THE ILLUMINATION OF CANBULAT STADIUM

(GRADUATION PROJECT)

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My grateful thanks are also due to Miss. SEBLA KAYA for her contributions to give the final form to the report.

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ABSTRACT

The aim of this project is to illuminate CANBULAT Stadium in Famagusta by using up-to-date illumination technology. Even if the illuminance level on the play ground is not equal at each point, it should be distributed according to their approximate equality because illumination of stadium must be made in order to let the players and spectators view the play without any difficulty. Also it is an important event that the motions of ball should be observed by the eye.

I obtain some documents about up-to-date stadium illumination by correspondence and with help of my course tutor.

The average illuminance was decided as 500 lux. We also decided on the number of projectors needed. Adding to them I realized to use four corner arrangement with 4 masts. 2000W HPI-T lumps are used. By the aid of computer program the point by point illumination is calculated

PART A

I INTRODUCTION

All the duties that the human being has to perform is in some way affected or governed by light. Human beings for many centuries depended on natural lighting such as the moon, sun and the stars but as the need for better and more efficient lighting grew. We started to depend on artificial lighting.

Up-to the beginning of the later years of the 19th century people were dependent on artificial lighting such as candles, oil lamps and the wood. However the invention of the incandescent lamp by H.GOBEL and A.EDISON opened a new pave wave in illumination technique.

During those years there was nor enough power to feed all the electrical suppleness until W.SIEMENCE invented the dynamo. After making great improvement in the incandescent lamp we arrived to the up-to-date lighting technique, the fluorescent lamp.

1-1 *THE SUBJECT OF ILLUMINATION*

The basic concept of illumination consist of the production, distribution,economics and measurements of light. Illumination has a very important role in the industries of all developed countries. Lighting any place no matter how small is a complex task. The solution of illumination problem can only be solved by the help of an electrical engineer who has technical ability and by an architect who has an artistic ability in illumination.

Nowadays lighting has become one of the most important needs of societies across the world.

As a summary, the following advantages are gained by a sufficient illumination:

(a) Seeing ability of eye.
(b) The health of eye is protected.
(c) The accidents are decreased.
(d) The performance of work is increased.
(e) The capacity of work in commerce is enlarged.
(f) The economical potential is increased.
(g) Security is provided (A street lamp is equivalent to a policemen)
(h) The esthetic feelings and the necessity of comfort are an answer.

1-2 *THE AIM OF ILLUMINATION*

The aim of illumination is to meet the priority of course this is not the only necessity to be met. According to it's purpose the three major necessities of illumination can be listed below.

(a) Physiological illumination : The main aim of physiological illumination is to help us distinguish shapes details and colours. In the installation of this sort of illumination special care should be taken to minimize the danger of physical damage which could generate as a result of faulty installation.

(b) Decorative illumination : In the decoration of homes, work place ...etc. decorative illumination plays a great role. In this type of illumination both the architect and the illumination engineer are very important.

(c) Attractive illumination : The aim of this type of illumination is to draw attention for such things as advertisements or for decorations. In order to accomplish this various lights and techniques are used.

1-3 *THE TYPE OF ILLUMINATION*

The types of illumination are divided into two groups; natural and artificial. Artificial illumination is also dividend into two groups as OUTDOOR and INDOOR.

(a) Natural illumination: It deals with the distribution of the natural light in a most suitable way. It is generally preferred as it is free and easily available

(b) Artificial illumination: It is obtained through electrical devices. The use of artificial illumination is divided into groups with incandescent, discharge and fluorescent lamps.

b-i) INDOOR ILLUMINATION:

Places like houses, schools, hospitals, factories, cinemas and the like are all subject to indoor illumination. Illumination in these places is accomplished through the reflection of the light from the walls and ceilings of the room. Indoor illumination can be divided into groups as direct, semi direct and indirect. For instance if 90-100 % of the light flux of the source is going to escape. This is called direct illumination system. 60-90 %, 40 %, 60 %, 10 %,

40 % and 0-10 % of the lights flux is called semi direct mix, semi indirect and indirect illumination system.

b-ii) OUTDOOR ILLUMINATION:

Outdoor illumination is used to light-up such places as football pitches or any place which has no wall surroundings. Such places need direct light.

PART B

II STADIUM ILLUMINATION

2-1 *BASIC DATA*

(a) FOOTBALL: Football and various other games are outdoor games. As it is played in open air and very often at nights outdoor illumination is very important.

(b) MEASUREMENTS: The size of a football pitch accepted by the FIFA (shown in fig. 1) has a width between 45m-90m and a length of 90m-120m . the width and length of the penalty area is 40.32m and 16.5m consequently. The length of the goal post area is 18.32m with a width of 5.5m. The diameter of pitch center is 9.15m.

(c) SPORTS CENTERS: It is usually arranged according to the number of spectators. Therefore the maximum vision distances for illumination must be taken into consideration. Different illumination techniques are required depending on the type of playground and it's capacity. The material used in these playgrounds varies from sand, gravel or grass. Those playgrounds which has great spectators are called "stadium".

(d) THE IMPORTANCE OF ILLUMINATION: Illumination is very important for both the players and spectators. The most important function of illumination is to follow the motions of the ball which is the smallest item in the playground. Researchers show that in order to perceive and identify a thing in motion illumination level, environment and the degree of illumination play an important role. So the difference of illumination level between ball and playground should be as high as possible.

A playground which has Av. reflection degrees are 0.1 - 0.3, for instance. It is 0.1 - 0.15 at gravel playground and it is 0.15 - 0.25 at lawn playground according to its cut and humidity. According to the material and illumination used with a light colour ball (reflection degree $\rho>0.5$) the intensity of illumination level between ball and playground varies between 2/1 and 5/1.

In this system as the spectators distance from the ball increased the view of the ball decreased. So equal illumination level and high illumination power are accepted. As in graph 1 the visibility angle of a ball of 25cm in diameter can decrease from 4 sec to 8 sec depending on the stadium figure.

For a good solution it is necessary to see and follow a ball which is in motion and to keep a certain perceiving duration. Therefore, when we apply practically those data obtained scientifically, the close relationship can be used between the perceiving duration of view angle, illumination level of surrounding and contrast.

(e) THE SEEING NECESSITY OF PLAYERS: From a scientific point of view the view of a player is limited to 100m. At graph 2, we can see the perceiving duration according to the illumination level. Therefore, the illumination level of a playground should be at least 10 abs (1 candela = 3.4 abs) and the proportion of reflection is between 0.25 and 0.125.

(f) SEEING NECESSITY OF SPECTATORS: In order for the spectators to see the motions of the ball it is necessary

to relate the position stated in graph 4. While the illumination level of a pitch is determined by horizontal illumination power, the distance of spectators from the ball depend on vertical illumination the power of vertical illumination varies in accordance to its place.

Certain measurements would charge the power of vertical, illumination situated at certain places in the middle and edges of playground. The contrast between playground and illumination level can only be at the top part of ball which the contrast of this is only be determined by horizontal illumination.

At the first approach, the illumination level of top part of ball up to 45 degree angle is determined by horizontal illumination. It is shown at fig. 2. In this position, the diameter of top point be 0.7 Of the whole diameter (d).

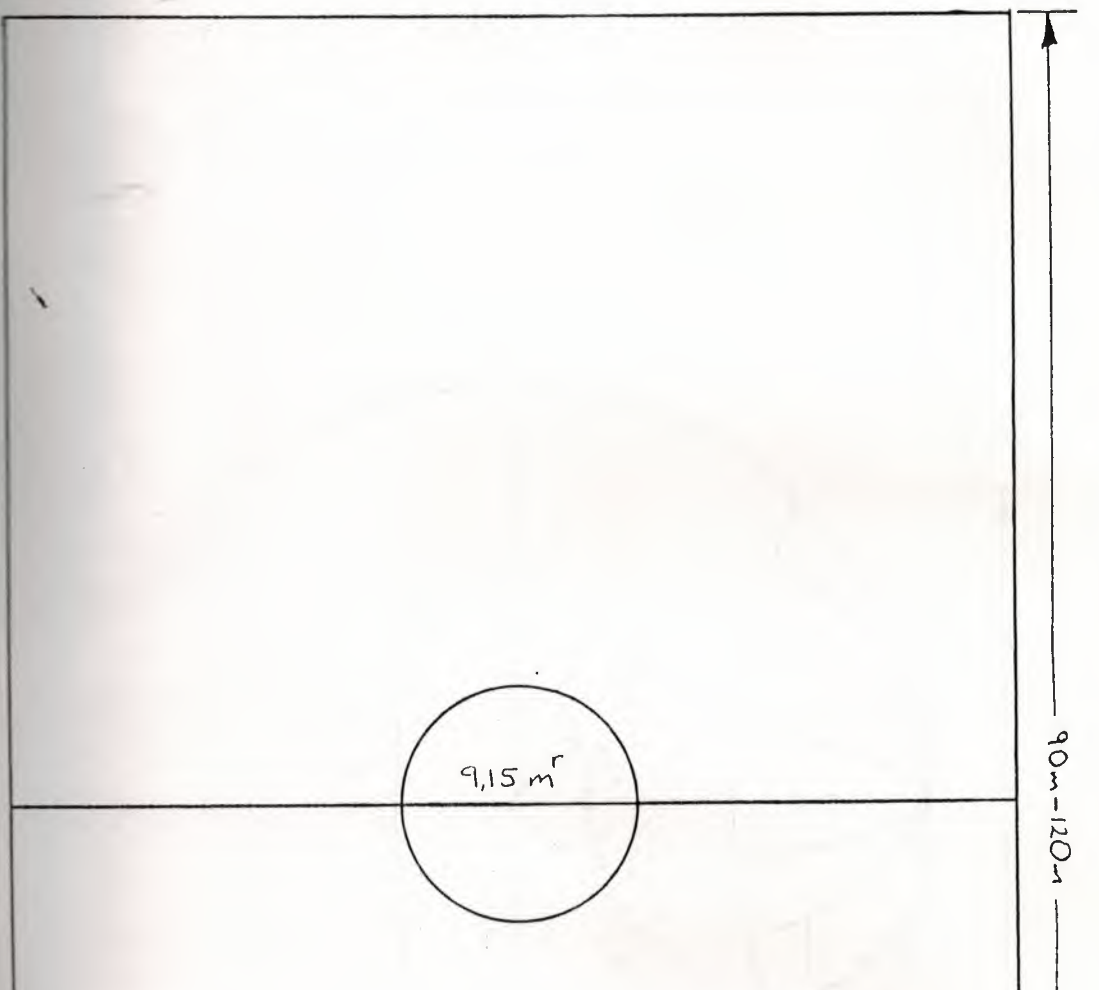
(g) EFFECT OF SHADOW: There should be no shadows on the stadium. This is achieved by multi-directional illumination. Because of the difference in vertical illumination a plastic appearance on human body is given.

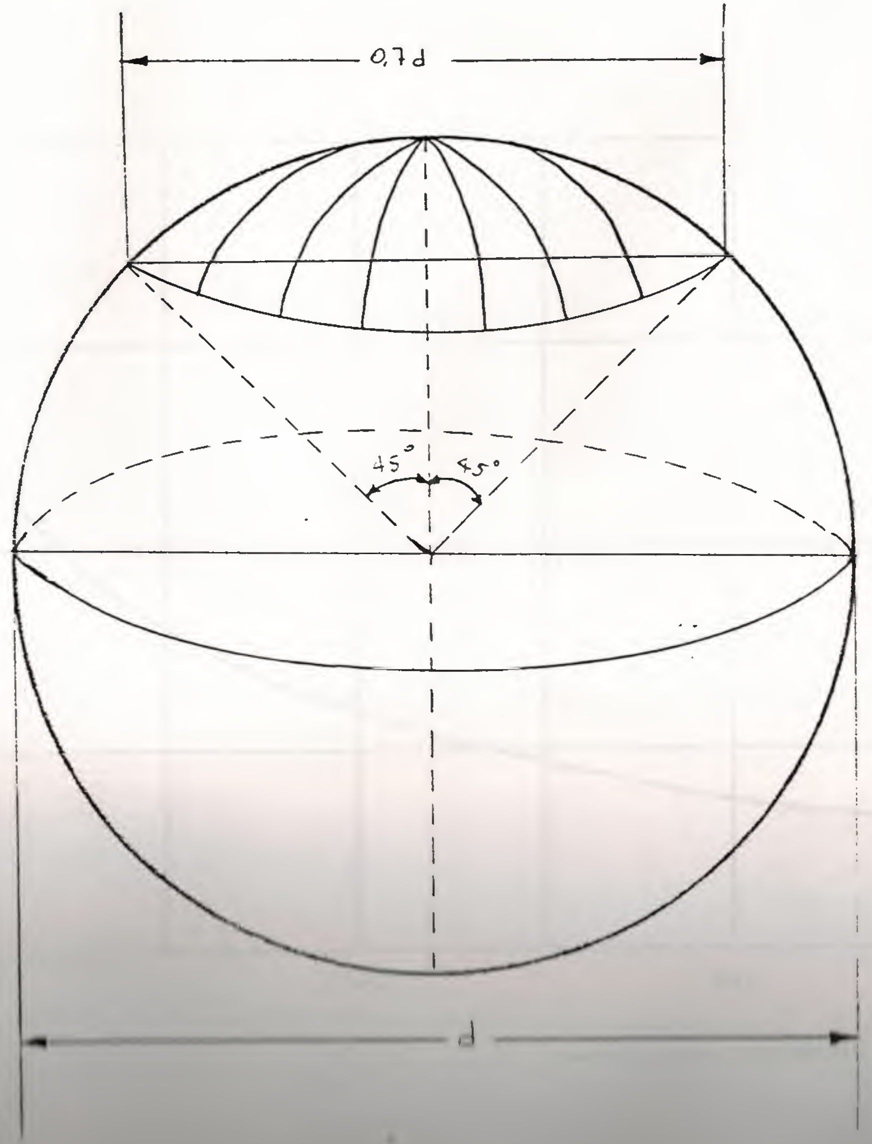
(h) MIXTURE OF LIGHT: The mixture of light is different for spectators and the players. Ideally no light should fall onto the spectators. However this is very hard to do as they are under high vertical illumination. There are physical effects of this;

(i) COLOUR: It is important both spectators as well as players that lights are not spoiled. Specially skin colour should be kept by adding red colour to illumination.

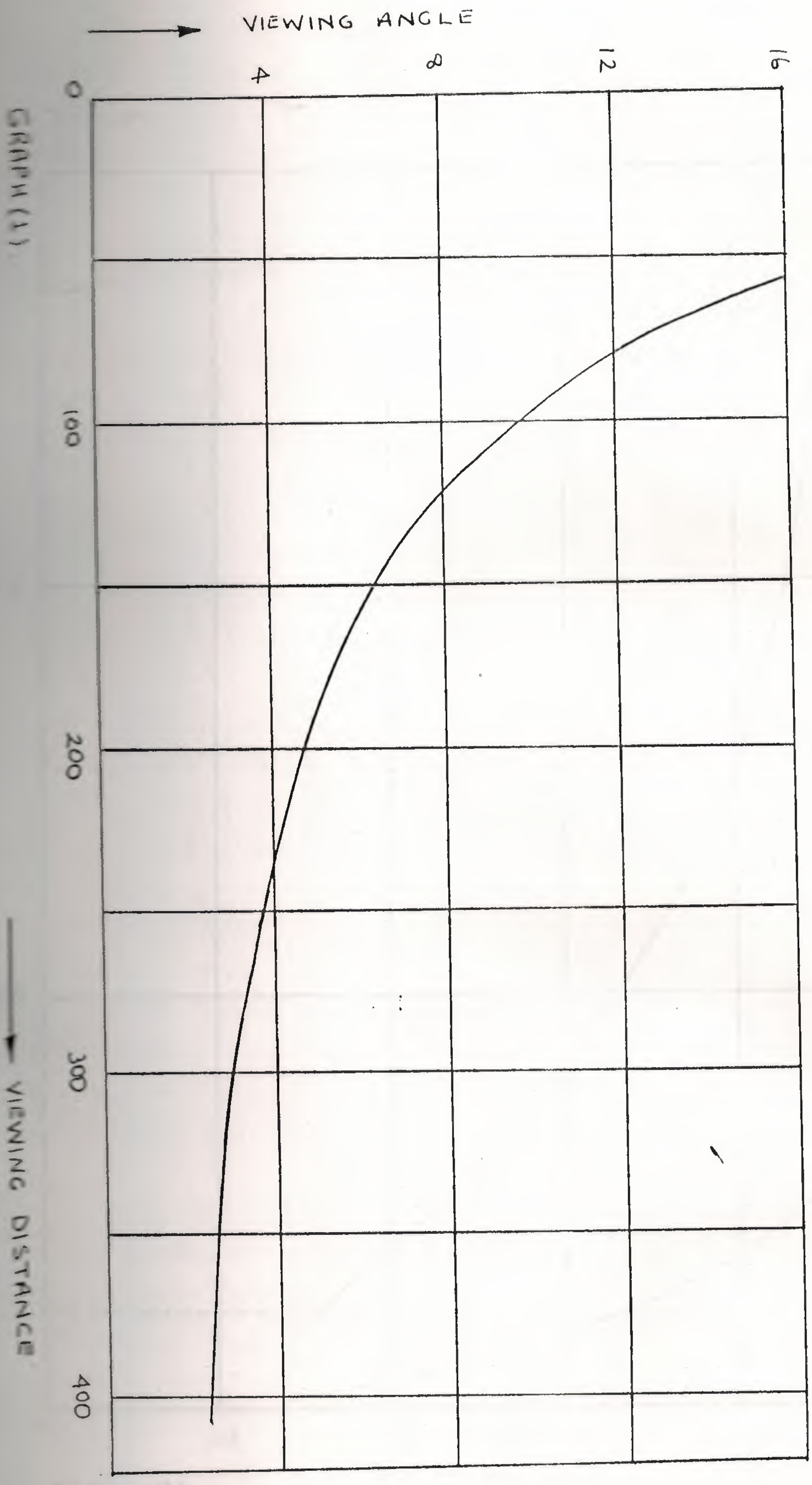
(j) APPROPRIATENESS FOR CAMERA AND TV BROADCASTS: TV and cameras have different sensitivity then the human face. When choosing a light source for television and cameras the vertical illumination should be the average of more than 250 lux as the quality of film is spoiled at less illumination. The average illumination for tv broadcasts should be about 800-1000 lux.

Fig (1)

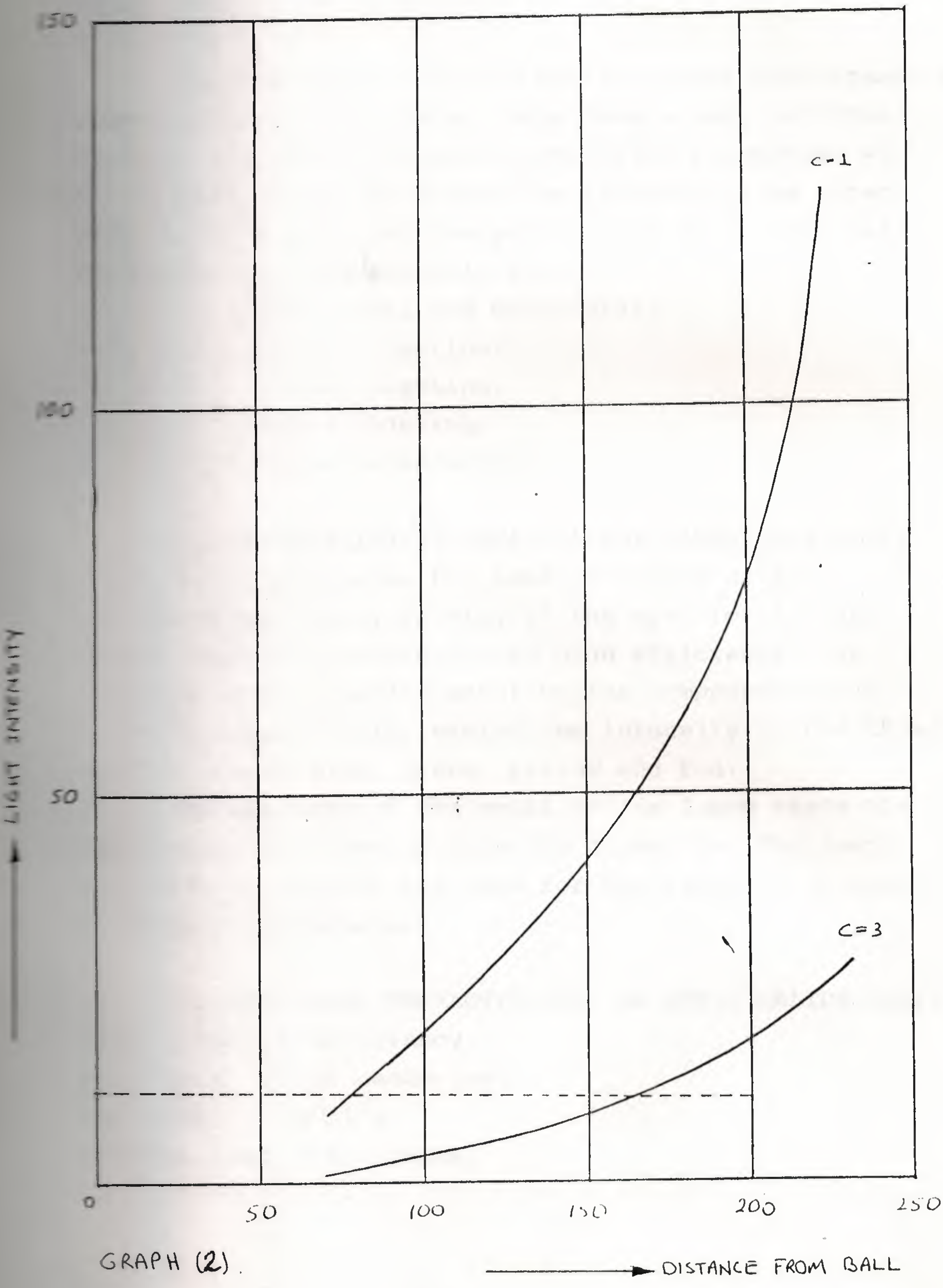




Fig(3)



GRAPH (1)


150
100
50
0
50
100
150
200
250
LIGHT INTENSITY
DISTANCE FROM BALL
c-1
C=3

GRAPH (2).

2-2 *EQUIPMENT*

(a) LIGHT SOURCES: At stadium illumination usually as a light source, metal halide lamps or high-pressure metal halide lamps are used.

(b) DEFINITION OF METAL HALIDE LAMPS: High-pressure metal halide gas discharge lamps have a very luminous efficacy and excellent colour rendering properties with an internal diffusion coating on the hard glass outer bulb and a stable lumen output through their long life, HPI lamps are very suitable for;

- Industrial and commercial.
- Indoor lighting.
- Public lighting.
- Flood lighting.
- Plant irradiation.

(c) DESCRIPTION OF METAL HALIDE LAMPS: Basically HPI-T lamps operate on the same principle as all gas-discharge lamps. In view of the need for a light source rendering combined with high efficiency, the discharge tube contains metal halide compounds which have the effect if increasing the intensity in the three spectral bands blue, green, yellow and red.

The spectrum of the metal halide lamps meets the requirements for colour film and colour tv. The lamps are therefore highly suitable for the lighting of colour television broadcasts.

(d) THE LAMPS CHARACTERISTIC OF METAL HALIDE LAMPS

-High luminous efficiency.
-Excellent colour rendering.
-Reliable, long life.
-Stable lumen maintenance.

(e) APPLICATIONS OF METAL HALIDE LAMPS:

-Lighting for colour tv. broadcasting.
-Lighting for colour films.
-Public lighting.
-Sports ground lighting.
-Flood lighting.
-Industrial and commercial indoor lighting.
-Plant irradiation.

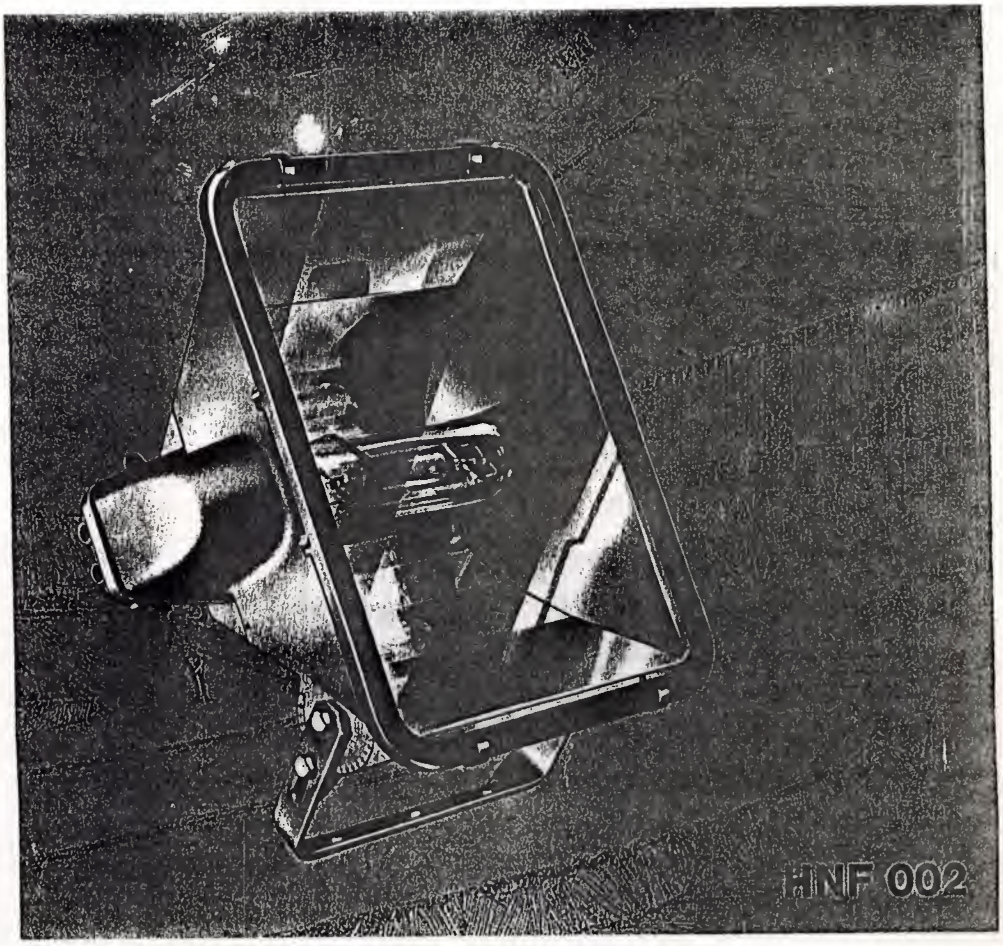
(f) BALLASTS AND IGNITORS: Metal halide lamps require high quality ballast for optimum operation, as well as ignitors to ensure reliable ignition for ballast and ignitors.

(g) TEMPERATURES: Maximum permissible base temperatures;

250 degree C	for	400 W	
300 degree C	for	1000 - 2000 W	

ATION

Floodlight for use with one SON/T 1000 W high-pressure sodium lamp or one HPI/T 2000 W metal halide lamp.



DESCRIPTION

- Housing and rear-cover: rugged all-cast aluminium construction
- Castings of low-copper-content alloy for excellent corrosion-resistance, even in coastal and industrial areas
- Two beam-versions, as different reflectors are available:

	HPI/T 2000 W	SON/T 1000 W
narrow beam	2×9°	2×9°
wide beam	2×23°	2×27°

- High-grade aluminium reflectors for accurate beam control
- Lamp replacement is effected by removing the rear-cover, thus facilitating servicing
- Easy-to-operate stainless-steel clips on the rear-cover; to be closed by hand and opened with a simple tool. The floodlight cannot be easily opened by unauthorized persons.
- Cast-on beam-aiming sight and protractor scale for quick daylight adjustment
- Ozone-resistant ethylene-propylene rubber gasket for jet-proof and dustproof sealing of front glass; 4 extra safety clamps.

APPLICATIONS

- Sports grounds
- Floodlighting of buildings
- Marshalling yards
- Car parks
- Skating rinks
- High-mast lighting
- Sports halls
- Shipyards

ORDERING DATA

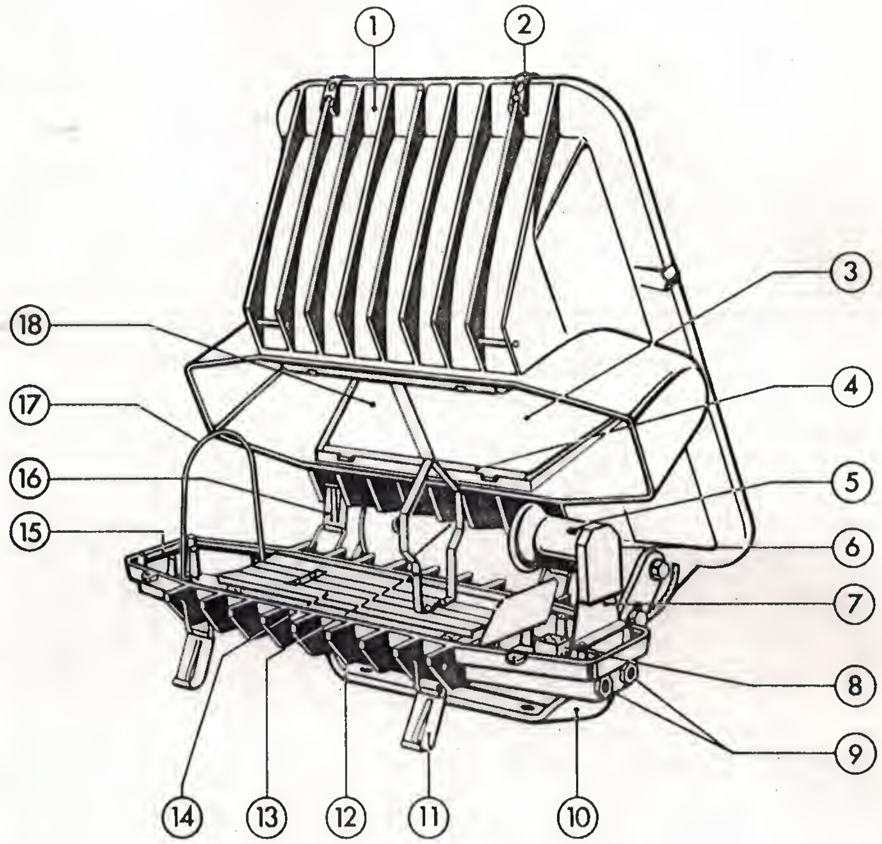
Designation	For lamps	Ordering number*) Narrow-beam type	Wide-beam type	Weight kg
HNF 002	1 × HPI/T 2000 W	9112 718 502	9112 718 503	23,5
	1 × SON/T 1000 W	9112 718 504	9112 718 505	23,5

*) Complete floodlight

FLOODLIGHT FOR HIGH-PRESSURE SODIUM LAMPS OR METAL HALIDE LAMPS

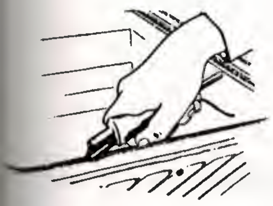
DETAILED DRAWING

1. Housing
2. Safety clamp (4×)
3. Front glass
4. Reflector
5. Lampholder
6. Lampholder insulating plate
7. Lampholder bracket
8. Terminal block
9. Glands for dust-filters
10. Bracket
11. Closing clip top (2×)
12. Rear-cover
13. Lamp support
14. Reflector rear-cover
15. Gasket
16. Closing clip bottom (2×)
17. Additional lamp support
18. Side reflector

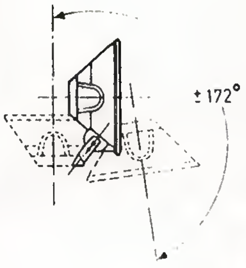


ECIAL TOOL

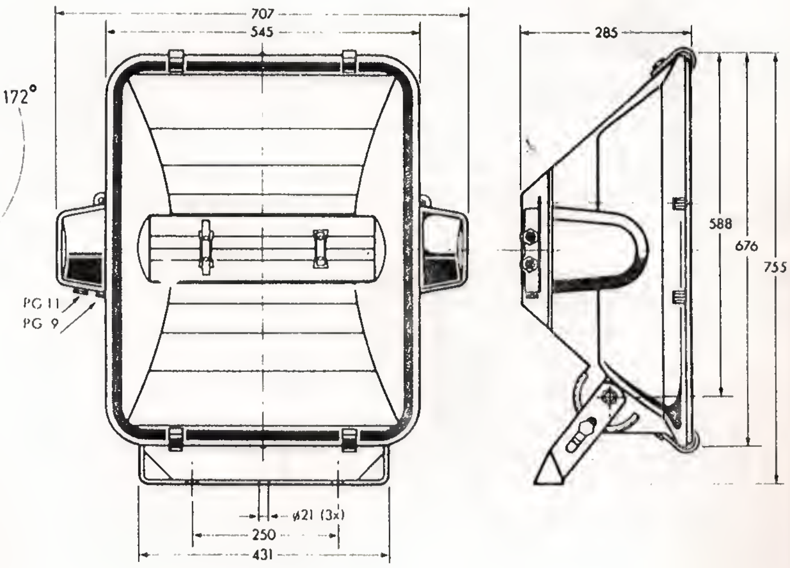
e front glass is provided with
special type of gasket. To re-
ce the glass, a special gas-
insertion tool can be used,
nsisting of a handle with
se removable clips to suit
e different floodlights. Order-
g number for complete set
19 260 005 . .

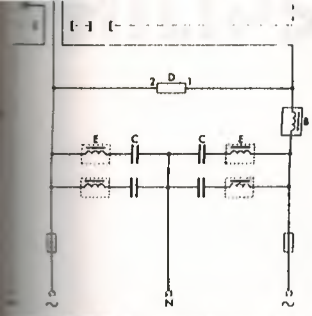


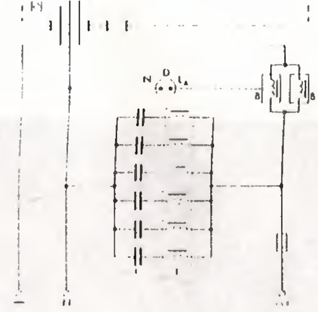
ADJUSTMENT POSSIBILITIES

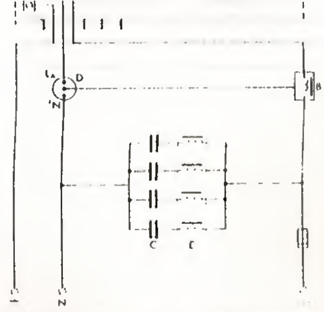


DIMENSIONS





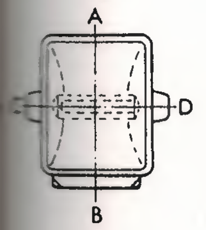




ing grams	For lamps	Mains voltage	Starting current	Operating current	cos φ	A Lamp	B Ballast	C Capacitor	D Ignitor	E Filter coil
	HPI/T 2000 W	380 V	10,9 A	6,4 A	0,9	9280 735 092	9136 070 089	50 μF (25 + 25 paral.)	9136 190 799 . .	2 × 9136 800 011 . . (paral.)
	HPI/T 2000 W	220 V	14,8 A	10,4 A	0,9	9280 736 092	9136 068 103 . .	130μF (4 × 20 + 2 × 25)	9136 190 699 . .	4 × 9136 800 010 . . + 2 × 9136 800 011 . .
	SON/T 1000 W	220 V	13,8 A	10,3 A	0,9	9281 545 092	9136 290 003 .	120 μF (4 × 30)	9136 280 103	4 × 9136 800 009

GHTING DATA

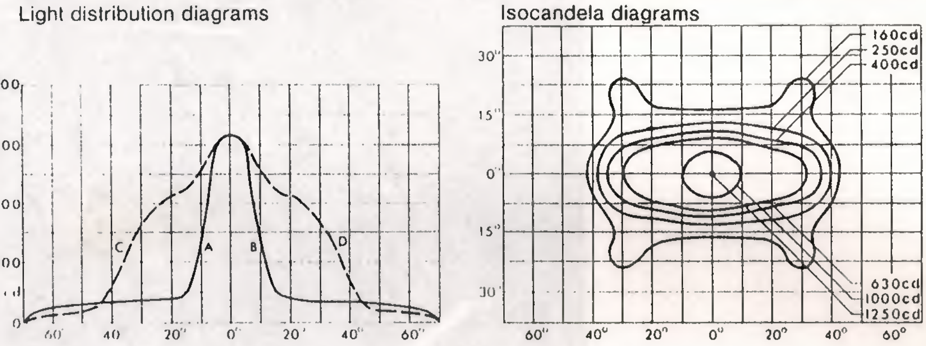
/1000 lm



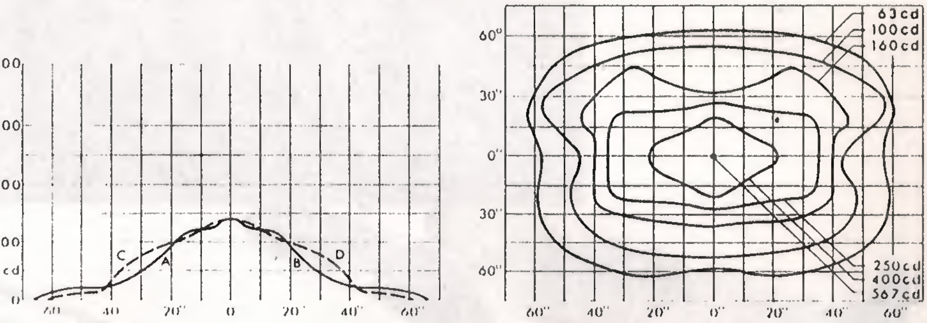
Light distribution diagrams

Isocandela diagrams

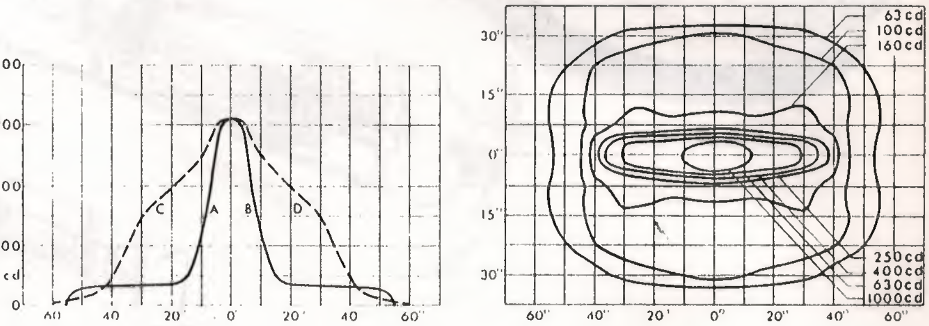
1 × HPI/T 2000 W
narrow beam



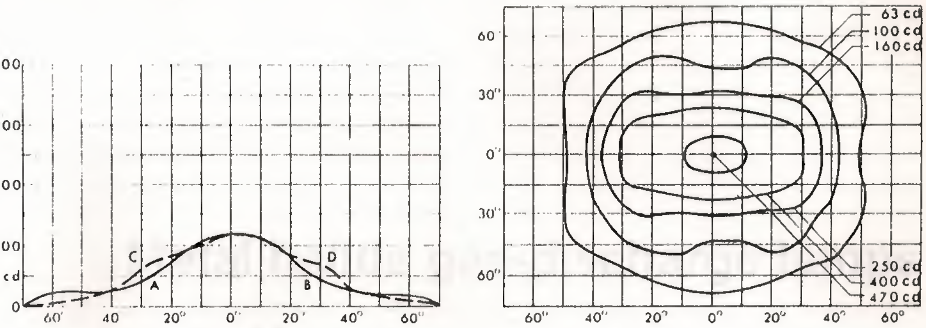
1 × HPI/T 2000 W
wide beam



1 × SON/T 1000 W
narrow beam

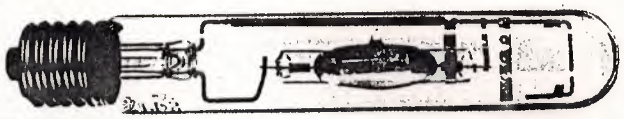


1 × SON/T 1000 W
wide beam



PHILIPS

Metal halide gas-discharge lamps


HPI-T 250 W
HPI-T 400 W


HPI 250 W


HPI 400 W

Why metal halide lamps?

The quick answer to this question is:
- Improved colour appearance
- Improved colour rendering
- High luminous efficacy
- Reliable long life
- Well balanced spectrum

The careful development of the mixture of metal halides has made these features possible. Inside the gas-discharge tube of an HPI lamp there is a precisely measured 'cocktail' of sodium, thallium and indium, all chemically compounded in iodide form.

This particular combination has been found to be very effective in terms of colour characteristics (see pages 8-9) and also in the reliability and stability of the light source.

The range at a glance

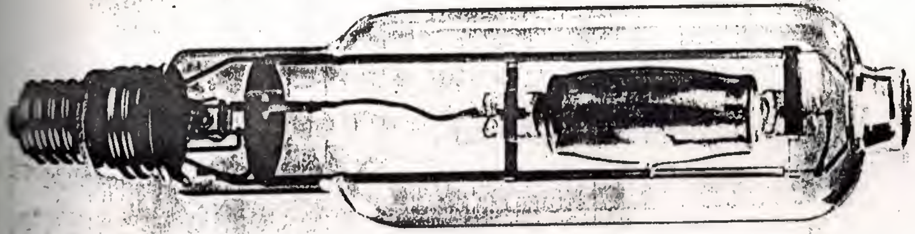
HPI 250W BU - An ovoid coated lamp; can be used with a standard 250W mercury lamp ballast; burning position is vertical base-up.

HPI-T 250W - Tubular in shape, this clear lamp is designed for use with a 250W mercury lamp ballast and external ignitor; burning position is horizontal.

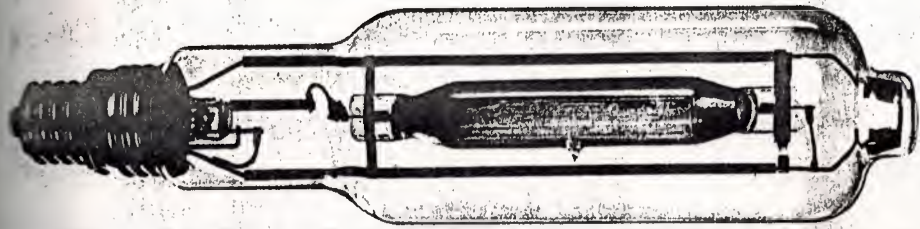
HPI 400W - An ovoid coated lamp for use on a 400W mercury lamp ballast plus external ignitor; burning position is horizontal.

HPI 400W BU, HPI 400W BUS - Both types are ovoid coated lamps;
the 400W BU lamp can be applied in existing HPI installations equipped with ignitors and can also replace 400W dysprosium lamps;

HPI-T 1000 W



HPI-T 2000 W/220 V



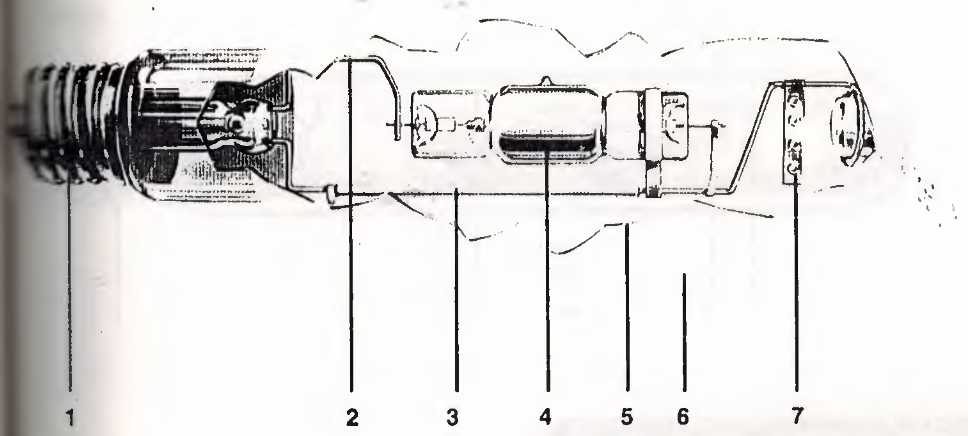
HPI-T 2000 W/380 V

the 400W BUS lamp is self-starting and therefore needs no ignitor; can directly replace a 400W mercury vapour lamp since it is designed to run on a standard 400W mercury lamp ballast; burning position of both lamp types is vertical base-up.

HPI-T 400W - A clear tubular lamp designed for use in optical systems for floodlighting and indoor applications; needs a 400W mercury lamp ballast plus an ignitor; burning position is horizontal.

HPI-T 1000W - Also tubular and clear, this lamp operates on a 1000W mercury lamp ballast with an ignitor; specially designed for floodlighting and illuminating sports arenas; burning position is horizontal.

HPI-T 2000W - Two versions, both tubular and clear, are available: 220V and 380V; the 220V type may be operated in almost any burning position, with minimal colour shift even at steeply tilted angles; ideal for floodlighting large sports stadiums, particularly 4-mast installations; the 380V type is limited to the horizontal burning position; a reliable light source for training fields and floodlighting of large stadiums; both lamp types require an external ignitor; the 220V version needs two parallel 1000W mercury lamp ballasts whilst for the 380V version, a special ballast has been designed.



ow metal halide lamps work

nucleus of a metal halide lamp is the harge tube, manufactured from quartz. Into end of the tube are sealed lead-in wires porting electrodes in the form of tungsten als. Also contained within the tube is a ure of two gases - neon and argon - and metals in iodide form - indium, thallium and ium - plus metallic mercury.

er, the discharge tube is housed in a clear ar hard glass outer bulb (HPI-T) or in an d envelope having a diffusing fluorescent ng (HPI). The whole structure is firmly held ace by support wires and by springs to hion any effects of vibration on the lamp.

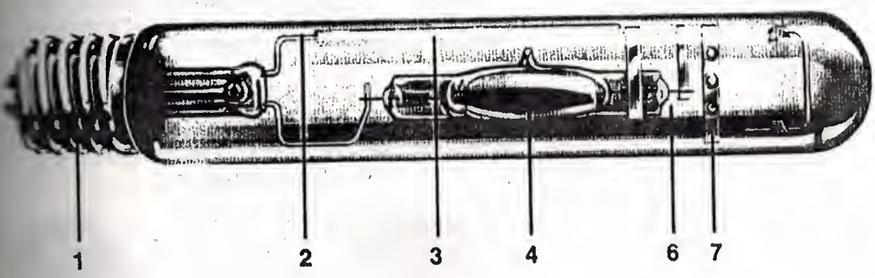
g the space between the discharge tube the outer envelope is a mixture of neon and nitrogen. The former serves to nullify the emission of neon from the discharge tube itself whilst the latter prevents any likelihood of 'flash-over', where a discharge can take place outside the confines of the discharge tube.

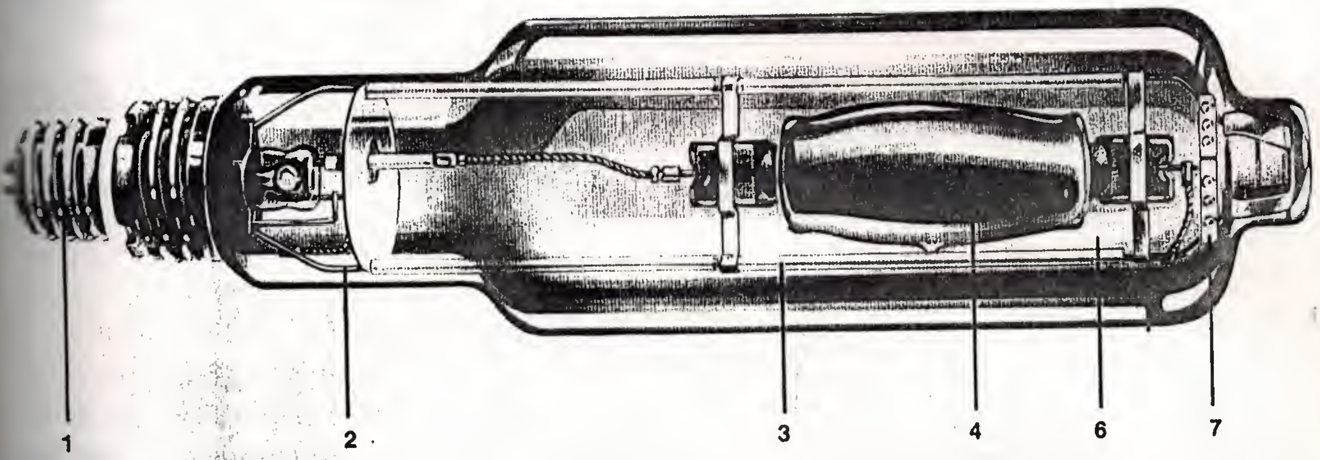
Also located within the outer bulb is a getter whose function is to absorb any impurities in the gases which could otherwise adversely affect the correct running of the lamp; in the case of the metal halide lamps, hydrogen represents the greatest potential danger.

As an additional measure, a sleeve is slid over the support wire to reduce the possibility of 'photo-emission', whereby the sodium deserts the discharge and causes blackening of the outer bulb.

Finally, an E40 lamp base is mechanically

HPI-T





attached to the glass envelope, giving a sturdy overall construction.

In operation, metal halide lamps work on a similar principle to all gas-discharge lamps - that is, light is obtained from an electric discharge occurring between two electrodes inside a discharge tube.

With the aid of the two starting gases, ignition takes place and causes a rise in temperature, followed by evaporation of the mercury and the three iodides. After dissociation of the metal halides, the metals alone are excited and produce specific radiation mainly in the visible part of the spectrum.

The feature of such a discharge is that the three primary colours - red, blue and green - are very well represented in the spectrum. This is not only important for colour quality as perceived by the human eye, but also for the colour sensitivity of colour films and CTV cameras

With the internal fluorescent coating converting UV radiation into visible radiation - and hence improving the colour impression - the ovoid-shaped HPI lamps are especially suited to indoor applications.

Cut-away view

1. Mechanically fitted E40 screw base
2. Lead-in wire / support
3. Sleeve protecting the support
4. Quartz discharge tube
5. Internal phosphor coating
6. Tubular or elliptical hard glass outer bulb, impervious to atmospheric conditions
7. Getter ring for maintaining a clean gas atmosphere, thus ensuring maximum lamp efficacy

ditions of use

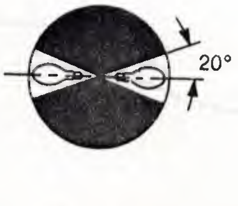
ctory performance of this type of lamp can only be ed if the ballast on which it is operated complies with cations laid down by the lamp manufacturer. Moreover, the supply voltage may not fluctuate more than ± 5% from the oltage of the ballast.

the possibility of personal injury or damage to property from shattering, the BUS (Base Up Self-starting) lamp always be *incorporated in an enclosed luminaire.*

g positions

PI 400 W lamp may only burn in a horizontal position ±20°. BU and BUS lamps may only burn in a vertical position ±15°.

PI 250 W BU
PI 400 W BU and BUS



HPI 400 W

Dimensions

Lamp designation	A max.	B max.	C max.
HPI 250 W BU	227	53	92
HPI 400 W	292	58	122
HPI 400 W BU	292	58	122
HPI 400 W BUS	292	58	122

nical data

gnation	Base	Min. supply voltage for ignition[1] V		Average lamp voltage[2][4] V	Average lamp current[2][4] A	Lamp starting current A(max.)	Minimum permissible lamp wattage[2] W	Average lamp wattage[2][4] W	Maximum permissible lamp wattage[2] W	Average luminous flux[2][4] lm	Average luminance[2][4] cd/cm²	Run-up time[3][4] min.
		+20°C	−18°C									
50 W BU	E40	200	200	125	2,2	3,2	210	250	290	17 500	3,7	3
00 W	E40	200	200	125	3,4	6,0	330	390	450	27 600	3,5	3
00 W BU	E40	200	200	125	3,4	6,0	340	400	460	30 600	3,8	3
00 W BUS	E40	200	200	125	3,4	6,0	340	400	460	30 600	3,8	3

hours. [2] After 100 burning hours.

number of minutes after which the lamp has reached 80% of its final luminous flux. colour rendering properties will be reached after 10-15 minutes.

sured at nominal supply voltage and reference ballast for a free burning lamp.

ering and packing data

ation	Ordering number	Nett weight g	Packing unit			
			Qty	Weight kg	Dimensions cm	Volume m³
50 W BU	9280 767 098 . .	200	12	3,90	47 x 37,5 x 27,5	0,048
00 W	9280 731 098 . .	260	6	3,10	51 x 36 x 37	0,068
00 W BU	9280 743 098 . .	260	6	3,10	51 x 36 x 37	0,068
00 W BUS	9280 747 098 . .	260	6	3,10	51 x 36 x 37	0,068

THE ILLUMINATION OF CANBULAT STADIUM
(GRADUATION PROJECT)

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EASTERN MEDITERRANEAN UNIVERSITY
T.R.N.C.

1992 JULY

ACKNOWLEDGEMENTS

I would like to thank my teachers, friends and those who have helped me to design this project.

My sincere thanks are due to my supervisor ,Prof. HALDUN GURMEN at the department Electrical Engineering in Famagusta who encouraged me in the early stages of this project and provided me the required documents, books, read and commented on the final version of the manuscript.

. I would also like to thank, to close friends of mine, Mr. M. TASEL BABAGIL, who permitted to use his computer for typing the final version of this manuscript and to print it out. He also helped me to write the computer program for point by point illumination.

My grateful thanks are also due to Miss. SEBLA KAYA for her contributions to give the final form to the report.

TABLE OF CONTENT

ABSTRACT

The aim of this project is to illuminate CANBULAT Stadium in Famagusta by using up-to-date illumination technology. Even if the illuminance level on the play ground is not equal at each point, it should be distributed according to their approximate equality because illumination of stadium must be made in order to let the players and spectators view the play without any difficulty. Also it is an important event that the motions of ball should be observed by the eye.

I obtain some documents about up-to-date stadium illumination by correspondence and with help of my course tutor.

The average illuminance was decided as 500 lux. We also decided on the number of projectors needed. Adding to them I realized to use four corner arrangement with 4 masts. 2000W HPI-T lumps are used. By the aid of computer program the point by point illumination is calculated

PART A

I INTRODUCTION

All the duties that the human being has to perform is in some way affected or governed by light. Human beings for many centuries depended on natural lighting such as the moon, sun and the stars but as the need for better and more efficient lighting grew. We started to depend on artificial lighting.

Up-to the beginning of the later years of the 19th century people were dependent on artificial lighting such as candles, oil lamps and the wood. However the invention of the incandescent lamp by H.GOBEL and A.EDISON opened a new pave wave in illumination technique.

During those years there was nor enough power to feed all the electrical suppleness until W.SIEMENCE invented the dynamo. After making great improvement in the incandescent lamp we arrived to the up-to-date lighting technique, the fluorescent lamp.

1-1 *THE SUBJECT OF ILLUMINATION*

The basic concept of illumination consist of the production, distribution,economics and measurements of light. Illumination has a very important role in the industries of all developed countries. Lighting any place no matter how small is a complex task. The solution of illumination problem can only be solved by the help of an electrical engineer who has technical ability and by an architect who has an artistic ability in illumination.

Nowadays lighting has become one of the most important needs of societies across the world.

As a summary, the following advantages are gained by a sufficient illumination:

(a) Seeing ability of eye.

(b) The health of eye is protected.

(c) The accidents are decreased.

(d) The performance of work is increased.

(e) The capacity of work in commerce is enlarged.

(f) The economical potential is increased.

(g) Security is provided (A street lamp is equivalent to a policemen)

(h) The esthetic feelings and the necessity of comfort are an answer.

1-2 *THE AIM OF ILLUMINATION*

The aim of illumination is to meet the priority of course this is not the only necessity to be met. According to it's purpose the three major necessities of illumination can be listed below.

(a) Physiological illumination : The main aim of physiological illumination is to help us distinguish shapes details and colours. In the installation of this sort of illumination special care should be taken to minimize the danger of physical damage which could generate as a result of faulty installation.

(b) Decorative illumination : In the decoration of homes, work place ...etc. decorative illumination plays a great role. In this type of illumination both the architect and the illumination engineer are very important.

(c) Attractive illumination : The aim of this type of illumination is to draw attention for such things as advertisements or for decorations. In order to accomplish this various lights and techniques are used.

1-3 *THE TYPE OF ILLUMINATION*

The types of illumination are divided into two groups; natural and artificial. Artificial illumination is also dividend into two groups as OUTDOOR and INDOOR.

(a) Natural illumination: It deals with the distribution of the natural light in a most suitable way. It is generally preferred as it is free and easily available

(b) Artificial illumination: It is obtained through electrical devices. The use of artificial illumination is divided into groups with incandescent, discharge and fluorescent lamps.

b-i) INDOOR ILLUMINATION:

Places like houses, schools, hospitals, factories, cinemas and the like are all subject to indoor illumination. Illumination in these places is accomplished through the reflection of the light from the walls and ceilings of the room. Indoor illumination can be divided into groups as direct, semi direct and indirect. For instance if 90-100 % of the light flux of the source is going to escape. This is called direct illumination system. 60-90 %, 40 %, 60 %, 10 %,

40 % and 0-10 % of the lights flux is called semi direct mix, semi indirect and indirect illumination system.

b-ii) OUTDOOR ILLUMINATION:

Outdoor illumination is used to light-up such places as football pitches or any place which has no wall surroundings. Such places need direct light.

PART B

II STADIUM ILLUMINATION

2-1 *BASIC DATA*

(a) FOOTBALL: Football and various other games are outdoor games. As it is played in open air and very often at nights outdoor illumination is very important.

(b) MEASUREMENTS: The size of a football pitch accepted by the FIFA (shown in fig. 1) has a width between 45m-90m and a length of 90m-120m . the width and length of the penalty area is 40.32m and 16.5m consequently. The length of the goal post area is 18.32m with a width of 5.5m. The diameter of pitch center is 9.15m.

(c) SPORTS CENTERS: It is usually arranged according to the number of spectators. Therefore the maximum vision distances for illumination must be taken into consideration. Different illumination techniques are required depending on the type of playground and it's capacity. The material used in these playgrounds varies from sand, gravel or grass. Those playgrounds which has great spectators are called "stadium".

(d) THE IMPORTANCE OF ILLUMINATION: Illumination is very important for both the players and spectators. The most important function of illumination is to follow the motions of the ball which is the smallest item in the playground. Researchers show that in order to perceive and identify a thing in motion illumination level, environment and the degree of illumination play an important role. So the difference of illumination level between ball and playground should be as high as possible.

A playground which has Av. reflection degrees are 0.1 - 0.3, for instance. It is 0.1 - 0.15 at gravel playground and it is 0.15 - 0.25 at lawn playground according to its cut and humidity. According to the material and illumination used with a light colour ball (reflection degree $\rho>0.5$) the intensity of illumination level between ball and playground varies between 2/1 and 5/1.

In this system as the spectators distance from the ball increased the view of the ball decreased. So equal illumination level and high illumination power are accepted. As in graph 1 the visibility angle of a ball of 25cm in diameter can decrease from 4 sec to 8 sec depending on the stadium figure.

For a good solution it is necessary to see and follow a ball which is in motion and to keep a certain perceiving duration. Therefore, when we apply practically those data obtained scientifically, the close relationship can be used between the perceiving duration of view angle, illumination level of surrounding and contrast.

(e) THE SEEING NECESSITY OF PLAYERS: From a scientific point of view the view of a player is limited to 100m. At graph 2, we can see the perceiving duration according to the illumination level. Therefore, the illumination level of a playground should be at least 10 abs (1 candela = 3.4 abs) and the proportion of reflection is between 0.25 and 0.125.

(f) SEEING NECESSITY OF SPECTATORS: In order for the spectators to see the motions of the ball it is necessary

to relate the position stated in graph 4. While the illumination level of a pitch is determined by horizontal illumination power, the distance of spectators from the ball depend on vertical illumination the power of vertical illumination varies in accordance to its place.

Certain measurements would charge the power of vertical, illumination situated at certain places in the middle and edges of playground. The contrast between playground and illumination level can only be at the top part of ball which the contrast of this is only be determined by horizontal illumination.

At the first approach, the illumination level of top part of ball up to 45 degree angle is determined by horizontal illumination. It is shown at fig. 2. In this position, the diameter of top point be 0.7 Of the whole diameter (d).

(g) EFFECT OF SHADOW: There should be no shadows on the stadium. This is achieved by multi-directional illumination. Because of the difference in vertical illumination a plastic appearance on human body is given.

(h) MIXTURE OF LIGHT: The mixture of light is different for spectators and the players. Ideally no light should fall onto the spectators. However this is very hard to do as they are under high vertical illumination. There are physical effects of this;

(i) COLOUR: It is important both spectators as well as players that lights are not spoiled. Specially skin colour should be kept by adding red colour to illumination.

(j) APPROPRIATENESS FOR CAMERA AND TV BROADCASTS: TV and cameras have different sensitivity then the human face. When choosing a light source for television and cameras the vertical illumination should be the average of more than 250 lux as the quality of film is spoiled at less illumination. The average illumination for tv broadcasts should be about 800-1000 lux.

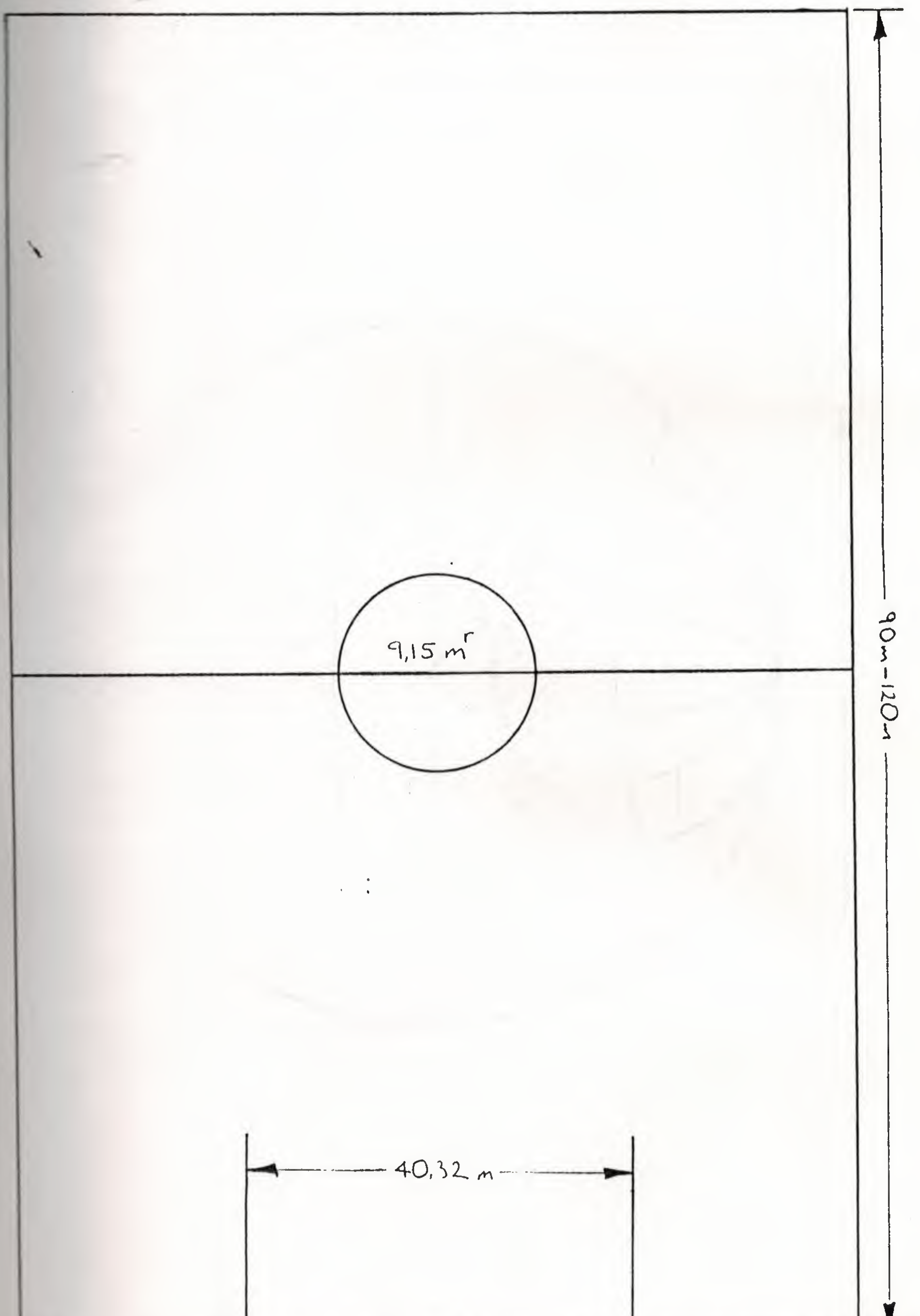
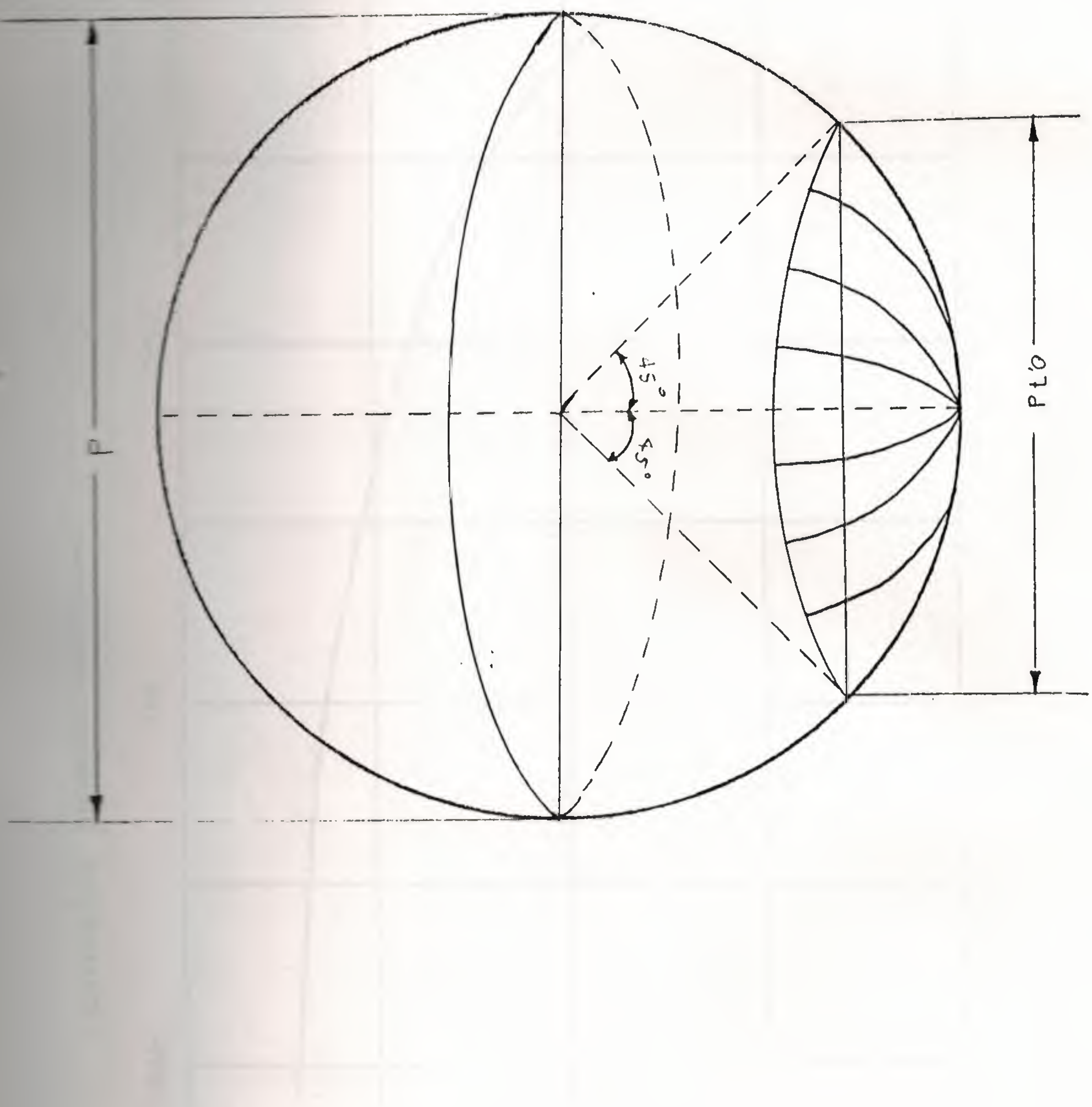
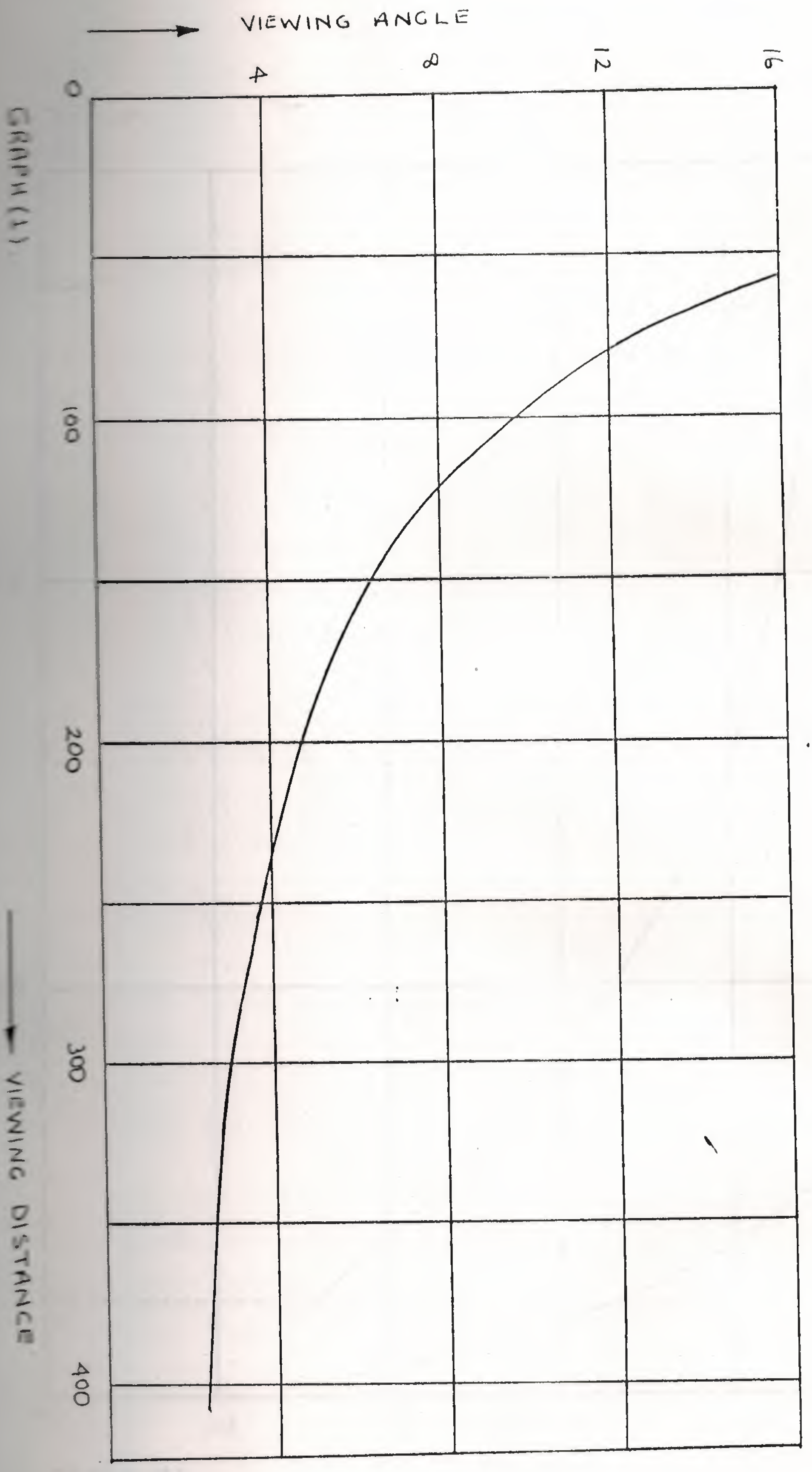


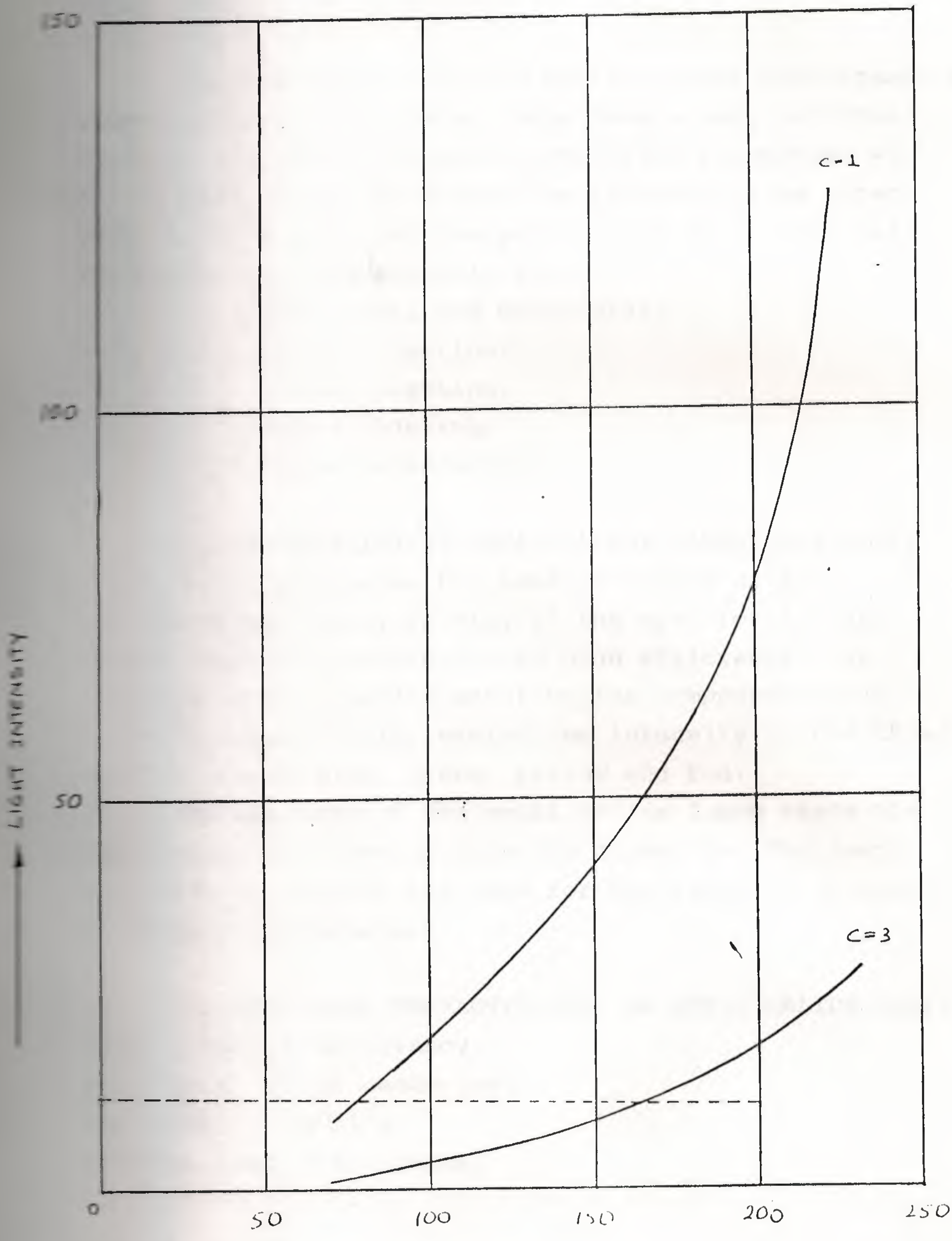
Fig (1)

Fig(3)





GRAPH (1)


150
100
50
0
50
100
150
200
250
LIGHT INTENSITY
c-1
C=3
DISTANCE FROM BALL

GRAPH (2).

2-2 *EQUIPMENT*

(a) LIGHT SOURCES: At stadium illumination usually as a light source, metal halide lamps or high-pressure metal halide lamps are used.

(b) DEFINITION OF METAL HALIDE LAMPS: High-pressure metal halide gas discharge lamps have a very luminous efficacy and excellent colour rendering properties with an internal diffusion coating on the hard glass outer bulb and a stable lumen output through their long life, HPI lamps are very suitable for;

* Industrial and commercial.
* Indoor lighting.
* Public lighting.
* Flood lighting.
* Plant irradiation.

(c) DESCRIPTION OF METAL HALIDE LAMPS: Basically HPI-T lamps operate on the same principle as all gas-discharge lamps. In view of the need for a light source rendering combined with high efficiency, the discharge tube contains metal halide compounds which have the effect if increasing the intensity in the three spectral bands blue, green, yellow and red.

The spectrum of the metal halide lamps meets the requirements for colour film and colour tv. The lamps are therefore highly suitable for the lighting of colour television broadcasts.

(d) THE LAMPS CHARACTERISTIC OF METAL HALIDE LAMPS

-High luminous efficiency.
-Excellent colour rendering.
-Reliable, long life.
-Stable lumen maintenance.

(e) APPLICATIONS OF METAL HALIDE LAMPS:

- -Lighting for colour tv. broadcasting.
- -Lighting for colour films.
- -Public lighting.
- -Sports ground lighting.
- -Flood lighting.
- -Industrial and commercial indoor lighting.
- -Plant irradiation.

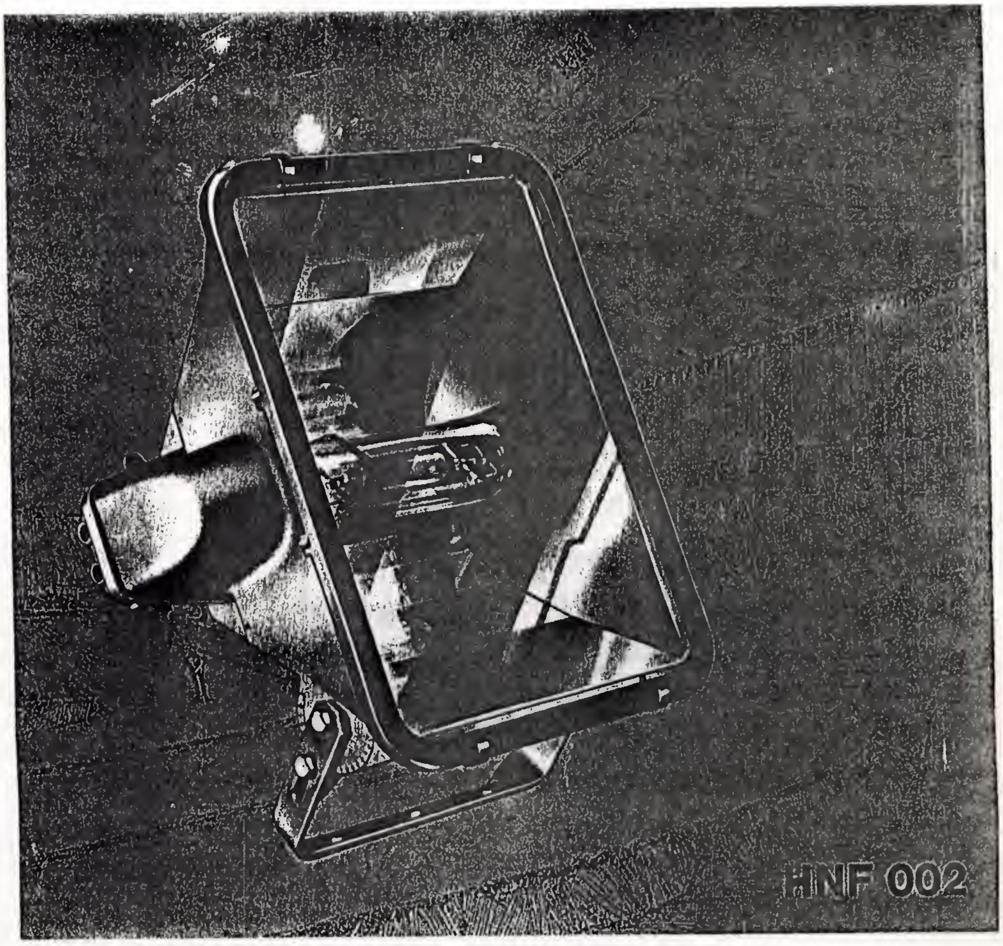
(f) BALLASTS AND IGNITORS: Metal halide lamps require high quality ballast for optimum operation, as well as ignitors to ensure reliable ignition for ballast and ignitors.

(g) TEMPERATURES: Maximum permissible base temperatures;

	250 degree C	for	400 W
	300 degree C	for	1000 - 2000 W

ON

for use with one 000 W high-pressure lamp or one HPI/T etal halide lamp.



RIPTION

- ousing and rear-cover: rugged all-cast aluminium construction
- ings of low-copper-con- for excellent corrosion-resistance, even in coastal and industrial areas
- beam-versions, as different reflectors are available:

	HPI/T 2000 W	SON/T 1000 W
beam	2×9°	2×9°
eam	2×23°	2×27°

- -grade aluminium reflectors for accurate beam control
- Lamp replacement is effected by removing the rear-cover, thus facilitating servicing
- Easy-to-operate stainless-steel clips on the rear-cover; to be closed by hand and opened with a simple tool. The floodlight cannot be easily opened by unauthorized persons.
- Cast-on beam-aiming sight and protractor scale for quick daylight adjustment
- Ozone-resistant ethylene-propylene rubber gasket for jetproof and dustproof sealing of front glass; 4 extra safety clamps.

APPLICATIONS

- Sports grounds
- Floodlighting of buildings
- Marshalling yards
- Car parks
- Skating rinks
- High-mast lighting
- Sports halls
- Shipyards

ORDERING DATA

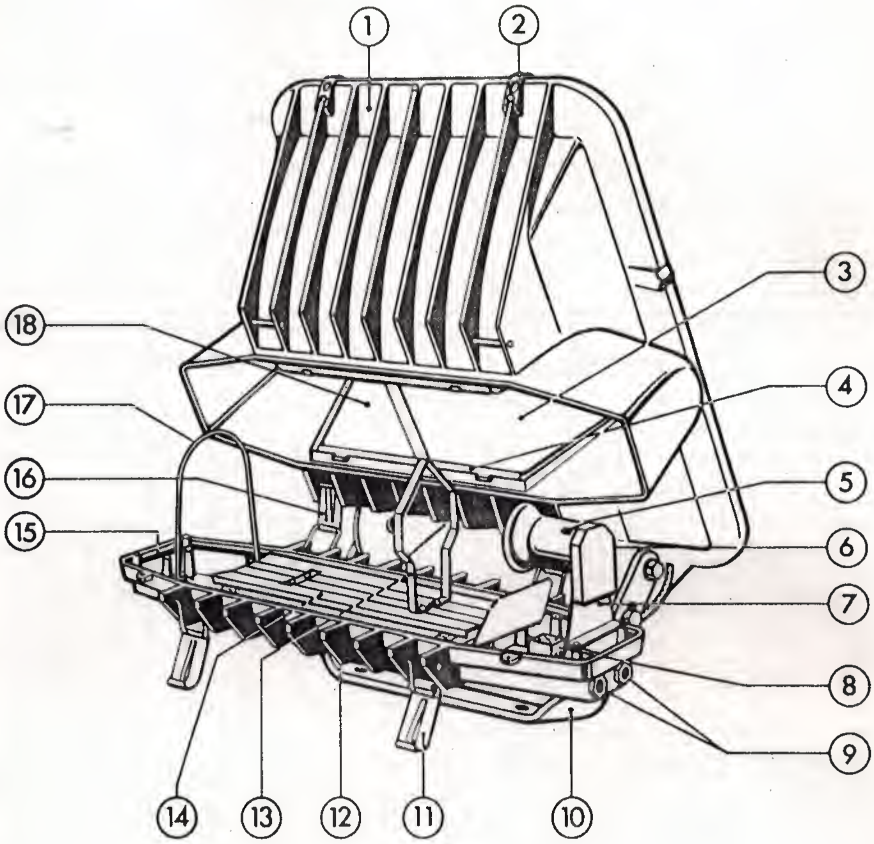
Designation	For lamps	Ordering number *)		Weight kg
		Narrow-beam type	Wide-beam type	
HNF 002	1 × HPI/T 2000 W	9112 718 502 .	9112 718 503 .	23,5
	1 × SON/T 1000 W	9112 718 504	9112 718 505 . .	23,5

*) Complete floodlight

FLOODLIGHT FOR HIGH-PRESSURE SODIUM LAMPS OR METAL HALIDE LAMPS

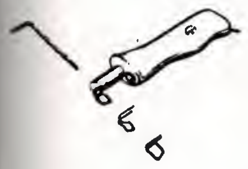
DETAILED DRAWING

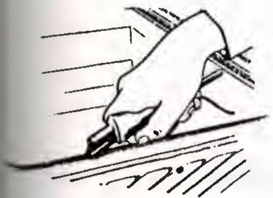
1. Housing
2. Safety clamp (4×)
3. Front glass
4. Reflector
5. Lampholder
6. Lampholder insulating plate
7. Lampholder bracket
8. Terminal block
9. Glands for dust-filters
10. Bracket
11. Closing clip top (2×)
12. Rear-cover
13. Lamp support
14. Reflector rear-cover
15. Gasket
16. Closing clip bottom (2×)
17. Additional lamp support
18. Side reflector



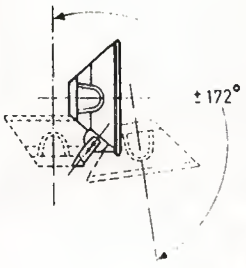
ECIAL TOOL

e front glass is provided with
special type of gasket. To re-
ce the glass, a special gas-
insertion tool can be used,
nsisting of a handle with
e removable clips to suit
different floodlights. Order-
number for complete set
19 260 005 . .

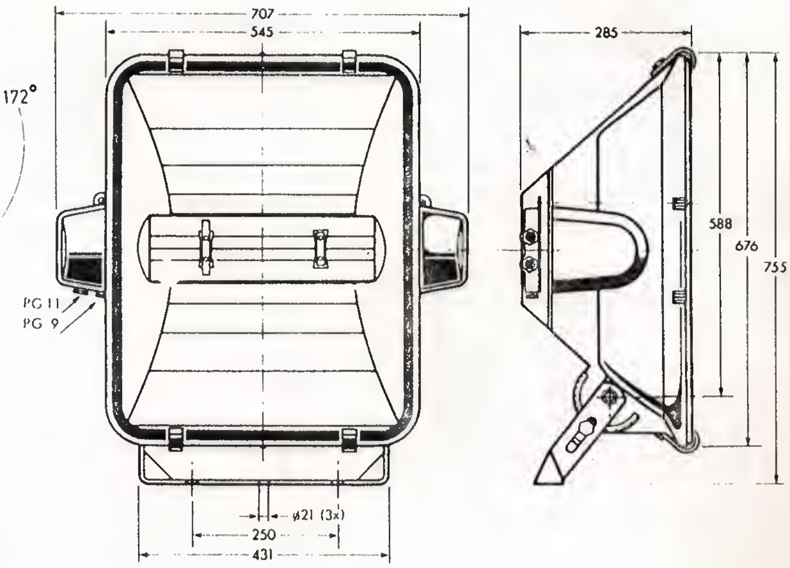


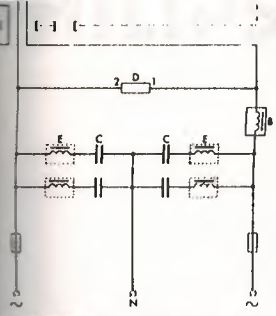


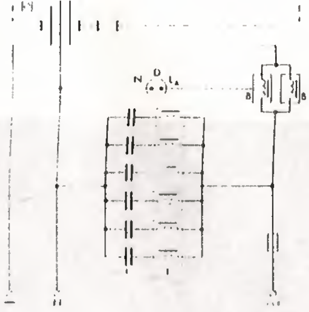
ADJUSTMENT POSSIBILITIES

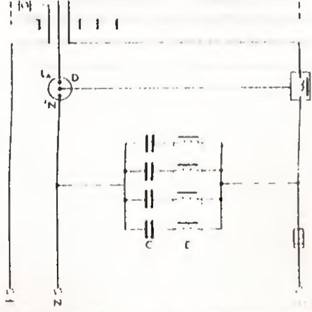


DIMENSIONS







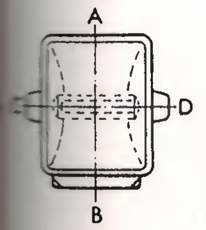


agrams	For lamps	Mains voltage	Starting current	Operating current	cos φ	A Lamp	B Ballast	C Capacitor	D Ignitor	E Filter coil
	HPI/T 2000 W	380 V	10,9 A	6,4 A	0,9	9280 735 092	9136 070 089	50 μF (25 + 25 paral.)	9136 190 799	2 × 9136 800 011 (paral.)
	HPI/T 2000 W	220 V	14,8 A	10,4 A	0,9	9280 736 092	9136 068 103	130μF (4 × 20 + 2 × 25)	9136 190 699	4 × 9136 800 010 + 2 × 9136 800 011
	SON/T 1000 W	220 V	13,8 A	10,3 A	0,9	9281 545 092	9136 290 003	120 μF (4 × 30)	9136 280 103	4 × 9136 800 009

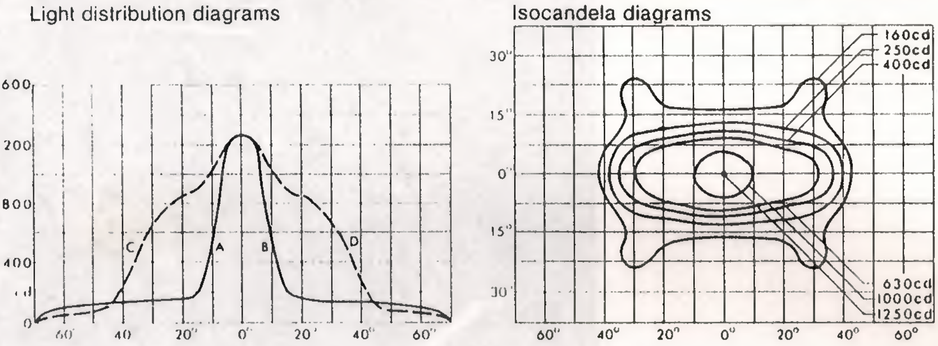
GHTING DATA
/1000 lm

Light distribution diagrams

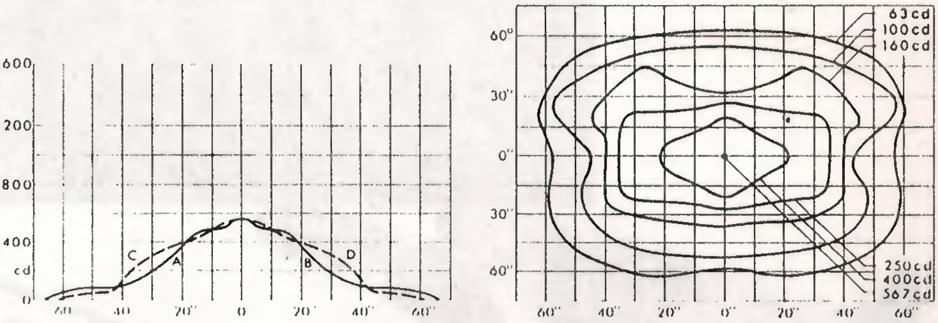
Isocandela diagrams



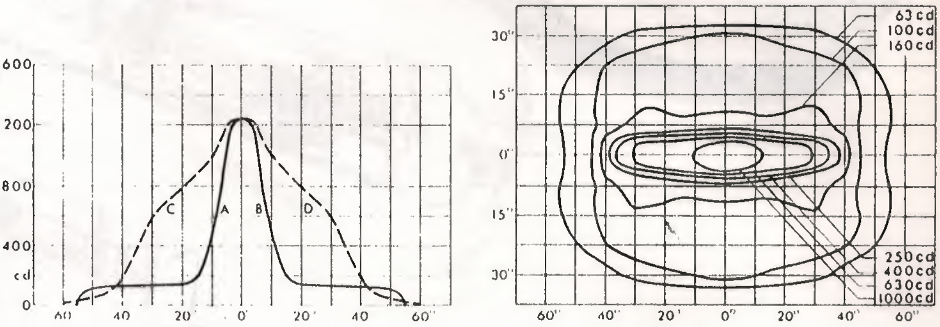
1 × HPI/T 2000 W
narrow beam



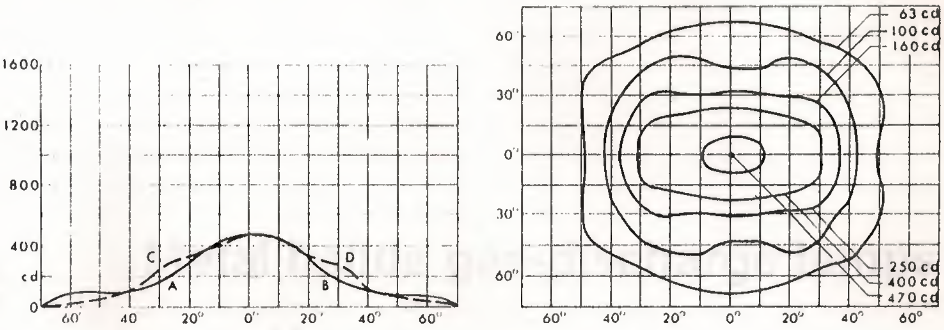
1 × HPI/T 2000 W
wide beam

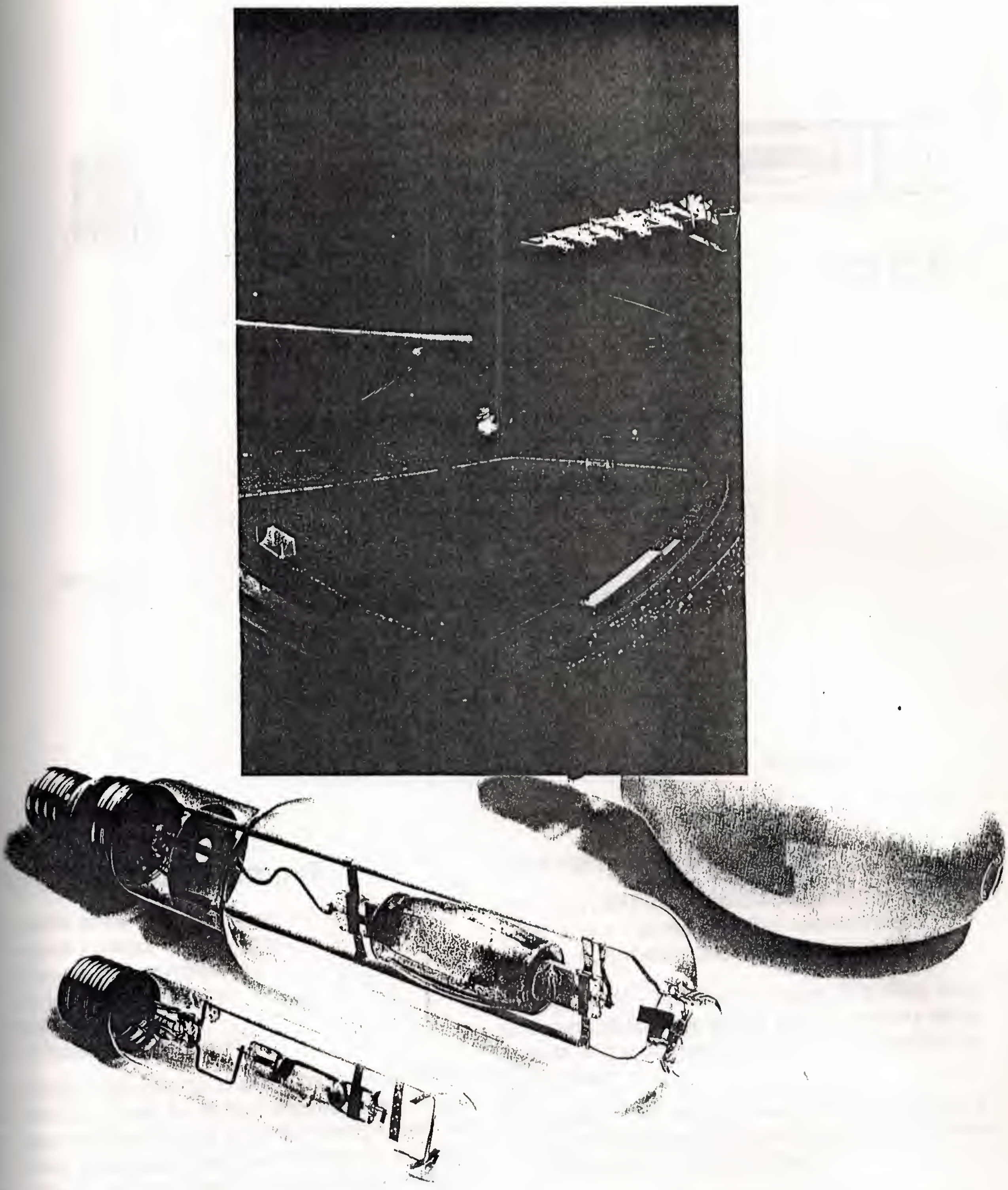


1 × SON/T 1000 W
narrow beam

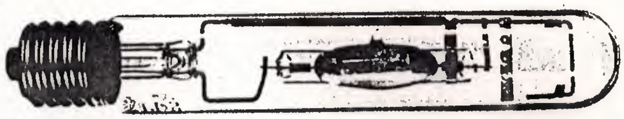


1 × SON/T 1000 W
wide beam





Metal halide gas-discharge lamps


HPI-T 250 W
HPI-T 400 W


HPI 250 W


HPI 400 W

Why metal halide lamps?

The quick answer to this question is:
- Improved colour appearance
- Improved colour rendering
- High luminous efficacy
- Reliable long life
- Well balanced spectrum

The careful development of the mixture of metal halides has made these features possible. Inside the gas-discharge tube of an HPI lamp there is a precisely measured 'cocktail' of sodium, thallium and indium, all chemically compounded in iodide form.

This particular combination has been found to be very effective in terms of colour characteristics (see pages 8-9) and also in the reliability and stability of the light source.

The range at a glance

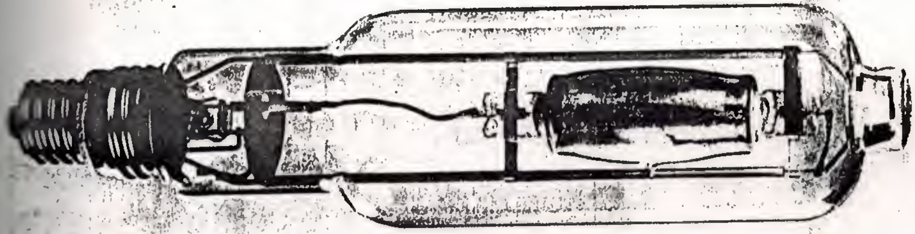
HPI 250W BU - An ovoid coated lamp; can be used with a standard 250W mercury lamp ballast; burning position is vertical base-up.

HPI-T 250W - Tubular in shape, this clear lamp is designed for use with a 250W mercury lamp ballast and external ignitor; burning position is horizontal.

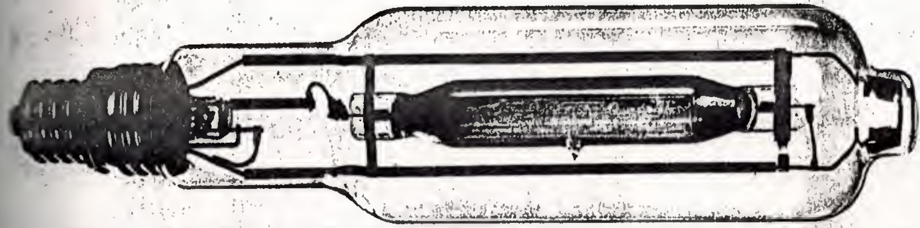
HPI 400W - An ovoid coated lamp for use on a 400W mercury lamp ballast plus external ignitor; burning position is horizontal.

HPI 400W BU, HPI 400W BUS - Both types are ovoid coated lamps;
the 400W BU lamp can be applied in existing HPI installations equipped with ignitors and can also replace 400W dysprosium lamps;

HPI-T 1000 W



HPI-T 2000 W/220 V



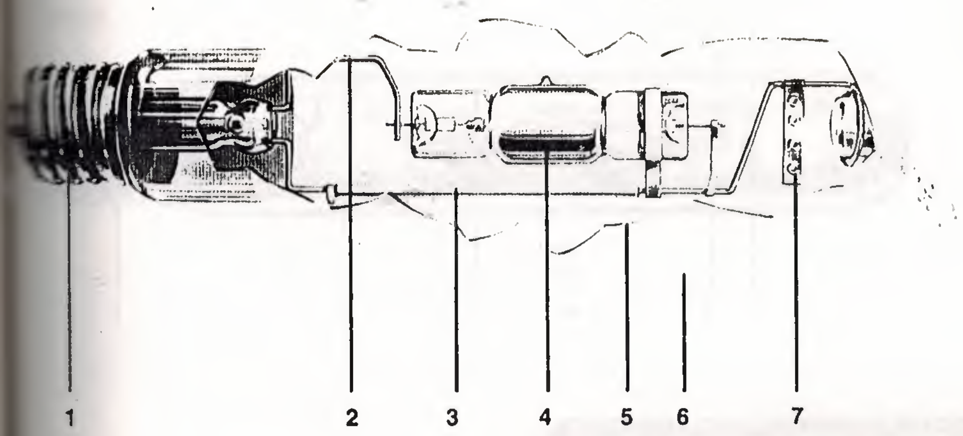
HPI-T 2000 W/380 V

the 400W BUS lamp is self-starting and therefore needs nc ignitor; can directly replace a 400W mercury vapour lamp since it is designed to run on a standard 400W mercury lamp ballast; burning position of both lamp types is vertical base-up.

HPI-T 400W - A clear tubular lamp designed for use in optical systems for floodlighting and indoor applications; needs a 400W mercury lamp ballast plus an ignitor; burning position is horizontal.

HPI-T 1000W - Also tubular and clear, this lamp operates on a 1000W mercury lamp ballast with an ignitor; specially designed for floodlighting and illuminating sports arenas; burning position is horizontal.

HPI-T 2000W - Two versions, both tubular and clear, are available: 220V and 380V;
the 220V type may be operated in almost any burning position, with minimal colour shift even at steeply tilted angles; ideal for floodlighting large sports stadiums, particularly 4-mast installations; the 380V type is limited to the horizontal burning position; a reliable light source for training fields and floodlighting of large stadiums; both lamp types require an external ignitor; the 220V version needs two parallel 1000W mercury lamp ballasts whilst for the 380V version, a special ballast has been designed.



ow metal halide lamps work

e nucleus of a metal halide lamp is the
charge tube, manufactured from quartz. Into
h end of the tube are sealed lead-in wires
porting electrodes in the form of tungsten
rals. Also contained within the tube is a
ture of two gases - neon and argon - and
ee metals in iodide form - indium, thallium and
dium - plus metallic mercury.

ther, the discharge tube is housed in a clear
ular hard glass outer bulb (HPI-T) or in an
oid envelope having a diffusing fluorescent
ing (HPI). The whole structure is firmly held
lace by support wires and by springs to
hion any effects of vibration on the lamp.

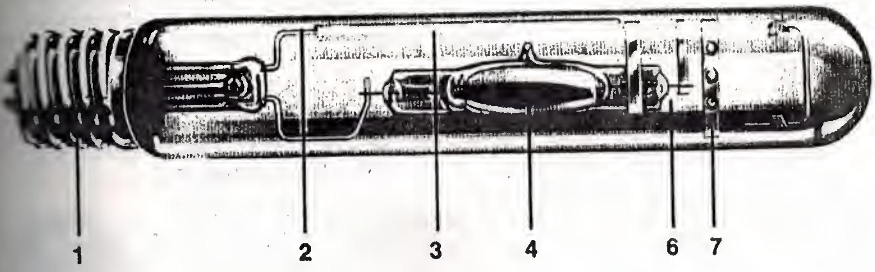
g the space between the discharge tube
the outer envelope is a mixture of neon and nitrogen. The former serves to nullify the emission of neon from the discharge tube itself whilst the latter prevents any likelihood of 'flash-over', where a discharge can take place outside the confines of the discharge tube.

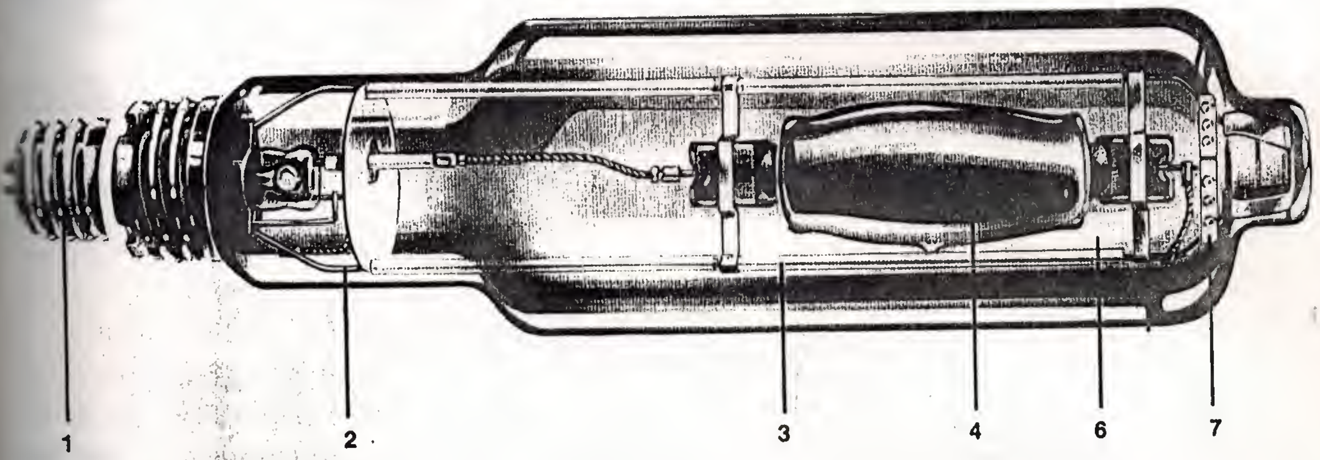
Also located within the outer bulb is a getter whose function is to absorb any impurities in the gases which could otherwise adversely affect the correct running of the lamp; in the case of the metal halide lamps, hydrogen represents the greatest potential danger.

As an additional measure, a sleeve is slid over the support wire to reduce the possibility of 'photo-emission', whereby the sodium deserts the discharge and causes blackening of the outer bulb.

Finally, an E40 lamp base is mechanically

HPI-T





attached to the glass envelope, giving a sturdy overall construction.

In operation, metal halide lamps work on a similar principle to all gas-discharge lamps - that is, light is obtained from an electric discharge occurring between two electrodes inside a discharge tube.

With the aid of the two starting gases, ignition takes place and causes a rise in temperature, followed by evaporation of the mercury and the three iodides. After dissociation of the metal halides, the metals alone are excited and produce specific radiation mainly in the visible part of the spectrum.

The feature of such a discharge is that the three primary colours - red, blue and green - are very well represented in the spectrum. This is not only important for colour quality as perceived by the human eye, but also for the colour sensitivity of colour films and CTV cameras

With the internal fluorescent coating converting UV radiation into visible radiation - and hence improving the colour impression - the ovoid-shaped HPI lamps are especially suited to indoor applications.

Cut-away view

1. Mechanically fitted E40 screw base
2. Lead-in wire / support
3. Sleeve protecting the support
4. Quartz discharge tube
5. Internal phosphor coating
6. Tubular or elliptical hard glass outer bulb, impervious to atmospheric conditions
7. Getter ring for maintaining a clean gas atmosphere, thus ensuring maximum lamp efficacy

ditions of use

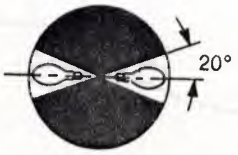
ctory performance of this type of lamp can only be ed if the ballast on which it is operated complies with cations laid down by the lamp manufacturer. Moreover, the supply voltage may not fluctuate more than ± 5% from the oltage of the ballast.

oid the possibility of personal injury or damage to property g from shattering, the BUS (Base Up Self-starting) lamp always *be incorporated in an enclosed luminaire.*

ng positions

PI 400 W lamp may only burn in a horizontal position ±20°. BU and BUS lamps may only burn in a vertical position ±15°.

PI 250 W BU
PI 400 W BU and BUS



HPI 400 W

Dimensions

Lamp designation	A max.	B max.	C max.
HPI 250 W BU	227	53	92
HPI 400 W	292	58	122
HPI 400 W BU	292	58	122
HPI 400 W BUS	292	58	122

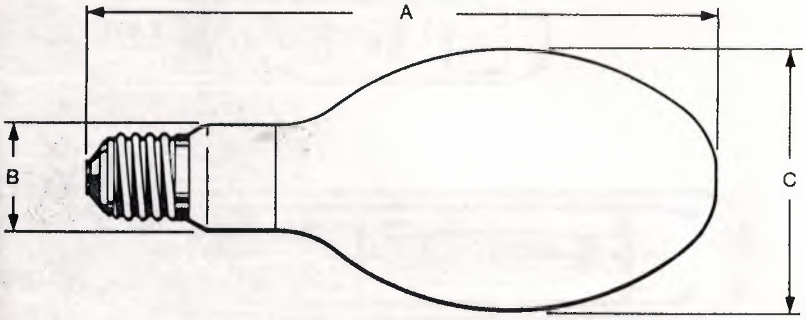
nical data

gnation	Base	Min. supply voltage for ignition1) V		Average lamp voltage2)4) V	Average lamp current2)4) A	Lamp starting current A(max.)	Minimum permissible lamp wattage2) W	Average lamp wattage2)4) W	Maximum permissible lamp wattage2) W	Average luminous flux2)4) lm	Average luminance2)4) cd/cm²	Run-up time3)4) min.
		+20°C	−18°C									
250 W BU	E40	200	200	125	2,2	3,2	210	250	290	17 500	3,7	3
400 W	E40	200	200	125	3,4	6,0	330	390	450	27 600	3,5	3
400 W BU	E40	200	200	125	3,4	6,0	340	400	460	30 600	3,8	3
400 W BUS	E40	200	200	125	3,4	6,0	340	400	460	30 600	3,8	3

hours. 2) After 100 burning hours.
e number of minutes after which the lamp has reached 80% of its final luminous flux.
al colour rendering properties will be reached after 10-15 minutes.
easured at nominal supply voltage and reference ballast for a free burning lamp.

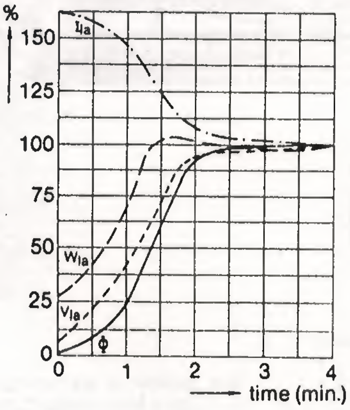
ering and packing data

ation	Ordering number	Nett weight g	Packing unit			
			Qty	Weight kg	Dimensions cm	Volume m³
50 W BU	9280 767 098 . .	200	12	3,90	47 x 37,5 x 27,5	0,048
00 W	9280 731 098 . .	260	6	3,10	51 x 36 x 37	0,068
00 W BU	9280 743 098 . .	260	6	3,10	51 x 36 x 37	0,068
00 W BUS	9280 747 098 . .	260	6	3,10	51 x 36 x 37	0,068

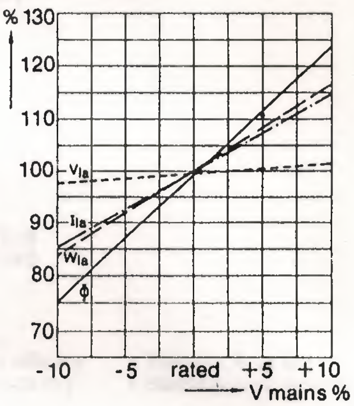


Typical curves

Lamp performance during starting period

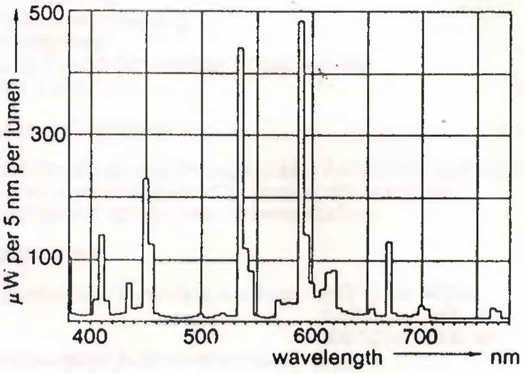


Effects of mains voltage variations

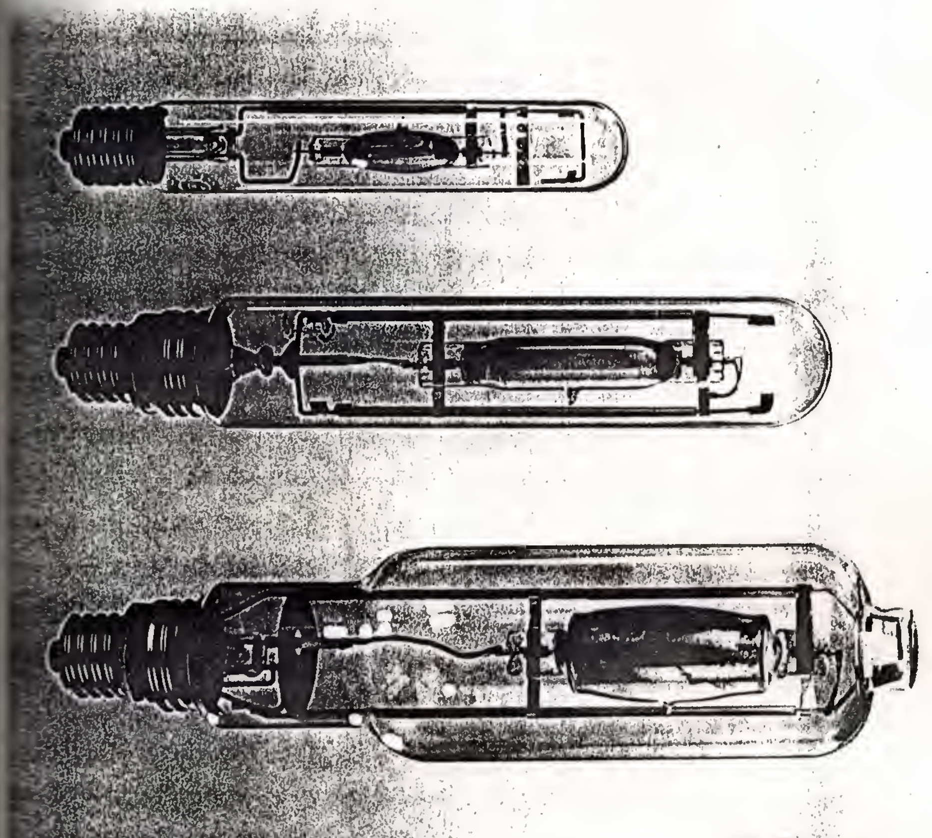


W_{la} = lamp wattage
V_{la} = lamp voltage
I_{la} = lamp current
Φ = luminous flux

Normalised spectral power distribution



HPI-T lamps



HPI-T 250 W
HPI-T 400 W
HPI-T 1000 W
HPI-T 2000 W/220
HPI-T 2000 W/380

efinition

gh-pressure metal halide gas-discharge lamps, for indoor and door use, with iodide additives indium, thallium and sodium in e mercury discharge. The discharge tube is enclosed in a ar, tubular hard glass outer bulb.

escription

- Basically, HPI-T lamps operate om the same principe as all gas-discharge lamps.
- In view of the need for a light source with excellent colour rendering combined with high efficacy, the discharge tube contains metal halide compounds which have the effect of increasing the intensity of the radiation in the three spectral bands blue, green and yellow-red. Consequently, the colour appearance and colour rendering are improved and the luminous efficacy is considerably increased.
- When used together with the appropriate optical systems, this combination provides a highly efficient source of accurately controlled, powerful beams of light.
- The spectrum of the metal halide lamp meets the requirements for colour film and colour television. The lamps are therefore highly suitable for the lighting of colour television broadcasts.

Lamp characteristics:
- Very high luminous efficacy
- Excellent colour rendering
- Reliable, long life
- Stable lumen maintenance

Applications

- Lighting for colour TV broadcasting
- Lighting for colour filming
- Public lighting
- Sports ground lighting
- Floodlighting
- Industrial and commercial indoor lighting
- Plant irradiation

Ballasts and ignitors

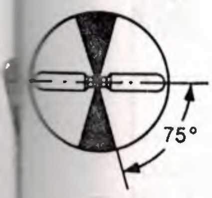
Metal halide lamps require high quality ballasts for optimum operation, as well as ignitors to ensure reliable ignition.
For ballasts and ignitors see relevant leaflets.

Temperatures

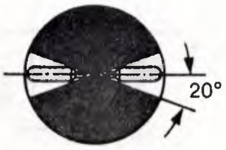
Max. permissible base temperatures:	250°C for 400W
	300°C for 1000 W
	300°C for 2000 W
Max. permissible bulb termperature:	600°C

urning positions

e HPI-T 250 W, HPI-T 400 W, HPI-T 1000 W and HPI-T 2000 W, 80 V lamps may burn in a horizontal position ± 20° only, while e burning angle of the HPI-T 2000 W, 220 V lamp may be varied y approximately 75° from the horizontal. This means that the 000 W, 220 V lamp can be used in rotation-symmetrical oodlights in a declined position without the colour rendering roperties being affected.



PI-T 2000 W/220 V



HPI-T 250 W
HPI-T 400 W
HPI-T 1000 W
HPI-T 2000 W/380 V

Dimensions

Lamp designation	A max.	B nom.	C max.	D nom.
HPI-T 250 W	257	158	47	30
HPI-T 400 W	283	175	47	41
HPI-T 1000 W	382	240	67	80
HPI-T 2000 W/220	430	290	102	85
HPI-T 2000 W/380	430	260	102	135

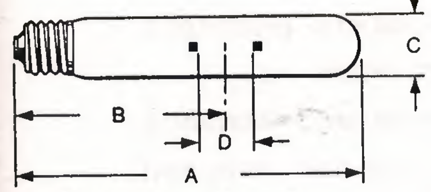
echnical data

amp esignation	Base	Min. supply voltage for ignition¹) V		Average lamp voltage²)⁴) V	Average lamp current²)⁴) A	Lamp starting current A(max.)	Minimum permissible lamp wattage²) W	Nominal lamp wattage²)⁴) W	Maximum permissible lamp wattage²) W	Average luminous flux²)⁴) lm	Average luminance²)⁴) cd/cm²	Run-up time³)⁴) min.
		+20°C	—18°C									
PI-T 250 W	E40	200	200	125	2,1	5	210	245	285	17 000	700	3
PI-T 400 W	E40	200	200	125	3,4	6	330	390	450	31 500	770	3
PI-T 1000 W	E40	200	200	130	8,25	14	800	965	1100	81 000	950	3
PI-T 2000 W/220	E40	200	200	135	16,5	24	1650	1960	2200	189 000	1100	3
PI-T 2000 W/380	E40	330	340	240	8,6	14	1650	1900	2200	183 000	870	3

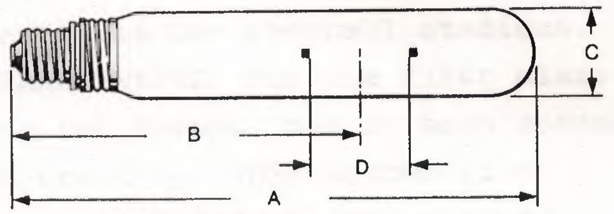
At 0 hours. ²) After 100 burning hours.
The number of minutes after which the lamp has reached 80% of its final luminous flux.
inal colour rendering properties will be reached after 10-15 minutes.
Measured at nominal supply voltage and reference ballast for a free burning lamp.

rdering and packing data

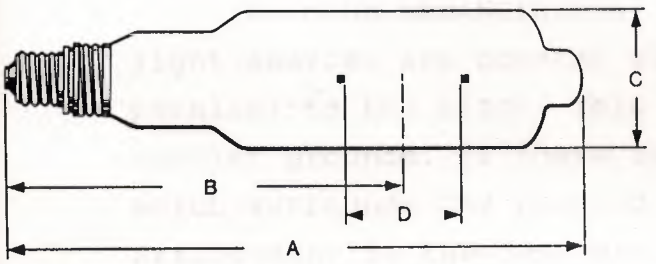
amp esignation	Ordering number	Nett weight g	Packing unit			
			Qty	Weight kg	Dimensions cm	Volume m³
PI-T 250 W	9280 761 092 . .	180	12	4,46	36 x 29 x 39	0,041
PI-T 400 W	9280 734 092 . .	180	12	4,46	36 x 29 x 39	0,041
PI-T 1000 W	9280 740 092 . .	400	4	4,65	32 x 32 x 51	0,052
PI-T 2000 W/220	9280 736 092 . .	650	4	5,00	35 x 35 x 60	0,074
PI-T 2000 W/380	9280 718 092 . .	670	4	5,00	35 x 35 x 60	0,074



HPI-T 250 W base E40/45
HPI-T 400 W base E40/45

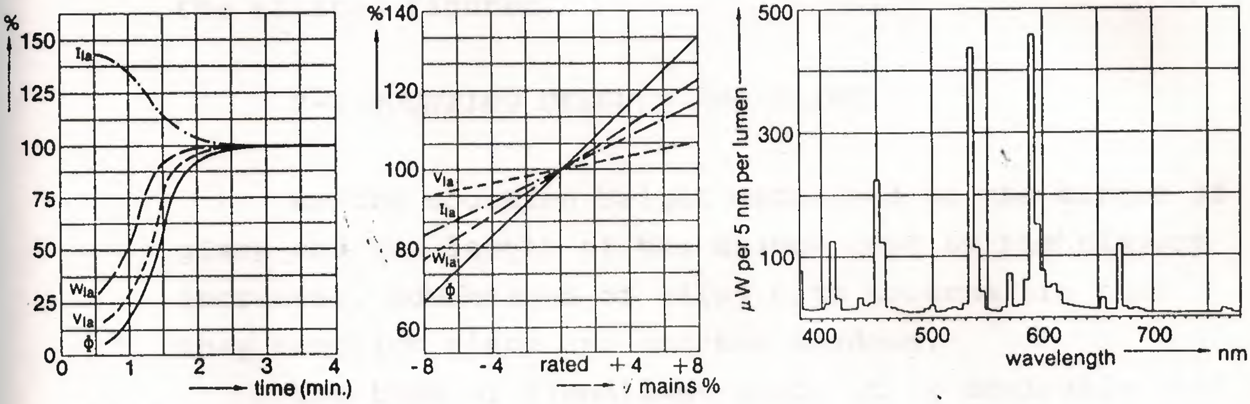


HPI-T 1000 W base E40/45



HPI-T 2000 W/220 V base E40/80 x 50
HPI-T 2000 W/380 V base E40/80 x 50

Typical curves



Lamp performance during starting period

Effects of mains voltage variations

Normalised spectral power distribution

W_{la} = lamp wattage
V_{la} = lamp voltage
I_{la} = lamp current
Φ = luminous flux

2-3 *MAST ARRANGEMENTS*

There are basically two important alternative lighting arrangements suitable for football stadiums.

1- FOUR CORNER ARRANGEMENTS: For the first class grounds the system using for towers, one at each corner has now become accepted practice. This system gives minimum glare to spectators and also to the players because there is no source of glare within the area bounded by the two goal line.

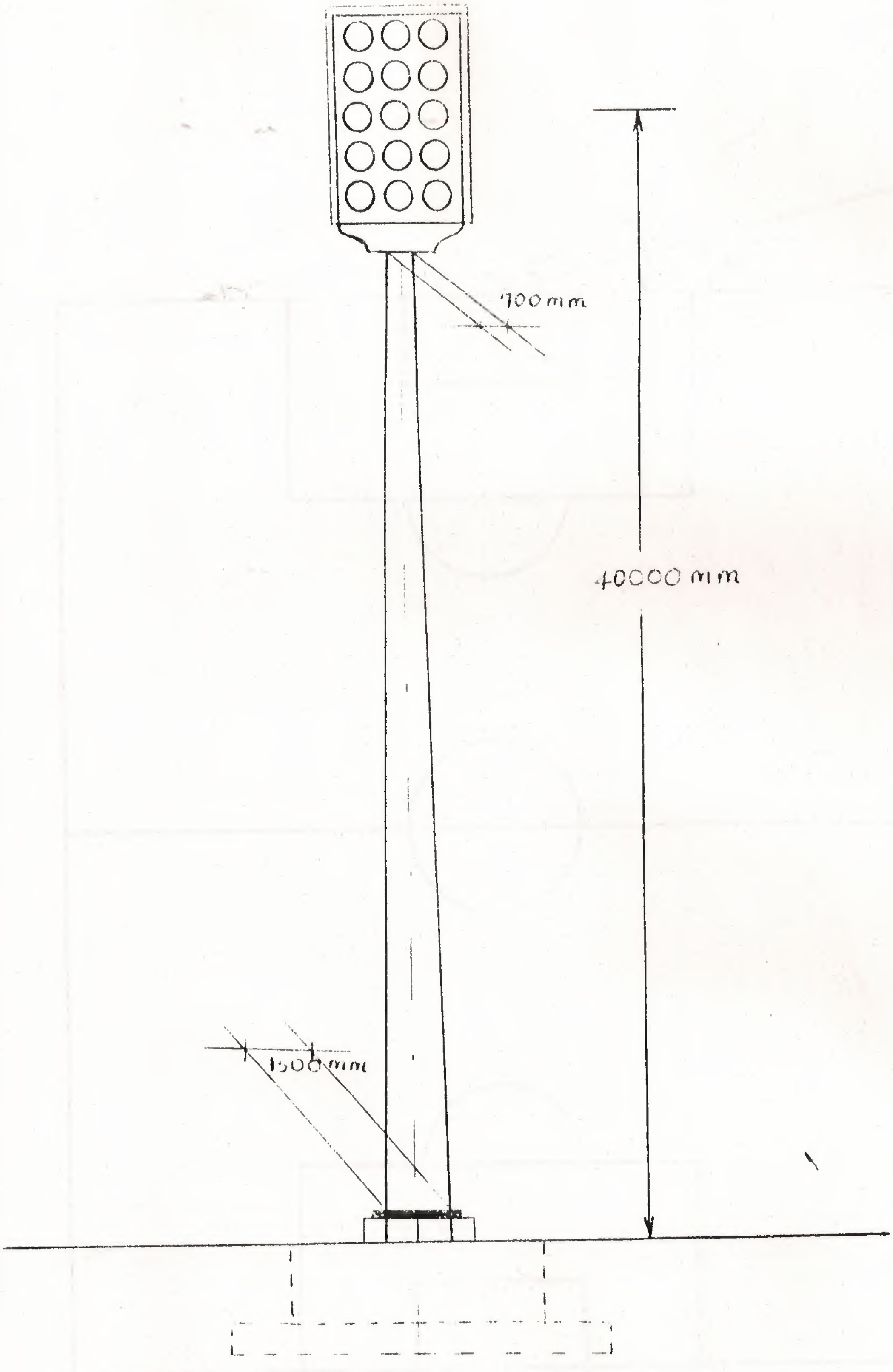
2- SIDE ARRANGEMENTS: With this arrangement the light sources are mounted either on columns or in rows parallel to the pitch. This system is popular for the smaller grounds. If there is no roof for spectators area which surrounds the playing field the four corner arrangement is the best one.

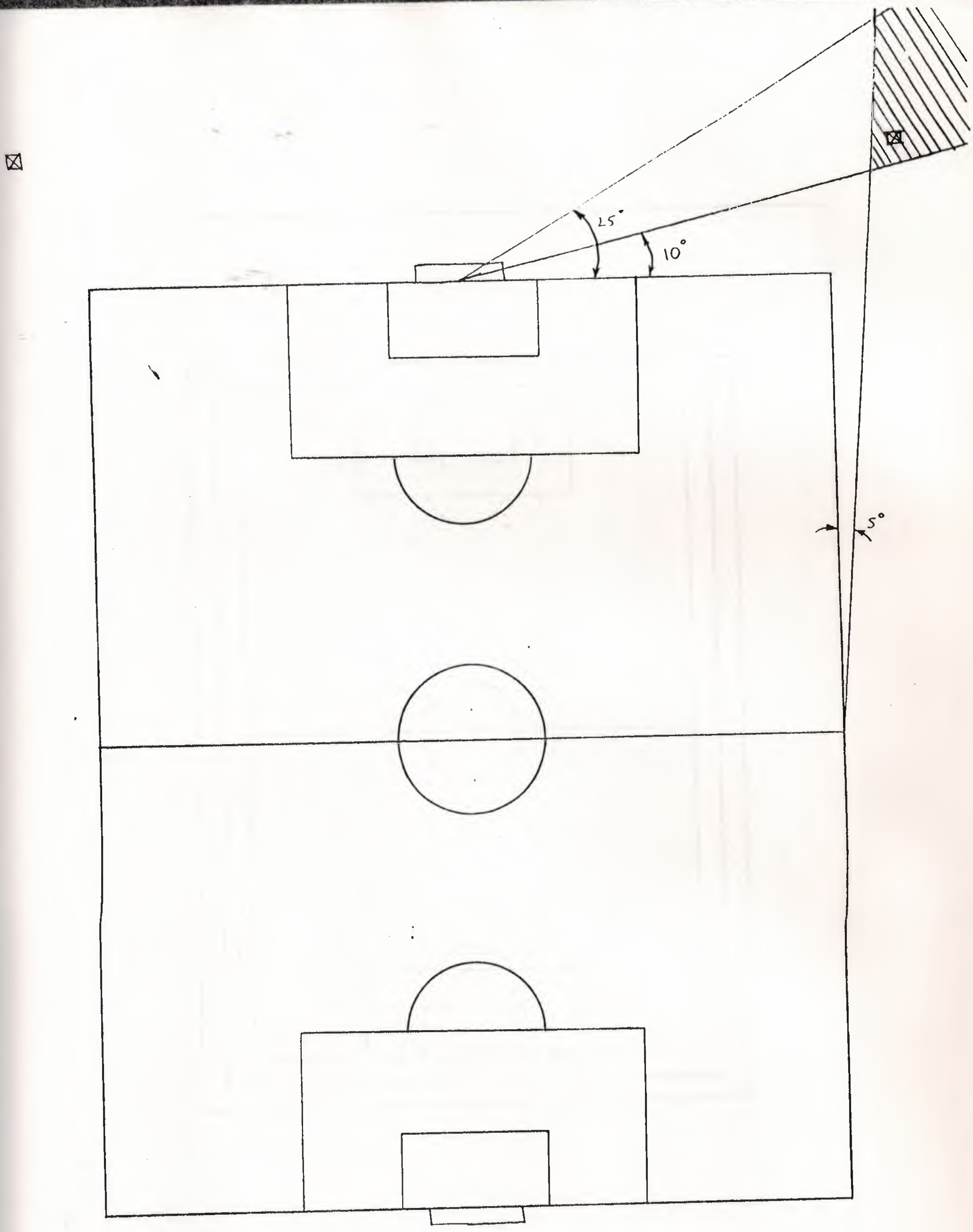
We preferred the four-corner arrangements. According to this kind of arrangement the mounting masts creates 10 degrees and 25 degrees from the goal-post towards back. Masts are mounted to field in lines between 25 and 10 degrees which starts from the middle of the playing field and it should not be nearer from the line which makes 5 degrees to the edge of the field.(shown in the related figures)

2-4 *MOUNTING HEIGHTS AND GLARE*

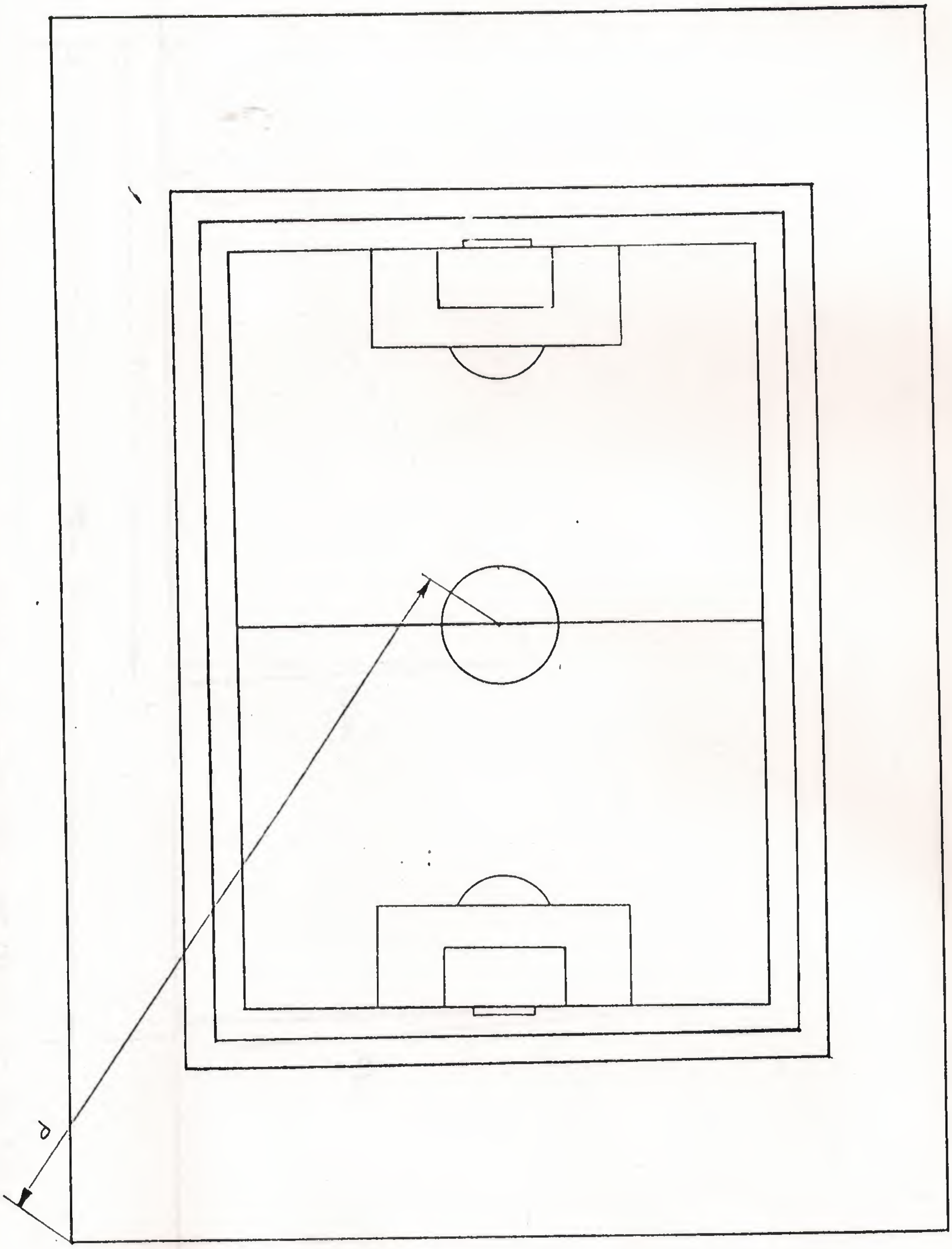
As the mounting height decreases so the danger of glare and the length of the shadow cast by the players increases. Advantages of using high columns are that they restrict glare and shorter shadows.

The type of floodlight used, it is desirable that the angles subtended at the center of pitch between the horizontal and the lowest point of each flood light battery, be at least 25 degrees. (shown at fig.)


700 mm
40000 mm
1500 mm

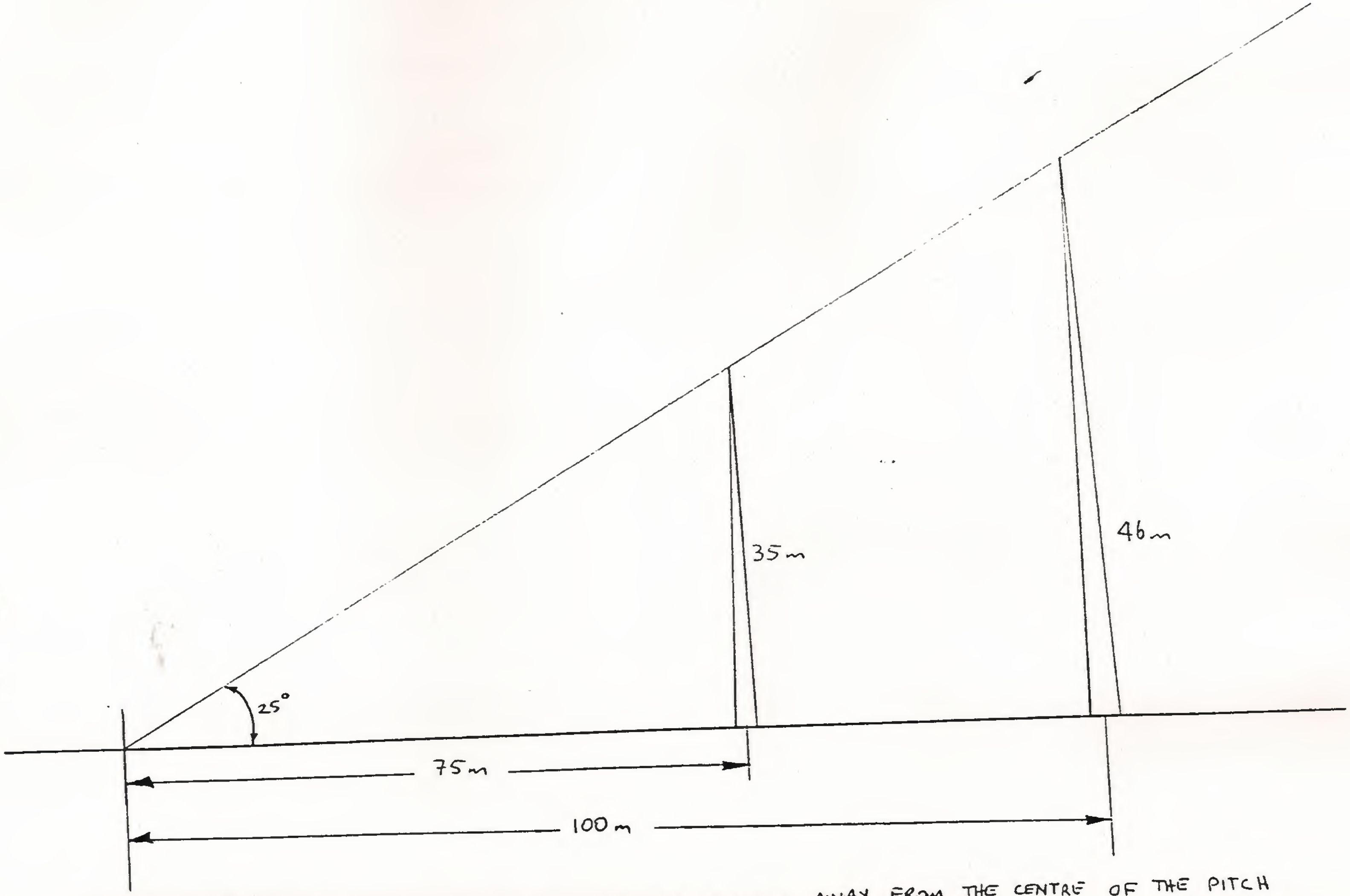


FOUR-CORNER ARRANGEMENT OF STADIUM LIGHTING SHOWING
THE POSITION OF THE COLUMNS



VIEWING DISTANCE FROM FARTHEST SPECTATOR TO PITCH CENTER

14.1



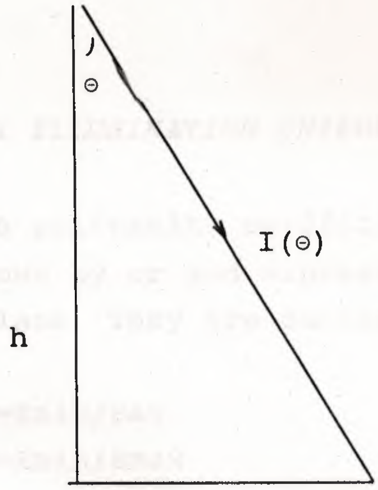
MOUNTING HEIGHT INCREASING WITH DISTANCE AWAY FROM THE CENTRE OF THE PITCH

PART C

III CALCULATIONS AND COMPUTATIONS

3-1 *FORMULAS:* Illuminance at any point (X , Y) can be found from

$E = I(\theta)\ (\cos \theta)^3 / h^2$ .Where θ is angle between the mast and the light intensity $I(\theta)$



$(\cos \theta)^3 = 1 / (1+x'^2+y'^2)^{(3/2)}$......Where $x'=x/h$

$y'=y/h$

To find $I(\theta)$ we must find γ & C ;

$\gamma = \arccos(A/\mathrm{SQRT}\ B)$

$A= (1+x'+xo'+y'+yo')$ ....Where $xo'=xo/h$

$B=(1+x'^2+y'^2)(1+xo'^2+yo'^2)$ $yo'=yo/h$

C = arctan ((tan α SQRT(1+(tan A)^2))/tan A)

Where;

A=arctan(y'SQRT(1+x'^2)/(1+xo'x')-arctan(yo'/SQRT(1+xo'^2))

α=arccos((1+x'xo'+y'^2.P)/SQRT((1+x'^2+y'^2)(Q)))

P=((1+xo'^2)/(1+x'xo'))

Q=(1+xo'^2+yo'^2((1+xo')/(1+xo'x'))^2)

After find C and γ, we can find easily I(Θ) from C-γ matrix.

3-2 *ILLUMINATION UNIFORMITY*

The uniformity coefficient must also be estimated. It is shown by or and expresses the uniformity according to the place. They are defined as;

$\rho1$=Emin/Eav

$\rho2$=Emin/Emax

xo=It is the x-coordinate on the surface which the projector axis intercept the plane that will be illuminated.

yo=It is the y-coordinate on the surface of the point at which the projector axis intercept the plane that will be illuminated.

x,y=The coordinates of the point at which we want to calculate the illuminance.

3-3 *PROCEDURE OF CALCULATION OF NUMBER OF PROJECTORS*

-At the first of all Eav choosing for stadium illumination.

-Each mast will illuminate one quarter of the playground so quarter of stadium area must known.

-Useful flux must be calculated from;

$$\phi\ (\text{USEFUL}) = \text{Eav} * \text{Area}$$

-Then total flux must be find from;

$$\phi\ (\text{TOTAL}) = \phi\ (\text{USEFUL})\ /\ \text{Efficiency}$$

-Lamps must be choosing for use in stadium illumination.

-Finally the number of projectors calculated from;

$$\#\ \text{of lamps} = \phi\ (\text{TOTAL})\ /\ \phi\ (\text{LAMP})$$

(The number of lamps after calculating can be decimal but as it is impossible usually we take the nearest [illegible] number.)

3-4 *SOME BASIC CONCEPTS*

COLOUR RENDERING: The effect of light source on the colour appearance under a reference light source.

GLARE: A condition of vision which a discomfort and/or a reduction in the ability to see significant object, due to the unsuitable distribution or range of brightness, or to extreme contrasts simultaneous or successive in the field of view.

DIFFUSED LIGHTING: Lighting in which the light on the working plane or an object is not predominantly incident from any particular direction.

MAINTENANCE FACTOR: It is a factor used in illumination calculation to allow the reduction of light output from a source of fitting of dust and foreign matter being deposited on it.

OBJECTIVE BRIGHTNESS: This is the luminous intensity of the light source. It is the light output divided by the projected area of the light source in the particular direction measured in candles per unit area.

PART D

COMPUTER PROGRAM OF POINT BY POINT ILLUMINATION

```
      DIMENSION A(181,351) ,E(28,121),M(117)
      REAL E,ALFA,ALFA1,X1,Y1,XO1,YO1,C1,C,GAMA,C3,A1,XO,YO
      INTEGER M5
      REAL AL,FA,X,Y,G3,C4,TOT,REG
      OPEN(1,FILE='MATRIX')
      OPEN(2,FILE='OUTPUT.TXT',STATUS='NEW')
      DO 10 I=1,181,3
      DO 10 J=1,351,5
      READ(1,*)A(I,J)
10    CONTINUE
      CLOSE (1)
      DO 100 I1=1,15
      I2=0
      WRITE(5,*)'I/P XO & YO'
      READ(5,*)XO
      READ(5,*)YO
      WRITE(5,9)XO,YO
      WRITE(2,9)XO,YO
      FORMAT(2X,'FOR:',' XO=',F4.1,3X,'YO=',F4.1)
      WRITE(5,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~
      WRITE(5,*)
      WRITE(5,*)' X      Y       C      GAMA         I           E'
      WRITE(5,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~'
      WRITE(2,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~'
      WRITE(2,*)
      WRITE(2,*)' X      Y       C      GANA         I           E'
      WRITE(2,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
      DO 100 X=8,40,8
      DO 100 Y=5,61,14
      I2=I2+1
      X1=X/40
      Y1=Y/40
      XO1=XO/40
      YO1=YO/40
      C3=1/(((1+X1*X1+Y1*Y1))**(1.5))
      AL=1+X1*XO1+Y1*Y1*((1+XO1*XO1)/(1+X1*XO1))
      F1=(1+X1**2+Y1**2)*(1+XO1**2+(Y1**2)*((1+XO1**2)/(1+XO1*X1))**2)
      FA=SQRT(F1)
      ALFA1=ACOS(AL/FA)
      ALFA=((ALFA1*180.0)/3.1415926)
      S=SQRT(1+XO1**2)
      A1=ATAN((Y1*SQRT(1+XO1*XO1))/(1+XO1*X1))-ATAN(YO1/S)
      A2=((A1*180)/3.1415926)
      C1=ATAN(TAN(ALFA1*SURT(1+TAN(A1)*TAN(A1)))/TAN(A1+.01))
      C=((C1*180)/3.1415926)
      GAMA1=ATAN(SQRT((TAN(ALFA1))**2*(1+(TAN(A1))**2)+(TAN(A1))**2))
      GAMA=((GAMA1*180)/3.1415926)
      IF ((A2.LT.0).AND.(X.GT.XO)) C=C+180
      IF ((A2.LT.0).AND.(X.LT.XO)) C=180-C
      IF ((A2.GT.0).AND.(X.LT.XO)) C=360-C
      IF ((A2.GT.0).AND.(X.GT.XO)) C=C
      IF ((A2.EQ.0).OR.(X.EQ.XO)) C=0
      C=NINT(C)
      C4=MOD(C,5.0)
```

THE ILLUMINATION OF CANBULAT STADIUM

(GRADUATION PROJECT)

PREPARED BY : ERHAN BOLKAN
86205

PREPARED TO : ELECTRICAL & ELECTRONIC ENGINEERING
DEPARTMENT

SUPERVISED BY : PROF. HALDUN GURMEN

EASTERN MEDITERRANEAN UNIVERSITY
T.R.N.C.

1992 JULY

ACKNOWLEDGEMENTS

I would like to thank my teachers, friends and those who have helped me to design this project.

My sincere thanks are due to my supervisor ,Prof. HALDUN GURMEN at the department Electrical Engineering in Famagusta who encouraged me in the early stages of this project and provided me the required documents, books, read and commented on the final version of the manuscript.

. I would also like to thank, to close friends of mine, Mr. M. TASEL BABAGIL, who permitted to use his computer for typing the final version of this manuscript and to print it out. He also helped me to write the computer program for point by point illumination.

My grateful thanks are also due to Miss. SEBLA KAYA for her contributions to give the final form to the report.

TABLE OF CONTENT

ABSTRACT

The aim of this project is to illuminate CANBULAT Stadium in Famagusta by using up-to-date illumination technology. Even if the illuminance level on the play ground is not equal at each point, it should be distributed according to their approximate equality because illumination of stadium must be made in order to let the players and spectators view the play without any difficulty. Also it is an important event that the motions of ball should be observed by the eye.

I obtain some documents about up-to-date stadium illumination by correspondence and with help of my course tutor.

The average illuminance was decided as 500 lux. We also decided on the number of projectors needed. Adding to them I realized to use four corner arrangement with 4 masts. 2000W HPI-T lumps are used. By the aid of computer program the point by point illumination is calculated

PART A

I INTRODUCTION

All the duties that the human being has to perform is in some way affected or governed by light. Human beings for many centuries depended on natural lighting such as the moon, sun and the stars but as the need for better and more efficient lighting grew. We started to depend on artificial lighting.

Up-to the beginning of the later years of the 19th century people were dependent on artificial lighting such as candles, oil lamps and the wood. However the invention of the incandescent lamp by H.GOBEL and A.EDISON opened a new pave wave in illumination technique.

During those years there was nor enough power to feed all the electrical suppleness until W.SIEMENCE invented the dynamo. After making great improvement in the incandescent lamp we arrived to the up-to-date lighting technique, the fluorescent lamp.

1-1 *THE SUBJECT OF ILLUMINATION*

The basic concept of illumination consist of the production, distribution,economics and measurements of light. Illumination has a very important role in the industries of all developed countries. Lighting any place no matter how small is a complex task. The solution of illumination problem can only be solved by the help of an electrical engineer who has technical ability and by an architect who has an artistic ability in illumination.

Nowadays lighting has become one of the most important needs of societies across the world.

As a summary, the following advantages are gained by a sufficient illumination:

(a) Seeing ability of eye.

(b) The health of eye is protected.

(c) The accidents are decreased.

(d) The performance of work is increased.

(e) The capacity of work in commerce is enlarged.

(f) The economical potential is increased.

(g) Security is provided (A street lamp is equivalent to a policemen)

(h) The esthetic feelings and the necessity of comfort are an answer.

1-2 *THE AIM OF ILLUMINATION*

The aim of illumination is to meet the priority of course this is not the only necessity to be met. According to it's purpose the three major necessities of illumination can be listed below.

(a) Physiological illumination : The main aim of physiological illumination is to help us distinguish shapes details and colours. In the installation of this sort of illumination special care should be taken to minimize the danger of physical damage which could generate as a result of faulty installation.

(b) Decorative illumination : In the decoration of homes, work place ...etc. decorative illumination plays a great role. In this type of illumination both the architect and the illumination engineer are very important.

(c) Attractive illumination : The aim of this type of illumination is to draw attention for such things as advertisements or for decorations. In order to accomplish this various lights and techniques are used.

1-3 *THE TYPE OF ILLUMINATION*

The types of illumination are divided into two groups; natural and artificial. Artificial illumination is also dividend into two groups as OUTDOOR and INDOOR.

(a) Natural illumination: It deals with the distribution of the natural light in a most suitable way. It is generally preferred as it is free and easily available

(b) Artificial illumination: It is obtained through electrical devices. The use of artificial illumination is divided into groups with incandescent, discharge and fluorescent lamps.

b-i) INDOOR ILLUMINATION:

Places like houses, schools, hospitals, factories, cinemas and the like are all subject to indoor illumination. Illumination in these places is accomplished through the reflection of the light from the walls and ceilings of the room. Indoor illumination can be divided into groups as direct, semi direct and indirect. For instance if 90-100 % of the light flux of the source is going to escape. This is called direct illumination system. 60-90 %, 40 %, 60 %, 10 %,

40 % and 0-10 % of the lights flux is called semi direct mix, semi indirect and indirect illumination system.

b-ii) OUTDOOR ILLUMINATION:

Outdoor illumination is used to light-up such places as football pitches or any place which has no wall surroundings. Such places need direct light.

PART B

II STADIUM ILLUMINATION

2-1 *BASIC DATA*

(a) FOOTBALL: Football and various other games are outdoor games. As it is played in open air and very often at nights outdoor illumination is very important.

(b) MEASUREMENTS: The size of a football pitch accepted by the FIFA (shown in fig. 1) has a width between 45m-90m and a length of 90m-120m . the width and length of the penalty area is 40.32m and 16.5m consequently. The length of the goal post area is 18.32m with a width of 5.5m. The diameter of pitch center is 9.15m.

(c) SPORTS CENTERS: It is usually arranged according to the number of spectators. Therefore the maximum vision distances for illumination must be taken into consideration. Different illumination techniques are required depending on the type of playground and it's capacity. The material used in these playgrounds varies from sand, gravel or grass. Those playgrounds which has great spectators are called "stadium".

(d) THE IMPORTANCE OF ILLUMINATION: Illumination is very important for both the players and spectators. The most important function of illumination is to follow the motions of the ball which is the smallest item in the playground. Researchers show that in order to perceive and identify a thing in motion illumination level, environment and the degree of illumination play an important role. So the difference of illumination level between ball and playground should be as high as possible.

A playground which has Av. reflection degrees are 0.1 - 0.3, for instance. It is 0.1 - 0.15 at gravel playground and it is 0.15 - 0.25 at lawn playground according to its cut and humidity. According to the material and illumination used with a light colour ball (reflection degree $\rho>0.5$) the intensity of illumination level between ball and playground varies between 2/1 and 5/1.

In this system as the spectators distance from the ball increased the view of the ball decreased. So equal illumination level and high illumination power are accepted. As in graph 1 the visibility angle of a ball of 25cm in diameter can decrease from 4 sec to 8 sec depending on the stadium figure.

For a good solution it is necessary to see and follow a ball which is in motion and to keep a certain perceiving duration. Therefore, when we apply practically those data obtained scientifically, the close relationship can be used between the perceiving duration of view angle, illumination level of surrounding and contrast.

(e) THE SEEING NECESSITY OF PLAYERS: From a scientific point of view the view of a player is limited to 100m. At graph 2, we can see the perceiving duration according to the illumination level. Therefore, the illumination level of a playground should be at least 10 abs (1 candela = 3.4 abs) and the proportion of reflection is between 0.25 and 0.125.

(f) SEEING NECESSITY OF SPECTATORS: In order for the spectators to see the motions of the ball it is necessary

to relate the position stated in graph 4. While the illumination level of a pitch is determined by horizontal illumination power, the distance of spectators from the ball depend on vertical illumination the power of vertical illumination varies in accordance to its place.

Certain measurements would charge the power of vertical, illumination situated at certain places in the middle and edges of playground. The contrast between playground and illumination level can only be at the top part of ball which the contrast of this is only be determined by horizontal illumination.

At the first approach, the illumination level of top part of ball up to 45 degree angle is determined by horizontal illumination. It is shown at fig. 2. In this position, the diameter of top point be 0.7 Of the whole diameter (d).

(g) EFFECT OF SHADOW: There should be no shadows on the stadium. This is achieved by multi-directional illumination. Because of the difference in vertical illumination a plastic appearance on human body is given.

(h) MIXTURE OF LIGHT: The mixture of light is different for spectators and the players. Ideally no light should fall onto the spectators. However this is very hard to do as they are under high vertical illumination. There are physical effects of this;

(i) COLOUR: It is important both spectators as well as players that lights are not spoiled. Specially skin colour should be kept by adding red colour to illumination.

(j) APPROPRIATENESS FOR CAMERA AND TV BROADCASTS: TV and cameras have different sensitivity then the human face. When choosing a light source for television and cameras the vertical illumination should be the average of more than 250 lux as the quality of film is spoiled at less illumination. The average illumination for tv broadcasts should be about 800-1000 lux.

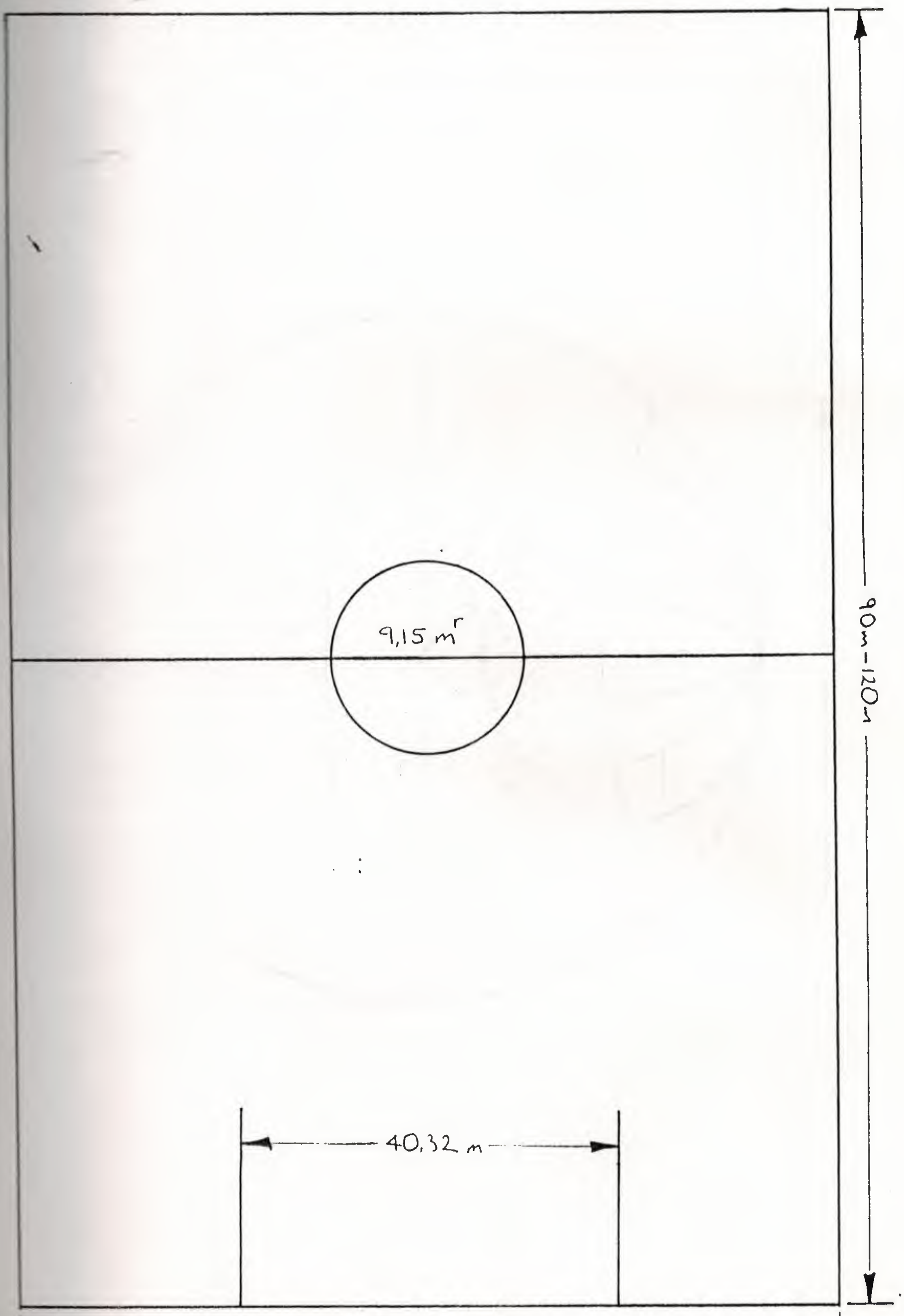
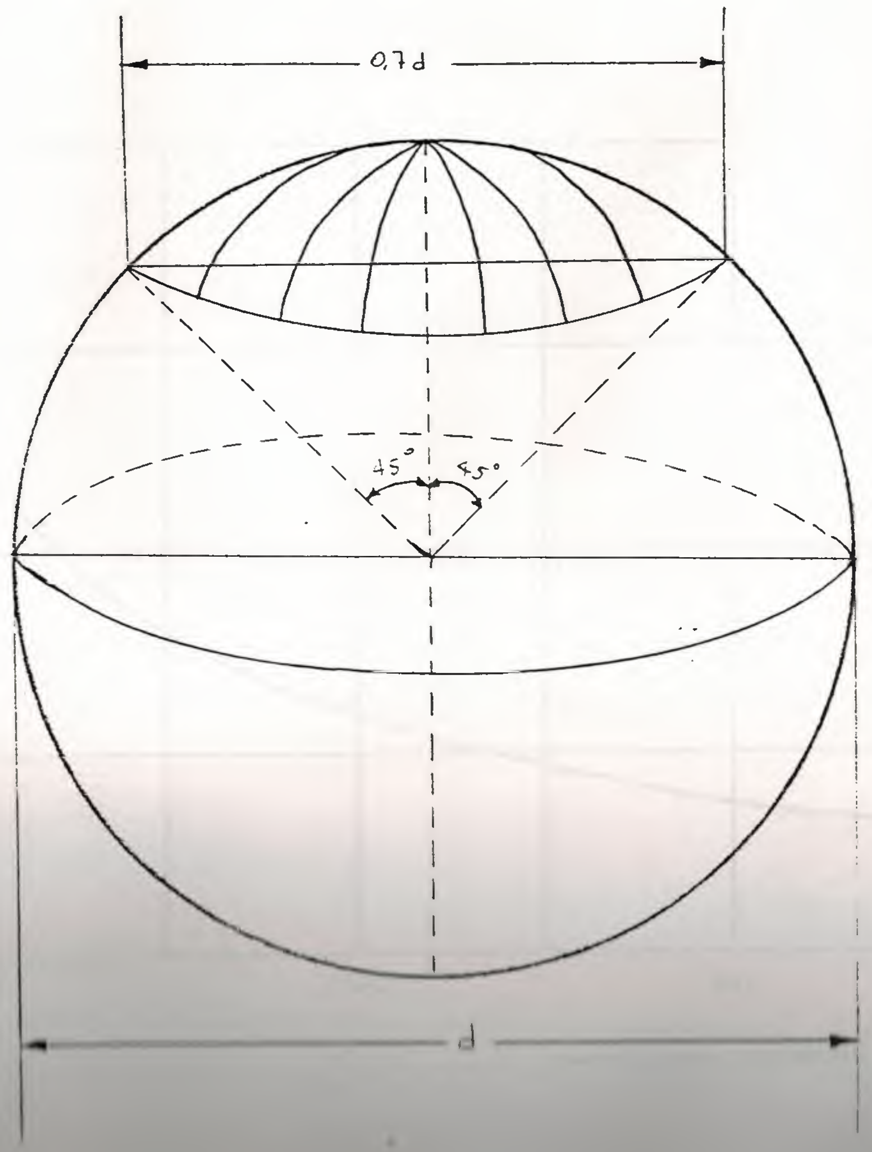
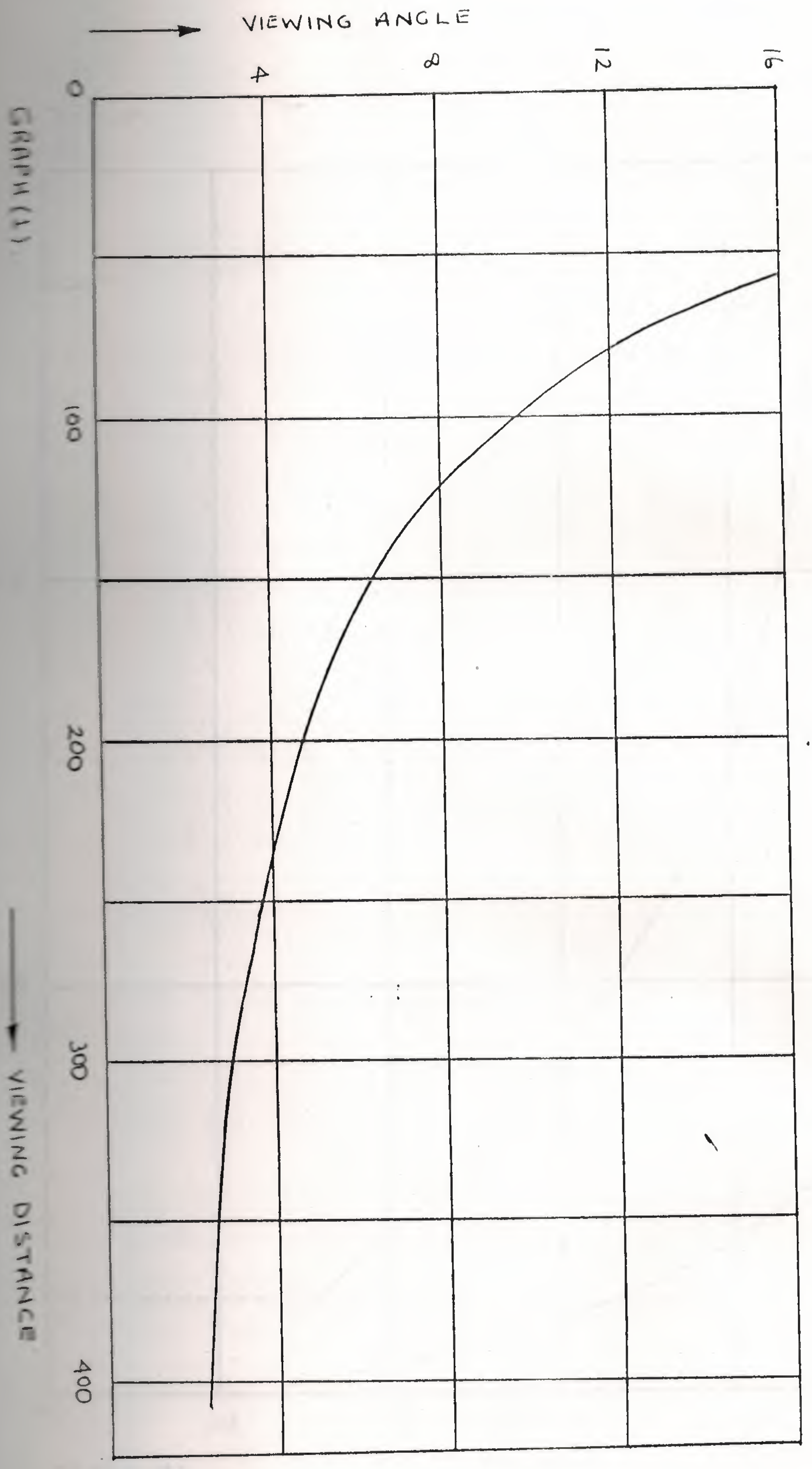


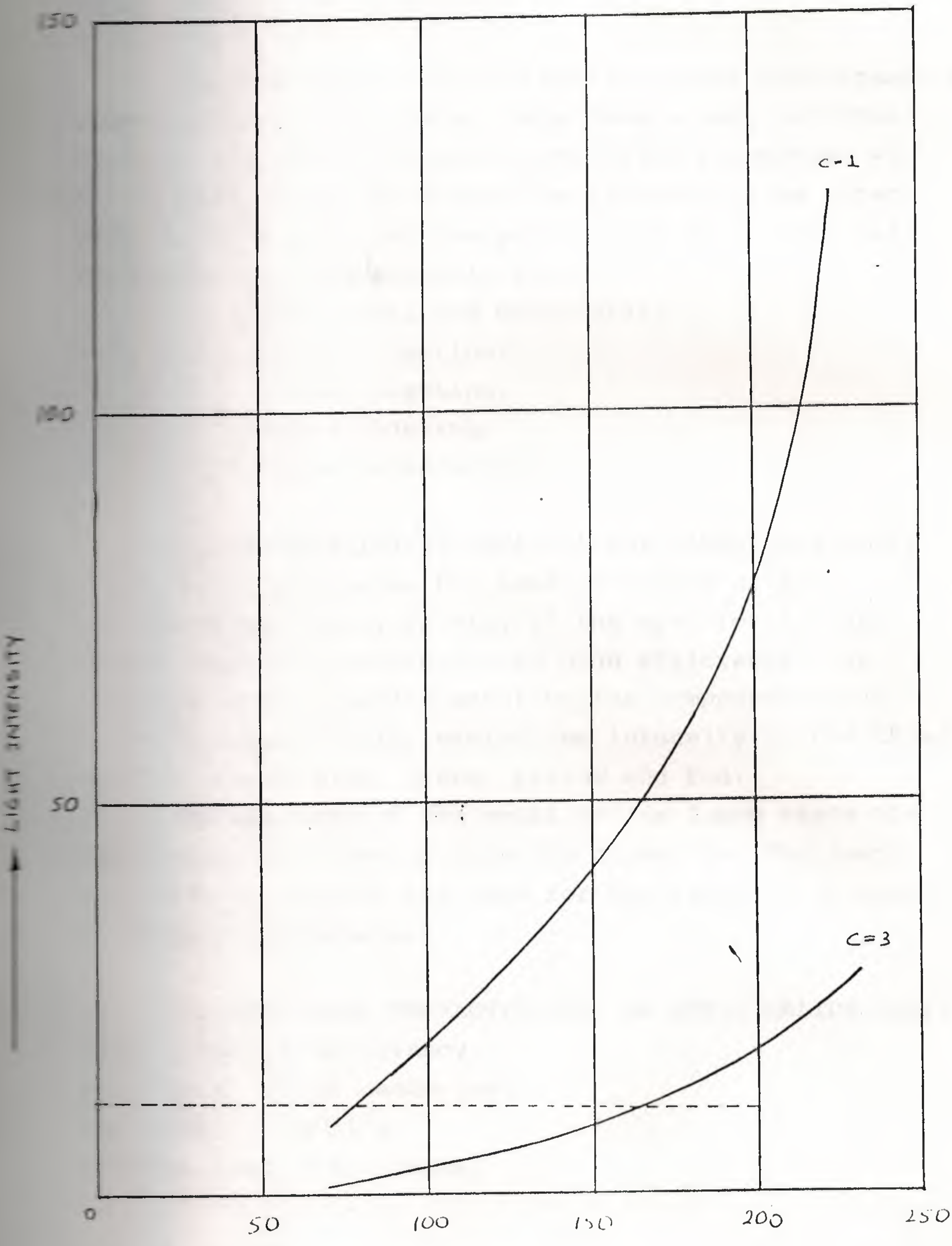
Fig (1)



Fig(3)



GRAPH (1)


150
100
50
0
LIGHT INTENSITY
C-1
C=3
50
100
150
200
250
DISTANCE FROM BALL

GRAPH (2).

2-2 *EQUIPMENT*

(a) LIGHT SOURCES: At stadium illumination usually as a light source, metal halide lamps or high-pressure metal halide lamps are used.

(b) DEFINITION OF METAL HALIDE LAMPS: High-pressure metal halide gas discharge lamps have a very luminous efficacy and excellent colour rendering properties with an internal diffusion coating on the hard glass outer bulb and a stable lumen output through their long life, HPI lamps are very suitable for;

- Industrial and commercial.
- Indoor lighting.
- Public lighting.
- Flood lighting.
- Plant irradiation.

(c) DESCRIPTION OF METAL HALIDE LAMPS: Basically HPI-T lamps operate on the same principle as all gas-discharge lamps. In view of the need for a light source rendering combined with high efficiency, the discharge tube contains metal halide compounds which have the effect if increasing the intensity in the three spectral bands blue, green, yellow and red.

The spectrum of the metal halide lamps meets the requirements for colour film and colour tv. The lamps are therefore highly suitable for the lighting of colour television broadcasts.

(d) THE LAMPS CHARACTERISTIC OF METAL HALIDE LAMPS

-High luminous efficiency.

-Excellent colour rendering.

-Reliable, long life.

-Stable lumen maintenance.

(e) APPLICATIONS OF METAL HALIDE LAMPS:

-Lighting for colour tv. broadcasting.
-Lighting for colour films.
-Public lighting.
-Sports ground lighting.
-Flood lighting.
-Industrial and commercial indoor lighting.
-Plant irradiation.

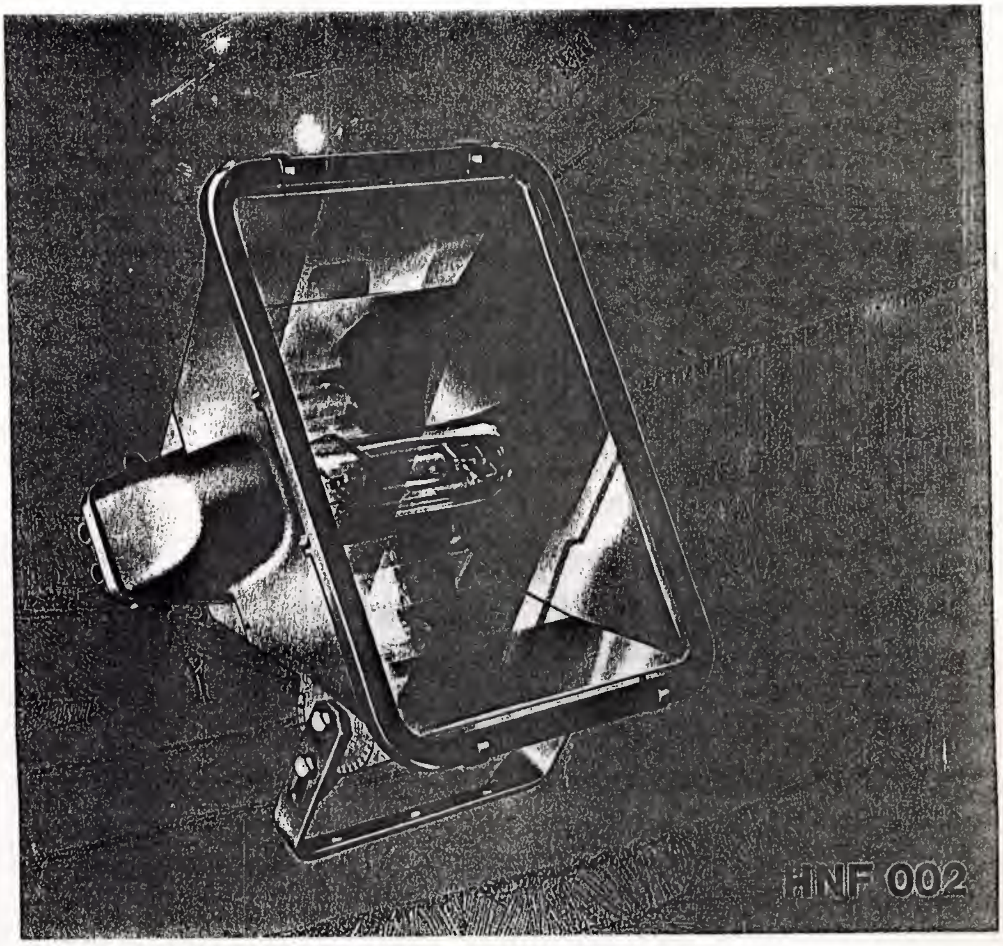
(f) BALLASTS AND IGNITORS: Metal halide lamps require high quality ballast for optimum operation, as well as ignitors to ensure reliable ignition for ballast and ignitors.

(g) TEMPERATURES: Maximum permissible base temperatures;

250 degree C for 400 W
300 degree C for 1000 - 2000 W

ON

for use with one 1000 W high-pressure amp or one HPI/T etal halide lamp.



CRIPTION

- ousing and rear-cover: rugged all-cast aluminium construction
- ngs of low-copper-con- or excellent corrosion-stance, even in coastal ndustrial areas
- beam-versions, as differ- reflectors are available:

	HPI/T 2000 W	SON/T 1000 W
beam	2 × 9°	2 × 9°
eam	2 × 23°	2 × 27°

- -grade aluminium reflec- for accurate beam con-
- Lamp replacement is effected by removing the rear-cover, thus facilitating servicing
- Easy-to-operate stainless-steel clips on the rear-cover; to be closed by hand and opened with a simple tool. The floodlight cannot be easily opened by unauthorized persons.
- Cast-on beam-aiming sight and protractor scale for quick daylight adjustment
- Ozone-resistant ethylene-propylene rubber gasket for jet-proof and dustproof sealing of front glass; 4 extra safety clamps.

APPLICATIONS

- Sports grounds
- Floodlighting of buildings
- Marshalling yards
- Car parks
- Skating rinks
- High-mast lighting
- Sports halls
- Shipyards

ORDERING DATA

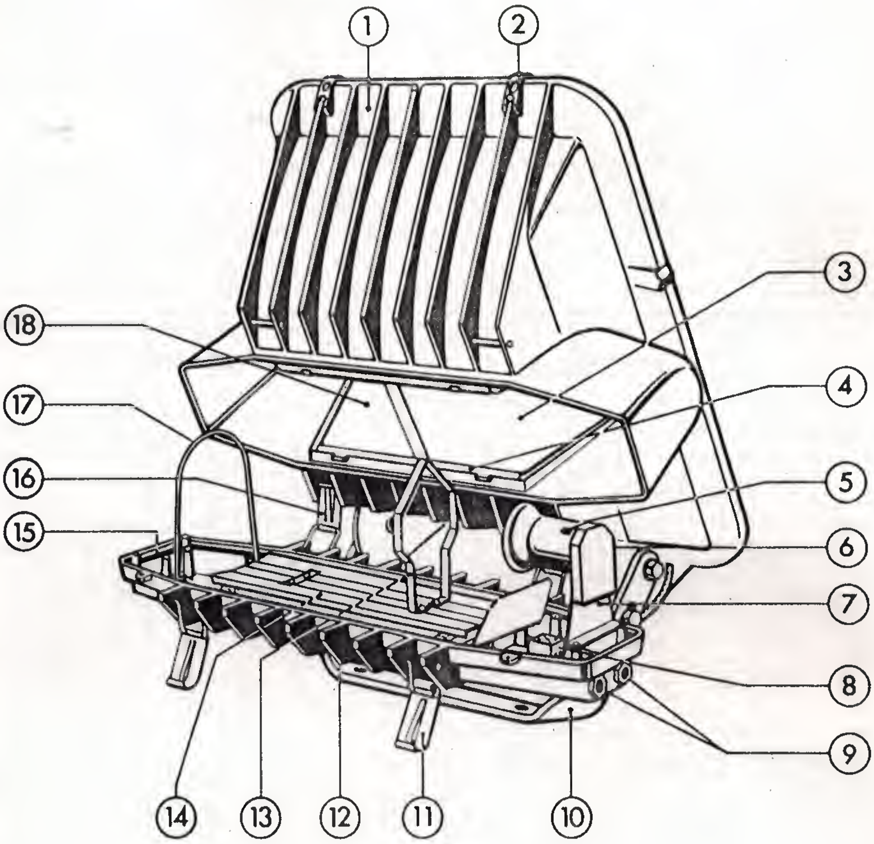
Designation	For lamps	Ordering number*) Narrow-beam type	Wide-beam type	Weight kg
HNF 002	1 × HPI/T 2000 W	9112 718 502	9112 718 503	23,5
	1 × SON/T 1000 W	9112 718 504	9112 718 505	23,5

*) Complete floodlight

FLOODLIGHT FOR HIGH-PRESSURE SODIUM LAMPS OR METAL HALIDE LAMPS

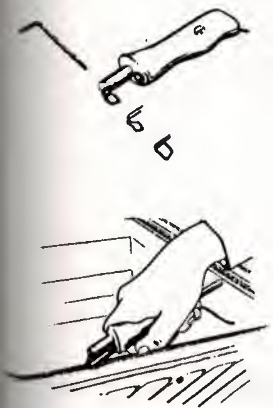
DETAILED DRAWING

1. Housing
2. Safety clamp (4 ×)
3. Front glass
4. Reflector
5. Lampholder
6. Lampholder insulating plate
7. Lampholder bracket
8. Terminal block
9. Glands for dust-filters
10. Bracket
11. Closing clip top (2 ×)
12. Rear-cover
13. Lamp support
14. Reflector rear-cover
15. Gasket
16. Closing clip bottom (2 ×)
17. Additional lamp support
18. Side reflector

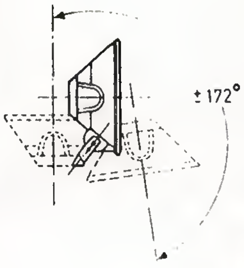


ECIAL TOOL

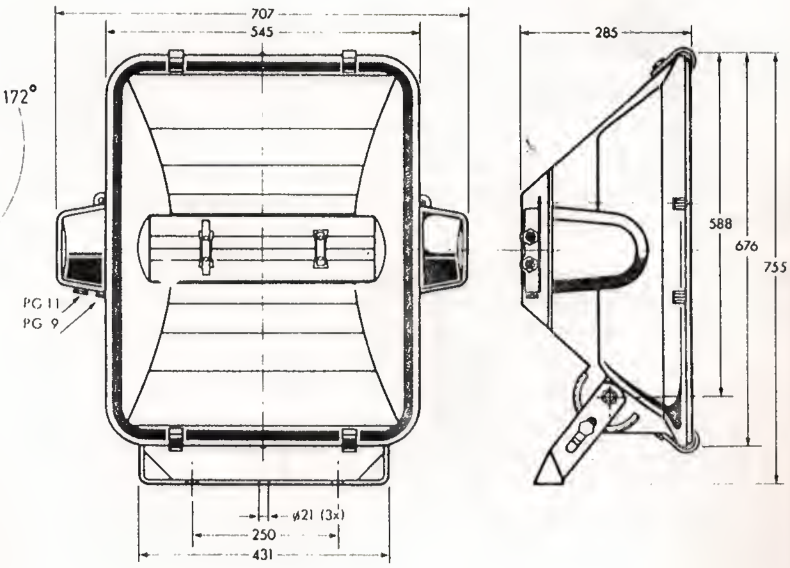
he front glass is provided with
special type of gasket. To re-
ce the glass, a special gas-
insertion tool can be used,
nsisting of a handle with
se removable clips to suit
e different floodlights. Order-
g number for complete set
19 260 005 . .

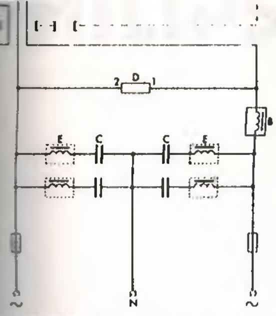


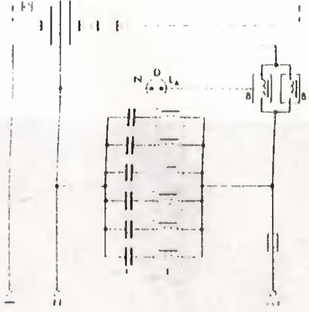
ADJUSTMENT POSSIBILITIES

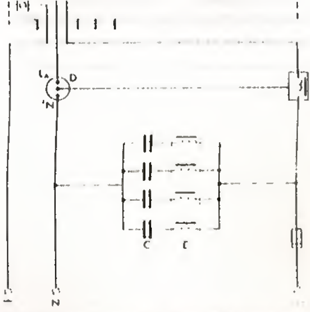


DIMENSIONS









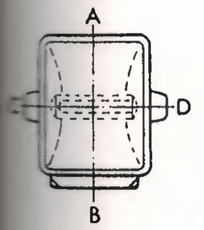
grams	For lamps	Mains voltage	Starting current	Operating current	cos φ	A Lamp	B Ballast	C Capacitor	D Ignitor	E Filter coil
	HPI/T 2000 W	380 V	10,9 A	6,4 A	0,9	9280 735 092..	9136 070 089	50 μF (25 + 25 paral.)	9136 190 799 ..	2 × 9136 800 011 .. (paral.)
	HPI/T 2000 W	220 V	14,8 A	10,4 A	0,9	9280 736 092	9136 068 103 ..	130μF (4 × 20 + 2 × 25)	9136 190 699 ..	4 × 9136 800 010 .. + 2 × 9136 800 011 ..
	SON/T 1000 W	220 V	13,8 A	10,3 A	0,9	9281 545 092	9136 290 003 .	120 μF (4 × 30)	9136 280 103	4 × 9136 800 009

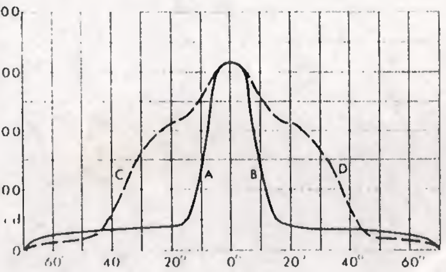
GHTING DATA

1000 lm

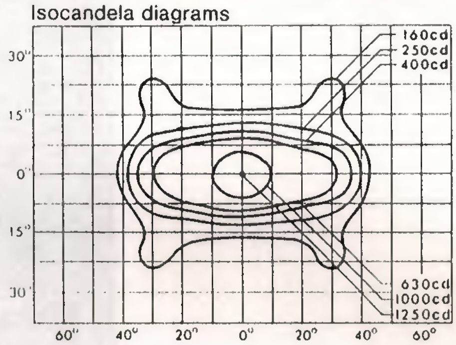
Light distribution diagrams

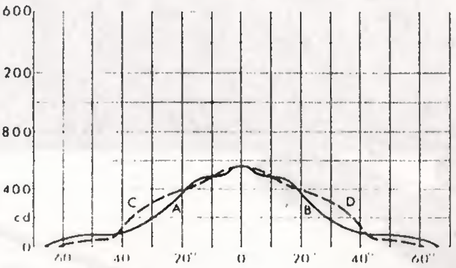
Isocandela diagrams



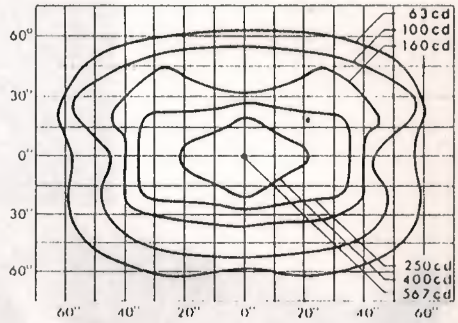


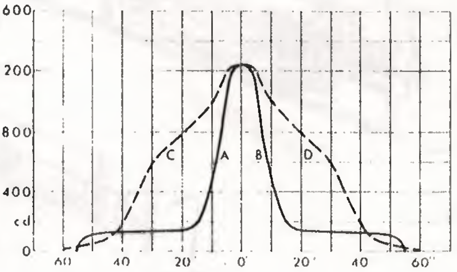
1 × HPI/T 2000 W
narrow beam



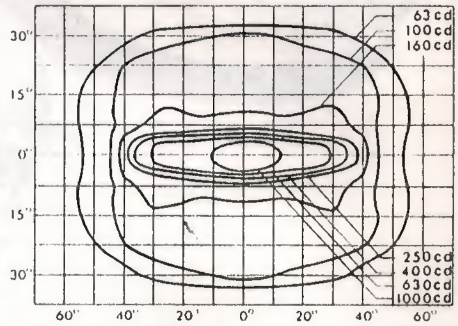


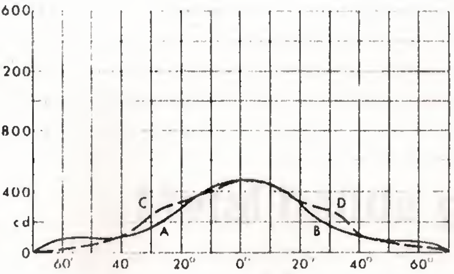
1 × HPI/T 2000 W
wide beam



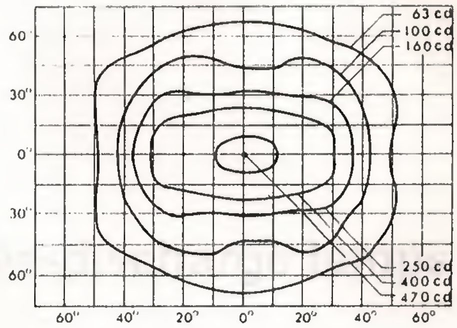


1 × SON/T 1000 W
narrow beam



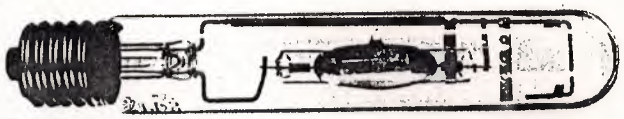


1 × SON/T 1000 W
wide beam



PHILIPS

Metal halide gas-discharge lamps



HPI-T 250 W
HPI-T 400 W

HPI 250 W

HPI 400 W

Why metal halide lamps?

The quick answer to this question is:
- Improved colour appearance
- Improved colour rendering
- High luminous efficacy
- Reliable long life
- Well balanced spectrum

The careful development of the mixture of metal halides has made these features possible. Inside the gas-discharge tube of an HPI lamp there is a precisely measured 'cocktail' of sodium, thallium and indium, all chemically compounded in iodide form.

This particular combination has been found to be very effective in terms of colour characteristics (see pages 8-9) and also in the reliability and stability of the light source.

The range at a glance

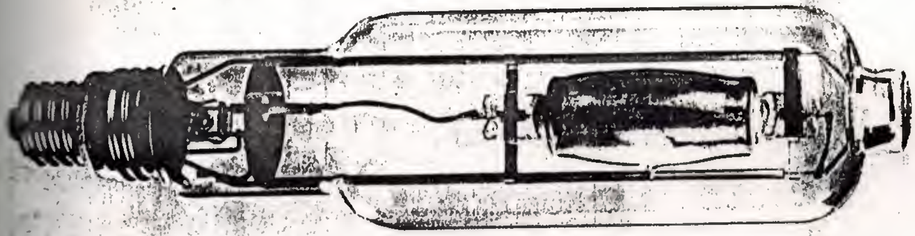
HPI 250W BU - An ovoid coated lamp; can be used with a standard 250W mercury lamp ballast; burning position is vertical base-up.

HPI-T 250W - Tubular in shape, this clear lamp is designed for use with a 250W mercury lamp ballast and external ignitor; burning position is horizontal.

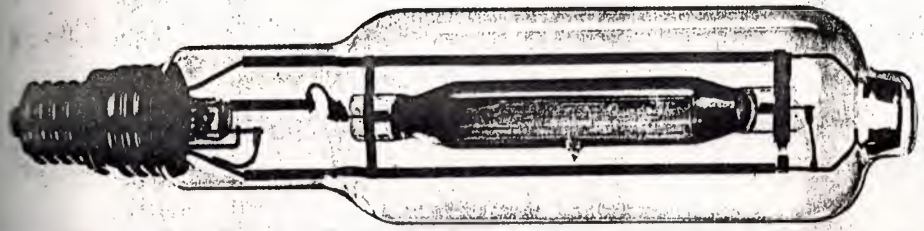
HPI 400W - An ovoid coated lamp for use on a 400W mercury lamp ballast plus external ignitor; burning position is horizontal.

HPI 400W BU, HPI 400W BUS - Both types are ovoid coated lamps;
the 400W BU lamp can be applied in existing HPI installations equipped with ignitors and can also replace 400W dysprosium lamps;

HPI-T 1000 W



HPI-T 2000 W/220 V



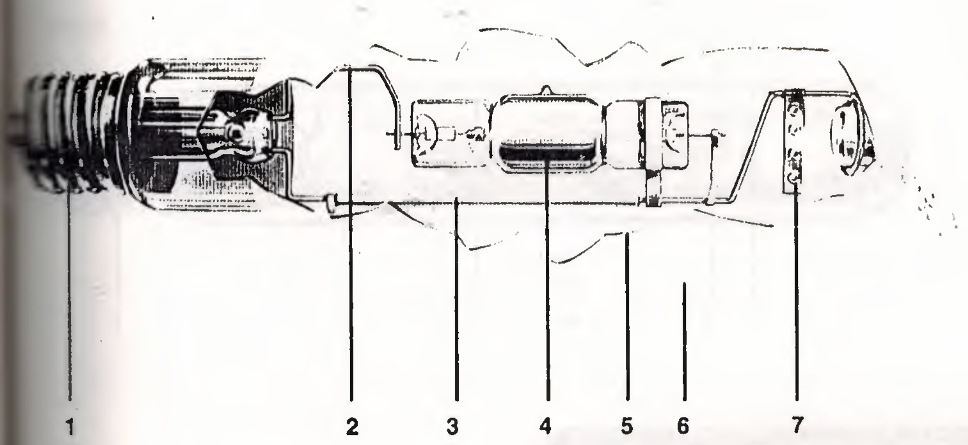
HPI-T 2000 W/380 V

the 400W BUS lamp is self-starting and therefore needs no ignitor; can directly replace a 400W mercury vapour lamp since it is designed to run on a standard 400W mercury lamp ballast; burning position of both lamp types is vertical base-up.

HPI-T 400W - A clear tubular lamp designed for use in optical systems for floodlighting and indoor applications; needs a 400W mercury lamp ballast plus an ignitor; burning position is horizontal.

HPI-T 1000W - Also tubular and clear, this lamp operates on a 1000W mercury lamp ballast with an ignitor; specially designed for floodlighting and illuminating sports arenas; burning position is horizontal.

HPI-T 2000W - Two versions, both tubular and clear, are available: 220V and 380V; the 220V type may be operated in almost any burning position, with minimal colour shift even at steeply tilted angles; ideal for floodlighting large sports stadiums, particularly 4-mast installations; the 380V type is limited to the horizontal burning position; a reliable light source for training fields and floodlighting of large stadiums; both lamp types require an external ignitor; the 220V version needs two parallel 1000W mercury lamp ballasts whilst for the 380V version, a special ballast has been designed.



ow metal halide lamps work

e nucleus of a metal halide lamp is the charge tube, manufactured from quartz. Into h end of the tube are sealed lead-in wires pporting electrodes in the form of tungsten rals. Also contained within the tube is a ture of two gases - neon and argon - and ee metals in iodide form - indium, thallium and dium - plus metallic mercury.

ther, the discharge tube is housed in a clear ular hard glass outer bulb (HPI-T) or in an id envelope having a diffusing fluorescent ing (HPI). The whole structure is firmly held lace by support wires and by springs to shion any effects of vibration on the lamp.

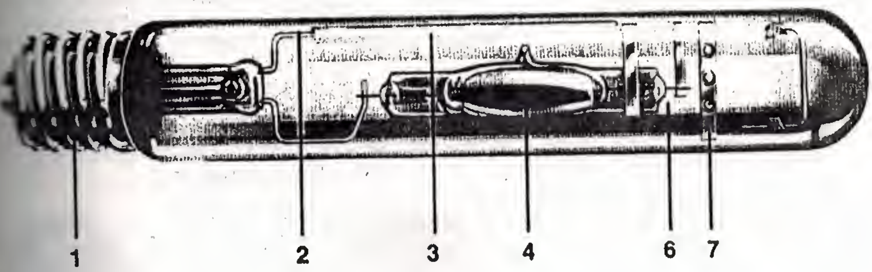
g the space between the discharge tube the outer envelope is a mixture of neon and nitrogen. The former serves to nullify the emission of neon from the discharge tube itself whilst the latter prevents any likelihood of 'flash-over', where a discharge can take place outside the confines of the discharge tube.

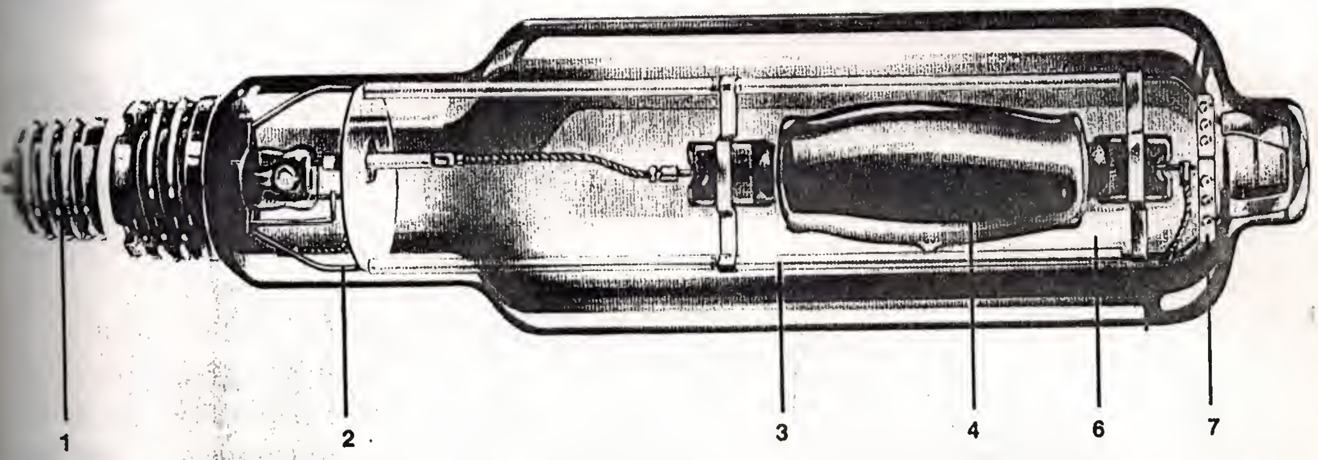
Also located within the outer bulb is a getter whose function is to absorb any impurities in the gases which could otherwise adversely affect the correct running of the lamp; in the case of the metal halide lamps, hydrogen represents the greatest potential danger.

As an additional measure, a sleeve is slid over the support wire to reduce the possibility of 'photo-emission', whereby the sodium deserts the discharge and causes blackening of the outer bulb.

Finally, an E40 lamp base is mechanically

HPI-T





attached to the glass envelope, giving a sturdy overall construction.

In operation, metal halide lamps work on a similar principle to all gas-discharge lamps - that is, light is obtained from an electric discharge occurring between two electrodes inside a discharge tube.

With the aid of the two starting gases, ignition takes place and causes a rise in temperature, followed by evaporation of the mercury and the three iodides. After dissociation of the metal halides, the metals alone are excited and produce specific radiation mainly in the visible part of the spectrum.

The feature of such a discharge is that the three primary colours - red, blue and green - are very well represented in the spectrum. This is not only important for colour quality as perceived by the human eye, but also for the colour sensitivity of colour films and CTV cameras

With the internal fluorescent coating converting UV radiation into visible radiation - and hence improving the colour impression - the ovoid-shaped HPI lamps are especially suited to indoor applications.

Cut-away view

1. Mechanically fitted E40 screw base
2. Lead-in wire / support
3. Sleeve protecting the support
4. Quartz discharge tube
5. Internal phosphor coating
6. Tubular or elliptical hard glass outer bulb, impervious to atmospheric conditions
7. Getter ring for maintaining a clean gas atmosphere, thus ensuring maximum lamp efficacy

ditions of use

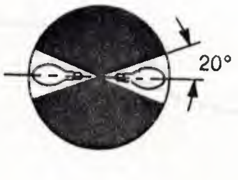
factory performance of this type of lamp can only be ected if the ballast on which it is operated complies with cifications laid down by the lamp manufacturer. Moreover, the supply voltage may not fluctuate more than ± 5% from the voltage of the ballast.

avoid the possibility of personal injury or damage to property ing from shattering, the BUS (Base Up Self-starting) lamp ld always be incorporated in an enclosed luminaire.

ng positions

HPI 400 W lamp may only burn in a horizontal position ±20°. BU and BUS lamps may only burn in a vertical position ±15°.

HPI 250 W BU
HPI 400 W BU and BUS



HPI 400 W

Dimensions

Lamp designation	A max.	B max.	C max.
HPI 250 W BU	227	53	92
HPI 400 W	292	58	122
HPI 400 W BU	292	58	122
HPI 400 W BUS	292	58	122

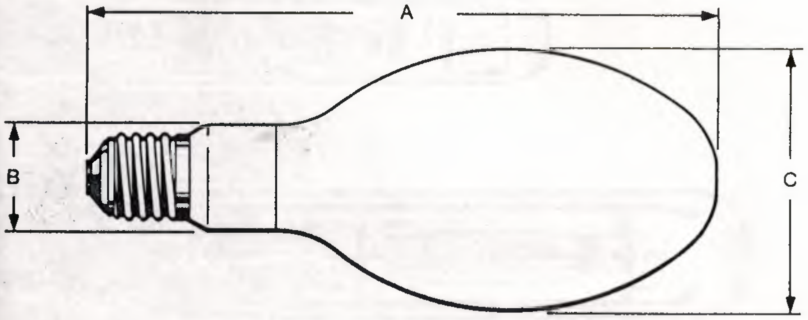
nical data

gnation	Base	Min. supply voltage for ignition¹) V		Average lamp voltage²)⁴) V	Average lamp current²)⁴) A	Lamp starting current A(max.)	Minimum permissible lamp wattage²) W	Average lamp wattage²)⁴) W	Maximum permissible lamp wattage²) W	Average luminous flux²)⁴) lm	Average luminance²)⁴) cd/cm²	Run-up time³)⁴) min.
		+20°C	−18°C									
250 W BU	E40	200	200	125	2,2	3,2	210	250	290	17 500	3,7	3
400 W	E40	200	200	125	3,4	6,0	330	390	450	27 600	3,5	3
400 W BU	E40	200	200	125	3,4	6,0	340	400	460	30 600	3,8	3
400 W BUS	E40	200	200	125	3,4	6,0	340	400	460	30 600	3,8	3

hours. ²) After 100 burning hours.
number of minutes after which the lamp has reached 80% of its final luminous flux.
colour rendering properties will be reached after 10-15 minutes.
sured at nominal supply voltage and reference ballast for a free burning lamp.

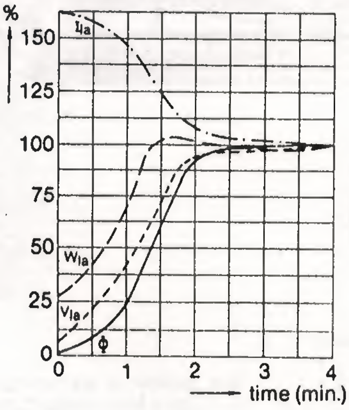
ering and packing data

ation	Ordering number	Nett weight g	Packing unit Qty	Weight kg	Dimensions cm	Volume m³
50 W BU	9280 767 098 . .	200	12	3,90	47 x 37,5 x 27,5	0,048
00 W	9280 731 098 . .	260	6	3,10	51 x 36 x 37	0,068
00 W BU	9280 743 098 . .	260	6	3,10	51 x 36 x 37	0,068
00 W BUS	9280 747 098 . .	260	6	3,10	51 x 36 x 37	0,068

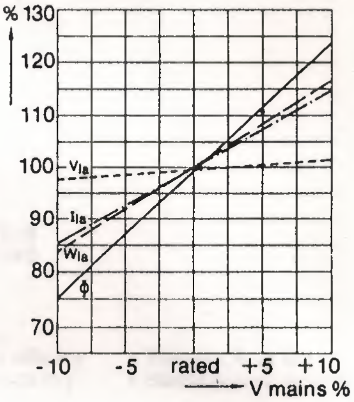


Typical curves

Lamp performance during starting period

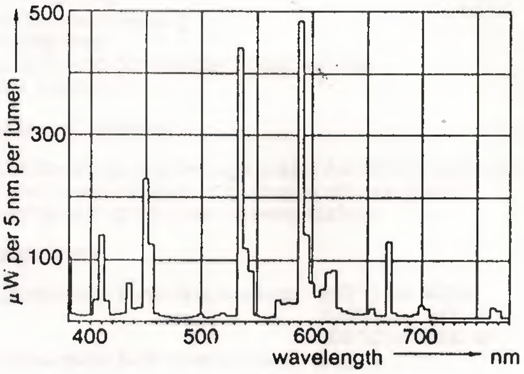


Effects of mains voltage variations

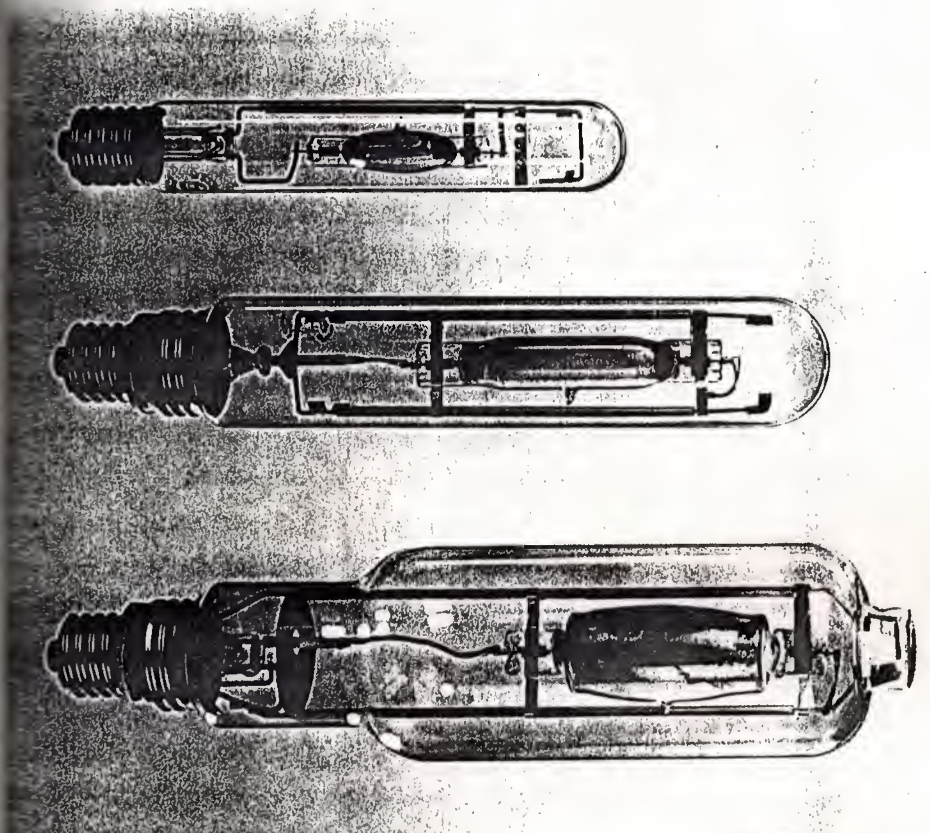


W_{la} = lamp wattage
V_{la} = lamp voltage
I_{la} = lamp current
Φ = luminous flux

Normalised spectral power distribution



HPI-T lamps



HPI-T 250 W
HPI-T 400 W
HPI-T 1000 W
HPI-T 2000 W/220
HPI-T 2000 W/380

efinition

gh-pressure metal halide gas-discharge lamps, for indoor and door use, with iodide additives indium, thallium and sodium in e mercury discharge. The discharge tube is enclosed in a ear, tubular hard glass outer bulb.

escription

- Basically, HPI-T lamps operate om the same principe as all gas-discharge lamps.
- In view of the need for a light source with excellent colour rendering combined with high efficacy, the discharge tube contains metal halide compounds which have the effect of increasing the intensity of the radiation in the three spectral bands blue, green and yellow-red. Consequently, the colour appearance and colour rendering are improved and the luminous efficacy is considerably increased.
- When used together with the appropriate optical systems, this combination provides a highly efficient source of accurately controlled, powerful beams of light.
- The spectrum of the metal halide lamp meets the requirements for colour film and colour television. The lamps are therefore highly suitable for the lighting of colour television broadcasts.

Lamp characteristics:

- Very high luminous efficacy
- Excellent colour rendering
- Reliable, long life
- Stable lumen maintenance

Applications

- Lighting for colour TV broadcasting
- Lighting for colour filming
- Public lighting
- Sports ground lighting
- Floodlighting
- Industrial and commercial indoor lighting
- Plant irradiation

Ballasts and ignitors

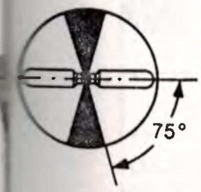
Metal halide lamps require high quality ballasts for optimum operation, as well as ignitors to ensure reliable ignition.
For ballasts and ignitors see relevant leaflets.

Temperatures

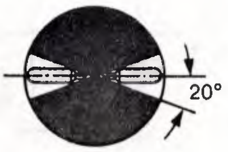
Max. permissible base temperatures:	250°C for 400W 300°C for 1000 W 300°C for 2000 W
Max. permissible bulb termperature:	600°C

Burning positions

The HPI-T 250 W, HPI-T 400 W, HPI-T 1000 W and HPI-T 2000 W, 380 V lamps may burn in a horizontal position ± 20° only, while the burning angle of the HPI-T 2000 W, 220 V lamp may be varied by approximately 75° from the horizontal. This means that the 2000 W, 220 V lamp can be used in rotation-symmetrical floodlights in a declined position without the colour rendering properties being affected.



PI-T 2000 W/220 V



HPI-T 250 W
HPI-T 400 W
HPI-T 1000 W
HPI-T 2000 W/380 V

Dimensions

Lamp designation	A max.	B nom.	C max.	D nom.
HPI-T 250 W	257	158	47	30
HPI-T 400 W	283	175	47	41
HPI-T 1000 W	382	240	67	80
HPI-T 2000 W/220	430	290	102	85
HPI-T 2000 W/380	430	260	102	135

echnical data

amp esignation	Base	Min. supply voltage for ignition1) V		Average lamp voltage2)4) V	Average lamp current2)4) A	Lamp starting current A(max.)	Minimum permissible lamp wattage2) W	Nominal lamp wattage2)4) W	Maximum permissible lamp wattage2) W	Average luminous flux2)4) lm	Average luminance2)4) cd/cm^2	Run-up time3)4) min.
		+20°C	—18°C									
PI-T 250 W	E40	200	200	125	2,1	5	210	245	285	17 000	700	3
PI-T 400 W	E40	200	200	125	3,4	6	330	390	450	31 500	770	3
PI-T 1000 W	E40	200	200	130	8,25	14	800	965	1100	81 000	950	3
PI-T 2000 W/220	E40	200	200	135	16,5	24	1650	1960	2200	189 000	1100	3
PI-T 2000 W/380	E40	330	340	240	8,6	14	1650	1900	2200	183 000	870	3

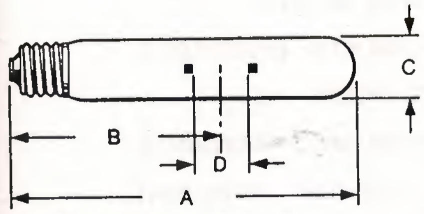
At 0 hours. 2) After 100 burning hours.

The number of minutes after which the lamp has reached 80% of its final luminous flux. Final colour rendering properties will be reached after 10-15 minutes.

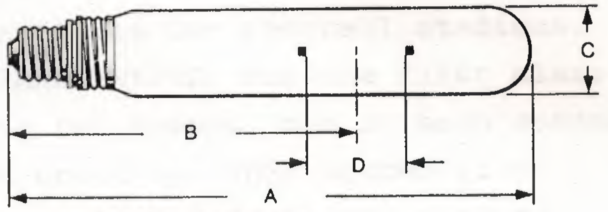
Measured at nominal supply voltage and reference ballast for a free burning lamp.

rdering and packing data

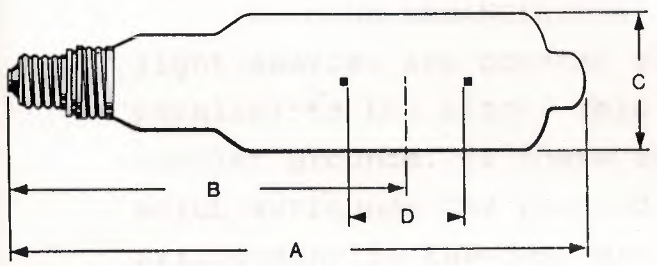
amp esignation	Ordering number	Nett weight g	Packing unit Qty	Weight kg	Dimensions cm	Volume m^3
PI-T 250 W	9280 761 092 . .	180	12	4,46	36 x 29 x 39	0,041
PI-T 400 W	9280 734 092 . .	180	12	4,46	36 x 29 x 39	0,041
PI-T 1000 W	9280 740 092 . .	400	4	4,65	32 x 32 x 51	0,052
PI-T 2000 W/220	9280 736 092 . .	650	4	5,00	35 x 35 x 60	0,074
PI-T 2000 W/380	9280 718 092 . .	670	4	5,00	35 x 35 x 60	0,074



HPI-T 250 W base E40/45
HPI-T 400 W base E40/45



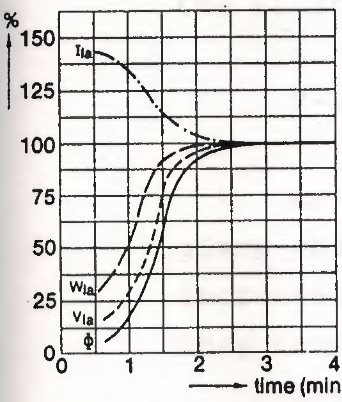
HPI-T 1000 W base E40/45



HPI-T 2000 W/220 V base E40/80 x 50
HPI-T 2000 W/380 V base E40/80 x 50

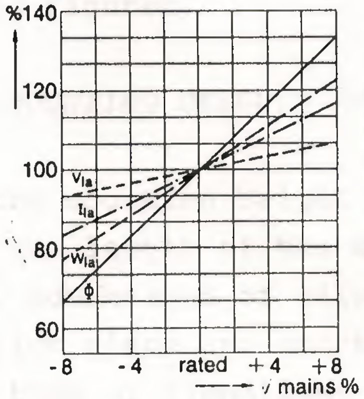
Typical curves

Lamp performance during starting period

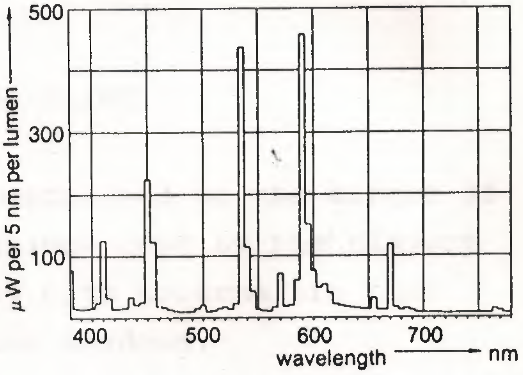


W_{la} = lamp wattage
V_{la} = lamp voltage
I_{la} = lamp current
Φ = luminous flux

Effects of mains voltage variations



Normalised spectral power distribution



2-3 *MAST ARRANGEMENTS*

There are basically two important alternative lighting arrangements suitable for football stadiums.

1- FOUR CORNER ARRANGEMENTS: For the first class grounds the system using for towers, one at each corner has now become accepted practice. This system gives minimum glare to spectators and also to the players because there is no source of glare within the area bounded by the two goal line.

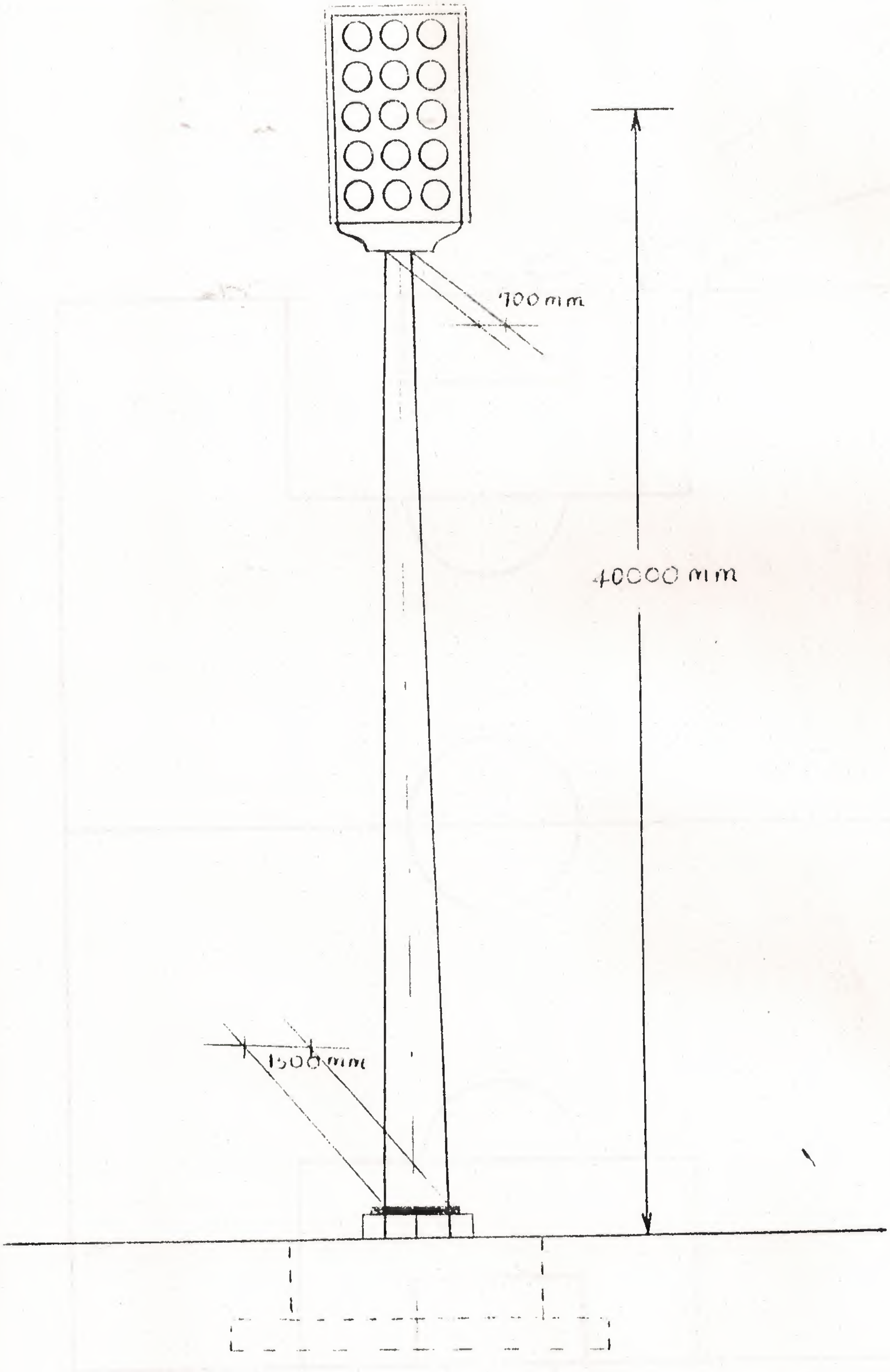
2- SIDE ARRANGEMENTS: With this arrangement the light sources are mounted either on columns or in rows parallel to the pitch. This system is popular for the smaller grounds. If there is no roof for spectators area which surrounds the playing field the four corner arrangement is the best one.

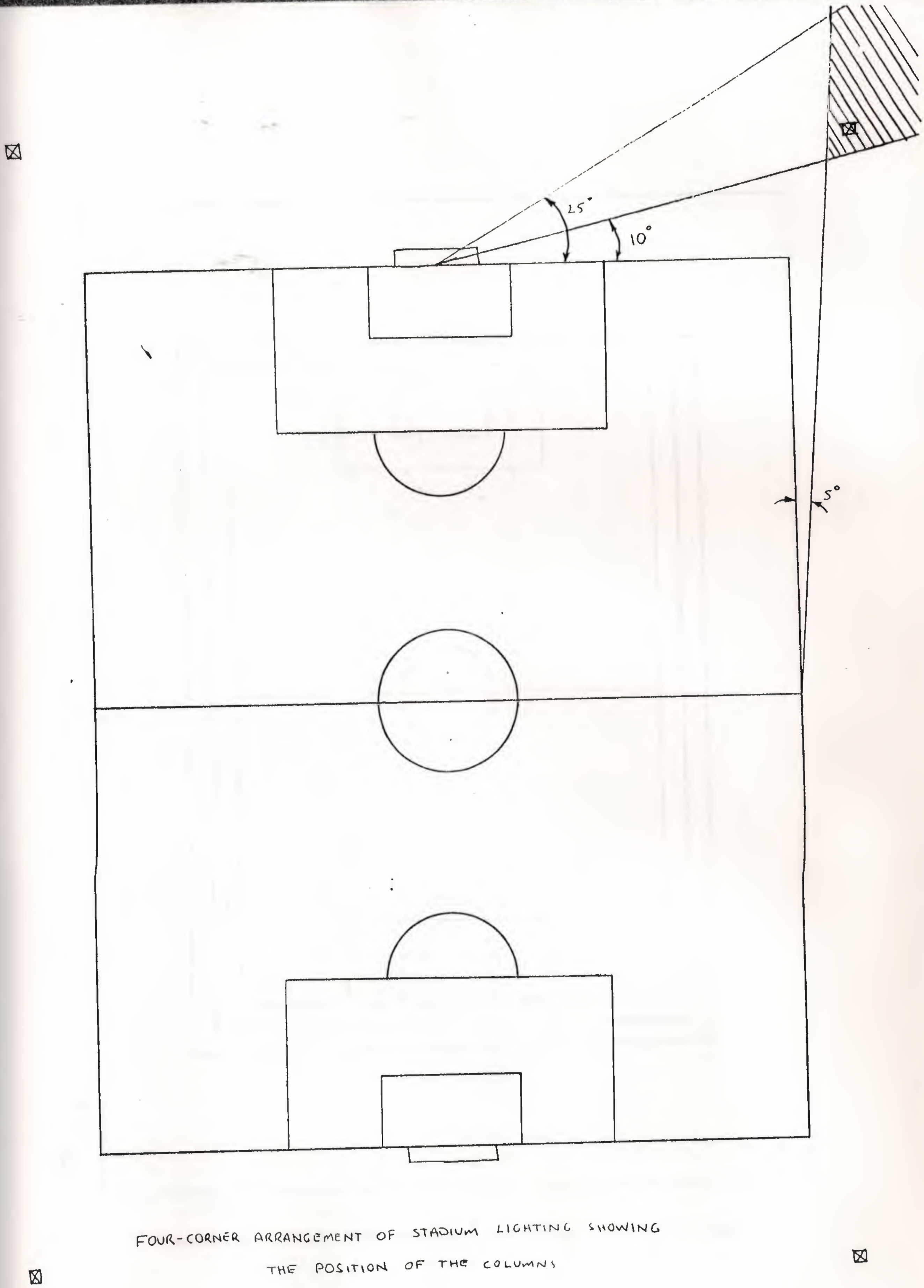
We preferred the four-corner arrangements. According to this kind of arrangement the mounting masts creates 10 degrees and 25 degrees from the goal-post towards back. Masts are mounted to field in lines between 25 and 10 degrees which starts from the middle of the playing field and it should not be nearer from the line which makes 5 degrees to the edge of the field.(shown in the related figures)

2-4 *MOUNTING HEIGHTS AND GLARE*

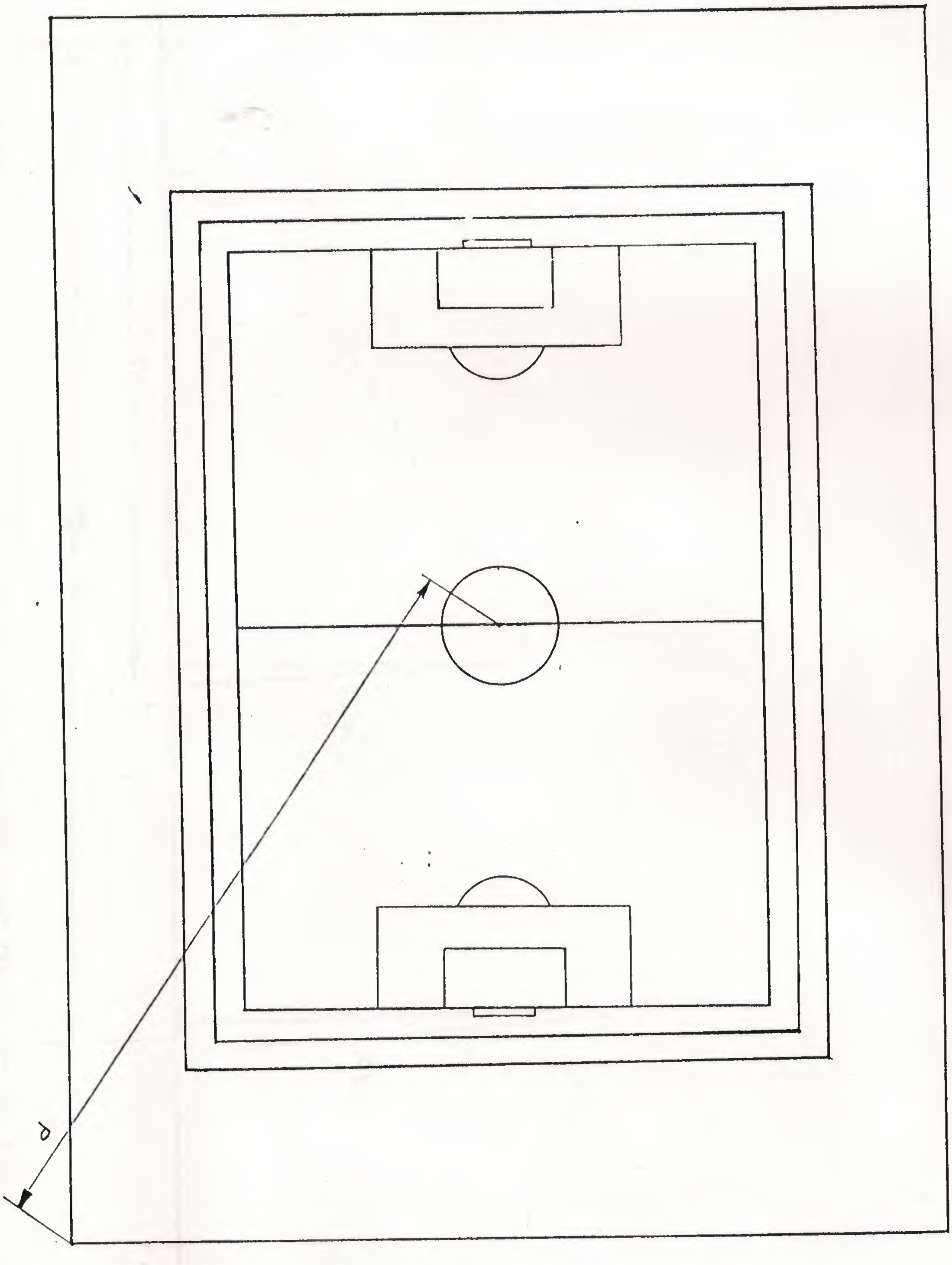
As the mounting height decreases so the danger of glare and the length of the shadow cast by the players increases. Advantages of using high columns are that they restrict glare and shorter shadows.

The type of floodlight used, it is desirable that the angles subtended at the center of pitch between the horizontal and the lowest point of each flood light battery, be at least 25 degrees. (shown at fig.)


700 mm
40000 mm
1500 mm

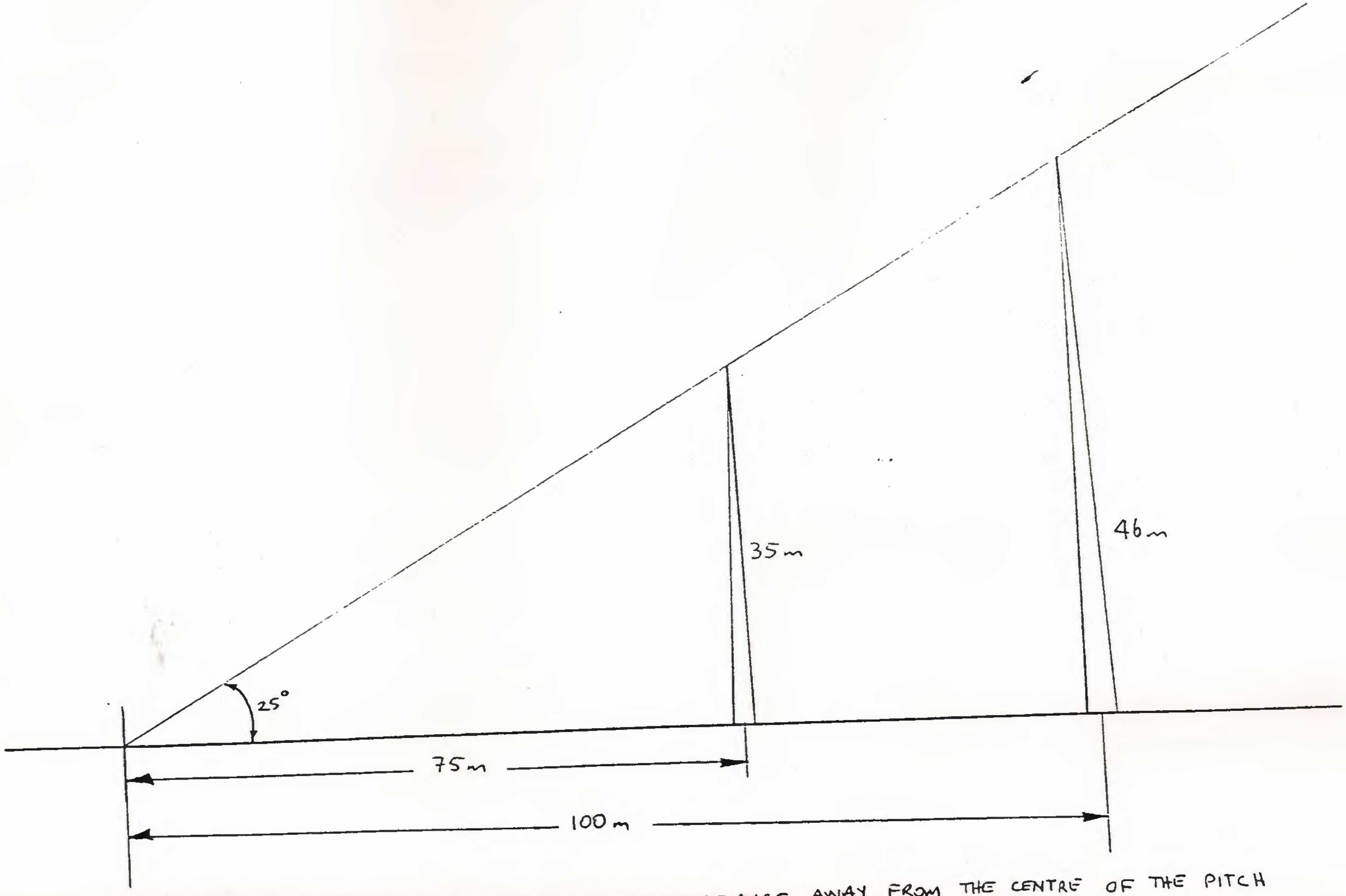


FOUR-CORNER ARRANGEMENT OF STADIUM LIGHTING SHOWING
THE POSITION OF THE COLUMNS



VIEWING DISTANCE FROM FARTHEST SPECTATOR TO PITCH CENTER

14.1



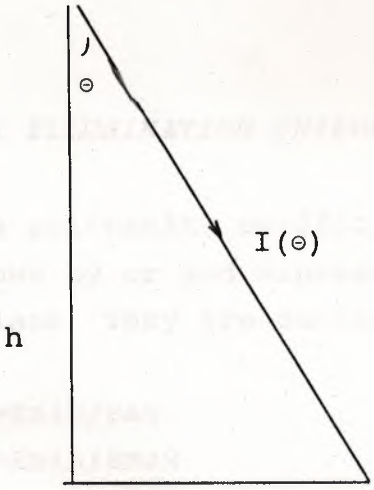
MOUNTING HEIGHT INCREASING WITH DISTANCE AWAY FROM THE CENTRE OF THE PITCH

PART C

III CALCULATIONS AND COMPUTATIONS

3-1 *FORMULAS:* Illuminance at any point (X , Y) can be found from

$E = I(\Theta)\ (\cos \Theta)^3 / h^2$ .Where Θ is angle between the mast and the light intensity $I(\Theta)$



$(\cos \Theta)^3 = 1 / (1+x'^2+y'^2)^{(3/2)}$......Where $x'=x/h$

$y'=y/h$

To find $I(\Theta)$ we must find γ & C ;

$\gamma = \arccos(A/\mathrm{SQRT}\ B)$

$A= (1+x'+xo'+y'+yo')$ ....Where $xo'=xo/h$

$B=(1+x'^2+y'^2)(1+xo'^2+yo'^2)$ $yo'=yo/h$

$C = \arctan((\tan \alpha \; SQRT(1+(\tan A)^2))/\tan A)$

Where;

$A=\arctan(y'SQRT(1+x'^2)/(1+xo'x')-\arctan(yo'/SQRT(1+xo'^2))$

$\alpha=\arccos((1+x'xo'+y'^2.P)/SQRT((1+x'^2+y'^2)(Q)))$

$P=((1+xo'^2)/(1+x'xo'))$

$Q=(1+xo'^2+yo'^2((1+xo')/(1+xo'x'))^2)$

After find C and γ, we can find easily $I(\theta)$ from C-γ matrix.

3-2 *ILLUMINATION UNIFORMITY*

The uniformity coefficient must also be estimated. It is shown by or and expresses the uniformity according to the place. They are defined as;

$\rho 1=Emin/Eav$

$\rho 2=Emin/Emax$

xo=It is the x-coordinate on the surface which the projector axis intercept the plane that will be illuminated.

yo=It is the y-coordinate on the surface of the point at which the projector axis intercept the plane that will be illuminated.

x,y=The coordinates of the point at which we want to calculate the illuminance.

3-3 *PROCEDURE OF CALCULATION OF NUMBER OF PROJECTORS*

-At the first of all Eav choosing for stadium illumination.

-Each mast will illuminate one quarter of the playground so quarter of stadium area must known.

-Useful flux must be calculated from;

$$\phi\ (\mathrm{USEFUL}) = \mathrm{Eav} * \mathrm{Area}$$

-Then total flux must be find from;

$$\phi\ (\mathrm{TOTAL}) = \phi\ (\mathrm{USEFUL})\ /\ \mathrm{Efficiency}$$

-Lamps must be choosing for use in stadium illumination.

-Finally the number of projectors calculated from;

$$\#\ \mathrm{of\ lamps} = \phi\ (\mathrm{TOTAL})\ /\ \phi\ (\mathrm{LAMP})$$

(The number of lamps after calculating can be decimal but as it is impossible usually we take the nearest [illegible] number.)

3-4 *SOME BASIC CONCEPTS*

COLOUR RENDERING: The effect of light source on the colour appearance under a reference light source.

GLARE: A condition of vision which a discomfort and/or a reduction in the ability to see significant object, due to the unsuitable distribution or range of brightness, or to extreme contrasts simultaneous or successive in the field of view.

DIFFUSED LIGHTING: Lighting in which the light on the working plane or an object is not predominantly incident from any particular direction.

MAINTENANCE FACTOR: It is a factor used in illumination calculation to allow the reduction of light output from a source of fitting of dust and foreign matter being deposited on it.

OBJECTIVE BRIGHTNESS: This is the luminous intensity of the light source. It is the light output divided by the projected area of the light source in the particular direction measured in candles per unit area.

PART D

COMPUTER PROGRAM OF POINT BY POINT ILLUMINATION

```
   DIMENSION A(181,351) ,E(28,121),M(117)
   REAL E,ALFA,ALFA1,X1,Y1,XO1,YO1,C1,C,GAMA,C3,A1,XO,YO
   INTEGER M5
   REAL AL,FA,X,Y,G3,C4,TOT,REG
   OPEN(1,FILE='MATRIX')
   OPEN(2,FILE='OUTPUT.TXT',STATUS='NEW')
   DO 10 I=1,181,3
   DO 10 J=1,351,5
   READ(1,*)A(I,J)
10 CONTINUE
   CLOSE (1)
   DO 100 I1=1,15
   I2=0
   WRITE(5,*)'I/P XO & YO'
   READ(5,*)XO
   READ(5,*)YO
   WRITE(5,9)XO,YO
   WRITE(2,9)XO,YO
   FORMAT(2X,'FOR:',' XO=',F4.1,3X,'YO=',F4.1)
   WRITE(5,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~'
   WRITE(5,*)
   WRITE(5,*)' X      Y       C     GAMA          I          E'
   WRITE(5,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~'
   WRITE(2,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~'
   WRITE(2,*)
   WRITE(2,*)' X      Y       C     GANA          I          E'
   WRITE(2,*)'~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   DO 100 X=8,40,8
   DO 100 Y=5,61,14
   I2=I2+1
   X1=X/40
   Y1=Y/40
   XO1=XO/40
   YO1=YO/40
   C3=1/(((1+X1*X1+Y1*Y1))**(1.5))
   AL=1+X1*XO1+Y1*Y1*((1+XO1*XO1)/(1+X1*XO1))
   F1=(1+X1**2+Y1**2)*(1+XO1**2+(Y1**2)*((1+XO1**2)/(1+XO1*X1))**2)
   FA=SQRT(F1)
   ALFA1=ACOS(AL/FA)
   ALFA=((ALFA1*180.0)/3.1415926)
   S=SQRT(1+XO1**2)
   A1=ATAN((Y1*SQRT(1+XO1*XO1))/(1+XO1*X1))-ATAN(YO1/S)
   A2=((A1*180)/3.1415926)
   C1=ATAN(TAN(ALFA1*SURT(1+TAN(A1)*TAN(A1)))/TAN(A1+.01))
   C=((C1*180)/3.1415926)
   GAMA1=ATAN(SQRT((TAN(ALFA1))**2*(1+(TAN(A1))**2)+(TAN(A1))**2))
   GAMA=((GAMA1*180)/3.1415926)
   IF ((A2.LT.0).AND.(X.GT.XO)) C=C+180
   IF ((A2.LT.0).AND.(X.LT.XO)) C=180-C
   IF ((A2.GT.0).AND.(X.LT.XO)) C=360-C
   IF ((A2.GT.0).AND.(X.GT.XO)) C=C
   IF ((A2.EQ.0).OR.(X.EQ.XO)) C=0
   C=NINT(C)
   C4=MOD(C,5.0)
```

```
IF (C4.EQ.0) CO=C+1
IF (C4.EQ.1) CO=C
IF (C4.EQ.2) CO=C-1
IF (C4.EQ.3) CO=C-2
IF (C4.EQ.4) CO=C+2
L=CO
IF (L.EQ.356) L=351
GAMA=NINT(GAMA)
G3=MOD(GAMA,3.0)
IF (G3.EQ.0) GAMA=GAMA+1
IF (G3.EQ.1) GAMA=GAMA
IF (G3.EQ.2) GAMA=GAMA-1
K=GAMA
E(I1,I2)=A(K,L)*183*C3/1600
WRITE(5,60)X,Y,C,GAMA,A(K,L),E(I1,I2)
FORMAT(F4.1,2X,F4.1,3X,F6.1,2X,F7.3,2X,F10.3,2X,F9.3,2X)
WRITE(2,60)X,Y,C,GAMA,A(K,L),E(I1,I2)
CONTINUE
DO 200 I2=1,25
M1=E(1,I2)+E(2,I2)+E(3,I2)+E(4,I2)+E(5,I2)+E(6,I2)
M2=E(7,I2)+E(8,I2)+E(9,I2)+E(10,I2)+E(11,I2)
M3=E(12,I2)+E(13,I2)+E(14,I2)+E(15,I2)
M(I2)=M1+M2+M3
WRITE(5,*)M(I2)
WRITE(2,*)M(I2)
CONTINUE
CLOSE(2)
STOP
END
```

```
 FOR: XO= 8.0    YO=33.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

 X         Y           C        GAMA              I                E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 8.0     5.0         0.0      31.000          862.000           90.902
 8.0    19.0         0.0      13.000         1020.000           81.936
 8.0    33.0         0.0       1.000         1044.000           52.906
 8.0    47.0         0.0      10.000          990.000           30.066
 8.0    61.0         0.0      16.000          990.000           18.339
16.0     5.0       161.0      34.000           20.000            1.795
16.0    19.0       145.0      19.000          200.000           14.025
16.0    33.0        93.0       7.000          210.000            9.618
16.0    47.0        37.0      10.000          446.000           12.597
16.0    61.0        20.0      16.000          450.000            7.909
24.0     5.0       146.0      37.000            2.000            0.142
24.0    19.0       128.0      25.000            6.000            0.344
24.0    33.0        95.0      16.000           90.000            3.531
24.0    47.0        59.0      16.000          140.000            3.529
24.0    61.0        37.0      19.000          110.000            1.778
32.0     5.0       135.0      43.000            0.000            0.000
32.0    19.0       119.0      31.000            1.000            0.045
32.0    33.0        96.0      22.000            3.000            0.097
32.0    47.0        70.0      22.000            4.000            0.087
32.0    61.0        50.0      22.000           11.000            0.159
40.0     5.0       127.0      46.000            0.000            0.000
40.0    19.0       114.0      37.000            0.000            0.000
40.0    33.0        96.0      28.000            0.000            0.000
40.0    47.0        76.0      25.000            0.000            0.000
40.0    61.0        59.0      25.000            1.000            0.013
```

```
   FOR: XO= 8.0    YO=60.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  X        Y          C        GAMA            I              E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0     5.0        0.0     49.000        188.000         19.826
  8.0    19.0        0.0     31.000        862.000         69.244
  8.0    33.0        0.0     16.000        990.000         50.169
  8.0    47.0        0.0      7.000       1030.000         31.281
  8.0    61.0        0.0      1.000       1044.000         19.339
 16.0     5.0      166.0     49.000          3.000          0.269
 16.0    19.0      162.0     34.000         20.000          1.402
 16.0    33.0      154.0     19.000        350.000         16.031
 16.0    47.0      135.0     10.000        354.000          9.998
 16.0    61.0      270.0      7.000        500.000          8.788
 24.0     5.0      153.0     52.000          0.000          0.000
 24.0    19.0      148.0     37.000          2.000          0.115
 24.0    33.0      138.0     25.000         10.000          0.392
 24.0    47.0      121.0     16.000        130.000          3.277
 24.0    61.0       95.0     13.000        159.000          2.570
 32.0     5.0      142.0     55.000          0.000          0.000
 32.0    19.0      137.0     40.000          0.000          0.000
 32.0    33.0      128.0     31.000          1.000          0.032
 32.0    47.0      114.0     22.000          5.000          0.109
 32.0    61.0       96.0     16.000         90.000          1.303
 40.0     5.0      132.0     58.000          0.000          0.000
 40.0    19.0      130.0     46.000          0.000          0.000
 40.0    33.0      122.0     34.000          0.000          0.000
 40.0    47.0      111.0     28.000          0.000          0.000
 40.0    61.0       97.0     22.000          3.000          0.038
```

```
 FOR: XO=16.0    YO=33.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  X      Y         C       GAMA           I             E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0    5.0     200.0    31.000       496.000        52.306
  8.0   19.0     220.0    16.000       550.000        44.181
  8.0   33.0     287.0     7.000       500.000        25.338
  8.0   47.0     331.0    13.000       720.000        21.866
  8.0   61.0     343.0    19.000       700.000        12.967
 16.0    5.0       0.0    31.000       862.000        77.346
 16.0   19.0       0.0    13.000      1020.000        71.526
 16.0   33.0       0.0     1.000      1044.000        47.817
 16.0   47.0       0.0    10.000       990.000        27.961
 16.0   61.0       0.0    16.000       990.000        17.400
 24.0    5.0     162.0    31.000        76.000         5.388
 24.0   19.0     149.0    16.000       320.000        18.331
 24.0   33.0      99.0     7.000       220.000         8.632
 24.0   47.0      37.0    10.000       446.000        11.243
 24.0   61.0      19.0    16.000       450.000         7.274
 32.0    5.0     149.0    34.000         4.000         0.215
 32.0   19.0     134.0    22.000        21.000         0.943
 32.0   33.0     101.0    16.000       100.000         3.235
 32.0   47.0      61.0    13.000       200.000         4.357
 32.0   61.0      37.0    16.000       290.000         4.200
 40.0    5.0     140.0    40.000         1.000         0.040
 40.0   19.0     125.0    28.000         3.000         0.103
 40.0   33.0     102.0    19.000        60.000         1.564
 40.0   47.0      74.0    19.000        45.000         0.828
 40.0   61.0      52.0    19.000        70.000         0.890
```

```
  FOR: XO=16.0    YO=60.0
~~~~~~~~~~~~~~~~~~~~~~~~~~

 X     Y       C      GAMA        I          E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0   5.0    195.0   49.000     260.000     27.418
  8.0  19.0    200.0   31.000     496.000     39.843
  8.0  33.0    210.0   16.000     600.000     30.406
  8.0  47.0    239.0    7.000     560.000     17.007
  8.0  61.0    297.0    7.000     520.000      9.632
 16.0   5.0      0.0   49.000     188.000     16.869
 16.0  19.0      0.0   31.000     862.000     60.446
 16.0  33.0      0.0   16.000     990.000     45.344
 16.0  47.0      0.0    7.000    1030.000     29.091
 16.0  61.0      0.0    1.000    1044.000     18.349
 24.0   5.0    167.0   49.000       3.000      0.213
 24.0  19.0    164.0   34.000      60.000      3.437
 24.0  33.0    157.0   19.000     350.000     13.733
 24.0  47.0    141.0   10.000     398.000     10.033
 24.0  61.0     98.0    7.000     215.000      3.475
 32.0   5.0    157.0   52.000       0.000      0.000
 32.0  19.0    152.0   37.000       3.000      0.135
 32.0  33.0    143.0   25.000      20.000      0.647
 32.0  47.0    128.0   16.000     160.000      3.486
 32.0  61.0    103.0   10.000     170.000      2.462
 40.0   5.0    148.0   52.000       0.000      0.000
 40.0  19.0    143.0   40.000       1.000      0.034
 40.0  33.0    135.0   28.000       7.000      0.182
 40.0  47.0    122.0   22.000       7.000      0.129
 40.0  61.0    105.0   16.000     100.000      1.271
```

```
  FOR: X0=24.0   Y0= 5.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  X       Y          C        GAMA             I                E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0     5.0      275.0     19.000         360.000          37.964
  8.0    19.0      318.0     28.000         404.000          32.453
  8.0    33.0      335.0     37.000         310.000          15.710
  8.0    47.0      342.0     46.000         244.000           7.410
  8.0    61.0      346.0     52.000         260.000           4.816
 16.0     5.0      277.0     10.000         496.000          44.505
 16.0    19.0      335.0     19.000         550.000          38.568
 16.0    33.0      347.0     31.000         555.000          25.420
 16.0    47.0      351.0     43.000         500.000          14.122
 16.0    61.0      353.0     49.000         333.000           5.853
 24.0     5.0        0.0      1.000        1044.000          74.008
 24.0    19.0        0.0     16.000         990.000          56.711
 24.0    33.0        0.0     28.000         900.000          35.313
 24.0    47.0        0.0     40.000         480.000          12.100
 24.0    61.0        0.0     46.000         298.000           4.817
 32.0     5.0      269.0      7.000         500.000          26.845
 32.0    19.0       26.0     16.000         400.000          17.954
 32.0    33.0       14.0     28.000         200.000           6.471
 32.0    47.0        9.0     37.000         150.000           3.268
 32.0    61.0        7.0     43.000         150.000           2.172
 40.0     5.0       91.0     13.000         145.000           5.795
 40.0    19.0       45.0     19.000          70.000           2.411
 40.0    33.0       26.0     28.000          90.000           2.345
 40.0    47.0       18.0     37.000          35.000           0.644
 40.0    61.0       14.0     43.000          10.000           0.127
```

```
  FOR: XO=24.0    YO=33.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

 X        Y         C        GAMA           I             E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  8.0     5.0     218.0    34.000       350.000        36.909
  8.0    19.0     246.0    19.000       360.000        28.919
  8.0    33.0     291.0    16.000       445.000        22.551
  8.0    47.0     321.0    19.000       520.000        15.792
  8.0    61.0     334.0    25.000       500.000         9.262
 16.0     5.0     199.0    31.000       496.000        44.505
 16.0    19.0     219.0    13.000       520.000        36.464
 16.0    33.0     293.0     7.000       510.000        23.359
 16.0    47.0     335.0    13.000       800.000        22.595
 16.0    61.0     345.0    19.000       800.000        14.060
 24.0     5.0       0.0    28.000       900.000        63.800
 24.0    19.0       0.0    13.000      1020.000        58.429
 24.0    33.0       0.0     1.000      1044.000        40.963
 24.0    47.0       0.0    10.000       990.000        24.957
 24.0    61.0       0.0    16.000       990.000        16.003
 32.0     5.0     164.0    31.000       170.000         9.127
 32.0    19.0     153.0    16.000       320.000        14.363
 32.0    33.0     104.0     7.000       250.000         8.088
 32.0    47.0      35.0    10.000       446.000         9.717
 32.0    61.0      18.0    16.000       600.000         8.690
 40.0     5.0     153.0    34.000         4.000         0.160
 40.0    19.0     139.0    22.000        38.000         1.309
 40.0    33.0     107.0    13.000       175.000         4.561
 40.0    47.0      62.0    13.000       200.000         3.680
 40.0    61.0      36.0    16.000       290.000         3.687
```

```
  FOR: XO=24.0    YO=47.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  X        Y          C        GAMA            I              E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  8.0    5.0      211.0    43.000      220.000         23.200
  8.0   19.0      226.0    25.000      400.000         32.132
  8.0   33.0      256.0    16.000      420.000         21.284
  8.0   47.0      295.0    13.000      510.000         15.489
  8.0   61.0      320.0    16.000      520.000          9.632
 16.0    5.0      195.0    40.000      303.000         27.188
 16.0   19.0      203.0    22.000      624.000         43.757
 16.0   33.0      227.0    10.000      627.000         28.718
 16.0   47.0      297.0     7.000      520.000         14.687
 16.0   61.0      333.0    10.000      784.000         13.779
 24.0    5.0        0.0    40.000      480.000         34.027
 24.0   19.0        0.0    22.000      957.000         54.820
 24.0   33.0        0.0    10.000      990.000         38.844
 24.0   47.0        0.0     1.000     1044.000         26.318
 24.0   61.0        0.0     7.000     1030.000         16.650
 32.0    5.0      168.0    40.000       13.000          0.698
 32.0   19.0      163.0    25.000      150.000          6.733
 32.0   33.0      151.0    13.000      460.000         14.883
 32.0   47.0      108.0     7.000      250.000          5.447
 32.0   61.0       42.0     7.000      470.000          6.807
 40.0    5.0      158.0    43.000        2.000          0.080
 40.0   19.0      151.0    28.000       15.000          0.517
 40.0   33.0      138.0    19.000      150.000          3.909
 40.0   47.0      110.0    13.000      200.000          3.680
 40.0   61.0       71.0    10.000      200.000          2.543
```

```
  FOR: XO=24.0    YO=60.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  X        Y          C        GAMA          I            E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0      5.0      208.0     49.000      170.000       17.927
  8.0     19.0      217.0     31.000      425.000       34.140
  8.0     33.0      235.0     19.000      386.000       19.561
  8.0     47.0      266.0     13.000      420.000       12.755
  8.0     61.0      300.0     13.000      520.000        9.632
 16.0      5.0      193.0     46.000      368.000       33.020
 16.0     19.0      198.0     28.000      600.000       42.074
 16.0     33.0      208.0     16.000      700.000       32.061
 16.0     47.0      239.0      7.000      560.000       15.816
 16.0     61.0      304.0      7.000      570.000       10.018
 24.0      5.0        0.0     46.000      298.000       21.125
 24.0     19.0        0.0     31.000      862.000       49.378
 24.0     33.0        0.0     16.000      990.000       38.844
 24.0     47.0        0.0      7.000     1030.000       25.965
 24.0     61.0        0.0      1.000     1044.000       16.876
 32.0      5.0      169.0     46.000       24.000        1.289
 32.0     19.0      166.0     31.000      170.000        7.630
 32.0     33.0      160.0     19.000      420.000       13.589
 32.0     47.0      147.0     10.000      453.000        9.869
 32.0     61.0      105.0      4.000      355.000        5.142
 40.0      5.0      160.0     49.000        1.000        0.040
 40.0     19.0      156.0     34.000        8.000        0.276
 40.0     33.0      148.0     25.000       40.000        1.042
 40.0     47.0      135.0     16.000      180.000        3.312
 40.0     61.0      110.0     10.000      190.000        2.416
```

```
  FOR: XO=32.0    YO= 5.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  X       Y        C       GAMA          I           E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0     5.0    276.0    28.000      255.000      26.891
  8.0    19.0    310.0    34.000      320.000      25.705
  8.0    33.0    327.0    43.000      180.000       9.122
  8.0    47.0    336.0    49.000      143.000       4.343
  8.0    61.0    341.0    55.000      194.000       3.594
 16.0     5.0    276.0    16.000      435.000      39.032
 16.0    19.0    321.0    25.000      405.000      28.400
 16.0    33.0    337.0    34.000      380.000      17.405
 16.0    47.0    344.0    43.000      400.000      11.297
 16.0    61.0    348.0    52.000      260.000       4.570
 24.0     5.0    279.0     7.000      500.000      35.445
 24.0    19.0    337.0    19.000      550.000      31.506
 24.0    33.0    348.0    31.000      555.000      21.776
 24.0    47.0    352.0    40.000      500.000      12.605
 24.0    61.0    354.0    46.000      410.000       6.627
 32.0     5.0      0.0     1.000     1044.000      56.052
 32.0    19.0      0.0    16.000      990.000      44.435
 32.0    33.0      0.0    28.000      900.000      29.118
 32.0    47.0      0.0    37.000      500.000      10.893
 32.0    61.0      0.0    43.000      360.000       5.214
 40.0     5.0    269.0     7.000      500.000      19.984
 40.0    19.0     24.0    13.000      570.000      19.635
 40.0    33.0     13.0    25.000      500.000      13.030
 40.0    47.0      8.0    34.000      424.000       7.802
 40.0    61.0      6.0    43.000      150.000       1.907
```

```
   FOR: XO=32.0    YO=33.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

   X        Y          C        GAMA            I              E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   8.0      5.0      232.0     37.000        220.000         23.200
   8.0     19.0      260.0     25.000        310.000         24.902
   8.0     33.0      295.0     22.000        356.000         18.041
   8.0     47.0      317.0     25.000        390.000         11.844
   8.0     61.0      330.0     31.000        423.000          7.836
  16.0      5.0      215.0     31.000        425.000         38.134
  16.0     19.0      245.0     16.000        420.000         29.452
  16.0     33.0      295.0     16.000        455.000         20.840
  16.0     47.0      325.0     19.000        520.000         14.687
  16.0     61.0      337.0     25.000        500.000          8.788
  24.0      5.0      197.0     28.000        600.000         42.534
  24.0     19.0      216.0     13.000        670.000         38.380
  24.0     33.0      298.0      7.000        520.000         20.403
  24.0     47.0      338.0     13.000        800.000         20.167
  24.0     61.0      347.0     22.000        730.000         11.800
  32.0      5.0        0.0     28.000        900.000         48.320
  32.0     19.0        0.0     13.000       1020.000         45.782
  32.0     33.0        0.0      1.000       1044.000         33.777
  32.0     47.0        0.0     10.000        990.000         21.569
  32.0     61.0        0.0     16.000        990.000         14.338
  40.0      5.0      166.0     28.000        100.000          3.997
  40.0     19.0      156.0     16.000        400.000         13.779
  40.0     33.0      108.0      7.000        250.000          6.515
  40.0     47.0       33.0     10.000        516.000          9.495
  40.0     61.0       16.0     16.000        600.000          7.628
```

```
  FOR: XO=32.0   YO=47.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

  X       Y          C        GAMA              I               E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0    5.0     224.0     43.000         140.000          14.764
  8.0   19.0     242.0     28.000         290.000          23.295
  8.0   33.0      91.0     22.000           3.000           0.152
  8.0   47.0     300.0     19.000         450.000          13.666
  8.0   61.0     318.0     22.000         393.000           7.280
 16.0    5.0     208.0     40.000         239.000          21.445
 16.0   19.0     223.0     22.000         413.000          28.961
 16.0   33.0     256.0     13.000         400.000          18.321
 16.0   47.0     301.0     13.000         320.000          14.687
 16.0   61.0     325.0     16.000         560.000           9.842
 24.0    5.0     193.0     37.000         420.000          29.774
 24.0   19.0     200.0     22.000         624.000          35.745
 24.0   33.0     224.0     10.000         627.000          24.601
 24.0   47.0     303.0      7.000         540.000          13.613
 24.0   61.0     337.0     10.000         854.000          13.805
 32.0    5.0       0.0     37.000         500.000          26.845
 32.0   19.0       0.0     22.000         957.000          42.954
 32.0   33.0       0.0     10.000         990.000          32.030
 32.0   47.0       0.0      1.000        1044.000          22.745
 32.0   61.0       0.0      7.000        1030.000          14.918
 40.0    5.0     169.0     37.000         110.000           4.397
 40.0   19.0     165.0     25.000         230.000           7.923
 40.0   33.0     154.0     13.000         525.000          13.682
 40.0   47.0     113.0      7.000         260.000           4.784
 40.0   61.0      39.0      7.000         470.000           5.975
```

```
  FOR: XO=32.0   YO=60.0
~~~~~~~~~~~~~~~~~~~~~~~~~~

 X      Y        C      GAMA         I            E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

 8.0   5.0     220.0   49.000     114.000      12.022
 8.0  19.0     232.0   31.000     360.000      28.919
 8.0  33.0     253.0   22.000     360.000      18.243
 8.0  47.0     281.0   19.000     360.000      10.933
 8.0  61.0     304.0   19.000     500.000       9.262
16.0   5.0     205.0   46.000     202.000      18.125
16.0  19.0     214.0   28.000     430.000      30.153
16.0  33.0     233.0   16.000     480.000      21.985
16.0  47.0     269.0   10.000     492.000      13.896
16.0  61.0     306.0   13.000     560.000       9.842
24.0   5.0     191.0   43.000     370.000      26.229
24.0  19.0     196.0   28.000     600.000      34.370
24.0  33.0     205.0   16.000     700.000      27.465
24.0  47.0     238.0    7.000     595.000      14.999
24.0  61.0     310.0    7.000     580.000       9.375
32.0   5.0       0.0   43.000     360.000      19.328
32.0  19.0       0.0   28.000     900.000      40.396
32.0  33.0       0.0   16.000     990.000      32.030
32.0  47.0       0.0    7.000    1030.000      22.440
32.0  61.0       0.0    1.000    1044.000      15.120
40.0   5.0     171.0   46.000      24.000       0.959
40.0  19.0     168.0   31.000     170.000       5.856
40.0  33.0     163.0   19.000     420.000      10.945
40.0  47.0     151.0   10.000     525.000       9.660
40.0  61.0     110.0    4.000     360.000       4.577
```

```
 FOR: XO=40.0    YO= 5.0
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

X        Y          C        GAMA              I               E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

 8.0     5.0     276.0     34.000        210.000          22.146
 8.0    19.0     305.0     37.000        210.000          16.869
 8.0    33.0     322.0     46.000        143.000           7.247
 8.0    47.0     332.0     52.000        130.000           3.948
 8.0    61.0     337.0     58.000        143.000           2.649
16.0     5.0     276.0     22.000        358.000          32.123
16.0    19.0     313.0     28.000        390.000          27.348
16.0    33.0     330.0     40.000        237.000          10.855
16.0    47.0     339.0     46.000        244.000           6.891
16.0    61.0     343.0     52.000        210.000           3.691
24.0     5.0     277.0     13.000        460.000          32.609
24.0    19.0     324.0     22.000        421.000          24.116
24.0    33.0     339.0     34.000        390.000          15.302
24.0    47.0     345.0     43.000        400.000          10.084
24.0    61.0     349.0     49.000        333.000           5.383
32.0     5.0     280.0      7.000        500.000          26.845
32.0    19.0     339.0     16.000        700.000          31.419
32.0    33.0     349.0     28.000        800.000          25.883
32.0    47.0     353.0     37.000        650.000          14.161
32.0    61.0     354.0     46.000        410.000           5.938
40.0     5.0       0.0      1.000       1044.000          41.727
40.0    19.0       0.0     13.000       1020.000          35.136
40.0    33.0       0.0     25.000        900.000          23.454
40.0    47.0       0.0     34.000        734.000          13.506
40.0    61.0       0.0     43.000        360.000           4.577
```

```
   FOR: XO=40.0    YO=33.0
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

   X        Y           C        GAMA              I              E
 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   8.0     5.0        242.0    40.000          153.000         16.135
   8.0    19.0        269.0    31.000          211.000         16.949
   8.0    33.0        298.0    28.000          285.000         14.443
   8.0    47.0        317.0    31.000          391.000         11.875
   8.0    61.0        328.0    34.000          350.000          6.483
  16.0     5.0        228.0    31.000          402.000         36.071
  16.0    19.0        260.0    22.000          362.000         25.385
  16.0    33.0        298.0    19.000          420.000         19.237
  16.0    47.0        321.0    25.000          405.000         11.439
  16.0    61.0        333.0    31.000          423.000          7.434
  24.0     5.0        212.0    28.000          450.000         31.900
  24.0    19.0        242.0    16.000          470.000         26.923
  24.0    33.0        299.0    13.000          520.000         20.403
  24.0    47.0        328.0    19.000          520.000         13.109
  24.0    61.0        340.0    25.000          580.000          9.375
  32.0     5.0        195.0    25.000          624.000         33.502
  32.0    19.0        213.0    10.000          770.000         34.561
  32.0    33.0        301.0     7.000          540.000         17.471
  32.0    47.0        340.0    13.000          880.000         19.172
  32.0    61.0        349.0    19.000          950.000         13.759
  40.0     5.0          0.0    25.000          900.000         35.972
  40.0    19.0          0.0    13.000         1020.000         35.136
  40.0    33.0          0.0     1.000         1044.000         27.207
  40.0    47.0          0.0    10.000          990.000         18.217
  40.0    61.0          0.0    16.000          990.000         12.586
```

```
  FOR: XO=40.0   YO=60.0
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 X        Y          C        GAMA            I              E
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  8.0     5.0      230.0     49.000        117.000        12.338
  8.0    19.0      244.0     34.000        160.000        12.853
  8.0    33.0      266.0     25.000        310.000        15.710
  8.0    47.0      290.0     22.000        356.000        10.812
  8.0    61.0      308.0     22.000        365.000         6.761
 16.0     5.0      215.0     46.000        150.000        13.459
 16.0    19.0      228.0     28.000        400.000        28.049
 16.0    33.0      252.0     19.000        360.000        16.489
 16.0    47.0      283.0     16.000        440.000        12.427
 16.0    61.0      309.0     16.000        510.000         8.964
 24.0     5.0      202.0     43.000        245.000        17.368
 24.0    19.0      210.0     28.000        450.000        25.778
 24.0    33.0      229.0     16.000        480.000        18.833
 24.0    47.0      270.0     10.000        492.000        12.403
 24.0    61.0      311.0     10.000        590.000         9.537
 32.0     5.0      190.0     40.000        387.000        20.778
 32.0    19.0      194.0     28.000        600.000        26.931
 32.0    33.0      202.0     16.000        800.000        25.883
 32.0    47.0      234.0      7.000        595.000        12.963
 32.0    61.0      315.0      4.000        950.000        13.759
 40.0     5.0        0.0     43.000        360.000        14.389
 40.0    19.0        0.0     28.000        900.000        31.002
 40.0    33.0        0.0     16.000        990.000        25.800
 40.0    47.0        0.0      7.000       1030.000        18.953
 40.0    61.0        0.0      1.000       1044.000        13.273
```
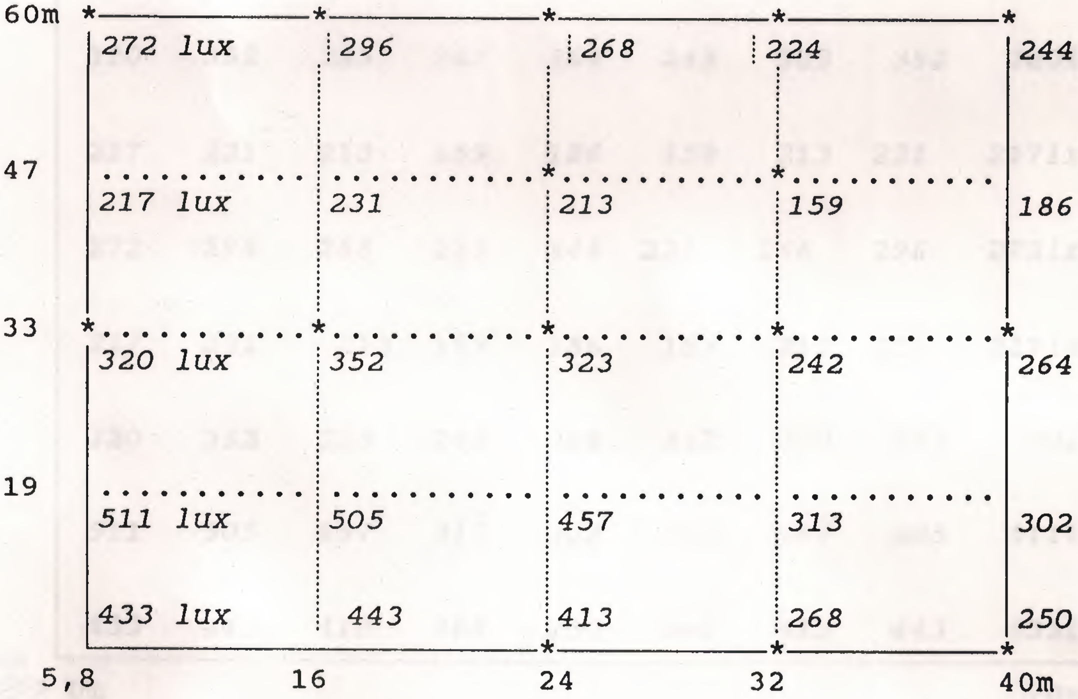

ONE QUARTER ILLUMINATION OF CANBULAT STADIUM PROJECT



60m	272 lux	296	268	224	244
47	217 lux	231	213	159	186
33	320 lux	352	323	242	264
19	511 lux	505	457	313	302
	433 lux	443	413	268	250
	5,8	16	24	32	40m

▨ (mast)
0,0 m

* : The points which the projectors are turned.

THE ILLUMINANCES POINT-BY-POINT WITH ALL DIMENSIONS.

▨ ▨

110m

433	443	413	268	250	268	413	413	433lx
511	505	457	313	302	313	457	505	511lx
320	352	323	242	264	242	323	352	320lx
217	231	213	159	186	159	213	231	217lx
272	296	268	224	244	224	268	296	272lx
217	231	213	159	186	159	213	231	217lx
320	352	323	242	264	242	323	352	320lx
511	505	457	313	302	313	457	505	511lx
433	443	413	268	250	268	413	443	433lx

0m

▨ 0m 70m ▨

▨ : *masts*

PART E

THE COST OF THE PROJECT

The cost of the equipment and installation used in the project;

(1)	STEP UP-DOWN TRANSFORMER	200,000,000 TL
(2)	FOUR MASTS	40,000,000 TL
(3)	FLOODLIGHTS	80,000,000 TL
(4)	CABLES	80,000,000 TL
(5)	DIESEL GENERATOR	200,000,000 TL
(6)	CONDUCTORS AND FUSSES	80,000,000 TL
(7)	OTHER	50,000,000 TL
	TOTAL COST	730,000,000 TL
(8)	INSTALLATION (80 %)	584,000,000 TL
	NET COST	1,314,000,000 TL
	NET COST	190,000 $

THE WAY OF FEEDING

The electrical power for stadium illumination is going to be provided by normal **LINK** and when the electricity is cut off from an equivalent **generator.**

LINK: It is going to be feed by 11 kv underground cables with oil circuit-breaker at power unit and a step-down transformer. Its power will be 500 kVA. Voltages of the transformer for the link part will be 11 kv for input and 415/240 for the output

GENERATOR: A diesel generator with same power as step-down transformer is been though, in order to feed the whole system urgently from generator. It is also thought that, the diesel generator must get switched on automatically while producing electrical power, in order to prevent loss of time.

FUSE: We can calculate the value of necessary fuse for each projector as;

$$P=V\ I\ \cos\theta$$

$P= 2000$ W

$V= 240$ V

$\cos\theta= 0.9$ SO; $I=2000/(240*0.9)=9.3$

Then it can be taken of around 10 A.

REFERENCES

1- LECTURE NOTES..................Prof. Haldun GURMEN

2- LAMPS AND LIGHTING.............Edward ARNOLD

3- DOCUMENTS AND CATALOGUES.......PHILIPS