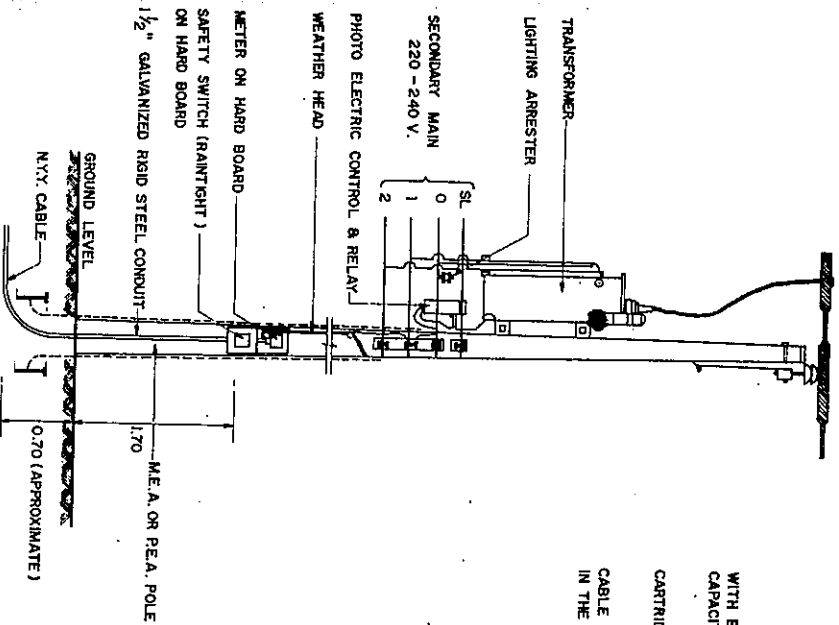
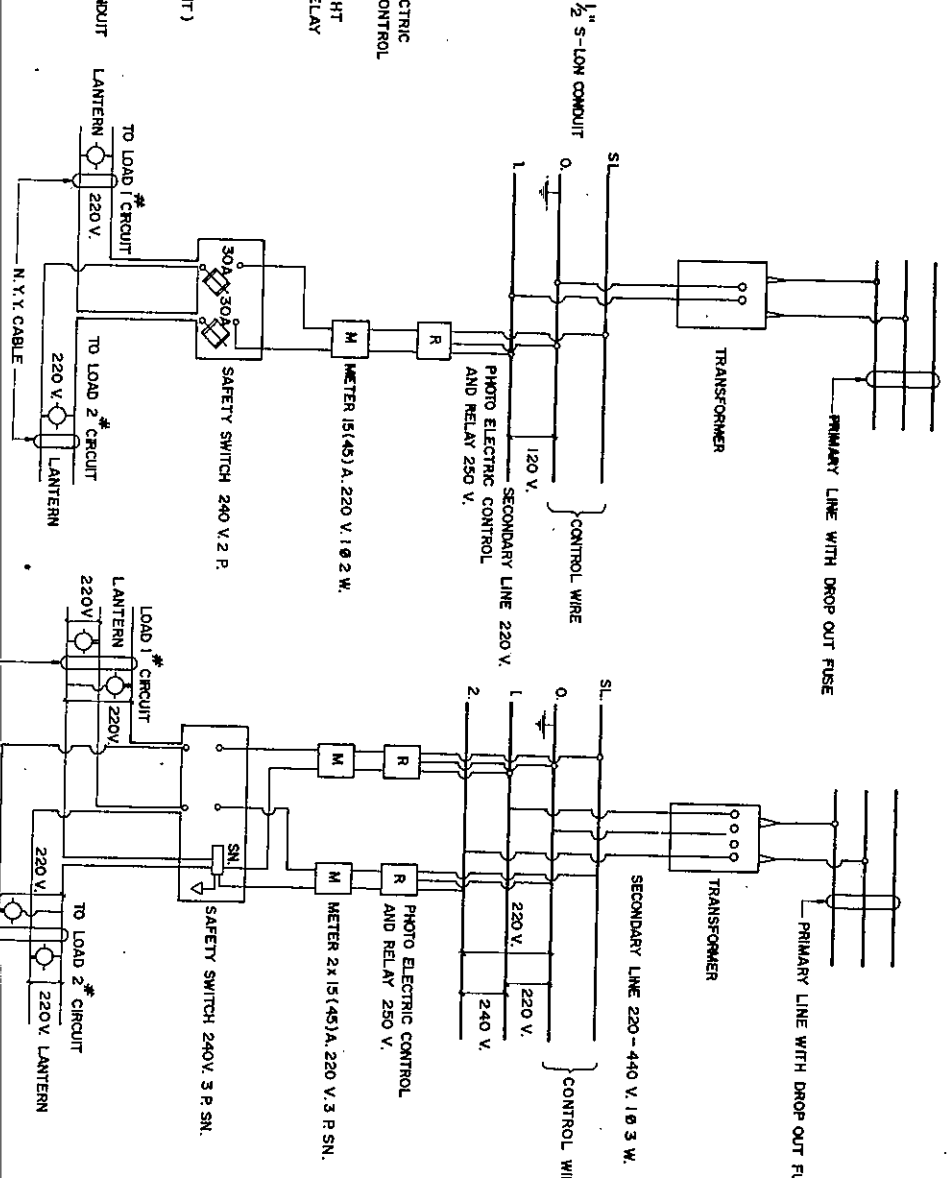


PRIMARY LINE WITH DROP OUT FUSE



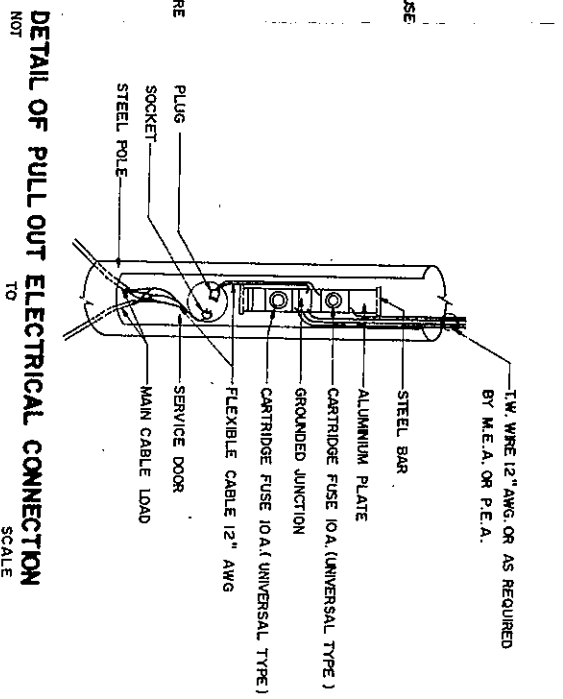
TAIL OF THE INSTALLATION OF TRANSFORMER, RELAY METER AND SAFETY SWITCH ON ELECTRICAL POLE

CIRCUIT DIAGRAM



BLOCK DIAGRAM (1)

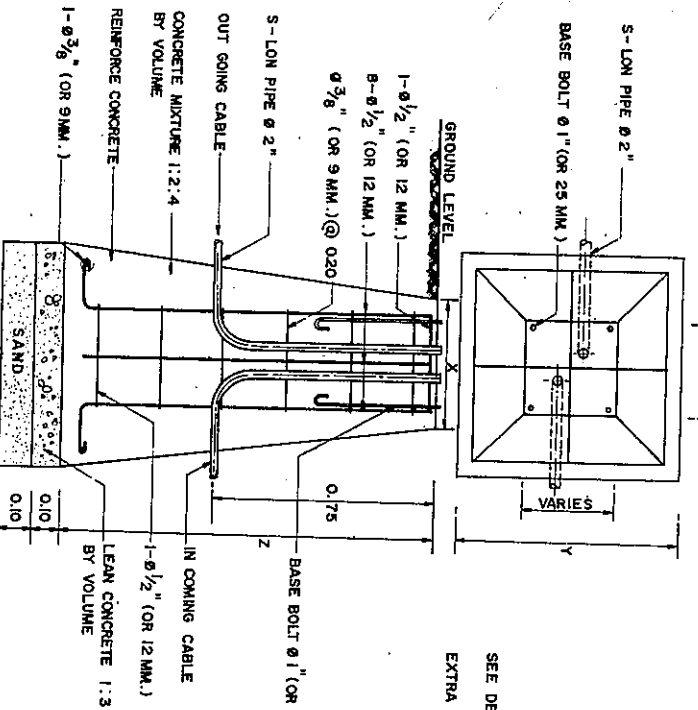
BLOCK DIAGRAM (2)



DETAIL OF PULL OUT ELECTRICAL CONNECTION

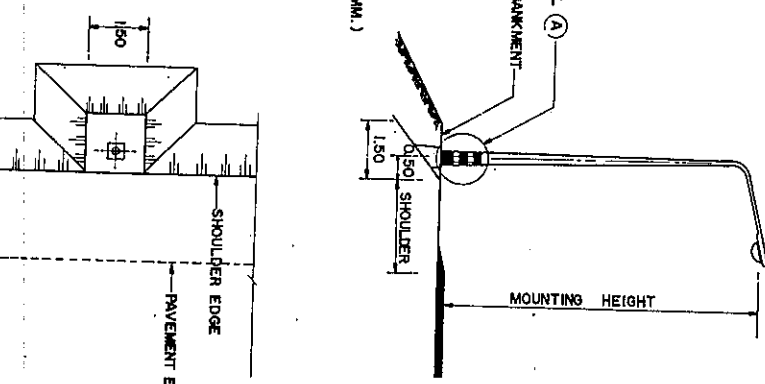
NOTES :

1. ALL DIMENSION ARE IN METERS UNLESS OTHERWISE INDICATED.
2. THE DETAIL DRAWING IS THE MINIMUM REQUIREMENT BY THE D.O.H. IN CASE OF ANY DISCREPANCY BETWEEN THIS DRAWING AND M.E.A. OR P.E.A. STANDARDS ARISES, SUCH ORGANIZING STANDARDS SHALL PREVAIL AT THE EXPENSE OF THE CONTRACTOR.
3. THE ELEVATION OF LIGHTING POLE FOUNDATION SHALL BE LOCATED AS FOLLOWS :
  - 3.1 FOR LIGHTING POLE ON EDGE OF SHOULDER, RAISED MEDIAN AND SIDEWALK, THE TOP OF FOUNDATION LEVEL SHALL BE ABOUT 5 CM. HIGHER THAN GROUND LEVEL.
  - 3.2 FOR LIGHTING POLE IN DEPRESSION MEDIAN, THE TOP OF FOUNDATION LEVEL SHALL KEEP THE SAME ELEVATION AS ROAD PROFILE GRADE.
4. THE GALVANIZED RIGID STEEL CONDUIT (G.R.C.) SHALL CONFORM TO TIS. 770
5. FOR P.E.A. GROUND ROD SHALL USE GALVANIZED STEEL ROD.

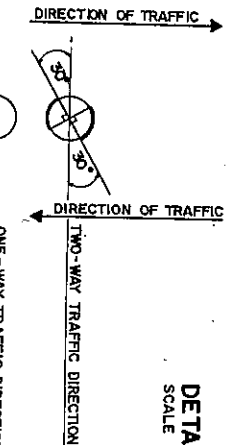


LIGHTING POLE FOUNDATION DETAILS

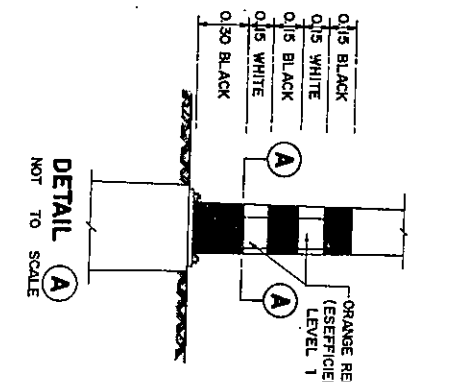
H	X (CM.)	Y (CM.)	Z (CM.)	REMARK
9.00	40x40	80x80	120	FOR SIDE ENTRY OR POST TOP MOUNTING
10.00	45x45	90x90	120	FOR SIDE ENTRY OR POST TOP MOUNTING
11.00	45x45	90x90	120	FOR SIDE ENTRY OR POST TOP MOUNTING
12.00	50x50	100x100	120	FOR SIDE ENTRY OR POST TOP MOUNTING
14.00	55x55	130x130	150	FOR POST TOP MOUNTING ONLY



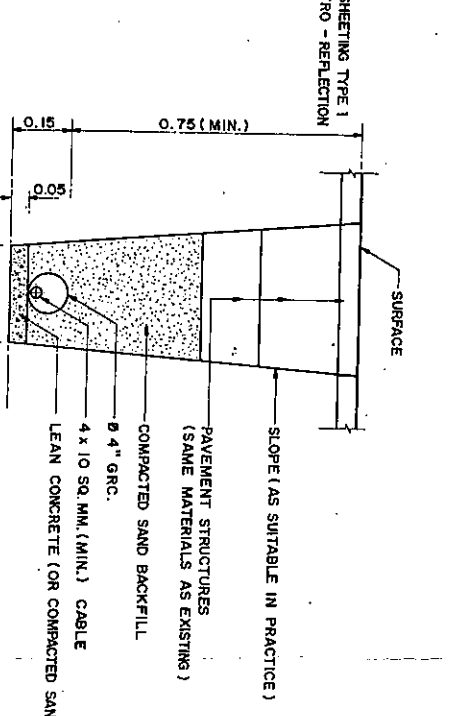
LOCATION OF LIGHTING POLE



SECTION A-A



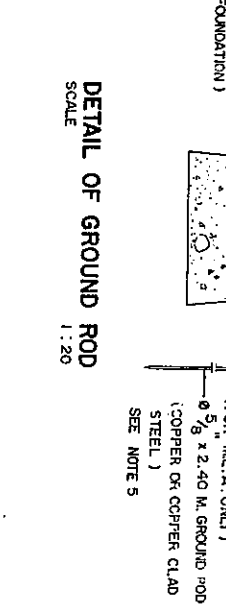
DETAIL A



DETAIL OF BURIAL CABLE UNDER ROADWAY



DETAIL OF BURIAL CABLE UNDER GROUND



DETAIL OF GROUND ROD

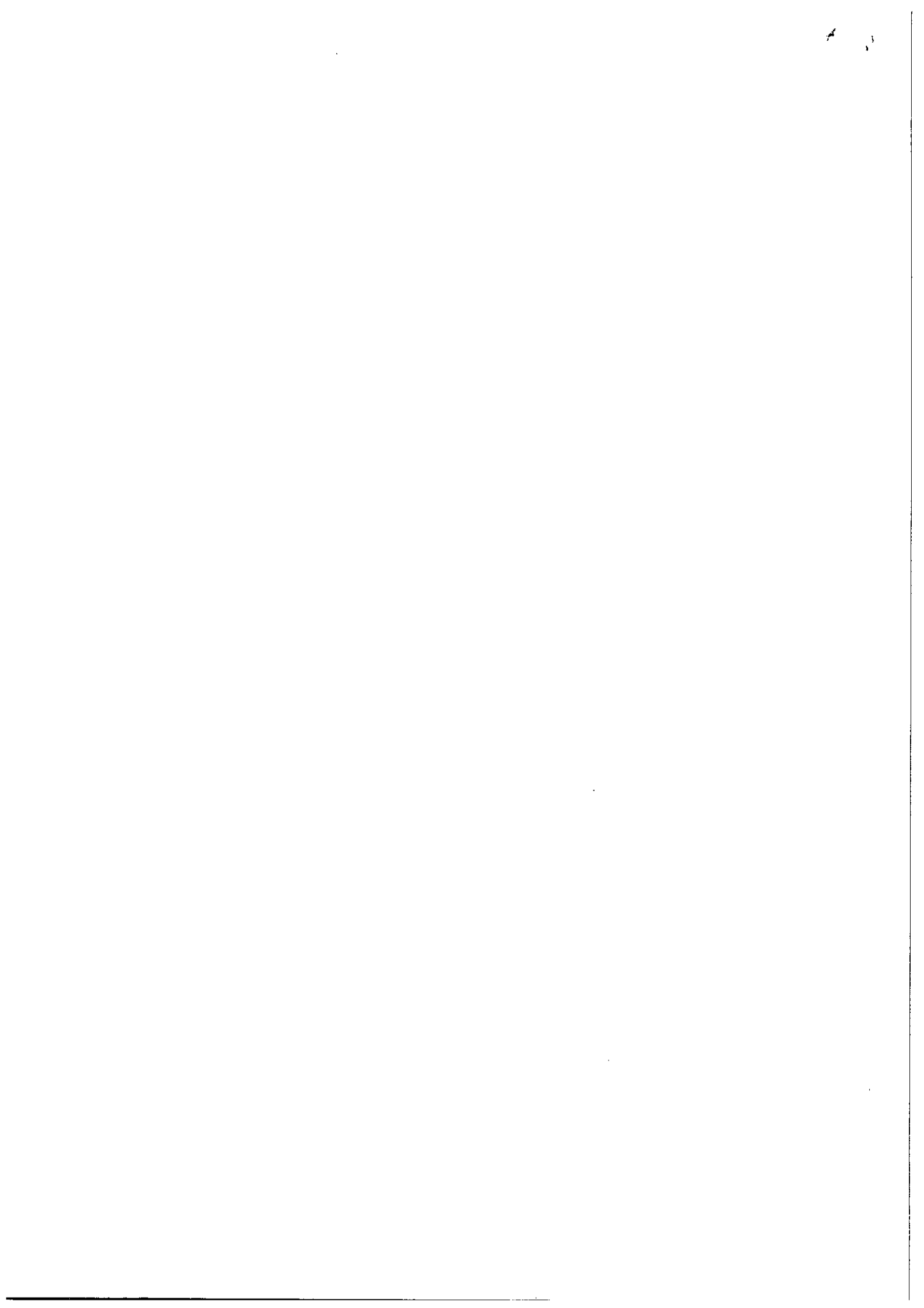
**KINGDOM OF THAILAND**  
**MINISTRY OF TRANSPORT AND COMMUNICATIONS**  
**DEPARTMENT OF HIGHWAYS**

STANDARD DRAWING  
**MISCELLANEOUS LIGHTING DETAILS**

DESIGNED : D.O.H. & CONSULTANTS  
 CHECKED :  
 SUBMITTED :  
 DATE JULY 1994  
 SCALE AS SHOWN  
 DWG. NO. MH-601  
 SHEET NO. 107



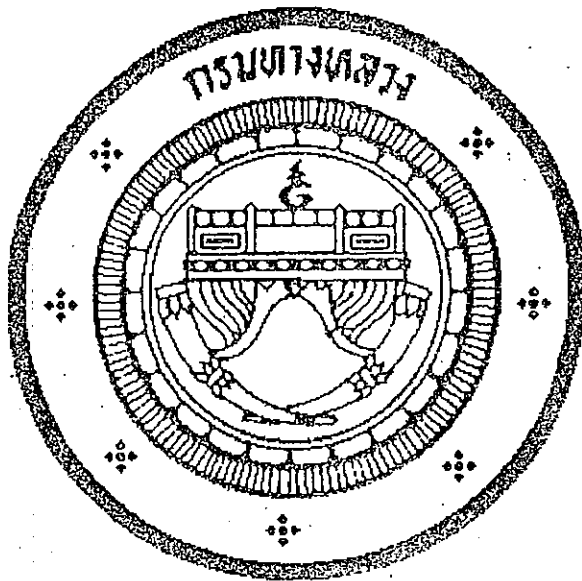
ชุดแบบมาตรฐานงานติดตั้งและซ่อมแซมไฟฟ้าแสงสว่าง  
ชนิดเสากิ่งคู่และเสากิ่งเดี่ยว



# ข้อกำหนดและมาตรฐานทั่วไป

งาน

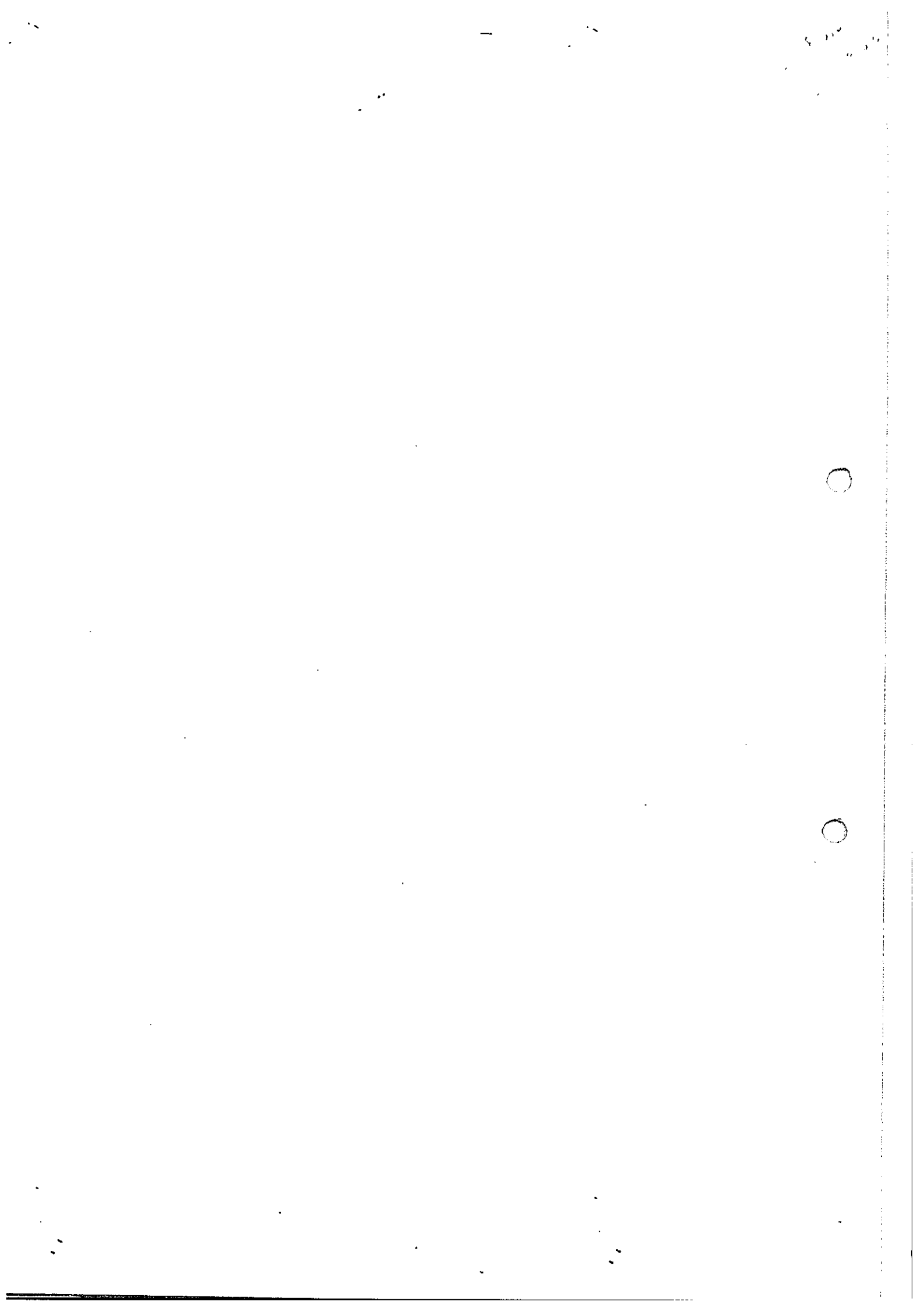
ติดตั้งไฟฟ้าแสงสว่างบนทางหลวง  
(GENERAL SPECIFICATION)



กรมทางหลวง

มกราคม 2522

กระทรวงคมนาคม



คำสั่งกรมทางหลวง

ที่ บ.1/61/2521

เรื่อง แต่งตั้งคณะกรรมการ กำหนดมาตรฐานเรื่องไฟฟ้าแสงสว่างและไฟสัญญาณจราจร

เพื่อประโยชน์แก่ราชการ จึงให้แต่งตั้งคณะกรรมการ กำหนดมาตรฐาน  
เรื่องไฟฟ้าแสงสว่างและไฟสัญญาณจราจร ซึ่งประกอบด้วยข้าราชการ ดังมีรายนาม  
ต่อไปนี้

- |   |                   |
|---|-------------------|
| 1. ผู้อำนวยการกองสำรวจและออกแบบ               | เป็นประธานกรรมการ |
| 2. นายเอนก ปิยวงศ์สุวรรณ ตำแหน่งนายช่างโยธา 6 | เป็นกรรมการ       |
| 3. นายปริญญา ศุภะบุตร ตำแหน่งนายช่างโยธา 6    | เป็นกรรมการ       |
| 4. นายปัญญา วัฒนสินธุ์ ตำแหน่งวิศวกรโยธา 5    | เป็นกรรมการ       |
| 5. นายวงศ์ชัย เจริญสุวรรณ ตำแหน่งวิศวกรโยธา 5 | เป็นกรรมการ       |

ทั้งนี้ ตั้งแต่บัดนี้เป็นต้นไป

สั่ง ณ วันที่ 9 พฤศจิกายน 2521

เจดีย์ว วัชรพุกก์

(นายเจดีย์ว วัชรพุกก์)

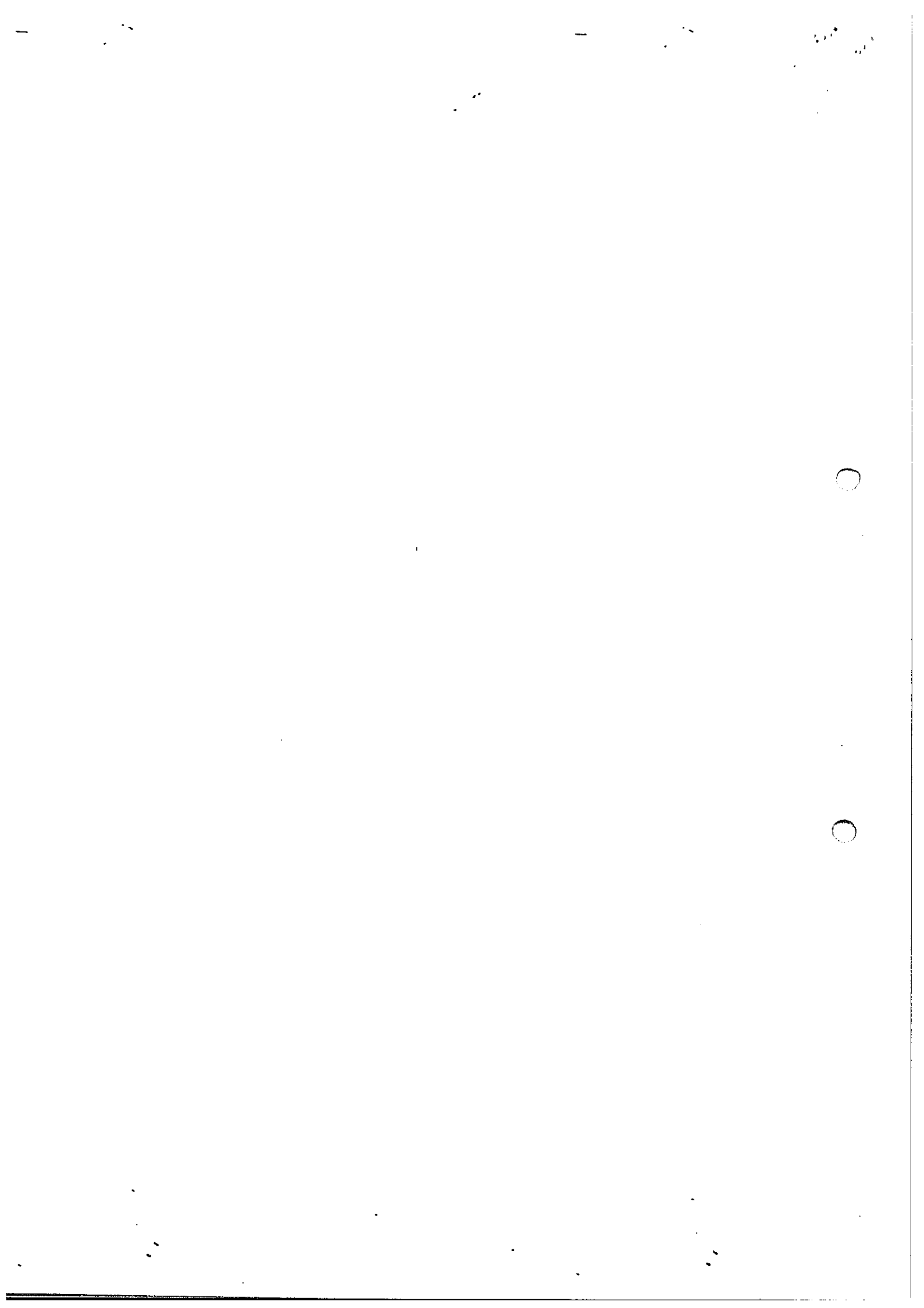
อธิบดี

สำเนาถูกต้อง

ดกตง

นายสมหมาย ตรีธรรม  
อธิบดีกรมทางหลวง

นายสมหมาย ตรีธรรม  
นายสมชาย ตรีธรรม  
นายสมชาย ตรีธรรม





คำสั่งกรมทางหลวง

ที่ บ.1/62/2521

เรื่อง แต่งตั้งคณะกรรมการกำหนดมาตรฐานเรื่องไฟฟ้าแสงสว่างและไฟสัญญาณจราจร

ตามคำสั่งกรมทางหลวงที่ บ.1/61/2521 ลงวันที่ 9 พฤศจิกายน 2521 เรื่อง แต่งตั้งคณะกรรมการกำหนดมาตรฐานเรื่องไฟฟ้าแสงสว่างและไฟสัญญาณจราจร นั้น เพื่อประโยชน์แก่ราชการ จึงให้ นายรักษ์ ศตายุ ตำแหน่งนายช่างโยธา 5 กองบำรุง เป็นกรรมการร่วมในคณะกรรมการดังกล่าวด้วย.

สั่ง ณ วันที่ 27 พฤศจิกายน 2521

เจดีย์ว วัชรพุกก

(นายเจดีย์ว วัชรพุกก)

อธิบดี

สำเนาถูกต้อง

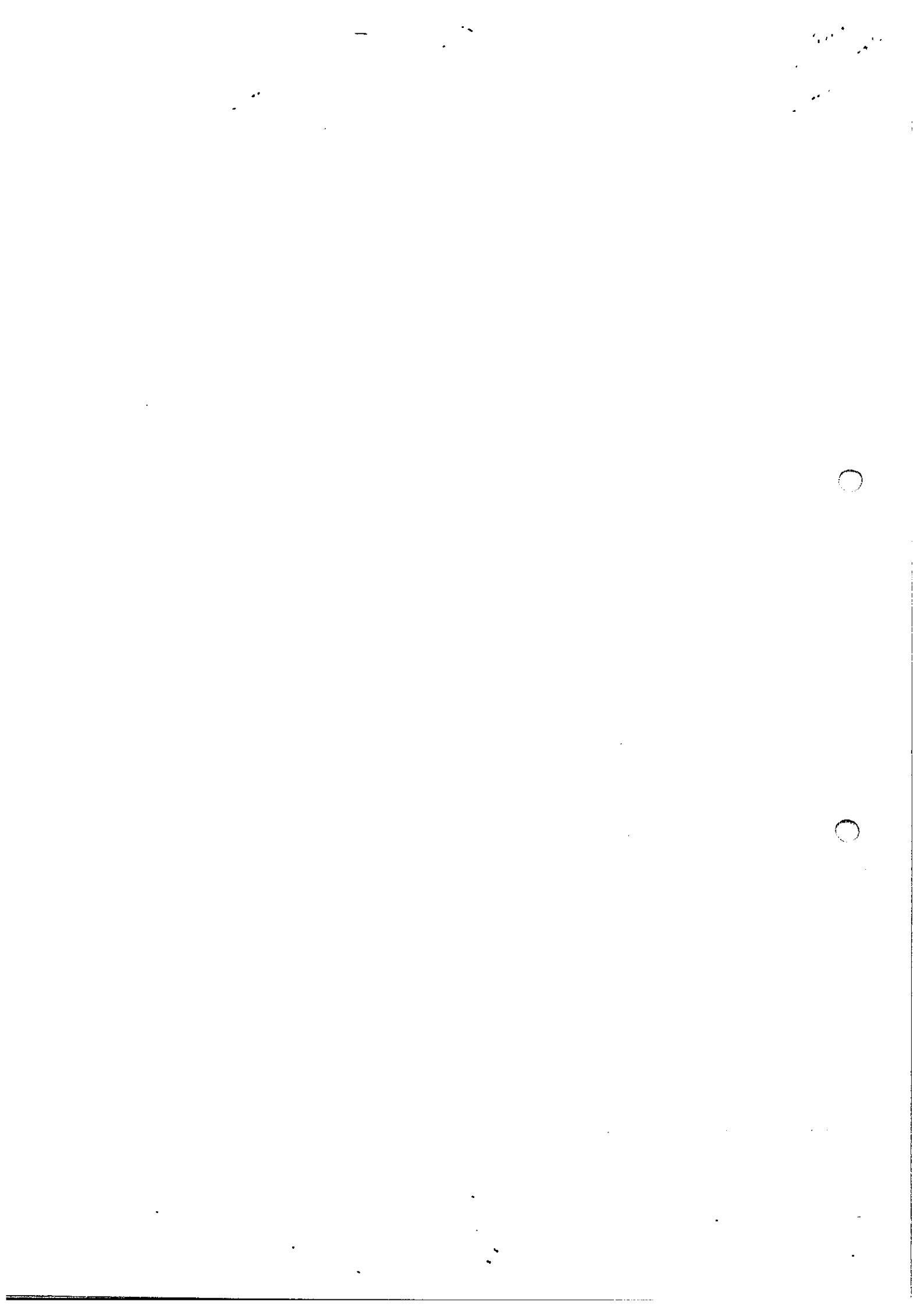
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(นายมนตรี ชาติสุวรรณ)

วิศวกรโยธา 7

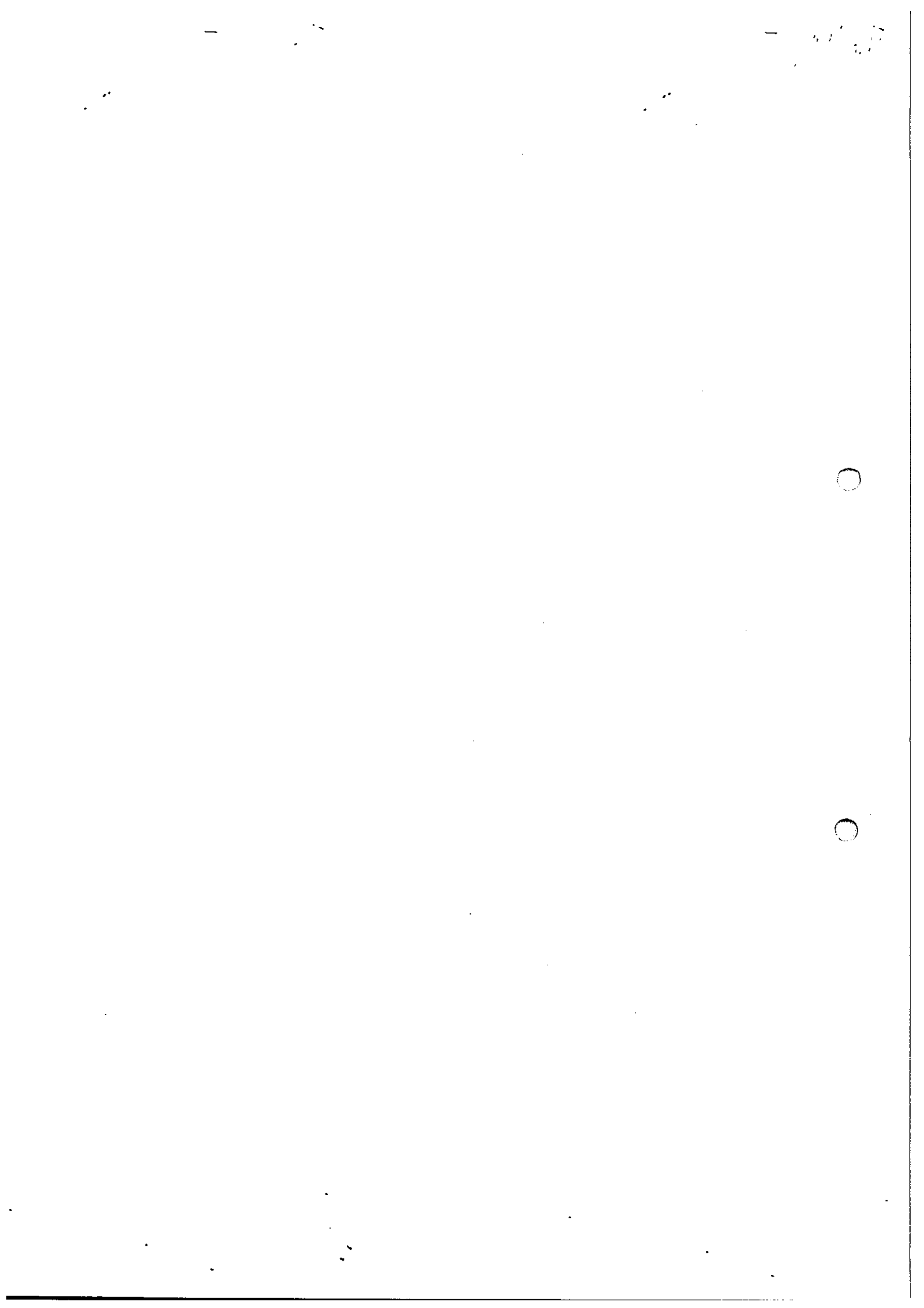
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ร่าง

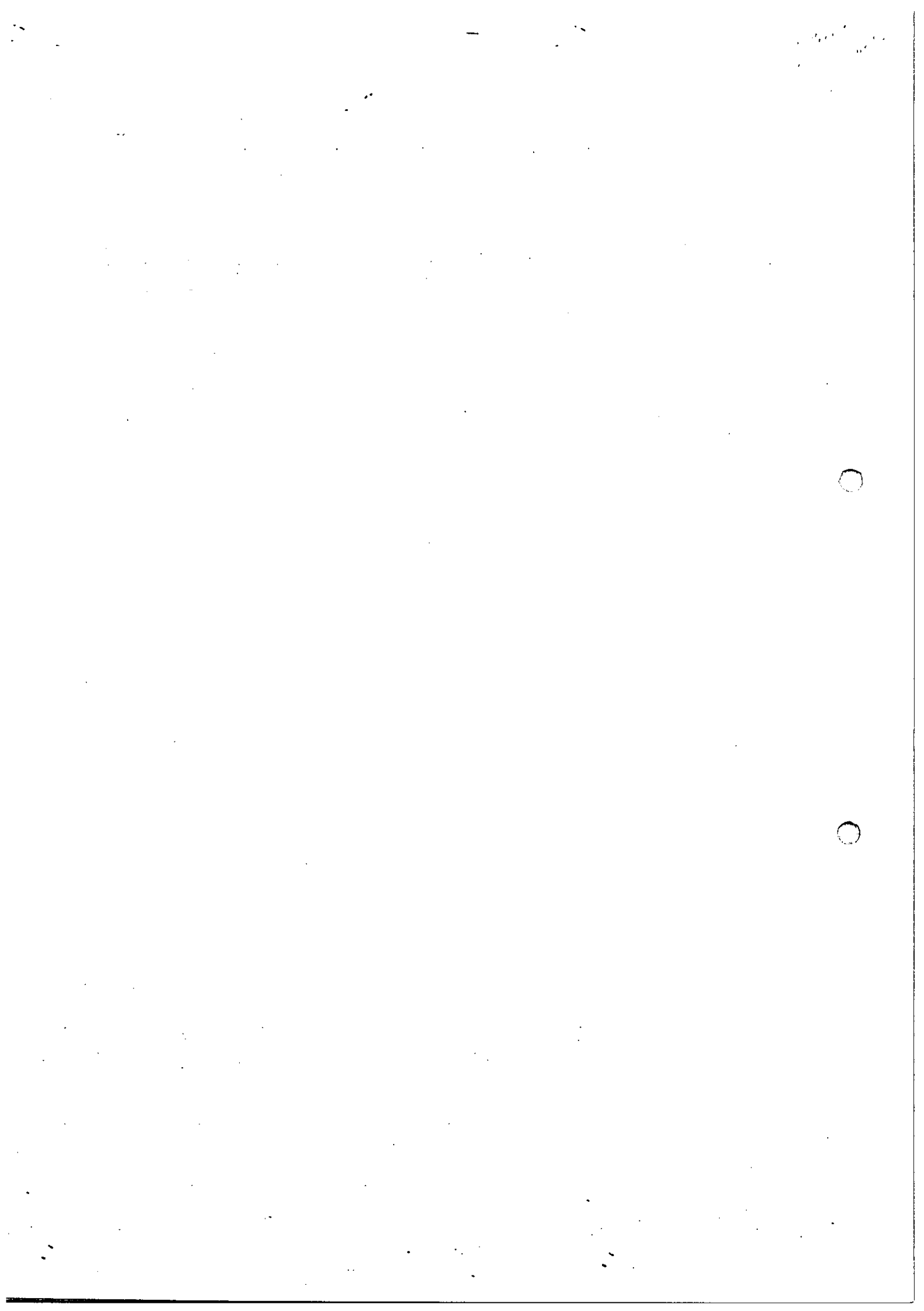


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## GENERAL SPECIFICATION FOR STREET LIGHTING

### 1. General

#### 1.1 Description

This work shall consist of the supply of all lanterns complete, brackets, columns and other supporting devices, bases, cables, switchgear and all necessary ancillary equipment together with the transportation, storage, assembly, erections, connection and testing of the same in order to supply a complete street lighting system in accordance with the details shown on the plans and as specified herein and in the Special Provisions if any. Design of the system shall be included.

#### 1.2 Responsibility for Design and Materials

The Contractor shall be solely responsible for the adequate design and the co-ordinated functioning of all goods and construction furnished under this contract. All the component parts shall be designed so as to ensure their proper co-ordinated functioning and operation. All equipment shall be of the maker's standard models and shall include all recent improvements in design and materials. All materials used in manufacture and construction shall be of high quality and fully in accordance with the best modern practice.

The equipment offered and the work done shall be suitable for continued trouble-free operation under adverse climatic conditions of heavy rain, high humidity and intense sunlight. The equipment must be able to withstand over long periods ambient air temperatures varying from a normal of 4° C. to a maximum of 50° C.

All materials used in the manufacture and construction shall be free from defects and shall be made having proper regard for safety and in strict accordance with all the relevant requirements and regulations of the Electricity Supply Authority.

### 1.3 Compliance with Manufacture's Specifications

The Contractor shall ensure that the equipment and parts used will be entirely suitable for the work to be performed and that they will be manufactured to proper clearances and fit. He shall further ensure that the loading of equipment will under all normal circumstances not exceed the maximum laid down or agreed in writing by the manufacturer.

The Contractor shall be responsible for the inspection of all equipment and parts before their incorporation in the works to ensure that they comply with the conditions of the contract and that they are not defective in any way as regards materials or workmanship should any such non-compliance or defects be found during the inspection, the Contractor shall correct, or cause to be corrected such non-compliance and defects, all at the Contractor's expense and to the satisfaction of the Engineer

### 1.4 Maintenance Period

All repairs and replacements required during the Maintenance Period shall be carried out with despatch and an adequate supply of spares shall be available for this purpose. (See also clause 10)

### 1.5 Electricity Supply

The Contractor shall carry out negotiations with the Electricity Supply Authority concerned on behalf of the Department of Highways for permanent electricity supply to the installation, and any costs associated with obtaining this supply shall be included in the contract rates. The Contractor must ensure that the equipment supplied will function correctly at the supply voltage, and must allow for normal variations and surges.



## 1.6 Definitions

Unless specifically defined herein, definitions shall be as given in British Standard 1892 : 1967 "Glossary of Highway Engineering Terms" and in British Standard Code of Practice CP 1004 "Street Lighting", both as amended at the time of Tender.

- a) Lantern. A housing for one or more lamps comprising the body and any refractor, reflector, diffuser or enclosure associated with the lamp or lamps.
- b) Outreach. The distance measured horizontally between the centre of a lantern mounted on a bracket and the centre of the column or wall face.
- c) Overhang. The distance measured horizontally between the centre of a lantern and the adjacent edge of the pavement.
- d) Mounting Height. The vertical distance between the centre of the lantern and the surface of the pavement.
- e) Spacing. The distance, measured parallel to the centre line of the road, between successive lanterns. In a staggered arrangement, this distance is measured parallel to the centre line from the centre of a lantern on one side of the road to the centre of the next lantern on the opposite side.
- f) Beam. That portion of the light output of the lantern contained by the solid angle subtended at the effective light centre of the lantern containing the maximum intensity but no intensity less than 90 % of the maximum intensity.
- g) Luminous Flux. The light given by a light source of lantern or received by a surface, irrespective of the direction in which it is distributed.  
The unit of luminous Flux is the Lumen (LM)

- h) Lower Hemispherical Flux or Downward Flux. The luminous Flux emitted by a lantern in all directions below the horizontal.
- i) Peak Intensity Ratio. The ratio of the maximum intensity to the mean hemispherical intensity of the light emitted below the horizontal.
- j) Mean Hemispherical Intensity. The downward flux divided by 6.28.  
(This is the average intensity in the lower hemisphere).
- k) Intensity Ratio. The ratio of the actual intensity in any direction of a lantern to the mean hemispherical intensity.
- l) Luminous Intensity. The light giving power of a lantern in any particular direction. The unit of luminous intensity is the Candela (cd). Beam Center, Isocandela Curve, Isocandela diagram, Polar Curve.
- m) Beam center. A direction midway between the directions for which the intensity is 90 percent of the maximum in a vertical plane through the maximum and on a conical surface through the maximum.
- n) Isocandela curve. A curve traced on an imaginary sphere with the source at its center and joining all the points corresponding to those directions in which the luminous intensity is the same, or a plane projection of this curve.
- o) Isocandela diagram. An array of isocandela curves.
- p) Polar Curve. Curve of light distribution using polar co-ordinates.

## 2. Materials and Equipment

### 2.1 Lanterns

The supplier must submit the guaranteed letter of these. Body of luminaire shall be non-corrosive light alloy metal, colour if applied shall be stove enamelled finish in gray or aluminum shade.

Reflector, if used, shall be mirror type and made of anodized aluminum sheet. Gasket shall be applied on every part where insect is expected to enter into lamp compartment including that at slipfitter collar. The gasket used shall be non-aging and heat-resistant type, Transverse and longitude cross-section drawing of the luminair scaled 1:1 shall be furnished with the quotation.

Refractor (enclosing bowl) if made of the transparent acrylic will not produce less output due to colour changing within first 5 years of service.

- a) Lanterns shall be of the cut-off<sup>9</sup> or the semi-cut-off type as shown on the Drawings or as specified in the Special Provisions. Non-cut-off lanterns shall not be used.
- b) Unless otherwise specified, the mounting height shall be not less than 7.5 meters (or 25'0") nor more than 12 meters (or 40'0").
- c) Where there is no speed limit on the road or where there is a speed limit of more than 60 kilometers per hour the minimum clearance between columns and the edge of the pavement shall normally be 1.5 meters but where this is not reasonably attainable, such as bridge locations and other restricted areas the minimum clearance may with the previous permission of the engineer be reduced to 1.0 meter.

Where there is a speed limit of less than 60 kilometers per hour the minimum clearance between columns and the edge of the pavement should be 1.5 meters but this may be reduced to

0.50 meter for crossfalls of not more than 1 in 40 towards the curb

0.60 meter for crossfalls of between 1 in 40 and 1 in 24 towards the curb

0.75 meter for crossfalls of more than 1 in 24 towards to curb with the previous permission of the Engineer

d) Each lantern should normally direct two beams along the length of the road. The polar curves of the lanterns in both horizontal and vertical planes should be smooth and free from any abrupt variations so that the luminous intensity diminishes smoothly and progressively from its maximum. For centrally mounted lanterns the beams should be approximately axial; for lanterns mounted at the sides of the roadway, the maximum toe-in of the beam will be  $15^{\circ}$ .

Adequate but not excessive light should be directed towards the curbs and outer edge of the road. Where area illumination is required using high mast lighting, these provisions shall not necessarily apply.

e) For cut-off lanterns, the beam should be in a direction about  $65^{\circ}$  from the downward vertical. The peak intensity ratio shall be between 2.0 and 4.0; the intensity ratio in the zone  $0^{\circ}$  to  $30^{\circ}$  below a horizontal plane through the lantern shall be between 0.3 and 2.0. An intensity ratio of 1.2 shall lie between elevations of  $72^{\circ}$  and  $78^{\circ}$  from the downward vertical in the vertical plane parallel to the axis of the roadway and the horizontal intensity ratio in the same plane shall be not greater than 0.15.

f) In the case of semi-out-off lanterns, the beam should lie in a direction about  $75^{\circ}$  from the downward vertical. The peak intensity ratio shall be between 1.8 and 4.0. The intensity ratio in the  $0^{\circ}$  to  $30^{\circ}$  zone below a horizontal plane through the lantern shall be between 0.3 and 1.7. An intensity ratio of 1.2 shall lie between elevations of  $78^{\circ}$  and  $84^{\circ}$  from the downward vertical in the vertical plane parallel to the axis of the roadway and the horizontal intensity ratio in the same plane shall be not greater than 0.6 except that in the case of sodium lamps, the intensity ratio of 1.2 shall lie similarly between  $80^{\circ}$  and  $86^{\circ}$  and the horizontal intensity ratio in the same plane shall not exceed 0.7.

g) The siting of lanterns shall be in accordance with the following table which gives minimum required illumination. Particular care shall be taken with the siting of lanterns on bends and summit vertical curves. At junctions and roundabouts, lantern spacing shall be designed so as to give at least the minimum illumination required by the following tables and also lanterns shall be spaced and sited, where possible, so as to delineate the course of the roadway plainly to road user approaching from any normal direction without any possible misleading impressions.

The level of illumination provided at road junctions and roundabouts shall be at least as high as that on any of the approach roads and in the case of roundabouts, a minimum level of illumination at any curb line of 10 lumens per square meter shall be provided.

Required minimum Average Horizontal Illumination  
in lumens per Square Meter (Lumens per Square Foot)

	Central-Urban		Sub-Urban		Rural	
	Areas		Areas		Areas	
✓ High Grade Motorways	21.5	(2.0)	15.0	(1.4)	10.75	(1.0)
At Junctions	21.5	(2.0)	21.5	(2.0)	15.0	(1.4)
✓ Main Routes	21.5	(2.0)	13.0	(1.2)	9.7	(0.9)
✓ Secondary Routes	13.0	(1.2)	9.7	(0.9)	6.5	(0.6)
Local Roads	9.7	(0.9)	6.5	(0.5)	2.1	(0.2)

(Residential  
areas only)

*incl Area*  
*incl note (SECONDARY + TOWN)*

The Contractor shall certify that the design of the installation has been done in accordance with "American Standard Practice for Roadway lighting," (D 12.1 - 1963) published by the Illuminating Engineering Society, 345, East 47th Street, New York, or in accordance with British Standard Code of practice CP 1004 of 1963 "Street lighting" Published by the British Standards Institution 2, Park Lane, London, W.1., except in so far as these have been varied by the provisions of this specification or any special provisions.

## 2.2 Wiring and Switching

The Wiring and switching supplied for control of lanterns (each device controlling a group of lantern) shall be of a type approved by and agreed with the Electricity Supply Authority. Unless otherwise specified, photoelectric relay switching shall be used.

### 2.3 Columns and Brackets

a) Columns shall be of steel construction and shall consist of tapered round hollow shafts with anchor bases. Each column shall be provided with a suitable cable slot and a weatherproof service door fitted with a tamperproof lock. All locks shall be of the same pattern, and six keys shall be provided for them.

b) A non-hygroscopic mounting board composed of electrically insulating material shall be fitted in an easily accessible position inside the column, and shall be of suitable size to take all necessary electrical equipment. Adjacent to this mounting board, there shall be provided on the inside of the column two stainless steel studs, not less than 4 centimeters long nor less than 8 millimeters diameter and complete with stainless steel lock nuts and washers, for use as earthing connections.

c) Brackets to provide the required outreach shall be of sufficiently strong construction to support the lantern under all normal conditions without significant movement, and shall be provided with suitable fittings to take the lanterns. When in position, brackets shall be inclined upwards at an angle of approximately  $15^{\circ}$  to the horizontal, and shall be fixed to their supports by suitable welding, fastenings or wall plates.

d) Columns and brackets shall be structural steel having the following mechanical properties :

- Thickness of sheet steel (min)      4 mm.
- Ultimate Tensile Strength (min)      41 kg/mm<sup>2</sup>
- Yield Point (min)                      25 kg/mm<sup>2</sup>
- Elongation (min)                        21 %

e) Straightness. That part of the column above the ground shall not deviate from straightness by more than an amount calculated at a rate of 2.1 mm. per meter of column length.

## 2.4 High Mast Lighting

Mounting heights from 20 meters and more shall be High Mast.

a) Columns carrying high mast lighting shall be designed to permit the whole of the lantern carriage to be easily, safely and quickly lowered to ground level for maintenance works. The columns shall be designed in accordance with British Standard 449 or other internationally accepted standard for design of structural steelwork in buildings, except that the temporary horizontal deflection of the top of the column may be up to 7.5 % of the height above ground. In calculating the bending moment at ground level due to wind load, it shall be assumed that the wind speed at a point ten meters above ground level is 60 kilometers per hour, and the design of the column shall be such that wind excited oscillations are damped as much as possible. Adequate allowance shall be made for the stresses produced by such oscillations. Details shall be given of the vertical and horizontal load and the bending moment at the foundations.

b) The base plate shall be free from laminations and all dimensions of the base plate shall be provided, including details of the holding down bolts. A cable entry hole of not less than 30 centimeters diameter shall be provided centrally in each base plate, and the bottom of the mast shall pass through the base plate and be welded on both sides. An alternative construction of equal strength may be accepted by the Engineer, but a butt weld on the base plate will not be accepted.

Each holding down bolt shall be tensioned to the design value, and within the maintenance period, the bolts shall be checked and retightened as necessary, after which the nuts shall be repainted.

c) The columns shall be delivered to the site in the minimum practicable number of lengths. Any joints necessary shall be positioned as near the top of the columns as possible.



d) The lantern carriage shall support the designed number of lanterns without significant sway or movement, and shall be capable of supporting these lanterns and a cradle with two men for maintenance work. The lantern carriage shall be protected to prevent damage to the painted surface of the columns, rotation of the carriage during raising and lowering shall be prevented and correct location when raised shall be ensured by some positive means. It shall be possible to remove the lantern carriage without lowering the column.

e) The lantern carriage shall be raised and lowered by a self sustaining winch capable of being operated either by hand or by a portable electrically operated tool. It shall be possible to lock the winch in any position by a simple, robust and easily operated mechanism. The worm gear shall have a ratio of at least 20:1.

f) The winch shall have removable handles, and it shall be mounted within the base compartment at a convenient working height. The opening in the column shall be of sufficient size to allow proper operation and maintenance of the winch mechanism. A weatherproof label shall be fixed in an obvious position within the column base, giving a full list of all lubricating points on the winch and other mechanism, and detail of recommended lubricants. Winches fixed inside the column shall be provided with a substantial cover to fully protect them falling dirt and dust.

g) A sufficient number of turns of the hoisting cable shall be left on the winch drum when the carriage is fully lowered to ensure that the cable anchorage on the drum does not take the full load of the carriage at any time.

h) the last 30 centimeters of travel to the fully raised position of the carriage shall be by hand operation, and for this purpose either a limit switch shall be provided to cut off the power supply to the portable electric tool at the appropriate time, or else some form of indication shall be provided to indicate when the carriage is 30 centimeters from the fully raised position.

i) The winch cable shall be of stranded stainless steel wires and shall have sufficient capacity to carry safely the lantern carriage complete with lanterns and a cradle with two men attached thereto. Great care shall be taken during installation to ensure that the hoisting cables do not twist or kink, and any set twist or kink shall be sufficient reason for the rejection of that cable.

j) All parts of the raising and lowering mechanism which are inaccessible after erection of the columns shall be adequately protected against moisture, dirt and corrosion. Where necessary, pulleys shall be fitted with shields to prevent the winch cable becoming displaced. Pulleys for electrical cables shall be of sufficient diameter that the cable will not be bent to a smaller radius than that permitted by local regulations or those of the British Institution of Electrical Engineers, 14th Edition. Where necessary for continued trouble free operation, metal parts shall be of stainless steel or other approved non-corrodible material.

k) When power tool operation is used, a suitable power outlet shall be provided and the operator shall be adequately safeguarded against any electrical shocks. The power tool shall preferably be designed to work on a reduced voltage and in this case, a suitable approved type of transformer shall be provided. The power tool shall be designed so that continuous operation will cause no harmful effects on either the winch or the tool, and in the event of power failure the winch shall be self locking. Conversion from power to hand operation and vice versa shall be quick and easy and shall not require special tools. Full information on the type of power tool proposed shall be given with the tender.

## 2.5 Protection Against Corrosion

Unless otherwise specified, columns, bracket arms, and brackets shall be protected against corrosion either by painting or galvanizing as follows :

### 2.5.1 Painting.

a) Columns and masts shall be treated internally with hot asphalt under high pressure so as to give a complete and unbroken asphaltic covering or other approved anti-corrosion treatment shall be applied to give at least equally good protection. Bases shall be similarly treated up to a level of 25 centimeters above ground level.

b) Before delivery to the site, columns, masts, steel brackets, and external fitting shall have all external welds ground down and all external surfaces cleaned by shot blasting or other approved method to a white metal finish free of all signs of rust.

Immediately following this treatment the items shall be painted with two coats of tropical red lead undercoat followed by two coats of aluminium paint or they shall be treated in a similar and not less effective manner acceptable to the Engineer to prevent subsequent corrosion. After erection, all imperfections and damage shall be made good to the Engineer's satisfaction and the items shall be given a final coat of all aluminium paint.

### 2.5.2 Galvanizing

a) Before delivery to the site, columns, masts, steel brackets, and external fittings shall have all external welds ground down. Poles and other ferrous materials shall be galvanized both inside and outside by hot dipped in accordance with ASTM A 525-76. Weight of zinc coating shall not be less than 550 gram per square meter.

b) Base of columns, both inside and outside shall be coated with bituminous paint up to a level of 25 centimeters above the base plate.

### 3. Construction Methods

#### 3.1 Excavation and Reinstatement

Excavation for cable or conduit laying or for foundations and reinstatement shall be carried out in accordance with the provisions of Section 2.5 (Sub-Clause 2.5.3.2) of these specifications. Reinstatement shall be such that the surface is restored to at least its original standard.

#### 3.2 Concrete Work

All necessary foundations and footings or other concrete work shall be carried out in accordance with Sections 5.1 (sub-Clause 5.1.1.2) and 5.2 of these specifications. Unless otherwise specified on the Drawings or in the Special Provisions\*, concrete shall be class B. Foundations shall be placed in one operation except that the top 5 centimeters may be placed after the superimposed structure is in position. The exposed portions of foundations shall be formed to present a neat and tidy appearance and sloped to shed water away from the structure supported. Where existing obstructions prevent the construction of foundations as shown on the plans, then an effective alternative may be provided subject to the prior approval of the Engineer.

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\* Ministry of National Development, Department of Highways, Specification For Highway Construction, 1970, Bangkok, Thailand.

### 3.3 Conduits, fittings and boxes

Conduits, fittings and boxes shall be provided and installed in accordance with the provisions of Section 5.11 of these Specifications, except that chemically stable tough plastic conduits, fittings and boxes, according to samples previously approved by the Engineer, will be permitted providing that they do not soften when exposed to high ambient temperature.

The contractor may use a larger size of conduit than that specified, at no extra charge, if he wishes, but in this case the entire run shall be of the same size. No reducing couplings will be permitted.

When metal conduits are used, cuts shall be made square and true and all couplings shall be screwed up until the ends of the conduits are brought together in order to provide a good electrical contact throughout. The threads on all ferrous metal conduits shall be painted with rust preventing paint before couplings are made up. Where the coating on ferrous metal conduit has been damaged in handling, such damaged places shall be painted with rust preventing paint before installation.

All conduit ends shall be threaded and capped until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

Conduits shall be laid to a depth of not less than 50 centimeters below paved footwalks and medians and not less than 75 centimeters below the roadway surface. The location of all conduits at curb lines shall be marked by means of a "Y" at least 10 centimeters high incised in the face of the curb directly above the conduit. Conduit terminating in a standard, cabinet or pedestal shall extend at least 5 centimeters vertically above the bottom of the box. Such conduit shall be sloped towards the top of the box to facilitate pulling. Conduit entering the bottom of the box shall enter in the direction of the run.

### 3.4 Pull boxes or Junction Boxes.

Pull boxes shall be installed as shown on the plans and in any case at no more than 60 meters intervals. The contractor may install additional pull boxes without extra charge if he wishes. Pull boxes shall be of reinforced concrete not less than 10 centimeters thick and may be of approved pre-cast design. Reinforced concrete covers, secured by two recessed brass bolts shall be used on footwalks, the covers being inscribed 'Street Lighting' on the outside. Under the roadway, covers shall be of steel or cast iron, inscribed as specified above, and laid in a suitable concrete footing to withstand traffic loads. Metal covers shall be effectively earthed to an earthing rod inside the box. Tops of pull boxes shall be effectively level with the surrounding paved areas, whether footwalk or roadway, but in unpaved areas, the tops of pull boxes shall be buried 30 centimeters below ground level. The bottom of pull boxes shall be bedded in sand and cement or crushed rock. Permanent markers shall be provided and to show the position of all pull boxes.

### 3.5 Testing

A functional test shall be made on completion of the work in order to demonstrate that every part of the equipment and installation functions as intended and specified. This test shall consist of not less than five nights continuous and satisfactory operation. If any defects or unsatisfactory operation are revealed, this condition shall be corrected and the test continued until the required five nights of satisfactory operation have been performed.

Prior to the functional test, the contractor shall carry out the following tests to the entire satisfaction of the Engineer.

- 1) Each circuit shall be tested for continuity
- 2) Each circuit shall be tested for cathing

3) A 'megger' test shall be made between each circuit and earth. The insulation resistance shall be shown to be at least that specified within the relevant codes.

4) the distribution horizontal illumination value of specified spacing in each code item, in rate of lux measured between two luminaires every two meters along longitudinal and transverse road way line. are essentially measured to show max. mean, min. Illumination and uniformity ratios.

$$\begin{aligned} \text{Uniformity ratio} &= \frac{\text{minimum illumination}}{\text{average illumination}} \\ &= \text{not less than } 1:2.5 \\ \text{and} &= \frac{\text{maximum illumination}}{\text{minimum illumination}} \\ &= \text{not more than } 6:1 \end{aligned}$$

#### 5) Rainproof Test.

The lantern under test shall be mounted in its normal orientation on an adjustable support as shown in fig. 1, so that the fitting is near the center of the arc described by the oscillating tube.

After being switched on for one hour the lantern shall be subjected to a spray of water at a temperature not exceeding 20° C and at a pressure of approximately 5.7 lbs/in<sup>2</sup> (0.4 kgs/cm<sup>2</sup>) the tube being oscillated so as to describe an angle of 60 degrees from the vertical and in both directions from it. This treatment shall be continued for 20 minutes, the fitting being switched off after 10 minutes.

At the end of this test, there shall be no damage to the lamp or enclosure and no visible evidence of water having accumulated in the fitting.

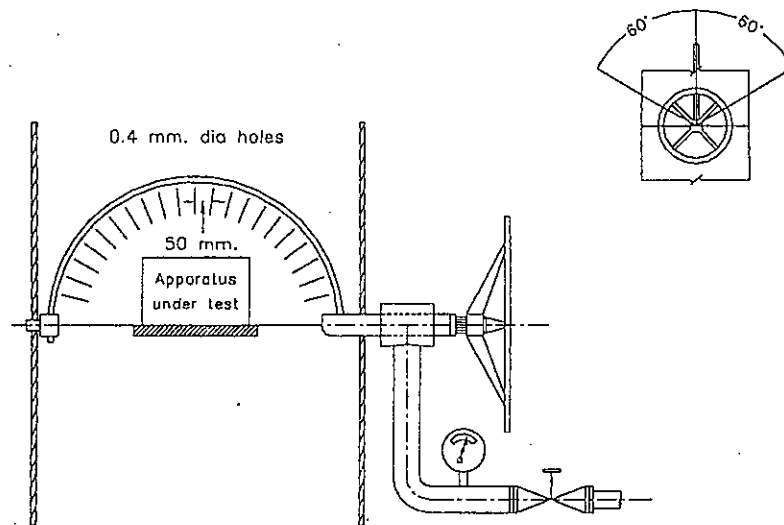


Fig.1 Apparatus for rainproof test

On the completion of testing, the contractor shall supply to the engineer three copies of 'as built' plans and circuit diagrams, which shall clearly indicate any modifications which have been made to the original design.

#### 4. Measurement

4.1 Unless a Bill of quantities is provided this item will not be measured and payment shall be made on a lumpsum basis.

4.2 When a Bill of Quantities is provided measurements shall be made on the items detailed in the Bill of quantities completed, accepted and measured in place. The unit of measurement for each item shall be the unit of measurement shown in the Bill of Quantities.



## 5. Payment

5.1 The lump sum payment for the street lighting installation shall be full compensation for furnishing all materials, labour, equipment, tools, supervision, testing and incidentals necessary to complete the work, including any necessary backfill, foundations, restoration of footwalk, roadway, curbing and appurtenances damaged or destroyed during construction. The payment shall also cover the cost of design where this is called for.

The lump sum payment shall be deemed to include full compensation for all additional materials and work not shown on the Drawings or specified which are necessary to complete the installation.

5.2 The work measured as provided in 4.2 shall be paid at the contract unit price for each item, such price and payment constituting full compensation for all materials, labour, equipment, tools and incidentals needed to complete the work. All materials and work necessary for satisfactory completion of the installation which are not specifically mentioned in the Bill of quantities shall be deemed to be included in the items shown.

## 6. Information to be supplied by bidders

6.1 catalogs of electrical components; lanterns, ballast, etc.

6.2 Plans and circuit diagrams, ground rod connection diagram.

6.3 Photometric data

6.3.1 Utilisation Curve

6.3.2 Isocandela diagram

6.3.3 Horizontal isofootcandle diagram

6.3.4 Polar light distribution curve

6.4 Details of columns., Brackets, Base Plates, concrete foundations.

7. Other details of steel columns not mentioned above should comply with British Standard 1840 : 1960. The decision shall be made by the Department.