000 NEMA 7x6
40.	H10CS76HU1 (H10CHS76HU) (HS1000WHHU)	Hubbell MGL-1000S-614 1	Rectangular Flood/Magnuliter II 1000W. H.P.S./LU1000/BD NEMA 7x6 (137.1°Hx123.9°V)
41.	H10CS76WI1 (H10CHS76WI)	Wide-Lite F-1001-DWRB-EX NA	Rectangular Flood/F Series 1000 W. H.P.S./LU1000/BD NEMA 7x6 (140°Hx127°V)
42.	V10CS65HO1 (V10CHS65HO)	Holophane 855-277 NA	Cylindrical Flood/Vectorflood 1000W. H.P.S./LU1000 NEMA 6x5 (113°Hx76°V)
43.	V10CS76CH1 (V10CHSGRCH)	Crouse Hinds GALR-10LEC7 NA	Same as No. 39 but with C.P. data in Vertical Polar Axis (VPA) format.

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
	Quartz (80-99)		
80.	H300Q65GE1 (H300Q65GE)	General Electric C524G006 NA	Rectangular Flood/QF-500A 300W. Quartz/Q300T3/CL NEMA 6x5 (100°Hx93°V)
81.	H500Q55LA1 (H500Q65LA1) (H500Q65LA)	Landmark Lighting TA063 NA	Rectangular Flood/TA 500 Watt Series 500W. Quartz/Q500T3/CL NEMA 6x5 (98°Hx86°V)
82.	H500065GE2 (H500Q65GE1) (H500Q65GE)	General ELectric C524G006 NA	Rectangular Flood/QF-500A 500W. Quartz/Q500T3/CL NEMA 6x5 (100°Hx93°V)
83.	H15CQ62GE1 (H1500Q62GE)	General Electric C525G005 NA	Rectangular Flood/QF-1500A 1500W. Quartz/Q1500T3/CL NEMA 6x2 (120°Hx27°V)
84.	H15CQ62GE2	General Electric C525G004 NA	Rectangular Flood/QF-1500A 1500W. Quartz/Q1500T3/CL NEMA 6x2 (109°Hx23°V)
85.	H15CQ64LA1 (H1500Q64L)	Landmark Lighting TE041 NA	Rectangular Flood/TE 1500 Watt Series 1500W. Quartz/Q1500T3/CL NEMA 6x4 (118°Hx54°V)
86.	H15CQ64GE1	General Electric C525G005 NA	Rectangular Flood/QF-1500A 1500W. Quartz/Q1500T3/CL NEMA 6x4 (118°Hx48°V)
87.	H15CQ65LA1 (H1500Q65L)	Landmark Lighting TE061 NA	Rectangular Flood/TE 1500 Watt Series 1500W. Quartz/Q1500T3/CL NEMA 6x5 (119°Hx99°V)
88.	H15CQ65GE1	General Electric C525G006 NA	Rectangular Flood/QF-1500A 1500W. Quartz/Q1500T3/CL NEMA 6x5 (121°Hx96°V)
89.	H15CQ65GE2	General Electric C525G006 NA	Same as Fixture No. 88 see Luminaire Index
90.	H15CQ65GE3	General ELectric C525G006 NA	Same as Fixture No. 88 see Luminaire Index
91.	H15CQ65GE4	General Electric C525G006 NA	Same as Fixture No. 88 see Luminaire Index
92.	H15CQ65HU1	Hubbell 5505-G NA	Rectangular Flood/Quartzliter Series 6000 1500W. Quartz/Q1500T3/CL NEMA 6x5 (120.9°Hx80°V)

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
93.	H15CQ66GE1 (H1500Q66GE)	General Electric C525G006 NA	Rectangular Flood/QF-1500A 1500W. Quartz/Q1500T3/CL NEMA 6x6 (122°Hx100°V)

* For rectangular floodlights, the lamp axis is parallel to the lense, in either a vertical or horizontal position. (For quartz-iodine floodlights the horizontal position is standard.) Circular or oval floodlights have the lamp axis oriented perpendicular to the lense. For roadway luminaires, the lamp axis lies in the vertical plane that would bisect the unit longitudinally; its position is horizontal or nearly horizontal.

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
		B. ROADWAY (100-199)	
		Low Pressure Sodium (100-119)	
100.	V180L4MAE1	American Electric 66-88H4-6 Center	Roadway/Series 66 180W. L.P.S./SOX180 IES Type IV, Medium, Noncutoff
101.	V180L4MAE2	American Electric 66-88H4-6 Lower	Roadway/Series 66 180W. L.P.S./SOX180 IES Type IV, Medium, Noncutoff
102.	V180L4MLU1	Lustra Lighting SRP-252-277 I	Roadway/SRP 252 180W. L.P.S./SOX180 IES Type IV, Medium, Cutoff
103.	V180L4SAE1	American Electric 66-884-6 Upper	Roadway/Series 66 180W. L.P.S./SOX180 IES Type IV, Short, Noncutoff
104.	V180L4SQU1	Quality Outdoor Ltg. 9754-27 -	Roadway/Series 9752-9754 180W. L.P.S./SOX180 IES Type IV, Short, Cutoff

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
	High Pressure Sodium (120-149)		
120.	V150S3MGE1	General Electric C728G550-OP4 1	Std. Roadway/M-250A POWR/DOOR 150W. H.P.S./LU150 IES Type III, Medium, Cutoff
121.	V250S3MAE1	American Electric(ITT) 26-6533 3W/SP.A	Std. Roadway/American "400" 250W. H.P.S./LU150 IES Type III, Medium, Semicutoff
122.	V250S3MGE1 (V250S3MGE)	General Electric C724-G-797-OP3(277) 6	Std. Roadway/M-400A POWR/DOOR 250W. H.P.S./LU250 IES Type III, Medium, Semicutoff
123.	V250S3MGE2 (V250HS3SG3)	General ELectric C724G574-277 2	Std. Roadway/M400A 250W. H.P.S./LU250 IES Type III, Medium, Noncutoff
124.	V250S3MWE1	Westinghouse TIG-SNGD-3EA M-A	Std. Roadway/Tudor, OV15 250W. H.P.S/C250 IES Type III, Medium, Semicutoff
125.	V250S4LAE1 (V250HSRLAE)	American Electric(ITT) 186-6536 -	Deep Setback Roadway/Interstate 250W. H.P.S./LU250 IES Type IV, Wide distribution
126.	V250S4MWE1	Westinghouse V2G-SNGD-4EA #7-M-A	Std. Roadway/Tudor, OV-25 250W. H.P.S./C250 IES Type IV, Medium, Semicutoff
127.	V400S2SGE1 (V400HS2SGE)	General Electric (Test Luminaire) -	Standard Roadway 400W. H.P.S./LU400 IES Type II
128.	V400S3MGE1	General Electric C724G564-OP3(277) 6	Std. Roadway/M-400A POWR/DOOR 400W. H.P.S./LU400 IES Type III, Medium, Semicutoff
129.	V400S4LAE1 (V400HSGLAE)	American Electric(ITT) 186-6546 -	Deep Set-Back Roadway/Interstate 400W. H.P.S./LU400 IES Type IV, Wide distribution
130.	V400S4MWE1	Westinghouse V2G-SPGD-4EA #M-A	Std. Roadway/OV-25 400W. H.P.S./C400 IES Type IV, Medium, Noncutoff

LUMINAIRE IDENTIFICATION GUIDE
January 1978

No.	Computer Code	Manufacturer Catalog No. Socket Position	Fixture Type*/Model No. Wattage and Lamp Type/Lamp No. Light Distribution Category
		C. MISCELLANEOUS (300-399)	
300.	V35WL4MN01	Norelco 33825 -	Wall Mounted Unit/SWP-465 35W. Low Pressure Sodium/**SOX35** IES Type IV
301.	V55WL4SN01	Norelco 33826 -	Wall Mounted Unit/SWP-465 55W. Low Pressure Sodium/**SOX55** IES Type IV
302.	H300P56WGE	GE#300PAR56-WFL (Hubbell Lampholder #S-400) NA	PAR Lampholder 300W. PAR/300 PAR56-WFL Wide Beam (60°Hx30°V)
303.	V150S4LLA1	Landmark Lighting JB-57061 Center	Wall Mounted Unit/Series 82 150W. H.P.S./**LU150/BU** IES Type IV
304.	V180LGWVL1	Voight Lighting Ind. O-18 Center	Architectural Roadway/General 180W. Low Pressure Sodium/**SOX180** General Roadway
305.	H400S64CH1 (H400HS75CH)	Crouse-Hinds 1123-400 NA	Oval Floodlight/Series 1100 400W. H.P.S./**LU400/BU** NEMA 6x4 (128.5°Hx48.9°V)
306.	V10CS5MGE1 (V10CHS6GE)	General Electric C741G044 1	High Mast/HM-1000 Symmetrical Luminaire 1000 W. H.P.S./**LU1000/BU** IES Type IV
307.	H10CS76CH2 (H10CHS76CH) (HS1000WHCH)	Crouse Hinds 1123-1000 NA	H.P.S. Floodlight/Series 1100 1000W. H.P.S./**LU1000/BU** NEMA 7x6 (157.6°Hx122.2°V)
308.	H20MX76AD1 (H20MXE76AD)	American Daylight Co. ADC-20 NA	High Intensity Floodlight 20,000W. Xenon Lamp very wide beam NEMA 7x6 (176.2°Hx121.2°V)

CANDLEPROOF TABLE EXHIBIT

NO.	LUMI	NO.	LUMI	NO.	LUMI	NO.	LUMI
1	H150[illegible]5GE3	2	H500[illegible]5GE2	3	V250[illegible]3M3E1	4	V160L4SAE1
5	V140L4MAE2	6	H150[illegible]5LA1	7	H150[illegible]01	8	V3DWL4MN01
9	V55WL4SN01	10	H10C[illegible]76CH1	11	V150[illegible]LLA1	12	H10C[illegible]5GE2
13	H60L[illegible]65N01	14	H180[illegible]76N01	15	H10C[illegible]7bH01	16	H10C[illegible]76CH2
17	H400[illegible]64CH1	18	V10C[illegible]76CH1	19	H20W[illegible]76E01	20	V300[illegible]5GE1
21	H400[illegible]76SV1	22	H250[illegible]7bXE1	23	H150[illegible]5GE1	24	H400[illegible]7bW1
25	H300[illegible]56VGE	26	H4[illegible]5bHU1	27	H250[illegible]7bGE1	28	H4[illegible]2CH1L
29	H250[illegible]76GE1	30	V400[illegible]2SGE1	31	V1[illegible]GE1	32	H10C[illegible]5HU1
33	V250[illegible]3WGE2	34	V25[illegible]GE1	35	V25[illegible]GE1	36	V400S4WAE1
37	V400[illegible]3GE1	38	V150[illegible]GE1	39	H1[illegible]GE1	40	H150[illegible]2GE1
41	H150[illegible]5GE1	42	H150[illegible]5GE1	43	H10[illegible]5GE2	44	H400S7bCH1
45	H400[illegible]76GE1	46	H400[illegible]GE1	47	H40[illegible]5GE1	48	H400S[illegible]5E1
49	H400[illegible]5GE1	50	H135[illegible]5GE1	51	H40L[illegible]5GE1	52	H1C0L75GE1
53	H250[illegible]5WE1	54	H10C[illegible]76N11	55	V160L[illegible]WVL1	56	V400S4LAE1
57	H400[illegible]67CH1	58	H250[illegible]5GHU1	59	V10C[illegible]5HU1	60	V250[illegible]4LAE1
61	H400[illegible]5WE1	62	H10C[illegible]5GE4	63	V25[illegible]GE1	64	V150WL4SWU1
65	V18[illegible]4LU1	66	H500[illegible]5HL21	67	V1[illegible]GE1	68	V150L4S4UE

CANDLEPOWER TABLE SEGMENT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. [illegible]
SF PHOTO CURVE 57[illegible] 11/02/77
CANDLEPOWER CONSTANT -.70353000

HORZ. ANGLES (M 19 19)

VERT.	22.0	30.0	34.0	46.0	54.0	62.0	70.0	78.0	86.0
	90.0	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
-68.0		0	0	57	114	171	228	285	285	342
	342	342	285	285	228	171	114	57	0	0
-60.0		57	57	114	171	228	285	342	342	399
	399	399	342	342	285	228	171	114	57	57
-52.0		57	114	171	228	285	342	399	399	456
	456	456	399	399	342	285	228	171	114	57
-44.0		143	542	1426	2851	3422	3705	4559	4845	4845
	4845	4845	4845	4845	4845	4845	4845	4845	4845	4845
-36.0		257	970	2224	3422	4845	4845	5532	5247	5551
	5818	5551	5247	5532	4845	4845	3422	2224	970	257
-28.0		399	1369	2994	4791	6217	6531	7385	7072	7586
	7871	7586	7072	7385	6531	6217	4791	2994	1369	399
-20.0		513	1711	4043	6473	8242	9247	10465	10352	10808
	11179	10808	10352	10465	9297	8242	6473	4043	1711	513
-12.0		485	1996	5019	8470	11493	13546	15457	15371	16883
	16483	16855	15371	15457	13546	11493	8470	5019	1996	485
-4.0		570	2565	6555	14439	19941	20854	21944	21740	22443
	23327	22443	21737	21944	20854	19941	14439	6555	2565	570
0.0		627	2624	7215	12377	18554	20310	23470	23356	24264
	24981	24264	23356	23470	20310	18554	12377	7215	2624	627
4.0		513	2395	6569	11351	15742	18579	21737	21902	22985
	23670	22985	21902	21737	18579	15742	11351	6569	2395	513
12.0		513	2167	6475	9926	14201	15474	15970	15470	15569
	16996	16569	15970	15470	15474	14201	9926	6475	2167	513
20.0		456	1711	4674	6615	9555	9615	10465	10723	11122
	11464	11122	10723	10465	9615	9555	6615	4674	1711	456
28.0		371	1426	3134	4934	6148	6747	7757	7472	7471
	8156	7471	7472	7757	6747	6148	4934	3134	1426	371

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H15C065GE3 TABLE NO. 1
OF PHOTO CURVE 5765 11/03/77
CANDLEPOWER CONSTANT 5.70352000

VERT.	HORZ. ANGLES (H 15 19)								
	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
90.0	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	156.0
36.0	257	1027	2167	3593	4648	4941	5732	5390	5732
	6046	5732	5390	5732	4931	4649	3593	2167	1027	257
44.0	171	542	1483	2539	3622	3850	4477	4164	4107
	3992	4107	4164	4477	3850	3622	2539	1483	542	171
52.0	57	114	171	228	285	342	399	399	456
	513	456	399	399	342	285	228	171	114	57
60.0	57	57	114	171	228	285	342	342	399
	456	399	342	342	285	228	171	114	57	57
68.0	0	0	57	114	171	228	285	285	342
	399	342	285	285	228	171	114	57	0	0

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H500U55SE2 TABLE NO. 2
OF PHOTO CURVE 4254 11/30/77
CANDLEPOWER CONSTANT 15.76899634

HORZ. ANGLES (H 15 15)

VERT.	38.0	46.0	54.0	62.0	70.0	78.0	86.0	90.0	94.0
	102.0	110.0	118.0	126.0	134.0	142.0			
-52.0	0	0	158	158	158	158	158	158	158
	158	158	158	158	0	0			
-44.0	158	158	631	946	1104	1262	1262	1262	1262
	1262	1104	946	631	158	158			
-36.0	158	552	1104	1340	1498	1656	1656	1735	1656
	1656	1498	1340	1104	552	158			
-28.0	315	867	1419	1892	2208	2602	2681	2838	2681
	2602	2208	1892	1419	867	315			
-20.0	473	1104	1971	2602	3075	3627	3863	4100	3863
	3627	3075	2602	1971	1104	473			
-12.0	473	1340	2444	3469	4336	5125	5598	5835	5598
	5125	4336	3469	2444	1340	473			
-4.0	631	1577	3233	4652	5935	7175	7648	7884	7648
	7175	5835	4652	3233	1577	631			
0.0	631	1735	3548	5204	6544	7806	8042	8358	8042
	7806	6544	5204	3548	1735	631			
4.0	552	1498	3233	4731	5992	7175	7569	7884	7569
	7175	5992	4731	3233	1498	552			
12.0	473	1340	2602	3627	4494	5283	5598	5992	5598
	5283	4494	3627	2602	1340	473			
20.0	473	1183	1892	2523	3390	3863	4258	4415	4258
	3863	3390	2523	1892	1183	473			
28.0	394	867	1498	1971	2365	2681	2838	2996	2838
	2681	2365	1971	1498	867	394			
36.0	237	710	1104	1498	1656	1813	1892	2050	1892
	1813	1656	1498	1104	710	237			
44.0	158	315	631	946	1183	1262	1262	1419	1262
	1262	1183	946	631	315	158			

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H300M55GE2 TABLE NO. 2
OF PHOTO CURVE 4254 11/30/77
CANDLEPOWER CONSTANT 15.76998634

HORZ. ANGLES (H 15 15)

VERT.										
	38.0	46.0	54.0	62.0	70.0	78.0	86.0	90.0	94.0	
102.0	110.0	118.0	126.0	134.0	142.0					
52.0	0	0	158	158	158	158	158	158	158	
158	158	158	158	0	0					

B12

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V250S3MAE1 TABLE NO. 3

HORZ. ANGLES (V 3M 14)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0
	265.0	275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
0.0		300	450	500	540	440	320	300	120	20
	0	0	0	20	120	300	320	440	540	500
	450	300	80	0	0	0	0	0	40	250
	250	40	0	0	0	0	0	80	300	450
5.0		480	600	970	850	633	500	500	420	280
	140	130	140	240	420	500	500	533	850	970
	600	480	230	70	20	0	0	0	100	630
	630	100	0	0	0	20	70	230	480	600
10.0		635	1060	2230	4250	1700	650	540	660	430
	390	340	390	430	660	840	650	1700	4250	2230
	1060	635	360	210	100	50	0	0	95	640
	640	95	0	0	50	100	210	380	635	1060
15.0		1100	3700	6780	9700	4250	1600	1060	950	800
	650	640	650	800	950	1060	1600	4250	9700	6780
	3700	1100	620	490	325	125	90	80	90	620
	620	90	80	90	125	325	490	620	1100	3700
20.0		3825	8000	10500	9750	2660	2250	1700	1140	1140
	1160	1160	1160	1140	1190	1700	2250	2660	9750	10500
	8000	3825	960	638	430	375	230	200	200	500
	500	200	200	230	375	430	638	960	3825	8000
25.0		6760	9750	9720	8200	5780	3900	2600	2130	2220
	2260	2230	2260	2220	2130	2600	3900	5780	8200	9720
	9750	6760	2000	1120	900	630	460	420	420	475
	475	420	420	460	630	900	1120	2000	6760	9750
30.0		6050	7800	7100	6200	5720	5150	2800	3450	4000
	4300	4100	4300	4000	3450	2800	5150	5720	6200	7100
	7800	6050	3900	1950	1280	980	625	560	645	500
	500	645	560	625	980	1280	1950	3900	6050	7800
35.0		5520	6050	6050	5800	6250	5700	4950	5100	5400
	6300	6200	6300	5400	5100	4650	5700	6250	5800	6050
	6050	5520	5200	3300	2100	1600	1150	920	900	800
	800	900	920	1150	1600	2100	3300	5200	5520	6050

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V25[illegible]MAE1 TABLE NO. 3

HORZ. ANGLES (V 30 14)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
	275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
45.0		5000	5200	6600	5950	6350	5400	5720	5500	6500
	7100	6700	7100	6600	5900	5720	5400	6350	5950	6500
	5200	5000	4900	4500	3150	2750	2000	1450	1350	1400
	1400	1350	1450	2000	2750	3150	4500	4600	5000	5200
55.0		4900	5110	5040	5130	5400	5130	5170	5800	5400
	6300	5400	6300	6600	5800	5170	5130	5400	5140	5040
	5110	4900	4700	4450	3600	3250	2750	2225	1910	1950
	1950	1910	2225	2750	3250	3600	4450	4700	4900	5110
65.0		4770	4820	4810	4900	4950	4940	5110	5060	5100
	5300	5200	5300	5100	5060	5110	4940	4950	4900	4810
	4820	4770	4600	4200	3850	3650	3400	2550	2500	2570
	2570	2500	2550	3400	3650	3850	4200	4500	4770	4820
75.0		4600	4500	4570	4700	4990	5100	5500	5130	4650
	4800	4770	4800	4650	5130	5600	5100	4990	4700	4570
	4500	4500	4500	4200	3950	3780	3580	3400	3350	3500
	3500	3350	3400	3580	3780	3950	4200	4500	4600	4500
85.0		4200	4200	4350	4500	4650	4800	4700	4500	4300
	4210	4250	4210	4300	4500	4700	4800	4650	4500	4350
	4200	4200	4200	4100	3910	3900	3800	3760	3750	3790
	3790	3750	3760	3800	3900	3910	4100	4200	4200	4200
90.0		4000	4000	4000	4000	4000	4000	4000	4000	4000
	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V1A0L4SAE1 TABLE NO. 4

HORZ. ANGLES (V 34 13)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	90.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
VERT.									
0.0		251	372	570	743	1139	1615	1567	1515	529
	180	148	180	529	1515	1567	1615	1139	743	570
	372	251	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	251	372
5.0		530	1112	1548	2035	2564	2764	2745	1909	700
	376	341	376	700	1909	2745	2764	2564	2035	1548
	1112	530	433	329	0	0	0	0	0	0
	0	0	0	0	0	0	329	433	530	1112
10.0		1827	2435	3128	3635	3764	4046	3535	1939	1020
	676	644	676	1020	1939	3535	4045	3764	3635	3128
	2435	1827	1305	957	683	493	358	244	117	17
	17	117	244	358	493	683	957	1305	1827	2435
15.0		3692	3951	4374	4732	5167	5008	3551	2178	1345
	947	870	947	1345	2178	3551	5008	5167	4732	4374
	3951	3692	3094	2593	2179	1772	1445	984	521	62
	62	521	984	1445	1770	2179	2593	3094	3692	3951
20.0		4628	5110	5659	5964	5743	4906	3470	2479	1720
	1184	1100	1184	1720	2479	3470	4906	5783	5968	5559
	5110	4628	4198	3946	3530	3040	2574	1887	790	246
	246	790	1887	2576	3040	3530	3946	4198	4626	5110
25.0		5986	6179	6330	6214	5758	4761	3600	2711	2030
	1462	1309	1462	2030	2711	3600	4761	5758	6214	6330
	6179	5986	5660	5212	4797	4251	3313	2027	954	592
	592	954	2027	3313	4251	4797	5212	5660	5986	6179
35.0		6398	6322	6145	5806	5388	4554	3619	3103	2556
	2036	1969	2036	2556	3103	3619	4554	5388	5806	6145
	6322	6398	6245	5848	5142	4100	2977	2228	1591	1233
	1233	1591	2228	2977	4100	5142	5848	6245	6398	6322
45.0		5870	5881	5854	5505	4805	4116	3811	3579	3121
	2787	2755	2787	3121	3579	3811	4116	4805	5505	5854
	5881	5870	5634	5179	4469	3724	3128	2652	2146	1702
	1702	2146	2652	3128	3724	4469	5179	5634	5870	5881

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V1H0L4SAE1 TABLE NO. 4

HORZ. ANGLES (V 34 13)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
	275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
55.0		4724	4672	4531	4343	4206	4316	4163	3906	3582
	3364	3326	3356	3582	3906	4163	4315	4326	4343	4531
	4672	4724	4572	4277	3893	3631	3344	3012	2565	2229
	2229	2565	3012	3394	3631	3889	4277	4572	4724	4572
65.0		4423	4444	4439	4430	4324	4316	4299	4155	3909
	3724	3723	3726	3909	4155	4299	4316	4324	4430	4439
	4444	4423	4319	4182	3990	3782	3600	3290	3049	2910
	2910	3049	3290	3600	3782	3990	4182	4319	4423	4446
75.0		4265	4364	4321	4299	4263	4219	4125	4020	3903
	3842	3860	3842	3903	4020	4125	4210	4263	4299	4321
	4364	4265	4109	4044	3964	3872	3737	3587	3471	3381
	3381	3471	3587	3737	3872	3964	4044	4109	4265	4364
85.0		3939	3886	3877	3879	3875	3867	3856	3850	3850
	3849	3864	3849	3850	3850	3856	3867	3875	3879	3877
	3886	3889	3883	3866	3839	3804	3781	3756	3729	3733
	3733	3729	3756	3781	3804	3839	3866	3883	3889	3886
90.0		3775	3775	3775	3775	3775	3775	3775	3775	3775
	3775	3775	3775	3775	3775	3775	3775	3775	3775	3775
	3775	3775	3775	3775	3775	3775	3775	3775	3775	3775
	3775	3775	3775	3775	3775	3775	3775	3775	3775	3775

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V1x0L4MAE2 TABLE NO. 5

HORZ. ANGLES (V 39 13)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
	275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
0.0		1903	2152	2444	2652	2922	2942	2528	1490	445
	224	200	224	445	1490	2528	2942	2922	2652	2444
	2152	1903	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1903	2152
5.0		2612	3109	3490	3800	4022	3830	2751	1360	654
	422	391	422	654	1360	2751	3830	4022	3800	3490
	3109	2612	2184	1841	0	0	0	0	0	0
	0	0	0	0	0	0	1841	2184	2612	3109
10.0		3856	4300	4687	5094	4940	4049	2529	1541	965
	666	664	666	965	1541	2529	4049	4940	5094	4687
	4300	3856	3374	2853	2340	1811	1280	771	275	52
	52	275	771	1280	1811	2340	2853	3374	3856	4300
15.0		5178	5457	5668	5528	5059	3876	2590	1829	1269
	902	950	902	1269	1829	2590	3876	5059	5528	5668
	5457	5178	4596	4157	3647	2975	2309	1505	604	96
	96	604	1505	2309	2975	3647	4157	4596	5178	5457
20.0		5967	6203	6098	5625	4602	3545	2731	2100	1574
	1104	1023	1104	1574	2100	2731	3545	4602	5625	6098
	6203	5967	5636	5273	4650	3799	2749	1883	566	278
	278	566	1583	2749	3799	4650	5273	5636	5967	6203
25.0		5978	5915	5660	5116	4395	3690	2858	2313	1824
	1334	1246	1334	1824	2313	2858	3690	4395	5116	5660
	5915	5978	5631	5364	4642	3606	2410	1401	844	598
	598	844	1401	2410	3606	4642	5364	5631	5978	5915
35.0		5024	5043	4993	4736	4197	3465	3078	2712	2220
	1847	1800	1847	2220	2712	3078	3465	4197	4736	4993
	5043	5024	4850	4466	3873	3126	2420	1901	1433	1101
	1101	1433	1901	2420	3126	3873	4465	4850	5024	5043
45.0		4601	4553	4417	4050	3730	3560	3346	3032	2665
	2472	2441	2472	2665	3032	3346	3560	3730	4050	4417
	4553	4601	4372	3940	3453	3004	2551	2306	1898	1515
	1515	1988	2306	2651	3004	3453	3940	4372	4601	4553

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V18UL4MAE2 TABLE NO. 5

HORZ. ANGLES (V 39 13)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
	275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
55.0		3808	3809	3826	3842	3863	3887	3537	3310	3097
	2973	3000	2973	3097	3310	3537	3887	3863	3842	3826
	3809	3808	3725	3608	3421	3167	2906	2570	2233	2011
	2011	2233	2570	2908	3167	3421	3606	3725	3808	3809
65.0		3424	3835	3796	3766	3687	3663	3594	3585	3441
	3334	3364	3334	3441	3544	3694	3643	3587	3746	3796
	3835	3824	3715	3562	3343	3202	3034	2902	2652	2579
	2579	2652	2802	3034	3202	3383	3562	3715	3824	3835
75.0		3652	3742	3728	3714	3694	3647	3582	3525	3487
	3466	3500	3466	3487	3525	3582	3647	3594	3714	3728
	3742	3652	3529	3478	3412	3316	3209	3100	3057	3021
	3021	3057	3100	3209	3316	3412	3478	3529	3652	3742
85.0		3429	3439	3441	3453	3459	3459	3454	3459	3467
	3479	3479	3479	3467	3459	3454	3458	3458	3453	3441
	3439	3429	3421	3409	3390	3367	3362	3358	3355	3354
	3354	3355	3358	3362	3367	3390	3409	3421	3429	3439
90.0		3406	3406	3406	3406	3406	3406	3406	3406	3406
	3406	3406	3406	3406	3406	3406	3406	3406	3406	3406
	3406	3406	3406	3406	3406	3406	3406	3406	3406	3406
	3406	3406	3406	3406	3406	3406	3406	3406	3406	3406

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H15CW55LA1 TABLE NO. 6

HORZ. ANGLES (H 14 12)

VERT.	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0
	115.0	125.0	135.0	145.0	155.0				
-55.0		0	0	0	0	20	30	30	30	30
	20	0	0	0	0					
-45.0		0	0	40	1300	3360	3620	3770	3770	3620
	3360	1300	40	0	0					
-35.0		0	50	1320	3990	4530	4440	4420	4420	4440
	4530	3990	1320	50	0					
-25.0		0	240	3700	5530	6005	6000	5800	5400	6000
	6005	5530	3700	240	0					
-15.0		20	2280	6040	8920	10160	10300	10460	10460	1030
	10160	8920	6040	2280	20					
-5.0		60	5030	12570	20720	25910	27880	28980	28980	27880
	25910	20720	12570	5030	60					
5.0		40	4910	11980	20180	25150	27220	28460	28460	27220
	25150	20180	11980	4910	40					
15.0		10	1680	5800	8620	9930	10100	10150	10150	10100
	9930	8620	5800	1680	10					
25.0		0	180	3600	5490	6080	5620	5800	5800	5620
	6080	5480	3600	180	0					
35.0		0	20	974	3270	4420	4510	4560	4560	4510
	4420	3270	974	20	0					
45.0		0	0	200	1340	2760	3550	3740	3740	3550
	2760	1340	200	0	0					
55.0		0	0	0	0	20	30	40	40	30
	20	0	0	0	0					

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H15C055HU1 TABLE NO. 7

HORZ. ANGLES (H 14 16)

VERT.	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
-60.0		50	93	135	113	20	44	163	158	158
	163	44	20	113	135	93	50			
-52.0		80	190	205	175	145	218	327	317	317
	327	218	145	175	205	190	80			
-44.0		90	280	620	470	867	958	1350	674	674
	1350	958	867	470	620	280	90			
-36.0		110	470	1370	2350	3470	3740	4440	4440	4440
	4440	3740	3470	2350	1370	470	110			
-28.0		130	560	2270	4350	5780	6530	6700	6620	6620
	6700	6530	5780	4350	2270	560	130			
-20.0		160	650	3150	6640	9060	10190	10830	10620	10620
	10830	10190	9060	6640	3140	650	160			
-12.0		190	700	4250	9470	13400	15860	17320	17510	17510
	17320	15860	13400	9470	4260	700	190			
-4.0		220	750	4880	11760	17930		24880	25480	25480
	24880	22170	17930	11760	4880	750				
4.0		210	720	4810	11640	17640	21690	24310	24960	24960
	24310	21690	17640	11640	4810	720	210			
12.0		180	700	4055	9000	12870	15070	16420	16640	16640
	16420	15070	12870	9000	4055	700	180			
20.0		150	650	3020	6170	8430	9500	9930	9870	9870
	9930	9500	8430	6170	3020	650	150			
28.0		120	560	2060	4000	5300	6010	6170	6100	6100
	6170	6010	5300	4000	2060	560	120			
36.0		100	470	1170	2180	3230	3220	3660	4160	4160
	3680	3220	3230	2180	1170	470	100			
44.0		85	280	410	470	819	784	1140	674	674
	1140	784	819	470	410	280	85			

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: P15CQ65HU1 TABLE NO. 7

HORZ. ANGLES (M 16 16)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
105.0	115.0	125.0	135.0	145.0	155.0	165.0			
VERT.									
52.0	75	190	205	175	145	218	327	317	317
327	218	145	175	205	190	75			
60.0	30	93	135	118	20	44	163	156	158
163	44	20	118	135	93	30			

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V35WL4MN01 TABLE NO. 8

HORZ. ANGLES (V 3H 9)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
5.0		56	97	217	286	303	300	290	313	365
	404	404	365	313	290	300	303	286	217	97
	56	83	71	34	16	4	0	0	0	0
	0	0	4	16	34	71	83	56	97	
15.0		123	185	343	443	459	413	435	532	664
	715	715	664	532	435	413	459	443	343	185
	123	119	72	35	18	9	2	0	0	0
	0	2	9	18	35	72	119	123	185	
25.0		150	238	375	501	565	619	707	811	899
	923	923	899	811	707	619	565	501	375	238
	150	147	103	51	29	21	16	14	13	13
	14	16	21	29	51	103	147	150	238	
35.0		184	282	397	504	615	765	859	933	994
	1014	1014	994	933	859	765	615	504	397	282
	184	169	133	94	53	37	28	27	25	25
	27	28	37	53	94	133	168	184	282	
45.0		222	313	425	535	644	763	874	961	1010
	1032	1032	1010	961	874	763	644	535	425	313
	222	203	142	158	118	79	52	44	44	44
	44	52	79	118	158	182	203	222	313	
55.0		301	374	483	598	694	745	870	941	990
	1020	1020	990	941	870	785	694	598	483	374
	301	286	261	265	236	208	174	144	128	128
	144	174	208	236	265	281	286	301	374	
65.0		379	446	527	635	723	800	859	896	928
	948	948	928	896	859	800	723	635	527	446
	379	351	351	360	354	352	344	342	344	344
	342	344	352	354	360	351	351	379	446	
75.0		437	478	521	573	625	680	724	747	774
	788	788	774	747	724	680	625	573	521	478
	437	400	380	384	388	390	391	395	400	400
	395	391	390	388	384	380	400	437	478	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V35WL4MN01 TABLE NO. 0

HORZ. ANGLES (V 39 9)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
85.0		476	490	504	523	537	547	553	557	562
	564	564	562	557	553	547	537	523	504	490
	476	465	450	436	425	417	413	411	410	410
	411	413	417	425	436	450	465	476	490	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V55WL4SN01 TABLE NO. 9

HORZ. ANGLES (V 36 9)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
5.0		92	166	354	436	457	463	463	463	543
	584	544	543	493	463	460	457	436	356	166
	92	119	101	44	22	11	4	3	3	3
	3	4	11	22	44	101	119	92	166	
15.0		184	281	540	673	653	591	653	681	948
	1030	1030	948	681	653	591	653	673	540	281
	184	167	104	47	27	15	8	4	5	5
	4	8	15	27	47	104	167	184	281	
25.0		229	339	559	777	879	935	1030	1195	1308
	1361	1361	1308	1195	1030	935	879	777	559	339
	229	225	157	70	41	31	27	22	21	21
	22	27	31	41	70	157	225	229	339	
35.0		275	376	545	733	926	1175	1341	1471	1539
	1566	1566	1539	1471	1341	1175	926	733	545	376
	275	272	223	141	72	54	44	41	38	38
	41	44	54	72	141	223	272	275	376	
45.0		325	412	558	746	956	1145	1361	1505	1578
	1602	1602	1578	1505	1361	1145	956	746	558	412
	325	321	295	255	173	110	80	72	71	71
	72	80	110	173	255	295	321	325	412	
55.0		435	502	611	754	936	1113	1269	1405	1479
	1506	1506	1479	1405	1269	1113	936	754	611	502
	435	434	427	397	354	292	226	181	152	152
	181	226	292	354	397	427	434	435	502	
65.0		537	598	677	789	901	1021	1123	1199	1253
	1273	1273	1253	1199	1123	1021	901	789	677	598
	537	531	536	544	538	528	523	515	511	511
	515	523	528	538	544	536	531	537	598	
75.0		592	627	670	706	762	812	870	903	919
	930	930	919	903	870	812	762	706	670	627
	592	564	569	580	586	598	591	596	587	587
	596	591	598	586	580	569	564	592	627	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V55WL4SN01 TABLE NO. 9

HORZ. ANGLES (V 3# 9)

	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	

VERT.

85.0		628	634	647	662	679	690	697	700	699
	699	699	699	700	697	690	679	662	647	634
	624	617	602	590	580	574	572	576	577	577
	576	572	574	580	590	602	617	624	634	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H100S7sCH1 TABLE NO. 10

HORZ. ANGLES (H 18 14)

VERT.	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
-76.0		246	404	727	1108	1573	2178	2817	3221	3221
	2817	2178	1573	1108	727	404	246			
-68.0		458	937	1938	12422	15158	16687	17592	17963	17963
	17592	16687	15158	12422	1938	937	458			
-60.0		946	1615	10419	16655	18835	20112	21145	21872	21872
	21145	20112	18835	16655	10419	1615	946			
-52.0		1066	5429	14438	19442	21540	24457	26686	26842	26842
	26686	24457	21540	19442	14438	5429	1066			
-44.0		1712	9272	16380	20419	24166	29497	36605	44552	44552
	36605	29497	24166	20419	16380	9272	1712			
-36.0		2649	10532	15960	20289	26815	40191	64098	90268	90268
	64098	40191	26815	20289	15960	10532	2649			
-28.0		3036	9951	14797	19902	33277	55634	84065	105646	105646
	84065	55634	33277	19902	14797	9951	3036			
-20.0		2943	9206	12665	18609	32695	50529	72757	89751	89751
	72757	50529	32695	18609	12665	8206	2843			
-12.0		2326	6303	10985	16800	28302	39157	53954	64034	64034
	53954	39157	28302	16800	10985	6303	2326			
-4.0		1518	4523	9498	14312	18835	24328	31823	37542	37542
	31823	24328	18835	14312	9498	4523	1518			
4.0		888	1842	2988	4491	5185	6106	9385	12891	12891
	9385	6106	5185	4491	2988	1842	888			
12.0		507	1047	1809	2921	3418	4129	5964	7657	7657
	5964	4129	3418	2921	1809	1047	607			
20.0		498	795	1370	2171	2468	3173	5079	6668	6668
	5079	3173	2468	2171	1370	795	498			
28.0		417	620	934	1370	1593	2094	3512	4838	4838
	3512	2094	1593	1370	934	620	417			

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V150S4LLA1 TABLE NO. 11

HORZ. ANGLES (V 21 21)

VERT.	0.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	90.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	180.0								
-10.0		195	230	234	279	449	613	712	979	1183
	1150	1099	1150	1183	979	712	610	449	278	234
	230	195								
-5.0		212	292	303	358	581	776	993	1340	1862
	2005	1944	2005	1862	1340	993	776	581	358	303
	292	212								
0.0		252	413	438	529	895	1165	1566	2147	2724
	3027	3079	3027	2724	2147	1566	1165	895	529	438
	413	252								
5.0		340	661	661	803	1621	2019	2538	3195	3940
	4049	3987	4049	3940	3195	2538	2019	1621	803	661
	661	340								
10.0		635	1106	1026	1205	2289	3640	4798	5849	5893
	5853	5700	5853	5893	5849	4798	3640	2289	1205	1026
	1106	635								
15.0		1099	1581	1461	1683	3031	4152	5039	5221	5196
	4845	4791	4845	5196	5221	5039	4152	3031	1683	1461
	1581	1099								
20.0		1475	1625	1581	1384	2048	2885	3129	3370	3392
	3443	3425	3443	3392	3370	3129	2885	2048	1384	1581
	1625	1475								
25.0		1325	1672	1431	1384	1906	2574	2691	3089	3297
	3418	3377	3418	3297	3089	2691	2574	1906	1384	1431
	1672	1325								
30.0		1585	2151	1446	1475	2056	2611	2600	2804	3151
	3429	3469	3429	3151	2804	2600	2611	2056	1475	1446
	2151	1585								
35.0		2019	2771	2037	1650	2267	2724	2695	2702	2804
	2844	2848	2844	2804	2702	2695	2724	2267	1650	2037
	2771	2019								
40.0		2695	3553	2749	1972	2344	2859	2822	2736	2757
	2760	2768	2760	2757	2736	2822	2859	2344	1972	2749
	3553	2695								

[illegible]

[illegible] - [illegible]

[illegible] (V 21 21)

	0.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	180.0							
VERT.									
45.		3435	4035	3414	2572	2297	2559	2432	3556	3156
	2961	2934	2990	3052	3156	2532	2554	2297	2552	3414
	4035	3435								
50.0		3432	4232	3845	3145	2511	2472	2505	2817	3005
	3023	3027	3023	3005	2917	2565	2472	2511	3145	3845
	4232	3432								
55.0		3301	4004	4298	3751	3217	2854	2549	2571	2581
	2576	2745	2675	2531	2571	2549	2854	3217	3751	4298
	4004	3301								
60.0		3122	3811	4478	3547	3405	3154	2933	2555	2695
	2739	2724	2734	2545	2555	2533	3154	3455	3547	4478
	3811	3122								
65.0		2914	3159	4115	3854	3345	3134	2954	2506	2747
	2773	2786	2773	2747	2504	2494	3134	3345	3854	4115
	3159	2914								
70.0		2745	2954	3331	3319	3144	3015	3057	3140	3200
	3196	3195	3195	3200	3140	3057	3015	3144	3319	3331
	2954	2745								
75.		2426	2925	3096	3154	3319	3443	3534	3441	3455
	3407	3363	3407	3455	3441	3534	3443	3319	3144	3049
	2925	2426								
80.0		2954	3027	3155	3251	3348	3421	3494	3504	3504
	3504	3626	3604	3564	3554	3494	3421	3348	3251	3155
	3027	2954								
85.0		2947	2972	2969	3034	3074	3057	3089	3016	3023
	3054	3056	3056	3023	3016	4044	3057	3075	3034	2959
	2972	2947								
90.0		2337	2337	2337	2337	2337	2337	2337	2337	2337
	2337	2337	2337	2337	2337	2337	2337	2337	2337	2337
	2337	2337								

```
[illegible] TABLE [illegible]

CANDLEPOWER TABLE - [illegible] TABLE NO. 12

HORZ. ANGLES (H 1 - 18)
            22.0   30.0   38.0   46.0   54.0   62.0   70.0   78.0   86.0
     94.0  102.0  110.0  118.0  126.0  134.0  142.0  150.0  158.0
VERT.

-68.0          0      0     69    103    172    241    275    275    344
      344    275    275    241    172    103     69      0      0

-60.0         69     69    103    172    241    275    344    344    413
      413    344    344    275    241    172    103     69     69

-52.0         69    103    172    241    275    344    413    413    447
      447    413    413    344    275    241    172    103     69

-44.0        138    550   1410   2477   3440   3784   4369   4094   4575
     4575   4094   4369   3784   3440   2477   1410    550    138

-36.0        241    963   2236   3440   4541   4850   5536   5263   5814
     5814   5263   5536   4850   4541   3440   2236    963    241

-28.0        413   1376   2993   4782   6020   6536   7396   7086   7878
     7878   7086   7396   6536   6020   4782   2993   1376    413

-20.0        516   1720   4059   6467   8255   9288  10459  10354  11180
    11180  10354  10459   9288   8255   6467   4059   1720    516

-12.0        432   1995   5022   8462  11490  13554  15445  15377  15478
    15478  15377  15445  13554  11490   8462   5022   1995    432

 -4.0        585   2546   6015  11627  15462  18974  21544  21741  23323
    23323  21741  21544  18974  15462  11627   6015   2546    585

  4.0        516   2408   6605  11352  15755  18836  21810  21913  23667
    23667  21913  21810  18836  15755  11352   6605   2408    516

 12.0        516   2157   5470   9944  11937  13966  15962  15962  16994
    16994  15962  15962  13966  11937   9944   5470   2157    516

 20.0        447   1720   4094   6605   8566   9598  10870  10733  11455
    11455  10733  10870   9598   8566   6605   4094   1720    447

 28.0        378   1410   3096   4919   6142   6777   7774   7465   8153
     8153   7465   7774   6777   6142   4919   3096   1410    378

 36.0        241   1032   2167   3573   4644   4983   5745   5471   6054
     6054   5471   5745   4983   4644   3573   2167   1032    241
```

[illegible] TABLE [illegible]

[illegible] TABLE = LOAD [illegible] CODE: [illegible] TABLE NO. 13

HORZ. AXIS [illegible] 13 111

	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0
	120.0	130.0	140.0	150.0					
VERT.									
-50.0		0	0	0	740	780	740	790	790	780
	780	0	0	0					
-40.0		0	960	960	1260	1280	1330	1350	1330	1280
	1280	960	600	0					
-30.0		0	1200	1200	1300	1360	1420	1480	1420	1360
	1300	1200	840	0						
-20.0		700	1350	1350	1600	1800	2050	2300	2050	1800
	1600	1350	1000	0						
-10.0		400	3600	3600	4500	5600	6700	7900	6700	5600
	4500	3600	2100	700						
0.0		700	4700	4700	7200	6700	9500	10187	9500	8700
	7200	4700	2200	800						
10.0		0	3600	3600	4500	5600	6700	7900	6700	5600
	4500	3600	2100	700						
20.0		0	1350	1350	1600	1800	2050	2300	2050	1800
	1600	1350	1000	0						
30.0		0	1200	1200	1300	1360	1420	1480	1420	1360
	1300	1200	840	0						
40.0		0	960	960	1260	1280	1330	1350	1330	1280
	1280	960	600	0						
50.0		1449	0	0	740	780	740	790	790	780
	780	0	0	0						

[illegible] TABLE NO. 14

[illegible] (H 15 13)

VERT.	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0
	110.0	120.0	130.0	140.0	150.0	160.0			
-60.0		0	0	0	0	0	1500	1500	2000	1400
	1500	0	0	0	0	0				
-50.0		0	0	1600	2100	2600	3100	3300	3400	3300
	3100	2600	2100	1600	0	0				
-40.0		0	1500	2100	2600	3300	3400	3500	3600	3500
	3400	3300	2600	2100	1500	0				
-30.0		0	1600	2300	3000	3400	3500	3600	3700	3600
	3600	3400	3000	2300	1600	0				
-20.0		1500	1800	2300	3600	4300	4400	5500	6200	5600
	4900	4300	3600	2300	1800	0				
-10.0		2600	3200	5400	13200	11000	14000	13200	15500	15200
	14000	11000	13200	5400	3200	1500				
0.0		1500	6800	14200	14300	22200	24500	25500	25050	25500
	24500	22200	14300	13200	6800	2500				
10.0		0	3200	5400	13200	11000	14000	13200	15500	15200
	14000	11000	13200	5400	3200	1500				
20.0		0	1800	2300	3600	4300	4400	5500	6200	5600
	4900	4300	3600	2300	1800	0				
30.0		0	1600	2300	3000	3400	3500	3500	3700	3600
	3600	3400	3000	2300	1600	0				
40.0		0	1500	2100	2600	3300	3400	3500	3600	3500
	3400	3300	2600	2100	1500	0				
50.0		0	0	1600	2100	2600	3100	3300	3400	3300
	3100	2600	2100	1600	0	0				
60.0		22302	0	0	0	0	1500	1400	2000	1400
	1400	0	0	0	0	0				

CANDLEPOWER TABLE LAYOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 15

HORZ. ANGLES (H 1= 1=)

15.0 25.0 35.0 45.0 55.0 65.0 75.0 85.0 95.0
105.0 115.0 125.0 135.0 145.0 155.0 165.0

VERT.

-75.0		130	155	287	38[illegible]	462	543	592	592
	592	543	462	38[illegible]	287	155	13[illegible]		
-65.0		260	368	747	1310	2010	2320	2950	2730	2730
	2840	2320	2010	1310	747	368	260		
-55.0		400	698	1610	4910	6590	7610	7960	8030	8030
	7960	7610	6590	4910	1610	698	400		
-45.0		525	1400	3851	11300	14500	16700	16870	16800	16800
	16870	16700	14500	11300	3851	1400	525		
-35.0		600	2250	8850	17200	22500	27100	29150	29000	29000
	29150	27100	22500	17200	8850	2250	600		
-25.0		650	3640	13200	20600	28400	37000	41700	41200	41200
	41700	37000	28400	20600	13200	3640	650		
-15.0		700	5270	15800	22200	31600	43400	50000	48800	48800
	50000	43400	31600	22200	15800	5250	700		
-5.0		750	6740	16700	22500	32500	46000	52700	50500	50500
	52700	46000	32500	22500	16700	6740	750		
5.0		750	7910	16100	21500	30560	42900	49300	46500	46500
	49300	42900	30560	21500	16100	7910	750		
15.0		700	8140	14500	19200	26300	35400	39900	37400	37400
	39900	35400	26300	19200	14500	8140	700		
25.0		650	7130	12400	16100	21100	26200	28200	26600	26600
	28200	26200	21100	16100	12400	7130	650		
35.0		600	5580	9890	12800	15400	18200	19000	15600	15600
	19000	18200	15400	12800	9890	5580	600		
45.0		525	3260	7070	9210	11100	12600	13300	13400	13400
	13300	12600	11100	9210	7070	3260	525		
55.0		400	930	3910	5230	6710	8010	8570	8010	8010
	8670	8010	6710	5220	3910	930	400		

CANDIPROBER TABLE LAYOUT

CANDIPROBER TABLE - LOAD LINE CODE: [illegible] TABLE NO. 15

FREQ. ANGLES (H 1= 15)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
105.0	115.0	125.0	135.0	145.0	155.0	165.0			
WEST.									
65.0		300	620	1490	2330	3210	3950	4530	4700	4700
	4630	3950	3210	2330	1490	620	300			
75.0		260	388	670	987	1370	1670	1840	1840	1840
	1840	1670	1370	981	690	388	260			

[illegible] FOR TABLE [illegible]

CANDLEPOWER FOR TABLE - LUMINAIRE CODE: H1xC57xC42 TABLE NO. 15

HORZ. ANGLES (H 1a 14)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
VERT.									
-65.0	0	0	0	0	0	0	0	99	99
	0	0	0	0	0	0			
-55.0	0	0	0	0	201	1304	2653	3289	3289
	2653	1304	201	0	0	0	0		
-45.0	0	0	0	1355	3735	5362	6701	7697	7697
	6701	5362	3735	1355	0	0	0		
-35.0	0	0	3046	5889	7671	9428	11224	12336	12336
	11224	9928	7671	5889	3046	0	0		
-25.0	0	3876	8391	10514	13454	15187	16054	16283	16283
	16054	15187	13454	10514	8391	3876	0		
-15.0	3553	13101	15690	18925	21727	22029	21156	21809	21809
	21156	22029	21727	18925	15690	13101	3553		
-5.0	15921	26744	30690	31916	33213	33007	31973	33849	33849
	31973	33007	33213	31916	30690	26744	15921		
5.0	18584	27519	30805	32009	31968	34275	35660	35855	35855
	35660	34275	31968	32009	30805	27519	18584		
15.0	4868	14109	18044	18458	20643	23297	24560	24572	24572
	24660	23297	20643	18458	16049	14109	4868		
25.0	0	3721	8161	9907	12410	15725	18639	17336	17336
	18639	15725	12410	9907	8161	3721	0		
35.0	0	0	2126	5280	7269	9928	12007	13750	13750
	12007	9928	7269	5280	2126	0	0		
45.0	0	0	0	888	3574	5399	7109	8388	8388
	7109	5399	3574	888	0	0	0		
55.0	0	0	0	0	121	1264	2653	3289	3289
	2653	1264	121	0	0	0	0		
65.0	0	0	0	0	0	0	0	99	99
	0	0	0	0	0	0	0		

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H400S54C41 TABLE NO. 17

HORZ. ANGLES (H 14 13)

25.0 35.0 45.0 55.0 65.0 75.0 85.0 95.0 105.0
115.0 125.0 135.0 145.0 155.0

VERT.

-27.5		0	0	0	0	0	884	4409	4409	884
	0	0	0	0	0					
-22.5		0	0	0	0	0	4354	8553	8553	4354
	0	0	0	0	0					
-17.5		0	0	0	0	870	8503	12171	12171	8503
	870	0	0	0	0					
-12.5		166	0	0	0	5217	11972	18355	18355	11972
	5217	0	0	0	0					
-7.5		17031	2249	4259	4640	12173	18775	33026	33026	18775
	12173	4640	4259	2249	166					
-2.5		11406	22069	25185	31920	40072	52721	71513	71513	52721
	40072	31920	25185	22069	17031					
2.5		0	19540	22778	27280	40217	56802	69868	69868	56802
	40217	27280	22778	19540	11406					
7.5		0	1609	3333	4320	13260	20916	40066	40066	20816
	13260	4320	3333	1609	0					
12.5		0	0	0	0	6594	13197	33553	33553	13197
	6594	0	0	0	0					
17.5		0	0	0	0	1884	12789	13881	13881	12789
	1884	0	0	0	0					
22.5		0	0	0	0	0	5374	9473	9473	5374
	0	0	0	0	0					
27.5		0	0	0	0	0	1224	6710	6710	1224
	0	0	0	0	0					
32.5		0	0	0	0	0	0	1250	1250	0
	0	0	0	0	0					

CANDELA/M**2 TABLE - HISTOGRAM

CANDELA/M**2 TABLE - LUMINAIRE CODE: V1xC57xCH1 TABLE NO. 18

HORZ. ANGLES (V 15 14)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
VERT.									
-76.0		224	375	675	1029	1461	2022	2516	2991	2991
	2516	2022	1461	1029	675	375	224		
-68.0		435	870	1800	11535	14085	15435	16335	16680	16680
	16335	15495	14085	11535	1800	870	435		
-60.0		600	1500	9675	15465	17490	18675	19535	20310	20310
	19635	18675	17490	15465	9675	1500	600		
-52.0		990	5040	13500	18090	20280	22710	24780	26550	26550
	24780	22710	20280	18090	13500	5040	990			
-44.0		1590	8610	15210	18960	22440	27390	33990	41370	41370
	33990	27390	22440	18960	15210	8610	1590			
-36.0		2460	9750	14820	18840	24900	37320	59520	83820	83820
	59520	37320	24900	18840	14820	9750	2460			
-28.0		2820	9240	13740	18480	30900	51660	78060	98100	98100
	78060	51660	30900	18480	13740	9240	2820			
-20.0		2640	7620	11760	17280	30360	46920	67560	83340	83340
	67560	46920	30360	17280	11760	7620	2640			
-12.0		2160	5750	10200	15600	26250	36360	50100	59460	59460
	50100	36360	26250	15600	10200	5760	2160			
-4.0		1410	4200	8820	13290	17490	22590	29550	34860	34860
	29550	22590	17490	13290	8820	4200	1410			
4.0		825	1710	2775	4170	4815	5760	8715	11970	11970
	8715	5760	4815	4170	2775	1710	825			
12.0		564	972	1680	2712	3174	3834	5535	7110	7110
	5534	3834	3174	2712	1680	972	564			
20.0		462	734	1272	2016	2292	2945	4716	6192	6192
	4716	2945	2292	2016	1272	734	462			
28.0		387	570	867	1272	1479	1944	3001	4442	4442
	3261	1944	1479	1272	867	576	387			

[illegible] T [illegible] -INTO T

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 19

-0.0Z. ANGLES (H 1[illegible] 14)

5.0 15.0 25.0 35.0 45.0 55.0 65.0 75.0 85.0
95.0 105.0 115.0 125.0 135.0 145.0 155.0 165.0 175.0

VERT.

-85.0 3480 6790 4838 5325 4320 5405 8474 9097 10426
10426 9097 8474 5405 4320 5325 4838 6790 3480

-75.0 11543 20793 13547 13755 14484 15492 14724 14552 15674
15674 14552 14724 15492 14484 13755 13547 20793 11543

-65.0 13154 33513 21414 21090 20499 20934 14011 14652 14694
14694 14652 14011 20934 20499 21090 21414 33513 13154

-55.0 26458 45020 31563 26114 32886 42974 40300 42340 47340
47340 42340 40300 42974 32886 26114 31563 45020 26458

-45.0 33340 57840 42588 33620 47551 47077 49062 61662 64966
64966 61662 49062 47077 47551 33620 42588 57840 33340

-35.0 30619 73927 58088 48078 47712 56597 57500 50146 51281
51281 50146 57500 56597 47712 48078 58088 73927 30619

-25.0 45081 83294 76774 66856 54462 69725 64430 59870 56126
56126 59870 64430 69726 54462 66856 76774 83294 45081

-15.0 49487 91871 95866 95538107723100183127212117494121351
121351117494127212100183107723 95538 95866 91871 49487

-5.0 525921006001146241248291800531573331427752032541990085
199085203259142775157333180095312482911462410060O 52592

5.0 525921006001146241248291800531573331427752032541990085
199085203259142775157333180095312482911462410060O 52592

15.0 49487 91871 95866 95538107723100183127212117494121351
121351117494127212100183107723 95538 95866 91871 49487

25.0 45081 83294 76774 66856 54462 69725 64430 59870 56126
56126 59870 64430 69726 54462 66856 76774 83294 45081

35.0 30619 73927 58088 48078 47712 56597 57500 50146 51281
51281 50146 57500 56597 47712 48078 58088 73927 30619

45.0 33340 57840 42588 33620 47551 47077 49062 61662 64966
64966 61662 49062 47077 47551 33620 42588 57840 33340

B44

[illegible] TABLE [illegible]

[illegible] TABLE - LUMINAIRE CODE: H20M3/330] TABLE NO. 19

HORZ. ANGLES (H 1H 1H)

	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
VERT.									
55.0		25458	45020	31563	25114	32435	42474	40300	42340	47340
	47340	42340	40300	42474	32435	25114	31563	45020	25458	
65.0		13159	33513	21414	21090	20899	20935	19011	14852	14694
	14694	14852	19011	20935	20899	21090	21414	33513	19159	
75.0		11543	20793	13547	13755	14844	15492	14724	14652	15674
	15674	14652	14724	15492	14844	13755	13547	20793	11543	
85.0		3380	6790	4694	5325	4320	5905	6474	9097	10426
	10426	9097	6474	5905	4320	5325	4695	6790	3380	

RADIATION TABLE REPORT

RADIATION TABLE - LOW ALTITUDE 30KM; 4800 BEAM Table No. 20

HORZ. ANGLES (M 14 14)

VERT.	33.0	45.0	56.0	67.0	78.0	78.0	85.0	94.0	102.0	110.0	114.0	126.0	144.0	162.0
-52.0	93	99	0	0	72	99	93	99	117	117	89	99	72	0
-44.0	510	527	359	81	94	14	714	726	726	714	527	359	81	94
-36.0	936	757	611	324	94	835	951	932	932	951	757	611	324	94
-28.0	1237	1087	791	485	199	1237	1487	1515	1515	1487	1087	791	485	199
-20.0	1732	1482	1114	807	243	1732	2051	2145	2145	2051	1482	1114	807	243
-12.0	2444	1976	1401	768	293	2444	2914	3175	3175	2914	1976	1401	768	293
-4.0	3319	2634	1833	890	377	3319	4073	4340	4340	4073	2634	1833	890	377
4.0	3402	2457	1833	949	33	3402	4073	4293	4293	4073	2457	1833	949	33
12.0	2534	2040	1473	755	293	2534	3043	3175	3175	3043	2040	1473	755	293
20.0	1914	1416	1079	689	243	1914	2200	2419	2419	2200	1416	1079	689	243
28.0	1330	1120	862	445	235	1330	1518	1602	1602	1518	1120	862	445	235
36.0	928	456	611	404	142	928	1041	1078	1078	1041	456	611	404	142
44.0	513	527	503	162	94	514	714	726	726	714	527	503	162	94
52.0	94	94	72	0	0	93	99	117	117	89	94	72	0	0

B46

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: W4C05/RSTI TABLE NO. 21

HORZ. ANGLES (M [illegible])

VERT.	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
-85.0		4	10	17	22	25	3	34	33	33
	33	33	34	34	25	22	17	11	4	
-75.0		12	24	44	74	115	171	221	230	220
	220	230	221	171	115	74	44	24	12	
-65.0		20	50	123	225	321	437	495	521	529
	529	521	495	437	321	225	123	50	20	
-55.0		26	92	223	411	2443	2654	2445	2325	2241
	2241	2325	2445	2654	2443	411	223	92	26	
-45.0		31	152	360	2704	4525	4340	4141	3910	3900
	3900	3910	4141	4340	4525	2704	360	152	31	
-35.0		35	221	596	5060	5144	5035	4943	4904	4820
	4820	4904	4943	5035	5144	5060	596	221	35	
-25.0		39	291	1611	6361	6094	6152	5792	5745	5521
	5521	5745	5792	6152	6094	6361	1611	291	39	
-15.0		41	354	5629	13560	13517	12759	10630	11204	10881
	10881	11204	10630	12759	13517	13560	5629	354	41	
-5.0		43	415	9204	25531	29144	24475	16242	17462	16234
	16234	17462	16242	24675	29144	25531	9204	415	43	
5.0		43	427	11647	30416	34111	27190	17433	18966	17087
	17087	18966	17433	27190	34111	30416	11647	427	43	
15.0		42	390	9397	28419	32075	27287	15443	16997	15656
	15656	16997	15443	27287	32075	28419	9397	390	42	
25.0		40	322	4341	19213	17000	11509	8127	7871	7081
	7081	7871	8127	11509	17000	19213	4341	322	40	
35.0		37	234	2057	7545	5945	5325	5011	4945	4656
	4656	4945	5011	5325	5945	7545	2057	234	37	
45.0		34	152	440	4095	4504	4230	3951	3916	3511
	3511	3916	3951	4230	4504	4095	440	152	34	

[illegible] TABLE [illegible]

[illegible] TABLE - [illegible] TABLE NO. 21

HORZ. ANGLES (H [illegible])

	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
VERT.									
55.0		29	91	213	410	2160	2023	1423	1719	1933
	1533	1719	1863	2023	2160	410	213	91	29	
65.0		23	52	178	176	233	297	327	348	363
	343	348	327	297	233	176	178	52	23	
75.0		14	34	51	73	100	135	170	183	193
	193	183	170	138	100	73	51	34	14	
85.0		5	14	25	29	37	42	51	55	53
	53	55	51	42	37	29	25	14	5	

[illegible] TABLE REPORT

[illegible] TABLE - LUMPED-PARAMETER CODE: [illegible] TABLE NO. 22

HORZ. ANGLES (M 12 12)

24.0 36.0 48.0 60.0 72.0 84.0 96.0 108.0 120.0
132.0 144.0 156.0

VERT.										
-55.0		0	134	144	65	0	0	0	0	65
	144	135	0							
-45.0		39	2183	2095	1493	1670	1629	1629	1670	1493
	2095	2183	39							
-35.0		1250	2811	2643	2697	2322	2061	2061	2322	2697
	2643	2811	1250							
-25.0		2422	3378	3933	5014	4009	2803	2803	4009	5014
	3933	3378	2422							
-15.0		2500	3892	5646	7740	6631	6070	6070	6631	7740
	5646	3892	2500							
-5.0		2578	4216	7140	10425	13630	12700	12700	13630	13626
	7140	4216	2578							
5.0		2539	4108	7375	11560	13463	13019	13019	13463	11560
	7375	4108	2539							
15.0		2500	3892	6199	9515	9136	7939	7939	9136	9515
	6199	3892	2500							
25.0		2383	3564	4247	4207	4354	3014	3014	4354	4207
	4247	3564	2383							
35.0		430	2944	3100	2661	2455	2141	2141	2455	2661
	3100	2944	430							
45.0		39	2297	2344	2183	1747	1534	1534	1747	2183
	2344	2297	39							
55.0		0	270	791	734	217	0	0	217	734
	791	270	0							

[illegible] TABLE [illegible]

[illegible] TABLE = LOW [illegible] COUNT OF CURRENT TABLE NO. 23

[illegible]	[illegible]	(M	14	14)						
	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	
	115.0	125.0	135.0	145.0	155.0					
MEAN										
-52.0		145	143	241	361	448	511	761	711	511
	544	361	241	143	145					
-44.0		145	1146	2344	3562	4435	4833	4373	4373	4833
	4034	3562	2344	1146	145					
-36.0		349	1044	3431	4417	5449	6343	6229	6229	6343
	5669	4417	3431	1049	349					
-28.0		583	2364	4825	6824	7491	8154	8428	8428	8154
	7891	6824	4825	2364	583					
-20.0		881	3030	6105	9731	10249	11072	11491	11491	11072
	10249	9731	6105	3030	881					
-12.0		875	3725	7616	11049	13107	13489	13834	13834	13489
	13107	11049	7616	3725	875					
-4.0		1070	4441	9196	13447	16372	14214	14358	14358	14234
	16372	13447	9196	4441	1070					
4.0		1070	4513	9302	13397	16193	14234	14312	14312	14234
	16190	13397	9302	4513	1077					
12.0		873	3858	7949	11249	13489	13831	13977	13977	13831
	13469	11249	7944	3852	873					
20.0		875	3050	6395	9192	10439	12511	12500	12500	12511
	10533	9192	6395	3050	875					
28.0		778	2364	5058	7075	8118	9532	9447	9447	9532
	8118	7075	5058	2364	778					
36.0		583	1862	3779	5319	5941	6834	6724	6724	6834
	5941	5319	3779	1862	583					
44.0		349	1259	2554	3743	4334	4814	4455	4455	4814
	4354	3743	2554	1259	349					
52.0		145	143	340	512	771	948	805	845	894
	771	502	344	143	145					

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: P4005/6EL TABLE NO. 24

VERT. \ HORZ. ANGLES (H 12 121)	24.0	36.0	48.0	60.0	72.0	84.0	96.0	108.0	120.0	132.0	144.0	156.0
-55.0	0	256	252	108	0	0	0	0	108	252	256	0
-45.0	77	4315	4123	3644	3285	3203	3203	3285	3644	4123	4315	77
-35.0	2465	5540	5545	5303	4567	4051	4051	4567	5303	5545	5540	2465
-25.0	4776	6659	7741	9957	7485	5119	5119	7485	9957	7741	6659	4776
-15.0	4930	7671	11190	15295	13437	11934	11934	13437	15296	11190	7671	4930
-5.0	5084	8310	14050	21285	26808	24967	24967	26808	21285	14050	8310	5084
5.0	5007	8097	14513	22728	26480	25595	25595	26480	22728	14513	8097	5007
15.0	4930	7671	12199	18647	17971	15608	15608	17971	18647	12199	7671	4930
25.0	4699	7032	9455	9452	8478	5935	5935	8478	9452	8455	7032	4699
35.0	847	5807	6100	5231	4829	4208	4208	4829	5231	6100	5807	847
45.0	77	4529	4711	4293	3515	3015	3015	3515	4293	4711	4529	77
55.0	0	533	1556	1443	427	0	0	427	1443	1556	533	0

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H30UPSERGE TABLE NO. 25

HORZ. ANGLES (H 16 16)

VERT.	56.0	60.0	64.0	68.0	72.0	76.0	80.0	84.0	88.0	92.0
	96.0	100.0	104.0	108.0	112.0	116.0	120.0			
-15.0		0	0	400	700	900	900	1000	1000	1000
	1000	900	800	700	400	0	0			
-13.0		0	300	800	1300	1650	1900	2000	2000	2000
	2000	1900	1650	1300	800	400	0			
-11.0		200	700	1400	2150	3000	3700	4000	4000	4000
	4000	3700	3000	2150	1400	700	200			
-9.0		400	1000	2250	3500	4500	5200	5700	6000	6000
	5700	5200	4500	3500	2250	1000	400			
-7.0		750	1600	3000	4400	5500	6500	7800	8000	8000
	7800	6500	5500	4400	3000	1600	750			
-5.0		900	2000	3800	5000	6300	8100	8700	9000	9000
	8700	8100	6300	5000	3800	2000	900			
-3.0		1000	2500	4300	5600	7800	8500	9300	10000	10000
	9300	8500	7800	5600	4300	2500	1000			
-1.0		1000	2500	4400	6000	8000	8900	9650	10500	10500
	9650	8900	8000	6000	4400	2500	1000			
1.0		1000	2500	4400	6000	8000	8900	9650	10500	10500
	9650	8900	8000	6000	4400	2500	1000			
3.0		1000	2500	4300	5600	7800	8500	9300	10000	10000
	9300	8500	7800	5600	4300	2500	1000			
5.0		900	2000	3800	5000	6300	8100	8700	9000	9000
	8700	8100	6300	5000	3800	2000	900			
7.0		750	1600	3000	4400	5500	6500	7800	8000	8000
	7800	6500	5500	4400	3000	1600	750			
9.0		400	1000	2250	3500	4500	5200	5700	6000	6000
	5700	5200	4500	3500	2250	1000	400			
11.0		200	700	1400	2150	3000	3700	4000	4000	4000
	4000	3700	3000	2150	1400	700	200			

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: ABCDEFGHIJ TABLE NO. 25

VERT.	HORZ. ANGLES (H 16 18)								
	60.0	64.0	68.0	72.0	76.0	80.0	84.0	88.0	92.0
	96.0	100.0	104.0	108.0	112.0	116.0	120.0		
13.0	0	300	800	1300	1650	1800	2000	2000	2000
	2000	1800	1650	1300	800	300	0		
15.0	0	0	400	700	800	900	1000	1000	1000
	1000	900	800	700	400	0	0		

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H400S55401 TABLE NO. 26

HORZ. ANGLES (H 12 15)

VERT.	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
-60.0	0	0	0	0	68	62	174	279	383
	383	279	174	62	68	0	0	0	0
-52.0	0	0	89	152	607	868	987	1061	1094
	1094	1061	987	868	607	152	89	0	0
-44.0	0	0	256	759	2294	3276	3833	4298	4594
	4594	4298	3833	3276	2294	759	266	0	0
-36.0	0	109	620	1747	4048	6243	7549	9042	10009
	10009	9042	7549	6243	4048	1747	620	109	0
-28.0	0	436	1063	3341	5409	8775	11962	15014	16956
	16956	15014	11962	8778	6439	3341	1063	436	0
-20.0	146	546	1683	4784	8163	11374	16318	21265	25215
	25215	21265	16318	11374	8163	4784	1583	546	146
-12.0	146	764	2215	5771	9917	13970	19860	28466	37685
	37685	28466	19860	13970	9917	5771	2215	764	146
-4.0	146	873	2480	6378	10591	15577	22647	34717	53602
	53602	34717	22647	15577	10591	6378	2480	873	146
4.0	146	873	2569	6374	10389	14497	21486	31368	44468
	44468	31368	21486	14897	10389	6378	2569	873	146
12.0	146	655	2480	5771	9040	12542	17130	23163	28551
	28551	23163	17130	12548	9040	5771	2480	655	146
20.0	0	436	1949	4708	7488	10076	13414	16968	19581
	19581	16968	13414	10076	7488	4708	1949	436	0
28.0	0	436	1506	3721	6274	8036	10162	12503	14002
	14002	12503	10162	8036	6274	3721	1506	436	0
36.0	0	218	886	2582	4520	6162	7549	8875	9845
	9845	8875	7549	6162	4520	2582	886	218	0
44.0	0	0	443	1443	2564	3833	5165	5637	6235
	6235	5637	5165	3833	2564	1443	443	0	0

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 25

HORZ. ANGLES (H 15 15)

	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VERT.									
90.0		0	0	177	456	1012	1918	2149	2456	2571
	2571	2456	2149	1918	1012	456	177	0	0	
80.0		0	0	0	76	279	495	581	726	820
	820	726	581	495	279	76	0	0	0	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: PARMS/CWEI TABLE NO. 27

HORZ. ANGLES (H 1 22)

	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
VERT.									
-84.0		7	5	6	6	4	4	11	9
	9	11	9	9	8	6	5	7	
-76.0		4	8	8	16	28	47	67	84
	84	81	67	42	28	16	8	8	4
-68.0		6	10	24	56	85	155	182	206	229
	229	206	182	156	85	56	24	10	6
-60.0		8	15	57	122	296	311	314	357	350
	350	357	314	311	296	122	57	15	8
-52.0		8	29	102	654	1413	1245	1116	1184	1224
	1224	1184	1116	1285	1413	654	102	29	8
-44.0		8	44	155	2060	2382	2162	1942	1966	1959
	1959	1966	1942	2162	2382	2060	155	44	8
-36.0		8	59	211	2579	2895	2767	2535	2460	2318
	2318	2460	2535	2767	2895	2579	211	59	8
-28.0		8	75	604	2944	3481	3854	3768	3402	2866
	2866	3402	3768	3829	3481	2944	604	75	8
-20.0		8	98	1159	3759	4592	5504	7084	6049	4614
	4614	6049	7084	5504	4592	3759	1159	88	8
-12.0		8	97	1931	3253	5687	7139	11176	10830	11209
	11209	10830	11176	7139	5687	3253	1931	97	8
-4.0		8	101	2304	3335	5901	7964	13541	13626	16532
	16532	13626	13641	7964	5901	3335	2304	101	8
4.0		8	99	2269	3328	5500	6007	13728	13561	16442
	16442	13561	13728	6007	5500	3328	2269	99	8
12.0		8	93	1828	3222	4872	7263	11322	11186	11347
	11347	11186	11322	7263	4872	3222	1828	93	8
20.0		8	82	993	3135	4145	5541	7194	6515	4465
	4465	4515	7194	5541	4145	3135	993	82	8

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 27

HORZ. ANGLES (H 13 22)

VERT.	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
20.0		8	68	265	2795	3445	3654	3773	3236	2725
	2725	3236	3773	3654	3445	2795	265	68	8	
36.0		4	53	193	2499	2927	2632	2410	2296	2143
	2143	2296	2410	2632	2927	2499	193	53	8	
44.0		8	39	145	1793	2375	2069	1779	1741	1706
	1706	1741	1779	2069	2375	1793	145	39	8	
52.0		2	26	98	421	1374	1227	975	980	967
	967	980	975	1227	1374	421	98	26	8	
60.0		8	16	63	125	208	252	233	258	249
	249	258	233	252	208	125	63	16	8	
68.0		6	10	24	54	96	138	171	193	204
	204	193	171	138	96	54	24	10	6	
76.0		4	8	11	19	33	55	85	105	116
	116	105	85	55	33	19	11	8	4	
84.0		2	5	4	4	10	14	60	76	17
	17	76	60	14	10	4	4	5	2	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: 4400:22401 TABLE NO. 28

HORZ. ANGLES (H IA ...le)

	73.0	75.0	77.0	79.0	81.0	83.0	85.0	87.0	89.0
	91.0	93.0	95.0	97.0	99.0	101.0	103.0	105.0	107.0

VERT.

-15.0	10088	12622	15194	18617	21277	24618	27255	27032	27032
	27032	27032	27255	24618	21277	18617	15194	12622	10088
-13.0	11922	15326	18774	22163	27483	33410	39554	43600	44472
	44472	43600	39554	33410	27483	22163	18774	15326	11922
-11.0	14674	18031	22349	28369	37234	47477	59786	67143	69759
	69759	67143	59786	47477	37234	28369	22349	18031	14674
-9.0	16508	18933	25926	36348	48759	64182	78249	91559	98535
	98535	91559	78249	64182	48759	36349	25926	18933	16508
-7.0	16508	21637	30395	44326	62057	80007	101108	120335	134647
	134647	120335	101108	80007	62057	44326	30395	21637	16508
-5.0	17425	23440	35759	52305	71809	95833	125662	173526	223230
	223230	173526	126605	95833	71809	52305	35759	23440	17425
-3.0	17425	27948	40229	60284	80674	103746	144189	244158	369724
	369724	244158	144189	103746	80674	60284	40229	27948	17425
-1.0	19259	29751	45593	67376	87766	109900	155616	254622	458868
	458868	254622	155616	109900	87766	67376	45593	29751	19259
1.0	21093	29751	43805	65603	82447	97541	130121	211543	363342
	363342	211543	130121	97591	82447	65603	43805	29751	21093
3.0	21093	28850	41123	54965	71809	88799	112538	139519	189222
	189222	139519	112538	88799	71809	54965	41123	28850	21093
5.0	20716	26145	35759	52305	69149	90895	91437	104639	129055
	129055	104639	91437	80886	69149	52305	35759	26145	20716
7.0	19259	24342	32183	41667	54078	65940	75511	84583	93303
	93303	84583	75511	65940	54078	41667	32183	24342	19259
9.0	17425	20736	25925	31915	40780	50114	60565	69759	73247
	73247	69759	60665	50114	40780	31915	25925	20736	17425
11.0	13757	16031	20561	24823	30142	37806	45714	55808	61039
	61039	55808	45714	37806	30142	24823	20561	16031	13757

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: 5400S22:001 TABLE NO. 28

HORZ. ANGLES (H 1H 1H)									
	73.0	75.0	77.0	79.0	81.0	83.0	85.0	87.0	89.0
	91.0	93.0	95.0	97.0	99.0	101.0	103.0	105.0	107.0
VERT.									
13.0		11005	14425	16946	18617	23050	29134	33410	39240	41956
	41956	39240	33410	29134	23050	18617	16946	14425	11005	
15.0		10048	10819	13410	15953	17731	20222	30772	27904	29648
	29648	27904	30772	20222	17731	15953	13410	10819	10048	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: H25[illegible]76SE1 TABLE NO. 29

HORZ. ANGLES (H 1a 14)

VERT.	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
-85.0	0	0	129	459	1709	2188	2754	3621	3494
	3494	3621	2754	2188	1709	459	129	0	0
-75.0	0	77	332	1964	2754	4412	5075	3876	3035
	3035	3876	5075	4412	2754	1964	332	77	0
-65.0	0	204	1250	2499	3749	5916	4412	3417	3162
	3162	3417	4412	5916	3749	2499	1250	204	0
-55.0	0	204	2372	2831	4998	8951	4616	4157	3825
	3825	4157	4616	8951	4998	2831	2372	204	0
-45.0	0	255	2576	3162	6962	15453	7038	5661	5330
	5330	5661	7038	15453	6962	3162	2576	255	0
-35.0	0	204	2703	3417	8543	15122	9869	8415	8492
	8492	8415	9869	15122	8543	3417	2703	204	0
-25.0	0	255	2703	3366	7956	12954	13286	11118	14153
	14153	11118	13286	12954	7956	3366	2703	255	0
-15.0	0	204	2423	3086	5202	8874	9333	10736	15122
	15122	10736	9333	8874	5202	3086	2423	204	0
-5.0	0	204	2244	2831	3672	5749	6579	7625	8619
	8619	7625	6579	5749	3672	2831	2244	204	0
5.0	0	204	2040	2499	2831	3494	3621	4157	4539
	4539	4157	3621	3494	2831	2499	2040	204	0
15.0	0	128	1122	2168	2372	2499	2576	2703	3035
	3035	2703	2576	2499	2372	2168	1122	128	0
25.0	0	128	128	1836	1964	1964	1964	1913	1836
	1836	1913	1964	1964	1964	1836	128	128	0
35.0	0	0	128	867	1326	1250	1173	1046	995
	995	1046	1173	1250	1326	867	128	0	0
45.0	0	0	0	0	128	128	128	128	128
	128	128	128	128	128	0	0	0	0

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V400S25NEI TABLE NO. 30

HORZ. ANGLES (V 90)	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0	27.5
	32.5	35.0	37.5	45.0	65.0	85.0	90.0	95.0	115.0	135.0
	142.5	145.0	148.5	152.5	155.0	157.5	162.5	165.0	167.5	172.5
	175.0	177.5	182.5	195.0	197.5	192.5	195.0	197.5	202.5	205.0
	207.5	212.5	215.0	225.0	245.0	265.0	270.0	285.0	305.0	315.0
	325.0	327.5	332.5	335.0	337.5	342.5	345.0	347.5	352.5	355.0
	357.5									
VERT.										
0.0		1120	1120	1120	1120	1120	1120	1120	1120	1120
	1062	1011	790	527	527	527	0	527	527	527
	790	1011	1062	1126	1120	1120	1120	1120	1120	1120
	1120	1120	1120	958	790	789	593	593	593	527
	527	527	527	527	527	527	527	527	527	527
	527	527	527	527	593	593	593	789	790	958
	1120									
2.5		1262	1325	1383	1383	1415	1449	1515	1515	1515
	1317	1250	988	659	564	564	527	564	564	659
	988	1250	1317	1515	1515	1515	1449	1415	1383	1383
	1325	1262	1120	1120	1120	939	705	707	593	527
	527	527	527	527	527	527	527	527	527	527
	527	527	527	527	593	707	705	939	1120	1120
	1120									
5.0		1447	1702	1779	2086	2043	2371	2371	2371	2412
	1977	1515	1317	790	593	593	564	593	593	790
	1317	1515	1977	2412	2371	2371	2371	2043	2086	1779
	1702	1447	1515	1372	1185	1120	1043	942	676	593
	593	593	593	593	593	593	593	593	593	593
	593	593	593	593	676	942	1043	1120	1185	1372
	1515									
7.5		3360	3830	4151	4814	4575	4523	4282	3935	3836
	2701	1861	1713	1053	809	670	593	670	808	1053
	1713	1861	2701	3836	3935	4282	4523	4575	4814	4151
	3830	3360	2503	2021	1735	1449	1245	1101	942	851
	790	726	707	740	725	725	725	725	725	740
	707	726	790	851	942	1101	1245	1449	1735	2024
	2503									
10.0		6556	7235	7774	8367	8046	8037	7180	5500	5995
	3569	2207	1911	1317	1021	840	840	840	1021	1317
	1911	2207	3558	5995	5500	7180	8037	8086	8367	7774
	7235	6556	4743	4362	4145	2305	1968	1647	1317	1255
	1186	1120	1120	1120	956	956	556	550	550	1120
	1120	1120	1186	1255	1317	1647	1968	2305	4145	4362
	4743									

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V400S25SE1 TABLE NO. 30

HORZ. ANGLES (V 60 90)

	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0	27.5
	32.5	35.0	37.5	45.0	55.0	85.0	90.0	95.0	115.0	135.0
	142.5	145.0	148.5	152.5	155.0	157.5	162.5	165.0	167.5	172.5
	175.0	177.5	182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0
	207.5	212.5	215.0	225.0	235.0	255.0	270.0	285.0	305.0	315.0
	325.0	327.5	332.5	335.0	337.5	342.5	345.0	347.5	352.5	355.0
	357.5									
WEST.										
12.5		11920	12450	13770	14610	13830	13240	10150	7065	6286
	3886	2552	2043	1581	1235	989	989	989	1235	1581
	2043	2552	3886	6286	7065	10150	13240	13830	14160	13770
	12450	11920	9222	7447	6720	4480	3724	3030	2110	1894
	1845	1449	1330	1251	988	988	988	988	988	1251
	1330	1449	1845	1894	2110	3030	3724	4480	6720	7447
	9222									
15.0		18640	21810	21610	22200	21210	18970	11790	8630	6390
	3492	2898	2503	1845	1449	1064	1064	1064	1449	1845
	2503	2898	3492	6390	8630	11790	18970	21210	22200	21610
	21810	18640	15350	14230	11660	8564	7576	5665	3228	2767
	2371	1647	1449	1186	1120	1120	1186	1186	1120	1186
	1449	1647	2371	2767	3228	5665	7576	8564	11660	14230
	15350									
17.5		29310	24050	30630	26480	21050	18970	11130	8877	6390
	4084	3835	3294	2733	1841	1317	1317	1317	1841	2733
	3294	3835	4084	6390	8877	11130	18970	21050	26480	30800
	24050	29310	25030	16580	19500	19490	8203	9882	5271	3129
	3030	1977	1663	1350	1350	1350	1449	1350	1350	1350
	1663	1977	3030	3129	5271	9882	8203	19490	19500	16580
	25030									
20.0		33470	26290	32480	26550	20880	18120	10540	9124	6456
	4743	4775	4018	3620	2272	1543	1460	1543	2272	3626
	4019	4775	4743	6456	9124	10540	10120	20888	26550	32480
	26290	33470	29640	16710	23510	16960	8828	11000	4875	3492
	3096	1977	1877	1515	1960	1581	1713	1581	1460	1515
	1877	1977	3096	3492	4875	11000	8828	16960	23510	16710
	29640									
22.5		32740	28530	31360	25692	20720	18450	11560	9377	7642
	6258	5714	5665	4512	2684	2128	1543	2128	2684	4512
	5665	5714	6258	7642	9377	11660	18450	20720	25692	31360
	28530	32740	29970	20950	23580	16960	9454	10570	5665	3896
	3492	2503	2091	1618	1663	1812	1976	1812	1663	1618
	2091	2503	3492	3896	5665	10670	9454	16960	23580	20950
	29970									

BC2

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V400S2S4E1 TABLE NO. 30

HORZ. ANGLES (V 60 30)

VERT.	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0	27.5
	32.5	35.0	37.5	45.0	65.0	85.0	90.0	95.0	115.0	135.0
	142.5	145.0	148.5	152.5	155.0	157.5	162.5	165.0	167.5	172.5
	175.0	177.5	182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0
	207.5	212.5	215.0	225.0	235.0	255.0	270.0	285.0	305.0	315.0
	325.0	327.5	332.5	335.0	337.5	342.5	345.0	347.5	352.5	355.0
	357.5									
25.0		31820	31820	29640	23780	20550	17000	11590	9618	5598
	7114	6654	6456	5401	3046	2371	2128	2371	3046	5401
	6456	6654	7114	8598	9618	11590	17000	20550	23780	29640
	31820	31820	28790	23190	22270	15220	10080	9289	4743	4216
	3426	2603	2305	1845	1845	2043	2240	2043	1845	1845
	2305	2603	3426	4216	4743	9289	10030	15220	22270	23190
	28790									
27.5		27930	27930	25930	21490	18930	16600	12520	9970	9289
	7312	6784	6654	5467	3886	3511	2371	3511	3886	5467
	6654	6784	7312	9289	9970	12520	16600	18930	21490	25930
	27930	27930	26090	20200	20100	13770	9289	8169	4875	4018
	3360	2833	2437	1976	1976	2106	2240	2106	1976	1976
	2437	2833	3360	4018	4875	8169	9289	13770	20100	20200
	26090									
30.0		25160	25160	23780	19760	17300	15680	11920	10320	8827
	6917	6916	6917	5533	4677	4256	3511	4256	4677	5533
	6917	6916	6917	8827	10320	11920	15680	17300	19760	23780
	25160	25160	2220	17220	16800	11400	8498	7246	4342	3819
	3162	2833	2569	2108	2106	2174	2240	2174	2106	2108
	2569	2833	3162	3819	4348	7246	8498	11400	16800	17220
	2220									
35.0		16070	16070	16560	16120	15680	14010	12340	10670	8861
	7410	7048	6596	5599	5467	4743	4256	4743	5467	5599
	6596	7048	7410	8861	10670	12340	14010	15680	16120	16560
	16070	16070	15150	14230	12060	9883	7708	6346	4984	3624
	3316	3009	2701	2240	2240	2240	2240	2240	2240	2240
	2701	3009	3316	3624	4984	6346	7708	9883	12060	14230
	15150									
45.0		12920	12920	13920	14080	14230	13320	12430	11530	10705
	10030	9882	9043	7312	6061	5271	4743	5271	6061	7312
	9043	9882	10030	10705	11530	12430	13320	14230	14080	13920
	12820	12920	11890	10940	9970	8684	8037	6982	5928	4875
	4215	3557	2848	2503	2240	2240	2240	2240	2240	2503
	2898	3557	4215	4875	5928	6982	8037	8684	9970	10940
	11880									

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V40052S8e1 TABLE NO. 30

HORZ. ANGLES (V 60 20)

	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0	27.5
	32.5	35.0	37.5	45.0	85.0	95.0	90.0	95.0	115.0	135.0
	142.5	145.0	148.5	152.5	155.0	157.5	162.5	165.0	167.5	172.5
	175.0	177.5	182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0
	207.5	212.5	215.0	225.0	235.0	255.0	270.0	285.0	305.0	315.0
	325.0	327.5	332.5	335.0	337.5	342.5	345.0	347.5	352.5	355.0
	357.5									

VERT.

55.0		10410	10610	11550	12030	12520	12570	12520	12970	12189
	11545	11336	10640	9091	7444	6324	5271	6324	7444	9091
	10640	11396	11515	12189	12970	12420	12670	12520	12030	11550
	10610	10610	10140	9864	9112	8541	7971	7224	6477	5647
	4918	4106	3294	2437	2240	2240	2305	2240	2240	2437
	3294	4106	4918	5647	6477	7224	7971	8541	9112	9864
	10140									
65.0		10010	10010	10540	10670	10900	10753	10760	10740	10441
	10200	10415	10000	9750	9552	8504	6324	8504	9552	9750
	10080	10145	10200	10441	10740	10760	10753	10900	10670	10540
	10010	10010	9620	9223	8698	8170	7642	7048	6456	5863
	5358	4852	4348	2898	2513	2174	2105	2174	2513	2898
	4349	4852	5354	5863	6456	7048	7642	8170	8698	9223
	9623									
75.0		9440	9440	9771	9860	9950	10010	10080	10150	10211
	10270	10277	10320	10408	10670	9816	8504	9816	10670	10408
	10320	10277	10270	10211	10150	10080	10010	9950	9860	9771
	9440	9440	9201	8959	8739	8521	8301	8037	7729	7444
	7180	6916	6654	6051	5401	4348	4262	4348	5401	6051
	6654	6916	7180	7444	7729	8037	8301	8521	8739	8959
	9201									
85.0		10630	10670	10720	10750	10800	10830	10850	10870	10936
	10990	11000	10960	10940	10740	9583	9816	9583	10740	10940
	10960	11000	10990	10936	10870	10850	10830	10800	10750	10720
	10670	10620	10580	10540	10450	10370	10280	10250	10230	10210
	10190	10170	10150	9816	9684	9355	9421	9355	9684	9816
	10150	10170	10190	10210	10230	10250	10280	10370	10450	10540
	10580									
90.0		10630	10670	10720	10750	10800	10830	10850	10870	10936
	10990	11000	10960	10940	10740	10540	10540	10540	10740	10940
	10960	11000	10990	10936	10870	10850	10830	10800	10750	10720
	10670	10630	10580	10540	10450	10370	10280	10250	10230	10210
	10190	10170	10150	9816	9684	9355	9421	9355	9684	9816
	10150	10170	10190	10210	10230	10250	10280	10370	10450	10540
	10520									

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V1UCSDMGEI TABLE NO. 31

VERT.	HORZ. ANGLES (V 2 10) 0.0	360.0
5.0	3460	3460
15.0	11245	11245
25.0	19030	19030
35.0	25950	25950
45.0	22490	22490
55.0	14270	14270
65.0	9060	9060
75.0	6490	6490
85.0	6920	6920
90.0	9040	9040

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 32

HORZ. ANGLES (H 19 19)

VERT.	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0
	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
-90.0		1613	1538	1288	1026	732	438	263	207	182
	225	182	207	263	438	732	1026	1288	1538	1613
-80.0		1613	1900	1980	1750	1300	990	735	530	495
	525	495	530	735	990	1300	1750	1980	1900	1613
-70.0		1613	2250	2650	2860	2900	2400	1961	1629	1355
	1375	1355	1629	1961	2400	2900	2860	2650	2250	1613
-60.0		1613	2400	3490	4410	4500	4050	3100	3800	4000
	3975	4000	3800	3100	4050	4500	4410	3490	2400	1613
-50.0		1613	2980	4350	6200	7750	7600	7825	8400	8500
	8425	8500	8400	7825	7600	7750	6200	4350	2980	1613
-40.0		1613	3300	5350	8027	10994	11000	14000	15400	15140
	14875	15140	15400	14000	11000	10994	8027	5350	3300	1613
-30.0		1613	3600	6550	10200	14000	17400	23080	23650	22700
	22725	22700	23650	23080	17400	14000	10200	6550	3600	1613
-20.0		1613	3900	7250	11700	17360	26000	34350	35350	35500
	36700	35500	35350	34350	26000	17360	11700	7250	3900	1613
-10.0		1613	3940	7700	13150	20500	35000	49500	50250	64000
	64325	64000	60250	49500	35000	20500	13150	7700	3940	1613
0.0		1613	3957	7756	13294	21263	36725	67388	98676	124431
	149056	124431	98676	67388	36725	21263	13294	7756	3957	1613
10.0		1613	3900	7550	12890	20190	36400	52965	58440	63900
	66250	63900	58440	52965	36400	20190	12890	7550	3900	1613
20.0		1613	3820	6960	11350	16920	28340	39560	35060	36190
	35875	36190	35060	39660	28340	16920	11350	6960	3820	1613
30.0		1613	3475	6200	9740	13400	17600	24000	21520	21560
	21800	21560	21520	24000	17600	13400	9740	6200	3475	1613
40.0		1613	3170	5030	7630	10510	10700	13700	12760	13500
	13325	13500	12760	13700	10700	10510	7630	5030	3170	1613

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE COLOR: [illegible] TABLE NO. 32.

VERT.	HORZ. ANGLES (H 19 @ 19)								
	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0
	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
50.0		1613	2830	4050	5830	7400	7140	7245	7390	7650
	7450	7650	7390	7245	7140	7400	5830	4050	2830	1613
60.0		1613	2770	3205	4100	4200	3800	2950	3500	3700
	3550	3700	3500	2950	3800	4200	4100	3205	2770	1613
70.0		1613	2070	2400	2630	2700	2250	1840	1530	1290
	1325	1290	1530	1840	2250	2700	2630	2400	2070	1613
80.0		1613	1700	1740	1595	1200	930	800	500	465
	450	465	500	680	930	1200	1595	1740	1700	1613
90.0		1613	1350	1103	919	844	400	238	200	194
	150	194	200	238	400	844	919	1103	1350	1613

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V250S3AREZ TABLE NO. 33

HORZ. ANGLES (V S1 1E)									
	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0
145.0	150.0	155.0	160.0	165.0	170.0	175.0	180.0	185.0	190.0
195.0	200.0	205.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0
280.0	290.0	300.0	310.0	320.0	330.0	335.0	340.0	345.0	350.0
355.0	360.0								
VERT.									
-40.0		160	170	170	170	170	170	170	170	160
	170	170	160	160	150	160	160	170	170	150
	170	170	170	170	170	170	170	160	160	160
	150	150	140	130	125	120	120	100	100	100
	100	100	120	120	125	130	140	150	150	160
	160	160								
-30.0		227	227	227	227	205	205	200	200	200
	200	220	220	200	200	200	220	220	200	200
	200	200	205	205	227	227	227	227	220	205
	205	190	180	170	160	150	150	140	140	140
	140	140	150	150	160	170	180	190	205	205
	220	227								
-20.0		300	300	300	300	260	280	280	280	270
	250	270	270	250	220	250	270	270	250	270
	260	260	280	280	300	300	300	300	300	280
	260	240	220	205	205	200	190	175	175	160
	175	175	190	200	205	205	220	240	260	280
	300	300								
-10.0		350	400	400	400	390	390	390	400	475
	410	325	325	325	325	325	325	325	410	475
	400	390	390	390	400	400	400	350	350	325
	325	300	250	240	250	240	220	205	205	205
	205	205	220	240	250	240	250	300	325	325
	350	350								
0.0		600	600	600	630	1000	1000	1000	1000	1000
	630	400	400	410	445	410	400	400	630	1000
	1000	1000	1000	1000	630	600	600	600	515	400
	390	360	350	325	325	325	250	235	232	232
	235	235	250	325	325	325	350	360	340	400
	515	600								
2.5		630	645	1000	1600	2500	3250	2500	2050	1300
	815	515	475	450	442	435	475	515	815	1300
	2050	2500	3250	2500	1600	1000	545	530	500	515
	440	400	375	360	345	345	287	250	250	250
	250	250	287	345	345	360	375	400	440	515
	600	630								

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V25-S3M-E2 TABLE NO. 33

(V S1 18)

HORZ. ANGLES									
	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0
145.0	150.0	155.0	160.0	165.0	170.0	175.0	180.0	185.0	190.0
195.0	200.0	205.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0
280.0	290.0	300.0	310.0	320.0	330.0	335.0	340.0	345.0	350.0
355.0	360.0								

VERT.									
5.0		2050	2875	4000	6300	7145	6400	5150	3250	2500
	1000	630	552	530	538	530	552	630	1000	2500
	3250	5150	6300	7145	6300	4000	2875	2050	1300	630
	555	515	450	400	365	365	324	300	325	400
	325	300	324	365	365	400	450	515	555	630
	1300	2050								
7.5		3250	6300	7990	8995	10000	7990	6300	4000	3250
	1300	815	630	587	584	587	630	815	1300	3250
	4000	6300	7990	10000	8995	7990	6300	3250	2050	1200
	815	630	555	515	385	385	361	350	400	460
	400	350	361	385	385	515	555	630	815	1200
	2050	3250								
10.0		6300	8995	10000	10650	11000	10000	7990	5150	3500
	1600	1000	815	630	600	630	815	1000	1600	3500
	5150	7990	10000	11000	10650	10000	8995	6300	2500	1600
	1000	815	720	555	400	400	400	400	515	515
	515	400	400	400	400	555	720	815	1000	1600
	2500	6300								
15.0		7145	10000	11830	12750	12750	11900	9330	7145	4575
	2500	1900	1600	1000	1000	1000	1600	1900	2500	4575
	7145	9330	11900	12750	12750	11830	10000	7145	4000	2500
	1600	1200	1000	815	630	630	630	630	630	815
	630	630	630	630	630	815	1000	1200	1600	2500
	4000	7145								
20.0		7145	9330	11900	13670	14125	12750	9330	7145	5825
	3250	2500	2050	2050	1900	2050	2050	2500	3250	5825
	7145	9330	12750	14125	13670	11900	9330	7145	4000	3000
	2200	1600	1300	1200	1000	1000	1000	1000	1000	1000
	1000	1000	1000	1000	1000	1100	1300	1500	2200	3000
	4000	7145								
30.0		5540	7145	8650	11000	12750	12750	10000	8995	7145
	4770	3250	3250	3250	2500	3250	3250	3250	4770	7145
	8995	10000	12750	12750	11000	8650	7145	5540	4000	3000
	2275	1825	1500	1200	1100	1100	1100	1100	1100	1100
	1100	1100	1100	1100	1100	1200	1500	1825	2275	3000
	4000	5540								

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMI FIRE CORP: VERSAMBEE TABLE NO. 33

VERT.	HORZ. ANGLES (V 51 15)									
	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	
	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0
	145.0	150.0	155.0	160.0	165.0	170.0	175.0	180.0	185.0	190.0
	195.0	200.0	205.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0
	280.0	290.0	300.0	310.0	320.0	330.0	335.0	340.0	345.0	350.0
	355.0	360.0								
40.0		5250	5725	7145	8660	10000	10000	10000	9330	8660
	6300	5150	4575	4380	4000	4380	4575	5150	6300	8660
	9330	10000	10000	10000	8660	7145	5725	5250	4000	3000
	2275	1825	1500	1400	1200	1200	1200	1200	1200	1200
	1200	1200	1200	1200	1200	1400	1500	1825	2275	3000
	4000	5250								
50.0		4575	5150	5725	6860	7990	7990	8500	8390	6860
	7145	7000	6300	5940	5840	5940	6300	7000	7145	8390
	8390	8500	7990	7990	6860	5725	5150	4575	3500	3000
	2275	1900	1500	1400	1300	1300	1300	1300	1300	1300
	1300	1300	1300	1300	1300	1400	1500	1900	2275	3000
	3500	4575								
60.0		3500	4000	4575	5150	5530	6300	6300	6300	5870
	7250	7500	7500	7250	7250	7250	7500	7500	7250	5870
	6300	6300	6300	5530	5150	4575	4000	3500	3000	2580
	2200	1900	1500	1400	1400	1400	1400	1400	1400	1400
	1400	1400	1400	1400	1400	1400	1500	1900	2200	2580
	3000	3500								
70.0		3000	3250	3500	4000	4575	5530	5150	5150	5540
	6300	7000	7000	7000	7000	7000	7000	7000	6300	5540
	5150	5150	5530	4575	4000	3500	3250	3000	2800	2500
	2050	1900	1600	1500	1500	1500	1500	1500	1500	1500
	1500	1500	1500	1500	1500	1500	1600	1900	2050	2500
	2800	3000								
80.0		3000	3250	3500	3625	3810	4100	4575	4770	5150
	5530	5840	6300	6300	6300	6300	6300	5540	5530	5150
	4770	4575	4100	3810	3625	3500	3250	3000	2720	2700
	2500	2200	1900	2050	1600	1600	1500	1500	1500	1500
	1600	1600	1600	1600	1600	2050	1900	2200	2500	2700
	2720	3000								
90.0		3000	3000	3000	3000	3000	3000	3000	3000	3000
	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
	3000	3000								

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V2[illegible] TABLE NO. 34

HORZ. ANGLES (V 3R (7)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
VERT.									
-35.0		0	0	0	0	0	0	[illegible]	[illegible]
	90	90	85	80	75	[illegible]	[illegible]	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	
-25.0		75	110	125	110	130	105	135	160	175
	185	185	175	160	135	105	130	110	125	110
	75	95	95	85	90	75	0	0	0	0
	0	0	75	90	85	95	80	75	110	
-15.0		160	160	200	210	215	225	210	220	260
	320	320	260	220	210	225	215	210	200	160
	160	175	190	205	230	185	150	105	75	75
	105	150	185	230	205	190	175	150	160	
-5.0		265	260	370	390	445	425	370	360	390
	425	425	390	360	370	425	425	350	370	260
	265	260	345	365	410	330	225	205	145	195
	205	225	330	410	365	345	250	205	260	
5.0		425	450	630	630	640	1075	730	625	630
	820	820	630	625	750	1075	940	530	630	450
	430	460	500	575	610	450	410	350	350	350
	390	410	450	610	575	500	450	430	430	
10.0		530	610	1075	1730	2550	2700	1545	1075	1000
	1100	1100	1000	1075	1525	2700	2550	1705	1075	610
	530	490	570	615	720	530	510	450	460	460
	450	510	530	720	615	570	490	530	610	
15.0		638	800	3800	8500	13000	8500	4000	2300	1700
	1785	1785	1700	2300	3000	8500	13000	8500	3800	800
	638	625	635	660	730	610	610	605	570	570
	605	610	610	630	660	535	525	535	500	
20.0		1125	1525	7000	11500	13500	10000	5300	3300	3000
	2550	2550	3000	3300	5300	10000	14500	11500	7000	1525
	1125	930	850	860	850	675	640	700	575	675
	700	640	675	820	750	630	550	1125	1525	

CANDLEPOWER TABLE UNTITLED

CANDLEPOWER TABLE - LUMINAIRE CODE: V2[illegible] TABLE NO. 34

	HORZ. ANGLES (V 33 17)								
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
VERT.										
25.0		2200	2600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2200	1275	1125	1075	1100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	930	940	910	1100	1075	1125	[illegible]	2200	[illegible]	[illegible]
30.0		2575	3000	4900	7600	7700	[illegible]	6400	6100	6700
	7650	7650	6700	6100	5400	[illegible]	[illegible]	[illegible]	[illegible]	3000
	2575	2600	1775	1260	1200	[illegible]	1110	1160	1150	1150
	1160	1110	1060	1200	[illegible]	1775	[illegible]	2575	3000	
35.0		2700	3500	4500	4900	[illegible]	[illegible]	[illegible]	7500	7700
	7750	7750	7700	7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3500
	2700	2400	2100	1525	1370	1275	[illegible]	1360	1350	1350
	1380	1295	1275	1375	1525	2100	[illegible]	2700	3500	
45.0		2700	3900	4200	4800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7800	7800	7800	7750	[illegible]	[illegible]	[illegible]	[illegible]	4200	3900
	2700	3000	2650	2300	1900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1660	1680	1600	1900	2300	[illegible]	3000	2700	3500	
55.0		2660	2800	4000	[illegible]	[illegible]	[illegible]	[illegible]	7400	7650
	7700	7700	7650	7400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2660	2575	2400	2200	1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1820	1800	1790	1800	2200	[illegible]	[illegible]	[illegible]	2400	
65.0		1975	2500	3300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1975	1950	1785	2200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2100	2100	1990	2100	2200	[illegible]	[illegible]	[illegible]	2500	
75.0		2100	2400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2100	2180	2150	2100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2330	2310	2290	2250	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
85.0		2400	2500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE [illegible] TABLE NO. 34

HORZ. ANGLES (V 3H '7)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
VERT.									
90.0	2805	2805	2805	2805	2805	2805	2805	2805	2805
	2805	2805	2805	2805	2805	2805	2805	2805	2805
	2805	2805	2805	2805	2805	2805	2805	2805	2805
	2805	2805	2805	2805	2805	2805	2805	2805	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE 2007: VERTICAL TABLE NO. 33

HORZ. ANGLES (V 37 15)

	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0	185.0
195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0	285.0
295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0		

VERT.

-25.0		110	75	60	40	20	40	40	50	50
	50	50	40	40	20	45	50	75	110	100
	102	80	50	0	0	0	0	0	0	0
	0	0	0	50	0	102	100	110		
-15.0		175	175	170	150	145	135	135	125	125
	125	125	130	155	145	150	170	175	175	215
	245	205	165	140	125	100	45	50	50	95
	100	125	140	165	205	245	215	175		
-5.0		330	360	340	250	250	240	240	145	145
	185	185	240	240	250	260	340	380	380	405
	445	375	300	275	250	260	255	300	300	250
	265	260	275	300	375	445	405	385		
5.0		900	890	640	550	520	450	445	380	340
	340	380	445	480	520	580	540	590	900	940
	635	625	520	495	470	460	455	500	502	455
	460	470	495	520	625	534	540	900		
10.0		2550	2550	2550	1225	750	600	570	450	425
	425	450	550	600	750	1225	2550	2550	2550	2550
	1925	940	620	580	550	580	570	540	580	570
	580	550	540	620	640	1425	2550	2550		
15.0		9000	10100	5500	2200	1260	930	836	580	520
	520	560	638	930	1260	2200	5500	10100	9000	5225
	2200	1220	890	720	645	700	800	790	790	800
	700	645	720	890	1220	2200	5225	9000		
20.0		9000	10200	6500	3900	2350	1575	1050	635	570
	570	635	1050	1575	2350	3900	6500	10200	9000	5500
	3400	1850	1250	940	820	1075	1200	1125	1125	1200
	1075	820	840	1250	1950	3400	5500	9000		
25.0		7500	8000	6400	4300	3000	1500	1180	840	760
	760	840	1180	1600	3000	4300	6400	8000	7500	5500
	3700	2400	1525	1210	1230	1440	1525	1525	1625	1625
	1440	1230	1210	1525	2400	3700	5500	7500		

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: VERIFICATION TABLE NO. 35

HORZ. ANGLES (V 37 IN)									
	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0	185.0
195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0	285.0
295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0		
VERT.									
30.0		6200	6400	6000	5100	4300	2600	1800	1045	1075
	1075	1045	1500	2600	4300	5100	5000	5400	6200	5460
	4300	2400	1740	1400	1400	1750	2300	2300	2300	2350
	1750	1400	1400	1790	2600	4300	5450	5200		
35.0		5500	5425	5325	5500	5370	3700	2100	1650	1550
	1550	1650	2100	3700	5370	5500	5325	5425	5500	5425
	4400	3400	2150	1640	1685	1950	2300	2700	2700	2300
	1950	1685	1650	2150	3400	4400	5425	5500		
45.0		5100	5075	5355	5525	5500	5225	4300	3300	3100
	3100	3300	4300	5225	5500	5525	5355	5075	5100	5350
	4800	3500	2400	2050	1975	2025	2400	2750	2750	2400
	2025	1975	2050	2400	3500	4400	5350	5100		
55.0		5550	5650	5800	6000	5750	5500	5400	5050	5050
	5050	5050	5400	5500	5750	6000	5800	5550	5550	5425
	5200	3900	2800	2455	2360	2375	2400	2500	2600	2400
	2375	2360	2455	2800	3800	5200	5425	5550		
65.0		5400	5475	5525	5750	5850	6000	5900	5550	5600
	5600	5650	5800	6000	5850	5750	5525	5475	5400	5050
	4400	4000	3400	3150	2700	2600	2550	3100	3100	2550
	2600	2700	3150	3400	4000	4400	5050	5400		
75.0		4800	5075	5225	5425	5475	5440	5450	5460	5470
	5470	5460	5450	5440	5375	5425	5225	5075	4800	4750
	4670	4100	3850	3700	3500	3500	3500	3700	3700	3500
	3500	3500	3700	3850	4100	4670	4750	4800		
85.0		4500	4550	4650	4700	4700	4550	4600	4700	4750
	4750	4700	4600	4640	4700	4700	4650	4550	4500	4470
	4400	4200	4175	4100	4000	3950	4000	4100	4100	4000
	3950	4000	4100	4175	4200	4400	4470	4550		
90.0		4310	4310	4310	4310	4310	4310	4310	4310	4310
	4310	4310	4310	4310	4310	4310	4310	4310	4310	4310
	4310	4310	4310	4310	4310	4310	4310	4310	4310	4310
	4310	4310	4310	4310	4310	4310	4310	4310		

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V410 4MMSI TABLE NO. 35

HORZ. ANGLES (V 35 17)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
VERT.									
-35.0	125	150	145	140	135	125	130	135	150
175	175	150	145	130	125	135	140	145	150
125	100	90	70	40	0	0	0	0	0
0	0	0	40	70	90	100	125	150	
-25.0	250	270	275	280	285	275	275	280	310
375	375	310	280	275	275	285	280	275	270
250	230	200	180	175	150	100	40	40	40
90	105	160	175	180	200	230	250	270	
-15.0	375	405	420	410	450	430	420	425	410
490	490	410	425	420	430	430	410	420	405
375	355	350	345	330	340	320	280	180	180
260	320	390	340	345	350	350	375	405	
-5.0	500	600	700	750	775	850	780	750	875
1060	1060	875	750	780	850	775	750	700	600
500	500	550	575	600	650	450	400	360	360
400	450	550	600	575	550	500	500	600	
5.0	750	1000	1750	2250	3100	3750	2200	1875	1900
2200	2200	1900	1375	2200	3750	3100	2250	1750	1000
750	775	810	840	825	750	550	525	500	500
625	650	750	825	840	810	775	750	1000	
10.0	835	1250	3750	9500	17000	14000	4500	3400	3000
3300	3300	3000	3400	4800	13000	17000	9500	3750	1250
835	825	860	950	1000	840	800	775	750	750
775	900	840	1000	950	960	925	835	1250	
15.0	1125	2600	17000	33500	30000	16000	10200	5200	4350
4100	4100	4350	5200	10200	16000	30000	33500	17000	2600
1125	1020	1000	1175	1275	950	900	950	925	925
950	900	950	1275	1175	1000	1020	1125	2600	
20.0	2200	7000	20000	27000	24000	17500	10000	7500	6650
7000	7000	6650	7500	10000	17500	24000	27000	20000	7000
2200	1560	1500	1550	1550	1125	1050	1125	1125	1125
1125	1050	1125	1550	1550	1500	1550	2200	7000	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMI[illegible] TABLE NO. 45

HORZ. ANGLES (V 38 17)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
25.0		2300	7000	14000	14000	14000	14500	10500	9400	9200
	12500	12500	9200	9200	10500	14500	14000	14000	14000	7000
	4300	2500	2250	2100	1450	1350	1400	1450	1500	1500
	1450	1400	1350	1850	2100	2250	2500	4300	7000	
30.0		5575	8000	11000	14000	14500	13000	12500	12500	13750
	16000	14000	13750	12500	12500	13000	14500	14000	11000	8000
	5575	5000	4025	2600	2100	1875	1800	1875	1925	1925
	1875	1800	1875	2100	2600	4025	5000	5575	8000	
35.0		6800	8200	9200	10200	12700	12500	14500	16000	14500
	17800	17800	16500	16000	14500	12500	12700	10200	9200	8200
	6800	5575	4900	3700	2800	2450	2400	2450	2475	2475
	2450	2400	2450	2800	3700	4900	5575	5500	8200	
45.0		6800	7600	8300	9300	11250	12500	14500	17000	17200
	16800	14800	17200	17000	14500	12500	11250	9300	8300	7600
	6800	5900	5250	4400	3700	3100	2900	2625	2700	2700
	2625	2900	3100	3700	4400	5250	5500	5400	7600	
55.0		5600	5750	7600	8500	9700	10400	12250	14000	14750
	15000	15000	14750	14000	12250	10400	9700	8500	7600	5750
	5600	5150	4750	4300	3900	3650	3250	3100	3000	3000
	3100	3250	3450	3900	4300	4750	5150	5600	5750	
65.0		4750	4900	5500	7800	9500	9000	9200	10500	11250
	12000	12000	11250	10500	9500	9000	8500	7800	5500	4600
	4750	4650	4300	4100	3950	3850	3800	3425	3350	3350
	3425	3600	3650	3950	4100	4300	4650	4750	4900	
75.0		4650	4825	5200	6500	7200	7700	8300	8600	9200
	9500	9500	9200	8600	8300	7700	7200	6500	5200	4925
	4650	4475	4200	4100	4000	3850	3750	3700	3650	3650
	3700	3750	3850	4000	4100	4200	4475	4650	4825	
85.0		4950	4950	5150	5500	6000	6300	6500	7000	7200
	7300	7300	7200	7000	6600	6300	6000	5500	5150	4950
	4900	4750	4650	4525	4450	4400	4350	4300	4270	4270
	4300	4350	4400	4450	4525	4650	4750	4900	4950	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE TYPE: WALLPACK I TABLE NO. 30

HORZ. ANGLES (V 30 Y)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
90.0	5100	5100	5100	5100	5100	5100	5100	5100	5100
	5100	5100	5100	5100	5100	5100	5100	5100	5100
	5100	5100	5100	5100	5100	5100	5100	5100	5100
	5100	5100	5100	5100	5100	5100	5100	5100	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 37

HORZ. ANGLES (V SR -4)									
	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	25.0	27.5
35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
335.0	337.5	342.5	345.0	347.5	352.5	355.0	357.5	362.5	
VERT.									
-35.0		58	58	58	58	58	58	58	58	58
	58	58	58	58	58	58	58	58	58	58
	58	58	58	58	58	58	58	58	58	58
	58	58	58	58	58	58	58	58	58	58
	58	58	58	58	58	58	58	58	58	58
	58	58	58	58	58	58	58	58	58	
-25.0		186	226	117	117	88	88	88	88	88
	88	58	58	58	58	58	58	58	58	58
	58	88	88	88	88	88	88	117	117	226
	186	146	117	58	29	36	51	58	58	58
	58	58	58	58	58	58	58	58	58	58
	58	51	36	29	58	117	146	186	226	
-15.0		358	394	466	452	423	408	384	321	306
	291	291	204	262	262	204	204	262	262	204
	291	291	306	321	344	408	423	452	466	394
	358	321	285	212	175	146	87	58	58	58
	58	58	58	58	58	58	58	58	58	58
	58	87	146	175	212	285	321	358	394	
-5.0		514	562	610	618	633	640	625	611	598
	525	580	495	495	437	408	408	437	495	495
	580	525	568	610	625	640	633	618	610	562
	514	466	437	379	358	328	262	233	175	146
	58	58	58	58	58	58	58	58	146	175
	233	262	328	350	379	437	466	514	562	
0.0		610	730	788	846	930	975	1020	1078	1105
	1131	1046	611	577	472	455	435	472	577	611
	1046	1131	1105	1078	1020	975	930	945	788	730
	610	583	555	495	452	408	321	321	263	263
	233	175	146	117	117	146	175	233	263	263
	321	321	408	452	495	555	583	610	730	
2.5		700	875	990	1105	1260	1353	1455	1515	1630
	1737	1512	727	650	597	502	512	597	654	727
	1512	1737	1630	1515	1455	1353	1260	1105	990	875
	700	640	580	495	466	437	408	394	306	321
	321	233	189	146	145	189	233	321	321	306
	364	408	437	466	495	580	640	700	875	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] Table No. 37

HORZ. ANGLES (V SR 24)									
	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	25.0	27.5
35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
335.0	337.5	342.5	345.0	347.5	352.5	355.0	357.5	362.5	
VERT.									
5.0		815	1135	1340	1515	1620	2115	2270	2755	2795
	2040	1745	745	700	525	525	525	525	700	735
	1745	2040	2795	2765	2270	2115	1920	1515	1340	1135
	815	730	700	445	525	465	379	405	350	379
	408	291	233	175	175	233	291	408	379	350
	408	379	466	525	495	700	730	815	1135	
7.5		2620	785	990	1195	1650	1950	2240	3410	3465
	5130	2709	1120	925	744	714	714	744	925	1120
	2709	5130	3465	3410	2240	1950	1650	1195	990	785
	2620	2445	2270	1720	1545	1370	465	533	451	473
	474	363	306	276	276	306	363	474	473	451
	533	466	1370	1545	1720	2270	2445	2620	785	
10.0		1575	2535	3160	3735	5200	5925	6650	8350	8700
	8220	3673	1455	1150	963	903	903	963	1150	1455
	3673	8220	8700	8350	6650	5925	5200	3735	3160	2535
	1575	1328	1080	755	668	598	565	597	553	567
	539	436	379	379	379	379	436	539	567	553
	657	555	580	668	755	1080	1328	1575	2535	
12.5		2765	4395	5440	6500	9100	10400	11700	13650	13650
	11310	4636	1790	1375	1141	1041	1041	1141	1375	1790
	4636	11310	13650	13650	11700	10400	9100	6500	5440	4395
	2765	2285	1805	1080	918	755	730	781	554	661
	605	508	452	479	479	452	565	605	661	654
	781	730	755	918	1040	1405	2285	2765	4395	
15.0		4895	7750	9400	11550	15600	17700	20050	21400	21050
	14400	5600	2125	1600	1400	1250	1250	1400	1600	2125
	5600	14400	21050	21400	20050	17700	15600	11550	9400	7750
	4895	3755	2885	1720	1400	1195	905	915	755	752
	670	580	525	580	540	525	540	570	755	755
	905	905	1195	1400	1720	2555	3755	4395	7750	
17.5		8100	13000	15875	18750	25400	27325	24250	27700	25850
	16342	6513	3131	2234	1855	1755	1755	1855	2234	3131
	6513	16342	25850	27700	24250	27325	25400	18750	15875	13000
	8100	6525	4950	2765	2213	1550	1225	1115	844	836
	786	726	736	681	681	739	726	736	836	844
	1115	1225	1660	2213	2765	4450	6525	8100	13000	

B80

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 37

HORZ. ANGLES (V 5A 34)									
	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	25.0	27.5
35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
335.0	337.5	342.5	345.0	347.5	352.5	355.0	357.5	302.5	
VERT.									
20.0	11200	17850	21950	26050	33500	35500	37500	32925	29950
17855	7425	4138	2869	2331	1435	1835	2331	2868	4138
7425	17855	29950	32925	37500	35500	33500	26050	21950	17850
11200	8725	6250	3380	2665	1950	1400	1325	1033	918
903	873	948	793	793	948	873	903	918	1033
1325	1400	1950	2665	3380	6250	8725	11200	17850	
22.5	13550	21550	25750	29550	35550	35425	37300	31275	28000
17323	8338	5444	3591	2735	2113	2113	2743	3591	5444
8338	17323	28000	31275	37300	35425	35550	29550	25750	21550
13550	10725	7900	4195	3305	2415	1640	1538	1171	999
1019	1019	1159	894	894	1159	1019	1019	999	1171
1538	1690	2415	3305	4195	7900	10725	13550	21550	
25.0	13350	20950	24800	28750	34550	35450	35500	29150	25500
16800	9250	6150	4135	3260	2390	2340	3260	4135	6150
9250	16800	25500	29150	35600	35450	34550	28750	24800	20950
13350	10500	7850	4395	3405	2680	1920	1745	1310	1080
1135	1165	1370	985	945	1370	1165	1135	1040	1310
1745	1920	2680	3405	4395	7850	10500	13350	20950	
27.5	12600	19500	21500	24500	29400	28575	28950	24200	23300
18088	10413	6575	4539	3477	3130	3143	3470	4539	6575
10413	18088	23300	24200	29950	28675	22400	24500	21500	19500
12600	10325	8050	5000	4160	3320	2445	2263	1849	1549
1493	1464	1625	1329	1329	1625	1464	1493	1559	1349
2263	2445	3320	4160	5000	8050	10325	12500	18500	
30.0	11100	15950	18575	21200	25025	25700	26350	23700	22500
19375	11575	7000	4943	4480	3470	3570	4480	4943	7000
11575	19375	22500	23700	26350	25700	25025	21200	18575	15950
11100	9275	7450	5200	4625	4050	3405	2745	2388	2028
1850	1763	1880	1673	1673	1880	1763	1850	2048	2388
2780	3405	4050	4625	5200	7450	9275	11100	15950	
35.0	10238	13213	14700	16425	19475	21500	22303	24650	23300
21950	13900	7850	5750	5700	5450	5430	5700	5750	7850
13900	21950	23300	24650	22303	21500	19475	16425	14700	13213
10238	8750	7813	5938	5000	4704	4111	3913	3465	3115
2565	2360	2390	2360	2340	2340	2340	2565	3115	3465
3815	4111	4704	5000	5938	7813	8750	10238	13213	

B81

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 37

HORZ. ANGLES (V 53 84)

VERT.	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	25.0	27.5
	35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
	135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
	182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
	235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
	335.0	337.5	342.5	345.0	347.5	352.5	355.0	357.5	362.5	
45.0		9138	11713	13000	14650	17950	19600	20013	21250	19350
	17450	13150	9000	7000	5550	4775	4775	5450	7000	9000
	13150	17450	19350	21250	20013	19600	17950	14650	13000	11713
	9138	7850	7125	5675	4950	4674	4121	3845	3495	2855
	2505	2475	2445	2415	2415	2445	2475	2505	2555	2495
	3845	4121	4674	4950	5675	7125	7850	9138	11713	
55.0		5461	4984	4745	5234	9211	10700	11338	13250	13450
	13650	12700	11000	10000	9550	7250	7250	9550	10000	11000
	12700	13650	13450	13250	11338	10700	9211	6234	4745	4984
	5461	5700	5273	4418	3990	3237	3379	3175	2745	2650
	2590	2620	3260	2765	2765	3260	2620	2590	2650	2795
	3175	3379	3837	3990	4418	5273	5700	5461	4984	
65.0		4648	5383	5750	6225	7175	7650	8075	9350	9450
	10550	11050	11200	11200	10300	9400	9500	10300	11200	11200
	11050	10550	9950	9350	8075	7650	7175	6225	5750	5383
	4648	4280	3989	3406	3116	3006	2650	2535	2300	2240
	2240	2415	2505	2475	2475	2505	2415	2240	2240	2300
	2535	2690	3006	3115	3404	3489	4231	4648	5383	
75.0		4104	4032	4970	5165	5525	5750	5025	9550	7425
	8000	8950	9600	9750	10100	10550	10550	10100	9750	9600
	8950	8000	7425	6850	5025	5750	5525	5165	4970	4032
	4104	3815	3611	3204	3000	3001	3002	2505	2240	2045
	2010	2040	2040	2125	2125	2040	2040	2010	2045	2240
	2505	3002	3001	3000	3204	3411	3415	4104	4032	
85.0		4735	4709	5050	5125	5275	5350	5438	5700	5825
	5950	6400	6700	7000	7250	7450	7450	7250	7000	6700
	6400	5950	5825	5700	5438	5350	5275	5125	5050	4709
	4735	4630	4535	4345	4250	4250	4251	3900	3540	3465
	3260	3235	3205	3175	3175	3205	3235	3260	3465	3540
	3900	4251	4250	4250	4345	4535	4535	4735	4704	
90.0		5116	5116	5116	5116	5116	5116	5116	5116	5116
	5116	5116	5116	5116	5116	5116	5116	5116	5116	5116
	5116	5116	5116	5116	5116	5116	5116	5116	5116	5116
	5116	5116	5116	5116	5116	5116	5116	5116	5116	5116
	5116	5116	5116	5116	5116	5116	5116	5116	5116	5116
	5116	5116	5116	5116	5116	5116	5116	5116	5116	5116

B0L

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: VI[illegible] TABLE NO. 33

HORZ. ANGLES (V, SA, -4)									
	-2.5	2.5	5.0	7.5	12.5	15.	17.5	25.0	27.5
35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
335.0	337.5	342.5	345.0	347.5	352.5	355.0	357.5	362.5	
VERT.									
-35.0		0	0	0	0	0	0	0	0	0
	0	7	7	22	22	37	37	22	22	7
	7	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
-25.0		61	64	66	72	77	81	78	74	69
	56	88	110	118	133	133	133	118	110	
	88	56	65	74	74	81	77	72	66	54
	61	59	61	64	66	57	55	59	59	7
	7	7	7	7	7	7	7	7	7	29
	29	48	57	66	64	61	64	61	64	
-15.0		102	113	114	114	112	110	203	103	114
	125	155	176	192	198	206	210	198	192	176
	155	125	114	103	203	110	112	110	110	113
	102	96	96	96	96	94	92	88	74	96
	66	15	0	0	0	0	15	66	66	74
	88	90	94	96	96	96	99	102	113	
-5.0		176	187	192	203	224	230	323	230	130
	258	272	266	246	240	240	240	240	258	258
	272	258	130	235	324	230	224	213	192	187
	176	170	163	148	140	134	130	133	133	206
	206	118	66	59	59	86	118	206	206	133
	133	135	138	140	144	163	170	176	187	
0.0		294	302	313	323	356	360	340	400	340
	527	453	388	353	317	329	327	317	353	388
	453	527	340	600	340	385	342	323	313	302
	294	280	266	198	181	174	174	163	165	225
	386	199	132	107	107	132	194	385	625	165
	163	184	184	191	195	200	202	254	312	
2.5		360	616	566	515	552	575	514	743	574
	661	544	448	346	335	341	346	335	448	448
	544	661	574	763	513	575	552	513	556	515
	360	313	256	213	200	193	194	177	142	234
	476	240	165	131	131	165	240	475	234	142
	177	184	198	206	213	256	313	360	515	883

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: VIDEOSCREEN TABLE NO. 35

HORZ. ANGLES (V 58 34)

VERT.	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	25.0	27.5
	35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
	135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
	182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
	235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
	335.0	337.5	342.5	345.0	347.5	352.5	355.0	357.5	362.5	
5.0		442	597	722	773	693	638	607	565	398
	795	634	509	419	354	260	350	354	419	509
	634	795	898	965	987	631	953	773	722	597
	442	398	331	250	235	221	138	192	198	243
	566	280	198	155	155	198	241	305	243	198
	192	199	221	235	250	331	338	442	597	
7.5		611	877	1087	1295	1775	2335	2592	1522	1484
	1132	831	627	513	424	405	405	424	513	627
	831	1132	1664	1920	2936	2336	1775	1295	1087	877
	611	519	427	323	287	259	251	241	233	258
	519	326	227	190	190	227	328	319	255	233
	281	250	250	267	323	427	519	511	877	
10.0		965	1525	2091	2656	3520	4144	4368	2575	1872
	1639	1028	744	607	494	449	449	494	607	744
	1028	1638	3072	2675	4368	4144	3520	2656	2091	1525
	965	800	634	442	387	331	317	359	259	273
	471	372	255	225	225	255	372	471	273	259
	369	317	331	387	442	534	800	965	1525	
12.5		1531	2688	3840	4992	6448	8712	8976	3528	3136
	1807	1224	862	701	544	448	448	504	701	862
	1224	1807	3136	3530	8976	8712	8448	4992	3840	2688
	1531	1076	920	611	455	299	472	454	314	287
	424	418	284	259	259	284	418	424	287	304
	459	472	299	455	611	920	1076	1531	2688	
15.0		2480	4480	6176	8040	9792	10272	9856	4354	3376
	2144	1421	979	795	634	538	538	634	795	979
	1421	2144	3376	4384	8896	10272	9792	8080	6176	4480
	2480	1840	1451	987	851	736	611	546	334	302
	376	464	312	294	294	412	454	376	312	334
	546	611	736	861	987	1451	1840	2480	4480	
17.5		3360	5616	6752	7936	8304	7520	5736	4552	1424
	2688	1734	1170	904	717	623	623	717	904	1170
	1734	2688	4128	4880	5736	7520	8304	7936	6752	5616
	3360	2496	2032	1362	1167	971	722	584	448	344
	385	459	359	342	342	359	459	385	343	435
	680	722	971	1167	1362	2032	2640	3360	5616	8064

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE [illegible] TABLE NO. 38

HORZ. ANGLES (V 58 24)									
	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	25.0	27.5
35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
335.0	337.5	342.5	345.0	347.5	350.5	355.0	357.5	362.5	
VERT.									
20.0		3872	4992	5432	5672	6272	6416	6552	6376	4752
	3232	2047	1362	1013	800	705	705	800	1013	1362
	2047	3232	4752	5376	6552	6416	6272	5672	5432	4992
	3872	3320	2768	1920	1616	1310	957	814	538	394
	395	453	407	430	430	407	453	395	364	538
	814	957	1310	1616	1920	2768	3320	3872	4992	
22.5		3392	4208	4720	5232	6256	6528	6544	6272	5456
	3776	2359	1553	1121	842	742	742	842	1121	1553
	2359	3776	5456	6272	6544	6528	6256	5232	4720	4208
	3392	2984	2576	1904	1663	1421	1184	960	837	440
	404	448	454	498	498	454	448	404	446	537
	948	1120	1421	1663	1904	2576	2984	3392	4208	
25.0		3200	4048	4784	5216	5600	6112	6384	6368	5792
	4320	2672	1744	1230	965	877	877	965	1230	1744
	2672	4320	5792	6368	6384	6112	5600	5216	4784	4048
	3200	2896	2496	2148	1808	1494	1184	1082	736	485
	413	442	501	566	566	501	442	413	496	736
	1082	1186	1494	1808	2148	2496	2816	3200	4048	
27.5		4816	2864	3128	3342	3504	3504	3424	5116	5952
	4464	2960	2196	1419	1114	751	751	1114	1419	2196
	2960	4464	5952	6116	3920	3504	3504	3342	3128	2864
	4816	4472	4128	3104	2776	2445	1392	1243	764	541
	474	501	578	664	664	578	501	474	541	764
	1243	1362	2448	2776	3104	4128	4472	4816	2864	
30.0		2672	3616	3936	4256	4784	5040	5312	5984	5808
	4608	3098	2448	1807	1274	526	526	1274	1537	2448
	3098	4608	5808	5864	5312	5040	4784	4256	3936	3616
	2672	2544	2416	1952	1776	1600	1370	1257	813	297
	535	560	656	762	762	656	560	535	597	813
	1257	1370	1600	1776	1952	2416	2544	2672	3616	
35.0		2636	3044	3248	3492	3840	4224	5008	5360	5124
	4896	3824	3152	1984	1542	974	974	1542	1984	3152
	3824	4896	5128	5340	5008	4224	3840	3248	3044	2636
	2626	2432	2220	1795	1582	1457	1217	1082	844	707
	656	677	810	957	957	810	677	535	717	959
	1082	1207	1457	1582	1795	2220	2432	2626	3044	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: V1[illegible] TABLE NO. 33

HORZ. ANGLES (V SM -4)									
	-2.5	2.5	5.0	7.5	12.5	15.[illegible]	17.5	25.0	27.5
35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0
135.0	145.0	152.5	155.0	162.5	165.0	167.5	172.5	175.0	177.5
182.5	185.0	187.5	192.5	195.0	197.5	202.5	205.0	215.0	225.0
235.0	245.0	255.0	265.0	275.0	285.0	295.0	305.0	315.0	325.0
335.0	337.5	342.5	345.0	347.5	352.5	355.0	357.5	362.5	
VERT.									
45.0		2528	2880	3056	3140	3424	3552	4396	4524	4712
	4896	4640	4016	3200	2864	2736	2736	2560	3200	4016
	4640	4896	4712	4528	4392	3552	3424	3140	3056	2880
	2528	2352	2188	1860	1696	1574	1332	1204	965	854
	810	803	840	906	905	840	803	810	854	965
	1208	1330	1574	1696	1860	2168	2332	2524	2696	
55.0		2552	2696	2768	2780	2804	2816	3774	3836	3932
	3696	3984	3728	3600	3344	3168	3164	3144	3600	3728
	3984	3696	3392	3988	3774	2816	2804	2736	2760	2696
	2552	2480	2292	1916	1728	1596	1332	1200	1004	920
	861	832	840	846	846	840	832	861	920	1008
	1200	1332	1596	1728	1916	2292	2404	2532	2696	
65.0		1988	2092	2144	2154	2274	2264	3160	2364	2448
	2528	2656	2688	2640	2576	2400	2400	2576	2544	2588
	2656	2528	2448	2368	3160	2264	2274	2164	2144	2092
	1988	1936	1850	1677	1598	1511	1393	1274	1124	1024
	957	942	928	898	898	928	942	957	1024	1120
	1274	1353	1511	1598	1677	1758	1938	1998	2096	
75.0		1688	1768	1808	1824	1858	1872	2032	1920	1938
	1952	2000	2096	2040	2044	2032	2132	2040	2040	2048
	2000	1952	1936	1920	2552	1872	1858	1824	1808	1768
	1688	1648	1619	1560	1531	1504	1449	1421	1347	1298
	1251	1186	1134	1098	1098	1134	1186	1251	1298	1347
	1421	1449	1504	1531	1560	1619	1648	1688	1745	
85.0		1660	1684	1696	1700	1704	1712	1939	1744	1752
	1760	1760	1760	1760	1760	1744	1744	1760	1760	1760
	1760	1760	1752	1744	1939	1712	1704	1700	1696	1684
	1660	1648	1632	1605	1590	1579	1557	1545	1505	1472
	1458	1435	1414	1384	1384	1414	1435	1458	1472	1519
	1546	1557	1579	1590	1605	1632	1545	1559	1634	
90.0		1632	1632	1632	1632	1632	1632	1632	1632	1632
	1632	1632	1632	1632	1632	1632	1632	1632	1632	1632
	1632	1632	1632	1632	1632	1632	1632	1632	1632	1632
	1632	1632	1632	1632	1632	1632	1632	1632	1632	1632
	1632	1632	1632	1632	1632	1632	1632	1632	1632	1632
	1632	1632	1632	1632	1632	1632	1632	1632	1632	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 39

HORZ. ANGLES (H 12 14)

VERT.	35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0	115.0	125.0	135.0	145.0
-32.5	0	0	0	0	140	0	0	140	0	0	0	0
-27.5	0	0	160	2320	5040	1120	1120	5040	2320	160	0	0
-22.5	0	465	4570	5440	5450	5140	5140	5650	5440	4570	445	0
-17.5	0	2230	6020	6340	6470	6060	6000	6570	6380	6020	2230	0
-12.5	340	5945	7780	8410	8470	7990	7990	8370	8410	7780	5945	340
-7.5	2290	9290	13800	15450	15790	14110	14110	15790	15450	13800	9290	2290
-2.5	3660	20530	33290	41840	44500	45750	45750	44500	41840	33290	20530	3660
2.5	3780	22945	36980	45980	51870	49740	49790	51870	45980	36980	22945	3780
7.5	1950	9570	14200	16240	16860	15230	15230	16860	16240	14200	9570	1950
12.5	230	6220	8180	8740	8990	7990	7990	8990	8740	8180	6220	230
17.5	0	2510	6020	6820	6440	6200	6200	6840	6820	6020	2510	0
22.5	0	460	4490	5650	5420	5340	5340	5420	5650	4490	460	0
27.5	0	0	240	2470	5340	2040	2040	5340	2470	240	0	0
32.5	0	0	0	0	140	0	0	140	0	0	0	0

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE [illegible]

HORZ. ANGLES (H 14 14)

	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0	105.0
115.0	125.0	135.0	145.0	155.0					
VERT.									
-19.5		1030	2290	3560	4150	4570	5330	5160	6160	5330
	4590	4150	3560	2290	1030					
-16.5		1090	2480	3720	4410	5060	5910	7150	7150	6010
	5080	4410	3720	2480	1090					
-13.5		1130	2675	3875	4820	5530	6690	7920	7420	6690
	5560	4820	3875	2675	1130					
-10.5		1180	3060	4960	6020	7370	8920	9270	8370	6820
	7370	6020	4960	3060	1180					
-7.5		1220	4200	8060	10970	12420	14750	15500	15500	14750
	12820	10970	8060	4200	1220					
-4.5		1260	8790	20450	29290	34090	40500	38500	38500	40600
	34090	29290	20450	8790	1260					
-1.5		1300	16430	41990	59920	68550	81220	78440	78440	81220
	68550	59920	41990	16430	1300					
1.5		1320	17200	42300	62060	72540	85200	79060	79040	85200
	72540	62060	42300	17200	1320					
4.5		1280	9360	23550	33970	40140	44440	44300	44300	44440
	40140	33970	23550	9360	1280					
7.5		1240	4590	10540	13780	15500	20050	20130	20130	20040
	16560	13780	10540	4590	1240					
10.5		1190	3060	5270	6960	8700	10100	10490	10540	10100
	8700	6960	5270	3060	1190					
13.5		1140	2870	4030	4950	6170	7250	7620	8240	7260
	6170	4950	4030	2870	1140					
16.5		1080	2470	3560	4280	5075	5900	7040	7040	5900
	5075	4280	3560	2470	1080					
19.5		1020	2280	3510	4010	4470	5220	5020	5020	5220
	4470	4010	3510	2280	1020					

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 41

VERT.	HORZ. ANGLES (H 18 18)								
	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
-42.5	99	594	1551	2541	3366	[illegible]	[illegible]	[illegible]	4191
	4191	3861	4092	3663	3366	2541	1551	594	[illegible]
-37.5	165	858	1782	2838	3432	3729	4191	4059	4620
	4620	4059	4191	3729	3432	2838	1782	858	165
-32.5	231	1023	2079	3069	3630	3894	4356	[illegible]	5049
	5049	4389	4356	3894	3630	3069	2079	1023	231
-27.5	330	1353	2508	3531	3861	[illegible]	4653	4752	5544
	5544	4752	4653	4092	3861	3531	[illegible]	1353	330
-22.5	495	1584	2904	4158	[illegible]	[illegible]	[illegible]	5346	[illegible]
	6204	5346	5148	4587	4389	4158	[illegible]	1584	495
-17.5	495	1980	3663	5346	[illegible]	[illegible]	6600	6765	7986
	7986	6765	6600	5973	5808	5346	[illegible]	1980	495
-12.5	528	2277	5115	8052	9537	[illegible]	10923	10791	12309
	12309	10791	10923	9966	9537	8052	5115	2277	528
-7.5	528	3102	9438	16269	21252	24453	26895	25410	27060
	27060	25410	26895	24453	21252	16269	9438	3102	528
-2.5	528	4455	16533	30822	41712	[illegible]	[illegible]	[illegible]	[illegible]
	53856	52140	57024	50292	41712	30822	[illegible]	4455	528
2.5	561	4224	15840	29898	41359	49444	55242	51315	52734
	52734	51315	55242	49444	40359	29898	[illegible]	4224	561
7.5	561	2607	7986	14223	18579	21450	23958	23001	24651
	24651	23001	23958	21450	18579	14223	[illegible]	2607	561
12.5	561	2046	4554	7293	8745	[illegible]	10659	10560	12111
	12111	10560	10659	9537	8745	7293	[illegible]	2046	561
17.5	528	1749	3366	5049	5643	[illegible]	6600	[illegible]	[illegible]
	8085	6798	6600	5940	5643	[illegible]	[illegible]	1749	528
22.5	462	1584	2871	4125	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	6534	5412	5181	4620	4389	4125	[illegible]	[illegible]	[illegible]

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CO #: [illegible] TABLE NO. 41

HORZ. ANGLES (H 18 12)

	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VERT.									
27.5		396	1320	2508	3531	3[illegible]91	[illegible]	[illegible]	[illegible]
	5610	4752	4653	4042	3461	3[illegible]31	2[illegible]	1[illegible]	[illegible]
32.5		297	1089	2145	3657	3729	[illegible]	[illegible]	[illegible]
	5148	4455	4488	4026	3729	3267	2[illegible]	1[illegible]	[illegible]
37.5		132	858	1782	2838	3498	3795	4141	3960	4620
	4620	3960	4191	3795	3498	2838	1782	858	132	
42.5		132	561	1551	2511	3366	3729	4125	3894	4026
	4026	3894	4125	3729	3366	2511	1551	561	132	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible]

HORZ. ANGLES (M 1M 1M)

	22.0	30.0	34.0	46.0	58.0	70.0	82.0	94.0		
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0	
VERT.										
-68.0		0	0	66	99	165	231	264	264	330
	330	264	264	231	165	99	33	0	0	
-60.0		66	66	99	165	231	264	330	330	396
	396	330	330	264	231	165	99	66	66	
-52.0		66	99	165	231	264	330	330	396	429
	429	396	396	330	264	231	165	99	66	
-44.0		132	528	1353	2376	3300	3630	4191	3927	4125
	4125	3927	4191	3630	3300	2376	1353	528	132	
-36.0		231	924	2145	3630	4455	4983	5313	5148	5346
	5346	5148	5313	4653	4356	3300	2145	924	231	
-28.0		396	1320	2871	4587	5775	6270	7095	6798	7293
	7293	6798	7095	6270	5775	4587	2871	1320	396	
-20.0		495	1650	3795	6204	7920	9405	10032	9933	10362
	10362	9933	10032	9405	7920	6204	3795	1650	495	
-12.0		462	1914	4818	9115	11922	13992	14817	14751	15411
	15411	14751	14817	13992	11922	9115	4818	1914	462	
-4.0		561	2442	6336	11154	15312	18183	20955	20856	21714
	21714	20856	20955	18183	15312	11154	6336	2442	561	
4.0		495	2310	6336	10890	15114	18117	20922	21021	22044
	22044	21021	20922	18117	15114	10890	6336	2310	495	
12.0		495	2079	5247	9504	11451	13398	15312	15312	15906
	15906	15312	15312	13398	11451	9504	5247	2079	495	
20.0		429	1650	3927	6336	8217	9867	10428	10296	10659
	10659	10296	10428	9867	8217	6336	3927	1650	429	
28.0		363	1353	2970	4719	6402	7491	7953	7161	7557
	7557	7161	7953	7491	6402	4719	2970	1353	363	
36.0		231	990	2079	3432	4455	4719	5511	5181	5511
	5511	5181	5511	4719	4455	3432	2079	990	231	

CANDLEPOWER TABLE - [illegible]

CANDLEPOWER TABLE - LUMINAIRE [illegible] PHOTOMETRIC TABLE NO. 42

HORZ. ANGLES	(H	1=	1=)						
	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0	
VERT.									
44.0	165	528	1410	2442	3465	3960	4290	3630	3927
3927	3993	4290	3696	3465	2442	1410	924	165	
52.0	96	99	165	231	264	33	396	396	429
429	396	396	330	264	231	165	99	66	
60.0	66	66	99	165	231	264	330	330	396
396	330	330	264	231	165	99	66	66	
68.0	0	0	66	99	165	231	264	264	330
330	264	264	231	165	99	66	0	0	

CANDLEPOWER FOR TABLE HEADOUT

CANDLEPOWER FOR TABLE - LOW BEAM CODE: HEADLIGHT TABLE V4.43

HORZ. ANGLES (DEGREES)									
	22.0	30.0	34.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VERT.									
-17.0		561	1914	3829	5214	5742	5214	5005	5005	5831
	6831	6006	6006	5214	5742	5214	3829	1914	561	
-15.0		561	2178	4389	6333	6567	6333	6567	6831	7656
	7656	6831	6567	6333	6567	6333	4389	2178	561	
-13.0		561	2178	4653	7125	7920	7125	7392	7392	8745
	8745	7392	7392	7125	7920	7125	4653	2178	561	
-11.0		561	2475	5742	8745	9867	8745	8745	9042	10131
	10131	9042	8745	8745	9867	8745	5742	2475	561	
-9.0		561	2739	7392	11484	13134	12045	11484	11484	12309
	12309	11484	11484	12045	13134	11484	7392	2739	561	
-7.0		561	3564	9867	16137	19791	18512	17220	16137	16698
	16698	16137	17220	18512	19791	16137	9867	3564	561	
-5.0		561	3564	12309	23265	32274	36427	34749	30657	24007
	29007	30657	34749	36427	32274	23265	12309	3564	561	
-3.0		561	3564	13959	29007	44319	54014	55109	51570	50489
	50489	51570	55109	54014	44319	29007	13959	3564	561	
-1.0		561	3828	14457	30360	46033	56573	59196	51674	54413
	54413	51674	59196	56573	46033	30360	14457	3828	561	
1.0		561	3564	12870	27621	44615	59367	70005	70804	64282
	64282	70804	70005	59367	44615	27621	12870	3564	561	
3.0		561	3003	11220	22704	34221	42405	44444	45144	45144
	45144	45144	44444	42405	34221	22704	11220	3003	561	
5.0		561	3300	9042	17226	23001	25179	25443	23793	24354
	24354	23793	25443	25179	23001	17226	9042	3300	561	
7.0		561	2739	7392	13134	16434	16698	16698	15873	16698
	16698	15873	16698	16698	16434	13134	7392	2739	561	
9.0		561	2739	6567	11349	14373	15204	12045	11484	12523
	12523	11484	12045	15204	14373	11349	6567	2739	561	

CARDIFF-FM TABLE PRINTOUT

CARDIFF-FM TABLE - LOW IF CHAN: 4150.0 MHz TABLE NO. 43

HORZ. ANGLES (M 12 15)

22.0 30.0 38.0 46.0 54.0 62.0 70.0 78.0 86.0
94.0 102.0 110.0 118.0 126.0 134.0 142.0 150.0 158.0

VERT.

11.0 561 2472 5478 12345 9867 9306 9306 9306 10395
10395 9306 9306 9306 9867 12345 5478 2472 561

13.0 561 1914 4553 7125 7561 7392 7559 7392 7425
6745 7392 7656 7392 7920 7125 4553 1914 561

15.0 561 1914 4389 6006 6567 6318 6831 6831 7920
7920 6831 6831 6393 6567 6006 4389 1914 561

17.0 561 1914 3828 5478 5478 5214 6006 6006 7128
7128 6006 6006 5214 5478 5478 3828 1914 561

894

[illegible] TABLE NO. 44

HORZ. ANGLES (H 1= 14)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
VERT.									
-76.0		73	173	241	315	393	733	1131	1202	1202
	1131	733	393	315	241	173	73		
-68.0		193	293	829	4219	4421	5325	5351	5749	5749
	5611	5325	4821	4219	829	293	193		
-60.0		210	510	4143	5243	5415	6530	7050	7258	7258
	7050	6630	6015	5243	4143	510	210		
-52.0		273	1403	4793	5945	6553	7815	8525	8940	8940
	8525	7815	6553	5945	4793	1403	273		
-44.0		549	2100	4475	6143	7505	9555	12153	15075	15075
	12153	9555	7505	6195	4475	2100	549		
-36.0		960	2310	4530	6150	11235	17550	19395	21150	21150
	19395	17550	11235	6150	4530	2310	960		
-28.0		1155	2535	4440	6555	11355	18945	22575	27555	27555
	22575	18945	11355	6600	4440	2535	1155		
-20.0		990	1635	4110	6675	11505	17625	22827	25350	25350
	22845	17625	11505	6678	4110	1635	990		
-12.0		663	1313	4215	6435	14115	20715	25485	27300	27300
	25485	20700	14115	6435	4215	1313	663		
-4.0		458	1035	3713	5943	7478	8925	12023	12450	12450
	12023	8925	7478	5943	3713	1035	458		
4.0		291	533	999	1344	1673	1991	2576	2663	2663
	2576	1991	1673	1344	999	533	291		
12.0		183	333	547	868	1136	1357	1739	2306	2306
	1758	1067	1056	868	547	333	183		
20.0		161	149	254	371	453	534	1939	2723	2723
	1939	534	453	371	254	149	161		
28.0		137	154	149	225	247	275	444	577	577
	444	275	247	225	149	154	137		

CANDLEPOWER TABLE - [illegible]

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 45

HORZ. ANGLES (H 16 15)

VERT.	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
-75.0	0	0	0	247	234	242	1987	1020	987
	987	1020	1007	502	234	247	0	0	0
-65.0	0	0	385	574	935	1817	1993	1871	1839
	1806	1871	1993	1817	935	574	385	0	0
-55.0	0	0	775	1149	2337	3213	3080	2891	2796
	2796	2891	3080	3213	2337	1149	775	0	0
-45.0	0	859	1863	3736	5942	7229	6226	5736	5263
	5263	5736	6226	7229	5942	3736	1863	859	0
-35.0	0	835	1850	4045	11444	11446	11776	8503	7730
	7730	8503	11776	11446	11444	4045	1850	835	0
-25.0	0	858	3483	10345	15884	16205	14674	12545	11184
	11184	12545	14674	16205	15884	10345	3483	858	0
-15.0	0	854	5426	12644	19159	20884	21014	20748	18914
	18914	20748	21014	20884	19159	12644	5426	854	0
-5.0	0	1316	5814	13215	19859	22283	23181	24932	22862
	22862	24932	23181	22283	19859	13215	5814	1316	0
5.0	0	1316	5814	12644	19492	19881	20933	19907	17599
	17599	19907	20933	19881	19492	12644	5814	1316	0
15.0	0	1316	3476	10345	15421	14859	13495	11395	10197
	10197	11395	13495	14859	15421	10345	3476	1316	0
25.0	0	859	2326	8045	10743	11044	9420	7493	7237
	7237	7493	9420	11044	10743	8045	2326	859	0
35.0	0	859	1163	4923	6776	7431	6521	5742	5263
	5263	5742	6521	7431	6776	4923	1163	859	0
45.0	0	859	775	1724	3271	4414	4157	3912	3818
	3818	3912	4157	4414	3271	1724	775	859	0
55.0	0	0	388	575	935	2491	2595	2551	2467
	2467	2551	2595	2491	935	575	388	0	0

[illegible] TABLE [illegible]

[illegible] TABLE - LOFT [illegible]; [illegible] TABLE NO. 45

HORZ. ANGLES (H [illegible])

	5.0	15.0	25.0	35.0	[illegible]	[illegible]	[illegible]	75.0	[illegible]
	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
VERT.									
65.0		0	0	352	497	[illegible]	[illegible]	1551	1151
	1151	1531	1539	1295	467	497	[illegible]	0	
75.0		0	0	0	0	[illegible]	[illegible]	175	100
	100	170	101	201	[illegible]	0	0	0	

CONDENSED TABLE - LOWER LIMB

CONDENSED TABLE - LOWER LIMB CONT: 400-444 BY TABLE NO. 40

NOWZ. ANGLES (M = 1, J=1)

	47.5	52.5	57.5	62.5	67.5	72.5	77.5	82.5	87.5
	92.5	97.5	102.5	107.5	112.5	117.5	122.5	127.5	132.5
WEPT.									
-42.5		3295	3482	3650	3834	3987	3743	3530	3704	3950
	3599	3709	3682	3725	3957	3935	3931	3454	3246	
-37.5		3556	3826	3945	3419	3491	4115	4794	5345	5227
	5827	5549	4790	4115	3550	3695	3743	3525	3550	
-32.5		3252	3156	3610	4020	5245	5244	9129	11462	12711
	12710	11462	9029	6998	5245	4021	3500	3163	3252	
-27.5		3376	3817	4373	5574	8570	13415	17040	20323	21439
	21439	20323	17040	13414	8570	5574	4373	3817	3376	
-22.5		3678	4472	6235	9212	14441	20174	24245	27143	28109
	28109	27143	24245	20174	14441	9212	6235	4472	3678	
-17.5		4077	5259	9206	13862	19440	25247	28751	32544	34201
	34201	32844	28751	25240	19440	13862	9206	5259	4077	
-12.5		4323	6169	10167	16827	23232	27954	33443	36996	43009
	43009	36996	33443	27954	23232	16827	10167	6169	4323	
-7.5		4510	6914	12259	19343	25301	30721	36760	44772	58553
	58553	44772	36760	30721	25301	19343	12259	6914	4510	
-2.5		4663	7405	13428	21779	27747	33124	39944	54529	104167
	104167	54529	39944	33124	27747	21779	13428	7405	4663	
2.5		4654	7354	13311	20564	27697	32772	39932	53672	112946
	112946	53672	39932	32772	27697	20564	13311	7354	4654	
7.5		4503	6921	12380	19690	25550	30934	38732	46827	63644
	63644	46827	38732	30939	25550	19690	12380	6921	4503	
12.5		4313	6174	10312	17535	24244	28415	32373	38934	46076
	46076	38934	32373	28415	24244	17535	10312	6174	4313	
17.5		4106	5225	8232	14040	19432	23014	27440	29221	31013
	31013	29221	27440	23014	19432	14041	8232	5225	4106	
22.5		3744	4533	6413	9295	13598	17102	22271	24299	25162
	25162	24299	22271	17102	13598	9295	6413	4533	3744	

HORZ. ANGLES (H 14 18)

	47.5	52.5	57.5	62.5	67.5	72.5	77.5	82.5	87.5
92.5	97.5	102.5	107.5	112.5	117.5	122.5	127.5	132.5	

VERT.

27.5		4541	4114	4837	5414	5774	12469	15594	14846	14573
	19573	18494	16654	12626	5774	5414	4837	4114	3541	
32.5		4621	3649	4211	4854	5191	7295	9953	11781	14930
	12930	11781	9930	7966	6131	4854	4211	3649	3621	
37.5		4067	3661	3743	4154	4617	5335	6136	6941	7483
	7483	6901	6152	5335	4617	4154	3743	3566	4067	
42.5		3420	4114	3764	3732	3994	4366	4566	4551	5152
	5052	4951	4562	4366	3949	3732	3764	4114	3420	

[illegible] TABLE [illegible]

[illegible] TABLE HEIGHT [illegible] [illegible] [illegible] PAGE NO. 47

-252. ANGLES (M 14 14)

	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VERT.									
-68.0	0	0	0	98	284	472	656	828	967
	1060	1105	1052	972	864	698	472	228	0
-60.0	0	21	240	648	1142	1675	2214	2713	3174
	3174	3613	2904	1874	1142	648	240	21	0
-52.0	0	242	921	1744	2684	3726	4804	5409	5794
	5794	5409	4804	3722	2684	1744	921	242	0
-44.0	91	807	1781	3124	4538	5927	7111	7947	8482
	8482	7947	7111	5927	4538	3124	1781	807	91
-36.0	253	1152	3124	5448	7711	9454	10737	11513	11933
	11933	11513	10737	9454	7711	5448	3124	1152	253
-28.0	455	1907	3918	6194	8498	10441	12000	13045	13314
	13314	13045	12000	10441	8498	6194	3918	1907	455
-20.0	554	2512	4152	6018	7980	9751	11261	12355	12995
	12995	12355	11261	9751	7980	6018	4152	2512	554
-12.0	774	3011	3677	4324	11244	19245	25512	28913	33140
	33140	28913	25502	19245	11244	4324	3677	3011	774
-4.0	863	4194	9481	9048	11752	21743	27265	31634	36417
	36417	31634	27265	21743	11752	9048	9481	4194	863
4.0	495	3232	9525	9023	11813	21513	27374	31092	33343
	33343	31092	27374	21513	11803	9023	9525	3232	495
12.0	432	3073	8730	4353	10435	19471	25177	28813	29345
	29345	28813	25177	19471	10335	4353	8730	3073	432
20.0	706	2683	4249	8670	7933	14493	20415	23950	25506
	25506	23950	20415	14493	7933	8670	4249	2683	706
28.0	523	2016	4010	8363	6830	9520	12454	14745	15454
	15454	14745	12454	9520	6830	8363	4010	2016	523
36.0	311	1697	3250	4185	5504	6937	7743	8114	11557
	11557	8114	7743	6937	5504	4185	3250	1297	311

B100

[illegible]

[illegible]

HORZ. ANGLES (m 15 15)

	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VERT.									
44.0		107	501	2071	3635	4215	3813	4000	4424	5533
	5533	4424	4000	3813	4215	3635	2071	501	107	
52.0		0	356	1021	2041	3336	4105	4427	4069	3957
	3957	4069	4427	4105	3336	2041	1021	356	0	
60.0		0	17	364	928	1356	2107	2904	3235	3431
	3431	3235	2804	2107	1356	928	364	17	0	
68.0		0	0	0	115	339	576	796	957	1033
	1033	957	796	576	339	115	0	0	0	

B101

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. [illegible]

HORZ. ANGLES (H 13 10)

VERT.	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0
-15.0	500	1000	2000	3000	4000	4000	4000	4000	4000	3000	2000	1000	500
-12.0	2000	4000	7000	9000	9000	9000	9000	9000	9000	9000	7000	4000	2000
-9.0	3000	6000	10000	12000	13000	13000	13000	13000	13000	12000	10000	6000	3000
-6.0	3500	12000	21000	25000	26000	26000	25000	26000	26000	25000	21000	12000	3500
-3.0	4000	16000	47000	50000	55000	54000	58000	54000	55000	50000	47000	16000	4000
0.0	5000	26000	54000	70000	71000	72000	70000	72000	71000	70000	53000	26000	5000
3.0	5000	22000	40000	52000	57000	54000	50000	54000	57000	52000	40000	22000	5000
6.0	4000	15000	23000	28000	30000	36000	37000	36000	30000	28000	23000	15000	4000
9.0	3000	7000	11000	13000	14000	14000	14000	14000	14000	13000	11000	7000	3000
12.0	1000	1500	2000	3000	4000	4500	5000	4500	4000	3000	2000	1500	1000

CANDLESTICK TABLE PRINTOUT

CANDLESTICK TABLE - LOAT [illegible]

HORZ. ANGLES (M 13 13)

VERT.	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0
-48.0	500	1000	1500	1500	1500	1500	1500	1500	1500	1500	1000	500	
-40.0	1000	2500	3000	3500	4000	4000	4500	4000	4000	3500	3000	2500	1000
-32.0	1500	4000	5500	6500	7500	8500	9000	8500	7500	6500	5500	4000	1500
-24.0	2000	4500	7000	11500	12000	14000	14500	13000	12000	11500	7000	4500	2000
-16.0	2000	6000	12000	14000	17000	23000	24000	23000	17000	14000	12000	6000	2000
-8.0	2000	4000	13500	19500	22500	24500	25000	24500	22500	19500	14500	4000	2000
0.0	2000	3500	17000	21500	24500	27500	30000	27500	24500	21500	17000	9500	2000
8.0	2500	7500	14000	13500	22000	24000	25000	24000	22000	14500	14000	7500	2500
16.0	2000	5500	10000	14000	14000	17500	18000	17500	15000	13000	10000	5500	2000
24.0	2000	4500	8500	9000	11000	12500	13000	12500	11000	9000	8500	4500	2000
32.0	1000	3000	4500	6000	7000	7500	8000	7500	7000	6000	4500	3000	1000
40.0	500	1500	3000	3300	3500	3700	4000	3700	3500	3300	3000	1500	500
48.0	200	300	500	1000	1000	1000	1000	1000	1000	1000	500	300	200

B103

CANDLEPOWER TABLE - 2" FLOOD

CANDLEPOWER TABLE - LUMP [illegible] INCH T BULB [illegible] 30

HORZ. ANGLES (H 15 11)

VERT.	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0
	110.0	120.0	130.0	140.0	150.0	160.0			
-40.0		0	0	0	00	1[illegible]0	11[illegible]	11[illegible]	11[illegible]	11[illegible]
	1100	1000	900	[illegible]	[illegible]				
-30.0		0	00	1400	1300	1400	1[illegible]	1[illegible]	1[illegible]	1[illegible]
	1500	1400	1300	1200	00				
-20.0		400	1200	1700	2100	2[illegible]0	2[illegible]0	2[illegible]0	2[illegible]0	2[illegible]0
	2600	2500	2100	1700	1200	800				
-10.0		1200	1400	2700	3500	4[illegible]00	5[illegible]00	5[illegible]00	6300	6200
	5600	4700	3500	2700	1400	1200				
0.0		1400	3500	5300	8[illegible]00	9[illegible]00	10500	11300	11300	11300
	10500	9[illegible]00	8[illegible]00	5300	3[illegible]00	1[illegible]00				
10.0		1400	2600	5000	7[illegible]00	9[illegible]00	9[illegible]00	9[illegible]00	10000	9[illegible]00
	9300	9[illegible]00	7600	5000	2[illegible]00	1400				
20.0		1300	1[illegible]00	2[illegible]00	2[illegible]00	3[illegible]00	3[illegible]00	3[illegible]00	3[illegible]00	3[illegible]00
	3400	3[illegible]00	2[illegible]00	2[illegible]00	1[illegible]00	1300				
30.0		1200	1[illegible]00	2[illegible]00	2[illegible]00	2[illegible]00	2[illegible]00	2[illegible]00	2[illegible]00	2[illegible]00
	2500	2[illegible]00	2[illegible]00	2[illegible]00	1[illegible]00	1[illegible]00				
40.0		900	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00
	1700	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	[illegible]00				
50.0		0	900	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00	1[illegible]00
	1400	1300	1[illegible]50	1[illegible]00	[illegible]00	0				
60.0		0	0	0	0	0	[illegible]00	1000	1000	1000
	900	0	0	0	0	0				

5104

[illegible]

[illegible]

[illegible]										
		20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0
	110.0	120.0	130.0	140.0	150.0	160.0				
VERT.										
-40.0		0	0	200	700	900	900	900	900	900
	600	300	700	200	0	0				
-30.0		0	300	300	1000	1100	1300	1400	1500	1400
	1300	1100	1000	900	900	0				
-20.0		300	900	1300	1700	2100	2400	2400	2400	2400
	2200	2100	1700	1300	900	300				
-10.0		500	1500	2700	4000	4900	5000	5100	5100	5100
	5000	4500	4000	2700	1500	500				
0.0		400	2600	4600	6400	7100	7500	7200	7200	7200
	6800	6200	5400	4200	2600	400				
10.0		900	2300	4500	6400	7900	8100	8000	8000	8000
	5800	6400	4900	3500	2300	900				
20.0		0	300	1400	2500	3100	3400	2400	2400	2400
	2500	3400	2500	1400	300	0				
30.0		0	400	1400	1500	1500	1400	1400	1400	1400
	1500	1400	1500	1400	400	0				
40.0		0	0	200	600	1100	1100	1200	1300	1200
	1100	1000	900	200	0	0				
50.0		0	0	0	0	200	200	200	200	200
	200	600	0	0	0	0				

[illegible]

[illegible] (M 17 11)

	10.0	20.0	40.0	60.0	80.0	100.0	120.0	140.0	160.0	180.0
WEST.										
-40.0	0	0	0	1000	1400	1600	1700	1800	1800	1800
	1800	1800	1800	1800	1600	0	0	0		
-30.0	0	0	1200	2100	2200	2300	2300	2400	2400	2400
	2400	2400	2300	2200	2100	1200	0	0		
-20.0	0	1400	2400	2700	2800	2800	1600	3100	3300	3400
	3100	3000	2900	2800	2700	2400	1300	0	0	0
-10.0	800	2400	4000	5200	5700	6000	7000	7000	7000	7000
	7000	7000	6600	5700	5200	4900	2600	900		
0.0	2000	4400	6200	11400	14000	16400	17400	18000	18000	18000
	18000	17400	16400	14000	11400	6200	4400	2000		
10.0	1000	4000	7600	11000	13200	15200	15800	16800	17200	17200
	17200	16800	15200	13200	11000	7600	4000	1000		
20.0	500	2700	6300	9400	7000	7400	9400	8400	9000	9000
	8500	8400	7500	7000	6500	6500	2700	500	0	0
30.0	0	1600	2500	3500	4200	4700	5000	5100	5200	5200
	5100	5000	4700	4200	3500	2400	1300	0	0	0
40.0	0	500	2000	2200	2200	2400	2700	2400	2400	2400
	2400	2700	2400	2200	2200	2000	500	0	0	0
50.0	0	0	500	1400	2100	2200	2300	2400	2500	2500
	2500	2400	2400	2100	1400	500	0	0	0	0
60.0	0	0	0	0	500	1400	1500	1400	1400	1400
	1400	1400	1500	500	0	0	0	0	0	0

```
     [illegible] TABLE OUTPUT

     [illegible] TABLE [illegible] NO.  53



     [illegible] (H   1-  18)
                22.0   30.0   38.0   46.0   54.0   62.0   70.0   78.0   86.0
          94.0 102.0  110.0  118.0  126.0  134.0  142.0  150.0  158.0
VERT.

-68.0            37     37     74     74    111    129    144    144    148
           148    144    144    129    111     74     74     37     37

-60.0            55    111    129    155    148    203    203    221    221
           221    221    203    203    148    155    129    111     55

-52.0            74    148    959   1114    959    656    793    756    645
           645    756    793    656    959   1114    959    148     74

-44.0           111    461   1444   1554   1662   1507   1494   1423   1180
          1180   1423   1494   1507   1662   1554   1444    461    111

-36.0           148   2231   2766   2654   2469   2711   2536   2176   1715
          1715   2176   2536   2711   2654   2469   2766   2231    148

-28.0           155   2600   3204   3614   4001   3923   3923   3079   2120
          2120   3079   3923   3923   4001   3614   3204   2600    155

-20.0           221   2840   3532   5151   5974   6635   5472   5421   3513
          3513   5421   5472   6635   5974   5151   3532   2840    221

-12.0           255   3005   3891   7412   7412  10406  10731  10165   6809
          6809  10165  10731  10406   7412   7412   3891   3005    255

 -4.0           255   3153   4078   4078   5353  11937  12834  13663  13732
         13732  13663  12834  11937   5353   4078   4078   3153    255

  4.0           245   2510   4130   5057   6611  12532  13534  13755  13996
         13996  13755  13534  12532   6611   5057   4130   2510    245

 12.0           240   3061   4038   7209   7800  11265  12544  10934  11377
         11377  10934  12544  11265   7800   7209   4038   3061    240

 20.0           221   2914   3841   4942   5491   7671   7726   6454   4905
          4905   6454   7726   7671   5491   4942   3841   2914    221

 28.0           155   2655   3448   3925   4425   4314   4157   3134   2065
          2065   3134   4157   4314   4425   3925   3448   2655    155

 36.0           111   1523   3066   3314   3170   2821   2454   2134   1715
          1715   2134   2454   2821   3170   3314   3066   1523    111
```

B107

CANDLEPOWER TABLE INCREMENT

CANDLEPOWER TABLE - LIGHT LOSS FACTOR: 0.80 - CANDLEPOWER TABLE NO. 93

DIST. ALONG (M 15 LINE)

	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VERT.									
44.0		74	203	2378	2400	2342	2147	1704	1383
	1343	1660	1744	2047	2342	2500	2378	2253	74
52.		37	129	716	1291	1198	1114	853	848	737
	737	548	905	1014	1146	1191	716	129	47	
60.0		37	74	111	144	203	203	203	221	221
	221	221	203	203	203	144	111	74	37	
68.0		0	37	37	74	74	111	148	148	148
	148	148	148	111	74	74	37	37	0	

[illegible] TABLE [illegible]

[illegible] TABLE [illegible] [illegible] [illegible] [illegible] 54

[illegible] (H 16 14)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
VERT.									
-65.0	0	0	0	0	50	510	990	1120	1120
	990	510	50	0	0	0	0		
-55.0	0	0	247	3930	8050	7010	8150	1590	1980
	8150	7010	8050	3990	247	0	0		
-45.0	0	550	5490	9430	9920	10030	12050	13290	13290
	12050	10030	9920	9430	5490	550	0		
-35.0	0	3490	10110	11790	13010	13370	13510	13350	13350
	13510	13370	13010	11790	10110	3490	0		
-25.0	130	7540	13050	15550	17210	17910	24010	24530	24530
	24010	17910	17210	15550	13050	7540	130		
-15.0	260	9540	15460	18430	22290	25730	32170	45530	45530
	32170	25730	22290	18430	15460	9540	260		
-5.0	300	10150	17130	21400	25550	30540	42490	50900	50900
	42490	30540	25550	21400	17130	10150	300		
5.0	260	9920	17410	22010	26390	33470	48200	58120	58120
	48200	33470	26390	22010	17410	9920	260		
15.0	0	7530	15670	21350	25050	29250	40500	52750	52750
	40500	29250	25050	21350	15670	7530	0		
25.0	0	5120	14030	19150	21770	24000	32110	41150	41150
	32110	24000	21770	19150	14030	5120	0		
35.0	0	2640	11260	15470	17310	17750	21500	25000	25000
	21500	17750	17310	15470	11260	2640	0		
45.0	0	540	6950	11050	12550	12520	14420	15460	15460
	14420	12520	12550	11050	6950	540	0		
55.0	0	0	1380	5120	6410	6370	8830	8940	8940
	8830	6370	6410	5120	1380	0	0		
65.0	0	0	0	420	1040	1250	1251	1120	1120
	1251	1250	1040	420	0	0	0		

B109

[illegible]

[illegible]

AZ. ANGLE (V = 12)

	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
-5.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
175.0	185.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
275.0	285.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	

VERT.

-15.0	245	245	235	180	220	167	159	115	43
22	22	43	115	159	167	220	180	235	245
245	235	180	220	167	159	115	43	22	22
43	115	159	167	220	180	235	245	245	
-5.0	914	914	905	227	644	867	644	356	150
36	36	150	356	644	867	644	227	905	914
914	905	227	644	867	644	356	150	36	36
150	356	644	867	644	227	905	914	914	
5.0	2360	2360	2295	1544	2060	1913	1509	1073	644
143	143	644	1073	1509	1913	2060	1544	2295	2360
2360	2295	1544	2060	1913	1509	1073	644	143	143
644	1073	1509	1913	2060	1544	2295	2360	2360	
15.0	3515	3515	3368	2188	3003	2947	2550	2231	1609
665	665	1609	2231	2660	2947	3003	2188	3368	3515
3515	3368	2188	3003	2947	2660	2231	1609	665	665
1609	2231	2660	2947	3003	2188	3368	3515	3515	
25.0	4270	4270	4226	3067	3647	3505	3218	3003	2467
1802	1802	2467	3003	3218	3505	3647	3067	4226	4270
4270	4226	3067	3647	3505	3218	3003	2467	1802	1802
2467	3003	3218	3505	3647	3067	4226	4270	4270	
35.0	5148	5148	4676	3904	4204	4161	3815	3542	3110
2681	2681	3110	3542	3815	4161	4204	3904	4676	5148
5148	4676	3904	4204	4161	3815	3542	3110	2681	2681
3110	3542	3815	4161	4204	3904	4676	5148	5148	
45.0	5234	5234	5200	4376	4550	4419	4354	4183	3647
3218	3218	3647	4183	4354	4419	4550	4376	5200	5234
5234	5200	4376	4550	4419	4354	4183	3647	3218	3218
3647	4183	4354	4419	4550	4376	5200	5234	5234	
55.0	5190	5190	5212	5140	5470	5500	5191	5490	4290
3792	3792	4290	5490	5191	5500	5470	5140	5212	5190
5190	5212	5140	5470	5500	5191	5490	4290	3792	3792
4290	5490	5191	5500	5470	5140	5212	5190	5190	

B110

[illegible] TABLE PRINTOUT

[illegible] TABLE - LOOKUP TABLE CODE: VI-LEVEL TABLE NO. 55

[illegible]	[illegible]	(V	3[illegible]	12)					
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
[illegible] T.									
45.0	5490	5490	5513	5320	5556	5577	5534	5320	4934
4290	4290	4934	5320	5534	5577	5556	5320	5513	5490
5490	5513	5320	5556	5577	5534	5320	4934	4290	4290
4934	5320	5534	5577	5556	5320	5513	5490	5490	
75.0	5277	5277	5405	5556	5513	5534	5534	5504	5363
5084	5084	5363	5504	5534	5534	5513	5556	5405	5277
5277	5405	5556	5513	5534	5534	5504	5363	5084	5084
5363	5504	5534	5534	5513	5556	5405	5277	5277	
[illegible]	5490	5490	5490	5490	5490	5490	5490	5490	5490
5490	5490	5490	5490	5490	5490	5490	5490	5490	5490
5490	5490	5490	5490	5490	5490	5490	5490	5490	5490
5490	5490	5490	5490	5490	5490	5490	5490	5490	
60.0	5490	5490	5490	5490	5490	5490	5490	5490	5490
5490	5490	5490	5490	5490	5490	5490	5490	5490	5490
5490	5490	5490	5490	5490	5490	5490	5490	5490	5490
5490	5490	5490	5490	5490	5490	5490	5490	5490	

[illegible] TABLE PRINTOUT

[illegible] TABLE = LOAD TYPE CODE: VARIABLE TABLE NO. 55

[illegible] (V 3[illegible] 12)

	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	

95.0 F.

-15.	615	729	486	220	196	297	295	387	396
297	247	396	387	295	297	196	220	486	729
615	643	666	324	225	202	198	198	194	194
198	198	202	225	324	666	643	615	729	
-5.	999	2930	590	342	342	1143	2644	3938	2552
776	706	2552	3938	2644	1148	342	342	590	2930
999	540	464	356	215	176	162	171	180	180
171	162	176	216	356	464	540	999	2930	
5.	494	1439	1132	1327	2515	3824	4725	4747	3186
2942	2942	3186	4747	4725	3824	2515	1327	1132	1439
494	415	423	360	220	180	165	157	171	171
157	165	180	220	360	423	415	994	1439	
15.	1017	11385	14678	7444	5328	4432	4806	6813	2142
1822	1822	2142	6813	4806	4432	5328	7444	14678	11385
1017	310	202	274	292	162	180	180	180	180
180	180	162	292	274	292	310	1017	11385	
25.	1345	11346	44483	31195	11025	6204	5881	3024	1224
1133	1133	1224	3024	5881	6204	11025	31195	44483	11346
1345	465	238	211	163	139	153	171	162	162
171	153	139	153	211	288	465	1345	11346	
35.	4651	6111	22846	45935	19309	13473	8136	4018	2848
2205	2205	2848	4018	8136	13473	19309	45935	22846	6111
3951	2470	1404	513	234	207	202	189	175	175
189	202	207	234	513	1404	2470	3951	6111	
45.	4635	6484	10710	13936	23697	25429	20430	15876	10566
6291	6291	10566	15876	20430	25429	23697	13936	10710	6484
4635	4459	3919	3546	1962	1442	415	301	265	265
301	415	1442	1962	3546	3919	4459	4635	6484	
55.	5242	5076	6741	10057	15354	19462	23719	32238	27765
22149	22149	27765	32238	23719	19462	15354	10057	6741	5076
5242	4748	4715	4383	4689	4234	3834	1575	557	557
1575	3834	4234	4689	4383	4715	4748	5242	5076	

B112

[illegible] TABLE [illegible]

[illegible] TABLE - [illegible] CODE: [illegible] TABLE NO. [illegible]

[illegible] (V 3/ 12)

	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0	
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
[illegible]	[illegible]	305.0	315.0	325.0	335.0	345.0	355.0	365.0	

WEST.

65.	3991	4279	4429	4473	7261	10422	13559	14949	13959
11714	11714	13959	14949	13559	10422	7261	4473	4429	4279
3991	4429	4351	4072	4554	5031	5044	3446	1075	1075
3446	5044	5031	4554	4072	4351	4429	3991	4279	
75.0	4023	3222	2635	2668	3167	3861	4221	4675	4603
4675	4221	3861	3167	2668	2635	3222	2565	2565	3222
4023	4383	4648	4644	4965	4617	2547	3127	7825	7825
3127	2547	4617	4965	4644	4648	4383	4023	3222	
85.0	4072	3954	3527	3321	3167	2952	2911	2754	2749
2711	2711	2749	2754	2911	2952	3167	3321	3627	3464
4072	4140	3942	3952	3919	4032	3919	4018	3926	3928
4018	3919	4032	3919	3952	3942	4140	4072	3954	
95.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
3400	3400	3400	3400	3400	3400	3400	3400	3400	3400
3400	3400	3400	3400	3400	3400	3400	3400	3400	3400
3400	3400	3400	3400	3400	3400	3400	3400	3400	

[illegible] TABLE - LOAT [illegible]: [illegible]/241 TABLE NO. 57

[illegible] (H 15 16)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
[illegible]									
-7[illegible]		137	229	273	273	262	244	305	313	313
	3[illegible]	244	292	273	273	229	137			
-[illegible]		19[illegible]	253	335	525	1599	3525	3923	4128	4128
	3923	3525	1599	525	335	253	19[illegible]			
-55.[illegible]		210	255	2250	3450	4290	4350	5550	7915	7915
	5550	4350	4290	3450	2250	255	210			
-45.[illegible]		250	450	2230	6740	8020	9900	10730	9910	9910
	10730	9900	8020	6740	2230	450	250			
-35.[illegible]		280	1300	4670	6310	7420	9[illegible]0	9460	9860	9860
	9860	9040	7920	6310	4670	1300	280			
-25.[illegible]		270	2070	3910	5110	6760	10740	13140	15550	15550
	13140	10740	6760	5110	3910	2070	270			
-15.[illegible]		260	1740	3050	5280	8220	11310	15050	16540	16560
	15050	11310	8220	5280	3060	1720	250			
-5.[illegible]		240	1400	2700	4450	5400	11530	14330	16670	16670
	14330	11530	8400	4450	2700	1400	240			
5.[illegible]		250	1420	2730	4370	6040	111[illegible]0	14100	16170	16170
	14100	11140	8040	4370	2730	1420	250			
15.0		240	1510	3130	5030	8040	11340	14960	16650	16200
	14960	11340	8040	5030	3130	1510	240			
25.0		270	2010	4000	5370	8040	9500	11300	13040	13080
	11300	9500	8040	5370	4000	2010	270			
35.0		250	660	4620	6340	7660	9130	9820	9820	9820
	9820	9130	7660	6340	4620	660	250			
45.0		210	420	2170	5200	7450	9540	10450	9720	9720
	10460	9540	7950	5200	2170	420	210			
55.[illegible]		170	250	2055	3300	4395	5030	5650	5250	5250
	5625	5030	4395	3300	2055	250	170			

[illegible] TABLE [illegible]

[illegible] TABLE - [illegible] [illegible]: [illegible] T [illegible] 90. 57

[illegible] S (H 15 . In)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
105.0	115.0	125.0	135.0	145.0	155.0	165.0			

VEHT.

[illegible]		198	263	335	525	1593	3923	4124	4125
	3923	3520	1594	525	335	263	[illegible]		
75.0		197	229	273	273	262	313	313	313
	3 5	294	262	273	273	229	197		

B115

[illegible] TABLE HISTOGRAM

[illegible] TABLE - [illegible] TABLE NO. 33

[illegible] (M 15 14)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
[illegible]									
-75.0		0	0	0	44	120	144	174	144	144
	174	104	120	44	0	0	0			
-65.0		0	155	230	327	482	544	546	606	630
	624	544	482	327	230	155	0			
-55.0		0	232	462	744	1124	1144	1344	1316	1316
	1344	1144	1124	744	462	232	0			
-45.0		142	310	1034	2009	2410	2454	2721	2730	2730
	2721	2454	2410	2009	1034	310	142			
-35.0		263	304	2134	3734	4196	4344	4524	4506	4506
	4524	4344	4196	3734	2134	304	263			
-25.0		263	620	3390	4756	5542	6413	6542	6776	6776
	6542	6413	5542	4756	3390	620	263			
-15.0		263	775	4138	5327	6827	8514	9542	9934	9934
	9502	8514	6827	5327	4138	775	263			
-5.0		263	853	4425	5514	7550	9491	11303	12500	12500
	11303	9491	7550	5514	4425	853	263			
5.0		263	853	4425	5514	7550	9514	11544	12204	12204
	11544	9414	7550	5514	4425	853	263			
15.0		263	775	4040	5350	6787	8370	9334	9440	9440
	9334	8370	6787	5350	4040	775	263			
25.0		263	620	3390	4756	5542	6304	6599	6470	6470
	6599	6304	5542	4766	3390	620	263			
35.0		263	465	2241	3595	4016	4234	4321	4243	4243
	4321	4234	4016	3594	2241	465	263			
45.0		132	310	1034	2103	2209	2355	2444	2401	2401
	2444	2355	2209	2103	1034	310	132			
55.0		0	310	434	841	1044	1147	1251	1243	1243
	1251	1147	1044	841	434	310	0			

[illegible] TABLE [illegible]

[illegible] TABLE - [illegible] CODE: [illegible] TABLE NO. 38

[illegible] (F IN IN)

	15.0	25.0	35.0	45.0	55.0	65.0	75.0	85.0	95.0
	105.0	115.0	125.0	135.0	145.0	155.0	165.0		
VELOCITY									
65.		0	139	297	457	602	734	854	959
	71.	962	512	457	297	139	0		
70.		0	0	57	146	200	254	293	320
	293	254	200	146	57	0	0		

[illegible] TABLE WITHOUT

[illegible] TABLE - LOWER LEFT CORNER OF TABLE NO. 34

[illegible] (V 37 19)

	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0
	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0
	290.0	300.0	310.0	320.0	330.0	340.0	350.0	360.0		

[illegible]

0.0		1813	1534	1285	1029	731	447	262	216	181
	216	181	216	262	447	731	1029	1285	1534	1813
	1534	1105	914	844	800	737	800	844	914	1105
	1534	337	400	844	914	1105	1534	1813		
5.0		2491	2394	2150	1756	1200	819	481	331	294
	350	294	331	481	819	1200	1756	2150	2394	2491
	2219	1469	1294	1150	756	444	313	294	275	294
	313	444	756	1150	1294	1469	2219	2491		
10.0		4556	3856	3369	2600	2087	1400	969	969	475
	525	475	969	969	1400	2087	2600	3369	3850	3956
	3956	3112	2594	1400	1275	913	594	463	463	463
	532	813	1275	1400	2594	3112	3956	3956		
15.0		5904	5531	4944	4231	3250	2256	1500	1000	787
	525	787	1000	1500	2256	3250	4231	4944	5531	5869
	5225	4644	3936	3019	2100	1412	962	762	750	762
	962	1412	2100	3019	3936	4644	5225	5869		
20.0		7756	7612	6994	6136	4919	3594	2436	1756	1400
	1375	1400	1756	2436	3594	4919	6136	6994	7612	7756
	7225	6637	5806	4631	3350	2406	1756	1436	1325	1436
	1756	2406	3350	4631	5806	6637	7244	7756		
25.0		10300	10144	9437	8512	7125	5412	3994	2969	2344
	2306	2344	2969	3994	5412	7125	8512	9437	10144	10300
	9744	8031	8044	6700	4956	3631	2794	2350	2225	2350
	2794	3631	4956	6700	8044	9031	9744	10300		
30.0		13294	13112	12275	11294	9794	7425	5569	4550	4019
	3975	4019	4550	5569	7825	9794	11294	12275	13112	13294
	12563	11450	10519	9281	7244	5381	4175	3556	3550	3556
	4175	5381	7244	9281	10519	11550	12563	13294		
35.0		15481	16030	15500	14337	12781	10644	8359	6653	5869
	5850	5869	6653	8359	10644	12781	14337	15500	16030	15481
	15063	13994	13837	12269	10044	7469	6213	5431	5225	5431
	6213	7469	10044	12269	13987	15994	16594	15481		

B118

[illegible] TABLE [illegible]

[illegible] TABLE - (CONT.) [illegible] : VISCOSITY TABLE NO. 39

HOR. [illegible] (V	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0
	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0
	290.0	300.0	310.0	320.0	330.0	340.0	350.0	360.0		
VERT.										
40.0		21262	20394	19231	17812	15736	13594	11294	9436	8219
	8425	8519	9436	11294	13594	15736	17812	19231	20394	21262
	20100	19250	17100	15231	13050	10600	8425	7719	7436	7719
	8425	10600	13050	15231	17100	19250	20100	21262		
45.0		27500	26575	23725	21213	18736	16394	14212	12425	11506
	11525	11506	12425	14212	16394	18736	21213	23725	26575	27500
	26644	23252	20681	18413	15950	13550	11531	10481	10225	10481
	11531	13550	15950	18413	20681	23252	25944	27500		
50.0		34725	32506	29456	25575	22250	19375	17119	15544	14731
	14875	14731	15544	17119	19375	22250	25575	29456	32506	34725
	33562	29481	24850	21719	18944	16450	14412	13506	13325	13506
	14512	16450	18944	21719	24850	29481	33562	36762		
55.0		50744	46125	37400	31344	26514	23356	20900	19200	18325
	18456	18325	19200	20900	23356	26514	31344	37400	46125	50744
	45337	36814	30606	25556	23250	20545	18744	17525	17325	17625
	18738	20525	23250	25556	30606	36814	45337	50744		
60.0		67387	56819	46500	37906	32281	28244	25406	23594	22706
	22725	22706	23594	25406	28244	32281	37906	46500	56819	67387
	54037	44063	37525	31675	27456	25303	23456	22175	21931	22175
	23463	25363	27425	31675	37525	46106	56837	67387		
65.0		83256	74131	57456	46350	39400	34525	31450	29519	28544
	28625	28544	29519	31450	34525	39400	46350	57456	74131	83256
	73175	56756	45925	39081	34581	31525	29513	28050	27825	28050
	29519	31438	34581	39181	45944	56956	73175	83256		
70.0		94675	79631	71431	57819	49250	43431	39506	37337	36494
	36750	36494	37337	39506	43431	49250	57819	71431	79631	94675
	87850	71356	57531	49350	43844	40069	37519	36056	35875	36056
	37519	40069	43844	49350	57531	71356	87850	93557		
75.0		112311	95644	84344	73937	63475	56414	51919	49269	48381
	48581	48381	49269	51919	56414	63475	73937	84344	95644	112311
	112513	96469	82737	73131	65481	59131	54856	52519	51700	52519
	54856	59131	65481	73131	82737	96469	112513			

[illegible]

[illegible] - [illegible] (Vertical Table 0. 0)

[illegible] (V 3 12)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
WEST.									
-15.0		322	404	274	132	116	116	140	235	209
	182	182	209	235	140	116	116	132	274	404
	322	364	350	170	114	102	80	74	95	80
	74	80	102	114	170	350	364	322	404	
-5.0		964	1614	470	145	166	636	1430	2488	1514
	410	410	1514	2048	1430	636	166	145	340	1614
	564	290	248	148	110	82	78	78	78	78
	78	78	82	110	148	248	290	564	1614	
5.0		540	760	638	746	1320	1425	2313	2490	1750
	1750	1750	1750	2490	2313	1425	1320	746	638	760
	540	238	210	146	110	88	88	80	80	80
	80	80	88	110	146	210	238	540	760	
15.0		947	6241	10630	4072	2850	2207	2367	3587	1092
	1092	1092	1092	3587	2367	2207	2850	4072	10630	6241
	947	167	135	134	96	78	78	78	96	80
	78	78	78	96	134	135	167	947	6241	
25.0		1947	5333	24259	16131	3581	3547	2595	1542	545
	617	617	645	1542	2595	3547	3581	16131	24259	5333
	1947	257	145	110	78	70	70	80	80	80
	80	80	80	78	110	145	257	1947	5333	
35.0		2120	3097	10982	23657	10042	7242	4327	2108	1034
	1150	1150	1530	2108	4327	7242	10042	23657	10982	3097
	2120	1382	820	322	140	93	88	78	88	88
	78	93	93	140	322	820	1382	2120	3097	
45.0		2527	3465	5812	7150	11427	13247	10482	8640	5405
	3447	3447	5815	8545	10682	13247	11927	7150	5812	3462
	2527	2447	2172	1965	1372	445	213	132	117	117
	132	213	445	1372	1965	2172	2447	2527	3465	
55.0		3015	2837	3732	5450	7457	10042	11942	10542	14335
	11642	11642	14335	10542	11942	10042	7457	5450	3732	2837
	3015	2592	2545	2345	2435	2215	2115	932	315	315
	932	2115	2215	2435	2345	2545	2592	3015	2837	

B121

[illegible] TABLE [illegible]

[illegible] TABLE - LOW SIDE CONN: [illegible] TABLE NO. 60

60HZ. [illegible] (V 3- 12)

	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
AMBT.										
65.0		2175	2267	2415	2515	3445	5000	6645	7430	6927
	6927	6932	6927	7430	6645	5500	3845	2515	2415	2297
	2175	2435	2362	2220	2385	2742	2642	1832	977	977
	1832	2692	2702	2355	2227	2382	2435	2175	2297	
75.0		2165	1742	1440	1435	1832	1900	2150	2340	2360
	2490	2430	2300	2340	2150	1900	1832	1435	1440	1742
	2165	2370	2555	2357	2347	2357	1332	1700	4352	4352
	1700	1332	2357	2347	2547	2555	2370	2165	1742	
85.0		2177	2105	1922	1752	1410	1532	1455	1410	1412
	1337	1347	1412	1410	1435	1532	1351	1752	1922	2105
	2177	2217	2145	2015	2110	2155	2156	2157	2045	2045
	2157	2102	2165	2110	2095	2145	2217	2177	2105	
90.0		1800	1800	1800	1500	1500	1500	1800	1500	1500
	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
	1500	1500	1500	1500	1500	1500	1500	1500	1500	

[illegible] TABLE PRINTOUT

[illegible] TABLE - LUMINANCE (CD/M²) MESOPIC TABLE NO. 61

HORZ. ANGLES (M									
	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0	
WEST.									
-68.		72	72	145	145	217	289	289	289	289
	289	289	289	289	217	145	145	72	72	
-60.0		145	217	289	361	289	361	361	434	434
	434	434	361	361	289	361	289	217	145	
-52.		145	289	1301	1446	1591	1735	1591	1446	1301
	1157	1302	1591	1735	1880	1880	1735	289	145	
-44.0		217	940	3615	3832	3687	3832	2964	2748	2314
	2314	2748	2964	3832	3687	3832	3615	940	217	
-36.		289	4374	5423	5421	5782	5615	4953	4265	3353
	3353	4265	4953	5315	5782	5421	5423	4374	289	
-28.		325	5044	6240	7145	7445	7701	7701	6047	4157
	4157	6047	7701	7701	7445	7180	6240	5044	325	
-20.0		434	5500	7122	10160	11714	13015	12590	10630	6869
	6869	10630	12590	13015	11714	10160	7122	5500	434	
-12.		506	6494	7529	14534	14534	20341	21041	14921	14234
	14234	14921	21041	20341	14534	14534	7529	6494	506	
-4.		506	8162	7940	15838	15474	23341	25154	26740	27044
	27044	26740	25154	23341	15838	15838	7940	8162	506	
4.		578	5114	8099	15799	15864	24565	26537	26971	27441
	27441	26971	26537	24565	15864	15799	8099	5114	578	
12.		470	6002	7918	14136	15294	22090	24694	21434	22307
	22307	21434	24694	22090	15294	14136	7918	6002	470	
20.		434	5713	7629	9689	12727	15040	15149	12654	9617
	9617	12654	15149	15040	12727	9689	7629	5713	434	
28.		325	5205	6781	7701	8677	8681	8171	6145	4049
	4049	6145	8171	8681	8677	7701	6781	5205	325	
36.		217	3192	5304	6867	7234	6512	4841	3154	2353
	2353	3154	4841	6512	7234	6867	5304	3192	217	

[illegible] TABLE REPORT

[illegible] TABLE - LOAD [illegible]: PROPOSED TABLE NO. 81

[illegible] (R 13 14)

	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VENT.									
44.0		147	340	4504	5[illegible]	4591	4013	3507	3254	2712
	2712	3254	3507	4013	4591	5[illegible]	4504	340	147	
52.0		72	253	1417	2531	2350	1418	1771	1663	1445
	1445	1663	1771	1498	2350	2531	1417	253	72	
60.0		72	145	217	362	345	348	345	434	434
	434	434	348	348	348	362	217	145	72	
68.0		0	72	72	145	145	217	289	289	289
	289	289	289	217	145	145	72	72	0	

[illegible] TABLE [illegible]

[illegible] TABLE - [illegible] TABLE NO. 62

[illegible]	[illegible]	(M	[illegible]	[illegible]					
	22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0
VECT.									
-68.0		0	0	69	138	172	241	275	275	344
	344	275	275	241	172	138	69	0	0	
-60.0		69	69	138	172	241	275	344	344	413
	413	344	344	275	241	172	138	69	69	
-52.0		69	138	172	241	275	344	413	413	447
	447	413	413	344	275	241	172	138	69	
-44.0		138	550	1410	2477	3444	3784	4359	4044	4300
	4300	4044	4359	3784	3444	2477	1410	550	138	
-36.0		241	482	2236	3444	4541	4482	5534	5263	5573
	5573	5263	5534	4826	4541	3444	2236	963	241	
-28.0		413	1376	2993	4732	5962	6536	7346	7086	7602
	7602	7086	7346	6536	5962	4732	2993	1376	413	
-20.0		516	1720	4059	6447	8256	9285	10454	10354	10402
	10402	10354	10454	9285	8256	6447	4059	1720	516	
-12.0		482	1995	5022	8462	11440	13554	15446	15377	16065
	16065	15377	15446	13554	11440	8462	5022	1995	482	
-4.		895	2546	6605	11627	15962	18054	21474	21741	22635
	22635	21741	21474	18054	15962	11627	6605	2546	895	
4.		516	2408	6605	11356	15734	18054	21616	21913	22979
	22979	21913	21616	18054	15734	11356	6605	2408	516	
12.		516	2167	5471	9444	11837	13955	15962	15962	16581
	16581	15962	15962	13956	11937	9444	5471	2167	516	
20.0		447	1720	4094	6605	8566	9548	10570	10733	11111
	11111	10733	10570	9548	8566	6605	4094	1720	447	
28.0		378	1410	3096	4819	6192	6777	7774	7465	7979
	7979	7465	7774	6777	6192	4819	3096	1410	378	
36.0		241	1032	2167	3574	4644	4948	5745	5401	5745
	5745	5401	5745	4948	4644	3574	2167	1032	241	

B125

[illegible] TABLE PRINTOUT

[illegible] TABLE - [illegible] [illegible] [illegible] TABLE NO. 62

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		22.0	30.0	38.0	46.0	54.0	62.0	70.0	78.0	86.0
	94.0	102.0	110.0	118.0	126.0	134.0	142.0	150.0	158.0	
VERT.										
44.0		172	551	1479	2546	3612	4033	4472	4152	3444
	2756	4152	4472	4033	3612	2546	1479	551	172	
52.0		69	138	172	241	275	344	413	413	447
	447	413	413	344	275	241	172	138	69	
60.0		69	69	138	172	241	275	344	344	413
	413	344	344	275	241	172	138	69	69	
68.0		0	0	69	138	172	241	275	275	344
	344	275	275	241	172	138	69	0	0	

[illegible] TABLE [illegible]

[illegible] TABLE - [illegible] VER. [illegible] TABLE NO. 53

ROW	[illegible]	(V	AB	(B)					
	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0
27.5	35.0	45.0	55.0	65.0	75.0	85.0	90.0	95.0	105.0
115.0	125.0	135.0	145.0	152.5	155.0	157.5	162.5	165.0	167.5
172.5	175.0	177.5	182.5	185.0	187.5	192.5	195.0	197.5	202.5
205.0	207.5	215.0	225.0	235.0	240.0	250.0	260.0	275.0	285.0
295.0	305.0	315.0	325.0	332.5	335.0	337.5	342.5	345.0	347.5
352.5	355.0	357.5	362.5						
VERT.									
-35.0		30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30						
-25.0		95	115	50	35	45	45	45	45	45
	45	45	30	30	30	30	30	30	30	30
	30	30	30	45	45	45	45	45	45	45
	66	54	115	45	74	60	30	15	15	26
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	45	14	15	30
	45	74	95	115						
-15.0		143	201	234	231	215	215	180	171	164
	163	145	145	174	134	134	134	89	134	134
	134	134	145	145	154	164	171	146	205	215
	231	233	201	183	164	145	134	89	74	44
	30	30	30	30	30	30	30	30	30	30
	30	30	30	30	30	30	44	74	89	104
	145	164	145	201						
-5.0		262	287	311	315	323	325	314	314	311
	295	295	295	252	252	223	200	200	200	223
	252	252	295	262	250	311	314	314	325	323
	315	311	287	252	234	223	143	179	167	134
	119	105	89	74	30	30	30	30	30	30
	30	30	74	89	105	119	134	167	179	193
	223	234	252	287						
5.0		357	445	574	563	538	540	742	815	824
	83	445	771	571	338	254	255	252	255	254
	334	471	771	584	43	264	215	742	541	538
	583	574	445	357	325	295	252	234	223	208
	195	179	135	184	134	115	95	74	75	98
	115	184	184	135	174	135	215	223	234	252
	295	325	357	445						

B127

CONDENSED FREQUENCY DISTRIBUTION

CONDENSED FREQUENCY TABLE - LIGHT [illegible] Version of Table No. 53

FROM	ABOVE	0 TO	5.0 TO	10.0 TO	15.0 TO	20.0 TO	25.0 TO	30.0 TO	35.0 TO	40.0 TO
		2.5	7.5	12.5	17.5	22.5	27.5	32.5	37.5	42.5
	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0
	95.0	100.0	105.0	110.0	115.0	120.0	125.0	130.0	135.0	140.0
	145.0	150.0	155.0	160.0	165.0	170.0	175.0	180.0	185.0	190.0
	195.0	200.0	205.0	210.0	215.0	220.0	225.0	230.0	235.0	240.0
	245.0	250.0	255.0	260.0	265.0	270.0	275.0	280.0	285.0	290.0
	295.0	300.0	305.0	310.0	315.0	320.0	325.0	330.0	335.0	340.0
	345.0	350.0	355.0	360.0						

POINT.

5.0		416	574	583	773	961	1114	1150	1340	1410
	1425	1040	890	400	357	298	265	265	265	268
	357	400	890	1040	1425	1410	1340	1150	1114	980
	773	583	579	416	372	357	298	265	235	193
	2[illegible]	193	179	193	228	148	115	89	89	115
	143	208	193	179	143	208	143	235	265	252
	357	372	416	574						

7.5		1335	400	504	609	447	595	1140	2230	2000
	177	2617	1362	571	472	379	304	355	344	379
	472	571	1362	2617	1770	2000	2230	1140	995	847
	609	504	400	1336	1245	1101	877	784	699	238
	272	223	230	241	242	195	155	141	141	156
	195	242	241	230	223	272	238	599	786	877
	1147	1245	1335	400						

10.0		903	1243	1510	1430	2252	3020	3392	4040	4250
	4441	4192	1873	742	547	441	401	445	441	491
	547	742	1873	4192	4441	4250	4040	3392	3020	2652
	1930	1510	1243	903	677	551	495	341	296	253
	335	252	252	239	273	222	193	193	143	193
	222	273	244	282	252	335	243	295	341	385
	551	677	903	1243						

12.5		1410	2241	2782	3316	4550	5300	5970	7065	7065
	7065	5770	2364	913	701	602	505	533	596	602
	701	913	2364	5770	7065	7065	7065	5970	5300	4640
	3316	2780	2241	1410	1165	921	551	495	395	372
	395	342	334	337	389	259	231	244	244	231
	259	389	337	334	342	398	372	385	468	551
	921	1165	1410	2241						

15.0		2445	3953	4794	5990	9030	9030	10225	11440	10910
	10740	7140	2850	1080	816	714	595	522	553	714
	816	1080	2850	7140	10740	10910	11440	10225	9030	8080
	5[illegible]	4794	3953	2445	1415	1477	977	714	595	492
	492	441	395	395	342	295	251	295	296	258
	295	342	395	395	441	492	492	595	714	877
	1477	1415	2445	3950						

[illegible] TABLE [illegible]

[illegible] TABLE - [illegible] Table No. 33

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0	
27.5	30.0	45.0	55.0	65.0	75.0	85.0	90.0	95.0	105.0	
115.0	125.0	135.0	145.0	152.5	157.5	157.5	162.5	165.0	167.5	
172.5	175.0	177.5	182.5	185.0	187.5	192.5	195.0	197.5	202.5	
205.0	207.5	215.0	225.0	235.0	245.0	255.0	265.0	275.0	285.0	
295.0	305.0	315.0	325.0	332.5	335.0	337.5	342.5	345.0	347.5	
352.5	355.0	357.5	362.5							

VERT.

17.5		4131	6535	8190	9563	12450	13940	14920	15070	14130
	13140	9335	3320	1900	1140	451	749	715	749	451
	1140	1900	3320	5335	13140	14130	15070	14920	13940	12450
	9563	8190	6630	4130	3330	2525	1410	1130	847	625
	563	525	426	426	401	376	375	347	347	375
	376	401	426	426	525	563	625	847	1130	1410
	2525	3330	4130	5630						
20.0		4712	8103	11200	13295	17065	18100	19125	18310	16790
	15275	9113	3790	2110	1469	1190	935	910	935	1190
	1469	2110	3790	9119	15275	16790	18310	19125	18100	17065
	13295	11200	8103	5710	4459	3149	1724	1305	995	714
	575	534	527	462	451	445	443	399	339	443
	445	451	462	527	634	575	714	995	1360	1724
	3149	4459	5710	8105						
22.5		5911	10991	13130	15070	16130	18540	19020	17620	15950
	12295	9439	4230	2740	1785	1425	1010	903	1040	1425
	1785	2740	4230	8035	14280	15950	17620	19020	18580	18130
	15070	13130	10991	6910	5470	4053	2140	1595	1230	962
	744	742	597	505	520	520	540	451	451	540
	521	520	505	597	742	704	962	1230	1595	2140
	4060	5470	6910	10990						
25.0		6809	10695	12650	14650	17420	18280	18180	16140	14870
	13005	9570	4720	3140	2110	1500	1220	947	1220	1490
	2110	3140	4720	8270	13005	14870	16140	18180	18280	17620
	14660	12550	10695	6910	5355	4000	2240	1740	1345	979
	80	947	664	551	579	594	599	502	502	694
	594	579	551	664	947	849	979	1345	1740	2240
	4000	5355	6910	10690						
27.5		6426	9435	11970	12530	14490	14825	14750	13820	12340
	11240	8224	5510	3370	2315	1470	1240	1240	1600	1470
	2315	3350	5310	8225	11240	12340	13820	14750	14825	14490
	12530	11970	9435	6425	4295	2700	2100	2120	1600	1240
	1150	1140	949	810	741	747	974	974	974	949
	747	741	810	949	1140	1150	1240	1590	2120	2550
	4120	5265	6425	9435						

[illegible] TABLE PRINTOUT

[illegible] TABLE - [illegible] VERSUS MAP TABLE NO. 53

HORZ. ANGLES	(V	53	(3)						
-2.5	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0	
27.5	35.0	45.0	55.0	65.0	75.0	85.0	90.0	95.0	105.0
115.0	125.0	135.0	145.0	152.5	155.0	157.5	162.5	165.0	167.5
172.5	175.0	177.5	182.5	185.0	187.5	192.5	195.0	197.5	202.5
205.0	207.5	215.0	225.0	235.0	245.0	255.0	265.0	275.0	285.0
295.0	305.0	315.0	325.0	332.5	335.0	337.5	342.5	345.0	347.5
352.5	355.0	357.5	362.5						

VERT.

30.0	5561	8135	9470	10810	12775	13100	13440	12700	12030
11475	6480	5900	3570	2520	2285	1970	2090	1970	2285
2520	3570	5900	9890	11475	12040	12700	13440	13100	12775
10810	9470	8135	5660	4730	3400	2550	2360	2065	1735
1420	1660	1220	1070	944	893	959	853	853	959
840	944	1070	1220	1460	1420	1735	2065	2360	2650
3800	4730	5660	8135						
35.0	6222	6739	7500	8360	10130	11060	11405	12130	12570
11980	11190	7090	4000	2930	2419	2730	2540	2730	2910
2430	000	7090	11190	11980	12570	12130	11405	11020	10130
9380	7500	6739	5220	4460	3965	3030	2550	2400	2095
1960	1860	1770	1590	1395	1200	1220	1205	1205	1220
1200	1304	1590	1770	1960	1950	2095	2400	2550	3030
3965	4460	5220	6740						
45.0	4660	5974	6630	7470	9150	9995	10210	10420	10440
9870	8400	6710	4590	3570	3035	2435	2135	2435	3035
3570	4590	6710	8900	9870	10440	10420	10210	9995	9150
7471	6630	5974	4960	4000	3435	2945	2545	2340	2100
1960	1970	1780	1460	1278	1260	1250	1230	1230	1250
1241	1278	1460	1780	1970	1960	2100	2340	2525	2945
3635	4000	4660	5975						
55.0	2785	2542	2420	3180	4700	5460	5780	6450	6760
6880	6960	6430	5610	5190	4350	3700	3365	3700	4360
5100	5610	6460	6960	6880	6760	6450	5780	5460	4700
3140	2420	2542	2785	2910	2690	2250	2035	1955	1725
1620	1525	1425	1350	1321	1340	1560	1410	1410	1660
1340	1321	1350	1425	1525	1620	1725	1955	2035	2250
2690	2910	2785	2540						
65.0	2370	2745	2933	3174	3660	3900	4120	4550	4770
5075	5330	5640	5710	5710	5250	5000	4870	5000	5250
5710	5710	5640	5330	5075	4770	4550	4120	3900	3660
3174	2933	2745	2370	2140	2035	1740	1590	1535	1365
1241	1230	1170	1140	1140	1230	1241	1250	1230	1280
1231	1140	1140	1170	1230	1241	1365	1535	1590	1740
2035	2140	2370	2745						

8130

CANDLEPROOF TABLE PRINTOUT

CANDLEPROOF TABLE - FUNCTION CODE: VERTICAL TABLE NO. 03

HORZ. VALUES (X AXIS)

	-2.5	2.5	5.0	7.5	12.5	15.0	17.5	22.5	25.0
27.5	35.0	45.0	55.0	65.0	75.0	85.0	90.0	95.0	105.0
115.0	125.0	135.0	145.0	152.5	155.0	157.5	162.5	165.0	167.5
172.5	175.0	177.5	182.5	185.0	187.5	192.5	193.0	197.5	202.5
205.0	207.5	215.0	225.0	235.0	245.0	255.0	265.0	275.0	285.0
295.0	305.0	315.0	325.0	332.5	335.0	337.5	342.5	345.0	347.5
352.5	355.0	357.5	362.5						

VERT.

75.0		2043	2036	2535	2634	2631	2730	3073	3370	3490
	3730	4080	4550	4900	4975	5151	5330	5495	5340	5151
	4975	4900	4550	4080	3740	3490	3370	3073	2930	2830
	2634	2535	2036	2045	1945	1740	1635	1530	1530	1530
	1240	1210	1140	1070	1045	1040	1040	1045	1045	1040
	1040	1025	1070	1140	1210	1240	1530	1530	1530	1535
	1840	1945	2045	2035						
95.0		2415	2402	2574	2614	2693	2710	2770	2875	2910
	2970	3035	3250	3410	3570	3700	3500	3350	3800	3700
	3577	3410	3260	3035	2970	2810	2575	2770	2730	2690
	2614	2576	2402	2415	2350	2315	2215	2170	2170	2170
	1991	1920	1855	1770	1650	1650	1635	1520	1520	1635
	1650	1960	1770	1855	1920	1940	2170	2170	2170	2215
	2315	2360	2415	2400						
90.0		2609	2609	2609	2609	2609	2609	2609	2609	2609
	2609	2609	2609	2609	2609	2609	2609	2609	2609	2609
	2609	2609	2609	2609	2609	2609	2609	2609	2609	2609
	2609	2609	2609	2609	2609	2609	2609	2609	2609	2609
	2609	2609	2609	2609	2609	2609	2609	2609	2609	2609
	2609	2609	2609	2609	2609	2609	2609	2609	2609	2609
	2609	2609	2609	2609						

B132

[illegible]

[illegible] TABLE = LOAD CASE COMBINATION TABLE NO. 44

HORZ. ANGLES (V = 3[illegible] 13)

	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	

VERT.

55.0		6194	6232	6225	6142	6149	6[illegible]	6[illegible]	6446	6057
	6442	6449	6057	6456	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6232
	6144	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	4469	4469
	6542	6[illegible]	6322	6353	6[illegible]	6[illegible]	6[illegible]	6194	6232	
65.0		6441	6659	6645	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6010	5762
	5604	6404	6762	6010	6252	6[illegible]	6[illegible]	6[illegible]	6645	6659
	6641	6[illegible]	6477	6335	6[illegible]	6[illegible]	6[illegible]	6427	6264	6264
	6427	6[illegible]	6944	6[illegible]	6[illegible]	6477	6[illegible]	6641	6[illegible]	
75.0		6367	6373	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6422	6[illegible]
	6762	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6337	6361	6373
	6367	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]
	6633	6742	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6[illegible]	6367	6373	
85.0		5749	5751	5756	5756	5744	5736	5716	5726	5688
	5674	5674	5688	5732	5716	5736	5744	5756	5756	5751
	5744	5747	5744	5696	5676	5696	5731	5696	5688	5688
	5674	5631	5653	5676	5696	5744	5747	5744	5751	
90.0		5725	5725	5725	5725	5725	5725	5725	5725	5725
	5725	5725	5725	5725	5725	5725	5725	5725	5725	5725
	5725	5725	5725	5725	5725	5725	5725	5725	5725	5725
	5725	5725	5725	5725	5725	5725	5725	5725	5725	

CANDLEPOWER TABLE (WITHOUT

CANDLEPOWER TABLE - LIGHT SIDE CODE: VI-CANDLEPOWER TABLE NO. 45

HORZ. ANGLES (V 3: 17)

	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
	175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
	275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
VERT.										
-5.0		350	350	350	375	430	450	570	430	300
	170	160	170	300	430	570	450	430	375	360
	350	350	350	375	430	450	570	430	300	170
	170	300	430	570	450	430	375	300	350	350
0.0		470	470	510	590	640	745	1150	860	435
	300	300	300	435	860	1150	745	640	590	510
	470	470	510	590	640	785	1150	450	435	300
	300	435	860	1150	745	640	590	510	470	470
5.0		640	840	855	870	870	1550	2170	1440	740
	540	450	540	740	1440	2170	1550	870	870	855
	840	840	855	870	870	1550	2170	1440	740	540
	540	740	1440	2170	1550	870	870	855	840	840
10.0		1720	1720	1720	1700	2550	3450	3900	2120	1290
	780	720	780	1290	2120	3900	3450	2550	1700	1720
	1720	1720	1720	1700	2550	3450	3900	2120	1290	780
	780	1290	2120	3900	3450	2550	1700	1720	1720	1720
12.5		2400	2400	2550	2600	5150	5440	4320	2240	1700
	900	900	900	1700	2220	4320	5440	5150	2600	2500
	2400	2400	2500	2600	5150	5440	4320	2240	1700	900
	900	1700	2280	4320	5440	5150	2600	2500	2400	2400
15.0		3450	3450	3900	5150	5550	7320	4700	2350	1730
	1080	880	1080	1730	2350	4700	7320	6440	5150	3400
	3450	3450	3900	5150	6440	7320	4700	2350	1730	1080
	1080	1730	2350	4700	7320	5550	5150	3900	3450	3450
17.5		5750	5750	6330	7320	7470	7500	4500	2320	1750
	1250	1120	1250	1750	2320	4500	7500	7470	7320	6330
	5750	5750	6330	7320	7470	7500	4500	2320	1750	1250
	1250	1750	2320	4500	7500	7470	7320	6330	5750	5750
20.0		7320	7320	7780	8000	8400	8440	3900	2200	1870
	1430	1360	1430	1870	2200	3900	8440	8400	8000	7780
	7320	7320	7780	8000	8400	8440	3900	2200	1870	1430
	1430	1870	2200	3900	8440	8400	8000	7780	7320	7320

B134

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: VI-9L+MLOU TABLE NO. 65

HORZ. ANGLES	(V	39	47)						
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	90.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
VERT.									
25.0		8250	8250	8600	7960	7320	4730	3020	2430	2170
	1775	1720	1775	2170	2430	3020	4730	7320	7960	8600
	8250	8250	8600	7960	7320	4730	3020	2430	2170	1775
	1775	2170	2430	3020	4730	7320	7960	8600	8250	8250
30.0		8000	8000	7760	7100	5500	3400	3230	2720	2410
	2200	2150	2200	2410	2720	3230	3400	5500	7100	7760
	8000	8000	7760	7100	5500	3400	3230	2720	2410	2200
	2200	2410	2720	3230	3400	5500	7100	7760	8000	8000
35.0		7150	7150	6800	6100	5150	4040	3600	3020	2800
	2650	2400	2650	2800	3020	3600	4040	5150	6100	6800
	7150	7150	6800	6100	5150	4040	3600	3020	2800	2650
	2650	2400	3020	3600	4040	5150	6100	6800	7150	7150
45.0		5800	5800	5650	5150	4770	4600	4100	3660	3400
	3200	3170	3200	3400	3660	4100	4600	4770	5160	5650
	5800	5800	5650	5160	4770	4600	4100	3660	3400	3200
	3200	3400	3660	4100	4600	4770	5150	5650	5800	5800
55.0		5500	5600	5500	5300	5250	5100	4450	4100	3920
	3670	3600	3670	3920	4100	4450	5100	5250	5300	5500
	5600	5600	5500	5300	5250	5100	4450	4100	3920	3670
	3670	3920	4100	4450	5100	5250	5300	5500	5600	5600
65.0		6030	6030	5900	5620	5350	5050	4730	4440	4300
	4000	3930	4000	4300	4440	4730	5050	5350	5620	5900
	6030	6030	5900	5620	5350	5050	4730	4440	4300	4000
	4000	4300	4440	4730	5050	5350	5620	5900	6030	6030
75.0		5370	5370	5280	5150	5050	4940	4750	4600	4400
	4310	4310	4310	4400	4600	4750	4940	5050	5160	5280
	5370	5370	5280	5160	5050	4940	4750	4600	4400	4310
	4310	4400	4600	4750	4940	5050	5160	5280	5370	5370
85.0		4730	4730	4720	4700	4670	4640	4550	4570	4500
	4460	4460	4450	4500	4570	4650	4640	4570	4700	4720
	4730	4730	4720	4700	4670	4640	4650	4570	4500	4450
	4460	4500	4570	4550	4640	4670	4700	4720	4730	4730

B135

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: VIPER-MLOI TABLE NO. 65

HORZ. ANGLES (V 30 17)									
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	90.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
VERT.									
90.0	4554	4554	4554	4554	4554	4554	4554	4554	4554
4554	4554	4554	4554	4554	4554	4554	4554	4554	4554
4554	4554	4554	4554	4554	4554	4554	4554	4554	4554
4554	4554	4554	4554	4554	4554	4554	4554	4554	4554

B13C

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: 4000.0SEAL TABLE NO. 60

HORZ. ANGLES (H 1A 1A)									
	39.0	45.0	51.0	57.0	63.0	69.0	75.0	81.0	87.0
93.0	99.0	105.0	111.0	117.0	123.0	129.0	135.0	141.0	
VERT.									
-45.0	0	0	0	0	0	0	0	92	366
366	92	0	0	0	0	0	0	0	
-39.0	0	0	0	0	615	978	1040	1017	1047
1047	1017	1040	978	615	0	0	0	0	
-33.0	0	0	235	762	1537	1455	1414	1479	1371
1371	1479	1415	1466	1537	762	235	0	0	
-27.0	0	0	353	1523	1844	1955	1890	1846	1828
1828	1846	1890	1955	1844	1523	353	0	0	
-21.0	0	240	940	1959	2350	2542	2363	2403	2377
2377	2403	2363	2542	2350	1959	940	240	0	
-15.0	0	1290	1645	2720	3074	3519	3497	3664	3656
3656	3664	3497	3519	3074	2720	1645	1290	0	
-9.0	145	2455	2703	4026	5020	5375	5333	5915	5349
6309	5915	6333	5376	5020	4026	2703	2455	145	
-3.0	145	3620	6463	8311	8914	10958	12476	13216	14260
14260	13216	12476	10958	8914	8311	6463	3620	145	
3.0	0	3100	4465	7073	10143	12414	13800	13956	14250
14250	13956	13800	12414	10143	7073	4465	3100	0	
9.0	0	2325	3290	4135	5027	5465	5616	5747	5764
5764	5747	5616	5465	5020	4135	3295	2325	0	
15.0	0	130	2115	2934	3279	3617	3592	3614	3748
3748	3614	3592	3617	3279	2934	2115	130	0	
21.0	0	0	705	2067	2459	2542	2457	2403	2468
2468	2403	2457	2542	2459	2067	705	0	0	
27.0	0	0	119	1028	1844	1957	1890	1756	1828
1828	1756	1890	1857	1844	1088	119	0	0	
33.0	0	0	0	214	1125	1465	1323	1294	1371
1371	1294	1323	1466	1025	214	0	0	0	

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE CODE: PROTOTYPICAL Table No. 66

HORZ. ANGLES (M 15)

	39.0	45.0	51.0	57.0	63.0	69.0	75.0	81.0	87.0
93.0	99.0	105.0	111.0	117.0	123.0	129.0	135.0	141.0	

VERT.

39.0		0	0	0	0	102	587	851	739	623
	623	739	851	587	102	0	0	0	0	

CANDLEPOWER TABLE DISTRIBUT

CANDLEPOWER TABLE - LUMINAIRE CODE: [illegible] TABLE NO. 87

HORZ. ANGLES (V 3[illegible] 13)

VERT.	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
-5.0	90.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0
0.0	[illegible]	1135	1497	1715	[illegible]	[illegible]	2372	1716	499
	225	201	225	499	1714	2372	2384	2381	1715	1497
	1135	339	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	339	1135
5.0		1580	2067	2480	2832	3249	3497	3135	1883	692
	427	397	427	692	1883	3135	3497	3240	2892	2480
	2067	1580	1171	916	0	0	0	0	0	0
	0	0	0	0	0	0	916	1171	1580	2067
10.0		2811	3271	3723	4343	4758	4471	3173	1758	1008
	704	681	704	1008	1758	3173	4471	4708	4343	3723
	3271	2811	2314	1552	1444	1448	725	449	100	55
	55	141	449	725	1044	1444	1952	2314	2811	3271
15.0		4293	4801	5244	5432	5455	4813	3043	2035	1328
	939	870	932	1328	2035	3043	4813	5445	5442	5244
	4801	4293	3706	3282	2469	2469	1844	1292	943	95
	95	585	1292	1844	2349	2469	3282	3706	4293	4801
20.0		5711	6227	6409	6030	5304	4287	3128	2316	1660
	1144	1154	1144	1660	2314	3128	4287	5304	6030	6409
	6227	5771	5264	4854	4373	3729	2999	1927	838	271
	27	536	1927	2986	3729	4373	4999	5264	5771	6227
25.0		6387	6361	6149	5777	5142	4287	3434	2631	1928
	1387	1271	1387	1928	2631	3434	4287	5142	5777	6149
	6361	6387	6192	5738	5111	4227	3300	1710	872	507
	507	872	1710	3010	4227	5111	5738	6192	6387	6360
35.0		6733	6683	6544	6355	4937	3999	3331	2925	2375
	1917	1339	1917	2375	2925	3331	3999	4937	5355	6544
	6683	6733	6563	6149	4526	3411	2715	2059	1441	1160
	1160	1441	2059	2715	3411	4526	5154	6563	6733	6683
45.0		6327	6319	6168	4753	4183	3774	3375	3280	2956
	2564	2511	2564	2956	3280	3375	3774	4183	4753	6168
	6319	6327	6065	4543	3642	3372	2854	2439	1966	1562
	1562	1966	2439	2854	3372	3642	4543	6065	6327	6319

CANDLEPOWER TABLE PRINTOUT

CANDLEPOWER TABLE - LUMINAIRE [illegible] VISUAL/PANEL TABLE NO. 57

HORZ. ANGLES (V 3, 13)

	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	90.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0
175.0	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0
275.0	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0

VERT.

55.0		4157	4132	4102	4060	4070	3946	3767	3561	3295
	3115	3074	3116	3295	3561	3767	3946	4070	4060	4102
	4132	4157	4043	3869	3634	3380	3119	2731	2323	2046
	2046	2323	2731	3119	3380	3634	3869	4043	4157	4132
65.0		4111	4122	4103	4045	3937	3915	3937	3822	3631
	3508	3507	3504	3631	3822	3937	3915	3937	4045	4103
	4122	4111	3994	3830	3634	3429	3235	2908	2764	2644
	2644	2764	2903	3236	3429	3634	3830	3994	4111	4122
75.0		3997	3948	3961	3902	3842	3743	3812	3743	3590
	3644	3674	3644	3611	3743	3812	3743	3842	3952	3980
	3948	3997	3747	3700	3625	3529	3347	3259	3143	3120
	3120	3183	3296	3397	3529	3625	3700	3747	3897	3948
85.0		3624	3637	3641	3650	3624	3633	3546	3645	3642
	3643	3653	3648	3642	3646	3648	3653	3654	3650	3641
	3637	3624	3612	3611	3598	3558	3541	3524	3517	3482
	3482	3507	3524	3541	3558	3582	3611	3612	3624	3637
90.0		3557	3557	3557	3557	3557	3557	3557	3557	3557
	3557	3557	3557	3557	3557	3557	3557	3557	3557	3557
	3557	3557	3557	3557	3557	3557	3557	3557	3557	3557
	3557	3557	3557	3557	3557	3557	3557	3557	3557	3557

[illegible] TABLE PRINTOUT

[illegible] TABLE - LUMINANCE CODE: VISIBILITY TABLE NO. 48

HORZ. ANGLES	IV	3-	13						
	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
85.0	85.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	
VERT.									
-40.0	78	74	70	56	43	33	25	19	17
17	17	17	19	25	33	43	54	70	78
78	66	47	36	25	17	10	8	6	6
6	10	17	25	35	47	66	78	78	
-20.0	130	132	136	134	126	124	124	116	107
101	101	107	114	120	124	126	134	136	132
130	130	122	111	96	87	78	56	39	39
56	78	87	96	111	122	130	130	132	
-5.0	39	41	41	39	39	39	45	103	103
101	101	103	103	99	54	39	39	41	41
39	39	41	47	54	64	81	99	111	111
99	89	84	58	47	41	39	39	41	
5.0	176	136	210	238	282	322	320	208	499
271	271	499	308	322	358	290	238	210	146
174	187	149	205	210	274	314	282	161	161
282	310	274	210	210	199	187	176	186	
15.0	3202	3250	3498	3853	4325	4429	3991	2579	1353
1058	1058	1353	2579	3991	4429	4325	3853	3498	3250
3202	3269	3386	3537	3652	3403	2785	1099	804	804
1049	2785	3403	3552	3537	3386	3269	3202	3240	
25.0	7653	7777	7885	7795	7177	4934	3932	3177	2640
2300	2300	2640	3177	3952	4834	7107	7799	7885	7777
7653	7529	7251	6529	4309	3424	2713	2238	1959	1959
2238	2713	3424	4309	6529	7251	7529	7653	7777	
35.0	6495	6531	6498	6249	5673	4974	4500	4276	3677
3399	3399	3677	4276	4630	4974	5673	6249	6498	6531
6495	6363	6041	5304	4618	4214	3879	3640	3025	3025
3298	3873	4218	4518	5394	6161	6333	6495	6531	
45.0	6116	6156	6148	6072	5430	5721	5436	5152	4603
4335	4335	4603	5152	5436	5721	5430	6072	6148	6156
6116	6013	5657	5046	5373	5112	4792	4224	3987	3987
4224	4792	5112	5373	5643	5937	6113	6116	6156	

B141

[illegible]

[illegible]

[illegible]

[illegible] (V 3[illegible] (3)

	-5.0	5.0	15.0	25.0	35.0	45.0	55.0	65.0	75.0
	85.0	95.0	105.0	115.0	125.0	135.0	145.0	155.0	165.0	175.0
	185.0	195.0	205.0	215.0	225.0	235.0	245.0	255.0	265.0	275.0
	285.0	295.0	305.0	315.0	325.0	335.0	345.0	355.0	365.0	

VERT.

55.0		6346	6426	6414	6353	6235	6154	5989	5535	5214
	4906	4304	5214	5635	5945	6104	6235	6353	6414	6426
	6336	6295	6160	5975	5736	5467	5214	4724	4304	4906
	4724	5214	5467	5736	5975	6160	6295	6336	6426	
65.0		6447	6405	6451	6423	6742	6622	6444	6196	5941
	5778	5778	5941	6196	6444	6622	6742	6423	6451	6405
	5847	5783	6078	6531	6349	6134	5965	5395	5427	5427
	5596	5496	6130	6349	6531	6078	5783	6447	6545	
75.0		6564	6571	6559	6533	6476	6353	6243	6110	6009
	5941	5941	6009	6106	6253	6303	6476	6333	6258	6571
	6564	6513	6440	6335	6207	6054	5933	5913	5790	5730
	5813	5920	6054	6207	6335	6440	6513	6564	6571	
85.0		5927	5929	5932	5934	5942	5950	5953	5879	5804
	5850	5850	5864	5879	5893	5908	5922	5934	5932	5929
	5927	5925	5922	5873	5951	5928	5950	5793	5761	5761
	5783	5816	5828	5851	5873	5922	5925	5927	5934	
90.0		5903	5903	5903	5903	5903	5903	5903	5903	5903
	5903	5903	5903	5903	5903	5903	5903	5903	5903	5903
	5903	5903	5903	5903	5903	5903	5903	5903	5903	5903
	5903	5903	5903	5903	5903	5903	5903	5903	5903	

[illegible] 78/02/09 09.11.12

B142

```
      FULL  DAYFILE.   79/02/04. 09.11.13.*08.SD.41* PAGE    1

08.56.41. (*=T132 .
08.56.42. ACCOUNT.(CF0101).
08.56.42.COMMENT.7120212014
08.56.42.COMMENT.CHARGE THIS JOB TO ACCOUNT 7120212014
08.56.42.*
08.56.42.ATTACH(TAPE1=CANDLER/MSG)
08.56.42.GET(TAPE2=LIGHTIT)
08.56.43.REWIND(TAPE1,TAPE2)
08.56.43.RUNGR(LIGHTIT)
08.56.44.COPYSBF(TAPE2,OUTPUT)
08.56.44.  END OF INFORMATION ENCOUNTERED.
08.56.44.REWIND(TAPE2)
08.56.44.SAT(LIGHTIT)
08.56.47.REL(70006)
09.02.44.LIGHTIT(TAPE2)
09.02.44.  CM MAX = 52248. LOADER USED 6661QB
09.11.12.     STOP
09.11.12.     12.731 CP SECONDS EXECUTION TIME
09.11.12.REL(10000)
09.11.13.RETURN(TAPE1,TAPE2,LIGHTIO)
09.11.13.CTIME      14.151 SECS.
09.11.13.DAYFILE.
```

B143

```
.L  DAYFILE.  7M/02/0*.  09.11.14.*09.**.**.41*  PAGE    1
```

```
    .41.(**.T132 .
  .**.42.*CCOU T.*C=0101*.
 1A.44.42.COMM**T.712C212U1*
 0*.**.42.COMMENT.C****** T*I  10* 200 22INTT*.* /0*.
 0*.5*.42.*
 0*.5*.42.ATTAC-(TAPF1=CANUL=2/MEL)
 0*.5*.42.**T(TAPE2=LIGHT1T)
 0*.5*.43.REWIND(TAPF1,TAPE2)
 0*.5*.43.-UMGF(LIGHT1T)
 0*.5*.44.COPYSBF(TAPE2,OUTPUT)
 0*.5*.44.  END OF INFO**ATIO* ENCOUNTERED.
 0*.5*.44.REWIND(TAPE2)
 0*.5*.44.RET(LIGHT1O)
 0*.5*.47.*FL(70000)
 09.02.44.LIGHT1O(TAPE2)
 09.02.45.   CM (W**1 = 32***** LOADER USED  ******
 09.11.12.      STOP
 09.11.12.      12.701 CP SECO DS EXECUTION TIME
 09.11.12.*FL(10000)
 09.11.13.RETURN(TAPF1,TAPE2,LIGHT1O)
 09.11.13.CTIME      14.051 S-CS.
 09.11.13.DAYFILE.
 09.11.14. USER DAYFILE DUMPED.
 0*.11.14.DAYFILE.
```

B144

APPENDIX C

COMPUTER PRINTOUTS OF ILLUMINATION GRIDS FOR SELECTED PERIMETER LIGHTING ARRANGEMENTS

APPENDIX C

COMPUTER PRINTOUTS OF ILLUMINATION GRID FOR SELECTED PERIMETER LIGHTING ARRANGEMENTS

(See Par. 7-1 of Report)

INDEX

NOTE: Pages 38-114, 147-149 and 184-198 are missing due to deletion of area lighting printouts

ABBREVIATIONS

2x500 = two 500 watt luminaires
Q = quartz iodine
LPS = low pressure sodium
HPS = high pressure sodium
F = floodlight unit
R = roadway type of luminaire
PL = perimeter lighting

```
10          1          1
30      TEST 6 1X500W + 1X1500W @ 50 FT SPACING 30 FT MOUNTING
40      Q1500WL2GE      0.95       0.95       1.00
40      Q500MLGE        0.95       0.85       1.00
40      9999999999
60      Q1500WL2GE      0.00       0.00      30.00     135.00      50.00
60      Q1500WL2GE     50.00       0.00      30.00     135.00      50.00
60      Q1500WL2GE    100.00       0.00      30.00     135.00      50.00
60      Q500MLGE        0.00       0.00      30.00      90.00      30.00
60      Q500MLGE       50.00       0.00      30.00      90.00      30.00
60      Q500MLGE      100.00       0.00      30.00      90.00      30.00
60      9999999999
70           50.00     22.50       0.00       0.00       0.00
80           10.00      5.00         13         11          V     270.00
70           50.00     22.50       3.00       0.00       0.00
80           10.00      5.00         13         11          V     270.00
70           50.00     22.50       9.00       0.00       0.00
80           10.00      5.00         13         11          V     270.00
80      9999999999
```

SHT 1

TEST GRID 1 COORDINATES OF CENTER X 50.00; Y 22.50; Z 0.00
ANGLES OF ORIENTATION HORZ 0.00; VERT 0.00

		X 95.00	X 105.00	X 115.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	50.00	1.2941	.6932	.1853	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	45.00	3.0451	1.3339	.1693	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	40.00	8.4551	3.0157	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	35.00	14.6259	4.2456	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	30.00	10.0951	2.9062	.4086	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	25.00	3.8545	1.6968	.4153	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	20.00	3.3163	2.1437	.3667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	15.00	8.9645	8.9445	.2242	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	10.00	.4700	.4700	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	5.00	.1059	.1059	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

TEST GRID 1 COORDINATES OF CENTER X 50.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X -5.00	X 5.00	X 15.00	X 25.00	X 35.00	X 45.00	X 55.00	X 65.00	X 75.00	X 85.00	
Y	50.00	1.8719	1.5097	1.1996	1.2320	1.3801	1.8719	1.5097	1.1996	1.2320	1.3801	50.00 Y
Z	0.00											0.00 Z
Y	45.00	3.6672	2.2127	1.4240	1.8345	2.6747	3.6672	2.2127	1.4240	1.8345	2.4941	45.00 Y
Z	0.00											0.00 Z
Y	40.00	9.0393	3.9471	1.5025	2.9635	7.5911	9.0393	3.9471	1.5025	2.9635	7.2303	40.00 Y
Z	0.00											0.00 Z
Y	35.00	15.1714	5.2214	2.0969	7.4031	14.0963	15.1714	5.2214	2.0969	7.4031	17.7658	35.00 Y
Z	0.00											0.00 Z
Y	30.00	10.5839	3.8734	3.6000	12.8063	22.3449	10.5839	3.8734	3.6000	12.8063	22.0543	30.00 Y
Z	0.00											0.00 Z
Y	25.00	4.2686	2.7159	5.7032	16.7000	11.3202	4.2686	2.7159	5.7032	16.5482	11.0781	25.00 Y
Z	0.00											0.00 Z
Y	20.00	3.6569	3.1491	8.0263	13.3127	4.0154	3.6569	3.1491	8.0263	13.1928	3.8247	20.00 Y
Z	0.00											0.00 Z
Y	15.00	9.2206	9.7959	7.8381	6.4846	2.4406	9.2206	9.7959	7.8381	6.3977	2.3229	15.00 Y
Z	0.00											0.00 Z
Y	10.00	.6303	1.1524	4.9490	2.0175	1.2458	.6303	1.1524	4.9490	1.9632	1.1601	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.1775	.4485	2.0894	.5876	.0383	.1775	.4485	2.0894	.5624	0.0000	5.00 Y
Z	0.00											0.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.0000	.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 50.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X -5.00	X 5.00	X 15.00	X 25.00	X 35.00	X 45.00	X 55.00	X 65.00	X 75.00	X 85.00	
Y	50.00	.9559	1.3379	1.1719	1.0961	1.1252	.9559	1.3379	1.1719	1.0961	1.1252	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.1911	1.6594	1.3377	1.4522	1.6537	2.1911	1.6594	1.3377	1.4522	1.6537	45.00 Y
Z	3.00											3.00 Z
Y	40.00	4.9099	2.5742	1.3787	2.0455	3.1805	4.9099	2.5742	1.3787	2.0455	3.1805	40.00 Y
Z	3.00											3.00 Z
Y	35.00	13.6375	4.7722	1.5877	3.4007	10.0293	13.6375	4.7722	1.5877	3.4007	10.0293	35.00 Y
Z	3.00											3.00 Z
Y	30.00	21.0365	6.0999	1.9852	8.0488	25.0273	21.0365	6.0999	1.9852	8.0488	24.7464	30.00 Y
Z	3.00											3.00 Z
Y	25.00	8.7671	3.1786	2.8798	14.0549	24.5576	8.7671	3.1786	2.8798	14.0549	24.3210	25.00 Y
Z	3.00											3.00 Z
Y	20.00	4.0604	2.5715	4.3712	18.0338	8.7235	4.0604	2.5715	4.3712	18.0338	8.5360	20.00 Y
Z	3.00											3.00 Z
Y	15.00	11.5717	11.8881	4.5917	14.3227	3.6500	11.5717	11.8881	4.5917	14.3227	3.5136	15.00 Y
Z	3.00											3.00 Z
Y	10.00	.9049	1.1474	3.6993	5.4991	1.7341	.9049	1.1474	3.6993	5.4991	1.6498	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.2070	.3230	1.8729	1.4644	.0385	.2070	.3230	1.8729	1.4644	0.0000	5.00 Y
Z	3.00											3.00 Z
Y	-.00	.0000	.0000	.0000	0000	.0000	.0000	.0000	.0000	.0000	0.0000	.00 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 50.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 95.00	X 105.00	X 115.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	50.00	.9559	.5407	.1814	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	45.00	1.6236	.8080	.1614	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	40.00	4.3525	1.4420	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	35.00	13.1105	3.8573	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	30.00	20.5608	5.2444	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	25.00	8.3606	2.3718	.4507	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	20.00	3.7391	1.4718	.4280	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	15.00	11.3349	11.3349	.2934	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	10.00	.7585	.7585	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	5.00	.1426	.1426	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID 3 COORDINATES OF CENTER X 50.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X -5.00	X 5.00	X 15.00	X 25.00	X 35.00	X 45.00	X 55.00	X 65.00	X 75.00	X 85.00	
Y	50.00	.8752	.5318	.1487	1.0190	1.0301	.8752	.5318	.1487	1.0190	1.0301	50.00 Y
Z	9.00											9.00 Z
Y	45.00	1.0961	.6234	.1722	1.2747	1.3041	1.0961	.6234	.1722	1.2747	1.3041	45.00 Y
Z	9.00											9.00 Z
Y	40.00	1.4973	.7689	1.2490	1.6152	1.6903	1.4973	.7689	1.2490	1.6152	1.6903	40.00 Y
Z	9.00											9.00 Z
Y	35.00	2.7859	1.1136	1.4074	2.0482	2.6218	2.7859	1.1136	1.4074	2.0482	2.6218	35.00 Y
Z	9.00											9.00 Z
Y	30.00	10.2539	3.2884	1.5301	2.7324	5.4413	10.2539	3.2884	1.5301	2.7324	5.4413	30.00 Y
Z	9.00											9.00 Z
Y	25.00	32.0801	5.9305	1.4630	3.8510	20.5883	32.0801	5.9305	1.4630	3.8510	20.5883	25.00 Y
Z	9.00											9.00 Z
Y	20.00	19.0308	4.0475	1.3510	6.7817	38.5915	19.0308	4.0475	1.3510	6.7817	38.5915	20.00 Y
Z	9.00											9.00 Z
Y	15.00	6.1601	2.8112	1.5279	12.3530	22.8604	6.1601	2.8112	1.5279	12.3530	22.8604	15.00 Y
Z	9.00											9.00 Z
Y	10.00	13.4190	13.5498	.8123	13.3402	5.8368	13.4190	13.5498	.8123	13.3402	5.8368	10.00 Y
Z	9.00											9.00 Z
Y	5.00	.3815	.4380	.3980	6.4160	1.4096	.3815	.4380	.3980	6.4160	1.4096	5.00 Y
Z	9.00											9.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z

TEST GRID 3 COORDINATES OF CENTER X 50.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 95.00	X 105.00	X 115.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	50.00	.8752	.5318	.1487	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	45.00	1.0961	.6234	.1722	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	40.00	1.4973	.7489	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	35.00	2.7859	1.1136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	30.00	10.2539	2.5012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.
Z	9.00											0.0 Z
Y	25.00	32.0801	5.2223	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	20.00	19.0308	3.4407	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	15.00	4.1601	2.3766	.4043	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	10.00	13.2744	13.2744	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	5.00	.3162	.3162	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z

```
00100 0000
00110      TEST42 3X500 W Q 70 FT SPACING 15 FT MTG H100 V93
00120      Q500WMGE          0.95        0.85        1.00
00130      9999999999
00140      Q500WMGE          0.00        0.00       15.00      135.00      65.00
00150      Q500WMGE         70.00        0.00       15.00      135.00      65.00
00160      Q500WMGE        140.00        0.00       15.00      135.00      65.00
00170      Q500WMGE        210.00        0.00       15.00      135.00      65.00
00180      Q500WMGE          0.00        0.00       15.00       90.00      65.00
00190      Q500WMGE         70.00        0.00       15.00       90.00      65.00
00200      Q500WMGE        140.00        0.00       15.00       90.00      65.00
00210      Q500WMGE        210.00        0.00       15.00       90.00      65.00
00220      Q500WMGE          0.00        0.00       15.00       45.00      65.00
00230      Q500WMGE         70.00        0.00       15.00       45.00      65.00
00240      Q500WMGE        140.00        0.00       15.00       45.00      65.00
00250      Q500WMGE        210.00        0.00       15.00       45.00      65.00
00260      9999999999
00270           105.00      22.50        0.00        0.00        0.00
00280            10.00       5.00          10          11           V     270.00
00290           105.00      22.50        3.00        0.00        0.00
00300            10.00       5.00          10          11           V     270.00
00310           105.00      22.50        9.00        0.00        0.00
00320            10.00       5.00          10          11           V     270.00
00330      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 105.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 65.00	X 75.00	X 85.00	X 95.00	X 105.00	X 115.00	X 125.00	X 135.00	X 145.00	X 155.00	
Y	50.00	3.0027	2.9994	2.8863	2.6933	2.6184	2.6933	2.8854	3.0102	2.9918	2.8627	50.00 Y
Z	0.00											0.00 Z
Y	45.00	3.6351	3.6210	3.3691	3.0195	2.8629	3.0195	3.3680	3.6419	3.6142	3.3479	45.00 Y
Z	0.00											0.00 Z
Y	40.00	4.3634	4.3499	3.9746	3.4087	3.0880	3.4077	3.9746	4.3699	4.3634	3.9558	40.00 Y
Z	0.00											0.00 Z
Y	35.00	5.3233	5.3283	4.7703	3.6983	3.1796	3.6983	4.7703	5.3283	5.3233	4.7544	35.00 Y
Z	0.00											0.00 Z
Y	30.00	6.5298	6.5339	5.5057	3.9944	3.2378	3.9944	5.5057	6.5339	6.5298	5.4929	30.00 Y
Z	0.00											0.00 Z
Y	25.00	7.8387	7.8418	6.2864	3.8261	2.9532	3.8289	6.2864	7.8418	7.8387	6.2766	25.00 Y
Z	0.00											0.00 Z
Y	20.00	8.0276	8.0298	6.2722	3.4585	2.5866	3.4634	6.2722	8.0298	8.0276	6.2651	20.00 Y
Z	0.00											0.00 Z
Y	15.00	7.2382	7.2396	4.9958	2.6985	1.8547	2.6985	4.9914	7.2396	7.2382	4.9917	15.00 Y
Z	0.00											0.00 Z
Y	10.00	5.0858	5.0866	3.0790	1.6118	1.0507	1.6118	3.0790	5.0866	5.0858	3.0764	10.00 Y
Z	0.00											0.00 Z
Y	5.00	1.7498	1.7508	1.0414	.5378	.3595	.5378	1.0414	1.7501	1.7504	1.0404	5.00 Y
Z	0.00											0.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 105.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 65.00	X 75.00	X 85.00	X 95.00	X 105.00	X 115.00	X 125.00	X 135.00	X 145.00	X 155.00	
Y	50.00	2.7732	2.7790	2.6582	2.4972	2.4389	2.4972	2.6360	2.7803	2.7719	2.6361	50.00 Y
Z	3.00											3.00 Z
Y	45.00	3.3685	3.3672	3.1144	2.7815	2.6478	2.7810	3.1109	3.3748	3.3609	3.0945	45.00 Y
Z	3.00											3.00 Z
Y	40.00	4.0692	4.0749	3.6963	3.1375	2.8900	3.1358	3.6963	4.0749	4.0692	3.6786	40.00 Y
Z	3.00											3.00 Z
Y	35.00	5.3346	5.3194	4.5369	3.4147	2.9412	3.4147	4.5369	5.3394	5.3346	4.5218	35.00 Y
Z	3.00											3.00 Z
Y	30.00	7.2265	7.2304	5.6812	3.7253	2.9945	3.7253	5.6812	7.2304	7.2265	5.6691	30.00 Y
Z	3.00											3.00 Z
Y	25.00	9.4102	9.4132	6.9582	3.8071	2.7133	3.8107	6.9582	9.4132	9.4102	6.9484	25.00 Y
Z	3.00											3.00 Z
Y	20.00	11.9386	11.9408	7.6690	3.6616	2.3936	3.6973	7.6690	11.9408	11.9386	7.6621	20.00 Y
Z	3.00											3.00 Z
Y	15.00	12.0502	12.0517	7.2213	2.9447	1.7717	2.9447	7.2160	12.0517	12.0502	7.2168	15.00 Y
Z	3.00											3.00 Z
Y	10.00	9.7203	9.7211	4.8639	1.7787	1.0388	1.7787	4.8639	9.7211	9.7203	4.8614	10.00 Y
Z	3.00											3.00 Z
Y	5.00	3.8423	3.8400	1.7607	.6255	.3618	.6255	1.7607	3.8426	3.8397	1.7598	5.00 Y
Z	3.00											3.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 105.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 65.00	X 75.00	X 85.00	X 95.00	X 105.00	X 115.00	X 125.00	X 135.00	X 145.00	X 155.00	
Y	50.00	2.2980	2.2838	2.2096	2.0712	2.0397	2.0712	2.2091	2.3044	2.2773	2.1899	50.00 Y
Z	9.00											9.00 Z
Y	45.00	2.7584	2.7398	2.5524	2.2975	2.1916	2.2958	2.5438	2.7441	2.7341	2.5344	45.00 Y
Z	9.00											9.00 Z
Y	40.00	3.2678	3.2731	2.9859	2.5632	2.3260	2.5558	2.9859	3.2731	3.2578	2.9694	40.00 Y
Z	9.00											9.00 Z
Y	35.00	4.2452	4.2496	3.6371	2.7526	2.3723	2.7526	3.6371	4.2496	4.2452	3.6235	35.00 Y
Z	9.00											9.00 Z
Y	30.00	5.8324	5.8360	4.5345	2.9808	2.3884	2.9808	4.5345	5.8360	5.8324	4.5235	30. Y
Z	9.00											9.00 Z
Y	25.00	8.6225	8.6252	5.7641	3.0402	2.1297	3.0425	5.7641	8.6252	8.6225	5.7556	25.00 Y
Z	9.00											9.00 Z
Y	20.00	14.1143	14.1163	7.2253	2.9008	1.8779	2.9130	7.2253	14.1163	14.1143	7.2191	20.00 Y
Z	9.00											9.00 Z
Y	15.00	25.2640	25.2653	8.3460	2.3994	1.4121	2.3994	8.3510	25.2653	25.2640	8.3419	15.00 Y
Z	9.00											9.00 Z
Y	10.00	40.7163	40.7170	7.6472	1.5665	.8517	1.5665	7.6472	40.7170	40.7163	7.6450	10.00 Y
Z	9.00											9.00 Z
Y	5.00	29.7602	29.7794	3.6332	.5898	.3074	.5898	3.6332	29.7605	29.7791	3.6323	5.00 Y
Z	9.00											9.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z

```
10
30      TEST 50 2X500 QUARTZ H100 V93 60 FT SPACING 15 FT MOUNTING
40      Q500WMGE          0.95        0.85        1.00
40      9999999999
60      Q500WMGE          0.00        0.00       15.00      135.00      70.00
60      Q500WMGE         60.00        0.00       15.00      135.00      70.00
60      Q500WMGE        120.00        0.00       15.00      135.00      70.00
60      Q500WMGE          0.00        0.00       15.00       60.00      70.00
60      Q500WMGE         60.00        0.00       15.00       60.00      70.00
60      Q500WMGE        120.00        0.00       15.00       60.00      70.00
60      9999999999
70            60.00     22.50         0.00        0.00        0.00
80            10.00      5.00           13          11           V     270.00
70            60.00     22.50         3.00        0.00        0.00
80            10.00      5.00           13          11           V     270.00
70            60.00     22.50         9.00        0.00        0.00
80            10.00      5.00           13          11           V     270.00
80      9999999999
```

TEST 50 25500 QUARTZ H100 V90 60 FT SPACING 15 FT MOUNTING PAGE 4

TEST GRID 1 COORDINATES OF CENTER X 60.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 5.00	X 15.00	X 25.00	X 35.00	X 45.00	X 55.00	X 65.00	X 75.00	X 85.00	Y 95.00	
Y	50.00	2.1219	2.4337	2.7471	2.4954	2.2845	2.1794	2.3357	2.7174	2.7282	2.3772	50.00 Y
Z	0.00											0.00 Z
Y	45.00	2.4421	3.0450	3.1710	2.8955	2.5210	2.4035	2.6412	3.1341	3.1499	2.7818	45.00 Y
Z	0.00											0.00 Z
Y	40.00	2.7081	3.9388	3.5818	3.3191	2.8027	2.6749	2.8855	3.5994	3.5560	3.2128	40.00 Y
Z	0.00											0.00 Z
Y	35.00	3.2535	4.0724	3.8799	3.6005	3.0510	3.0134	3.4022	4.1174	3.8520	3.4034	35.00 Y
Z	0.00											0.00 Z
Y	30.00	3.7344	4.6620	4.0518	3.7814	3.6376	3.3091	3.8458	4.6808	4.0227	3.6961	30.00 Y
Z	0.00											0.00 Z
Y	25.00	4.0657	4.7148	3.9022	3.7839	4.0139	3.5068	4.1399	4.7282	3.8731	3.7133	25.00 Y
Z	0.00											0.00 Z
Y	20.00	4.3114	4.3543	3.2394	3.4085	4.0638	3.4968	4.3498	4.3561	3.2137	3.3554	20.00 Y
Z	0.00											0.00 Z
Y	15.00	4.0753	3.4103	2.1830	2.5206	3.6952	3.2483	4.0914	3.4072	2.1847	2.4844	15.00 Y
Z	0.00											0.00 Z
Y	10.00	2.8387	1.7447	1.0472	1.3324	2.5093	2.3256	2.8412	1.7544	1.0524	1.3100	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.9777	.4463	.2772	.4320	.8444	1.0633	.9747	.4502	.2715	.4234	5.00 Y
Z	0.00											0.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	0.00											0.00 Z

TEST GRID 1 COORDINATES OF CENTER X 60.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HOR Z 0.00, VERT 0.00

		X 105.00	X 115.00	X 125.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	50.00	2.0516	1.8037	1.7656	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	45.00	2.2969	2.0282	2.0508	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	40.00	2.5953	2.3154	2.2953	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	35.00	2.8655	2.6889	2.8303	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	30.00	3.4781	3.0304	3.3440	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	25.00	3.8854	3.2901	3.7256	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	20.00	3.9685	3.3246	4.0330	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	15.00	3.6321	3.1344	3.8774	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	10.00	2.4737	2.2445	2.7260	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	5.00	.8313	1.0412	.9346	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	.00	.0000	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 60.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 5.00	X 15.00	X 25.00	X 35.00	X 45.00	X 55.00	X 65.00	X 75.00	X 85.00	X 95.00	
Y	50.00	2.0237	2.4531	2.5584	2.3278	2.1457	2.0792	2.2221	2.5309	2.5407	2.2180	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.4104	2.9458	2.9764	2.7093	2.4374	2.3796	2.5955	3.0345	2.9558	2.6034	45.00 Y
Z	3.00											3.00 Z
Y	40.00	2.7792	3.6017	3.4680	3.1901	2.8245	2.7553	2.9445	3.6576	3.4445	3.0911	40.00 Y
Z	3.00											3.00 Z
Y	35.00	3.4028	4.2505	3.9357	3.6438	3.1321	3.1773	3.5396	4.2919	3.9098	3.5534	35.00 Y
Z	3.00											3.00 Z
Y	30.00	4.3079	4.9891	4.2393	3.9706	3.8439	3.7627	4.4122	5.0159	4.2119	3.8909	30.00 Y
Z	3.00											3 Z
Y	25.00	5.4946	5.6433	4.1658	4.0765	4.8534	4.4847	5.5648	5.6761	4.1386	4.0105	25.00 Y
Z	3.00											3.00 Z
Y	20.00	6.3289	5.8917	3.5742	3.8468	5.5950	4.9805	6.3662	5.8938	3.5517	3.7972	20.00 Y
Z	3.00											3.00 Z
Y	15.00	6.8602	4.8984	2.5328	3.0749	5.3900	5.2617	6.8783	4.8957	2.5156	3.0410	15.00 Y
Z	3.00											3.00 Z
Y	10.00	5.5821	2.7740	1.2632	1.7647	3.9981	4.4753	5.5850	2.7641	1.2490	1.7434	10.00 Y
Z	3.00											3.00 Z
Y	5.00	2.2175	.6813	.3166	.5685	1.4142	2.4476	2.2147	.6774	.3111	.5604	5.00 Y
Z	3.00											3.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 60.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HOR/ 0.00, VERT 0.00

		X 105.00	X 115.00	X 125.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	50.00	1.9304	1.7317	1.6926	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	45.00	2.2306	2.0334	2.0478	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	40.00	2.6328	2.4235	2.3983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	35.00	2.9597	2.6765	3.0132	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	30.00	3.6952	3.5030	3.9463	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	25.00	4.7333	4.2731	5.1778	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	20.00	5.5056	4.8211	6.0693	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	15.00	5.3306	5.1545	6.6749	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	10.00	3.9643	4.4176	5.4762	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	5.00	1.4022	2.4267	2.1763	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	.00	.0000	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID 3 COORDINATES OF CENTER X 60.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 5.00	X 15.00	X 25.00	X 35.00	X 45.00	X 55.00	X 65.00	X 75.00	X 85.00	X 95.00	
Y	50.00	1.7101	2.0117	2.1115	1.9334	1.8260	1.7877	1.8817	2.0810	2.0978	1.8392	50.00 Y
Z	9.00											9.00 Z
Y	45.00	2.0215	2.3993	2.4372	2.2184	2.0502	2.0322	2.1621	2.4611	2.4212	2.1281	45.00 Y
Z	9.00											9.00 Z
Y	40.00	2.3166	2.8438	2.8227	2.5682	2.3421	2.3770	2.4607	2.9445	2.8038	2.4833	40.00 Y
Z	9.00											9.00 Z
Y	35.00	2.9925	3.5703	3.1774	2.9178	2.6630	2.8989	3.1122	3.6082	3.1557	2.8394	35.00 Y
Z	9.00											9.00 Z
Y	30.00	4.1106	4.5075	3.4731	3.2952	3.4526	3.7375	4.2026	4.5320	3.4491	3.2250	30.00 Y
Z	9.00											9.00 Z
Y	25.00	6.1927	5.6360	3.5196	3.5575	4.7763	5.1939	6.2549	5.6476	3.4952	3.4985	25.00 Y
Z	9.00											9.00 Z
Y	20.00	10.4631	6.9509	3.1817	3.5641	6.6790	7.8591	10.4967	6.9527	3.1610	3.5192	20.00 Y
Z	9.00											9.00 Z
Y	15.00	17.7986	7.5829	2.4126	3.0230	8.7475	12.8624	17.8132	7.5841	2.3963	2.9919	15.00 Y
Z	9.00											9.00 Z
Y	10.00	25.7576	5.3886	1.2759	1.8616	8.3894	20.2173	25.7602	5.3793	1.2629	1.8429	10.00 Y
Z	9.00											9.00 Z
Y	5.00	17.8047	1.3708	.3201	.6607	3.6669	21.2181	17.8020	1.3672	.3150	.6533	5.00 Y
Z	9.00											9.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z

TEST GRID 3 COORDINATES OF CENTER X 60.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 105.00	X 115.00	X 125.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	50.00	1.6405	1.4910	1.4350	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	45.00	1.8720	1.7371	1.7221	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	40.00	2.1767	2.0949	2.0044	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	35.00	2.5144	2.6434	2.6749	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	30.00	3.3235	3.5165	3.8152	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	25.00	4.6710	5.0126	5.9315	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	20.00	6.5998	7.7211	10.2467	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	15.00	9.6943	12.7489	17.6421	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	10.00	8.3589	20.1462	25.6666	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	9.00	3.6555	21.1993	17.7681	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	.00	.0000	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z

```
00100 0000
00110      TEST 53 3X180 W LPS 120 FT SPACING 30 FT MTG
00120      LP180WGQV          0.75          1.00          1.00
00130      9999999999
00140      LP180WGQV          0.00         -1.00         30.00         90.00         20.00
00150      LP180WGQV          0.00         -1.00         30.00         90.00         20.00
00160      LP180WGQV          0.00         -1.00         30.00         90.00         20.00
00170      LP180WGQV        120.00         -1.00         30.00         90.00         20.00
00180      LP180WGQV        120.00         -1.00         30.00         90.00         20.00
00190      LP180WGQV        120.00         -1.00         30.00         90.00         20.00
00200      LP180WGQV        240.00         -1.00         30.00         90.00         20.00
00210      LP180WGQV        240.00         -1.00         30.00         90.00         20.00
00220      LP180WGQV        240.00         -1.00         30.00         90.00         20.00
00230      LP180WGQV        360.00         -1.00         30.00         90.00         20.00
00240      LP180WGQV        360.00         -1.00         30.00         90.00         20.00
00250      LP180WGQV        360.00         -1.00         30.00         90.00         20.00
00260      9999999999
00270           210.00         38.00          0.00          0.00          0.00
00280            10.00          5.00            10            17             V        270.00
00290           210.00         38.00          3.00          0.00          0.00
00300            10.00          5.00            10            17             V        270.00
00310           210.00         38.00          9.00          0.00          0.00
00320            10.00          5.00            10            17             V        270.00
00330      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 210.00, Y 30.00, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 170.00	X 180.00	X 190.00	X 200.00	X 210.00	X 220.00	X 230.00	X 240.00	X 250.00	X 260.00	
Y	80.50	1.8258	1.8013	1.8211	1.8954	1.9990	2.1010	2.1725	2.1989	2.1740	2.1013	80.50 Y
Z	0.00											0.00 Z
Y	75.50	1.8782	1.8411	1.8702	1.9667	2.1028	2.2320	2.3233	2.3591	2.3280	2.2376	75.50 Y
Z	0.00											0.00 Z
Y	70.50	1.9285	1.8771	1.9168	2.0432	2.2132	2.3742	2.4922	2.5402	2.5014	2.3862	70.50 Y
Z	0.00											0.00 Z
Y	65.50	1.9783	1.9076	1.9631	2.1197	2.3295	2.5286	2.6816	2.7452	2.6963	2.5486	65.50 Y
Z	0.00											0.00 Z
Y	60.50	2.0262	1.9308	2.0063	2.1950	2.4472	2.6967	2.9119	3.0035	2.9324	2.7267	60.50 Y
Z	0.00											0.00 Z
Y	55.50	2.0655	1.9607	2.0403	2.2667	2.5688	2.9157	3.2032	3.3264	3.2304	2.9564	55.50 Y
Z	0.00											0.00 Z
Y	50.50	2.0929	1.9799	2.0617	2.3273	2.7110	3.1595	3.5392	3.7017	3.5746	3.2135	50.50 Y
Z	0.00											0.00 Z
Y	45.50	2.1043	1.9742	2.0682	2.3711	2.8467	3.4216	3.9199	4.1382	3.9660	3.4909	45.50 Y
Z	0.00											0.00 Z
Y	40.50	2.0833	1.9362	2.0464	2.3845	2.9616	3.6863	4.3467	4.6491	4.4058	3.7735	40.50 Y
Z	0.00											0.00 Z
Y	35.50	2.0124	1.8647	1.9748	2.3551	3.0289	3.9438	4.8501	5.2547	4.9153	4.0484	35.50 Y
Z	0.00											0.00 Z
Y	30.50	1.8867	1.7287	1.8472	2.2626	3.0328	4.1861	5.3613	5.9017	5.4283	4.3034	30.50 Y
Z	0.00											0.00 Z
Y	25.50	1.6987	1.5453	1.6586	2.0978	2.9601	4.3234	5.7040	6.2772	5.7808	4.4543	25.50 Y
Z	0.00											0.00 Z
Y	20.50	1.4489	1.2933	1.4110	1.8481	2.7488	4.2281	5.6266	6.2923	5.7105	4.3744	20.50 Y
Z	0.00											0.00 Z

TEST S3 3X180 W LPS 120 FT SPACING 30 FT MTG PAGE 7

TEST GRID 2 COORDINATES OF CENTER X 210.00, Y 30.00, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 170.00	X 180.00	X 190.00	X 200.00	X 210.00	X 220.00	X 230.00	X 240.00	X 250.00	X 260.00	
Y	80.50	1.8593	1.8229	1.8562	1.9414	2.0536	2.1662	2.2445	2.2732	2.2459	2.1671	80.50 Y
Z	3.00											3.00 Z
Y	75.50	1.9843	1.8575	1.8964	2.0122	2.1656	2.3096	2.4106	2.4499	2.4152	2.3160	75.50 Y
Z	3.00											3.00 Z
Y	70.50	1.9487	1.8897	1.9364	2.0890	2.2860	2.4672	2.5993	2.6524	2.6085	2.4799	70.50 Y
Z	3.00											3.00 Z
Y	65.50	1.9972	1.9153	1.9812	2.1667	2.4146	2.6408	2.8141	2.8851	2.8290	2.6614	65.50 Y
Z	3.00											3.00 Z
Y	60.50	2.0437	1.9321	2.0229	2.2440	2.5441	2.8331	3.0589	3.1531	3.0807	2.8634	60 Y
	3.00											3.00 Z
Y	5.50	2.0808	1.9414	2.0544	2.3186	2.6740	3.0445	3.3423	3.4789	3.3733	3.0891	55.50 Y
Z	3.00											3.00 Z
Y	50 .)	2.1047	1.9831	2.0719	2.3795	2.8148	3.3031	3.7270	3.9105	3.7674	3.3641	50.50 Y
Z	3.											3.00 Z
Y	.50	2.1179	1.9802	2.0797	2.4304	2.9679	3.6100	4.1757	4.4260	4.2286	3.6884	45.50 Y
Z	3.00											3.00 Z
Y	40.50	2.1016	1.9448	2.0618	2.4661	3.1112	3.9331	4.6944	5.0369	4.7630	4.0333	40.50 Y
Z	3.00											3.00 Z
Y	35.50	2.0443	1.8653	2.0043	2.4483	3.2091	4.2523	5.2836	5.7692	5.3703	4.3794	35.50 Y
Z	3.00											3.00 Z
Y	30.50	1.9314	1.7406	1.8916	2.3651	3.2439	4.5498	5.9618	6.6317	6.0541	4.6944	30.50 Y
Z	3.00											3.00 Z
Y	25.50	1.7468	1.5568	1.7067	2.2048	3.1756	4.7788	6.4187	7.4885	6.7235	4.9431	25.50 Y
Z	3.00											3.00 Z
Y	20.50	1.4914	1.3042	1.4526	1.9513	2.9671	4.7929	6.8159	7.7538	6.9363	4.9809	20.50 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 30.00, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 170.00	X 180.00	X 190.00	X 200.00	X 210.00	X 220.00	X 230.00	X 240.00	X 250.00	X 260.00	
Y	80.50	2.0113	1.9963	1.9962	2.0656	2.1851	2.3094	2.3995	2.4273	2.3989	2.3168	80.50 Y
Z	9.00											9.00 Z
Y	75.50	2.0391	1.9965	2.0201	2.1282	2.2983	2.4598	2.5773	2.6238	2.5813	2.4682	75.50 Y
Z	9.00											9.00 Z
Y	70.50	2.0585	1.9884	2.0351	2.1928	2.4217	2.6450	2.8065	2.8700	2.8152	2.6586	70.50 Y
Z	9.00											9.00 Z
Y	65.50	2.0678	1.9713	2.0447	2.2545	2.5745	2.8579	3.0745	3.1609	3.0892	2.8790	65.50 Y
Z	9.00											9.00 Z
Y	60.50	2.0773	1.9449	2.0534	2.3325	2.7276	3.1011	3.3098	3.5069	3.4121	3.1319	60.50 Y
Z	9.00											9.00 Z
Y	55.50	2.0943	1.9511	2.0653	2.4045	2.8815	3.3777	3.7621	3.9212	3.7947	3.4220	55.50 Y
Z	9.00											9.00 Z
Y	50.50	2.1009	1.9624	2.0693	2.4571	3.0435	3.6912	4.2029	4.4201	4.2493	3.7543	50.50 Y
Z	9.00											9.00 Z
Y	45.50	2.1111	1.9605	2.0690	2.4952	3.2125	4.0431	4.7226	5.0216	4.7885	4.1324	45.50 Y
Z	9.00											9.00 Z
Y	40.50	2.1007	1.9284	2.0548	2.5134	3.3803	4.4249	5.3946	5.8497	5.4847	4.5517	40.50 Y
Z	9.00											9.00 Z
Y	35.50	2.0509	1.8520	2.0025	2.5259	3.5313	4.8894	6.2753	6.9338	6.3948	5.0527	35.50 Y
Z	9.00											9.00 Z
Y	30.50	1.9440	1.7299	1.8944	2.4877	3.6479	5.3777	7.3080	8.2803	7.4412	5.5787	30.50 Y
Z	9.00											9.00 Z
Y	25.50	1.7672	1.5468	1.7177	2.3663	3.6465	5.7859	8.4919	9.9828	8.6859	6.0313	25.50 Y
Z	9.00											9.00 Z
Y	20.50	1.5169	1.2914	1.4701	2.1336	3.4662	5.9716	9.7382	11.9310	9.9676	6.2681	20.50 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST 55 1X1500W Q 45 FT SPACING 15 FT MOUNTING H120 V63
00120      Q1500WML          0.95        0.85        1.00
00130      9999999999
00140      Q1500WML          0.00        0.00       15.00       90.00       60.
00150      Q1500WML         50.00        0.00       15.00       90.00       60.00
00160      Q1500WML        100.00        0.00       15.00       90.00       60.00
00170      Q1500WML        150.00        0.00       15.00       90.00       60.00
00180      9999999999
01000           90.00        22.50        0.00        0.00        0.00
01010            5.00         5.00          10          11           V      270.00
01020           90.00        22.50        3.00        0.00        0.00
01030            5.00         5.00          10          11           V      270.00
01040           90.00        22.50        9.00        0.00        0.00
01050            5.00         5.00          10          11           V      270.00
01060      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 90.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 70.00	X 75.00	X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	
Y	50.00	2.7187	2.7148	2.7187	2.7637	2.8265	2.8634	2.8685	2.8634	2.8265	2.7637	50.00 Y
Z	0.00											0.00 Z
Y	45.00	3.1967	3.1435	3.1967	3.1908	3.2944	3.2389	3.2428	3.2389	3.2944	3.1908	45.00 Y
Z	0.00											0.00 Z
Y	40.00	3.9587	3.8400	3.9587	4.3904	4.8596	4.9018	4.9337	4.9018	4.8596	4.3904	40.00 Y
Z	0.00											0.00 Z
Y	35.00	5.0236	4.7118	5.0236	6.0918	7.2580	8.8607	9.4478	8.8607	7.2580	6.0918	35.00 Y
Z	0.00											0.00 Z
Y	30.00	6.2047	5.7264	6.2047	10.6748	17.8739	23.9675	25.9.10	23.9675	17.8739	10.6748	30.00 Y
Z	0.00											0.00 Z
Y	25.00	8.3573	5.2177	8.3573	17.5820	29.8313	37.7939	39.5023	37.7939	29.8313	17.4820	25.00 Y
Z	0.00											0.00 Z
Y	20.00	8.2681	3.6499	7.5035	17.4832	27.1477	25.1415	20.0931	25.1415	27.1477	17.4832	20.00 Y
Z	0.00											0.00 Z
Y	15.00	2.3396	.8407	2.3396	7.5465	9.0691	9.3786	8.9271	9.3786	9.0601	7.5665	15.00 Y
Z	0.00											0.00 Z
Y	10.00	.1215	0.0000	.1215	.3638	2.0213	5.4306	3.8697	5.4306	2.0213	.3638	10.00 Y
Z	0.00											0.00 Z
Y	5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.00 Y
Z	0.00											0.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 90.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 70.00	X 75.00	X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	Y 114.00	
Y	50.00	2.4118	2.4007	2.4118	2.4741	2.3197	2.1440	2.0532	2.1440	2.3197	2.4741	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.8206	2.7668	2.8206	2.7981	2.7357	2.5836	2.5043	2.5836	2.7357	2.7981	45.00 Y
Z	3.00											3.00 Z
Y	40.00	3.2175	3.2423	3.2175	3.2354	3.3364	3.3338	3.3450	3.3338	3.3364	3.2354	40.00 Y
Z	3.00											3.00 Z
Y	35.00	3.5686	3.6916	3.5686	3.6692	4.7305	5.1585	5.2553	5.1585	4.7305	3.6692	35.00 Y
Z	3.00											3.00 Z
Y	30.00	4.2147	3.6442	4.2147	5.7412	7.8362	9.1683	9.4148	9.1683	7.8362	5.7412	3 Y
Z	3.00											3 Z
Y	25.00	4.6229	3.7057	4.6229	7.9233	17.6108	28.8639	32.5245	28.8639	17.6108	7.9233	25.00 Y
Z	3.00											3.00 Z
Y	20.00	8.1559	2.1119	4.1782	14.7304	36.1954	57.5780	61.7174	57.5780	36.1954	14.7304	20.00 Y
Z	3.00											3.00 Z
Y	15.00	2.0843	.5903	2.0843	12.6701	32.3578	26.9944	22.9803	26.9944	32.3578	12.6701	15.00 Y
Z	3.00											3.00 Z
Y	10.00	.1627	0.0000	.1627	1.3260	6.8525	11.2109	12.0623	11.2109	6.8525	1.3260	10.00 Y
Z	3.00											3.00 Z
Y	5.00	0.0000	0.0000	0.0000	0.0000	.0018	.0000	0.0000	.0000	.0018	0.0000	5.00 Y
Z	3.00											3.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 40.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 70.00	X 75.00	X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	
Y	50.00	1.7960	1.7799	1.7960	1.8539	1.7234	1.5405	1.4828	1.5409	1.7234	1.8539	50.00 Y
Z	9.00											9.00 Z
Y	45.00	2.0839	2.0348	2.0839	2.0979	2.0859	1.9698	2.0148	1.9098	2.0859	2.0979	45.00 Y
Z	9.00											9.00 Z
Y	40.00	2.3534	2.3524	2.3534	2.3773	2.5199	2.5719	2.5941	2.5719	2.5199	2.3773	40.00 Y
Z	9.00											9.00 Z
Y	35.00	2.4321	2.5205	2.4021	2.6597	3.2622	3.4342	3.4614	3.4342	3.2622	2.6597	35.00 Y
Z	9.00											9.00 Z
Y	30.00	2.2896	1.8806	2.2896	3.2283	4.2672	4.3112	4.8672	4.8112	4.2672	3.2283	30.00 Y
Z	9.00											9.00 Z
Y	25.00	1.9889	.7906	1.9889	3.8847	5.7606	7.2898	7.4622	7.2898	5.7606	3.8867	25.00 Y
Z	9.00											9.00 Z
Y	20.00	1.0497	.3769	.9627	4.3860	8.4839	12.3831	13.0031	12.3831	8.4839	4.3860	20.00 Y
Z	9.00											9.00 Z
Y	15.00	.3015	0.0000	.3015	3.7254	13.1335	31.0433	37.6592	31.0433	13.1335	3.7254	15.00 Y
Z	9.00											9.00 Z
Y	10.00	.0101	0.0000	.0101	.4074	16.3052	144.7714	246.8694	144.7714	16.3052	.4074	10.00 Y
Z	9.00											9.00 Z
Y	5.00	0.0000	0.0000	0.0000	0.0000	.6504	27.4100	41.2492	27.4100	.6504	0.0000	5.00 Y
Z	9.00											9.00 Z
Y	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST 55A 1X1500W Q 50 FT SPACING 15 FT MOUNTING H120 V63
00120      Q1500WML          0.95        0.85        1.00
00130      9999999999
00140      Q1500WML          0.00        0.00       15.00       90.00       65.00
00150      Q1500WML         50.00        0.00       15.00       90.00       65.00
00160      Q1500WML        100.00        0.00       15.00       90.00       65.00
00170      Q1500WML        150.00        0.00       15.00       90.00       65.00
00180      9999999999
01000           90.00        40.00        0.00        0.00        0.00
01010            5.00         5.00          10          17           V      270.00
01020           90.00        40.00        3.00        0.00        0.00
01030            5.00         5.00          10          17           V      270.00
01040           90.00        40.00        9.00        0.00        0.00
01050            5.00         5.00          10          17           V      270.00
01060      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 90.00, Y 40.00, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 70.00	X 75.00	X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00		
Y	82.50	1.6400	1.6443	1.6400	1.6282	1.6261	1.6150	1.6047	1.5990	1.5931	1.5764	82.50	Y
Z	0.00											0.00	Z
Y	77.50	1.8014	1.7948	1.8014	1.7907	1.7783	1.7809	1.7759	1.7660	1.7476	1.7449	77.50	Y
Z	0.00											0.00	Z
Y	72.50	1.9972	1.9839	1.9972	1.9821	1.9546	1.9550	1.9764	1.9433	1.9366	1.9452	72.50	Y
Z	0.00											0.00	Z
Y	67.50	2.2297	2.2210	2.2297	2.2070	2.1758	2.1644	2.1787	2.1624	2.1644	2.1814	67.50	Y
Z	0.00											0.00	Z
Y	62.50	2.5710	2.5208	2.5710	2.6020	2.5974	2.5912	2.5928	2.5912	2.5970	2.5904	62.50	Y
Z	0.00											0.00	Z
Y	57.50	3.1471	3.1495	3.1471	3.1967	3.2019	3.1569	3.1671	3.1567	3.2014	3.1955	57.50	Y
Z	0.00											0.00	Z
Y	52.50	3.9323	3.9236	3.9323	4.0496	4.0218	3.9567	3.9835	3.9565	4.0213	4.0485	52.50	Y
Z	0.00											0.00	Z
Y	47.50	4.9309	4.8601	4.9308	5.1065	5.1895	5.1058	5.1614	5.1057	5.1891	5.1057	47.50	Y
Z	0.00											0.00	Z
Y	42.50	6.3810	5.9350	6.3810	7.7047	9.3591	10.1923	10.5188	10.1923	9.3590	7.7043	42.50	Y
Z	0.00											0.00	Z
Y	37.50	9.3234	8.3010	9.3234	12.5041	16.7872	18.7612	19.5228	18.7612	16.7872	12.5041	37.50	Y
Z	0.00											0.00	Z
Y	32.50	12.8189	10.8681	12.8189	18.2551	23.8820	26.7296	27.4377	26.7298	23.8820	18.2551	32.50	Y
Z	0.00											0.00	Z
Y	27.50	13.8495	11.6413	13.8495	19.9044	28.5859	31.2165	30.2526	31.2165	28.5858	19.9044	27.50	Y
Z	0.00											0.00	Z
Y	22.50	10.8970	8.0417	10.8970	16.0544	16.1218	13.0804	12.3182	13.0804	16.1218	16.0544	22.50	Y
Z	0.00											0.00	Z
Y	17.50	4.4681	1.5389	4.4681	5.8210	7.4124	8.3968	7.8742	8.3968	7.4124	5.8210	17.50	Y
Z	0.00											0.00	Z
Y	12.50	.3634	.1989	.3634	1.4651	3.4334	6.2153	4.7970	6.2153	3.4334	1.4651	12.50	Y
Z	0.00											0.00	Z
Y	7.50	0.0000	0.0000	0.0000	.0015	.0229	0.0000	0.0000	0.0000	.0229	.0015	7.50	Y
Z	0.00											0.00	Z

TEST GRID 2 COORDINATES OF CENTER X 90.00, Y 40.00, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 70.00	X 75.00	X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	
Y	82.50	1.4941	1.5033	1.4941	1.4815	1.4839	1.4808	1.4740	1.4685	1.4586	1.4416	82.50 Y
Z	3.00											3.00 Z
Y	77.50	1.6304	1.6210	1.6304	1.6213	1.6154	1.6276	1.6269	1.6162	1.5918	1.5860	77.50 Y
Z	3.00											3.00 Z
Y	72.50	1.7971	1.7816	1.7971	1.7854	1.7705	1.7765	1.8103	1.7675	1.7535	1.7577	72.50 Y
Z	3.00											3.00 Z
Y	67.50	2.0002	1.9944	2.0002	1.9794	1.9569	1.9573	1.9715	1.9557	1.9483	1.9610	67.50 Y
Z	3.00											3.00 Z
Y	62.50	2.2532	2.2499	2.2532	2.2298	2.1906	2.1703	2.1571	2.1703	2.1906	2.2225	62.50 Y
Z	3.00											3.00 Z
Y	57.50	2.5488	2.5602	2.5488	2.5579	2.5065	2.4114	2.3993	2.4114	2.5065	2.5579	57.50 Y
Z	3.00											3.00 Z
Y	52.50	2.9170	2.9284	2.9170	2.9479	2.9052	2.8326	2.8255	2.8326	2.9052	2.9479	5 Y
Z	3.00											3 Z
Y	47.50	3.5220	3.3983	3.5220	3.7018	3.7796	3.7220	3.7181	3.7220	3.7796	3.7018	47.50 Y
Z	3.00											3.00 Z
Y	42.50	4.5058	4.3193	4.5058	4.7802	5.1154	5.0866	5.0880	5.0866	5.1154	4.7802	42.50 Y
Z	3.00											3.00 Z
Y	37.50	5.5837	5.3535	5.5837	6.3326	7.2341	7.5129	7.9066	7.5129	7.2341	6.3326	37.50 Y
Z	3.00											3.00 Z
Y	32.50	6.6754	6.0825	6.6754	10.1146	15.2064	18.9259	20.1778	18.9259	15.2064	10.1144	32.50 Y
Z	3.00											3.00 Z
Y	27.50	9.2678	6.4313	9.2678	16.6746	28.9662	37.1326	38.6943	37.1326	28.9662	16.6746	27.50 Y
Z	3.00											3.00 Z
Y	22.50	9.8462	5.9299	9.8462	20.8273	36.5202	51.5089	49.8408	51.5089	36.5202	20.8273	22.50 Y
Z	3.00											3.00 Z
Y	17.50	6.0091	1.5472	6.0091	18.0130	23.1439	19.8299	18.2318	19.8299	23.1439	18.0130	17.50 Y
Z	3.00											3.00 Z
Y	12.50	.8216	.2342	.8216	3.9889	8.0032	11.3710	11.4961	11.3710	8.0032	3.9889	12.50 Y
Z	3.00											3.00 Z
Y	7.50	0.0000	0.0000	0.0000	.0548	.3012	.7300	0.0000	.7300	.3012	.0548	7.50 Y
Z	3.00											3.00 Z

TEST 55A 1X1500W @ 50 FT SPACING 15 FT MOUNTING H120 V63 PAGE 1

TEST GRID 3 COORDINATES OF CENTER X 90.00, Y 40.00, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 70.00	X 75.00	X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	
Y 82.50		1.2873	1.2939	1.2873	1.2838	1.2946	1.2927	1.2883	1.2880	1.2851	1.2888	82.50 Y
Z 9.00												9.00 Z
Y 77.50		1.3841	1.3697	1.3841	1.3868	1.3861	1.4006	1.4021	1.3963	1.3772	1.3733	77.50 Y
Z 9.00												9.00 Z
Y 72.50		1.5051	1.4860	1.5051	1.5024	1.4911	1.4997	1.5339	1.4963	1.4846	1.4917	72.50 Y
Z 9.00												9.00 Z
Y 67.50		1.6555	1.6510	1.6555	1.6346	1.6144	1.6144	1.6258	1.6139	1.6111	1.6274	67.50 Y
Z 9.00												9.00 Z
Y 62.50		1.8446	1.8414	1.8446	1.8152	1.7638	1.7347	1.7136	1.7347	1.7638	1.8122	62.50 Y
Z 9.00												9.00 Z
Y 57.50		2.0565	2.0617	2.0565	2.0605	1.9800	1.8427	1.8200	1.8427	1.9800	2.0605	57.50 Y
Z 9.00												9.00 Z
Y 52.50		2.3081	2.3095	2.3081	2.3421	2.2028	2.0209	1.9614	2.0209	2.2028	2.3421	52.50 Y
Z 9.00												9.00 Z
Y 47.50		2.6070	2.5869	2.6070	2.6115	2.4819	2.3011	2.2496	2.3011	2.4819	2.6115	47.50 Y
Z 9.00												9.00 Z
Y 42.50		2.9476	2.9004	2.9476	2.8738	2.8813	2.7882	2.7904	2.7882	2.8813	2.8738	42.50 Y
Z 9.00												9.00 Z
Y 37.50		3.1364	3.2508	3.1364	3.2498	3.6011	3.6223	3.6294	3.6223	3.6011	3.2498	37.50 Y
Z 9.00												9.00 Z
Y 32.50		3.2923	3.2003	3.2923	3.8496	4.6416	4.9750	5.0362	4.9750	4.6416	3.8496	32.50 Y
Z 9.00												9.00 Z
Y 27.50		3.3753	2.7040	3.3753	4.6353	6.2534	7.3274	7.4977	7.3274	6.2534	4.6353	27.50 Y
Z 9.00												9.00 Z
Y 22.50		2.9112	1.9000	2.9112	5.5803	10.2432	14.5861	15.4119	14.5861	10.2432	5.5803	22.50 Y
Z 9.00												9.00 Z
Y 17.50		1.9369	.1333	1.9369	6.8985	17.6581	39.4782	51.8606	39.4782	17.6581	6.8985	17.50 Y
Z 9.00												9.00 Z
Y 12.50		.2898	.0265	.2898	4.3606	35.2408	131.4741	162.8697	131.4741	35.2408	4.3606	12.50 Y
Z 9.00												9.00 Z
Y 7.50		0.0000	0.0000	0.0000	.2771	10.5436	51.5349	51.3267	51.5349	10.5436	.2771	7.50 Y
Z 9.00												9.00 Z

```
00100 0000
00110      TEST 59 2X1500 Q 120 FT SPACING 15 FT MTG HT H119 V99
00120      Q1500WM2L          0.95        0.85        1.00
00130      9999999999
00140      Q1500WM2L          0.00        0.00       15.00      135.00      70.00
00150      Q1500WM2L          0.00        0.00       15.00       45.00      70.00
00160      Q1500WM2L        120.00        0.00       15.00      135.00      70.00
00170      Q1500WM2L        120.00        0.00       15.00       45.00      70.00
00180      Q1500WM2L        240.00        0.00       15.00      135.00      70.00
00190      Q1500WM2L        240.00        0.00       15.00       45.00      70.00
00200      Q1500WM2L        360.00        0.00       15.00      135.00      70.00
00210      Q1500WM2L        360.00        0.00       15.00       45.00      70.00
00220      Q1500WM2L        480.00        0.00       15.00      135.00      70.00
00230      Q1500WM2L        480.00        0.00       15.00       45.00      70.00
00240      9999999999
00250          210.00       22.50        0.00        0.00        0.00
00260            5.00        5.00          13          13           V      270.00
00270          210.00       22.50        3.00        0.00        0.00
00280            5.00        5.00          13          13           V      270.00
00290          210.00       22.50        9.00        0.00        0.00
00300            5.00        5.00          13          13           V      270.00
00310      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 210.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 182.50	X 187.50	X 192.50	X 197.50	X 202.50	X 207.50	X 212.50	X 217.50	X 222.50	X 227.50	
Y	55.00	3.1935	3.2862	3.4713	3.7272	4.0507	4.4324	4.6933	4.8640	4.8185	4.4891	55.00 Y
Z	0.00											0.00 Z
Y	50.00	3.3748	3.4909	3.7365	4.1123	4.5684	5.1098	5.6445	5.8593	5.8167	5.3419	50.00 Y
Z	0.00											0.00 Z
Y	45.00	3.4990	3.6465	3.9855	4.4793	5.1397	5.8583	6.4413	6.7884	6.8761	6.4332	45.00 Y
Z	0.00											0.00 Z
Y	40.00	3.5552	3.7439	4.1832	4.8041	5.5878	6.3548	7.1500	7.9311	8.1824	7.8991	40.00 Y
Z	0.00											0.00 Z
Y	35.00	3.5148	3.7375	4.2379	4.9947	5.7668	6.7535	7.9015	9.0641	9.8503	9.8910	35.00 Y
Z	0.00											0.00 Z
Y	30.00	3.2729	3.5807	4.1653	4.8331	5.7846	7.0066	8.5308	10.2383	11.9231	12.3494	30.00 Y
Z	0.00											0.00 Z
Y	25.00	2.8796	3.1829	3.7222	4.4810	5.5023	6.9572	8.8829	11.2665	12.8249	12.5830	25.00 Y
Z	0.00											0.00 Z
Y	20.00	2.3380	2.4181	3.0318	3.7346	4.8444	6.4476	8.6420	10.6283	11.2001	10.3713	20.00 Y
Z	0.00											0.00 Z
Y	15.00	1.6655	1.8584	2.1957	2.7904	3.7097	5.1507	7.2075	8.1760	7.7419	7.1093	15.00 Y
Z	0.00											0.00 Z
Y	10.00	.9985	1.1019	1.3040	1.6664	2.2727	3.2841	4.4041	4.8845	4.4770	4.7593	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.3998	.4379	.5174	.6610	.9043	1.3185	1.6872	1.8167	2.0350	2.3422	5.00 Y
Z	0.00											0.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID 1 COORDINATES OF CENTER X 210.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 232.50	X 237.50	X 242.50	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	4.7976	4.6298	4.5386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	50.00	5.5578	5.3474	5.2470	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	45.00	6.5366	6.2481	6.1637	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	40.00	6.9398	7.4425	7.3686	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	35.00	8.5983	9.0412	8.9944	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	30.00	10.5563	10.3141	10.4106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	25.00	10.5861	9.6754	10.1616	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	20.00	7.9959	7.4495	8.6149	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	15.00	5.4657	5.7415	6.7460	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	10.00	5.1379	4.0486	4.0486	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	5.00	3.0110	.0295	.0295	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	.00	.0000	.0000	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

TEST 59 2X1500 Q 120 FT SPACING 15 FT MTG HT H119 V99 PAGE 7

TEST GRID 2 COORDINATES OF CENTER X 210.00; Y 22.50; Z 3.00
ANGLES OF ORIENTATION HOR 0.00; VERT 0.00

		X 182.50	X 187.50	X 192.50	X 197.50	X 202.50	X 207.50	X 212.50	X 217.50	X 222.50	X 227.50	
Y	55.00	2.6650	2.7441	2.9022	3.1230	3.4024	3.7333	3.9700	4.1349	4.1193	3.8633	55.00 Y
Z	3.00											3.00 Z
Y	50.00	2.8180	2.9179	3.1278	3.4489	3.8428	4.3134	4.7853	5.0835	5.2249	4.9343	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.9262	3.0685	3.3418	3.7642	4.3337	4.9474	5.7700	6.3756	6.7364	6.5115	45.00 Y
Z	3.00											3.00 Z
Y	40.00	2.9794	3.1571	3.5155	4.0509	4.8124	5.8019	6.9342	8.1539	8.6644	8.4119	40.00 Y
Z	3.00											3.00 Z
Y	35.00	2.9529	3.1449	3.5751	4.2843	5.2794	6.6377	8.3122	9.6497	10.5938	10.7364	35.00 Y
Z	3.00											3.00 Z
Y	30.00	2.7606	3.0239	3.5287	4.3632	5.6428	7.3611	9.0854	11.0579	13.0677	13.7191	30.00 Y
Z	3.00											3.00 Z
Y	25.00	2.4403	2.7017	3.2709	4.2563	5.7247	7.3939	9.5942	12.3845	15.4829	17.7932	25.00 Y
Z	3.00											3.00 Z
Y	20.00	1.9921	2.2351	2.7650	3.7209	5.1179	6.9389	9.4846	13.1312	17.8519	20.0479	20.00 Y
Z	3.00											3.00 Z
Y	15.00	1.4286	1.6232	2.0675	2.8972	3.9539	5.6098	8.3357	12.4578	15.8183	15.8383	15.00 Y
Z	3.00											3.00 Z
Y	10.00	.8635	.9827	1.2581	1.7454	2.4345	3.6120	5.6871	8.7023	10.3184	8.9891	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.3481	.3961	.5071	.6942	.9729	1.4573	2.3353	3.4271	3.8009	4.3383	5.00 Y
Z	3.00											3.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 210.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HDWZ 0.00, VERT 0.00

		X 232.50	X 237.50	X 242.50	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	4.1915	4.0998	4.0096	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	50.00	5.2493	5.1726	5.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	45.00	6.7707	6.5915	6.4207	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	40.00	7.2963	8.0229	7.8270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	35.00	9.3710	9.9351	9.7326	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.
Z	3.00											0.00 Z
Y	30.00	12.4262	12.6139	12.4625	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	25.00	17.0408	15.9494	16.0726	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	20.00	17.9461	15.0816	16.0130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	15.00	12.4675	11.4713	13.3622	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	10.00	8.7307	8.1465	8.1665	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	5.00	5.2272	.0260	.0260	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	.00	.0000	.0000	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 182.50	X 187.50	X 192.50	X 197.50	X 202.50	X 207.50	X 212.50	X 217.50	X 222.50	X 227.50	
Y	55.00	1.6804	1.7155	1.7850	1.8834	2.0374	2.2346	2.3951	2.5257	2.5617	2.4675	55.00 Y
Z	9.00											9.00 Z
Y	50.00	1.7269	1.7705	1.8604	2.0382	2.2689	2.5478	2.8379	3.0561	3.1942	3.0987	50.00 Y
Z	9.00											9.00 Z
Y	45.00	1.7493	1.8083	1.9631	2.2046	2.5283	2.9203	3.3637	3.7826	4.0699	4.0356	45.00 Y
Z	9.00											9.00 Z
Y	40.00	1.7423	1.8427	2.0489	2.3546	2.7923	3.3650	4.0460	4.8028	5.3244	5.4920	40.00 Y
Z	9.00											9.00 Z
Y	35.00	1.7049	1.8311	2.0814	2.4835	3.0565	3.8477	4.8743	6.0901	7.2084	7.8468	35.00 Y
Z	9.00											9.00 Z
Y	30.00	1.5972	1.7422	2.0578	2.5377	3.2741	4.3328	5.8184	7.7598	10.0634	11.5618	30.00 Y
Z	9.00											9.00 Z
Y	25.00	1.4288	1.6492	1.9216	2.4894	3.3503	4.7066	6.7752	9.8094	13.8485	17.9189	25.00 Y
Z	9.00											9.00 Z
Y	20.00	1.1875	1.3929	1.6484	2.2103	3.1787	4.7942	7.4369	11.8924	18.9740	28.6304	20.00 Y
Z	9.00											9.00 Z
Y	15.00	.8723	.9881	1.2979	1.7572	2.6266	4.2076	7.2575	12.9993	24.1951	39.1350	15.00 Y
Z	9.00											9.00 Z
Y	10.00	.5434	.6156	.7872	1.1114	1.7195	2.9142	5.4501	11.0104	22.8260	43.9520	10.00 Y
Z	9.00											9.00 Z
Y	5.00	.2246	.2549	.3266	.4632	.7230	1.2453	2.3923	5.2049	11.3240	28.4505	5.00 Y
Z	9.00											9.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HOR? 0.00, VERT 0.00

		X 232.50	X 237.50	X 242.50	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	2.7581	2.7791	2.7003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	50.00	3.4071	3.4326	3.3260	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	45.00	4.3533	4.3864	4.2374	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	40.00	5.0488	5.0933	5.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	35.00	7.2849	8.1903	7.8189	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	30.00	11.2606	12.1098	11.4686	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	25.00	18.9214	19.4623	18.4983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	20.00	33.5222	31.7771	30.2237	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	15.00	53.1325	51.2909	50.0367	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	10.00	77.6210	60.0539	60.0539	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	5.00	37.7355	32.0752	32.0752	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	.00	.0000	.0000	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z

```
00100 0000
00110     TEST 75A    2X LP90WMSE   100 FT SPACING 15 FT MTG      H140 V90
00120     LP90WMSE          1.00        0.85        1.00
00130     9999999999
00140     LP90WMSE          0.00        0.00       15.00        45.00        70.00
00150     LP90WMSE        100.00        0.00       15.00        45.00        70.00
00160     LP90WMSE        100.00        0.00       15.00       135.00        70.00
00170     LP90WMSE        200.00        0.00       15.00        45.00        70.00
00180     LP90WMSE        200.00        0.00       15.00       135.00        70.00
00190     LP90WMSE        300.00        0.00       15.00        45.00        70.00
00200     LP90WMSE        300.00        0.00       15.00       135.00        70.00
00210     LP90WMSE        200.00        0.00       15.00       135.00        70.00
00220     9999999999
00230          190.00       22.50        0.00        0.00         0.00
00240            5.00        5.00          20          13            V      270.00
00250          190.00       22.50        3.00        0.00         0.00
00260            5.00        5.00          20          13            V      270.00
00270          190.00       22.50        9.00        0.00         0.00
00280            5.00        5.00          20          13            V      270.00
00290     9999999999
```

TEST 754 2X LP90WMSE 100 FT SPACING 15 FT MTG M140 V90 PAGE 4

TEST GRID 1 COORDINATES OF CENTER X 140.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	
Y	55.00	1.7791	1.8584	1.9770	2.1354	2.2952	2.4428	2.7029	2.9444	3.1749	3.3723	55.00 Y
Z	0.00											0.00 Z
Y	50.00	1.9077	2.0030	2.1458	2.3396	2.6120	2.8216	3.0038	3.4303	3.7477	4.0590	50.00 Y
Z	0.00											0.00 Z
Y	45.00	2.0268	2.1224	2.3098	2.5701	2.9172	3.3003	3.5773	4.0300	4.5302	4.9744	45.00 Y
Z	0.00											0.00 Z
Y	40.00	2.1117	2.2106	2.4283	2.7800	3.2329	3.8199	4.3443	4.8611	5.5176	6.2193	40.00 Y
Z	0.00											0.00 Z
Y	35.00	2.1492	2.2477	2.4796	2.8973	3.5389	4.3289	5.3286	5.8123	6.4040	7.2257	35.00 Y
Z	0.00											0.00 Z
Y	30.00	2.1066	2.1758	2.4374	2.9187	3.6823	4.8280	5.8404	6.4600	6.9376	8.3469	30.00 Y
Z	0.00											0.00 Z
Y	25.00	1.9343	2.0058	2.2803	2.7983	3.6500	4.7276	5.9011	7.0167	7.8990	9.4546	25 Y
Z	0.00											0 Z
Y	20.00	1.6522	1.7304	1.9986	2.5052	3.3112	4.2519	5.4748	6.4871	7.9734	8.2983	20.00 Y
Z	0.00											0.00 Z
Y	15.00	1.3041	1.3441	1.5922	2.0368	2.6525	3.5022	4.6915	5.9944	6.4648	5.9682	15.00 Y
Z	0.00											0.00 Z
Y	10.00	.8809	.9197	1.0835	1.4134	1.8317	2.4715	3.4384	4.1641	3.9844	4.3973	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.4281	.4468	.5269	.6791	.8808	1.2015	1.6855	1.9794	2.0189	2.0884	5.00 Y
Z	0.00											0.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST 79A 2X LP90xMSE 100 FT SPACING 15 FT MTG H140 V9 PAGE 9

TEST GRID 1 COORDINATES OF CENTER X 190.00, Y 82.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 195.00	X 200.00	X 205.00	X 210.00	X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	
Y	55.00	3.5124	3.3994	3.1878	2.7902	2.3817	1.9809	1.6335	1.3923	1.3303	1.2742	55.00 Y
Z	0.00											0.00 Z
Y	50.00	4.2856	4.1443	3.8513	3.2975	2.7260	2.1845	1.6589	1.5827	1.4711	1.3938	50.00 Y
Z	0.00											0.00 Z
Y	45.00	5.2880	5.1755	4.7411	3.9482	3.1985	2.3894	1.9103	1.7634	1.6253	1.5134	45.00 Y
Z	0.00											0.00 Z
Y	40.00	6.5961	6.4637	5.8493	4.7867	3.5808	2.4433	2.2246	1.9946	1.7927	1.6384	40.00 Y
Z	0.00											0.00 Z
Y	35.00	7.7322	7.5860	6.7161	5.3323	3.8470	2.8194	2.6217	2.2711	1.9690	1.7127	35.00 Y
Z	0.00											0.00 Z
Y	30.00	8.1112	8.9215	7.7168	5.8346	3.9415	3.2540	2.9401	2.5704	2.0829	1.7528	30.00 Y
Z	0.00											0.00 Z
Y	25.00	10.5669	10.2016	8.6197	6.1810	3.9697	3.5043	3.0654	2.5938	2.1254	1.6668	25.00 Y
Z	0.00											0.00 Z
Y	20.00	9.2713	9.9460	8.5344	6.2143	4.0595	3.5099	2.9144	2.3655	1.8588	1.4369	20.00 Y
Z	0.00											0.00 Z
Y	15.00	6.4325	8.0756	6.2803	3.0343	3.2869	3.0582	2.4580	1.8516	1.4291	1.1481	15.00 Y
Z	0.00											0.00 Z
Y	10.00	4.1912	4.7254	2.1204	2.2316	2.0282	2.1224	1.7656	1.2911	.9840	.7930	10.00 Y
Z	0.00											0.00 Z
Y	5.00	2.0093	.0292	1.0194	1.0632	1.0263	1.0236	.8676	.6272	.4732	.3813	5.00 Y
Z	0.00											0.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST 79A 2K LPROWNSE 100 FT SPACING 18 FT MTD M140 V9 PAGE 7

TEST GAIN Z COORDINATES OF CENTER X 190.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	
Y	55.00	1.6149	1.6790	1.7402	1.9178	2.0835	2.2550	2.5382	2.7958	2.9423	3.1501	55.00 Y
Z	3.00											3.00 Z
Y	50.00	1.7255	1.7984	1.9291	2.1084	2.3459	2.5898	2.8021	3.0209	3.2202	3.4021	50.00 Y
Z	3.00											3.00 Z
Y	45.00	1.8312	1.9097	2.0694	2.3068	2.6219	2.9868	3.3113	3.6034	4.2661	4.6821	45.00 Y
Z	3.00											3.00 Z
Y	40.00	1.9180	2.0029	2.1858	2.4978	2.9117	3.4476	3.9028	4.4000	5.2395	5.8990	40.00 Y
Z	3.00											3.00 Z
Y	35.00	1.9819	2.0708	2.2631	2.6354	3.1997	3.9269	4.8585	5.5614	6.8274	7.6154	35.00 Y
Z	3.00											3.00 Z
Y	30.00	1.9391	2.0128	2.2371	2.6954	3.3807	4.4088	5.7158	7.2429	8.0491	8.7559	30.00 Y
Z	3.00											3.00 Z
Y	25.00	1.8098	1.8852	2.1418	2.6280	3.4080	4.6517	6.6017	8.7836	9.9734	11.5730	25. Y
Z	3.00											1 Z
Y	20.00	1.5620	1.6351	1.8435	2.3781	3.2008	4.5790	6.6979	8.9974	11.2331	12.6972	20.00 Y
Z	3.00											3.00 Z
Y	15.00	1.2318	1.2876	1.5079	1.9425	2.7058	4.0288	5.7590	8.1416	10.0866	12.2699	15.00 Y
Z	3.00											3.00 Z
Y	10.00	.8341	.8702	1.0280	1.3697	1.9334	2.8936	4.2255	6.3621	8.1864	9.7049	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.4071	.4245	.5023	.6617	.9571	1.4223	2.1279	3.3373	3.9225	4.1242	5.00 Y
Z	3.00											3.00 Z
Y	0.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 140.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 195.00	X 200.00	X 205.00	X 210.00	X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	
Y	55.00	3.2848	3.1558	2.9417	2.5739	2.1964	1.8350	1.5214	1.2938	1.2268	1.1711	55.00 Y
Z	3.00											3.00 Z
Y	50.00	4.0019	3.8464	3.5652	3.0506	2.5239	2.0328	1.5522	1.4474	1.3516	1.2698	50.00 Y
Z	3.00											3.00 Z
Y	45.00	4.9878	4.8536	4.4133	3.6709	2.9147	2.2385	1.7832	1.6283	1.4865	1.3733	45.00 Y
Z	3.00											3.00 Z
Y	40.00	6.3843	6.2696	5.5959	4.4869	3.3678	2.3112	2.0744	1.8390	1.6323	1.4756	40.00 Y
Z	3.00											3.00 Z
Y	35.00	8.4304	8.3791	7.2909	5.5467	3.8534	2.8136	2.4405	2.0819	1.7853	1.5541	35.00 Y
Z	3.00											3.00 Z
Y	30.00	10.8272	10.7514	9.1450	6.6666	4.0612	3.4908	2.8840	2.3484	1.8977	1.5973	30.00 Y
Z	3.00											3.00 Z
Y	25.00	13.3256	13.2300	10.8631	7.2765	4.8529	4.2604	3.4063	2.5313	1.9452	1.5389	25.00 Y
Z	3.00											3.00 Z
Y	20.00	16.3037	15.8078	12.6716	8.3895	5.4851	4.5730	3.6135	2.5510	1.7772	1.3575	20.00 Y
Z	3.00											3.00 Z
Y	15.00	12.8074	14.8538	8.6622	6.1803	5.4828	4.2748	3.0739	2.1224	1.4495	1.0934	15.00 Y
Z	3.00											3.00 Z
Y	10.00	9.2485	9.6797	4.1528	3.8820	4.1248	3.2178	2.1555	1.4985	1.0308	.7582	10.00 Y
Z	3.00											3.00 Z
Y	5.00	4.2126	1.3188	2.1197	2.0761	1.9745	1.6866	1.0843	.7359	.5094	.3703	5.00 Y
Z	3.00											3.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 190.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	
Y	55.00	1.2808	1.3117	1.3894	1.4926	1.6045	1.7244	1.9432	2.1281	2.3026	2.4278	55.00 Y
Z	9.00											9.00 Z
Y	50.00	1.3391	1.3994	1.4928	1.6249	1.7946	1.9569	2.1530	2.4954	2.7482	2.9507	50.00 Y
Z	9.00											9.00 Z
Y	45.00	1.4101	1.4742	1.5916	1.7600	1.9838	2.2484	2.5261	2.9700	3.3458	3.6694	45.00 Y
Z	9.00											9.00 Z
Y	40.00	1.4636	1.5325	1.6723	1.8868	2.1781	2.5562	2.9869	3.4459	4.1669	4.6875	40.00 Y
Z	9.00											9.00 Z
Y	35.00	1.4855	1.5424	1.7208	1.9844	2.3685	2.8824	3.5409	4.2703	5.3219	6.1822	35.00 Y
Z	9.00											9.00 Z
Y	30.00	1.4623	1.5308	1.7194	2.0407	2.5232	3.2124	4.1465	5.3378	6.6619	8.0134	30.00 Y
Z	9.00											9.00 Z
Y	25.00	1.3755	1.4420	1.6437	2.0126	2.6050	3.4873	4.7849	6.6569	8.9650	11.7978	25.00 Y
Z	9.00											9.00 Z
Y	20.00	1.2078	1.2624	1.4730	1.8695	2.5277	3.6055	5.3195	8.1577	12.4800	16.5974	20.00 Y
Z	9.00											9.00 Z
Y	15.00	.9599	1.0015	1.1819	1.5478	2.2143	3.3767	5.3375	9.0707	16.4928	28.1436	15.00 Y
Z	9.00											9.00 Z
Y	10.00	.6500	.6774	.8080	1.0799	1.5889	2.5300	4.3590	8.2326	17.4979	35.4133	10.00 Y
Z	9.00											9.00 Z
Y	5.00	.3167	.3297	.3951	.5335	.7940	1.2949	2.3179	4.7445	11.1635	25.0838	5.00 Y
Z	9.00											9.00 Z
Y	0.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

TEST GRID 3 COORDINATES OF CENTER X 190.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 195.00	X 200.00	X 205.00	X 210.00	X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	
Y	55.00	2.5085	2.4046	2.2373	1.9835	1.7175	1.4103	1.1418	.9929	.9449	.9067	55.00 Y
Z	9.00											9.00 Z
Y	50.00	3.0834	2.9605	2.7149	2.3923	1.9592	1.5536	1.1956	1.1115	1.0391	.9784	50.00 Y
Z	9.00											9.00 Z
Y	45.00	3.8931	3.7501	3.3783	2.8387	2.2574	1.7117	1.3767	1.2478	1.1356	1.0505	45.00 Y
Z	9.00											9.00 Z
Y	40.00	5.0754	4.9179	4.3246	3.4898	2.6257	1.8231	1.5998	1.3984	1.2329	1.1160	40.00 Y
Z	9.00											9.00 Z
Y	35.00	6.8833	6.7329	5.7282	4.3659	3.0752	2.2258	1.8688	1.5585	1.3254	1.1634	35.00 Y
Z	9.00											9.00 Z
Y	30.00	9.6495	9.5943	7.8584	5.5548	3.6040	2.7500	2.1652	1.7164	1.3961	1.1854	30.00 Y
Z	9.00											9.00 Z
Y	25.00	14.2732	14.5842	11.2867	7.0849	4.4924	3.3833	2.4742	1.8419	1.4235	1.1541	25.00 Y
Z	9.00											9.00 Z
Y	20.00	22.7599	24.3004	17.1252	8.2716	6.0930	4.1369	2.7401	1.8837	1.3624	1.0569	20.00 Y
Z	9.00											9.00 Z
Y	15.00	38.3504	42.3846	26.0050	13.1566	8.2849	4.7277	2.7515	1.7485	1.1807	.8675	15.00 Y
Z	9.00											9.00 Z
Y	10.00	50.3300	62.8098	25.1061	17.7298	9.4079	4.1820	2.2100	1.3040	.8428	.6014	10.00 Y
Z	9.00											9.00 Z
Y	5.00	30.5927	38.5131	15.3068	12.5933	5.5935	2.3855	1.1744	.6660	.4226	.2969	5.00 Y
Z	9.00											9.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST 76F  1X 180 LP WMSE    60 FT SPACING   30 FT MTG H150 V90
00120      LP180WMSE        1.00      0.85      1.00
00130      9999999999
00140      LP180WMSE        0.00      0.00     15.00     90.00     60.00
00150      LP180WMSE       60.00      0.00     15.00     90.00     60.00
00160      LP180WMSE      120.00      0.00     15.00     90.00     60.00
00170      LP180WMSE      180.00      0.00     15.00     90.00     60.00
00180      LP180WMSE      240.00      0.00     15.00     90.00     60.00
00190      9999999999
00200          105.00       22.50      0.00      0.00      0.00
00210            5.00        5.00        10        13         V    270.00
00220          105.00       22.50      3.00      0.00      0.00
00230            5.00        5.00        10        13         V    270.00
00240          105.00       22.50      9.00      0.00      0.00
00250            5.00        5.00        10        13         V    270.00
00260      9999999999
```

TEST 76F 1X 180 LP WMSF 60 FT SPACING 30 FT MTG H150 V90 PAGE 4

TEST GRID 1 COORDINATES OF CENTER X 105.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00	
Y	55.00	1.6729	1.6499	1.6794	1.7243	1.7672	1.8040	1.8363	2.2989	1.8322	1.7469	55.00 Y
Z	0.00											0.00 Z
Y	50.00	1.9537	1.9314	1.9619	2.0367	2.1124	2.1791	2.2379	2.6339	2.2360	2.1744	50.00 Y
Z	0.00											0.00 Z
Y	45.00	2.2836	2.2452	2.2936	2.4112	2.5641	2.6933	2.7949	3.0442	2.7949	2.6916	45.00 Y
Z	0.00											0.00 Z
Y	40.00	2.6604	2.6017	2.6664	2.8553	3.1559	3.4107	3.7182	8.3648	3.7182	3.4107	40.00 Y
Z	0.00											0.00 Z
Y	35.00	3.0511	2.9459	3.0543	3.4795	4.3347	5.2443	5.8966	10.1772	5.8966	5.2443	35.00 Y
Z	0.00											0.00 Z
Y	30.00	3.1450	3.1742	3.6127	4.6265	6.2204	9.1466	9.6973	12.5040	9.6973	8.1464	30.00 Y
Z	0.00											0.00 Z
Y	25.00	3.2887	3.4193	4.0457	5.9201	8.6997	12.5045	15.0438	6.4827	15.0434	12.5043	25.00 Y
Z	0.00											0.00 Z
Y	20.00	4.0365	3.2927	4.0365	6.6279	10.8505	14.4901	17.6722	8.0321	17.6694	14.4879	20.00 Y
Z	0.00											0.00 Z
Y	15.00	3.2666	2.5278	3.2666	5.7282	9.4108	14.4555	16.5219	12.1054	16.5271	14.3472	15.00 Y
Z	0.00											0.00 Z
Y	10.00	1.8095	1.2925	1.7589	3.0472	5.8868	8.0895	9.0231	7.5448	9.0402	8.1147	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.2246	0.0000	.3811	.6604	1.2810	2.1713	2.8559	2.7966	2.9003	2.1713	5.00 Y
Z	0.00											0.00 Z
Y	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 105.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HOR/ 0.00, VERT 0.00

		X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00	
Y	55.00	1.3520	1.3411	1.3591	1.3978	1.4568	1.5082	1.5575	2.3329	1.5535	1.5004	55.00 Y
Z	3.00											3.00 Z
Y	50.00	1.5862	1.5483	1.5963	1.6594	1.7326	1.8129	1.8865	2.6833	1.8844	1.8072	50.00 Y
Z	3.00											3.00 Z
Y	45.00	1.8653	1.8355	1.8795	1.9830	2.1202	2.2462	2.3590	3.1282	2.3590	2.2438	45.00 Y
Z	3.00											3.00 Z
Y	40.00	2.1975	2.1475	2.2040	2.3759	2.6399	2.8811	3.0638	3.7222	3.0438	2.8811	40.00 Y
Z	3.00											3.00 Z
Y	35.00	2.5645	2.4811	2.5645	2.8628	3.3299	3.8133	4.1584	4.5342	4.1584	3.8133	35.00 Y
Z	3.00											3.00 Z
Y	30.00	2.9358	2.7168	2.9265	3.4371	4.2649	5.6080	6.7120	13.9622	6.7120	5.6080	30.
Z	3.00											3.
Y	25.00	3.1063	2.8080	3.1037	4.2200	6.6672	9.6652	12.3744	18.2136	12.3744	9.6652	25.00 Y
Z	3.00											3.00 Z
Y	20.00	3.0803	2.5750	3.0803	5.1685	9.4700	15.9505	22.6510	9.8288	22.6510	15.9505	20.00 Y
Z	3.00											3.00 Z
Y	15.00	2.6305	1.9228	2.6305	5.1227	11.5590	19.4001	24.9888	13.0231	26.9930	15.4359	15.00 Y
Z	3.00											3.00 Z
Y	10.00	1.4987	.9917	1.4583	3.4168	7.7682	15.8969	19.6682	11.6006	19.6756	15.9109	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.1595	0.0000	.3260	.9743	2.0452	4.4504	6.2635	6.5779	6.2636	4.4504	5.00 Y
Z	3.00											3.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 105.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00	
Y	55.00	1.1478	1.1452	1.1525	1.1641	1.1919	1.2194	1.2492	1.3639	1.2471	1.2154	55.00 Y
Z	9.00											9.00 Z
Y	50.00	1.2591	1.2546	1.2654	1.2885	1.3242	1.3669	1.4127	1.5452	1.4117	1.3640	50.00 Y
Z	9.00											9.00 Z
Y	45.00	1.3788	1.3686	1.3894	1.4323	1.4918	1.5618	1.6306	1.7709	1.6306	1.5605	45.00 Y
Z	9.00											9.00 Z
Y	40.00	1.5162	1.4973	1.5249	1.5923	1.6975	1.8209	1.9334	2.0902	1.9334	1.8209	40.00 Y
Z	9.00											9.00 Z
Y	35.00	1.6715	1.6327	1.6643	1.7843	1.9598	2.1674	2.3687	2.5529	2.3687	2.1674	35.00 Y
Z	9.00											9.00 Z
Y	30.00	1.8408	1.7493	1.8068	1.9939	2.3318	2.8689	3.3384	6.5056	3.3384	2.8689	30.00 Y
Z	9.00											9.00 Z
Y	25.00	1.9261	1.8207	1.9039	2.3263	3.1489	4.2851	5.3450	8.9313	5.3450	4.2851	25.00 Y
Z	9.00											9.00 Z
Y	20.00	1.9534	1.7267	1.9534	2.6997	4.2796	6.7848	9.5780	13.1685	9.5780	6.7848	20.00 Y
Z	9.00											9.00 Z
Y	15.00	1.4849	1.3821	1.6889	2.7496	5.4225	10.9996	20.7429	54.4669	20.7429	11.0105	15.00 Y
Z	9.00											9.00 Z
Y	10.00	.9549	.7160	.9549	1.9742	5.1501	18.6997	62.8471	38.5993	62.8471	13.9683	10.00 Y
Z	9.00											9.00 Z
Y	5.00	.0576	0.0000	.1109	.4912	2.0405	13.3038	63.5302	46.4023	63.5302	13.3038	5.00 Y
Z	9.00											9.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST SITE  1X 180 LP WGQV    80 FT SPACING   15 FT MTG H150 V9
00120      LP180WGQV          1.00          0.85          1.00
00130      9999999999
00140      LP180WGQV          0.00          0.00         15.00         90.00         20.00
00150      LP180WGQV         60.00          0.00         15.00         90.00         20.00
00160      LP180WGQV        120.00          0.00         15.00         90.00         20.00
00170      LP180WGQV        180.00          0.00         15.00         90.00         20.00
00180      LP180WGQV        240.00          0.00         15.00         90.00         20.00
00190      9999999999
00200                 105.00    22.50          0.00          0.00          0.00
00210                   5.00     5.00            12            13             V        270.00
00220                 105.00    22.50          3.00          0.00          0.00
00230                   5.00     5.00            12            13             V        270.00
00240                 105.00    22.50          9.00          0.00          0.00
00250                   5.00     5.00            12            13             V        270.00
00260      9999999999
```

TEST ROE 1X 180 LB WGOV 80 FT SPACING 15 FT MTG M150 V90 PAGE 4

TEST GRID 1 COORDINATES OF CENTER X 105.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HOR/ 0.00, VERT 0.00

		X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	
Y	55.00	2.3843	2.3894	2.3647	2.4034	2.4089	2.4122	2.4119	2.4164	2.4248	2.4185	55.00 Y
Z	0.00											0.00 Z
Y	50.00	2.5384	2.5123	2.4982	2.5298	2.5568	2.5921	2.6254	2.6741	2.6903	2.6784	50.00 Y
Z	0.00											0.00 Z
Y	45.00	2.7240	2.6474	2.6232	2.6536	2.7345	2.8091	2.9146	2.9904	3.0191	2.9990	45.00 Y
Z	0.00											0.00 Z
Y	40.00	2.9205	2.8009	2.7604	2.7967	2.9183	3.0949	3.2841	3.3848	3.4337	3.3996	40.00 Y
Z	0.00											0.00 Z
Y	35.00	3.1673	2.9492	2.8687	2.9341	3.1441	3.4207	3.6834	3.8800	3.9635	3.9061	35.00 Y
Z	0.00											0.00 Z
Y	30.00	3.4193	3.0940	2.9405	3.0655	3.3691	3.7724	4.1920	4.5527	4.7078	4.5949	30.00 Y
Z	0.00											0.00 Z
Y	25.00	3.6386	3.1819	3.0061	3.1340	3.5569	4.1774	4.9106	5.5358	5.8072	5.6009	25.00 Y
Z	0.00											0.00 Z
Y	20.00	3.7251	3.1342	2.9053	3.0807	3.6105	4.5270	5.7022	6.8091	7.3103	6.9072	20.00 Y
Z	0.00											0.00 Z
Y	15.00	3.6974	2.7810	2.5484	2.7223	3.3664	4.5738	6.4233	8.3357	9.2237	8.4417	15.00 Y
Z	0.00											0.00 Z
Y	10.00	2.7894	2.0558	1.8275	2.0007	2.6476	4.0052	6.2047	8.3436	9.3191	8.4817	10.00 Y
Z	0.00											0.00 Z
Y	5.00	1.4804	1.0068	.8683	.9709	1.3796	2.3317	3.8119	5.3481	0.0000	5.4169	5.00 Y
Z	0.00											0.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID 1 COORDINATES OF CENTER X 105.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HOR 0.00, VERT 0.00

		X 130.00	X 135.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	2.4143	2.4145	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	50.00	2.6345	2.5986	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	45.00	2.9299	2.8225	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	40.00	3.2897	3.1179	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	35.00	3.7251	3.4411	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	30.00	4.2589	3.8423	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	25.00	5.0132	4.2451	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	20.00	5.8542	4.6798	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	15.00	6.6152	4.7449	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	10.00	6.6400	4.2223	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	5.00	3.9584	2.4884	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 105.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	
Y	55.00	2.5654	2.5710	2.5612	2.5773	2.5763	2.5666	2.5584	2.5550	2.5668	2.5640	55.00 Y
Z	3.00											3.00 Z
Y	50.00	2.7291	2.7112	2.7091	2.7382	2.7331	2.7496	2.7724	2.8232	2.8420	2.8324	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.8969	2.8491	2.8432	2.8639	2.8987	2.9579	3.0699	3.1501	3.1799	3.1584	45.00 Y
Z	3.00											3.00 Z
Y	40.00	3.0483	2.9372	2.9089	2.9365	3.0478	3.2614	3.5962	3.8094	3.8663	3.8235	40.00 Y
Z	3.00											3.00 Z
Y	35.00	3.3047	3.0179	2.9160	2.9995	3.2815	3.6454	3.9756	4.2287	4.3214	4.2462	35.00 Y
Z	3.00											3.00 Z
Y	30.00	3.5702	3.1377	2.9244	3.1052	3.5152	4.0703	4.5169	5.0385	5.2194	5.0841	30.00 Y
Z	3.00											3.00 Z
Y	25.00	3.7925	3.1968	3.0030	3.1440	3.6996	4.5188	5.4125	6.1475	6.4920	6.2291	25.00 Y
Z	3.00											3.00 Z
Y	20.00	3.9333	3.1768	2.9160	3.1131	3.7976	4.9912	6.0045	7.0568	8.6232	8.0915	20.00 Y
Z	3.00											3.00 Z
Y	15.00	3.8154	2.8738	2.5678	2.8074	3.6712	5.2290	7.6509	10.4007	11.7861	10.5982	15.00 Y
Z	3.00											3.00 Z
Y	10.00	3.1002	2.1528	1.8422	2.0920	2.9424	4.6921	8.0720	12.5431	14.6902	12.8113	10.00 Y
Z	3.00											3.00 Z
Y	5.00	1.7431	1.0429	.8453	1.0105	1.5242	2.7994	5.6067	9.2735	0.0000	9.4579	5.00 Y
Z	3.00											3.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST RQE 1X 180 LB #GOV 80 FT SPACING 15 FT MTG H150 V90 PAGE

TEST GRID 2 COO-DINATES OF CENTER X 105.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 130.00	X 135.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	2.5703	2.5788	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	50.00	2.7910	2.7474	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	45.00	3.0884	2.9786	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	40.00	3.4925	3.2823	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	35.00	4.0179	3.8411	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	30.00	4.5832	4.1363	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	25.00	5.5334	4.4404	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	20.00	6.7004	5.1803	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	15.00	7.9339	5.4781	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	10.00	8.4554	4.9994	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	5.00	5.8905	3.8241	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID 3 COORDINATES OF CENTER X 105.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HOR/ 0.00, VERT 0.00

		X 80.00	X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	
Y	55.00	2.9188	2.9339	2.9127	2.9224	2.9049	2.8638	2.8387	2.8244	2.8508	2.8534	55.00 Y
Z	9.00											9.00 Z
Y	50.00	3.1388	3.1695	3.1283	3.1517	3.1014	3.0982	3.1158	3.1813	3.2135	3.2126	50.00 Y
Z	9.00											9.00 Z
Y	45.00	3.3822	3.3785	3.3449	3.2902	3.3125	3.3732	3.5259	3.6338	3.6894	3.6753	45.00 Y
Z	9.00											9.00 Z
Y	40.00	3.6197	3.6613	3.6131	3.5970	3.5154	3.7886	4.0561	4.2637	4.3319	4.2932	40.00 Y
Z	9.00											9.00 Z
Y	35.00	3.9233	3.9198	3.8967	3.8259	3.8019	4.2942	4.7488	5.0874	5.2359	5.1543	35.00 Y
Z	9.00											9.00 Z
Y	30.00	4.2080	4.2321	4.0115	3.9547	4.0619	4.8451	5.6719	6.2954	6.5600	6.3868	30.00 Y
Z	9.00											9.00 Z
Y	25.00	4.2172	3.1808	2.9530	3.1310	4.0642	5.4152	6.9020	8.0839	8.5459	8.2959	25.00 Y
Z	9.00											9.00 Z
Y	20.00	3.9424	3.0916	2.7385	2.9724	3.7813	5.7414	8.3924	10.9477	12.0576	11.1298	20.00 Y
Z	9.00											9.00 Z
Y	15.00	3.8248	2.6899	2.3233	2.5924	3.6123	5.7225	10.3356	15.8636	18.6345	16.2349	15.00 Y
Z	9.00											9.00 Z
Y	10.00	3.2084	1.9900	1.6345	1.8559	2.9823	5.6457	12.0328	24.0670	32.8967	24.9452	10.00 Y
Z	9.00											9.00 Z
Y	5.00	1.6694	.9169	.7363	.8939	1.5310	3.9138	10.1002	31.3713	58.0246	32.9274	5.00 Y
Z	9.00											9.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

TEST GRID 3 COORDINATES OF CENTER X 105.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 130.00	X 135.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	2.8728	2.8991	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	50.00	3.1716	3.1584	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	45.00	3.5954	3.4432	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	40.00	4.1447	3.9001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	35.00	4.8650	4.4345	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	30.00	5.8239	5.0180	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.
Z	0.00											0.0
Y	25.00	7.0921	5.4339	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	20.00	8.6011	6.0187	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	15.00	10.7993	6.0882	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	10.00	12.8180	6.0756	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	5.00	10.8694	3.8950	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

```
00100 0000                                                    70
00110      TEST 80F  1X 180 LP WGQV      80 FT SPACING  15 FT MTG H150 V90
00120      LP180WGQV          1.00      0.85      1.00
00130      9999999999
00140      LP180WGQV          0.00      0.00     15.00     90.00     20.00
00150      LP180WGQV         70.00      0.00     15.00     90.00     20.00
00160      LP180WGQV        140.00      0.00     15.00     90.00     20.00
00170      LP180WGQV        210.00      0.00     15.00     90.00     20.00
00180      LP180WGQV        280.00      0.00     15.00     90.00     20.00
00190      9999999999
00200           120.00      22.50      0.00      0.00      0.00
00210             5.00       5.00        12        13         V    270.00
00220           120.00      22.50      3.00      0.00      0.00
00230             5.00       5.00        12        13         V    270.00
00240           120.00      22.50      9.00      0.00      0.00
00250             5.00       5.00        12        13         V    270.00
00260      9999999999
```

TEST ROF 1X 100 LP WOOV 80 FT SPACING 15 FT MTG H150 V90 PAGE 4

TEST GRID 1 COORDINATES OF CENTER X 120.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	
Y	55.00	2.0233	2.0056	1.9996	2.010H	2.0311	2.04H4	2.0822	2.12H4	2.1687	2.1804	55.00 Y
Z	0.00											0.00 Z
Y	50.00	2.1049	2.0651	2.0690	2.0672	2.1118	2.1784	2.2752	2.3578	2.4178	2.4382	50.00 Y
Z	0.00											0.00 Z
Y	45.00	2.2155	2.1266	2.0892	2.1223	2.2099	2.3665	2.5070	2.6370	2.7284	2.762H	45.00 Y
Z	0.00											0.00 Z
Y	40.00	2.3595	2.1887	2.1305	2.1773	2.3402	2.5602	2.7789	2.9796	3.1202	3.1770	40.00 Y
Z	0.00											0.00 Z
Y	35.00	2.4988	2.2671	2.1557	2.2471	2.4622	2.7585	3.0947	3.3970	3.6184	3.7111	35.00 Y
Z	0.00											0.00 Z
Y	30.00	2.6059	2.3086	2.2093	2.2775	2.5511	2.9630	3.4421	3.9113	4.3005	4.4656	30.00 Y
Z	0.00											0.00
Y	25.00	2.7323	2.3096	2.1818	2.2724	2.5923	3.1511	3.8591	4.6455	5.3036	5.5885	25.00
Z	0.00											0.00 Z
Y	20.00	2.6311	2.1820	2.0237	2.1435	2.5493	3.2249	4.2375	5.4739	6.6146	7.1281	20.00 Y
Z	0.00											0.00 Z
Y	15.00	2.3293	1.8580	1.6893	1.8242	2.2467	3.0444	4.3434	6.2429	8.1822	9.0840	15.00 Y
Z	0.00											0.00 Z
Y	10.00	1.7336	1.3178	1.1697	1.2748	1.6388	2.4094	3.8422	6.0850	8.2561	9.2384	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.8542	.6125	.5402	.6038	.8194	1.2491	2.2753	3.7383	5.2965	0.0000	5.00 Y
Z	0.00											0.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID 1 COORDINATES OF CENTER X 120.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 145.00	X 150.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	Y 0.00	
Y	55.00	2.1724	2.1366	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	50.00	2.4242	2.3705	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	45.00	2.7388	2.6569	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	40.00	3.1382	3.0112	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	35.00	3.6479	3.4451	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	30.00	4.3469	3.9875	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	25.00	5.3735	4.7576	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	20.00	6.7168	5.6323	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	15.00	8.2984	6.4474	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	10.00	8.3965	6.3249	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	5.00	5.3499	3.8470	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 120.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	
Y	55.00	2.1671	2.1528	2.1459	2.1503	2.1590	2.1718	2.2063	2.2598	2.3024	2.3184	55.00 Y
Z	3.00											3.00 Z
Y	50.00	2.2667	2.2243	2.2387	2.2147	2.2515	2.3090	2.4111	2.4991	2.5632	2.5864	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.3525	2.2791	2.2428	2.2611	2.3290	2.4963	2.6466	2.7878	2.8864	2.9228	45.00 Y
Z	3.00											3.00 Z
Y	40.00	2.4598	2.2846	2.2184	2.2618	2.4324	2.6740	2.9376	3.1794	3.3462	3.4117	40.00 Y
Z	3.00											3.00 Z
Y	35.00	2.5621	2.2959	2.1625	2.2714	2.5221	2.8876	3.3160	3.6912	3.9626	4.0733	35.00 Y
Z	3.00											3.00 Z
Y	30.00	2.6493	2.2927	2.1891	2.2593	2.5895	3.1067	3.7411	4.3391	4.7938	4.9828	30.00 Y
Z	3.00											3.00 Z
Y	25.00	2.8934	2.2966	2.1548	2.2548	2.5970	3.2912	4.2031	5.1558	5.9255	6.2835	25.
Z	3.00											3.0
Y	20.00	2.6695	2.1784	2.0052	2.1323	2.5730	3.4091	4.7061	6.2843	7.7712	8.4501	20.00 Y
Z	3.00											3.00 Z
Y	15.00	2.4200	1.8597	1.6730	1.8168	2.3248	3.3491	5.0027	7.4773	10.2548	11.6539	15.00 Y
Z	3.00											3.00 Z
Y	10.00	1.8328	1.3171	1.1505	1.2661	1.7267	2.7078	4.5356	7.9584	12.4602	14.6142	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.8911	.6013	.5212	.5958	.8623	1.4395	2.7489	5.5384	9.2248	0.0000	5.00 Y
Z	3.00											3.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 129.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 145.00	X 150.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	2.3125	2.2794	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	50.00	2.5737	2.5205	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	45.00	2.8964	2.8101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	40.00	3.3631	3.2114	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	35.00	3.9918	3.7405	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	30.00	4.8437	4.4171	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	25.00	6.0127	5.2877	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	20.00	7.9106	6.4883	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	15.00	10.4624	7.7735	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	10.00	12.7309	8.3457	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	5.00	9.3954	5.8045	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID 3 COORDINATES OF CENTER X 120.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	
Y 55.00 Z 9.00		2.4482	2.4460	2.4371	2.4261	2.4049	2.4077	2.4469	2.5168	2.5705	2.5977	55.00 Y 9.00 Z
Y 50.00 Z 9.00		2.5867	2.5387	2.5782	2.5033	2.5225	2.5838	2.7181	2.8353	2.9197	2.9600	50.00 Y 9.00 Z
Y 45.00 Z 9.00		2.7092	2.6097	2.5372	2.5551	2.6223	2.8425	3.0484	3.2417	3.3767	3.4384	45.00 Y 9.00 Z
Y 40.00 Z 9.00		2.8831	2.5727	2.4237	2.5055	2.7843	3.1163	3.4559	3.7733	3.9925	4.0908	40.00 Y 9.00 Z
Y 35.00 Z 9.00		3.0111	2.4449	2.2154	2.4358	2.9008	3.3895	3.9662	4.4777	4.8486	5.0099	35.00 Y 9.00 Z
Y 30.00 Z 9.00		2.9083	2.2953	2.1707	2.2677	2.8098	3.6519	4.5692	5.4155	6.0769	6.3569	30.00 Y 9.00 Z
Y 25.00 Z 9.00		2.7294	2.2078	2.0388	2.1629	2.5821	3.6708	5.1226	6.6737	7.8928	8.4084	25.00 Y 9.
Y 20.00 Z 9.00		2.5768	2.0081	1.8146	1.9483	2.4547	3.4311	5.5124	8.2017	10.7883	11.9099	20.00 Y 9.00 Z
Y 15.00 Z 9.00		2.2937	1.6683	1.4595	1.6043	2.1541	3.3295	5.5272	10.1873	15.7398	18.5224	15.00 Y 9.00 Z
Y 10.00 Z 9.00		1.7141	1.1426	.9895	1.0980	1.5716	2.7802	5.5126	11.9369	23.9977	32.8335	10.00 Y 9.00 Z
Y 5.00 Z 9.00		.7883	.5033	.4321	.5053	.7720	1.4612	3.4714	10.0428	31.3303	58.0244	5.00 Y 9.00 Z
Y .00 Z 9.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y 9.00 Z
Y -5.00 Z 9.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y 9.00 Z

TEST GRID 3 COORDINATES OF CENTER X 120.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HOR/ 0.00, VERT 0.00

		X 145.00	X 150.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	55.00	2.5954	2.5405	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	50.00	2.9506	2.8897	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	45.00	3.4155	3.3113	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	40.00	4.0447	3.8654	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	35.00	4.9187	4.4008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	30.00	6.1731	5.5786	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	25.00	8.0213	6.8774	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	20.00	10.9759	8.4216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	15.00	16.1201	10.6448	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	10.00	29.8786	12.7271	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	5.00	32.8773	10.8006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z

```
00100 0000
00110     TEST 81   2X180WGQV   100 FT SPACING 15 FT MTG
00120     LP180WGQV        1.00       0.85       1.00
00130     9999999999
00140     LP180WGQV        0.00       0.00      15.00      90.00      20.00
00150     LP180WGQV        0.00       0.00      15.00      90.00      20.00
00160     LP180WGQV      100.00       0.00      15.00      90.00      20.00
00170     LP180WGQV      100.00       0.00      15.00      90.00      20.00
00180     LP180WGQV      200.00       0.00      15.00      90.00      20.00
00190     LP180WGQV      200.00       0.00      15.00      90.00      20.00
00200     LP180WGQV      300.00       0.00      15.00      90.00      20.00
00210     LP180WGQV      300.00       0.00      15.00      90.00      20.00
00220     LP180WGQV      400.00       0.00      15.00      90.00      20.00
00230     LP180WGQV      400.00       0.00      15.00      90.00      20.00
00240     9999999999
00250         175.00      22.50       0.00       0.00       0.00
00260           5.00       5.00         12         12          V     270.00
00270         175.00      22.50       3.00       0.00       0.00
00280           5.00       5.00         12         12          V     270.00
00290         175.00      22.50       9.00       0.00       0.00
00300           5.00       5.00         12         12          V     270.00
00310     9999999999
```

TEST A1 2X180WGQV 100 FT SPACING 15 FT MTG PAGE 4

TEST GRID 1 COORDINATES OF CENTER X 175.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	
Y	52.50	2.1762	2.2266	2.3692	2.5576	2.7739	3.0415	3.2740	3.5155	3.7061	3.8418	52.50 Y
Z	0.00											0.00 Z
Y	47.50	2.1494	2.2014	2.3574	2.5882	2.8451	3.2298	3.6054	3.9364	4.2145	4.4057	47.50 Y
Z	0.00											0.00 Z
Y	42.50	2.1505	2.1793	2.3206	2.5916	2.9878	3.4518	3.9846	4.4422	4.8469	5.1226	42.50 Y
Z	0.00											0.00 Z
Y	37.50	2.1189	2.1544	2.2934	2.5952	3.0742	3.6823	4.3678	5.0471	5.6347	6.0392	37.50 Y
Z	0.00											0.00 Z
Y	32.50	2.0416	2.0877	2.2663	2.5922	3.1268	3.8900	4.7940	5.7568	6.5936	7.2123	32.50 Y
Z	0.00											0.00 Z
Y	27.50	1.9043	1.9591	2.1689	2.5535	3.1574	4.0599	5.2489	6.5627	7.9118	8.9844	27.50 Y
Z	0.00											0.00 Z
Y	22.50	1.6866	1.7413	1.9653	2.3995	3.1065	4.1746	5.6423	7.5139	9.5982	11.3704	22.50 Y
Z	0.00											0.00 Z
Y	17.50	1.3494	1.4106	1.6440	2.0911	2.8334	4.0050	5.7081	8.1741	11.3576	14.4423	17.50 Y
Z	0.00											0.00 Z
Y	12.50	.9370	.9731	1.1731	1.5560	2.2499	3.3504	5.1256	8.0632	12.5041	16.7904	12.50 Y
Z	0.00											0.00 Z
Y	7.50	.5230	.5594	.6833	.9291	1.3694	2.1433	3.5585	6.2392	10.1755	14.2157	7.50 Y
Z	0.00											0.00 Z
Y	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	.7170	1.2445	2.3141	3.9682	0.0000	2.50 Y
Z	0.00											0.00 Z
Y	-2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-2.50 Y
Z	0.00											0.00 Z

TEST GRID 1 COORDINATES OF CENTER X 175.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 200.00	X 205.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	52.50	3.8878	3.8571	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	47.50	4.4759	4.4295	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	42.50	5.2302	5.1589	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	37.50	6.2057	6.0955	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	32.50	7.4724	7.2995	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	27.50	9.5412	9.1089	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	22.50	12.1441	11.5514	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0 Y
Z	0.00											0.00 Z
Y	17.50	15.8318	14.6731	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	12.50	18.6550	17.0605	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	7.50	19.8055	14.4463	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z
Y	-2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 175.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ. 0.00, VERT 0.00

		X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	
Y	52.50	2.2177	2.2816	2.4644	2.6989	2.9446	3.2469	3.5140	3.7742	3.9784	4.1236	52.50 Y
Z	3.00											3.00 Z
Y	47.50	2.1627	2.2301	2.4300	2.7315	3.0690	3.4547	3.8572	4.2129	4.5128	4.7184	47.50 Y
Z	3.00											3.00 Z
Y	42.50	2.1459	2.1817	2.3578	2.6985	3.1612	3.6503	4.2337	4.7276	5.1924	5.5097	42.50 Y
Z	3.00											3.00 Z
Y	37.50	2.0919	2.1350	2.2929	2.6233	3.1542	3.8083	4.6170	5.4361	6.1398	6.6173	37.50 Y
Z	3.00											3.00 Z
Y	32.50	1.9932	2.0436	2.2315	2.5610	3.1152	3.9960	5.0842	6.3046	7.3369	8.1014	32.50 Y
Z	3.00											3.00 Z
Y	27.50	1.8380	1.8956	2.1117	2.5024	3.1274	4.1245	5.5652	7.2603	8.8683	10.1042	27.50 Y
Z	3.00											3.00 Z
Y	22.50	1.6113	1.6726	1.9080	2.3538	3.0884	4.2231	5.9731	8.3179	10.8563	13.1018	22.50 Y
Z	3.00											3.00 Z
Y	17.50	1.2887	1.3515	1.5938	2.0524	2.8278	4.1344	6.2455	9.3321	13.4164	17.5023	17.50 Y
Z	3.00											3.00 Z
Y	12.50	.8918	.9290	1.1308	1.5222	2.2494	3.5576	5.7745	9.4796	15.5172	23.0784	12.50 Y
Z	3.00											3.00 Z
Y	7.50	.4928	.5325	.6562	.9046	1.3716	2.2933	4.0447	7.5088	14.4916	23.3640	7.50 Y
Z	3.00											3.00 Z
Y	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	.7676	1.4009	2.8165	5.9114	0.0000	2.50 Y
Z	3.00											3.00 Z
Y	-2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-2.50 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 175.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 200.00	X 205.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	52.50	4.1778	4.1502	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	47.50	4.7945	4.7471	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	42.50	5.6307	5.5444	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	37.50	6.8097	6.6728	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	32.50	8.4144	8.1907	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	27.50	10.6272	10.2488	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	22.50	14.1034	13.3316	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0. Y
Z	3.00											0.
Y	17.50	19.4361	17.8478	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	12.50	27.0351	23.5409	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	7.50	27.8256	23.9099	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z
Y	-2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	3.00											0.00 Z

TEST GRID 3 COORDINATES OF CENTER X 175.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	
Y	52.50	2.2664	2.3466	2.6389	2.9732	3.2821	3.6570	3.9926	4.3173	4.5740	4.7536	52.50 Y
Z	9.00											9.00 Z
Y	47.50	2.1545	2.2571	2.5519	3.0056	3.4708	3.9514	4.4672	4.9241	5.3106	5.5148	47.50 Y
Z	9.00											9.00 Z
Y	42.50	2.0936	2.1449	2.3968	2.9050	3.6319	4.2751	5.0280	5.6840	6.2719	6.6707	42.50 Y
Z	9.00											9.00 Z
Y	37.50	1.9863	2.0437	2.2485	2.7142	3.5398	4.5899	5.5965	6.6396	7.5505	8.1707	37.50 Y
Z	9.00											9.00 Z
Y	32.50	1.8368	1.8943	2.1202	2.5330	3.3194	4.6579	6.1988	7.8323	9.2312	10.2783	32.50 Y
Z	9.00											9.00 Z
Y	27.50	1.6395	1.6972	1.9254	2.3797	3.1105	4.4326	6.6570	9.0528	11.4851	13.3280	27.50 Y
Z	9.00											9.00 Z
Y	22.50	1.3868	1.4446	1.6785	2.1353	2.9212	4.1963	6.5047	10.2497	14.4494	17.8572	22.50 Y
Z	9.00											9.00 Z
Y	17.50	1.0984	1.1459	1.3512	1.7817	2.5624	3.9321	6.2908	10.6313	17.9650	25.6435	17.50 Y
Z	9.00											9.00 Z
Y	12.50	.7506	.7788	.9504	1.2973	1.9739	3.2973	5.8862	11.0724	22.0747	38.2587	12.50 Y
Z	9.00											9.00 Z
Y	7.50	.4081	.4385	.5423	.7581	1.1816	2.0830	4.1994	9.5671	20.9335	38.0038	7.50 Y
Z	9.00											9.00 Z
Y	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	.6879	1.4306	3.5427	10.9699	44.3089	2.50 Y
Z	9.00											9.00 Z
Y	-2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-2.50 Y
Z	9.00											9.00 Z

TEST GRID 3 COORDINATES OF CENTER X 175.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 200.00	X 200.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	X 0.00	
Y	52.50	4.8364	4.8145	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	47.50	5.4248	5.0545	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	42.50	6.8494	6.7762	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	37.50	8.4481	8.3094	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	32.50	10.7255	10.4624	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	27.50	14.1031	13.5698	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.0
Y	22.50	19.3189	18.1547	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	17.50	29.1339	26.1866	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	12.50	47.6856	39.4498	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	7.50	91.7065	60.4895	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	2.50	0.0000	60.4382	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z
Y	-2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00 Y
Z	9.00											0.00 Z

```
00100 0000
00110      TEST 91F  1X HP250        SPACING  30 FT MTG
00120      HS250GITT          0.85          0.85          1.00
00130      9999999999
00140      HS250GITT          0.00          0.00         30.00         90.00          10.0
00150      HS250GITT         40.00          0.00         30.00         90.00          10.0
00160      HS250GITT         80.00          0.00         30.00         90.00          10.0
00170      HS250GITT        120.00          0.00         30.00         90.00          10.0
00180      HS250GITT        160.00          0.00         30.00         90.00          10.0
00190      9999999999
00200            105.00         22.50          0.00          0.00          0.00
00210              3.00          5.00            10            13             V         270.0
00220            105.00         22.50          3.00          0.00          0.00
00230              3.00          5.00            10            13             V         270.0
00240            105.00         22.50          9.00          0.00          0.00
00250              3.00          5.00            10            13             V         270.0
00260      9999999999
```

180

TEST SIE 1X HP250 60 SPACING 30 FT MTG

TEST GRID 1 COORDINATES OF CENTER X 105.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HOR/ 0.00, VERT 0.00

		X 93.00	X 96.00	X 99.00	X 102.00	X 105.00	X 108.00	X 111.00	X 114.00	X 117.00	X 120.00	
Y	55.00	1.7283	2.1079	2.5994	3.0520	3.2781	2.9742	2.3872	1.9849	1.7059	1.5351	55.00 Y
Z	0.00											0.00 Z
Y	50.00	1.9861	2.3255	2.5737	2.8686	2.9609	2.6004	2.2424	1.9500	1.7504	1.5742	50.00 Y
Z	0.00											0.00 Z
Y	45.00	2.0289	2.0867	2.1937	2.4651	2.5155	2.4058	2.2083	2.0432	1.8733	1.6961	45.00 Y
Z	0.00											0.00 Z
Y	40.00	1.7397	1.7869	2.0847	2.3738	2.5189	2.4998	2.3743	2.2327	2.0441	1.8515	40.00 Y
Z	0.00											0.00 Z
Y	35.00	1.7784	2.0587	2.3397	2.6258	2.7911	2.6888	2.5558	2.4225	2.1982	1.8930	35.00 Y
Z	0.00											0.00 Z
Y	30.00	1.9284	2.2051	2.4895	2.7343	2.8700	2.8628	2.6930	2.4302	2.2029	1.8841	30.00 Y
Z	0.00											0.00 Z
Y	25.00	1.9090	2.3031	2.5765	2.7636	2.9665	2.8879	2.6552	2.3782	2.2211	1.9439	25 Y
Z	0.00											0.00 Z
Y	20.00	1.6462	2.0778	2.3766	2.5906	2.6601	2.61-8	2.4377	2.1213	1.7453	1.3931	20.00 Y
Z	0.00											0.00 Z
Y	15.00	1.3306	1.8338	2.2803	2.5181	2.5739	2.5107	2.2452	1.8193	1.4655	1.1587	15.00 Y
Z	0.00											0.00 Z
Y	10.00	.8104	1.1432	1.5745	1.8521	2.0271	1.9890	1.6742	1.2199	.9647	.8995	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.3216	.4455	.5972	.7232	.8460	.8380	.7668	.6212	.4918	.1554	5.00 Y
Z	0.00											0.10 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0(	'0'	.0000	.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 105.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 93.00	X 96.00	X 99.00	X 102.00	X 105.00	X 108.00	X 111.00	X 114.00	X 117.00	X 120.00	
Y	55.00	1.9290	2.4721	3.2104	3.8350	3.7599	3.1683	2.4613	2.0211	1.6667	1.4743	55.00 Y
Z	3.00											3.00 Z
Y	50.00	2.1306	2.7330	3.4713	3.8979	3.6104	2.8104	2.2784	1.9083	1.6934	1.5967	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.4681	2.8057	3.2386	3.5360	3.1069	2.6117	2.2249	1.9947	1.8073	1.6222	45.00 Y
Z	3.00											3.00 Z
Y	40.00	2.2681	2.3760	2.7502	2.9107	2.8166	2.5959	2.4176	2.1809	1.9294	1.7061	40.00 Y
Z	3.00											3.00 Z
Y	35.00	1.9323	2.2116	2.7013	2.9817	3.0253	2.8778	2.7076	2.4334	2.0802	1.7894	35.00 Y
Z	3.00											3.00 Z
Y	30.00	2.1758	2.5715	3.0289	3.3166	3.3072	3.1442	2.8633	2.4796	2.1357	1.7978	30.00 Y
Z	3.00											3.00 Z
Y	25.00	2.3149	2.8026	3.1923	3.4481	3.5417	3.1779	2.7767	2.4218	2.2133	2.0242	25.00 Y
Z	3.00											3.00 Z
Y	20.00	2.1802	2.7157	3.1563	3.3094	3.2572	3.0085	2.5937	2.2572	1.9566	1.6824	20.00 Y
Z	3.00											3.00 Z
Y	15.00	1.8573	2.4804	2.9460	3.0526	3.0723	2.7454	2.2372	1.8504	1.5513	1.2262	15.00 Y
Z	3.00											3.00 Z
Y	10.00	1.1174	1.7235	2.3754	2.7652	2.6313	2.1914	1.7127	1.3272	.9838	.8539	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.4712	.6911	.9397	1.1487	1.1822	.9350	.7275	.6388	.5288	.4631	5.00 Y
Z	3.00											3.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 105.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HOMZ 0.00, VERT 0.00

		X 93.00	X 96.00	X 99.00	X 102.00	X 105.00	X 108.00	X 111.00	X 114.00	X 117.00	X 120.00	
Y	55.00	2.7529	4.0018	4.9487	4.7130	3.8330	2.9680	2.2145	1.7699	1.4856	1.3424	55.00 Y
Z	9.00											9.00 Z
Y	50.00	3.2019	4.5113	5.4305	4.8950	3.8095	2.8216	2.1746	1.7196	1.5154	1.4621	50.00 Y
Z	9.00											9.00 Z
Y	45.00	3.6938	5.2762	5.8374	4.8749	3.5420	2.6253	1.9997	1.7738	1.6433	1.6029	45.00 Y
Z	9.00											9.00 Z
Y	40.00	4.2210	5.7607	5.9328	4.3241	3.1282	2.3678	2.0933	1.9201	1.7929	1.7574	40.00 Y
Z	9.00											9.00 Z
Y	35.00	4.3929	5.3007	4.8340	3.7432	2.9753	2.5787	2.2864	2.0842	1.9320	1.7703	35.00 Y
Z	9.00											9.00 Z
Y	30.00	3.2565	4.0401	4.1028	3.7616	3.3974	2.9947	2.5622	2.1849	1.9694	1.8294	3(Y
Z	9.00											Z
Y	25.00	3.5098	4.3406	4.5513	4.4142	4.1358	3.3708	2.6868	2.2224	2.0094	1.8889	25.00 Y
Z	9.00											9.00 Z
Y	20.00	4.0153	4.4809	5.0812	4.5871	3.8905	3.1075	2.6161	2.2699	2.2487	2.3504	20.00 Y
Z	9.00											9.00 Z
Y	15.00	3.8804	4.5072	4.6282	4.2548	3.4831	2.7584	2.3235	2.0715	1.9313	1.6179	15.00 Y
Z	9.00											9.00 Z
Y	10.00	3.5206	4.1390	4.3965	3.8228	2.7591	2.1556	1.6904	1.5179	1.5136	1.2738	10.00 Y
Z	9.00											9.00 Z
Y	5.00	1.4477	2.0164	2.2096	1.8314	1.3449	1.0326	.8368	.6482	.8281	.7657	5.00 Y
Z	9.00											9.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST 93    2X LS90WWNO   100 FT SPACING 15 FT MTG     H140 V90
00120      LS90WWNO          1.00          0.85          1.00
00130      9999999999
00140      LS90WWNO          0.00          0.00         15.00         45.00         70.00
00150      LS90WWNO        100.00          0.00         15.00         45.00         70.00
00160      LS90WWNO        100.00          0.00         15.00        135.00         70.00
00170      LS90WWNO        200.00          0.00         15.00         45.00         70.00
00180      LS90WWNO        200.00          0.00         15.00        135.00         70.00
00190      LS90WWNO        300.00          0.00         15.00         45.00         70.00
00200      LS90WWNO        300.00          0.00         15.00        135.00         70.00
00210      LS90WWNO        200.00          0.00         15.00        135.00         70.00
00220      9999999999
00230           190.00      22.50          0.00          0.00          0.00
00240             5.00       5.00            20            13             V        270.00
00250           190.00      22.50          3.00          0.00          0.00
00260             5.00       5.00            20            13             V        270.00
00270           190.00      22.50          9.00          0.00          0.00
00280             5.00       5.00            20            13             V        270.00
00290      9999999999
```

TEST 93 2X LS90NWNO 100 FT SPACING 15 FT MTG H140 V9 PAGE 4

TEST GRID 1 COORDINATES OF CENTER X 190.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	
Y	55.00	2.5462	2.6252	2.7243	2.7919	2.8866	2.9863	3.0751	3.0840	3.0212	3.1191	55.00 Y
Z	0.00											0.00 Z
Y	50.00	2.6760	2.8918	2.9647	3.0905	3.2581	3.4512	3.6425	3.7454	3.7205	3.8071	50.00 Y
Z	0.00											0.00 Z
Y	45.00	2.7881	2.9273	3.2016	3.4042	3.6755	3.9993	4.3399	4.6296	4.6854	4.7903	45.00 Y
Z	0.00											0.00 Z
Y	40.00	2.7729	2.9158	3.2252	3.7160	4.1245	4.6294	5.1958	5.7623	6.0408	6.2473	40.00 Y
Z	0.00											0.00 Z
Y	35.00	2.7014	2.8415	3.1845	3.7511	4.5720	5.3154	6.2145	6.9957	7.1841	6.7572	35.00 Y
Z	0.00											0.00 Z
Y	30.00	2.5552	2.6881	3.0552	3.6913	4.6489	5.9956	6.3690	7.6732	8.0134	7.5663	30.00 Y
Z	0.00											0.00 Z
Y	25.00	2.3143	2.4362	2.8093	3.4887	4.5698	5.8606	7.3803	8.3080	8.7064	8.1641	25 Y
Z	0.00											0.00 Z
Y	20.00	1.9493	2.0419	2.6105	3.1033	4.1292	5.1846	6.6733	8.8403	9.0076	7.5447	20.00 Y
Z	0.00											0.00 Z
Y	15.00	1.4703	1.5371	1.8353	2.4396	3.1856	4.0683	5.2554	6.7677	7.3067	4.2974	15.00 Y
Z	0.00											0.00 Z
Y	10.00	.9132	.9495	1.1487	1.5759	1.9987	2.5633	3.2888	3.7835	2.8688	3.4602	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.3856	.4011	.4787	.6306	.8131	1.0713	1.3704	1.4215	1.3030	1.7722	5.00 Y
Z	0.00											0.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID 1 COORDINATES OF CENTER X 190.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 195.00	X 200.00	X 205.00	X 210.00	X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	
Y	55.00	2.9540	3.2273	3.4166	2.5856	1.6867	1.7343	1.7528	1.7397	1.7307	1.7308	55.00 Y
Z	0.00											0.00 Z
Y	50.00	3.5484	3.8632	4.0097	2.9374	2.0273	2.0566	2.0291	1.9660	1.9103	1.8776	50.00 Y
Z	0.00											0.00 Z
Y	45.00	4.3807	4.7248	4.7900	3.3787	2.4984	2.4876	2.3672	2.2293	2.1088	2.0273	45.00 Y
Z	0.00											0.00 Z
Y	40.00	5.4861	5.7855	5.7236	3.9402	3.1624	3.0399	2.7809	2.5293	2.3190	2.1705	40.00 Y
Z	0.00											0.00 Z
Y	35.00	6.3898	6.6606	6.2448	3.4946	3.7181	3.6398	3.2719	2.8532	2.5233	2.1690	35.00 Y
Z	0.00											0.00 Z
Y	30.00	7.3028	7.6288	6.6018	3.8823	4.1151	3.9594	3.6278	3.1700	2.5367	2.1126	30.00 Y
Z	0.00											0.00 Z
Y	25.00	7.7619	8.2813	6.4167	4.1637	4.4426	4.2557	3.8096	3.0750	2.4653	1.9751	25.00 Y
Z	0.00											0.00 Z
Y	20.00	6.0611	6.4397	4.7064	3.8365	4.5741	4.4999	3.4306	2.7068	2.2086	1.7379	20.00 Y
Z	0.00											0.00 Z
Y	15.00	3.9010	4.9730	1.9949	2.1954	3.7046	3.4419	2.6959	2.1172	1.6974	1.3559	15.00 Y
Z	0.00											0.00 Z
Y	10.00	3.5429	4.3694	1.7998	1.7599	1.4671	1.9286	1.6875	1.3337	1.0645	.8722	10.00 Y
Z	0.00											0.00 Z
Y	5.00	2.0567	.0268	1.0417	.8999	.6664	.7273	.7043	.5585	.4350	.3521	5.00 Y
Z	0.00											0.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID 2 COORDINATES OF CENTER X 190.00; Y 22.50; Z 3.00
ANGLES OF ORIENTATION HORZ 0.00; VERT 0.00

		X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	
Y	55.00	2.3301	2.4143	2.5133	2.5770	2.6420	2.7148	2.7718	2.7740	2.7085	2.8935	55.00 Y
Z	3.00											3.00 Z
Y	50.00	2.4936	2.7241	2.7917	2.8828	3.0095	3.1625	3.3072	3.3837	3.3518	3.5237	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.6251	2.7802	3.0437	3.2085	3.4340	3.7013	3.9810	4.2078	4.2504	4.4270	45.00 Y
Z	3.00											3.00 Z
Y	40.00	2.6098	2.7449	3.0518	3.5395	3.9007	4.3396	4.8257	5.2980	5.5336	5.7759	40.00 Y
Z	3.00											3.00 Z
Y	35.00	2.5178	2.6461	2.9846	3.5500	4.3819	5.0609	5.8626	6.7146	7.4035	7.4628	35.00 Y
Z	3.00											3.00 Z
Y	30.00	2.3566	2.4791	2.8328	3.4602	4.4238	5.8122	7.0629	8.5400	10.0480	10.0586	30.00 Y
Z	3.00											3.00 Z
Y	25.00	2.1116	2.2203	2.5771	3.2386	4.3085	5.9345	8.3079	10.4061	11.6712	11.8044	25.
Z	3.00											3.00 Z
Y	20.00	1.7668	1.8494	2.1914	2.8514	3.9573	5.7564	8.3494	11.2889	13.0493	13.2563	20.00 Y
Z	3.00											3.00 Z
Y	15.00	1.3284	1.3874	1.6640	2.2332	3.2714	5.0815	7.0323	9.7982	14.2129	12.3864	15.00 Y
Z	3.00											3.00 Z
Y	10.00	.8396	.8723	1.0550	1.4500	2.1979	3.3930	4.7443	6.6388	8.2613	8.1142	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.3682	.3829	.4572	.6157	.9218	1.3946	2.0071	2.7611	2.8207	2.9339	5.00 Y
Z	3.00											3.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST 93 2X LS90WWNO 100 FT SPACING 15 FT MTG HI40 V9 PAGE 8

TEST GRID Z COORDINATES OF CENTER X 190.00; Y 22.50; Z 3.00
ANGLES OF ORIENTATION HORZ 0.00; VERT 0.00

		X 195.00	X 200.00	X 205.00	X 210.00	X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	
Y	55.00	2.8379	3.0869	3.2461	2.3606	1.5100	1.5567	1.5756	1.5742	1.5733	1.5867	55.00 Y
Z	3.00											3.00 Z
Y	50.00	3.4139	3.7138	3.8151	2.6637	1.8237	1.8542	1.8367	1.7928	1.7544	1.7411	50.00 Y
Z	3.00											3.00 Z
Y	45.00	4.2238	4.5737	4.5684	3.0378	2.2630	2.2565	2.1644	2.0538	1.9595	1.9001	45.00 Y
Z	3.00											3.00 Z
Y	40.00	5.4108	5.7890	5.5912	3.5046	2.8925	2.7893	2.5243	2.3606	2.1814	2.0554	40.00 Y
Z	3.00											3.00 Z
Y	35.00	7.2380	7.5656	7.0196	3.8343	3.8135	3.4829	3.0771	2.7047	2.4048	2.0436	35.00 Y
Z	3.00											3.00 Z
Y	30.00	9.3891	9.4993	8.3370	5.1175	5.1202	4.3788	3.6588	3.0597	2.4027	1.9727	30.00 Y
Z	3.00											3.00 Z
Y	25.00	11.1802	11.3682	8.8534	5.9751	5.9152	5.2935	4.2603	3.0906	2.3164	1.8276	25.00 Y
Z	3.00											3.00 Z
Y	20.00	12.0484	12.2758	8.2295	6.6854	6.5872	5.7156	4.2584	2.9805	2.1079	1.5932	20.00 Y
Z	3.00											3.00 Z
Y	15.00	8.4549	8.5373	4.2671	6.2351	7.1522	4.9511	3.5776	2.6158	1.7303	1.2394	15.00 Y
Z	3.00											3.00 Z
Y	10.00	5.8665	7.6899	2.9586	3.0838	4.1599	3.3527	2.4114	1.7445	1.1593	.8028	10.00 Y
Z	3.00											3.00 Z
Y	5.00	4.3221	1.3924	2.1730	1.4793	1.4237	1.3956	1.0212	.7189	.4881	.3430	5.00 Y
Z	3.00											3.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 190.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	
Y	55.00	1.5879	1.6439	1.7109	1.7573	1.8183	1.8796	1.9242	1.9385	1.9042	2.1033	55.00 Y
Z	9.00											9.00 Z
Y	50.00	1.6945	1.8403	1.8938	1.9818	2.0899	2.2087	2.3090	2.3665	2.3533	2.5702	50.00 Y
Z	9.00											9.00 Z
Y	45.00	1.7945	1.8835	2.0881	2.2368	2.4229	2.6261	2.8211	2.9589	2.9950	3.2303	45.00 Y
Z	9.00											9.00 Z
Y	40.00	1.7873	1.8877	2.1211	2.5187	2.8197	3.1400	3.5072	3.7975	3.9411	4.1975	40.00 Y
Z	9.00											9.00 Z
Y	35.00	1.7537	1.8386	2.0981	2.5589	3.2766	3.8326	4.4299	5.0037	5.3846	5.3845	35.00 Y
Z	9.00											9.00 Z
Y	30.00	1.6505	1.7313	2.0013	2.5088	3.3431	4.6420	5.6745	6.7500	7.6434	7.9163	30.00 Y
Z	9.00											9.00 Z
Y	25.00	1.4793	1.5485	1.8183	2.3441	3.2469	4.7624	7.2509	9.1142	10.9696	12.2769	25 Y
Z	9.00											5 Z
Y	20.00	1.2368	1.2916	1.5375	2.0387	2.9425	4.5440	7.3087	11.8566	15.8403	20.1016	20.00 Y
Z	9.00											9.00 Z
Y	15.00	.9337	.9726	1.1707	1.5887	2.3766	3.8619	6.6026	11.8881	22.0257	33.3127	15.00 Y
Z	9.00											9.00 Z
Y	10.00	.6051	.6296	.7602	1.0396	1.5849	2.6670	4.9265	10.0583	22.2189	44.6017	10.00 Y
Z	9.00											9.00 Z
Y	5.00	.2817	.2928	.3537	.4850	.7419	1.2365	2.3242	5.1760	13.1913	26.2973	5.00 Y
Z	9.00											9.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

TEST 93 2X LS90WWNO 100 FT SPACING 15 FT HTG M140 V2 PAGE 11

TEST GRID 3 COORDINATES OF CENTER X 190.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 195.00	X 200.00	X 205.00	X 210.00	X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00		
Y	55.00	2.1673	2.3384	2.4294	1.6969	1.0645	1.0908	1.0968	1.0922	1.0848	1.0841	55.00	Y
Z	9.00											9.00	Z
Y	50.00	2.6644	2.8902	2.9136	1.9011	1.2833	1.2995	1.2844	1.2529	1.2184	1.1971	50.00	Y
Z	9.00											9.00	Z
Y	45.00	3.3752	3.6807	3.5649	2.1165	1.5969	1.5886	1.5337	1.4555	1.3799	1.3217	45.00	Y
Z	9.00											9.00	Z
Y	40.00	4.4333	4.8402	4.4594	2.3082	2.0614	1.9992	1.8680	1.7138	1.5702	1.4556	40.00	Y
Z	9.00											9.00	Z
Y	35.00	6.0872	6.7090	5.7088	2.7674	2.7733	2.5920	2.3184	2.0386	1.7867	1.4639	35.00	Y
Z	9.00											9.00	Z
Y	30.00	8.6094	9.3984	7.3263	4.0229	3.8917	3.4534	2.9279	2.4291	1.8041	1.4216	30.00	Y
Z	9.00											9.00	Z
Y	25.00	13.0585	13.8927	9.6344	6.1921	5.5432	4.6226	3.7016	2.4727	1.7368	1.3166	25.00	Y
Z	9.00											9.00	Z
Y	20.00	22.2283	22.3496	13.1557	10.0931	7.9681	5.9801	3.7147	2.3450	1.5623	1.1366	20.00	Y
Z	9.00											9.00	Z
Y	15.00	39.5688	37.3890	19.8140	16.6873	11.0465	5.9820	3.3457	1.9847	1.2555	.8812	15.00	Y
Z	9.00											9.00	Z
Y	10.00	52.5935	50.7095	24.3157	22.3207	11.1271	5.0535	2.4918	1.3680	.8357	.5758	10.00	Y
Z	9.00											9.00	Z
Y	5.00	24.2560	30.5766	12.1370	13.1579	6.6057	2.5992	1.1751	.6348	.3907	.2685	5.00	Y
Z	9.00											9.00	Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00	Y
Z	9.00											9.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	9.00											9.00	Z

```
00100 0000
00110      TEST 94    2X LP180WWSE   120 FT SPACING 15 FT HTG    M140 V
00120      LP180WWSE        1.00      0.89      1.00
00130      9999999999
00140      LP180WWSE        0.00      0.00     15.00     45.00    70.00
00150      LP180WWSE      120.00      0.00     15.00     45.00    70.00
00160      LP180WWSE      120.00      0.00     15.00    135.00    70.00
00170      LP180WWSE      240.00      0.00     15.00     45.00    70.00
00180      LP180WWSE      240.00      0.00     15.00    135.00    70.00
00190      LP180WWSE      360.00      0.00     15.00     45.00    70.00
00200      LP180WWSE      360.00      0.00     15.00    135.00    70.00
00210      LP180WWSE      480.00      0.00     15.00    135.00    70.00
00220      9999999999
00230          210.00     22.50      0.00      0.00      0.00
00240            5.00      5.00        20        13         V    270.00
00250          210.00     22.50      0.00      0.00      0.00
00260            5.00      5.00        20        13         V    270.00
00270          210.00     22.50      0.00      0.00      0.00
00280            5.00      5.00        20        13         V    270.00
00290      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 210.00; Y 22.50; Z 0.00
ANGLES OF ORIENTATION HORZ 0.00; VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00	
Y	55.00	1.5577	1.4222	1.3296	1.3053	1.3305	1.4236	1.5597	1.7304	2.2170	2.6515	55.00 Y
Z	0.00											0.00 Z
Y	50.00	1.7218	1.5926	1.5417	1.5102	1.4423	1.5437	1.7229	1.9639	2.4830	3.0524	50.00 Y
Z	0.00											0.00 Z
Y	45.00	1.8878	1.6665	1.5432	1.5028	1.5438	1.6677	1.8896	2.2085	2.6214	3.5072	45.00 Y
Z	0.00											0.00 Z
Y	40.00	2.0469	1.7777	1.6228	1.5723	1.6233	1.7788	2.0485	2.4621	3.0158	3.7212	40.00 Y
Z	0.00											0.00 Z
Y	35.00	2.1879	1.8549	1.6859	1.6050	1.6663	1.8558	2.1493	2.7006	3.4260	4.3954	35.00 Y
Z	0.00											0.00 Z
Y	30.00	2.2651	1.8706	1.6557	1.5866	1.6561	1.8714	2.2662	2.8871	3.8098	5.1076	30.00 Y
Z	0.00											0.00 Z
Y	25.00	2.2481	1.8041	1.5604	1.4791	1.5607	1.8048	2.2490	2.9689	4.0859	5.2545	25.00 Y
Z	0.00											0.00 Z
Y	20.00	2.0873	1.6100	1.3804	1.2829	1.3607	1.6105	2.0877	2.8716	4.0092	5.2012	20.00 Y
Z	0.00											0.00 Z
Y	15.00	1.7182	1.2990	1.0846	.9953	1.0559	1.2759	1.7020	2.4447	3.3694	4.5234	15.00 Y
Z	0.00											0.00 Z
Y	10.00	1.0085	.7230	.6088	.6013	.6818	.8622	1.1862	1.7467	2.3581	3.2760	10.00 Y
Z	0.00											0.00 Z
Y	5.00	.2297	.2094	.2189	.2570	.3217	.4251	.5968	.8668	1.1696	1.6392	5.00 Y
Z	0.00											0.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST 94 2X LP180WMSE 120 FT SPACING 15 FT MTS M140 V PAGE 5

TEST GRID 1 COORDINATES OF CENTER X 210.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HOR2 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00		
Y	55.00	3.1558	3.4681	4.1915	3.8980	3.3413	4.2454	5.0568	4.6653	4.1915	3.4682	55.00	Y
Z	0.00											0.00	Z
Y	50.00	3.2410	4.4812	5.2330	5.0393	4.0821	5.3320	6.5290	5.9407	5.2330	4.4812	50.00	Y
Z	0.00											0.00	Z
Y	45.00	4.4406	5.5283	6.6300	6.0060	5.1848	6.8588	8.6174	7.7049	6.6300	5.5283	45.00	Y
Z	0.00											0.00	Z
Y	40.00	5.2631	6.8327	8.5190	9.5614	6.9908	8.9625	11.3470	10.1847	8.5190	6.7748	40.00	Y
Z	0.00											0.00	Z
Y	35.00	5.6318	8.1822	10.0222	11.8710	10.0610	11.6251	13.4754	11.8710	10.0222	7.9854	35.00	Y
Z	0.00											0.00	Z
Y	30.00	6.2725	8.6496	11.0396	13.7113	14.2693	15.5021	16.0973	13.7113	11.0156	8.4151	30.	
Z	0.00											0.	
Y	25.00	5.7185	7.6588	11.7820	15.3683	18.8615	19.9512	18.8616	15.3684	11.9221	7.6589	25.00	Y
Z	0.00											0.00	Z
Y	20.00	6.1434	5.0140	10.0060	14.1739	17.0836	17.9918	17.0833	14.2840	10.0060	5.0140	20.00	Y
Z	0.00											0.00	Z
Y	15.00	6.1980	7.5131	6.0146	9.7121	12.6475	13.8388	12.6475	10.1518	6.0146	7.5131	15.00	Y
Z	0.00											0.00	Z
Y	10.00	4.6505	5.7561	5.9494	6.3235	6.9911	8.2958	7.0029	6.3235	5.9493	5.7561	10.00	Y
Z	0.00											0.00	Z
Y	5.00	2.3568	2.7526	2.8573	2.7906	2.8405	3.2848	2.8405	2.8187	2.8573	2.7526	5.00	Y
Z	0.00											0.00	Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00	Y
Z	0.00											0.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	0.00											0.00	Z

TEST GRID 2 COORDINATES OF CENTER X 210.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00	
Y	55.00	1.2607	1.1930	1.1530	1.1395	1.1536	1.1943	1.2626	1.3588	1.7310	2.0838	55.00 Y
Z	3.00											3.00 Z
Y	50.00	1.3540	1.2542	1.2013	1.1839	1.2018	1.2553	1.3558	1.5391	1.9406	2.3063	50.00 Y
Z	3.00											3.00 Z
Y	45.00	1.4893	1.3157	1.2384	1.2163	1.2389	1.3168	1.4909	1.7384	2.0655	2.7770	45.00 Y
Z	3.00											3.00 Z
Y	40.00	1.6200	1.3959	1.2587	1.2309	1.2592	1.3969	1.6215	1.9485	2.3949	2.9733	40.00 Y
Z	3.00											3.00 Z
Y	35.00	1.7316	1.4518	1.2835	1.2200	1.2840	1.4526	1.7329	2.1511	2.7459	3.5556	35.00 Y
Z	3.00											3.00 Z
Y	30.00	1.7965	1.4631	1.2698	1.1913	1.2702	1.4638	1.7975	2.3165	3.0858	4.1908	30.00 Y
Z	3.00											3.00 Z
Y	25.00	1.7902	1.4129	1.1950	1.1203	1.1953	1.4134	1.7911	2.3993	3.3474	4.7918	25.00 Y
Z	3.00											3.00 Z
Y	20.00	1.6712	1.2661	1.0443	.9809	1.0445	1.2666	1.6719	2.3398	3.4170	5.1803	20.00 Y
Z	3.00											3.00 Z
Y	15.00	1.3849	1.0272	.8399	.7790	.8379	1.0276	1.3855	2.0154	3.1258	5.0701	15.00 Y
Z	3.00											3.00 Z
Y	10.00	.8616	.6226	.5227	.5133	.5756	.7184	.9825	1.4575	2.3234	3.7662	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.2655	.2303	.2240	.2432	.2865	.3631	.5000	.7491	1.2109	1.9088	5.00 Y
Z	3.00											3.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 210.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00		
Y	55.00	2.4987	2.9258	3.3668	3.4153	3.2914	3.7264	4.0659	3.7507	3.3658	2.9258	55.00	Y
Z	3.00											3.00	Z
Y	50.00	2.9777	3.5997	4.2392	4.3517	3.9856	4.7023	5.3119	4.8294	4.2392	3.5997	50.00	Y
Z	3.00											3.00	Z
Y	45.00	3.5588	4.4826	5.4310	5.8105	5.0093	6.0950	7.1172	6.3526	5.4310	4.4826	45.00	Y
Z	3.00											3.00	Z
Y	40.00	4.2552	5.6063	7.0804	8.2022	6.6140	8.1483	9.8094	8.5501	7.0804	5.5526	40.00	Y
Z	3.00											3.00	Z
Y	35.00	4.6067	7.0107	9.3787	11.7840	9.3151	11.2899	13.9525	11.7840	9.3787	6.8091	35.00	Y
Z	3.00											3.00	Z
Y	30.00	5.7206	8.7179	12.6934	15.8210	14.0450	15.7425	18.6637	15.8211	12.3886	8.2591	30.00	Y
Z	3.00											3.00	Z
Y	25.00	6.9488	9.5797	14.0371	18.6128	20.9220	22.3481	23.1906	18.6128	13.7629	9.5798	25.00	Y
Z	3.00											3.00	Z
Y	20.00	7.6786	8.7773	13.1128	20.8912	28.5578	31.0642	28.5578	20.9903	13.1128	8.7772	20.00	Y
Z	3.00											3.00	Z
Y	15.00	7.2564	9.8425	6.9038	18.8462	23.9730	26.0030	23.9729	19.7380	6.9037	9.8424	15.00	Y
Z	3.00											3.00	Z
Y	10.00	5.6056	8.5409	11.5864	11.8829	14.8661	17.0834	15.0168	11.8828	11.5863	8.5408	10.00	Y
Z	3.00											3.00	Z
Y	5.00	2.9096	4.6825	5.5054	5.8450	5.5165	7.3019	5.5165	5.8450	5.5054	4.6824	5.00	Y
Z	3.00											3.00	Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00	Y
Z	3.00											3.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	3.00											3.00	Z

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00		
Y	55.00	.9681	.9230	.8974	.8868	.8979	.9241	.9698	1.0340	1.2546	1.4887	55.00	Y
Z	9.00											9.00	Z
Y	50.00	1.0282	.9669	.9258	.9123	.9263	.9679	1.0297	1.1171	1.3116	1.6003	50.00	Y
Z	9.00											9.00	Z
Y	45.00	1.0849	.9970	.9449	.9280	.9454	.9980	1.0864	1.2023	1.3539	1.7110	45.00	Y
Z	9.00											9.00	Z
Y	40.00	1.1235	1.0147	.9512	.9304	.9516	1.0155	1.1248	1.2843	1.4872	1.7449	40.00	Y
Z	9.00											9.00	Z
Y	35.00	1.1445	1.0132	.9395	.9157	.9399	1.0140	1.1456	1.3423	1.6179	1.9713	35.00	Y
Z	9.00											9.00	Z
Y	30.00	1.1361	.9856	.9027	.8760	.9030	.9862	1.1370	1.3729	1.7181	2.2024	30.00	Y
Z	9.00											9.00	Z
Y	25.00	1.0896	.9219	.8293	.7987	.8296	.9223	1.0904	1.3599	1.7722	2.3899	25.00	Y
Z	9.00											9.00	Z
Y	20.00	.9862	.8081	.7138	.6844	.7140	.8085	.9868	1.2786	1.7406	2.4798	20.00	Y
Z	9.00											9.00	Z
Y	15.00	.8055	.6475	.5654	.5402	.5659	.6482	.8064	1.0813	1.5536	2.3963	15.00	Y
Z	9.00											9.00	Z
Y	10.00	.5662	.4506	.3903	.3718	.3904	.4508	.5687	.7787	1.1531	1.9710	10.00	Y
Z	9.00											9.00	Z
Y	5.00	.2904	.2285	.1971	.1873	.1969	.2282	.2901	.4018	.6056	1.0930	5.00	Y
Z	9.00											9.00	Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00	Y
Z	9.00											9.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	9.00											9.00	Z

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00	
Y	55.00	1.7623	2.0231	2.2966	2.5133	2.6906	2.7222	2.6805	2.5085	2.2966	2.0231	55.00 Y
Z	9.00											9.00 Z
Y	50.00	1.9572	2.3293	2.7071	3.0352	3.2923	3.3534	3.2826	3.0314	2.7071	2.3293	50.00 Y
Z	9.00											9.00 Z
Y	45.00	2.1676	2.7066	3.2401	3.7458	4.1334	4.2474	4.1248	3.7434	3.2401	2.7066	45.00 Y
Z	9.00											9.00 Z
Y	40.00	2.3937	3.1409	3.9420	4.7408	5.3517	5.5646	5.3457	4.7400	3.9428	3.1055	40.00 Y
Z	9.00											9.00 Z
Y	35.00	2.4216	3.6329	4.8744	6.1532	7.1934	7.6016	7.1918	6.1532	4.8744	3.4918	35.00 Y
Z	9.00											9.00 Z
Y	30.00	2.8456	4.1843	6.1464	8.6949	10.2644	11.2543	11.0268	8.6951	6.0652	3.8414	30.00 Y
Z	9.00											9.00 Z
Y	25.00	3.2914	4.8372	8.5743	13.5148	16.6151	18.0479	18.5257	13.5149	8.1586	4.8373	25.
Z	9.00											9.00 Z
Y	20.00	3.8812	6.5482	10.9380	21.6474	32.1252	31.9389	33.5167	21.4327	10.9379	6.5481	20.00 Y
Z	9.00											9.00 Z
Y	15.00	4.3276	8.2096	15.9811	34.2469	62.7413	62.4525	62.7412	32.4111	15.9809	8.2093	15.00 Y
Z	9.00											9.00 Z
Y	10.00	3.9307	8.5972	20.1685	34.6735	83.1895	123.9001	83.5857	34.6734	20.1683	8.5969	10.00 Y
Z	9.00											9.00 Z
Y	5.00	2.2763	5.4360	14.7822	33.9425	47.3419	68.1537	47.3418	33.9424	14.7821	5.0880	5.00 Y
Z	9.00											9.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

```
00100 0000
00110     TEST 95     2X LP180WWNO    120 FT SPACING 15 FT MTG     H140 V
00120     LP180WWNO          1.00        0.85        1.00
00130     9999999999
00140     LP180WWNO          0.00        0.00       15.00       45.00      70.00
00150     LP180WWNO        120.00        0.00       15.00       45.00      70.00
00160     LP180WWNO        120.00        0.00       15.00      135.00      70.00
00170     LP180WWNO        240.00        0.00       15.00       45.00      70.00
00180     LP180WWNO        240.00        0.00       15.00      135.00      70.00
00190     LP180WWNO        360.00        0.00       15.00       45.00      70.00
00200     LP180WWNO        360.00        0.00       15.00      135.00      70.00
00210     LP180WWNO        480.00        0.00       15.00      135.00      70.00
00220     9999999999
00230          210.00       22.50        0.00        0.00        0.00
00240            5.00        5.00          20          13           V     270.00
00250          210.00       22.50        3.00        0.00        0.00
00260            5.00        5.00          20          13           V     270.00
00270          210.00       22.50        9.00        0.00        0.00
00280            5.00        5.00          20          13           V     270.00
00290     9999999999
```

TEST 95 2X LP180WWNO 120 FT SPACING 19 FT MTG M148 V

TEST GRID 1 COORDINATES OF CENTER X 210.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00		
Y	55.00	3.0762	2.9017	2.7933	2.7502	2.7944	2.9039	3.0796	3.3132	3.6797	4.2126	55.00	Y
Z	0.00											0.00	Z
Y	50.00	3.3258	3.0955	2.9282	2.8738	2.9293	3.0975	3.3289	3.6450	4.0380	4.7808	50.00	Y
Z	0.00											0.00	Z
Y	45.00	3.5738	3.2237	3.0289	2.9637	3.0315	3.2287	3.5759	4.0066	4.5514	5.3284	45.00	Y
Z	0.00											0.00	Z
Y	40.00	3.7322	3.3019	3.0607	3.0021	3.0890	3.3211	3.7350	4.3860	5.1317	6.0307	40.00	Y
Z	0.00											0.00	Z
Y	35.00	3.8199	3.3058	3.0743	2.9877	3.0700	3.3491	3.8358	4.6057	5.7402	7.0056	35.00	Y
Z	0.00											0.00	Z
Y	30.00	3.8603	3.3674	3.0488	2.9056	2.9551	3.2111	3.7747	4.6915	6.0753	8.0747	30.00	Y
Z	0.00											0.00	Z
Y	25.00	4.0271	3.3436	2.8629	2.5833	2.6119	2.9127	3.5275	4.5581	6.1753	7.8984	25.	
Z	0.00											0.00	Z
Y	20.00	3.8618	2.8109	2.2679	2.0634	2.1260	2.4499	3.0879	4.1562	5.6732	6.9531	20.00	Y
Z	0.00											0.00	Z
Y	15.00	2.7541	2.0027	1.6270	1.5279	1.6198	1.9218	2.4866	3.4471	4.4541	5.4945	15.00	Y
Z	0.00											0.00	Z
Y	10.00	1.7146	1.3287	1.1350	1.0760	1.1352	1.3291	1.7152	2.4229	2.9439	3.5549	10.00	Y
Z	0.00											0.00	Z
Y	5.00	.8320	.6594	.5733	.5470	.5733	.6596	.8322	1.1168	1.3982	1.7275	5.00	Y
Z	0.00											0.00	Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00	Y
Z	0.00											0.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	0.00											0.00	Z

TEST GRID 1 COORDINATES OF CENTER X 210.00; Y 22.50; Z 0.00
ANGLES OF ORIENTATION. HORZ 0.0w; VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00	
Y	55.00	5.1929	5.3727	5.3766	6.0909	6.7677	6.8729	6.7677	6.0909	5.3417	4.7751	55.00 Y
Z	0.00											0.00 Z
Y	50.00	5.7663	6.8025	6.8530	7.6825	8.3700	8.5712	8.3700	7.6825	6.8271	5.8796	50.00 Y
Z	0.00											0.00 Z
Y	45.00	6.7170	8.8310	8.9984	9.4050	10.6074	10.9572	10.6074	9.4050	8.0711	6.7970	45.00 Y
Z	0.00											0.00 Z
Y	40.00	7.6442	10.2948	12.1928	12.1322	13.3515	13.7721	13.3515	12.1322	10.0952	7.9607	40.00 Y
Z	0.00											0.00 Z
Y	35.00	8.5080	11.6055	14.4511	13.0223	14.3189	15.0912	14.3189	12.6478	11.1779	9.7213	35.00 Y
Z	0.00											0.00 Z
Y	30.00	9.4300	10.7313	13.3263	13.6088	14.5133	15.8278	14.5133	12.7597	10.8137	10.3156	30.00 Y
Z	0.00											0.00 Z
Y	25.00	9.4147	10.4039	11.6392	12.4241	12.8597	15.1743	12.8557	12.3974	10.9641	10.4039	25.00 Y
Z	0.00											0.00 Z
Y	20.00	8.3623	9.6050	10.0524	9.4805	9.9374	11.3148	9.9374	9.4805	10.0524	9.6050	20.00 Y
Z	0.00											0.00 Z
Y	15.00	6.6322	7.5628	7.8816	5.8310	6.6587	7.9678	7.0717	5.8310	7.8816	7.5628	15.00 Y
Z	0.00											0.00 Z
Y	10.00	4.2036	4.7666	3.8977	4.6665	4.7285	7.4282	4.7285	4.6665	3.8977	4.7666	10.00 Y
Z	0.00											0.00 Z
Y	5.00	1.9454	1.8525	1.7539	2.3598	3.3132	3.4018	3.3132	2.3598	1.7539	1.8525	5.00 Y
Z	0.00											0.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST 95 8X LP180WWNO 120 FT SPACING 16 FT HTG M148 V

TEST GRID # COORDINATES OF CENTER X 210.00; Y 22.50; Z 3.00
ANGLES OF ORIENTATION HORZ 0.00; VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00		
Y	55.00	2.5970	2.5565	2.4763	2.4435	2.4774	2.5586	2.7001	2.8975	3.1343	3.4423	55.00	Y
Z	3.00											3.00	Z
Y	50.00	2.8928	2.7039	2.5744	2.5342	2.5775	2.7058	2.8956	3.1783	3.5343	4.0131	50.00	Y
Z	3.00											3.00	Z
Y	45.00	3.0982	2.8052	2.6514	2.6010	2.6522	2.8069	3.1008	3.4847	3.9770	4.6144	45.00	Y
Z	3.00											3.00	Z
Y	40.00	3.2478	2.8784	2.6711	2.6081	2.6719	2.8880	3.2500	3.8068	4.4796	5.3042	40.00	Y
Z	3.00											3.00	Z
Y	35.00	3.3373	2.8895	2.6274	2.5267	2.6170	2.8907	3.3394	4.0215	5.0119	6.1739	35.00	Y
Z	3.00											3.00	Z
Y	30.00	3.3432	2.8375	2.5241	2.3844	2.4717	2.7592	3.2957	4.1223	5.3543	7.1423	30.00	Y
Z	3.00											3.00	Z
Y	25.00	3.3512	2.7115	2.2971	2.1078	2.1916	2.5097	3.0858	4.0291	5.5025	7.7131	25.	
Z	3.00											3.00	Z
Y	20.00	3.1334	2.2782	1.8418	1.6977	1.7792	2.1026	2.7022	3.6862	5.2594	7.8355	20.00	Y
Z	3.00											3.00	Z
Y	15.00	2.3031	1.4770	1.3633	1.2828	1.3405	1.6361	2.1471	3.0276	4.5308	7.1116	15.00	Y
Z	3.00											3.00	Z
Y	10.00	1.5016	1.1720	1.0874	.9569	1.0076	1.1724	1.5022	2.1143	3.2587	5.0076	10.00	Y
Z	3.00											3.00	Z
Y	5.00	.7726	.6142	.5362	.5118	.5362	.6143	.7729	1.0646	1.6022	2.3584	5.00	Y
Z	3.00											3.00	Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00	Y
Z	3.00											3.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	3.00											3.00	Z

TEST 95 2X LP180WWNO 120 FT SPACING 15 FT HTG M140 V

TEST GRID 2 COORDINATES OF CENTER X 210.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00	
Y	55.00	4.1365	4.3746	4.4907	5.2416	5.9777	6.0769	5.9777	5.2416	4.4709	4.0460	55.00 Y
Z	3.00											3.00 Z
Y	50.00	4.6446	5.5383	5.7164	6.4378	7.4089	7.6134	7.4089	6.4378	5.5144	4.8552	50.00 Y
Z	3.00											3.00 Z
Y	45.00	5.5771	7.1072	7.5190	8.1088	9.4324	9.8047	9.4324	8.1088	6.9035	5.8781	45.00 Y
Z	3.00											3.00 Z
Y	40.00	6.5707	8.5175	10.2588	10.5174	12.3889	13.0314	12.3889	10.5174	8.7658	7.0677	40.00 Y
Z	3.00											3.00 Z
Y	35.00	7.5815	10.4047	14.5502	14.5794	16.8687	17.9591	16.8687	14.1132	11.2476	9.0226	35.00 Y
Z	3.00											3.00 Z
Y	30.00	9.2130	12.1663	18.6819	20.2916	20.8714	22.2934	20.8714	18.0135	14.0734	11.6544	30.00 Y
Z	3.00											3.00 Z
Y	25.00	11.0800	14.2450	17.9732	22.3309	21.6607	24.3467	21.6607	18.8472	15.8855	14.2950	25.00 Y
Z	3.00											3.00 Z
Y	20.00	11.4695	14.4507	16.3635	18.4496	18.2778	23.5206	18.2778	16.9083	16.3635	14.4507	20.00 Y
Z	3.00											3.00 Z
Y	15.00	9.5769	12.2925	14.3598	14.6588	13.5054	14.5895	14.2669	14.6588	14.3598	12.2925	15.00 Y
Z	3.00											3.00 Z
Y	10.00	6.5814	8.4762	9.7812	8.2630	7.8801	11.8952	7.8801	8.2630	9.7812	9.2564	10.00 Y
Z	3.00											3.00 Z
Y	5.00	3.1169	3.5178	3.6417	3.9364	5.7319	7.8067	5.7319	3.9364	3.6417	3.5178	5.00 Y
Z	3.00											3.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00	
Y	55.00	1.9667	1.8800	1.8334	1.8087	1.8342	1.8817	1.9692	2.0926	2.2241	2.3600	55.00 Y
Z	9.00											9.00 Z
Y	50.00	2.1606	1.8618	1.8870	1.8568	1.8878	1.9630	2.1029	2.2745	2.4946	2.7068	50.00 Y
Z	9.00											9.00 Z
Y	45.00	2.2275	2.0311	1.9198	1.8827	1.9205	2.0325	2.2296	2.4646	2.7760	3.1335	45.00 Y
Z	9.00											9.00 Z
Y	40.00	2.2955	2.0517	1.9135	1.8681	1.9141	2.0530	2.2978	2.6566	3.0848	3.6188	40.00 Y
Z	9.00											9.00 Z
Y	35.00	2.3258	2.0318	1.8521	1.7944	1.8526	2.0329	2.3275	2.7700	3.3984	4.1491	35.00 Y
Z	9.00											9.00 Z
Y	30.00	2.2746	1.9205	1.7308	1.6697	1.7313	1.9214	2.2740	2.8189	3.6805	4.7120	30.00 Y
Z	9.00											9.00 Z
Y	25.00	2.1103	1.7335	1.5270	1.4564	1.5274	1.7343	2.1116	2.7316	3.7004	5.1036	25.00 Y
Z	9.00											9.00 Z
Y	20.00	1.8266	1.4358	1.2343	1.1721	1.2347	1.4365	1.8276	2.4770	3.5141	5.2434	20.00 Y
Z	9.00											9.00 Z
Y	15.00	1.3971	1.0872	.9277	.8862	.9279	1.0877	1.3978	1.9563	2.9650	4.7700	15.00 Y
Z	9.00											9.00 Z
Y	10.00	.9826	.7886	.6871	.6555	.6872	.7889	.9830	1.3160	1.9531	3.3760	10.00 Y
Z	9.00											9.00 Z
Y	5.00	.5571	.4332	.3707	.3509	.3707	.4333	.5573	.7794	1.1792	1.9200	5.00 Y
Z	9.00											9.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

TEST GRID J COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00	
Y	55.00	2.6800	2.8928	3.0749	3.5935	4.1208	4.1885	4.1208	3.5935	3.0692	2.7922	55.00 Y
Z	9.00											9.00 Z
Y	50.00	2.9231	3.4265	3.8930	4.2889	5.0539	5.2080	5.0539	4.2889	3.6448	3.2533	50.00 Y
Z	9.00											9.00 Z
Y	45.00	3.4777	4.1479	4.5510	5.2088	6.3598	6.6768	6.3598	5.2088	4.4210	3.8553	45.00 Y
Z	9.00											9.00 Z
Y	40.00	4.1912	4.7401	5.2828	6.4412	8.2455	8.8792	8.2455	6.4417	5.5007	4.7401	40.00 Y
Z	9.00											9.00 Z
Y	35.00	5.0936	6.0294	7.6133	8.3929	11.0658	12.3489	11.0658	8.3142	7.0413	6.0294	35.00 Y
Z	9.00											9.00 Z
Y	30.00	6.0937	7.8009	9.5235	12.3644	15.7909	18.2516	15.7909	11.7849	9.4462	7.8009	30.00 Y
Z	9.00											9.00 Z
Y	25.00	7.1878	10.0439	14.0013	20.4538	24.2817	29.0546	24.2817	17.7453	13.4715	10.0439	25.00 Y
Z	9.00											9.00 Z
Y	20.00	8.0560	12.8002	19.4376	32.6805	40.8813	50.9993	40.8813	26.8795	19.4376	12.8002	20.00 Y
Z	9.00											9.00 Z
Y	15.00	8.1106	14.5900	27.2074	47.6124	80.2728	88.3213	71.1604	45.5649	27.2074	14.5900	15.00 Y
Z	9.00											9.00 Z
Y	10.00	6.4820	13.4524	30.3814	57.0361	73.2128	93.4485	66.9674	57.0361	31.7464	16.3530	10.00 Y
Z	9.00											9.00 Z
Y	5.00	3.5218	7.6886	19.4835	33.4817	32.6916	47.2399	32.6916	36.6044	22.2663	7.6886	5.00 Y
Z	9.00											9.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST 96A    1X 400W  HPS      80 FT SPACING  15 FT MTG
00120      HS400WMWE         0.85     0.85         1.00
00130      9999999999
00140      HS400WMWE         0.00     0.00        15.00      90.00      60.00
00150      HS400WMWE        80.00     0.00        15.00      90.00      60.00
00160      HS400WMWE       160.00     0.00        15.00      90.00      60.00
00170      HS400WMWE       240.00     0.00        15.00      90.00      60.00
00180      HS400WMWE       320.00     0.00        15.00      90.00      60.00
00190      9999999999
00200           140.00     22.50     0.00         0.00       0.00
00210             5.00      5.00       10           15          V     270.00
00220           140.00     22.50     3.00         0.00       0.00
00230             5.00      5.00       10           15          V     270.00
00240           140.00     22.50     9.00         0.00       0.00
00250             5.00      5.00       10           15          V     270.00
00260      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 140.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	
Y	60.00	2.9326	3.0113	3.1639	3.2698	3.3276	3.2766	3.1624	2.9850	2.9687	2.9850	60.00 Y
Z	0.00											0.00 Z
Y	55.00	3.0252	3.1736	3.4738	3.6687	3.8608	3.8981	3.8671	3.7564	3.7469	3.7564	55.00 Y
Z	0.00											0.00 Z
Y	50.00	3.2054	3.2928	3.6613	4.1165	4.4628	4.7098	4.8327	4.8478	4.8622	4.8478	50.00 Y
Z	0.00											0.00 Z
Y	45.00	3.4220	3.4231	3.6921	4.5179	5.2404	5.8461	6.1430	6.3300	6.4019	6.3291	45.00 Y
Z	0.00											0.00 Z
Y	40.00	3.5005	3.4749	3.6366	4.6947	6.1678	7.1377	7.7723	8.1736	8.3122	8.1728	40.00 Y
Z	0.00											0.00 Z
Y	35.00	2.9442	3.3104	3.9145	4.5800	6.7396	8.5253	9.9066	10.9025	11.2374	10.9023	35.00 Y
Z	0.00											0.00 Z
Y	30.00	2.2264	2.6842	3.8942	4.8677	6.5864	10.1483	12.7512	14.9388	15.5507	14.9388	30.00 Y
Z	0.00											0.00 Z
Y	25.00	1.8804	1.9730	2.6427	4.7451	6.5913	10.7294	15.5974	18.7887	19.8911	18.7887	25.00 Y
Z	0.00											0.00 Z
Y	20.00	.9650	1.2400	1.6691	2.8080	6.5390	9.6772	18.4410	22.4002	23.6742	22.4002	20.00 Y
Z	0.00											0.00 Z
Y	15.00	0.0000	.2106	.8097	1.9684	3.4079	9.0243	14.9339	23.3506	19.9225	23.3506	15.00 Y
Z	0.00											0.00 Z
Y	10.00	0.0000	0.0000	0.0000	0.0000	1.3974	3.8852	9.1189	13.5887	6.4435	13.5887	10.00 Y
Z	0.00											0.00 Z
Y	5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.8250	5.2354	2.6596	5.2354	5.00 Y
Z	0.00											0.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z
Y	-10.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-10.00 Y
Z	0.00											0.00 Z

TEST 96A 1X 400W MPS 80 FT SPACING 15 FT MTG PAGE 6

TEST GRID Z COORDINATES OF CENTER X 140.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	
Y 60.00 Z 3.00		2.7295	2.7655	2.8352	2.8978	2.9127	2.8106	2.5990	2.2856	2.2425	2.2856	60.00 Y 3.00 Z
Y 55.00 Z 3.00		2.8930	2.9380	3.1162	3.2517	3.3943	3.3609	3.2157	2.9115	2.8507	2.9115	55.00 Y 3.00 Z
Y 50.00 Z 3.00		3.0165	3.0792	3.3274	3.6696	3.9433	4.0893	4.0748	3.8201	3.7451	3.8201	50.00 Y 3.00 Z
Y 45.00 Z 3.00		3.1593	3.2000	3.4539	4.0894	4.6646	5.1257	5.2594	5.1288	5.0749	5.1280	45.00 Y 3.00 Z
Y 40.00 Z 3.00		3.2107	3.2521	3.5091	4.3724	5.6130	6.5412	6.9740	7.0784	7.0902	7.0777	40.00 Y 3.00 Z
Y 35.00 Z 3.00		2.8225	3.1326	3.7237	4.4867	6.5152	8.3234	9.4379	9.9679	10.1559	9.9678	35.00 Y 3.
Y 30.00 Z 3.00		2.2680	2.6470	3.7842	4.8918	6.6805	10.2772	12.6230	14.1812	14.7404	14.1812	30.00 Y 3.00 Z
Y 25.00 Z 3.00		1.9286	2.0312	2.7184	4.9338	6.8537	11.3121	16.7865	21.0885	22.6097	21.0885	25.00 Y 3.00 Z
Y 20.00 Z 3.00		1.0135	1.2875	1.7672	3.0145	7.1787	11.0036	21.2639	28.3518	31.0798	28.3518	20.00 Y 3.00 Z
Y 15.00 Z 3.00		0.0000	.2224	.8667	2.1666	3.9228	11.1141	20.3551	35.4712	37.3834	35.4712	15.00 Y 3.00 Z
Y 10.00 Z 3.00		0.0000	0.0000	0.0000	0.0000	1.6594	5.0249	15.4798	29.2273	17.9737	29.2273	10.00 Y 3.00 Z
Y 5.00 Z 3.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.8768	9.8512	5.3451	9.8512	5.00 Y 3.00 Z
Y .00 Z 3.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y 3.00 Z
Y -5.00 Z 3.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y 3.00 Z
Y -10.00 Z 3.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-10.00 Y 3.00 Z

TEST 96A 1X 400W HPS 80 FT SPACING 15 FT MTG PAGE 8

TEST GRID 3 COORDINATES OF CENTER X 140.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	
Y 60.00		2.2334	2.2476	2.2756	2.3145	2.3010	2.1688	1.9516	1.6580	1.6106	1.6580	60.00 Y
Z 9.00												9.00 Z
Y 55.00		2.3912	2.3927	2.4632	2.5379	2.6245	2.5134	2.2904	1.9114	1.8210	1.9114	55.00 Y
Z 9.00												9.00 Z
Y 50.00		2.4954	2.5373	2.6498	2.8147	2.9708	2.9609	2.7601	2.2733	2.1117	2.2733	50.00 Y
Z 9.00												9.00 Z
Y 45.00		2.5942	2.6588	2.8378	3.1346	3.4268	3.6023	3.4171	2.7796	2.5053	2.7791	45.00 Y
Z 9.00												9.00 Z
Y 40.00		2.6383	2.7194	3.0117	3.4695	4.0362	4.5011	4.3770	3.5451	3.0320	3.5447	40.00 Y
Z 9.00												9.00 Z
Y 35.00		2.5000	2.6727	3.1213	3.8398	4.7944	5.6256	5.8355	4.8524	3.9265	4.8523	35.00 Y
Z 9.00												9.00 Z
Y 30.00		2.2384	2.4472	3.0978	4.0485	5.4581	7.2913	8.5528	7.9490	6.7317	7.9490	30.00 Y
Z 9.00												9.00 Z
Y 25.00		1.9370	2.0636	2.5478	3.9284	6.0310	9.3775	13.2224	14.2544	13.0435	14.2544	25.00 Y
Z 9.00												9.00 Z
Y 20.00		1.0231	1.3191	1.8467	3.1091	6.4214	10.9271	20.6054	28.5702	27.3376	28.5702	20.00 Y
Z 9.00												9.00 Z
Y 15.00		0.0000	.2236	.9225	2.3942	4.5360	12.7428	25.8121	50.2844	58.9738	50.2844	15.00 Y
Z 9.00												9.00 Z
Y 10.00		0.0000	0.0000	0.0000	0.0000	2.0376	7.0688	28.7148	85.0555	124.3192	85.0555	10.00 Y
Z 9.00												9.00 Z
Y 5.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.6377	61.9192	71.8949	61.9192	5.00 Y
Z 9.00												9.00 Z
Y -.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z 9.00												9.00 Z
Y -5.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z 9.00												9.00 Z
Y -10.00		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-10.00 Y
Z 9.00												9.00 Z

```
00100 0000
00110      TEST 968   1X 400W  HPS      80 FT SPACING  15 FT MTG
00120      HS400WMWE        0.85      0.85        1.00
00130      9999999999
00140      HS400WMWE        0.00      0.00       15.00      90.00      60.00
00150      HS400WMWE       80.00      0.00       15.00      90.00      60.00
00160      HS400WMWE      160.00      0.00       15.00      90.00      60.00
00170      HS400WMWE      240.00      0.00       15.00      90.00      60.00
00180      HS400WMWE      320.00      0.00       15.00      90.00      60.00
00190      9999999999
00200          140.00      40.00      0.00        0.00       0.00
00210            5.00       5.00        10          17          V     270.00
00220          140.00      40.00      3.00        0.00       0.00
00230            5.00       5.00        10          17          V     270.00
00240          140.00      40.00      9.00        0.00       0.00
00250            5.00       5.00        10          17          V     270.00
00260      9999999999
```

TEST 968 1X 400W MPS 80 FT SPACING 15 FT MTG PAGE

TEST GRID 1 COORDINATES OF CENTER X 140.00, Y 40.00, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	
Y 82.50		2.0885	2.0934	2.0582	1.9809	1.9048	1.7911	1.6386	1.5086	1.5146	1.5085	82.50 Y
Z 0.00												0.00 Z
Y 77.50		2.2930	2.2637	2.2475	2.1971	2.1127	2.0062	1.8442	1.6910	1.6890	1.6909	77.50 Y
Z 0.00												0.00 Z
Y 72.50		2.5103	2.4890	2.4728	2.4494	2.3669	2.2775	2.1082	1.9193	1.9204	1.9192	72.50 Y
Z 0.00												0.00 Z
Y 67.50		2.7050	2.7274	2.7264	2.7501	2.6918	2.6158	2.4385	2.2394	2.2337	2.2394	67.50 Y
Z 0.00												0.00 Z
Y 62.50		2.8650	2.9249	3.0110	3.0815	3.0983	3.0270	2.8871	2.6896	2.6582	2.6896	62.50 Y
Z 0.00												0.00 Z
Y 57.50		2.9871	3.0956	3.3300	3.4692	3.5835	3.5623	3.4887	3.3363	3.3241	3.3363	57.50 Y
Z 0.00												0.00 Z
Y 52.50		3.1128	3.2417	3.5840	3.8814	4.1451	4.2714	4.3185	4.2544	4.2529	4.2544	52.50 Y
Z 0.00												0.00 Z
Y 47.50		3.3000	3.3576	3.6966	4.3695	4.8192	5.2339	5.4322	5.5450	5.6005	5.5447	47.50 Y
Z 0.00												0.00 Z
Y 42.50		3.5467	3.4580	3.6387	4.6116	5.7200	6.5016	6.8980	7.1724	7.2585	7.1712	42.50 Y
Z 0.00												0.00 Z
Y 37.50		3.2642	3.4709	3.7598	4.6879	6.6115	7.8069	8.7588	9.3996	9.6157	9.3981	37.50 Y
Z 0.00												0.00 Z
Y 32.50		2.5336	3.0420	4.0215	4.7121	6.7300	9.3103	11.2460	12.7612	13.2657	12.7647	32.50 Y
Z 0.00												0.00 Z
Y 27.50		2.0688	2.2308	3.3462	4.9718	6.2776	10.8197	14.1735	16.7484	17.5650	16.7484	27.50 Y
Z 0.00												0.00 Z
Y 22.50		1.5776	1.6264	2.0310	3.8456	6.8374	10.2631	17.0557	21.0360	22.5464	21.0360	22.50 Y
Z 0.00												0.00 Z
Y 17.50		.4074	.6256	1.4347	2.3313	4.9547	9.8715	17.6521	23.3301	23.9609	23.3301	17.50 Y
Z 0.00												0.00 Z
Y 12.50		0.0000	0.0000	.1856	1.0620	2.7533	5.8138	12.3652	19.0457	11.5032	19.0457	12.50 Y
Z 0.00												0.00 Z
Y 7.50		0.0000	0.0000	0.0000	0.0000	0.0000	1.7270	5.3418	8.3860	4.1162	8.3860	7.50 Y
Z 0.00												0.00 Z

TEST 968 1X 400W MPS 80 FT SPACING 15 FT MTG PAGE

TEST GRID 2 COORDINATES OF CENTER X 140.00, Y 40.00, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	X 145.50	X 150.00	X 155.00	X 160.00	X 165.00	
Y 82.50		1.9316	1.9248	1.9123	1.8420	1.7646	1.6561	1.5075	1.3795	1.3815	1.3794	82.50 Y
Z 3.00												3.00 Z
Y 77.50		2.1147	2.0937	2.0783	2.0237	1.9296	1.8098	1.6319	1.4622	1.4573	1.4621	77.50 Y
Z 3.00												3.00 Z
Y 72.50		2.3054	2.2862	2.2644	2.2265	2.1220	2.0062	1.7905	1.5549	1.5509	1.5548	72.50 Y
Z 3.00												3.00 Z
Y 67.50		2.4810	2.4905	2.4739	2.4671	2.3700	2.2494	1.9869	1.6997	1.6848	1.6987	67.50 Y
Z 3.00												3.00 Z
Y 62.50		2.6458	2.6793	2.7068	2.7322	2.7071	2.5925	2.3630	2.0496	2.0119	2.0496	62.50 Y
Z 3.00												3.00 Z
Y 57.50		2.8126	2.8524	2.9817	3.0718	3.1429	3.0621	2.8829	2.5690	2.5184	2.5690	57.50 Y
Z 3.00												3.00 Z
Y 52.50		2.9542	3.0155	3.2283	3.4483	3.6519	3.6943	3.6153	3.3230	3.2534	3.3230	52.50 Y
Z 3.00												3.00 Z
Y 47.50		3.0767	3.1478	3.4027	3.9121	4.2746	4.5641	4.6185	4.4111	4.3497	4.4109	47.50 Y
Z 3.00												3.00 Z
Y 42.50		3.2396	3.2348	3.4730	4.2336	5.1122	5.7913	6.0346	6.0063	5.9606	6.0053	42.50 Y
Z 3.00												3.00 Z
Y 37.50		3.0516	3.2489	3.6078	4.4678	6.1888	7.3734	8.0947	8.4255	8.5410	8.4251	37.50 Y
Z 3.00												3.00 Z
Y 32.50		2.5163	2.9287	3.8403	4.6660	6.6991	9.3071	10.9038	11.8222	12.1409	11.8254	32.50 Y
Z 3.00												3.00 Z
Y 27.50		2.1143	2.2816	3.3466	5.1005	6.4344	11.1159	14.6069	17.2261	18.1512	17.2261	27.50 Y
Z 3.00												3.00 Z
Y 22.50		1.6235	1.6815	2.1312	4.0495	7.2675	11.1998	19.2056	24.7653	26.6144	24.7653	22.50 Y
Z 3.00												3.00 Z
Y 17.50		.4166	.6855	1.5260	2.5537	5.5884	11.6028	22.0243	32.5829	35.9429	32.5829	17.50 Y
Z 3.00												3.00 Z
Y 12.50		0.0000	0.0000	.2019	1.1835	3.2355	7.3626	17.9857	37.2277	33.6812	37.2277	12.50 Y
Z 3.00												3.00 Z
Y 7.50		0.0000	0.0000	0.0000	0.0000	0.0000	2.3151	7.8961	18.5129	7.7498	18.5129	7.50 Y
Z 3.00												3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 140.00, Y 40.00, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 120.00	X 125.00	X 130.00	X 135.00	X 140.00	X 145.00	X 150.00	X 155.00	X 160.00	X 165.00	
Y	82.50	1.5854	1.5875	1.5890	1.5337	1.4717	1.3782	1.2661	1.1696	1.1683	1.1696	82.50 Y
Z	9.00											9.00 Z
Y	77.50	1.7181	1.7146	1.7182	1.6792	1.5943	1.4911	1.3586	1.2329	1.2297	1.2328	77.50 Y
Z	9.00											9.00 Z
Y	72.50	1.8667	1.8645	1.8621	1.8359	1.7578	1.6331	1.4758	1.3076	1.3051	1.3074	72.50 Y
Z	9.00											9.00 Z
Y	67.50	2.0149	2.0211	2.0212	2.0191	1.9255	1.8098	1.6222	1.4136	1.4005	1.4136	67.50 Y
Z	9.00											9.00 Z
Y	62.50	2.1574	2.1760	2.1894	2.2087	2.1623	2.0328	1.8257	1.5586	1.5262	1.5584	62.50 Y
Z	9.00											9.00 Z
Y	57.50	2.3117	2.3194	2.3692	2.4225	2.4570	2.3252	2.1070	1.7741	1.7078	1.7741	57.50 Y
Z	9.00											9.00 Z
Y	52.50	2.4451	2.4466	2.5524	2.6666	2.7867	2.7184	2.5097	2.0753	1.9540	2.0753	52.50 Y
Z	9.00											9.00 Z
Y	47.50	2.5379	2.6122	2.7446	2.9790	3.1817	3.2520	3.0644	2.5019	2.3007	2.5017	47.50 Y
Z	9.00											9.00 Z
Y	42.50	2.6389	2.6976	2.9303	3.2932	3.7112	4.0267	3.8472	3.1226	2.7348	3.1220	42.50 Y
Z	9.00											9.00 Z
Y	37.50	2.6868	2.7201	3.0736	3.6561	4.4333	5.0219	5.0133	4.1044	3.4190	4.1041	37.50 Y
Z	9.00											9.00 Z
Y	32.50	2.3732	2.5817	3.1448	3.9876	5.1248	6.3637	6.9230	6.0548	4.9590	6.0568	32.50 Y
Z	9.00											9.00 Z
Y	27.50	2.1039	2.2647	2.6833	4.0493	5.7845	8.4128	10.6928	10.5981	9.2988	10.5981	27.50 Y
Z	9.00											9.00 Z
Y	22.50	1.6434	1.7058	2.1881	3.5699	6.3185	10.2403	16.4851	19.3275	18.6562	19.3275	22.50 Y
Z	9.00											9.00 Z
Y	17.50	.4121	.6752	1.6188	2.7738	5.6450	12.1209	24.4418	37.0850	40.2114	37.0850	17.50 Y
Z	9.00											9.00 Z
Y	12.50	0.0000	0.0000	.2094	1.3224	3.85[illegible]	9.5674	27.2298	67.1460	90.[illegible]387	67.1460	12.50 Y
Z	9.00											9.00 Z
Y	7.50	0.0000	0.0000	0.0000	0.0000	0.0000	3.4668	15.6911	81.4204	149.5335	81.4204	7.50 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST 97   1X HS250WMWE   60 FT SPACING   15 FT MIG H129 V99
00120      HS250WMWE        1.00          0.85          1.00
00130      9999999999
00140      HS250WMWE        0.00          0.00         15.00         90.00          60.0
00150      HS250WMWE       60.00          0.00         15.00         90.00          60.0
00160      HS250WMWE      120.00          0.00         15.00         90.00          60.0
00170      HS250WMWE      180.00          0.00         15.00         90.00          60.0
00180      HS250WMWE      240.00          0.00         15.00         90.00          60.0
00190      9999999999
00200           105.00       22.50          0.00          0.00          0.00
00210             5.00        5.00            10            13             V         270.0
00220           105.00       22.50          3.00          0.00          0.00
00230             5.00        5.00            10            13             V         270.0
00240           105.00       22.50          9.00          0.00          0.00
00250             5.00        5.00            10            13             V         270.0
00260      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 105.00; Y 22.50; Z 0.00
ANGLES OF ORIENTATION HORZ 0.00; VERT 0.00

		X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00		
Y	55.00	3.0029	3.0723	3.0029	2.9852	2.9396	2.8685	2.7597	2.7251	2.7556	2.8684	55.00	Y
Z	0.00											0.00	Z
Y	50.00	3.3467	3.3018	3.3461	3.4352	3.4875	3.4447	3.3445	3.3263	3.3452	3.4454	50.00	Y
Z	0.00											0.00	Z
Y	45.00	3.6818	3.6172	3.6835	3.9896	4.1897	4.1912	4.1952	4.2018	4.1952	4.1921	45.00	Y
Z	0.00											0.00	Z
Y	40.00	3.9122	3.4817	3.9121	4.5520	4.8856	5.1040	5.3103	5.3859	5.3103	5.1039	40.00	Y
Z	0.00											0.00	Z
Y	35.00	3.8833	3.8725	3.8851	4.7179	5.5638	6.3577	6.9445	7.1625	6.9437	6.3564	35.00	Y
Z	0.00											0.00	Z
Y	30.00	3.8154	3.9641	3.8154	4.6840	6.4998	8.0027	9.2707	9.6035	9.2693	8.0053	30.00	Y
Z	0.00											0.00	Z
Y	25.00	3.5761	2.7841	3.5761	4.4905	6.8022	9.5522	11.3634	11.9944	11.3664	9.5542	25.00	Y
Z	0.00											0.00	Z
Y	20.00	2.3175	2.0030	2.3173	4.2177	5.9178	11.0644	13.4408	14.2047	13.4400	11.0644	20.00	Y
Z	0.00											0.00	Z
Y	15.00	1.2810	.9707	1.3042	2.0444	5.4142	8.9604	14.0105	11.9540	14.0105	8.9604	15.00	Y
Z	0.00											0.00	Z
Y	10.00	0.0000	0.0000	0.0000	.0384	2.3311	5.4715	8.1533	3.8662	8.1533	5.4715	10.00	Y
Z	0.00											0.00	Z
Y	5.00	0.0000	0.0000	0.0000	0.0000	0.0000	1.0950	3.1416	1.5956	3.1416	1.1044	5.00	Y
Z	0.00											0.00	Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00	Y
Z	0.00											0.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	0.00											0.00	Z

TEST 97 1X MS250WMME 60 FT SPACING 15 FT MIG H129 V99 PAGE 6

TEST GRID 2 COORDINATES OF CENTER X 105.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00		
Y	55.00	2.6906	2.7327	2.6906	2.6819	2.5765	2.4327	2.2102	2.1551	2.2101	2.4326	55.00	Y
Z	3.00											3.00	Z
Y	50.00	3.0368	2.9992	3.0356	3.0250	3.0538	2.9410	2.7837	2.6378	2.7043	2.9416	50.00	Y
Z	3.00											3.00	Z
Y	45.00	3.3673	3.1928	3.3670	3.5657	3.6909	3.6304	3.4667	3.4050	3.4667	3.6312	45.00	Y
Z	3.00											3.00	Z
Y	40.00	3.6178	3.3344	3.6172	4.1312	4.4725	4.6222	4.6556	4.6545	4.6556	4.6221	40.00	Y
Z	3.00											3.00	Z
Y	35.00	3.7121	3.6361	3.7137	4.5448	5.4477	6.0802	6.3871	6.5172	6.3864	6.0789	35.00	Y
Z	3.00											3.00	Z
Y	30.00	3.7917	3.8226	3.7917	4.5522	6.5847	7.9355	8.8185	9.1205	8.8171	7.9331	30.00	Y
Z	3.00											3.00	Z
Y	25.00	3.7166	2.8703	3.7104	4.6630	7.1593	10.2681	12.7438	13.6245	12.7471	10.2706	25.00	Y
Z	3.00											3.00	Z
Y	20.00	2.4690	2.1207	2.4687	4.6096	6.7146	12.7587	17.0111	18.6477	17.0111	12.7587	20.00	Y
Z	3.00											3.00	Z
Y	15.00	1.4335	1.3365	1.4270	2.3537	6.6684	12.2131	21.2828	22.4305	21.2828	12.2131	15.00	Y
Z	3.00											3.00	Z
Y	10.00	0.8800	0.8800	0.8800	.9957	3.0149	9.2874	17.5378	18.7850	17.5370	9.2874	10.00	Y
Z	3.00											3.00	Z
Y	5.00	0.0000	0.0000	0.0000	0.0000	0.0000	1.7262	5.9114	3.2068	5.9114	1.7396	5.00	Y
Z	3.00											3.00	Z
Y	.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00	Y
Z	3.00											3.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	3.00											3.00	Z

TEST GRID 3 COORDINATES OF CENTER X 105.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 85.00	X 90.00	X 95.00	X 100.00	X 105.00	X 110.00	X 115.00	X 120.00	X 125.00	X 130.00	
Y	55.00	2.1122	2.1253	2.1122	2.1042	1.9674	1.7896	1.5337	1.4680	1.5136	1.7895	55.00 Y
Z	9.00											9.00 Z
Y	50.00	2.3672	2.3492	2.3620	2.3557	2.2831	2.0708	1.7257	1.6172	1.7261	2.0712	50.00 Y
Z	9.00											9.00 Z
Y	45.00	2.6088	2.5693	2.6086	2.6626	2.6660	2.4675	2.0296	1.8458	2.0296	2.4660	45.00 Y
Z	9.00											9.00 Z
Y	40.00	2.8439	2.7843	2.8438	3.0198	3.1754	3.0407	2.5214	2.2064	2.5214	3.0406	40.00 Y
Z	9.00											9.00 Z
Y	35.00	3.0708	2.9354	3.0718	3.4190	3.8152	3.9070	3.3085	2.7718	3.3081	3.9062	35.00 Y
Z	9.00											9.00 Z
Y	30.00	3.1822	3.0081	3.1822	3.8124	4.7875	5.4877	5.0729	4.3077	5.0721	5.4863	30.00 Y
Z	9.00											9.00 Z
Y	25.00	3.1224	2.9694	3.1224	4.1727	5.9981	8.1274	8.6415	7.8820	8.6438	8.1293	25.00 Y
Z	9.00											9.00 Z
Y	20.00	2.5463	2.2181	2.5459	4.1571	6.6666	12.3636	15.9423	16.4020	15.9423	12.3636	20.00 Y
Z	9.00											9.00 Z
Y	15.00	1.5707	1.0995	1.5612	2.7216	7.6452	15.4872	30.1711	35.3831	30.1711	15.4872	15.00 Y
Z	9.00											9.00 Z
Y	10.00	0.0000	0.0000	0.0000	1.2226	4.2414	17.2288	51.0346	74.5909	51.0346	17.2288	10.00 Y
Z	9.00											9.00 Z
Y	5.00	0.0000	0.0000	0.0000	0.0000	0.0000	3.9827	37.1496	43.1398	37.1496	3.7946	5.00 Y
Z	9.00											9.00 Z
Y	-.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

```
00100 0000
00110      TEST 98    2X HS250WMWE   120 FT SPACING 15 FT MTG    H140 V90
00120      HS250WMWE        1.00      0.85      1.00
00130      9999999999
00140      HS250WMWE        0.00      0.00     15.00     45.00     70.00
00150      HS250WMWE      120.00      0.00     15.00     45.00     70.00
00160      HS250WMWE      120.00      0.00     15.00    135.00     70.00
00170      HS250WMWE      240.00      0.00     15.00     45.00     70.00
00180      HS250WMWE      240.00      0.00     15.00    135.00     70.00
00190      HS250WMWE      360.00      0.00     15.00     45.00     70.00
00200      HS250WMWE      360.00      0.00     15.00    135.00     70.00
00210      HS250WMWE      480.00      0.00     15.00    135.00     70.00
00220      9999999999
00230          210.00     22.50      0.00      0.00      0.00
00240            5.00      5.00        20        13         V    270.00
00250          210.00     22.50      3.00      0.00      0.00
00260            5.00      5.00        20        13         V    270.00
00270          210.00     22.50      9.00      0.00      0.00
00280            5.00      5.00        20        13         V    270.00
00290      9999999999
```

TEST GRID 1 COORDINATES OF CENTER X 210.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00		
Y	55.00	2.1630	2.0452	1.9743	1.9512	1.9755	2.0476	2.1647	2.3249	2.5229	2.7129	55.00	Y
Z	0.00											0.00	Z
Y	50.00	2.2920	2.1435	2.0529	2.0223	2.0540	2.1456	2.2952	2.5040	2.7649	3.0408	50.00	Y
Z	0.00											0.00	Z
Y	45.00	2.4107	2.2225	2.1124	2.0768	2.1133	2.2243	2.4134	2.6814	3.0249	3.4319	45.00	Y
Z	0.00											0.00	Z
Y	40.00	2.5053	2.2723	2.1388	2.0972	2.1396	2.2739	2.5077	2.8476	3.3003	3.7698	40.00	Y
Z	0.00											0.00	Z
Y	35.00	2.5549	2.2741	2.1119	2.0568	2.1127	2.2755	2.5570	2.9754	3.4826	4.0520	35.00	Y
Z	0.00											0.00	Z
Y	30.00	2.5208	2.1870	2.0045	1.9457	2.0051	2.1882	2.5226	2.9625	3.5328	4.2703	30.00	Y
Z	0.00											0.00	Z
Y	25.00	2.3319	1.9931	1.8073	1.7473	1.8078	1.9942	2.3334	2.8123	3.4592	4.3477	25.00	Y
Z	0.00											0.00	Z
Y	20.00	1.9865	1.6827	1.5269	1.4718	1.5273	1.6885	1.9877	2.4602	3.1615	4.1640	20.00	Y
Z	0.00											0.00	Z
Y	15.00	1.5313	1.2679	1.0956	1.0422	1.0959	1.2685	1.5322	1.9533	2.6242	3.6490	15.00	Y
Z	0.00											0.00	Z
Y	10.00	.9141	.7304	.6279	.5945	.6281	.7308	.9147	1.2327	1.7813	2.5882	10.00	Y
Z	0.00											0.00	Z
Y	5.00	.4090	.3433	.3070	.2952	.3071	.3435	.4093	.5197	.7012	.9921	5.00	Y
Z	0.00											0.00	Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00	Y
Z	0.00											0.00	Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00	Y
Z	0.00											0.00	Z

TEST 98 2X M525HMWE 120 FT SPACING 19 FT MTG M140 V PAGE 5

TEST GRID 1 COORDINATES OF CENTER X 210.00, Y 22.50, Z 0.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00	
Y	55.00	2.8898	3.2973	3.6538	3.4613	3.7084	4.2362	3.7084	3.4613	3.6538	3.2963	55.00 Y
Z	0.00											0.00 Z
Y	50.00	3.2682	3.6495	4.2513	4.1062	4.2438	4.9433	4.2438	4.1021	4.2508	3.6491	50.00 Y
Z	0.00											0.00 Z
Y	45.00	3.7742	4.0365	4.8094	4.9279	4.8787	5.8168	4.8787	4.8960	4.7899	4.0365	45.00 Y
Z	0.00											0.00 Z
Y	40.00	4.2550	4.6810	5.4253	6.0504	5.6941	6.9588	5.6921	5.9545	5.3960	4.6810	40.00 Y
Z	0.00											0.00 Z
Y	35.00	4.7272	5.4190	6.0269	7.5041	6.8868	8.4683	6.8516	7.3157	6.0269	5.4190	35.00 Y
Z	0.00											0.00 Z
Y	30.00	5.1860	6.2078	7.2621	8.8482	8.3738	10.1876	8.2945	8.6908	7.2623	6.2078	30.00 Y
Z	0.00											0.00 Z
Y	25.00	5.5181	6.7674	7.9186	9.7458	10.4775	12.0565	10.4315	9.7381	7.9186	6.767-	25..
Z	0.00											0.00 Z
Y	20.00	5.4224	6.7693	8.0612	9.8278	12.1548	12.3243	12.1548	9.8778	8.0612	6.7693	20.00 Y
Z	0.00											0.00 Z
Y	15.00	4.7582	6.0498	6.4754	6.5022	9.8229	11.3901	9.8413	6.5022	6.4754	6.0498	15.00 Y
Z	0.00											0.00 Z
Y	10.00	3.7114	4.9481	4.3398	2.5353	3.8955	9.5132	3.8955	2.5353	4.3398	4.9481	10.00 Y
Z	0.00											0.00 Z
Y	5.00	1.5239	2.2491	2.5873	1.9492	1.2703	2.8187	1.2703	1.9492	2.5873	2.2491	5.00 Y
Z	0.00											0.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	0.00											0.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	0.00											0.00 Z

TEST GRID Z COORDINATES OF CENTER X 210.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00	
Y	55.00	2.0025	1.8911	1.8286	1.8064	1.8298	1.8935	2.0061	2.1654	2.3613	2.5777	55.00 Y
Z	3.00											3.00 Z
Y	50.00	2.1232	1.9882	1.9038	1.8748	1.9048	1.9903	2.1263	2.3260	2.5814	2.8705	50.00 Y
Z	3.00											3.00 Z
Y	45.00	2.2404	2.0651	1.9652	1.9338	1.9660	2.0669	2.2431	2.4898	2.8197	3.2196	45.00 Y
Z	3.00											3.00 Z
Y	40.00	2.3370	2.1252	2.0028	1.9625	2.0036	2.1268	2.3394	2.6521	3.0714	3.6015	40.00 Y
Z	3.00											3.00 Z
Y	35.00	2.4003	2.1448	1.9977	1.9494	1.9984	2.1462	2.4024	2.7787	3.3127	4.0217	35.00 Y
Z	3.00											3.00 Z
Y	30.00	2.3844	2.0869	1.9277	1.8759	1.9283	2.0881	2.3862	2.8426	3.5097	4.4436	30.00 Y
Z	3.00											3.00 Z
Y	25.00	2.2541	1.9337	1.7613	1.7034	1.7617	1.9347	2.2556	2.7882	3.5830	4.6058	25.00 Y
Z	3.00											3.00 Z
Y	20.00	1.9685	1.6561	1.4992	1.4452	1.4996	1.6569	1.9696	2.4948	3.3190	4.4761	20.00 Y
Z	3.00											3.00 Z
Y	15.00	1.5383	1.2547	1.0815	1.0280	1.0817	1.2552	1.5392	2.0076	2.7405	3.9004	15.00 Y
Z	3.00											3.00 Z
Y	10.00	.9274	.7278	.6223	.5887	.6225	.7282	.9280	1.2791	1.8744	2.8444	10.00 Y
Z	3.00											3.00 Z
Y	5.00	.4193	.3451	.3063	.2942	.3064	.3453	.4195	.5447	.7471	1.1177	5.00 Y
Z	3.00											3.00 Z
Y	0.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 2 COORDINATES OF CENTER X 210.00, Y 22.50, Z 3.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00	
Y	55.00	2.7916	3.2245	3.6094	3.4370	3.7024	4.2400	3.7024	3.4370	3.6093	3.2218	55.00 Y
Z	3.00											3.00 Z
Y	50.00	3.1634	3.5677	4.2144	4.1093	4.2826	5.0111	4.2826	4.1093	4.2136	3.5643	50.00 Y
Z	3.00											3.00 Z
Y	45.00	3.6240	3.9851	4.8425	5.0260	5.0263	6.0426	5.0263	5.0260	4.8413	3.9851	45.00 Y
Z	3.00											3.00 Z
Y	40.00	4.2054	4.7383	5.5800	6.3101	5.9907	7.4089	5.9904	6.3042	5.5796	4.7383	40.00 Y
Z	3.00											3.00 Z
Y	35.00	4.8937	5.6847	6.2878	7.9332	7.3674	9.1923	7.3523	7.8615	6.2878	5.6847	35.00 Y
Z	3.00											3.00 Z
Y	30.00	5.4924	6.6698	7.7578	9.7389	9.4199	11.6893	9.3355	9.6106	7.7578	6.6698	30.00 Y
Z	3.00											3.00 Z
Y	25.00	5.9269	7.6035	9.4741	11.6998	12.7283	14.9667	12.4923	11.6066	9.4741	7.6035	25.0
Z	3.00											3.00 Z
Y	20.00	6.0931	8.3687	10.7784	13.5609	16.9689	18.6647	16.8346	13.5609	10.7784	8.3687	20.00 Y
Z	3.00											3.00 Z
Y	15.00	5.6937	8.0884	10.8616	12.6840	17.7354	18.6226	17.7576	12.6840	10.8616	8.0884	15.00 Y
Z	3.00											3.00 Z
Y	10.00	4.4526	6.7893	8.4603	6.4619	8.5375	16.6063	8.5375	6.4619	8.4603	6.7893	10.00 Y
Z	3.00											3.00 Z
Y	5.00	1.8718	3.2465	4.9424	4.2699	2.5065	7.7774	2.5065	4.2699	4.9424	3.2465	5.00 Y
Z	3.00											3.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	3.00											3.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	3.00											3.00 Z

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 165.00	X 170.00	X 175.00	X 180.00	X 185.00	X 190.00	X 195.00	X 200.00	X 205.00	X 210.00	
Y	55.00	1.4966	1.3781	1.3124	1.2894	1.3135	1.3803	1.5000	1.6772	1.8920	2.1309	55.00 Y
Z	9.00											9.00 Z
Y	50.00	1.5817	1.4685	1.3920	1.3640	1.3930	1.4705	1.5847	1.7750	2.0343	2.3429	50.00 Y
Z	9.00											9.00 Z
Y	45.00	1.6820	1.5474	1.4814	1.4644	1.4823	1.5491	1.6846	1.8755	2.1838	2.5799	45.00 Y
Z	9.00											9.00 Z
Y	40.00	1.7670	1.6439	1.5651	1.5449	1.5658	1.6354	1.7693	2.0125	2.3426	2.8420	40.00 Y
Z	9.00											9.00 Z
Y	35.00	1.8711	1.7051	1.6120	1.5808	1.6127	1.7064	1.8731	2.1246	2.5505	3.1350	35.00 Y
Z	9.00											9.00 Z
Y	30.00	1.9202	1.7149	1.6058	1.5691	1.6064	1.7161	1.9219	2.2486	2.7394	3.5075	30.00 Y
Z	9.00											9.00 Z
Y	25.00	1.8985	1.6503	1.5101	1.4592	1.5106	1.6512	1.8999	2.2954	2.9054	3.7889	25.00 Y
Z	9.00											9.00 Z
Y	20.00	1.7469	1.4568	1.3101	1.2607	1.3105	1.4576	1.7480	2.2088	2.8905	3.9561	20.00 Y
Z	9.00											9.00 Z
Y	15.00	1.4125	1.1371	.9720	.9215	.9722	1.1376	1.4134	1.8728	2.5932	3.7749	15.00 Y
Z	9.00											9.00 Z
Y	10.00	.8736	.6793	.5799	.5488	.5801	.6797	.8741	1.2251	1.8459	2.9057	10.00 Y
Z	9.00											9.00 Z
Y	5.00	.4010	.3248	.2853	.2731	.2854	.3250	.4013	.5318	.7547	1.1848	5.00 Y
Z	9.00											9.00 Z
Y	-.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	0.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

TEST 98 2X HS250WMWE 120 FT SPACING 15 FT MTG H140 V

TEST GRID 3 COORDINATES OF CENTER X 210.00, Y 22.50, Z 9.00
ANGLES OF ORIENTATION HORZ 0.00, VERT 0.00

		X 215.00	X 220.00	X 225.00	X 230.00	X 235.00	X 240.00	X 245.00	X 250.00	X 255.00	X 260.00	
Y	55.00	2.3884	2.8546	3.3083	3.2463	3.5063	3.9668	3.5063	3.2463	3.3080	2.8486	55.00 Y
Z	9.00											9.00 Z
Y	50.00	2.6962	3.1643	3.8861	3.9057	4.1228	4.7911	4.1228	3.9057	3.8836	3.1551	50.00 Y
Z	9.00											9.00 Z
Y	45.00	3.0482	3.5388	4.5061	4.8291	4.9289	5.9380	4.9289	4.8291	4.5003	3.5388	45.00 Y
Z	9.00											9.00 Z
Y	40.00	3.4511	4.1931	5.2475	6.1604	5.9983	7.5004	5.9983	6.1604	5.2366	4.1931	40.00 Y
Z	9.00											9.00 Z
Y	35.00	3.9628	4.9442	5.9407	7.9488	7.6196	9.6996	7.6196	7.9467	5.9407	4.9442	35.00 Y
Z	9.00											9.00 Z
Y	30.00	4.5148	5.8887	7.4997	10.0759	10.2007	13.0823	10.2007	10.0679	7.4997	5.8887	30.00 Y
Z	9.00											9.00 Z
Y	25.00	5.1310	7.0809	9.6519	12.6878	14.9937	18.6520	14.9937	12.6741	9.6819	7.0809	25.00 Y
Z	9.00											9.00 Z
Y	20.00	5.6762	8.4566	12.7134	17.5497	23.9830	28.4279	23.9597	17.5497	12.7134	8.4566	20.00 Y
Z	9.00											9.00 Z
Y	15.00	5.8033	9.5401	16.4020	25.5815	38.0228	45.8748	37.5097	25.5815	16.4020	9.5401	15.00 Y
Z	9.00											9.00 Z
Y	10.00	4.8108	8.7818	17.0573	32.8213	53.6894	74.1357	53.6894	32.8213	17.0573	8.7818	10.00 Y
Z	9.00											9.00 Z
Y	5.00	2.1723	4.5983	10.9896	26.8452	25.5750	66.1646	25.5750	26.8452	10.9896	4.5983	5.00 Y
Z	9.00											9.00 Z
Y	.00	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.00 Y
Z	9.00											9.00 Z
Y	-5.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-5.00 Y
Z	9.00											9.00 Z

APPENDIX D

ECONOMIC COMPARISONS

APPENDIX D

ECONOMIC COMPARISONS

INDEX

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

	PERIMETER LIGHTING SCHEME 1	PERIMETER LIGHTING SCHEME 2	PERIMETER LIGHTING SCHEME 3	PERIMETER LIGHTING SCHEME 4	PERIMETER LIGHTING SCHEME 5
I. INITIAL EQUIPMENT INVESTMENT					
1. QUANTITY OF LUMINAIRES	268	320	134	160	345
3. LUMINAIRE COST TOTAL	11256.00	17120.00	8710.00	10400.00	4485.00
4. QUANTITY OF POLES	134	160	67	160	115
9. POLE + FOUNDATION COST TOTAL	9380.00	11200.00	4690.00	11200.00	8050.00
14. ELECTRICAL DISTRIBUTION	26800.00	64000.00	40200.00	48000.00	34500.00
14A. STANDBY GENERATOR COST	22780.00	54400.00	34170.00	40800.00	29325.00
14C. UPS COST	0.00	0.00	0.00	0.00	0.00
16. TOTAL INIT EQUIP INCL LAMPS	73700.00	151200.00	89780.00	112800.00	80845.00
17. RELATIVE INIT EQUIP INVESTMENT	1.31	2.68	1.59	2.00	1.44
II. INITIAL LABOR ESTIMATES					
20. NET LABOR, POLES + LUMINAIRES	36850.00	46400.00	20435.00	36900.00	38525.00
21. LABOR ELECTRICAL DISTRIBUTION	20100.00	48000.00	30150.00	36000.00	25875.00
22. TOTAL INITIAL LABOR	59630.00	100800.00	54605.00	77600.00	67850.00
23. TOTAL INITIAL INVESTMENT	133330.00	252000.00	298785.00	344800.00	303095.00
24. RELATIVE INITIAL INVESTMENT	1.00	1.89	2.24	2.59	2.27
IV. ANNUAL COSTS					
31. TOTAL SYSTEM KW	134.	320.	201.	240.	173.
33. TOTAL ENERGY KWH/YEAR	536000.	1280000.	804000.	960000.	690000.
36. DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37. ANNUAL KWH COST	10720.00				
37D. DIESEL FUEL COST	214.40	512.00	321.60	384.00	276.00
40. REPLACEMENT LAMP COST	10452.00	13440.00	6030.00	7200.00	13455.00
V. ANNUAL MAINTENANCE, LABOR + MATERIALS					
44. RELAMPING COST - LABOR	2680.00	3200.00	1340.00	1600.00	3450.00
47. CLEANING COST - LABOR	0.00	0.00	0.00	0.00	0.00
50. PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51. REPLACEMENT PARTS, PAINT, ETC.	702.16	1467.20	877.70	1104.00	763.60
52. TOTAL ANNUAL MAINTENANCE COST	3382.16	4667.20	2217.70	2704.00	4213.60
53. ANNUAL OPERATING COST	24768.56	44219.20	24469.30	29488.00	31744.60
VI. ANNUAL OWNERSHIP + OPERATING COST					
55. FIXED OWNERSHIP COST	18438.13	35147.84	20217.25	26696.00	20477.82
56. ANNUAL OWNERSHIP + OPRING COST	43206.69	79367.04	44686.55	56184.00	52222.42
VII. RELATIVE COSTS OF LIGHT					
58. RELATIVE COST EXCLUDING FIXED	6.66	11.85	6.61	7.90	8.51
60. RELATIVE TOTAL COST	3.98	5.33	3.01	3.77	3.51

SHT. 1

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

		PERIMETER LIGHTING SCHEME 6	PERIMETER LIGHTING SCHEME 7	PERIMETER LIGHTING SCHEME 8	PERIMETER LIGHTING SCHEME 9	PERIMETER LIGHTING SCHEME 10
I.	INITIAL EQUIPMENT INVESTMENT					
1.	QUANTITY OF LUMINAIRES	200	134	134	100	160
3.	LUMINAIRE COST TOTAL	78000.00	32160.00	32160.00	25000.00	43680.00
4.	QUANTITY OF POLES	200	134	67	100	80
9.	POLE + FOUNDATION COST TOTAL	88000.00	9380.00	4690.00	7000.00	5600.00
14.	ELECTRICAL DISTRIBUTION	14500.00	9715.00	9715.00	11500.00	5600.00
14A.	STANDBY GENERATOR COST	12325.00	8257.75	8257.75	9775.00	4760.00
14C.	UPS COST	43500.00	29145.00	29145.00	34500.00	16800.00
16.	TOTAL INIT EQUIP INCL LAMPS	243925.00	92677.75	89059.75	91675.00	79320.00
17.	RELATIVE INIT EQUIP INVESTMENT	4.33	1.65	1.58	1.63	1.41
II.	INITIAL LABOR ESTIMATES					
20.	NET LABOR, POLES + LUMINAIRES	44400.00	28810.00	18425.00	23000.00	17200.00
21.	LABOR ELECTRICAL DISTRIBUTION	10875.00	7286.25	7286.25	8625.00	4200.00
22.	TOTAL INITIAL LABOR	62525.00	40953.75	30568.75	37375.00	24200.00
23.	TOTAL INITIAL INVESTMENT	466950.00	286031.50	274028.50	283450.00	257920.00
24.	RELATIVE INITIAL INVESTMENT	3.46	2.16	2.06	2.13	1.93
IV.	ANNUAL COSTS					
31.	TOTAL SYSTEM KW	73.	49.	49.	58.	28.
33.	TOTAL ENERGY KWH/YEAR	290000.	194300.	194300.	230000.	112000.
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37.	ANNUAL KWH COST	5800.00				
37D.	DIESEL FUEL COST	116.00	77.72	77.72	92.00	44.80
40.	REPLACEMENT LAMP COST	3840.00	2031.16	2572.80	1440.00	921.60
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS					
44.	RELAMPING COST - LABOR	336.84	225.68	225.68	123.08	170.67
47.	CLEANING COST - LABOR	231.58	155.16	155.16	138.46	234.67
50.	PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	2363.25	886.58	839.68	877.75	764.40
52.	TOTAL ANNUAL MAINTENANCE COST	2931.67	1267.42	1220.52	1139.29	1169.73
53.	ANNUAL OPERATING COST	12687.67	7262.30	7757.04	7271.29	4376.13
VI.	ANNUAL OWNERSHIP + OPERATING COST					
55.	FIXED OWNERSHIP COST	42436.70	18404.83	16264.18	17771.30	14290.88
56.	ANNUAL OWNERSHIP + OPRING COST	55124.37	25667.13	24021.22	25042.59	18667.01
VII.	RELATIVE COSTS OF LIGHT					
59.	RELATIVE COST EXCLUDING FIXED	3.40	1.95	2.08	1.95	1.17
60.	RELATIVE TOTAL COST	2.70	1.72	1.61	1.68	1.25

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

		PERIMETER LIGHTING SCHEME 11	PERIMETER LIGHTING SCHEME 12	PERIMETER LIGHTING SCHEME 13	PERIMETER LIGHTING SCHEME 14	PERIMETER LIGHTING SCHEME 15
I.	INITIAL EQUIPMENT INVESTMENT					
1.	QUANTITY OF LUMINAIRES	180	134	134	134	201
3.	LUMINAIRE COST TOTAL	49280.00	48240.00	48240.00	48240.00	80250.00
4.	QUANTITY OF POLES	88	134	67	67	67
9.	POLE + FOUNDATION COST TOTAL	9600.00	9380.00	4690.00	4690.00	8710.00
14.	ELECTRICAL DISTRIBUTION	5600.00	8040.00	8040.00	8040.00	12060.00
14A.	STANDBY GENERATOR COST	4740.00	6834.00	6834.00	6834.00	10251.00
14C.	UPS COST	16809.00	24120.00	24120.00	24120.00	36180.00
16.	TOTAL INIT EQUIP INCL LAMPS	84929.00	101036.00	93532.00	96346.00	124084.00
17.	RELATIVE INIT EQUIP INVESTMENT	1.51	1.79	1.66	1.71	2.20
II.	INITIAL LABOR ESTIMATES					
20.	NET LABOR, POLES + LUMINAIRES	17200.00	30820.00	20435.00	20435.00	25029.00
21.	LABOR ELECTRICAL DISTRIBUTION	4200.00	6030.00	6030.00	6030.00	9045.00
22.	TOTAL INITIAL LABOR	24200.00	40870.00	30485.00	30485.00	41004.00
23.	TOTAL INITIAL INVESTMENT	263520.00	296306.00	278617.00	281231.00	319448
24.	RELATIVE INITIAL INVESTMENT	1.98	2.22	2.09	2.11	2
IV.	ANNUAL COSTS					
31.	TOTAL SYSTEM KW	28.	40.	40.	40.	60.
33.	TOTAL ENERGY KWH/YEAR	112000.	160800.	160800.	160800.	241200.
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37.	ANNUAL KWH COST	2240.00				
370.	DIESEL FUEL COST	44.80	64.32	64.32	64.32	96.48
40.	REPLACEMENT LAMP COST	921.60	1415.04	1202.78	1415.04	2122.56
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS					
44.	RELAMPING COST - LABOR	170.67	142.93	110.77	142.93	214.40
47.	CLEANING COST - LABOR	234.67	196.53	196.53	196.53	294.80
50.	PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	820.40	946.14	891.10	919.24	1174.51
52.	TOTAL ANNUAL MAINTENANCE COST	1225.73	1305.61	1198.41	1258.71	1683.71
53.	ANNUAL OPERATING COST	4432.13	6000.97	5681.91	5954.07	8726.75
VI.	ANNUAL OWNERSHIP + OPERATING COST					
55.	FIXED OWNERSHIP COST	15086.68	16522.73	16982.49	17382.08	23500.61
56.	ANNUAL OWNERSHIP + OPRING COST	19518.21	22523.69	22664.40	23336.14	31227.36
VII.	RELATIVE COSTS OF LIGHT					
58.	RELATIVE COST EXCLUDING FIXED	1.19	1.61	1.52	1.60	2.34
60.	RELATIVE TOTAL COST	1.31	1.71	1.52	1.57	2.10

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

	PERIMETER LIGHTING SCHEME 16	PERIMETER LIGHTING SCHEME 17	PERIMETER LIGHTING SCHEME 18	PERIMETER LIGHTING SCHEME 19	PERIMETER LIGHTING SCHEME 20
I. INITIAL EQUIPMENT INVESTMENT					
1. QUANTITY OF LUMINAIRES	115	160	134	268	268
3. LUMINAIRE COST TOTAL	28750.00	40060.00	32160.00	40870.00	40870.00
4. QUANTITY OF POLES	115	80	67	67	67
9. POLE + FOUNDATION COST TOTAL	8050.00	5600.00	4690.00	4690.00	4690.00
14. ELECTRICAL DISTRIBUTION	6990.00	9400.00	7772.00	47972.00	34572.00
14A. STANDBY GENERATOR COST	5865.00	8160.00	8606.20	40776.20	29386.20
14C. UPS COST	20100.00	28000.00	0.00	0.00	0.00
16. TOTAL INIT EQUIP INCL LAMPS	74080.00	97440.00	56320.20	141410.20	116496.20
17. RELATIVE INIT EQUIP INVESTMENT	1.31	1.73	1.00	2.51	2.07
II. INITIAL LABOR ESTIMATES					
20. NET LABOR, POLES + LUMINAIRES	26450.00	24400.00	18425.00	28475.00	28475.00
21. LABOR ELECTRICAL DISTRIBUTION	8175.00	7200.00	6829.00	35979.00	25929.00
22. TOTAL INITIAL LABOR	35075.00	36400.00	25031.20	69251.20	57861.20
23. TOTAL INITIAL INVESTMENT	263535.00	288240.00	235751.40	210661.40	174347.40
24. RELATIVE INITIAL INVESTMENT	1.98	2.16	1.77	1.58	1.31
IV. ANNUAL COSTS					
31. TOTAL SYSTEM KW	35.	48.	39.	240.	173.
33. TOTAL ENERGY KWH/YEAR	138000.	192000.	155460.	159460.	158120.
36. DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37. ANNUAL KWH COST	2760.00				
37D. DIESEL FUEL COST	55.20	76.80	62.14	383.78	276.58
40. REPLACEMENT LAMP COST	1214.40	1689.60	2572.80	2602.95	2600.94
V. ANNUAL MAINTENANCE, LABOR + MATERIALS					
44. RELAMPING COST - LABOR	122.67	170.67	225.68	232.38	232.38
47. CLEANING COST - LABOR	100.67	234.67	155.16	419.81	419.81
50. PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51. REPLACEMENT PARTS, PAINT, ETC.	702.65	921.60	512.28	1343.00	1095.18
52. TOTAL ANNUAL MAINTENANCE COST	993.98	1326.93	893.12	1995.27	1747.37
53. ANNUAL OPERATING COST	5023.58	6933.33	6036.98	8171.20	7733.69
VI. ANNUAL OWNERSHIP + OPERATING COST					
55. FIXED OWNERSHIP COST	14958.28	18255.52	10828.85	28905.43	23767.87
56. ANNUAL OWNERSHIP + OPRTNG COST	19981.86	25188.85	17465.73	37076.63	31501.56
VII. RELATIVE COSTS OF LIGHT					
59. RELATIVE COST EXCLUDING FIXED	1.35	1.86	1.78	2.19	2.07
60. RELATIVE TOTAL COST	1.34	1.69	1.17	2.49	2.12

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

		PERIMETER LIGHTING SCHEME 21	PERIMETER LIGHTING SCHEME 22	PERIMETER LIGHTING SCHEME 23	PERIMETER LIGHTING SCHEME 24	PERIMETER LIGHTING SCHEME 25
I.	INITIAL EQUIPMENT INVESTMENT					
1.	QUANTITY OF LUMINAIRES	335	160	320	320	400
3.	LUMINAIRE COST TOTAL	40602.00	43680.00	54080.00	54080.00	53760.00
4.	QUANTITY OF POLES	67	80	80	80	80
9.	POLE + FOUNDATION COST TOTAL	4490.00	5600.00	5600.00	5600.00	5600.00
14.	ELECTRICAL DISTRIBUTION	27878.00	4480.00	52480.00	36480.00	28480.00
14A.	STANDBY GENERATOR COST	23691.20	3808.00	44608.00	31008.00	24208.00
14C.	UPS COST	0.00	0.00	0.00	0.00	0.00
16.	TOTAL INIT EQUIP INCL LAMPS	104540.20	60448.00	162048.00	132288.00	118048.00
17.	RELATIVE INIT EQUIP INVESTMENT	1.86	1.07	2.88	2.35	2.10
II.	INITIAL LABOR ESTIMATES					
20.	NET LABOR, POLES + LUMINAIRES	30485.00	17200.00	29200.00	29200.00	31400.00
21.	LABOR ELECTRICAL DISTRIBUTION	20904.00	3360.00	39360.00	27360.00	21360.00
22.	TOTAL INITIAL LABOR	54176.20	21008.00	73808.00	60208.00	55808.00
23.	TOTAL INITIAL INVESTMENT	158736.40	158841.00	235856.00	192496.00	173856
24.	RELATIVE INITIAL INVESTMENT	1.19	1.19	1.77	1.44	
IV.	ANNUAL COSTS					
31.	TOTAL SYSTEM KW	139.	22.	262.	182.	142.
33.	TOTAL ENERGY KWH/YEAR	157450.	89680.	94400.	92800.	92000.
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00	0.00	0.00
37.	ANNUAL KWH COST	3149.00				
370.	DIESEL FUEL COST	222.98	35.84	419.84	291.84	227.84
40.	REPLACEMENT LAMP COST	2612.00	921.60	957.60	955.20	960.40
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS					
44.	RELAMPING COST - LABOR	239.73	170.67	178.67	178.67	182.67
47.	CLEANING COST - LABOR	552.13	234.67	550.67	550.67	704.67
50.	PAINTING COST - LABOR	0.00	0.00	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	968.55	575.68	1567.68	1271.68	1120.68
52.	TOTAL ANNUAL MAINTENANCE COST	1756.42	981.01	2297.01	2001.01	2011.81
53.	ANNUAL OPERATING COST	7740.39	3730.45	9562.45	9104.85	9048.05
VI.	ANNUAL OWNERSHIP + OPERATING COST					
58.	FIXED OWNERSHIP COST	21446.46	11137.79	32741.79	26607.39	23835.55
59.	ANNUAL OWNERSHIP + OPRING COST	29186.85	14868.25	38304.25	31711.45	28883.61
VII.	RELATIVE COSTS OF LIGHT					
59.	RELATIVE COST EXCLUDING FIXED	2.07	1.00	1.49	1.37	1.35
60.	RELATIVE TOTAL COST	1.99	1.00	2.57	2.13	1.94

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

		PERIMETER LIGHTING SCHEME 26	PERIMETER LIGHTING SCHEME 27	PERIMETER LIGHTING SCHEME 28
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	160	100	134
3.	LUMINAIRE COST TOTAL	10400.00	25000.00	48240.00
4.	QUANTITY OF POLES	160	100	134
9.	POLE + FOUNDATION COST TOTAL	11200.00	7000.00	9380.00
14.	ELECTRICAL DISTRIBUTION	48000.00	11500.00	8040.00
14A.	STANDBY GENERATOR COST	40800.00	9775.00	6834.00
14C.	UPS COST	0.00	34500.00	24120.00
16.	TOTAL INIT EQUIP INCL LAMPS	112800.00	91675.00	101036.00
17.	RELATIVE INIT EQUIP INVESTMENT	1.23	1.00	1.10
II.	INITIAL LABOR ESTIMATES			
20.	NET LABOR, POLES + LUMINAIRES	36800.00	23000.00	30820.00
21.	LABOR ELECTRICAL DISTRIBUTION	36000.00	8625.00	6030.00
22.	TOTAL INITIAL LABOR	77600.00	37375.00	40870.00
23.	TOTAL INITIAL INVESTMENT	190400.00	129050.00	141906.00
24.	RELATIVE INITIAL INVESTMENT	1.48	1.00	1.10
IV.	ANNUAL COSTS			
31.	TOTAL SYSTEM KW	240.	58.	40.
33.	TOTAL ENERGY KWH/YEAR	960000.	230000.	160800.
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	19200.00		
37D.	DIESEL FUEL COST	384.00	92.00	64.32
40.	REPLACEMENT LAMP COST	7200.00	1440.00	1415.04
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS			
44.	RELAMPING COST - LABOR	1600.00	123.08	142.93
47.	CLEANING COST - LABOR	0.00	138.46	196.53
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1104.00	877.75	966.14
52.	TOTAL ANNUAL MAINTENANCE COST	2704.00	1139.29	1305.61
53.	ANNUAL OPERATING COST	29488.00	7271.29	6000.97
VI.	ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	26696.00	17771.30	19522.73
56.	ANNUAL OWNERSHIP + OPERATING COST	56184.00	25042.59	25523.69
VII.	RELATIVE COSTS OF LIGHT			
59.	RELATIVE COST EXCLUDING FIXED	4.91	1.21	1.00
60.	RELATIVE TOTAL COST	2.24	1.00	1.02

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 1 — TEST 50 2X500W QUARTZ H100 V93; 60 DEGREE AIMING; HORIZONTAL POSITION 60 - 135 DEGREES

		TOTAL FOR SYSTEM	2X500W QTZ Q500WMGE 60 FT SP 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	268	268
2.	LUMINAIRE COST EACH		42.00
3.	LUMINAIRE COST TOTAL	11256.00	11256.00
4.	QUANTITY OF POLES	134	134
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		9380.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	9380.00	9380.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		268
12.	LAMP COST EACH		13.00
13.	LAMP COST TOTAL	3484.00	3484.00
14.	ELECTRICAL DISTRIBUTION	26800.00	26800.00
14A.	STANDBY GENERATOR COST	22780.00	22780.00
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		70216.00
16.	TOTAL INIT EQUIP INCL LAMPS	73700.00	73700.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		60.00
20.	NET LABOR, POLES + LUMINAIRES	36850.00	36850.00
21.	LABOR ELECTRICAL DISTRIBUTION	20100.00	20100.00
21A.	LABOR STANDBY GENERATOR	2680.00	2680.00
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	59630.00	59630.00
23.	TOTAL INITIAL INVESTMENT	133330.00	133330.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		60.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.81
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT [redacted]	16.58	16.58

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 1 — TEST 50 2X500W QUARTZ H100 V93; 60 DEGREE AIMING; HORIZONTAL POSITION 60 135 DEGREES

		TOTAL FOR SYSTEM	2X500W QTZ Q500WMGE 60 FT SP 15 FT MTG
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.50
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	134.	134.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	536000.	536000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	10720.00	10720.00
37D.	DIESEL FUEL COST	214.40	214.40
38.	GROUP RELAMPING PERIOD (HOURS)		1600.
38A.	RATED LAMP LIFE (HOURS)		2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		804.
40.	REPLACEMENT LAMP COST	10452.00	10452.00
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		2.50
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.5000
44.	RELAMPING COST - LABOR	2680.00	2680.00
46.	CLEANINGS/YEAR/LUMINAIRE		0.00
47.	CLEANING COST - LABOR	0.00	0.00
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	702.16	702.16
52.	TOTAL ANNUAL MAINTENANCE COST	3382.16	3382.16
53.	ANNUAL OPERATING COST	24768.56	24768.56
54.	ANNUAL OP'ING COST PER FT ~~OR ACRE~~	3.08	3.08
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	18438.13	18438.13
56.	ANNUAL OWNERSHIP + OP'ING COST	43206.69	43206.69
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	5.37	5.37

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 2 — TEST 6 1X500 _ 1X1500W QUARTZ; 50 DEGREE AIMING 50 FT SPACING; HORIZONTAL POSITION 90 _ 135 DEGREES

		TOTAL FOR SYSTEM	500W 90 DEGREE 15 FT MTG	1500W 135 DEGREE 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	320	160	160
2.	LUMINAIRE COST EACH		42.00	65.00
3.	LUMINAIRE COST TOTAL	17120.00	6720.00	10400.00
4.	QUANTITY OF POLES	160	160	0
5.	MOUNTING HEIGHT		15.00	15.00
6.	POLE + BRACKET COST EACH		70.00	0.00
7.	POLE COST TOTAL		11200.00	0.00
8.	FOUNDATION COST EACH		0.00	0.00
9.	POLE + FOUNDATION COST TOTAL	11200.00	11200.00	0.00
10.	QTY LAMPS PER LUMINAIRE		1	1
11.	QUANTITY LAMPS		160	160
12.	LAMP COST EACH		13.00	15.00
13.	LAMP COST TOTAL	4480.00	2080.00	2400.00
14.	ELECTRICAL DISTRIBUTION	64000.00	16000.00	48000.00
14A.	STANDBY GENERATOR COST	54400.00	13600.00	40800.00
14C.	UPS COST	0.00	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		47520.00	99200.00
16.	TOTAL INIT EQUIP INCL LAMPS	151200.00	49600.00	101600.00
II.	INITIAL LABOR ESTIMATES			
18.	POLE ERECTION + PAINTING		155.00	0.00
19.	LUMINAIRE LABOR		60.00	75.00
20.	NET LABOR, POLES + LUMINAIRES	46400.00	34400.00	12000.00
21.	LABOR ELECTRICAL DISTRIBUTION	48000.00	12000.00	36000.00
21A.	LABOR STANDBY GENERATOR	6400.00	1600.00	4800.00
21B.	LABOR UPS	0.00	0.00	0.00
22.	TOTAL INITIAL LABOR	100800.00	48000.00	52800.00
23.	TOTAL INITIAL INVESTMENT	252000.00	97600.00	154400.00
III.	ILLUMINATION CALCULATIONS			
25.	SPACING OR AREA		50.00	50.00
26.	UTILIZATION FACTOR		0.00	0.00
27.	MAINTENANCE FACTOR		.81	.81
28.	DESIGN FOOTCANDLES		2.00	2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	31.50	12.20	19.30

29. INST COST PER LUMINAIRE ... OR ACRE

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 2 — TEST 6 1X500 1X1500W QUARTZ; 50 DEGREE AIMING 50 FT SPACING; HORIZONTAL POSITION 90 & 135 DEGREES

		TOTAL FOR SYSTEM	500W 90 DEGREE 15 FT MTG	1500W 135 DEGREE 15 FT MTG
IV.	**ANNUAL COSTS**			
30.	KW PER LUMINAIRE		.50	1.50
30A.	KW UPS POWER LOSS		0.00	0.00
31.	TOTAL SYSTEM KW	320.	80.	240.
32.	ANNUAL OPERATION (HOURS)		4000.	4000.
33.	TOTAL ENERGY KWH/YEAR	1280000.	320000.	960000.
34.	ENERGY COST PER KWH		.0200	.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000	0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	25600.00	6400.00	19200.00
37D.	DIESEL FUEL COST	512.00	128.00	384.00
38.	GROUP RELAMPING PERIOD (HOURS)		1600.	1600.
38A.	RATED LAMP LIFE (HOURS)		2000.	2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20	.20
39.	QUANTITY OF REPLACEMENT LAMPS		480.	480.
40.	REPLACEMENT LAMP COST	13440.00	6240.00	7200.00
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		2.50	2.50
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.5000	.5000
44.	RELAMPING COST - LABOR	3200.00	1600.00	1600.00
46.	CLEANINGS/YEAR/LUMINAIRE		0.00	0.00
47.	CLEANING COST - LABOR	0.00	0.00	0.00
48.	PAINTING TIME PER POLE		0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1467.20	475.20	992.00
52.	TOTAL ANNUAL MAINTENANCE COST	4667.20	2075.20	2592.00
53.	ANNUAL OPERATING COST	44219.20	14843.20	29376.00
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	5.53	1.86	3.67
VI.	**ANNUAL OWNERSHIP + OPERATING COST**			
55.	FIXED OWNERSHIP COST	35147.84	13563.84	21584.00
56.	ANNUAL OWNERSHIP + OP"ING COST	79367.04	28407.04	50960.00
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	9.92	3.55	6.37

U.S. ARMY CORPS OF ENGINEERS, OMAHA DI..RI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 3 — TEST 59 2X1500W QUARTZ H119 V99; 70 DEGREE AIMING 120 FT SPACING; HORIZONTAL 135 _ 45 DEGREES

		TOTAL FOR SYSTEM	2X1500W 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		65.00
3.	LUMINAIRE COST TOTAL	8710.00	8710.00
4.	QUANTITY OF POLES	67	67
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		4690.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		15.00
13.	LAMP COST TOTAL	2010.00	2010.00
14.	ELECTRICAL DISTRIBUTION	40200.00	40200.00
14A.	STANDBY GENERATOR COST	34170.00	34170.00
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		87770.00
16.	TOTAL INIT EQUIP INCL LAMPS	89780.00	89780.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	20435.00	20435.00
21.	LABOR ELECTRICAL DISTRIBUTION	30150.00	30150.00
21A.	LABOR STANDBY GENERATOR	4020.00	4020.00
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	54605.00	54605.00
23.	TOTAL INITIAL INVESTMENT	298785.00	144385.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		120.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.81
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	17.96	17.96

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 3 — TEST 59 2X1500W QUARTZ H119 V99; 70 DEGREE AIMING 120 FT SPACING; HORIZONTAL 135 _ 45 DEGREES

		TOTAL FOR SYSTEM	2X1500W 15 FT MTG
IV.	ANNUAL COSTS		
30.	KW PER LUMINAIRE		1.50
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	201.	201.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	804000.	804000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	16080.00	16090.00
37D.	DIESEL FUEL COST	321.60	321.60
38.	GROUP RELAMPING PERIOD (HOURS)		1600.
38A.	RATED LAMP LIFE (HOURS)		2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		402.
40.	REPLACEMENT LAMP COST	6030.00	6030.00
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		2.50
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.5000
44.	RELAMPING COST - LABOR	1340.00	1340.00
46.	CLEANINGS/YEAR/LUMINAIRE		0.00
47.	CLEANING COST - LABOR	0.00	0.00
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	877.70	877.70
52.	TOTAL ANNUAL MAINTENANCE COST	2217.70	2217.70
53.	ANNUAL OPERATING COST	24649.30	24649.30
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	3.07	3.07
VI.	ANNUAL OWNERSHIP + OPERATING COST		
55.	FIXED OWNERSHIP COST	20217.25	20217.25
56.	ANNUAL OWNERSHIP + OP"ING COST	44866.55	44866.55
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	5.58	5.58

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI(

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 4

TEST 55 1X1500W QUARTZ M120 V63
60 DEGREE AIMING 50 FT SPACING
HORIZONTAL POSITION 90 DEGREE

		TOTAL FOR SYSTEM	1X1500W 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	160	160
2.	LUMINAIRE COST EACH		65.00
3.	LUMINAIRE COST TOTAL	10400.00	10400.00
4.	QUANTITY OF POLES	160	160
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		11200.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	11200.00	11200.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		160
12.	LAMP COST EACH		15.00
13.	LAMP COST TOTAL	2400.00	2400.00
14.	ELECTRICAL DISTRIBUTION	48000.00	48000.00
14A.	STANDBY GENERATOR COST	40800.00	40800.00
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		110400.00
16.	TOTAL INIT EQUIP INCL LAMPS	112800.00	112800.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	36800.00	36800.00
21.	LABOR ELECTRICAL DISTRIBUTION	36000.00	36000.00
21A.	LABOR STANDBY GENERATOR	4800.00	4800.00
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	77600.00	77600.00
23.	TOTAL INITIAL INVESTMENT	344800.00	190400.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		50.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.81
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	23.80	23.80

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 4 — TEST 55 1X1500W QUARTZ H120 V63; 60 DEGREE AIMING 50 FT SPACING; HORIZONTAL POSITION 90 DEGREE

		TOTAL FOR SYSTEM	1X1500W 15 FT MTG
IV.	ANNUAL COSTS		
30.	KW PER LUMINAIRE		1.50
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	240.	240.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	960000.	960000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	19200.00	19200.00
37D.	DIESEL FUEL COST	384.00	384.00
38.	GROUP RELAMPING PERIOD (HOURS)		1600.
38A.	RATED LAMP LIFE (HOURS)		2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		480.
40.	REPLACEMENT LAMP COST	7200.00	7200.00
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		2.50
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.5000
44.	RELAMPING COST - LABOR	1600.00	1600.00
46.	CLEANINGS/YEAR/LUMINAIRE		0.00
47.	CLEANING COST - LABOR	0.00	0.00
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1104.00	1104.00
52.	TOTAL ANNUAL MAINTENANCE COST	2704.00	2704.00
53.	ANNUAL OPERATING COST	29488.00	29488.00
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	3.69	3.69
VI.	ANNUAL OWNERSHIP + OPERATING COST		
55.	FIXED OWNERSHIP COST	26696.00	26696.00
56.	ANNUAL OWNERSHIP + OP"ING COST	56184.00	56184.00
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	7.02	7.02

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 5 — TEST 42 3X500W QUARTZ H100 V93; 65 DEGREE AIMING 70 FT SPACING; HORIZONTAL POSITIONS 45 _ 90 _ 135 DEGREES

		TOTAL FOR SYSTEM	3X500W 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	345	345
2.	LUMINAIRE COST EACH		13.00
3.	LUMINAIRE COST TOTAL	4485.00	4485.00
4.	QUANTITY OF POLES	115	115
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		8050.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	8050.00	8050.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		345
12.	LAMP COST EACH		13.0[illegible]
13.	LAMP COST TOTAL	4485.00	4485.00
14.	ELECTRICAL DISTRIBUTION	34500.00	34500.00
14A.	STANDBY GENERATOR COST	29325.00	29325.00
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		76360.00
16.	TOTAL INIT EQUIP INCL LAMPS	80845.00	80845.00
II.	INITIAL LABOR ESTIMATES		
18.	P[illegible] ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		60.00
20.	NET LABOR, POLES + LUMINAIRES	38525.00	38525.00
21.	LABOR ELECTRICAL DISTRIBUTION	25875.00	25875.00
21A.	LABOR STANDBY GENERATOR	3450.00	3450.00
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	67850.00	67850.00
23.	TOTAL INITIAL INVESTMENT	303095.00	148695.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		70.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.81
28.	DESIGN FOOTCANDLES		2.0[illegible]
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	18.47	18.47

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 5

TEST 42 3X500W QUARTZ H100 V93
65 DEGREE AIMING 70 FT SPACING
HORIZONTAL POSITIONS 45 _ 90 _ 135 DEGREES

		TOTAL FOR SYSTEM	3X500W 15 FT MTG
IV. ANNUAL COSTS			
30.	KW PER LUMINAIRE		.50
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	173.	173.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	690000.	690000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	13800.00	13800.00
37D.	DICSEL FUEL COST	276.00	276.00
38.	GROUP RELAMPING PERIOD (HOURS)		1600.
38A.	RATED LAMP LIFE (HOURS)		2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		1035.
40.	REPLACEMENT LAMP COST	13455.00	13455.00
V. ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		2.50
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.5000
44.	RELAMPING COST - LABOR	3450.00	3450.00
46.	CLEANINGS/YEAR/LUMINAIRE		0.00
47.	CLEANING COST - LABOR	0.00	0.00
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	763.60	763.60
52.	TOTAL ANNUAL MAINTENANCE COST	4213.60	4213.60
53.	ANNUAL OPERATING COST	31744.60	31744.60
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	3.94	3.94
VI. ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	20477.82	20477.82
56.	ANNUAL OWNERSHIP + OP"ING COST	52222.42	52222.42
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	6.49	6.49

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 6 — TEST 91E 1X250W HP SODIUM ROADWAY; 10 DEGREE AIMING 40 FT SPACING; HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	1X250W GITT 30 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	200	200
2.	LUMINAIRE COST EACH		390.00
3.	LUMINAIRE COST TOTAL	78000.00	78000.00
4.	QUANTITY OF POLES	200	200
5.	MOUNTING HEIGHT		30.00
6.	POLE + BRACKET COST EACH		390.00
7.	POLE COST TOTAL		78000.00
8.	FOUNDATION COST EACH		50.00
9.	POLE + FOUNDATION COST TOTAL	88000.00	88000.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		200
12.	LAMP COST EACH		38.00
13.	LAMP COST TOTAL	7600.00	7600.00
14.	ELECTRICAL DISTRIBUTION	14500.00	14500.00
14A.	STANDBY GENERATOR COST	12325.00	12325.00
14C.	UPS COST	43500.00	43500.00
15.	TOTAL INIT EQUIP LESS LAMPS		236325.00
16.	TOTAL INIT EQUIP INCL LAMPS	243925.00	243925.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		162.00
19.	LUMINAIRE LABOR		60.00
20.	NET LABOR, POLES + LUMINAIRES	44400.00	44400.00
21.	LABOR ELECTRICAL DISTRIBUTION	10875.00	10875.00
21A.	LABOR STANDBY GENERATOR	1450.00	1450.00
21B.	LABOR UPS	5800.00	5800.00
22.	TOTAL INITIAL LABOR	62525.00	62525.00
23.	TOTAL INITIAL INVESTMENT	460950.00	306450.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		40.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.72
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	38.31	38.3.

U.S. ARMY CORPS OF ENGINEERS, OMAHA DIS

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 6 — TEST 91E 1X250W HP SODIUM ROADWAY
10 DEGREE AIMING 40 FT SPACING
HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	1X250W GITT 30 FT MTG
IV.	ANNUAL COSTS		
30.	KW PER LUMINAIRE		.29
30A.	KW UPS POWER LOSS		14.50
31.	TOTAL SYSTEM KW	73.	73.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	290000.	290000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	5800.00	5800.00
37D.	DIESEL FUEL COST	116.00	116.00
38.	GROUP RELAMPING PERIOD (HOURS)		9500.
39A.	RATED LAMP LIFE (HOURS)		15000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		101.
40.	REPLACEMENT LAMP COST	3840.00	3840.00
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.42
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0842
44.	RELAMPING COST - LABOR	336.84	336.84
46.	CLEANINGS/YEAR/LUMINAIRE		.58
47.	CLEANING COST - LABOR	231.58	231.58
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	2363.25	2363.25
52.	TOTAL ANNUAL MAINTENANCE COST	2931.67	2931.67
53.	ANNUAL OPERATING COST	12687.67	12687.67
54.	ANNUAL OP"NG COST PER FT [illegible]	1.59	1.59
VI.	ANNUAL OWNERSHIP + OPERATING COST		
55.	FIXED OWNERSHIP COST	42436.70	42436.70
56.	ANNUAL OWNERSHIP + OP"ING COST	55124.37	55124.37
58.	TOTAL PER LINEAL FOOT [illegible]	6.89	6.89

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 7 — TEST 97 1X250 HP SODIUM, 60 DEGREE AIMING 60 FT SPACING, HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	1X250W WMWE 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		240.00
3.	LUMINAIRE COST TOTAL	32160.00	32160.00
4.	QUANTITY OF POLES	134	134
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		9380.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	9380.00	9380.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		30.00
13.	LAMP COST TOTAL	4020.00	4020.00
14.	ELECTRICAL DISTRIBUTION	9715.00	9715.00
14A.	STANDBY GENERATOR COST	8257.75	8257.75
14C.	UPS COST	29145.00	29145.00
15.	TOTAL INIT EQUIP LESS LAMPS		88657.75
16.	TOTAL INIT EQUIP INCL LAMPS	92677.75	92677.75
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		60.00
20.	NET LABOR, POLES + LUMINAIRES	28810.00	28810.00
21.	LABOR ELECTRICAL DISTRIBUTION	7286.25	7286.25
21A.	LABOR STANDBY GENERATOR	971.50	971.50
21B.	LABOR UPS	3886.00	3886.00
22.	TOTAL INITIAL LABOR	40953.75	40953.75
23.	TOTAL INITIAL INVESTMENT	288031.50	133631.50
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		60.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.72
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	16.62	16.62

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 7 — TEST 97 1X250 HP SODIUM; 60 DEGREE AIMING 60 FT SPACING; HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	1X250W WMWE 15 FT MTG
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.29
30A.	KW UPS POWER LOSS		9.72
31.	TOTAL SYSTEM KW	49.	49.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	194300.	194300.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	3886.00	3886.00
37D.	DIESEL FUEL COST	77.72	77.72
38.	GROUP RELAMPING PERIOD (HOURS)		9500.
38A.	RATED LAMP LIFE (HOURS)		15000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		68.
40.	REPLACEMENT LAMP COST	2031.16	2031.16
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.42
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0842
44.	RELAMPING COST - LABOR	225.68	225.68
46.	CLEANINGS/YEAR/LUMINAIRE		.58
47.	CLEANING COST - LABOR	155.16	155.16
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	886.58	886.58
52.	TOTAL ANNUAL MAINTENANCE COST	1267.42	1267.42
53.	ANNUAL OPERATING COST	7262.30	7262.30
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.90	.90
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	18404.83	18404.83
56.	ANNUAL OWNERSHIP + OP"ING COST	25667.13	25667.13
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.19	3.19

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 8 — TEST 98 2X250 HP SODIUM; 70 DEGREE AIMING 120 FT SPACING; HORIZONTAL POSITION 45 135 DEGREES

		TOTAL FOR SYSTEM	2X250W WMWE 15 FT MTG
I.	**INITIAL EQUIPMENT INVESTMENT**		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		240.00
3.	LUMINAIRE COST TOTAL	32160.00	32160.00
4.	QUANTITY OF POLES	67	67
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		4690.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		38.00
13.	LAMP COST TOTAL	5092.00	5092.00
14.	ELECTRICAL DISTRIBUTION	9715.00	9715.00
14A.	STANDBY GENERATOR COST	8257.75	8257.75
14C.	UPS COST	29145.00	29145.00
15.	TOTAL INIT EQUIP LESS LAMPS		83967.75
16.	TOTAL INIT EQUIP INCL LAMPS	89059.75	89059.75
II.	**INITIAL LABOR ESTIMATES**		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		60.00
20.	NET LABOR, POLES + LUMINAIRES	18425.00	18425.00
21.	LABOR ELECTRICAL DISTRIBUTION	7286.25	7286.25
21A.	LABOR STANDBY GENERATOR	971.50	971.50
21B.	LABOR UPS	3886.00	3886.00
22.	TOTAL INITIAL LABOR	30568.75	30568.75
23.	TOTAL INITIAL INVESTMENT	274028.50	119628.50
III.	**ILLUMINATION CALCULATIONS**		
25.	SPACING OR AREA		120.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.72
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	14.88	14.88

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 8

TEST 98 2X250 HP SODIUM
70 DEGREE AIMING 120 FT SPACING
HORIZONTAL POSITION 45 135 DEGREES

		TOTAL FOR SYSTEM	2X250W WMWE 15 FT MTG
IV.	ANNUAL COSTS		
30.	KW PER LUMINAIRE		.29
30A.	KW UPS POWER LOSS		9.72
31.	TOTAL SYSTEM KW	49.	49.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	194300.	194300.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	3886.00	3886.00
37D.	DIESEL FUEL COST	77.72	77.72
38.	GROUP RELAMPING PERIOD (HOURS)		9500.
38A.	RATED LAMP LIFE (HOURS)		15000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		68.
40.	REPLACEMENT LAMP COST	2572.80	2572.80
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.42
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0842
44.	RELAMPING COST - LABOR	225.68	225.68
46.	CLEANINGS/YEAR/LUMINAIRE		.58
47.	CLEANING COST - LABOR	155.16	155.16
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	839.68	839.68
52.	TOTAL ANNUAL MAINTENANCE COST	1220.52	1220.52
53.	ANNUAL OPERATING COST	7757.04	7757.04
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.96	.96
VI.	ANNUAL OWNERSHIP + OPERATING COST		
55.	FIXED OWNERSHIP COST	16264.18	16264.18
56.	ANNUAL OWNERSHIP + OP"ING COST	24021.22	24021.22
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	2.99	2.99

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 9 — TEST 96A 1X400 W HP SODIUM
60 DEGREE AIMING 80 FT SPACING
HORIZONTAL POSITION 90 DEGREES AIMING

		TOTAL FOR SYSTEM	1X400W WMWE 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	100	100
2.	LUMINAIRE COST EACH		250.00
3.	LUMINAIRE COST TOTAL	25000.00	25000.00
4.	QUANTITY OF POLES	100	100
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		7000.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	7000.00	7000.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		100
12.	LAMP COST EACH		39.00
13.	LAMP COST TOTAL	3900.00	3900.00
14.	ELECTRICAL DISTRIBUTION	11500.00	11500.00
14A.	STANDBY GENERATOR COST	9775.00	9775.00
14C.	UPS COST	34500.00	34500.00
15.	TOTAL INIT EQUIP LESS LAMPS		87775.00
16.	TOTAL INIT EQUIP INCL LAMPS	91675.00	91675.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	23000.00	23000.00
21.	LABOR ELECTRICAL DISTRIBUTION	8625.00	8625.00
21A.	LABOR STANDBY GENERATOR	1150.00	1150.00
21B.	LABOR UPS	4600.00	4600.00
22.	TOTAL INITIAL LABOR	37375.00	37375.00
23.	TOTAL INITIAL INVESTMENT	283450.00	129050.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		80.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.72
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR AGRE~~	16.13	16.13

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 9

TEST 96A 1X400 W HP SODIUM
60 DEGREE AIMING 80 FT SPACING
HORIZONTAL POSITION 90 DEGREES AIMING

		TOTAL FOR SYSTEM	1X400W WMWE 15 FT MTG
IV. ANNUAL COSTS			
30.	KW PER LUMINAIRE		.46
30A.	KW UPS POWER LOSS		11.50
31.	TOTAL SYSTEM KW	58.	58.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	230000.	230000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	4600.00	4600.00
37D.	DIESEL FUEL COST	92.00	92.00
38.	GROUP RELAMPING PERIOD (HOURS)		13000.
38A.	RATED LAMP LIFE (HOURS)		20000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		37.
40.	REPLACEMENT LAMP COST	1440.00	1440.00
V. ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.31
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0615
44.	RELAMPING COST - LABOR	123.08	123.08
46.	CLEANINGS/YEAR/LUMINAIRE		.69
47.	CLEANING COST - LABOR	138.46	138.46
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	877.75	877.75
52.	TOTAL ANNUAL MAINTENANCE COST	1139.29	1139.29
53.	ANNUAL OPERATING COST	7271.29	7271.29
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.91	.91
VI. ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	17771.30	17771.30
56.	ANNUAL OWNERSHIP + OP"ING COST	25042.59	25042.59
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.13	3.13

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 10 — TEST 75A 2X90W LP SODIUM; 70 DEGREE AIMING 100 FT SPACING; HORIZONTAL POSITIONS 45 _ 135 DEGREES

		TOTAL FOR SYSTEM	2X90W WMSE 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	160	160
2.	LUMINAIRE COST EACH		273.00
3.	LUMINAIRE COST TOTAL	43680.00	43680.00
4.	QUANTITY OF POLES	80	80
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		5600.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	5600.00	5600.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		160
12.	LAMP COST EACH		18.00
13.	LAMP COST TOTAL	2880.00	2880.00
14.	ELECTRICAL DISTRIBUTION	5600.00	5600.00
14A.	STANDBY GENERATOR COST	4760.00	4760.00
14C.	UPS COST	16800.00	16800.00
15.	TOTAL INIT EQUIP LESS LAMPS		76440.00
16.	TOTAL INIT EQUIP INCL LAMPS	79320.00	79320.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		30.00
20.	NET LABOR, POLES + LUMINAIRES	17200.00	17200.00
21.	LABOR ELECTRICAL DISTRIBUTION	4200.00	4200.00
21A.	LABOR STANDBY GENERATOR	560.00	560.00
21B.	LABOR UPS	2240.00	2240.00
22.	TOTAL INITIAL LABOR	24200.00	24200.00
23.	TOTAL INITIAL INVESTMENT	257920.00	103520.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		100.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	12.94	12.94

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 10 — TEST 75A 2X90W LP SODIUM, 70 DEGREE AIMING 100 FT SPACING, HORIZONTAL POSITIONS 45 - 135 DEGREES

		TOTAL FOR SYSTEM	2X90W WMSE 15 FT MTG
IV. ANNUAL COSTS			
30.	KW PER LUMINAIRE		.14
30A.	KW UPS POWER LOSS		5.60
31.	TOTAL SYSTEM KW	28.	28.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	112000.	112000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	2240.00	2240.00
37D.	DIESEL FUEL COST	44.80	44.80
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		51.
40.	REPLACEMENT LAMP COST	921.60	921.60
V. ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	170.67	170.67
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	234.67	234.67
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	764.40	764.40
52.	TOTAL ANNUAL MAINTENANCE COST	1169.73	1169.73
53.	ANNUAL OPERATING COST	4376.13	4376.13
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.55	.55
VI. ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	14290.88	14290.88
56.	ANNUAL OWNERSHIP + OP"ING COST	18667.01	18667.01
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	2.33	2.33

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 11 — TEST 75A 2X90W LP SODIUM; 70 DEGREE AIMING 100 FT SPACING; HORIZONTAL POSITION 45 _ 135 DEGREES

		TOTAL FOR SYSTEM	2X90W WWNO 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	160	160
2.	LUMINAIRE COST EACH		308.00
3.	LUMINAIRE COST TOTAL	49280.00	49280.00
4.	QUANTITY OF POLES	80	80
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		5600.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	5600.00	5600.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		160
12.	LAMP COST EACH		18.00
13.	LAMP COST TOTAL	2880.00	2880.00
14.	ELECTRICAL DISTRIBUTION	5600.00	5600.00
14A.	STANDBY GENERATOR COST	4760.00	4760.00
14C.	UPS COST	16800.00	16800.00
15.	TOTAL INIT EQUIP LESS LAMPS		82040.00
16.	TOTAL INIT EQUIP INCL LAMPS	84920.00	84920.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		30.00
20.	NET LABOR, POLES + LUMINAIRES	17200.00	17200.00
21.	LABOR ELECTRICAL DISTRIBUTION	4200.00	4200.00
21A.	LABOR STANDBY GENERATOR	560.00	560.00
21B.	LABOR UPS	2240.00	2240.00
22.	TOTAL INITIAL LABOR	24200.00	24200.00
23.	TOTAL INITIAL INVESTMENT	263520.00	109120.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		100.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR AGRE~~	13.64	13.64

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 11 — TEST 75A 2X90W LP SODIUM, 70 DEGREE AIMING 100 FT SPACING, HORIZONTAL POSITION 45 _ 135 DEGREES

		TOTAL FOR SYSTEM	2X90W WWNO 15 FT MTG
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.14
30A.	KW UPS POWER LOSS		5.60
31.	TOTAL SYSTEM KW	28.	28.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	112000.	112000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	2240.00	2240.00
37D.	DIESEL FUEL COST	44.80	44.80
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		51.
40.	REPLACEMENT LAMP COST	921.60	921.60
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	170.67	170.67
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	234.67	234.67
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	820.40	820.40
52.	TOTAL ANNUAL MAINTENANCE COST	1225.73	1225.73
53.	ANNUAL OPERATING COST	4432.13	4432.13
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.55	.55
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	15086.08	15086.08
56.	ANNUAL OWNERSHIP + OP"ING COST	19518.21	19518.21
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	2.44	2.44

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 12 — TEST 76 1X180W LP SODIUM; 65 DEGREE AIMING 60 FT SPACING; HORIZONTAL POSITION 888 DEGREES

		TOTAL FOR SYSTEM	1X180W WMSE 75 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		360.00
3.	LUMINAIRE COST TOTAL	48240.00	48240.00
4.	QUANTITY OF POLES	134	134
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		9380.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	9380.00	9380.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		33.00
13.	LAMP COST TOTAL	4422.00	4422.00
14.	ELECTRICAL DISTRIBUTION	8040.00	8040.00
14A.	STANDBY GENERATOR COST	6834.00	6834.00
14C.	UPS COST	24120.00	24120.00
15.	TOTAL INIT EQUIP LESS LAMPS		96614.00
16.	TOTAL INIT EQUIP INCL LAMPS	101036.00	101036.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR.		75.00
20.	NET LABOR, POLES + LUMINAIRES	30820.00	30820.00
21.	LABOR ELECTRICAL DISTRIBUTION	6030.00	6030.00
21A.	LABOR STANDBY GENERATOR	804.00	804.00
21B.	LABOR UPS	3216.00	3216.00
22.	TOTAL INITIAL LABOR	40870.00	40870.00
23.	TOTAL INITIAL INVESTMENT	296306.00	141906.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		60.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	17.65	17.65

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR.

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 12

TEST 76 1X180W LP SODIUM
65 DEGREE AIMING 60 FT SPACING
HORIZONTAL POSITION ~~000~~ DEGREES

		TOTAL FOR SYSTEM	1X180W WMSE 75 FT MTG
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.24
30A.	KW UPS POWER LOSS		8.04
31.	TOTAL SYSTEM KW	40.	40.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	160800.	160800.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	3216.00	3216.00
37D.	DIESEL FUEL COST	64.32	64.32
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		43.
40.	REPLACEMENT LAMP COST	1415.04	1415.04
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	142.93	142.93
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	196.53	196.53
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	966.14	966.14
52.	TOTAL ANNUAL MAINTENANCE COST	1305.61	1305.61
53.	ANNUAL OPERATING COST	6000.97	6000.97
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.75	.75
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	19522.73	19522.73
56.	ANNUAL OWNERSHIP + OP"ING COST	25523.69	25523.69
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.17	3.17

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 13

TEST 95 2X180W LP SODIUM
70 DEGREE AIMING 120 FT SPACING
HORIZONTAL POSITION 45 135 DEGREES

		TOTAL FOR SYSTEM	2X180W WWNO 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		339.00
3.	LUMINAIRE COST TOTAL	45426.00	45426.00
4.	QUANTITY OF POLES	67	67
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		4690.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		33.00
13.	LAMP COST TOTAL	4422.00	4422.0
14.	ELECTRICAL DISTRIBUTION	8040.00	8040.00
14A.	STANDBY GENERATOR COST	6834.00	6834.00
14C.	UPS COST	24120.00	24120.00
15.	TOTAL INIT EQUIP LESS LAMPS		89110.00
16.	TOTAL INIT EQUIP INCL LAMPS	93532.00	93532.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	20435.00	20435.00
21.	LABOR ELECTRICAL DISTRIBUTION	6030.00	6030.00
21A.	LABOR STANDBY GENERATOR	804.00	804.00
21B.	LABOR UPS	3216.00	3216.00
22.	TOTAL INITIAL LABOR	30485.00	30485.00
23.	TOTAL INITIAL INVESTMENT	278417.00	124017.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		120.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.0
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	15.43	15.4

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 13 — TEST 95 2X180W LP SODIUM; 70 DEGREE AIMING 120 FT SPACING; HORIZONTAL POSITION 45 135 DEGREES

		TOTAL FOR SYSTEM	2X180W WWNO 15 FT MTG
IV. ANNUAL COSTS			
30.	KW PER LUMINAIRE		.24
30A.	KW UPS POWER LOSS		8.04
31.	TOTAL SYSTEM KW	40.	40.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	160800.	160800.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	3216.00	3216.00
37D.	DIESEL FUEL COST	64.32	64.32
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.02
39.	QUANTITY OF REPLACEMENT LAMPS		36.
40.	REPLACEMENT LAMP COST	1202.78	1202.78
V. ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0053
44.	RELAMPING COST - LABOR	110.77	110.77
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	196.53	196.53
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	891.10	891.10
52.	TOTAL ANNUAL MAINTENANCE COST	1198.41	1198.41
53.	ANNUAL OPERATING COST	5081.51	5681.51
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.71	.71
VI. ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	16982.49	16982.49
56.	ANNUAL OWNERSHIP + OP"ING COST	22664.00	22664.00
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	2.82	2.82

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 14 — TEST 94 2X180W LP SODIUM; 70 DEGREE AIMING 120 FT SPACING; HORIZONTAL POSITION 45 _ 135 DEGREES

		TOTAL FOR SYSTEM	2X180W WMSE 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		360.00
3.	LUMINAIRE COST TOTAL	48240.00	48240.00
4.	QUANTITY OF POLES	67	67
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		4690.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		33.00
13.	LAMP COST TOTAL	4422.00	4422.00
14.	ELECTRICAL DISTRIBUTION	8040.00	8040.00
14A.	STANDBY GENERATOR COST	6834.00	6834.00
14C.	UPS COST	24120.00	24120.00
15.	TOTAL INIT EQUIP LESS LAMPS		91924.00
16.	TOTAL INIT EQUIP INCL LAMPS	96346.00	96346.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	20435.00	20435.00
21.	LABOR ELECTRICAL DISTRIBUTION	6030.00	6030.00
21A.	LABOR STANDBY GENERATOR	804.00	804.00
21B.	LABOR UPS	3216.00	3216.00
22.	TOTAL INITIAL LABOR	30485.00	30485.00
23.	TOTAL INITIAL INVESTMENT	281231.00	126831.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		120.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	15.78	15.78

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 14 — TEST 94 2X180W LP SODIUM; 70 DEGREE AIMING 120 FT SPACING; HORIZONTAL POSITION 45 - 135 DEGREES

		TOTAL FOR SYSTEM	2X180W WMSE 15 FT MTG
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.24
30A.	KW UPS POWER LOSS		8.04
31.	TOTAL SYSTEM KW	40.	40.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	160800.	160800.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	3216.00	3216.00
37D.	DIESEL FUEL COST	64.32	64.32
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		19000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		43.
40.	REPLACEMENT LAMP COST	1415.04	1415.04
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	142.93	142.93
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	196.53	196.53
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	919.24	919.24
52.	TOTAL ANNUAL MAINTENANCE COST	1258.71	1258.71
53.	ANNUAL OPERATING COST	5954.07	5954.07
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.74	.74
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	17382.08	17382.08
56.	ANNUAL OWNERSHIP + OP"ING COST	23336.14	23336.14
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	2.90	2.90

U.S. ARMY CORPS OF ENGINEERS, OMAHA DIST

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 15 — TEST 53 3X180 W LP SODIUM, 20 DEGREE AIMING 120 FT SPACING, HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	3X180W WGQV 30 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	201	201
2.	LUMINAIRE COST EACH		250.00
3.	LUMINAIRE COST TOTAL	50250.00	50250.00
4.	QUANTITY OF POLES	67	67
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		130.00
7.	POLE COST TOTAL		8710.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	8710.00	8710.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		201
12.	LAMP COST EACH		33.00
13.	LAMP COST TOTAL	6633.00	6633.00
14.	ELECTRICAL DISTRIBUTION	12060.00	12060.
14A.	STANDBY GENERATOR COST	10251.00	10251.00
14C.	UPS COST	36180.00	36180.00
15.	TOTAL INIT EQUIP LESS LAMPS		117451.00
16.	TOTAL INIT EQUIP INCL LAMPS	124084.00	124084.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		162.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	25929.00	25929.00
21.	LABOR ELECTRICAL DISTRIBUTION	9045.00	9045.00
21A.	LABOR STANDBY GENERATOR	1206.00	1206.00
21B.	LABOR UPS	4824.00	4824.00
22.	TOTAL INITIAL LABOR	41004.00	41004.00
23.	TOTAL INITIAL INVESTMENT	319488.00	165088.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		120.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	20.53	20.5[illegible]

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER	TEST 53 3X180 W LP SODIUM
LIGHTING	20 DEGREE AIMING 120 FT SPACING
SCHEME 15	HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	3X180W WGQV 30 FT MTG
IV.	ANNUAL COSTS		
30.	KW PER LUMINAIRE		.24
30A.	KW UPS POWER LOSS		12.06
31.	TOTAL SYSTEM KW	60.	60.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	241200.	241200.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	4824.00	4824.00
37D.	DIESEL FUEL COST	96.48	96.48
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		64.
40.	REPLACEMENT LAMP COST	2122.56	2122.56
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	214.40	214.40
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	294.80	294.80
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
[illegible].	REPLACEMENT PARTS, PAINT, ETC.	1174.51	1174.51
.	TOTAL ANNUAL MAINTENANCE COST	1683.71	1683.71
53.	ANNUAL OPERATING COST	8726.75	8726.75
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	1.09	1.09
VI.	ANNUAL OWNERSHIP + OPERATING COST		
55.	FIXED OWNERSHIP COST	22500.61	22500.61
56.	ANNUAL OWNERSHIP + OP"ING COST	31227.36	31227.36
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.88	3.88

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 16 — TEST 80F 1X180 W LP SODIUM, 20 DEGREE AIMING 70 FT SPACING, HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	1X180W WGQV 15 FT MTG
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	115	115
2.	LUMINAIRE COST EACH		250.00
3.	LUMINAIRE COST TOTAL	28750.00	28750.00
4.	QUANTITY OF POLES	115	115
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		8050.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	8050.00	8050.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		115
12.	LAMP COST EACH		33.00
13.	LAMP COST TOTAL	3795.00	3795.00
14.	ELECTRICAL DISTRIBUTION	6900.00	6900.00
14A.	STANDBY GENERATOR COST	5865.00	5865.00
14C.	UPS COST	20700.00	20700.00
15.	TOTAL INIT EQUIP LESS LAMPS		70265.00
16.	TOTAL INIT EQUIP INCL LAMPS	74060.00	74060.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	26450.00	26450.00
21.	LABOR ELECTRICAL DISTRIBUTION	5175.00	5175.00
21A.	LABOR STANDBY GENERATOR	690.00	690.00
21B.	LABOR UPS	2760.00	2760.00
22.	TOTAL INITIAL LABOR	35075.00	35075.00
23.	TOTAL INITIAL INVESTMENT	263535.00	109135.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		70.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	13.56	13.56

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 16 — TEST 80F 1X180 W LP SODIUM; 20 DEGREE AIMING 70 FT SPACING; HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	1X180W WGQV 15 FT MTG
IV.	ANNUAL COSTS		
30.	KW PER LUMINAIRE		.24
30A.	KW UPS POWER LOSS		6.90
31.	TOTAL SYSTEM KW	35.	35.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	138000.	138000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	2760.00	2760.00
37D.	DIESEL FUEL COST	55.20	55.20
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
39A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		37.
40.	REPLACEMENT LAMP COST	1214.40	1214.40
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	122.67	122.67
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	168.67	168.67
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	702.65	702.65
52.	TOTAL ANNUAL MAINTENANCE COST	993.98	993.98
53.	ANNUAL OPERATING COST	5023.58	5023.58
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.62	.62
VI.	ANNUAL OWNERSHIP + OPERATING COST		
55.	FIXED OWNERSHIP COST	14958.28	14958.28
56.	ANNUAL OWNERSHIP + OP"ING COST	19981.86	19981.86
58.	TOTAL PER LINEAL FUOT ~~OR ACRE~~	2.48	2.48

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 17 — TEST 81 2X180W LP SODIUM, 20 DEGREES AIMING 100 FT SPACING, HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	2X180W WGQV 15 FT MTG
I.	**INITIAL EQUIPMENT INVESTMENT**		
1.	QUANTITY OF LUMINAIRES	160	160
2.	LUMINAIRE COST EACH		250.00
3.	LUMINAIRE COST TOTAL	40000.00	40000.00
4.	QUANTITY OF POLES	80	80
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		5600.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	5600.00	5600.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		160
12.	LAMP COST EACH		33.00
13.	LAMP COST TOTAL	5280.00	5280.00
14.	ELECTRICAL DISTRIBUTION	9600.00	9600.00
14A.	STANDBY GENERATOR COST	8160.00	8160.00
14C.	UPS COST	28800.00	28800.00
15.	TOTAL INIT EQUIP LESS LAMPS		92160.00
16.	TOTAL INIT EQUIP INCL LAMPS	97440.00	97440.00
II.	**INITIAL LABOR ESTIMATES**		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	24400.00	24400.00
21.	LABOR ELECTRICAL DISTRIBUTION	7200.00	7200.00
21A.	LABOR STANDBY GENERATOR	960.00	960.00
21B.	LABOR UPS	3840.00	3840.00
22.	TOTAL INITIAL LABOR	36400.00	36400.00
23.	TOTAL INITIAL INVESTMENT	288240.00	133840.00
III.	**ILLUMINATION CALCULATIONS**		
25.	SPACING OR AREA		100.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	16.73	16.73

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 17 — TEST 81 2X180W LP SODIUM; 20 DEGREES AIMING 100 FT SPACING; HORIZONTAL POSITION 90 DEGREES

		TOTAL FOR SYSTEM	2X180W WGQV 15 FT MTG
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.24
30A.	KW UPS POWER LOSS		9.60
31.	TOTAL SYSTEM KW	48.	48.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	192000.	192000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	3840.00	3840.00
37D.	DIESEL FUEL COST	76.80	76.80
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		51.
40.	REPLACEMENT LAMP COST	1689.60	1689.60
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	170.67	170.67
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	234.67	234.67
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	921.60	921.60
52.	TOTAL ANNUAL MAINTENANCE COST	1326.93	1326.93
53.	ANNUAL OPERATING COST	6933.33	6933.33
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.87	.87
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	18255.52	18255.52
56.	ANNUAL OWNERSHIP + OP"ING COST	25188.85	25188.85
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.15	3.15

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 18

HIGH PRESSURE SODIUM
WITHOUT UPS OR QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X250W HPS 120 FT SP SCHEME 8
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		240.00
3.	LUMINAIRE COST TOTAL	32160.00	32160.00
4.	QUANTITY OF POLES	67	67
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		4690.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		38.00
13.	LAMP COST TOTAL	5092.00	5092.00
14.	ELECTRICAL DISTRIBUTION	7772.00	7772.00
14A.	STANDBY GENERATOR COST	6606.20	6606.20
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		51228.20
16.	TOTAL INIT EQUIP INCL LAMPS	56320.20	56320.20
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		60.00
20.	NET LABOR, POLES + LUMINAIRES	18425.00	18425.00
21.	LABOR ELECTRICAL DISTRIBUTION	5829.00	5829.00
21A.	LABOR STANDBY GENERATOR	777.20	777.20
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	25031.20	25031.20
23.	TOTAL INITIAL INVESTMENT	235751.40	81351.40
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		120.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.72
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	10.12	10.12

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 18

HIGH PRESSURE SODIUM
WITHOUT UPS OR QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X250W HPS 120 FT SP SCHEME 8
IV. ANNUAL COSTS			
30.	KW PER LUMINAIRE		.29
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	39.	39.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	155440.	155440.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	3108.80	3108.80
37D.	DIESEL FUEL COST	62.18	62.18
38.	GROUP RELAMPING PERIOD (HOURS)		9500.
38A.	RATED LAMP LIFE (HOURS)		15000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		68.
40.	REPLACEMENT LAMP COST	2572.80	2572.80
V. ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.42
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0842
44.	RELAMPING COST - LABOR	225.68	225.68
46.	CLEANINGS/YEAR/LUMINAIRE		.58
47.	CLEANING COST - LABOR	155.16	155.16
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	512.28	512.28
52.	TOTAL ANNUAL MAINTENANCE COST	893.12	893.12
53.	ANNUAL OPERATING COST	6636.90	6636.90
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.83	.83
VI. ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	10828.83	10828.83
56.	ANNUAL OWNERSHIP + OP"ING COST	17465.73	17465.73
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	2.17	2.17

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 19 — HIGH PRESSURE SODIUM W/O UPS PLUS 100 PERCENT QUARTZ BACKUP SCHEME 18 PLUS SCHEME 3

		TOTAL FOR SYSTEM	2X250W HP 120 FT SP	2X1500W QUARTZ 120 FT SP
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	268	134	134
2.	LUMINAIRE COST EACH		240.00	65.00
3.	LUMINAIRE COST TOTAL	40870.00	32160.00	8710.00
4.	QUANTITY OF POLES	67	67	0
5.	MOUNTING HEIGHT		15.00	15.00
6.	POLE + BRACKET COST EACH		70.00	0.00
7.	POLE COST TOTAL		4690.00	0.00
8.	FOUNDATION COST EACH		0.00	0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00	0.00
10.	QTY LAMPS PER LUMINAIRE		1	1
11.	QUANTITY LAMPS		134	134
12.	LAMP COST EACH		38.00	15.00
13.	LAMP COST TOTAL	7102.00	5092.00	2010.00
14.	ELECTRICAL DISTRIBUTION	47972.00	7772.00	40200.00
14A.	STANDBY GENERATOR COST	40776.20	6606.20	34170.00
14C.	UPS COST	0.00	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		51228.20	83080.00
16.	TOTAL INIT EQUIP INCL LAMPS	141410.20	56320.20	85090.00
II.	INITIAL LABOR ESTIMATES			
18.	POLE ERECTION + PAINTING		155.00	0.00
19.	LUMINAIRE LABOR		60.00	75.00
20.	NET LABOR, POLES + LUMINAIRES	28475.00	18425.00	10050.00
21.	LABOR ELECTRICAL DISTRIBUTION	35979.00	5829.00	30150.00
21A.	LABOR STANDBY GENERATOR	4797.20	777.20	4020.00
21B.	LABOR UPS	0.00	0.00	0.00
22.	TOTAL INITIAL LABOR	69251.20	25031.20	44220.00
23.	TOTAL INITIAL INVESTMENT	210661.40	81351.40	129310.00
III.	ILLUMINATION CALCULATIONS			
25.	SPACING OR AREA		120.00	120.00
26.	UTILIZATION FACTOR		0.00	0.00
27.	MAINTENANCE FACTOR		.72	.81
28.	DESIGN FOOTCANDLES		2.00	2.00
29.	INIT COST PER LINEAL FT ~~OR AREA~~	26.20	10.12	16.08

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 19 — HIGH PRESSURE SODIUM W/O UPS PLUS 100 PERCENT QUARTZ BACKUP SCHEME 15 PLUS SCHEME 3

		TOTAL FOR SYSTEM	2X250W HP 120 FT SP	2X1500W QUARTZ 120 FT SP
IV.	ANNUAL COSTS			
30.	KW PER LUMINAIRE		.29	1.50
30A.	KW UPS POWER LOSS		0.00	0.00
31.	TOTAL SYSTEM KW	240.	39.	201.
32.	ANNUAL OPERATION (HOURS)		4000.	20.
33.	TOTAL ENERGY KWH/YEAR	159460.	155440.	4020.
34.	ENERGY COST PER KWH		.0200	.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000	0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	3189.20	3108.80	80.40
37D.	DIESEL FUEL COST	383.78	62.18	321.60
38.	GROUP RELAMPING PERIOD (HOURS)		9500.	1600.
38A.	RATED LAMP LIFE (HOURS)		15000.	2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20	.20
39.	QUANTITY OF REPLACEMENT LAMPS		68.	2.
40.	REPLACEMENT LAMP COST	2602.95	2572.80	30.15
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.42	.01
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0842	.0025
44.	RELAMPING COST - LABOR	232.38	225.68	6.70
46.	CLEANINGS/YEAR/LUMINAIRE		.58	.99
47.	CLEANING COST - LABOR	419.81	155.16	264.65
48.	PAINTING TIME PER POLE		0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1343.08	512.28	830.80
52.	TOTAL ANNUAL MAINTENANCE COST	1995.27	893.12	1102.15
53.	ANNUAL OPERATING COST	8171.20	6636.90	1534.30
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	1.02	.83	.19
VI.	ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	28905.43	10828.83	18076.60
56.	ANNUAL OWNERSHIP + OP"ING COST	37076.63	17465.73	19610.90
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	4.61	2.17	2.44

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 20 — HIGH PRESSURE SODIUM W/O UPS PLUS 75 PERCENT QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X250W HPS 120 FT SP	2X1000W Q 120 FT SP
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	268	134	134
2.	LUMINAIRE COST EACH		240.00	65.00
3.	LUMINAIRE COST TOTAL	40870.00	32160.00	8710.00
4.	QUANTITY OF POLES	67	67	0
5.	MOUNTING HEIGHT		15.00	15.00
6.	POLE + BRACKET COST EACH		70.00	0.00
7.	POLE COST TOTAL		4690.00	0.00
8.	FOUNDATION COST EACH		0.00	0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00	0.00
10.	QTY LAMPS PER LUMINAIRE		1	1
11.	QUANTITY LAMPS		134	134
12.	LAMP COST EACH		38.00	14.00
13.	LAMP COST TOTAL	6968.00	5092.00	1876.00
14.	ELECTRICAL DISTRIBUTION	34572.00	7772.00	26800.00
14A.	STANDBY GENERATOR COST	29386.20	6606.20	22780.00
14C.	UPS COST	0.00	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		51228.20	58290.00
16.	TOTAL INIT EQUIP INCL LAMPS	116486.20	56320.20	60166.00
II.	INITIAL LABOR ESTIMATES			
18.	POLE ERECTION + PAINTING		155.00	0.00
19.	LUMINAIRE LABOR		60.00	75.00
20.	NET LABOR, POLES + LUMINAIRES	28475.00	18425.00	10050.00
21.	LABOR ELECTRICAL DISTRIBUTION	25929.00	5829.00	20100.00
21A.	LABOR STANDBY GENERATOR	3457.20	777.20	2680.00
21B.	LABOR UPS	0.00	0.00	0.00
22.	TOTAL INITIAL LABOR	57861.20	25031.20	32830.00
23.	TOTAL INITIAL INVESTMENT	174347.40	81351.40	92996.00
III.	ILLUMINATION CALCULATIONS			
25.	SPACING OR AREA		120.00	120.00
26.	UTILIZATION FACTOR		0.00	0.00
27.	MAINTENANCE FACTOR		.72	.81
28.	DESIGN FOOTCANDLES		2.00	2.00
29.	INIT COST PER LINEAL FT ~~OF MORE~~	21.69	10.12	11.57

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 20 — HIGH PRESSURE SODIUM W/O UPS PLUS 75 PERCENT QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X250W HPS 120 FT SP	2X1000W Q 120 FT SP
IV.	ANNUAL COSTS			
30.	KW PER LUMINAIRE		.29	1.00
30A.	KW UPS POWER LOSS		0.00	0.00
31.	TOTAL SYSTEM KW	173.	39.	134.
32.	ANNUAL OPERATION (HOURS)		4000.	20.
33.	TOTAL ENERGY KWH/YEAR	158120.	155440.	2680.
34.	ENERGY COST PER KWH		.0200	0.0000
35.	DEMAND CHARGE/KW/MONTH		0.0000	0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	3108.80	3108.80	0.00
37D.	DIESEL FUEL COST	276.58	62.18	214.40
38.	GROUP RELAMPING PERIOD (HOURS)		9500.	1600.
38A.	RATED LAMP LIFE (HOURS)		15000.	2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20	.20
39.	QUANTITY OF REPLACEMENT LAMPS		68.	2.
40.	REPLACEMENT LAMP COST	2600.94	2572.80	28.14
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.42	.01
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0842	.0025
44.	RELAMPING COST - LABOR	232.38	225.68	6.70
46.	CLEANINGS/YEAR/LUMINAIRE		.58	.99
47.	CLEANING COST - LABOR	419.81	155.16	264.65
48.	PAINTING TIME PER POLE		0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1095.18	512.28	582.90
52.	TOTAL ANNUAL MAINTENANCE COST	1747.37	893.12	854.25
53.	ANNUAL OPERATING COST	7733.69	6636.90	1096.79
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.96	.83	.14
VI.	ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	23767.87	10828.83	12939.04
56.	ANNUAL OWNERSHIP + OP"ING COST	31501.56	17465.73	14035.83
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.92	2.17	1.75

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 21 — HIGH PRESSURE SODIUM W/O UPS PLUS 50 PERCENT QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X250W HPS 120 FT SP	3X500W Q 120 FT SP
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	335	134	201
2.	LUMINAIRE COST EACH		240.00	42.00
3.	LUMINAIRE COST TOTAL	40602.00	32160.00	8442.00
4.	QUANTITY OF POLES	67	67	0
5.	MOUNTING HEIGHT		15.00	15.00
6.	POLE + BRACKET COST EACH		70.00	0.00
7.	POLE COST TOTAL		4690.00	0.00
8.	FOUNDATION COST EACH		0.00	0.00
9.	POLE + FOUNDATION COST TOTAL	4690.00	4690.00	0.00
10.	QTY LAMPS PER LUMINAIRE		1	1
11.	QUANTITY LAMPS		134	201
12.	LAMP COST EACH		38.00	13.00
13.	LAMP COST TOTAL	7705.00	5092.00	2613.00
14.	ELECTRICAL DISTRIBUTION	27872.00	7772.00	20100.00
14A.	STANDBY GENERATOR COST	23691.20	6606.20	17085.00
14C.	UPS COST	0.00	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		51228.20	45627.00
16.	TOTAL INIT EQUIP INCL LAMPS	104560.20	56320.20	48240.00
II.	INITIAL LABOR ESTIMATES			
18.	POLE ERECTION + PAINTING		155.00	0.00
19.	LUMINAIRE LABOR		60.00	60.00
20.	NET LABOR, POLES + LUMINAIRES	30485.00	18425.00	12060.00
21.	LABOR ELECTRICAL DISTRIBUTION	20904.00	5829.00	15075.00
21A.	LABOR STANDBY GENERATOR	2787.20	777.20	2010.00
21B.	LABOR UPS	0.00	0.00	0.00
22.	TOTAL INITIAL LABOR	54176.20	25031.20	29145.00
23.	TOTAL INITIAL INVESTMENT	158736.40	81351.40	77385.00
III.	ILLUMINATION CALCULATIONS			
25.	SPACING OR AREA		120.00	120.00
26.	UTILIZATION FACTOR		0.00	0.00
27.	MAINTENANCE FACTOR		.72	.81
28.	DESIGN FOOTCANDLES		2.00	2.00
29.	INIT COST PER LINEAL FT [illegible]	19.74	10.12	9.63

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 21 — HIGH PRESSURE SODIUM W/O UPS PLUS 50 PERCENT QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X250W HPS 120 FT SP	3X500W Q 120 FT SP
IV.	ANNUAL COSTS			
30.	KW PER LUMINAIRE		.29	.50
30A.	KW UPS POWER LOSS		0.00	0.00
31.	TOTAL SYSTEM KW	139.	39.	101.
32.	ANNUAL OPERATION (HOURS)		4000.	20.
33.	TOTAL ENERGY KWH/YEAR	157450.	155440.	2010.
34.	ENERGY COST PER KWH		.0200	.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000	0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	3149.00	3108.80	40.20
37D.	DIESEL FUEL COST	222.98	62.18	160.80
38.	GROUP RELAMPING PERIOD (HOURS)		9500.	1600.
38A.	RATED LAMP LIFE (HOURS)		15000.	2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20	.20
39.	QUANTITY OF REPLACEMENT LAMPS		68.	3.
40.	REPLACEMENT LAMP COST	2612.00	2572.80	39.20
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.42	.01
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0842	.0025
44.	RELAMPING COST - LABOR	235.73	225.68	10.05
46.	CLEANINGS/YEAR/LUMINAIRE		.58	.99
47.	CLEANING COST - LABOR	552.13	155.16	396.98
48.	PAINTING TIME PER POLE		0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	968.55	512.28	456.27
52.	TOTAL ANNUAL MAINTENANCE COST	1756.42	893.12	863.29
53.	ANNUAL OPERATING COST	7740.39	6636.20	1103.49
54.	ANNUAL OP"NG COST PER FT ~~OF LAMP~~	.96	.83	.14
VI.	ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	21446.46	10828.83	10617.62
56.	ANNUAL OWNERSHIP + OP"ING COST	29186.85	17465.73	11721.11
58.	TOTAL PER LINEAL FOOT ~~OF LAMP~~	3.63	2.17	1.46

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRIC

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 22

LOW PRESSURE SODIUM
WITHOUT UPS OR QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	160	160
2.	LUMINAIRE COST EACH		273.00
3.	LUMINAIRE COST TOTAL	43680.00	43680.00
4.	QUANTITY OF POLES	80	80
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		5600.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	5600.00	5600.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		160
12.	LAMP COST EACH		18.00
13.	LAMP COST TOTAL	2880.00	2880.00
14.	ELECTRICAL DISTRIBUTION	4480.00	4480.00
14A.	STANDBY GENERATOR COST	3808.00	3808.00
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		57568.00
16.	TOTAL INIT EQUIP INCL LAMPS	60448.00	60448.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		30.00
20.	NET LABOR, POLES + LUMINAIRES	17200.00	17200.00
21.	LABOR ELECTRICAL DISTRIBUTION	3360.00	3360.00
21A.	LABOR STANDBY GENERATOR	448.00	448.00
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	21008.00	21008.00
23.	TOTAL INITIAL INVESTMENT	158841.00	81456.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		100.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	10.18	10.18

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRI

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 22

LOW PRESSURE SODIUM
WITHOUT UPS OR QUARTZ BACKUP

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP
IV. ANNUAL COSTS			
30.	KW PER LUMINAIRE		.14
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	22.	22.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	89600.	89600.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	1792.00	1792.00
37D.	DIESEL FUEL COST	35.84	35.84
38.	GROUP RELAMPING PERIOD (HOURS)		15000.
38A.	RATED LAMP LIFE (HOURS)		18000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		51.
40.	REPLACEMENT LAMP COST	921.60	921.60
V. ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533
44.	RELAMPING COST - LABOR	170.67	170.67
46.	CLEANINGS/YEAR/LUMINAIRE		.73
47.	CLEANING COST - LABOR	234.67	234.67
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	575.68	575.68
52.	TOTAL ANNUAL MAINTENANCE COST	981.01	981.01
53.	ANNUAL OPERATING COST	3730.45	3730.45
54.	ANNUAL OP"NG COST PER FT ~~OR ACRE~~	.47	.47
VI. ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	11157.79	11157.79
56.	ANNUAL OWNERSHIP + OP"ING COST	14888.25	14888.25
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	1.86	1.86

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 23 — LOW PRESSURE SODIUM WITH 100 PERCENT QUARTZ BACKUP NO UPS

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP	2X1500W Q 100 FT SP
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	320	160	160
2.	LUMINAIRE COST EACH		273.00	65.00
3.	LUMINAIRE COST TOTAL	54080.00	43680.00	10400.00
4.	QUANTITY OF POLES	80	80	0
5.	MOUNTING HEIGHT		15.00	15.00
6.	POLE + BRACKET COST EACH		70.00	0.00
7.	POLE COST TOTAL		5600.00	0.00
8.	FOUNDATION COST EACH		0.00	0.00
9.	POLE + FOUNDATION COST TOTAL	5600.00	5600.00	0.00
10.	QTY LAMPS PER LUMINAIRE		1	1
11.	QUANTITY LAMPS		160	160
12.	LAMP COST EACH		18.00	15.00
13.	LAMP COST TOTAL	5280.00	2880.00	2400.00
14.	ELECTRICAL DISTRIBUTION	52480.00	4480.00	48000.00
14A.	STANDBY GENERATOR COST	44608.00	3808.00	40800.00
14C.	UPS COST	0.00	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		57568.00	99200.00
16.	TOTAL INIT EQUIP INCL LAMPS	162048.00	60448.00	101600.00
II.	INITIAL LABOR ESTIMATES			
18.	POLE ERECTION + PAINTING		155.00	0.00
19.	LUMINAIRE LABOR		30.00	75.00
20.	NET LABOR, POLES + LUMINAIRES	[illegible].00	17200.00	12000.00
21.	LABOR ELECTRICAL DISTRIBUTION	39360.00	3360.00	36000.00
21A.	LABOR STANDBY GENERATOR	5248.00	448.00	4800.00
21B.	LABOR UPS	0.00	0.00	0.00
22.	TOTAL INITIAL LABOR	73808.00	21008.00	52800.00
23.	TOTAL INITIAL INVESTMENT	235856.00	81456.00	154400.00
III.	ILLUMINATION CALCULATIONS			
25.	SPACING OR AREA		100.00	100.00
26.	UTILIZATION FACTOR		0.00	0.00
27.	MAINTENANCE FACTOR		.85	.81
28.	DESIGN FOOTCANDLES		2.00	2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	29.48	10.18	19.30

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 23 — LOW PRESSURE SODIUM WITH 100 PERCENT QUARTZ BACKUP NO UPS

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP	2X1500W Q 100 FT SP
IV.	ANNUAL COSTS			
30.	KW PER LUMINAIRE		.14	1.50
30A.	KW UPS POWER LOSS		0.00	0.00
31.	TOTAL SYSTEM KW	262.	22.	240.
32.	ANNUAL OPERATION (HOURS)		4000.	20.
33.	TOTAL ENERGY KWH/YEAR	94400.	89600.	4800.
34.	ENERGY COST PER KWH		.0200	.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000	0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	1888.00	1792.00	96.00
37D.	DIESEL FUEL COST	419.84	35.84	384.00
38.	GROUP RELAMPING PERIOD (HOURS)		15000.	1600.
38A.	RATED LAMP LIFE (HOURS)		18000.	2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20	.20
39.	QUANTITY OF REPLACEMENT LAMPS		51.	2.
40.	REPLACEMENT LAMP COST	957.60	921.60	36.00
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27	.01
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533	.0025
44.	RELAMPING COST - LABOR	178.67	170.67	8.00
46.	CLEANINGS/YEAR/LUMINAIRE		.73	.99
47.	CLEANING COST - LABOR	550.67	234.67	316.00
48.	PAINTING TIME PER POLE		0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1567.68	575.68	992.00
52.	TOTAL ANNUAL MAINTENANCE COST	2297.01	981.01	1316.00
53.	ANNUAL OPERATING COST	5562.45	3730.45	1832.00
54.	ANNUAL OP"NG COST PER FT ~~OR MORE~~	.70	.47	.23
VI.	ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	32741.79	11157.79	21584.00
56.	ANNUAL OWNERSHIP + OP"ING COST	38304.25	14888.25	23416.00
58.	TOTAL PER LINEAL FOOT ~~OR MORE~~	4.79	1.86	2.93

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 24 — LOW PRESSURE SODIUM WITH 75 PERCENT QUARTZ BACKUP NO UPS

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP	2X1000 W Q 100 FT SP
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	320	160	160
2.	LUMINAIRE COST EACH		273.00	65.00
3.	LUMINAIRE COST TOTAL	54080.00	43680.00	10400.00
4.	QUANTITY OF POLES	80	80	0
5.	MOUNTING HEIGHT		15.00	15.00
6.	POLE + BRACKET COST EACH		70.00	0.00
7.	POLE COST TOTAL		5600.00	0.00
8.	FOUNDATION COST EACH		0.00	0.00
9.	POLE + FOUNDATION COST TOTAL	5600.00	5600.00	0.00
10.	QTY LAMPS PER LUMINAIRE		1	1
11.	QUANTITY LAMPS		160	160
12.	LAMP COST EACH		18.00	14.00
13.	LAMP COST TOTAL	5120.00	2880.00	2240.00
14.	ELECTRICAL DISTRIBUTION	36480.00	4480.00	32000.00
14A.	STANDBY GENERATOR COST	31008.00	3808.00	27200.00
14C.	UPS COST	0.00	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		57568.00	69600.00
16.	TOTAL INIT EQUIP INCL LAMPS	132288.00	60448.00	71840.00
II.	INITIAL LABOR ESTIMATES			
18.	POLE ERECTION + PAINTING		155.00	0.00
19.	LUMINAIRE LABOR		30.00	75.00
20.	NET LABOR, POLES + LUMINAIRES	29200.00	17200.00	12000.00
21.	LABOR ELECTRICAL DISTRIBUTION	27360.00	3360.00	24000.00
21A.	LABOR STANDBY GENERATOR	3648.00	448.00	3200.00
21B.	LABOR UPS	0.00	0.00	0.00
22.	TOTAL INITIAL LABOR	60208.00	21008.00	39200.00
23.	TOTAL INITIAL INVESTMENT	192496.00	81456.00	111040.00
III.	ILLUMINATION CALCULATIONS			
25.	SPACING OR AREA		100.00	100.00
26.	UTILIZATION FACTOR		0.00	0.00
27.	MAINTENANCE FACTOR		.85	.81
28.	DESIGN FOOTCANDLES		2.00	2.00
29.	INIT COST PER LINEAL FT ~~OR MORE~~	24.06	10.18	13.88

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 24 — LOW PRESSURE SODIUM WITH 75 PERCENT QUARTZ BACKUP NO UPS

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP	2X1000 W Q 100 FT SP
IV.	ANNUAL COSTS			
30.	KW PER LUMINAIRE		.14	1.00
30A.	KW UPS POWER LOSS		0.00	0.00
31.	TOTAL SYSTEM KW	182.	22.	160.
32.	ANNUAL OPERATION (HOURS)		4000.	20.
33.	TOTAL ENERGY KWH/YEAR	92800.	89600.	3200.
34.	ENERGY COST PER KWH		.0200	.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000	0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	1856.00	1792.00	64.00
37D.	DIESEL FUEL COST	291.84	35.84	256.00
38.	GROUP RELAMPING PERIOD (HOURS)		15000.	1600.
38A.	RATED LAMP LIFE (HOURS)		18000.	2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20	.20
39.	QUANTITY OF REPLACEMENT LAMPS		51.	2.
40.	REPLACEMENT LAMP COST	955.20	921.60	33.60
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27	.01
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533	.0025
44.	RELAMPING COST - LABOR	178.67	170.67	8.00
46.	CLEANINGS/YEAR/LUMINAIRE		.73	.99
47.	CLEANING COST - LABOR	550.67	234.67	316.00
48.	PAINTING TIME PER POLE		0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1271.68	575.68	696.00
52.	TOTAL ANNUAL MAINTENANCE COST	2001.01	981.01	1020.00
53.	ANNUAL OPERATING COST	5104.05	3730.45	1373.60
54.	ANNUAL OP"NG COST PER FT ~~OR 4CRE~~	.64	.47	.17
VI.	ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	26607.39	11157.79	15449.60
56.	ANNUAL OWNERSHIP + OP"NG COST	31711.45	14888.25	16823.20
58.	TOTAL PER LINEAL FOOT ~~OR 4CRE~~	3.96	1.86	2.10

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 25 — LOW PRESSURE SODIUM WITH 50 PERCENT QUARTZ BACKUP NO UPS

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP	3X500W Q 100 FT SP
I.	INITIAL EQUIPMENT INVESTMENT			
1.	QUANTITY OF LUMINAIRES	400	160	240
2.	LUMINAIRE COST EACH		273.00	42.00
3.	LUMINAIRE COST TOTAL	53760.00	43680.00	10080.00
4.	QUANTITY OF POLES	80	80	0
5.	MOUNTING HEIGHT		15.00	15.00
6.	POLE + BRACKET COST EACH		70.00	0.00
7.	POLE COST TOTAL		5600.00	0.00
8.	FOUNDATION COST EACH		0.00	0.00
9.	POLE + FOUNDATION COST TOTAL	5600.00	5600.00	0.00
10.	QTY LAMPS PER LUMINAIRE		1	1
11.	QUANTITY LAMPS		160	240
12.	LAMP COST EACH		18.00	13.00
13.	LAMP COST TOTAL	6000.00	2880.00	3120.00
14.	ELECTRICAL DISTRIBUTION	28480.00	4480.00	24000.00
14A.	STANDBY GENERATOR COST	24208.00	3808.00	20400.00
14C.	UPS COST	0.00	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		57568.00	54480.00
16.	TOTAL INIT EQUIP INCL LAMPS	118048.00	60448.00	57600.00
II.	INITIAL LABOR ESTIMATES			
18.	POLE ERECTION + PAINTING		155.00	0.00
19.	LUMINAIRE LABOR		30.00	60.00
20.	NET LABOR, POLES + LUMINAIRES	31600.00	17200.00	14400.00
21.	LABOR ELECTRICAL DISTRIBUTION	21360.00	3360.00	18000.00
21A.	LABOR STANDBY GENERATOR	2848.00	448.00	2400.00
21B.	LABOR UPS	0.00	0.00	0.00
22.	TOTAL INITIAL LABOR	55808.00	21008.00	34800.00
23.	TOTAL INITIAL INVESTMENT	173856.00	81456.00	92400.00
III.	ILLUMINATION CALCULATIONS			
25.	SPACING OR AREA		100.00	100.00
26.	UTILIZATION FACTOR		0.00	0.00
27.	MAINTENANCE FACTOR		.85	.81
28.	DESIGN FOOTCANDLES		2.00	2.00
29.	INIT COST PER LINEAL FT [illegible]	21.73	10.18	11.55

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 25 — LOW PRESSURE SODIUM WITH 50 PERCENT QUARTZ BACKUP NO UPS

		TOTAL FOR SYSTEM	2X90W LPS 100 FT SP	3X500W Q 100 FT SP
IV.	ANNUAL COSTS			
30.	KW PER LUMINAIRE		.14	.50
30A.	KW UPS POWER LOSS		0.00	0.00
31.	TOTAL SYSTEM KW	142.	22.	120.
32.	ANNUAL OPERATION (HOURS)		4000.	20.
33.	TOTAL ENERGY KWH/YEAR	92000.	89600.	2400.
34.	ENERGY COST PER KWH		.0200	.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000	0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00	0.00
37.	ANNUAL KWH COST	1840.00	1792.00	48.00
37D.	DIESEL FUEL COST	227.84	35.84	192.00
38.	GROUP RELAMPING PERIOD (HOURS)		15000.	1600.
38A.	RATED LAMP LIFE (HOURS)		18000.	2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20	.20
39.	QUANTITY OF REPLACEMENT LAMPS		51.	4.
40.	REPLACEMENT LAMP COST	968.40	921.60	46.80
V.	ANNUAL MAINTENANCE, LABOR + MATERIALS			
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.27	.01
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0533	.0025
44.	RELAMPING COST - LABOR	182.67	170.67	12.00
46.	CLEANINGS/YEAR/LUMINAIRE		.73	.99
47.	CLEANING COST - LABOR	708.67	234.67	474.00
48.	PAINTING TIME PER POLE		0.00	0.00
50.	PAINTING COST - LABOR	0.00	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1120.48	575.68	544.80
52.	TOTAL ANNUAL MAINTENANCE COST	2011.81	981.01	1030.80
53.	ANNUAL OPERATING COST	5048.05	3730.45	1317.60
54.	ANNUAL OP"NG COST PER FT OR ACRE	.63	.47	.16
VI.	ANNUAL OWNERSHIP + OPERATING COST			
55.	FIXED OWNERSHIP COST	23835.55	11157.79	12677.76
56.	ANNUAL OWNERSHIP + OP"ING COST	28883.61	14888.25	13995.36
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.61	1.86	1.75

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTR

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 26 — DOUBLE FENCE QUARTZ LIGHTING TEST 55A

		TOTAL FOR SYSTEM	1X1500W Q 15 FT MTG 50 FT SP
I.	**INITIAL EQUIPMENT INVESTMENT**		
1.	QUANTITY OF LUMINAIRES	160	160
2.	LUMINAIRE COST EACH		65.00
3.	LUMINAIRE COST TOTAL	10400.00	10400.00
4.	QUANTITY OF POLES	160	160
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		11200.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	11200.00	11200.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		160
12.	LAMP COST EACH		15.00
13.	LAMP COST TOTAL	2400.00	2400.00
14.	ELECTRICAL DISTRIBUTION	48000.00	48000.0
14A.	STANDBY GENERATOR COST	40800.00	40800.0
14C.	UPS COST	0.00	0.00
15.	TOTAL INIT EQUIP LESS LAMPS		110400.00
16.	TOTAL INIT EQUIP INCL LAMPS	112800.00	112800.00
II.	**INITIAL LABOR ESTIMATES**		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	36800.00	36800.00
21.	LABOR ELECTRICAL DISTRIBUTION	36000.00	36000.00
21A.	LABOR STANDBY GENERATOR	4800.00	4800.00
21B.	LABOR UPS	0.00	0.00
22.	TOTAL INITIAL LABOR	77600.00	77600.00
23.	TOTAL INITIAL INVESTMENT	190400.00	190400.00
III.	**ILLUMINATION CALCULATIONS**		
25.	SPACING OR AREA		50.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.81
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	23.80	23.80

U.S. ARMY CORPS OF ENGINEERS, OMAHA DIST

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 26

DOUBLE FENCE QUARTZ LIGHTING
TEST 55A

		TOTAL FOR SYSTEM	1X1500W Q 15 FT MTG 50 FT SP
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		1.50
30A.	KW UPS POWER LOSS		0.00
31.	TOTAL SYSTEM KW	240.	240.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	960000.	960000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	19200.00	19200.00
37D.	DIESEL FUEL COST	384.00	384.00
38.	GROUP RELAMPING PERIOD (HOURS)		1600.
38A.	RATED LAMP LIFE (HOURS)		2000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		480.
40.	REPLACEMENT LAMP COST	7200.00	7200.00
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		2.50
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.5000
44.	RELAMPING COST - LABOR	1600.00	1600.00
46.	CLEANINGS/YEAR/LUMINAIRE		0.00
47.	CLEANING COST - LABOR	0.00	0.00
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	1104.00	1104.00
52.	TOTAL ANNUAL MAINTENANCE COST	2704.00	2704.00
53.	ANNUAL OPERATING COST	29488.00	29488.00
54.	ANNUAL OPING COST PER FT ~~OR ACRE~~	3.69	3.69
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	26696.00	26696.00
56.	ANNUAL OWNERSHIP + OPING COST	56184.00	56184.00
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	7.02	7.02

U.S. ARMY CORPS OF ENGINEERS, OMAHA DIST

ECONOMIC COMPARISION 60

U.S. ARMY CORPS OF ENGINEERS, OMAHA DIST

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 27 — DOUBLE FENCE HIGH PRESSURE SODIUM TEST 90B WITH UPS

		TOTAL FOR SYSTEM	1X400W HPS 15 FT MTG 80 FT SP
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	100	100
2.	LUMINAIRE COST EACH		250.00
3.	LUMINAIRE COST TOTAL	25000.00	25000.00
4.	QUANTITY OF POLES	100	100
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		7000.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	7000.00	7000.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		100
12.	LAMP COST EACH		39.00
13.	LAMP COST TOTAL	3900.00	3900.00
14.	ELECTRICAL DISTRIBUTION	11500.00	11500.00
14A.	STANDBY GENERATOR COST	9775.00	9775.0
14C.	UPS COST	34500.00	34500.00
15.	TOTAL INIT EQUIP LESS LAMPS		87775.00
16.	TOTAL INIT EQUIP INCL LAMPS	91675.00	91675.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	23000.00	23000.00
21.	LABOR ELECTRICAL DISTRIBUTION	8625.00	8625.00
21A.	LABOR STANDBY GENERATOR	1150.00	1150.00
21B.	LABOR UPS	4600.00	4600.00
22.	TOTAL INITIAL LABOR	37375.00	37375.00
23.	TOTAL INITIAL INVESTMENT	129050.00	129050.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		80.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.72
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT [illegible]	16.13	16.13

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 27

DOUBLE FENCE HIGH PRESSURE SODIUM TEST 96B WITH UPS

		TOTAL FOR SYSTEM	1X400W HPS T5 FT MIG 80 FT SP
IV.	**ANNUAL COSTS**		
30.	KW PER LUMINAIRE		.46
30A.	KW UPS POWER LOSS		11.50
31.	TOTAL SYSTEM KW	58.	58.
32.	ANNUAL OPERATION (HOURS)		4000.
33.	TOTAL ENERGY KWH/YEAR	230000.	230000.
34.	ENERGY COST PER KWH		.0200
35.	DEMAND CHARGE/KW/MONTH		0.0000
36.	DEMAND CHARGE PER YEAR	0.00	0.00
37.	ANNUAL KWH COST	4600.00	4600.00
37D.	DIESEL FUEL COST	92.00	92.00
38.	GROUP RELAMPING PERIOD (HOURS)		13000.
38A.	RATED LAMP LIFE (HOURS)		20000.
38B.	PORTION OF LAMPS SPOT REPLACED		.20
39.	QUANTITY OF REPLACEMENT LAMPS		37.
40.	REPLACEMENT LAMP COST	1440.00	1440.00
V.	**ANNUAL MAINTENANCE, LABOR + MATERIALS**		
43.	GROUP RELAMPINGS/YEAR/LUMINAIRE		.31
43A.	SPOT RELAMPINGS/YEAR/LUMINAIRE		.0615
44.	RELAMPING COST - LABOR	123.08	123.08
46.	CLEANINGS/YEAR/LUMINAIRE		.69
47.	CLEANING COST - LABOR	138.46	138.46
48.	PAINTING TIME PER POLE		0.00
50.	PAINTING COST - LABOR	0.00	0.00
51.	REPLACEMENT PARTS, PAINT, ETC.	877.75	877.75
52.	TOTAL ANNUAL MAINTENANCE COST	1139.29	1139.29
53.	ANNUAL OPERATING COST	7271.29	7271.29
54.	ANNUAL OPING COST PER FT ~~OR ACRE~~	.91	.91
VI.	**ANNUAL OWNERSHIP + OPERATING COST**		
55.	FIXED OWNERSHIP COST	17771.30	17771.30
56.	ANNUAL OWNERSHIP + OPING COST	25042.59	25042.59
58.	TOTAL PER LINEAL FOOT ~~OR ACRE~~	3.13	3.13

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

ECONOMIC COMPARISION

PERIMETER LIGHTING SCHEME 28 — DOUBLE FENCE LOW PRESSURE SODIUM TEST 80E WITH UPS

		TOTAL FOR SYSTEM	1X180W LPS 15 FT MTG 60 FT SP
I.	INITIAL EQUIPMENT INVESTMENT		
1.	QUANTITY OF LUMINAIRES	134	134
2.	LUMINAIRE COST EACH		360.00
3.	LUMINAIRE COST TOTAL	48240.00	48240.00
4.	QUANTITY OF POLES	134	134
5.	MOUNTING HEIGHT		15.00
6.	POLE + BRACKET COST EACH		70.00
7.	POLE COST TOTAL		9380.00
8.	FOUNDATION COST EACH		0.00
9.	POLE + FOUNDATION COST TOTAL	9380.00	9380.00
10.	QTY LAMPS PER LUMINAIRE		1
11.	QUANTITY LAMPS		134
12.	LAMP COST EACH		33.00
13.	LAMP COST TOTAL	4422.00	4422.00
14.	ELECTRICAL DISTRIBUTION	8040.00	8040.00
14A.	STANDBY GENERATOR COST	6834.00	6834.00
14C.	UPS COST	24120.00	24120.00
15.	TOTAL INIT EQUIP LESS LAMPS		96614.00
16.	TOTAL INIT EQUIP INCL LAMPS	101036.00	101036.00
II.	INITIAL LABOR ESTIMATES		
18.	POLE ERECTION + PAINTING		155.00
19.	LUMINAIRE LABOR		75.00
20.	NET LABOR, POLES + LUMINAIRES	30820.00	30820.00
21.	LABOR ELECTRICAL DISTRIBUTION	6030.00	6030.00
21A.	LABOR STANDBY GENERATOR	804.00	804.00
21B.	LABOR UPS	3216.00	3216.00
22.	TOTAL INITIAL LABOR	40870.00	40870.00
23.	TOTAL INITIAL INVESTMENT	141906.00	141906.00
III.	ILLUMINATION CALCULATIONS		
25.	SPACING OR AREA		60.00
26.	UTILIZATION FACTOR		0.00
27.	MAINTENANCE FACTOR		.85
28.	DESIGN FOOTCANDLES		2.00
29.	INIT COST PER LINEAL FT ~~OR ACRE~~	17.65	17.65