REMOTE AIRPORT LIGHTING MANUAL

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March 2007

Ministry of Transportation Ontario

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CONTINUING RECORD OF REVISIONS MADE
TO THE
REMOTE AIRPORT LIGHTING MANUAL

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No.	Dated		
	This manual includes Revision #5 dated March 2007.		

FOREWORD

The Remote Airport Lighting Manual is to be used in the design, installation, operation and maintenance of airfield lighting equipment for remote airports in Ontario.

The manual consists of five chapters:

- Design
- Operation and maintenance
- Construction specifications
- Material Specifications
- Standards Drawings

The purpose of this manual is to establish systematic design and installation practises and procedures that will ensure standardization and ease of maintenance of the remote airports electrical systems.

It is also the purpose of this manual to provide maintenance personnel with the following:

- Description of level of service that is to be provided when inspecting, maintaining and repairing electrical airfield lighting equipment.
- Information to help plan and schedule maintenance activities.
- Standard maintenance procedures.

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CHAPTER 1

Design

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1.1 SCOPE

The intent of this chapter is to provide guidelines for the design of electrical systems for visual aids facilities at MTO Remote Airports and applies strictly to non-instrument, non-precision approach runways, code numbers 1, 2 and 3.

This chapter will assist the electrical designer in adapting the design standards to suit the particular airport layout and local site conditions.

The electrical designer shall review all chapters of this manual as well as reference drawings, standards and specifications to fully understand operation of the electrical systems and their functions at the airport, and also to understand the design principles.

Details of design that require special attention are discussed in Section 1.7. Also a designer's check list was developed for the convenience of a project design process control.

1.2 REFERENCES

The design standards for MTO Remote Airports were prepared based on the current Transport Canada requirements and International Civil Aviation Organization recommendations.

Transport Canada, as the licensing authority, sets minimum safety standards and operational requirements that must be met. Certain standards and practices described in the guidelines are in excess of Transport Canada's minimum licensing requirements and have been adopted by the Ministry of Transportation of Ontario (MTO) to improve the overall efficiency and reliability of operation of the Remote Airports.

Section 1.4 of this chapter includes essential information regarding airport zoning and lighting requirements in general, which provide a necessary background for the electrical designer.

The reader should refer to the following standards for further design principles and operating characteristics of various airport visual aid facilities.

1) Transport Canada Standard TP-312
Aerodrome Standards and Recommended Practices

2) International Civil Aviation Organization
Aerodrome Design Manual, Part 4 - Visual Aids

Transport Canada and International Civil Aviation Organization standards are compiled for a variety of situations, thus many standards do not necessarily apply to the typical small Remote Airport.

1.3 DEFINITIONS

Aerodrome

Any area of land, water (including frozen surface thereof) or other supporting surface used or designed, prepared, equipped or set apart for use either in whole or in part for the arrival and departure, movement or servicing of aircraft and includes any building, installations and equipment in connection therewith.

Aerodrome Beacon

An aeronautical beacon used to visually indicate the location of an aerodrome from the air.

Aerodrome Elevation

The elevation of the highest point on the landing area.

Aerodrome Operator

The holder of an airport license, or the person in charge of such airport, whether, an employee, agent or representative.

Aerodrome Reference Code

Code number and letter -- which is selected for aerodrome planning purposes, determined in accordance with the characteristics of the aeroplane for which an aerodrome facility is intended.

Aerodrome Reference Point

The designated point on an aerodrome normally located near the geometric centre of the runway complex that:

a) establishes the geographical location of an aerodrome for charting purposes, and

b) establishes the locus of the radius or radii of the outer surface (as defined in a Zoning Regulation).

Aerodrome Reference Temperature

The monthly mean of the maximum daily temperature for the hottest month of the year (the hottest month being that which has the highest monthly mean temperature).

Aeronautical Ground Light

Any light specially provided as an aid to air navigation, other than a light displayed on an aircraft.

Aeroplane

A power-driven heavier-than-air aircraft, deriving its lift in flight from aerodynamic reactions on surfaces that remain fixed under given conditions of flight.

Aeroplane Reference Field Length

The minimum field length required for take-off at maximum certificated take-off weight, sea level, standard atmospheric conditions, still air and zero runway slope, as shown in the appropriate aeroplane flight manual prescribed by the certificating authority or equivalent data from the aeroplane manufacturer. Field length means balanced field length for aeroplanes, if applicable, or take-off distance in other cases.

Air Side

The movement area of an aerodrome, adjacent terrain and buildings or portions thereof, access to which is controlled.

Aircraft

A machine capable of deriving support in the atmosphere from the reactions of the air.

Aircraft Stand

A designated area on an apron intended to be used for parking an aircraft.

Airport

An aerodrome for which, under Part III of the Air Regulations, an airport certificate has been issued by the Minister.

Airport Zoning Regulation

A Regulation respecting a given aerodrome pursuant to section 6 of the Aeronautics Act made by the Minister of Transport.

Approach Slope Indicator (ASI)

A visual landing aid that provides a pilot with precision glide slope information. Two types of ASI systems are available. Precision Approach Path Indicators (PAPI) consist of 4 light units and are required on Code 3 runways. Abbreviated Precision Approach Path Indicators (APAPI) consist of 2 light units and are used on Code 1 or 2 runways. Both systems indicate glide slope information to a pilot through the use of a series of red and white lights.

Apron

That part of an aerodrome, other than the manoeuvring area, intended to accommodate the loading and unloading of passengers and cargo, the refuelling, servicing, maintenance and parking of aircraft, and any movement of aircraft, vehicles and pedestrians necessary for such purposes.

Average Luminous Intensity

A theoretical intensity calculated so that the luminous intensity produced by a light unit, within the specified beam dimensions, nowhere falls to less than 50 per cent or rises to more than 150 per cent of the average value.

Balanced Field Length

A field length where the distance to accelerate and stop is equal to the take-off distance of an aeroplane experiencing an engine failure at the critical engine failure recognition speed (V_1).

Critical Aeroplane

The aeroplane or aeroplanes identified from among the aeroplanes the aerodrome is intended to serve as having the most demanding operational requirements with respect to the determination of movement area dimensions, pavement bearing strength and other physical characteristics in the design of aerodromes.

Declared Distances

a) Take-off run available (TORA). The length runway declared available and suitable for the ground run of an aeroplane taking off.

b) Take-off distance available (TODA). The length of the take-off run available plus the length of the clearway, if provided.

c) Accelerate stop distance available (ASDA). The length of the take-off run available plus the length of the stopway, if provided.

d) Landing distance available (LDA). The length of runway, which is declared available and suitable for, the ground run of an aeroplane landing.

Displaced Threshold

A threshold not located at the extremity of a runway. Displaced thresholds are used when an obstacle in the final approach area intrudes into the specific obstruction clearance surfaces. Displacing the threshold provides the required obstacle free slope. The declared landing distance available (LDA) which assumes a specified obstacle clearance plane is therefore measured from the displaced threshold; however there is no restriction to an aircraft actually landing on the usable runway prior to the displaced threshold. This portion of the runway is also available for take-off or rollout.

Elevation

The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.

Eye-to-Wheel Height

The vertical distance between the pilot's eye and the lowest point of the undercarriage when the aeroplane is in the flare altitude.

Fixed Light

A light having constant luminous intensity when observed from a fixed point.

Frangibility

A characteristic of an object to retain its structural integrity and stiffness up to a desired maximum load, but on impact from a greater load, to break, distort or yield in such a manner as to present the minimum hazard to aircraft.

Hazard Beacon

An aeronautical beacon used to designate a danger to air navigation.

Holding Bay

A defined area where aircraft can be held, or bypassed, to facilitate efficient surface movement of aircraft.

Instrument Approach Procedure

A series of predetermined manoeuvres by reference to flight instruments for the orderly transfer of an aircraft from the beginning of the initial approach to a landing, or to a point from which a landing may be made.

Instrument Approach Runway

A runway intended for the operation of aircraft using instrument approach procedures.

Light Failure

A light shall be considered to have failed when for any reason the average intensity determined using the specified angles of beam elevation, toe-in and spread falls below 50 per cent of the specified average intensity of a new light.

Manoeuvring Area

That part of an aerodrome intended to be used for the taking off and landing of aircraft and for the movement of aircraft associated with take-off and landing, excluding aprons.

Markers

Objects, displayed above ground level in order to indicate an obstacle or delineate a boundary.

Markings

A symbol or group of symbols displayed on the surface of the movement area in order to convey aeronautical information.

Minimum Eye Height Over Threshold (MEHT)

The height 2 minutes below the lowest on-course signal at a point directly above the threshold and the runway centre line.

Movement Area

That part of an aerodrome intended to be used for the surface movement of aircraft and includes the manoeuvring area and aprons.

Non-Instrument Approach Runway

A runway intended for the operation of aircraft using visual approach procedures.

Non-Precision Approach Runway

An instrument runway served by visual aids and a non-visual aid providing at least directional guidance adequate for a straight-in approach.

Obstacle

All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

Obstacle Clearance Surface (OCS)

OCS surface specifies minimum safe altitudes for each segment of approach procedures. For runway equipped with precision approach path indicators the OCS is a plane 1 degree below the angle which defines the lower boundary of the PAPI (APAPI) on-slope indication.

Obstacle Limitation Surface (OLS)

A surface that establishes the limit to which objects may project into the airspace associated with an aerodrome so that aircraft operations at the aerodrome may be conducted safely and, includes a take-off surface, an approach surface, a transitional surface and an outer surface.

Runway

A defined rectangular area, on a land aerodrome prepared for the landing and take-off of aircraft along its length.

Runway Approach Slope

An angle between a horizontal plane and a declining aircraft line appropriate for the use by the aircrafts using the approach.

Runway Strip

A defined area including the runway and stopway, if provided, intended to reduce the risk of damage to aircraft running off a runway and to protect aircraft flying over it during take-off or landing operations.

Shoulder

An area adjacent to the edge of a runway/taxiway so prepared as to provide a transition between the pavement and the adjacent surface.

Taxiway

A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another, including:

a) Aircraft stand taxilane. A portion of an apron designated as a taxiway and intended to provide access to aircraft stands only.

b) Apron taxiway. A portion of a taxiway system located on an apron and intended to provide a through taxi route across the apron.

Taxiway Holding Position

A designated position at which taxiing aircraft and other vehicles may be required to hold in order to provide adequate clearance from a runway.

Taxiway Strip

An area including a taxiway intended to protect an aircraft operating on the taxiway and to reduce the risk of damage to an aircraft accidentally running off the taxiway.

Threshold

The beginning of that portion of the runway usable for landing.

Touchdown Zone

The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway.

Transverse Slope

The slope of a runway or a strip measured perpendicular to the runway centre line.

1.4 AIRFIELD GENERAL CHARACTERISTICS AND LIGHTING REQUIREMENTS

1.4.1 Aerodrome Reference Code

Refer to Chapter 1 Section 1.5 for definition and details of aerodrome reference code.

1.4.2 Lighting Requirements

Where an aerodrome is intended to be used at night it shall be equipped with lighting facilities in accordance with the scales set out by Transport Canada as listed in Transport Canada Standard TP312, Aerodrome Standard and Recommended Practices. These are minimum requirements. The object of the lighting scales is to produce a range of lighting systems with compatible components.

1.4.3 Light Characteristics

Refer to Transport Canada Specification TP312, Aerodrome Standard and Recommended Practices for Light Characteristic Requirements.

1.4.4 Obstacle Limitation Surfaces

Refer to Chapter 1 Section 1.7.8 for Definitions and Dimensions of Obstacle Limitation Surfaces.

1.5 DESIGN PRINCIPLES

This chapter is intended for aerodromes with non-instrument or instrument, non-precision approach runways, code numbers 1, 2 and 3, which may be used at night.

In conformance to Aerodrome Lighting Requirements the following lighting facilities shall be provided:

a) Low intensity runway edge, end, threshold, taxiway and apron lights for Code 1 or Code 2 Runways.
b) Medium intensity runway edge, end, threshold taxiway and apron lights for Code 3 runways.
c) Airport beacon.
d) Illuminated wind direction indicator.
e) Apron floodlighting.
f) Illuminated guidance signs

In addition, the Code 1 or 2 runways may be equipped with abbreviated precision approach path indicators (APAPI units) and code 3 runways may be equipped with full PAPI.
The entire aerodrome lighting facilities are designed for stand-alone operation, ie. the lights can be controlled automatically by pilots through aircraft radio control aerodrome lighting (ARCAL) receiver system.

The design package covers the installation of all necessary systems and site work such as power distribution, controls, grounding, trenching and backfilling, etc., necessary to facilitate installation and operation of aerodrome lighting systems.

The aerodrome lighting facilities shall be designed and installed in conformance with the latest requirements of the Ontario Electrical Safety Code.

Power distribution design is based on the availability of a 200 Amp, 120/208 Volt, 3 phase, 4-wire power service in the maintenance building located at the airport site.

1.6 DESIGN PROCEDURE

The design process can be divided into four stages: review of project design criteria, site investigation, preparation of construction documentation and post installation inspection.

1.6.1 Review of Project Design Criteria

Review of project design criteria should be based on the following information.

a) project title and number.
b) airport location.
c) air side layout including locations of runway, taxiway, apron, runway ends, thresholds, runway primary and secondary approach numbers, airport building and service roads.
d) airport building layout, section and electrical record drawings.
e) existing/new surfaces and type of grading including dimensions, elevations, slopes, profiles, extent of shoulders, etc.
f) grade elevations at proposed locations for Approach Slope Indicators, Mini Power Centre and Wind Direction Indicator.
g) soil investigation report.
h) depth of frost penetration.
i) runway classification.
j) OLS surfaces.
k) approach slope angles for both runway ends.
l) eye-to-wheel height for critical aircraft that the runway is designed for.
m) aircraft minimum wheel clearance over the threshold.
n) radio frequency zoning requirements for ARCAL system.

1.6.2 Site Investigation

The purpose of site investigation is to check visually the existing site conditions as follows:

a) verification of layouts and preparation of sketches for layouts and existing installation details not available from project team.
b) verification of electrical service entrance location and rating.
c) verification of power demand and spare capacity.
d) conformation of power quality with the power supply authority.
e) checking of availability of service space for airfield power distribution equipment.
f) establishing of the distance from the existing power source to the proposed location of the airfield lighting main switch.
g) verification of existence of proper grounding system for service entrance.
h) visual verification of obstacle limitation in regards to visibility of wind direction indicator and aerodrome beacon from the air.
i) determination of needs for screening of dangerous and confusing lights.

1.6.3 Preparation of Construction Documentation

The design package shall consist of the following documentation.

1. Construction Layout Drawings
2. Non Standard Detail Drawings
3. Non Standard Material Specifications
4. Non Standard Construction Specifications
5. Bill of Materials (Day Labour Only)

Item 1 - Construction Layout Drawings

Location and quantities of all equipment, including edge lights, APAPIs, etc., shall be shown on the construction layout drawings.

It is recommended that the following layout drawings be developed.

1.1 Site Plan Electrical Layout

The following information shall be included in the drawing:

a) air side layout including runway, taxiway and apron, station marks and runway designation numbers.
b) location of airport building and service road.
c) locations of underground ducts and Electrical Handholes.
d) layout of elevated edge lights including: runway, taxiway, threshold, and apron-turn-off lights. Dimensions shall be shown only for any non-standard distances.

e) location of the wind direction indicator including dimensions from runway centreline and mini power centre.
f) location of rotating beacon.
g) location of floodlighting.
h) location of Approach Slope Indicators (ASI) units including distance from thresholds.
i) location of Mini Power Centre.
j) routing of underground cables and sizes.
k) location of cable protection planks (where required).
l) power sources including circuit numbers for all lights and other loads.

For items 'c', 'g' and 'i' include dimensions from defined structures located at the airfield.

Standard symbols shall be used as shown in Chapter 5, Standard drawing. MTO-E01: Legend.

1.2 Airport Building Electrical Layout

The following information shall be provided in the drawing.

a) electrical/service room location.
b) existing power distribution equipment layout.
c) new equipment layout.
d) routing of cables to remote loads.
e) location of the equipment platform on roof.
f) apron floodlighting fixtures if mounted on building.
g) routing of cables to equipment on roof.
h) power source including circuit number for all loads.

Item 2 - Non-Standard Detail Drawings

Normally, only reference to MTO, Airport Standard Electrical Drawings is required. If applicable, any non-standard modifications, to be implemented at the particular site due to its unique local conditions, shall be identified.

Item 3 - Non-Standard Material Specifications

Normally, only reference to MTO, Airport Standard Electrical Material Specifications is required. If applicable, any non-standard modifications, to be implemented at the particular site due to its unique local conditions, shall be identified.

Item 4 - Non-Standard Construction Specifications

Normally, only reference to MTO, Airport Lighting Standard Construction Specifications is required. If applicable, any non-standard modifications, to be implemented at a particular site due to its unique local conditions, shall be identified.

Item 5 - Bill of Materials

MTO, Airport Standard Electrical Bill of Materials shall be completed showing quantities of materials for each item. The materials listed in the Bill of Materials shall refer to the MTO Airport Standard Material Specifications where applicable.

Upon completion of the design package, the construction drawings and modified standards (if applicable) shall be submitted to MTO Thunder Bay Office for approval.

1.6.4 Post Installation Inspection

It is essential that upon completion of construction the entire installation be commissioned by the inspector, designated by the design engineer and accompanied by MTO Thunder Bay personnel. Correctness of the installation and as-built drawing mark-ups, as well as operation of systems shall be checked throughout. Also, the inspector shall witness all the tests listed in the construction specifications. It is recommended that Annual Inspection Check List, included in Chapter 2 be used for the purpose of record of inspection.

During the inspection, two (2) copies of complete documentation prepared by the design team will be required. One (1) copy, for the purpose of maintaining it at the airport site, shall be left with maintenance personnel or displayed in the airport office in accordance with the requirements of Chapter 2. One (1) copy of the complete documentation to be maintained in the Remote Northern Transportation Office (RNTO) - Electrical Shop in Thunder Bay.

The inventory schedule shall list size, manufacturer and part numbers for each equipment.

Maintenance personnel shall be trained on site to understand basics of aerodrome lighting equipment operation and to acknowledge their maintenance duties.

1.7 DESIGN STANDARDS AND GUIDELINES

1.7.1 Underground Ducts

Locations for duct banks shall be selected to facilitate installation of underground wiring at every aircraft manoeuvring surface and service road crossing. Standard drawing MTO-E04 or MTO-E05: Master Key Plan, illustrates a few possible locations. This drawing is meant strictly for general orientation purpose.

If the cables cross the access road to the maintenance building and apron they shall be protected by cable protection planks installed as shown on Standard drawing MTO-E13 Cable Installation. The planks shall be indicated on plan drawings.

1.7.2 Underground Electrical Handholes

Electrical Handholes are installed for the following applications:

i) To provide access for splitting of parallel wired edge light circuits and troubleshooting of failed underground cables. These Electrical Handholes shall be located on both sides of the runway equally spaced between mini power centre and threshold.

ii) To provide access for splicing of series circuits. Splicing is not recommended except when absolutely necessary.

iii) To provide a pulling point to facilitate the installation of series cables through polytubing or ducts. These Electrical Handholes shall be installed at strategic locations so as not to exceed the allowable cable pulling tension.

iv) To house isolating transformers at wind direction indicators, approach slope indicators, illuminated guidance signs and all edge lighting.

1.7.3 Footings for Airfield Equipment

The design standards specify two types of footings: concrete footing and steel footing. Both types are suitable for mounting of the equipment. Steel footing shall be used where possible unless there are rocks encountered on site. If one of those conditions exists concrete footing shall be specified and its depth shall be adjusted as follows:

a) 0.3m below anticipated frost level or
b) to a depth of bedrock elevation.

1.7.4 Power Distribution Equipment Layout

The preferable equipment layout is shown on standard drawings: MTO-E70 or MTO-E71 for Series or Parallel Connected Edge Lighting Power Distribution Equipment Layout. The equipment and wiring may be rearranged if space constraints exist, however, the equipment should be grouped in one location. It is important from a safety point of view to locate airfield lighting main switch adjacent to lighting panel LP1.

It is essential to verify the size of the main airfield lighting feeder (installed on line side of airfield lighting main switch) to ensure compliance with the Electrical Code.

1.7.5 Wiring

The circuit elements of parallel circuits are connected in parallel across the conductors to which the input voltage is applied. In theory the same voltage is applied to each light; however, the current through the conductors causes a decrease in voltage which for longer circuits may also reduce the voltage appreciably, and consequently the intensity of the lights at the far end of the circuit.

Voltage drop shall be calculated for all loads based on their distances from power source and cable sizes as shown on standard drawings MTO-E72 or MTO-E73 Power Distribution System-Wiring Diagram for Parallel or Series Connection and MTO-E74: Mini Power Centre Wiring Diagram. Power source voltage fluctuations measured on site shall also be taken into account.

Voltage drop at mini power centre can be compensated by adjustment of transformer taps.

The circuit arrangements at panels LP1 and LP2 were designed to achieve a good load balance. The load balance shall be checked if circuiting requires modification.

Nominal rating of cable insulation for underground installation shall be as follows:

Mini Power Centre Feeder	1000 Volt
APAPI, Wind Direction Indicator Cables	1000 Volt
Edge Lighting Cables	600 Volt

In a series connected lighting system, all edge lights are connected in series and in a loop configuration. The loop is powered by a constant current regulator. The regulator maintains a constant but adjustable current through the loop regardless of its length or the number of edge lights connected. This results in a uniform brightness over all the edge lights. Isolating transformers are used at

each edge light to prevent the entire loop from failing due to a fault in one light. Refer to part 5 of the ICAO Aerodrome Design Manual for a more detailed description of series circuits and their components.

Typical series circuit components include 5KV insulated power cable, isolating transformers, electrical handholes, a ground counterpoise system, series lamp edge lights and the constant current regulator.

Code 3 runways require adjustable intensity edge lighting, hence series connected edge lighting must be used. A series edge lighting system can be easily extended to suit a runway extension since circuit length has no effect on edge light brightness uniformity or the size of wiring.

1.7.6 Power Demand

Power demand of the existing airport facilities shall be revised by adding the airfield lighting load to ensure that overall demand does not exceed the service size maximum loading permitted by code and the power demand allowance from the power supply authority.

The power demand of a constant current regulator can be determined as follows:

	1.3X (sum of all lamp wattages)
+	150W per kilometre of circuit length
TOTAL	current regulator power demand

1.7.7 Grounding

The standard design for airfield lighting equipment grounding supplements the existing service grounding with additional ground electrodes located at remote equipment such as ASI's, wind direction indicator and Mini Power Centre.

Quantities of electrodes and their type shall be revised if required to suit local ground conditions.

Chemical filled electrodes shall be used for high resistivity grounds and L-shape chemical filled electrodes shall be used where rock is encountered.

Ground electrodes may not be required if steel footings are installed.

The ground counterpoise associated with a series lighting system is a grounding conductor installed over the primary cables for the purpose of interconnecting the system ground electrodes and providing lightning protection for the cables.

A ground counterpoise conductor shall be installed in all trenches or raceways containing series lighting cables.

The ground counterpoise shall be installed 80 mm above the primary cable.

The ground counterpoise conductor shall be soft drawn copper sized #8 AWG.

Where installed in raceways the counterpoise conductor shall be stranded, insulated (green).

1.7.8 Obstacle Limitation Consideration

All equipment shall be located within obstacle limitation surfaces established for the particular airport. Distance of wind direction indicator and mini power centre from the runway centreline are a function of the equipment's height and the type of runway involved. Standard details specify the following dimensions:

Equipment	Equipment Max. Elevation Above Runway Centreline	Distance From Runway Centreline
Mini Power Centre	2.0m	45m
Wind Direction Indicator	6.5m	75m

Standard locations of mini power centre and wind direction indicator shall be revised if the equipment, top elevation exceeds the above listed maximum values.

1.7.9 Elevated Edge Lights

Standard detail drawings specify mounting heights and distances from runway/taxiway centrelines. Fixture layout shall be prepared as follows:

a) Runway Edge Lights

Locate lights along runway edge on both sides of taxiway exit (Refer to Standard drawing MTO-E07 or MTO-E08: Runway/Taxiway Edge Lighting Layout).

Locate other lights at 60m intervals. Last light before threshold might be located at shorter distance, if required, to suit the runway length.

Light on opposite sides of the runway shall be located at exactly the same distances from thresholds.

Runway edge lights have clear lens.

b) Taxiway Lights and Turn-off Lights

Corner lights shall be located on both sides of taxiway and around turning buttons at both ends of runway as shown on standard drawings

MTO-E06: Runway Threshold Edge Lighting Layout, MTO-E07 and MTO-E08: Runway/Taxiway Edge Lighting Layout. Additional lights, if required, shall be equally spaced to ensure mounting intervals do not exceed 60m.

Taxiway edge, taxiway turn-off and turning button lights have blue lens.

c) Apron Lights

Apron lights shall have blue lens and shall be spaced around the edge of apron surface similarly to taxiway lights. If the ground side edge is illuminated by apron floodlighting, then apron edge lighting is not required.

Apron turn-off lights have yellow lens and are installed in pairs on both sides of the taxiway/apron junction.

There are two typical arrangements of the double yellow apron turn-off lights shown on drawings MTO-E07 and MTO-E08.

d) Threshold Lights

Threshold light layout shown on standard drawing MTO-E06 is a standard layout for 30m wide runway and must not be altered. Threshold lights have green lens from approach side and red lens from runway side.

e) Displaced Threshold Lights

If a displaced runway threshold light system is required it shall consist of 2-wing bars of lights showing aviation green in the direction of the approach for landing aircraft spaced symmetrically on either side of the runway, along the displaced threshold line. The portion of the runway between the displaced threshold and the runway end shall be outlined with blue runway edge lights (taxiway edge lights).

The runway end shall have lights showing aviation red in the direction of the approach and the reciprocal direction. Refer to Transport Canada Standard TP 312E for details.

1.7.10 Retro-Reflective Markers

Retro-reflective edge markers may be installed in lieu of taxiway and apron edge lights on taxiways/aprons associated with Code 1 or Code 2, non-instrument runways.

Retro-reflective markers are not suitable for marking taxiway turn-off or apron turn-off locations. Illuminated edge lights are required at all turn-off locations.

1.7.11 Wind Direction Indicator Assembly

For single runway, code 1 or code 2 aerodromes, the wind direction indicator should be centrally located from the ends of the runway and 60m from the edge (75m from centreline for runway 30m in width).

For a code 3 runway, two wind direction indicators are needed - one at each end, 150 m inwards from the threshold, 60 m off runway edge and preferably on the left side as viewed from approach.

If a location near the apron would be of greater value to the pilots in selecting the runway for take off such a site may be selected in lieu of the centre of the runway.

If a location near the apron is selected routing of underground cable shall be reviewed and proposed power source evaluated.

If the distance from a parallel connected wind direction indicator location to mini power centre is greater than to airport building, power may be supplied from panel LP1 through additional contact or contacts of contactor C1, see standard drawing MTO-E72: Power Distribution System-Wiring Diagram Parallel Connection.

Runways using series edge lighting are to be equipped with series connected wind direction indicators powered from the edge lighting circuit.

Also, the step-up transformer in equipment room and step-down transformer at wind direction indicator might have to be specified for voltage drop compensation.

Any modification of power distribution, standard drawing MTO-E72, MTO-E74: Mini Power Centre Wiring Diagram and MTO-E76: Parallel Connected Edge Lighting Control Schematic shall be modified and included in construction drawings and bill of material.

1.7.12 Layout and Elevation Setting Angles for Approach Slope Indicator (ASI) Units

Approach slope indicator system provides visual indications of the desired approach slope. The slope setting allows for a safe minimum wheel clearance over the runway threshold and a safe clearance of all obstacles on final approach. There are two arrangements of precision approach path indicator units. The first one consists of 4 sharp transition multi lamp units which are positioned on the

left side of the runway unless it is impractical to do so and it is called PAPI. A combination of left-hand and right-hand arrays also may be used. Figure 1.1 indicates positions and angle settings for the PAPI system. The second arrangement consists of a wing bar of 2 sharp transition, multi lamp units and is called APAPI. The APAPI system is intended for use on runways where the code number is 1 or 2 and the PAPI system is intended for use on runways where the code number is 3. Figure 1.2 indicates positions and angle settings for the APAPI system. The units are aimed in such a manner that a pilot making an approach will observe the following:

a) When on the approach slope, see the unit near the runway as red and the unit further from the runway as white.

b) When above the approach slope, see both units white.

c) When below the approach slope, see both units red.

1.7.12.01 Siting of ASI Units, Graphical Method

Assumptions

i) The ASI units are sited so as to provide visual guidance for aircraft to land at the threshold area while clearing all obstacles on the approach.

ii) The approach slope is 3^{O}

ii) The type of aircraft using the runway will determine the longitudinal placement of the unit with respect to the threshold. The critical distance on the aircraft is the cockpit-to-wheel height. Typical aircraft using remote airports generally fall in Height Group I (general aviation, small commuters, corporate turbo-jets), have a cockpit-to-wheel height of 3 metres or less and have a visual threshold crossing height of 6 metres. The threshold crossing height is defined as the height of the lowest on-course signal at a point directly above the threshold and the runway centreline. For a full description of cockpit-to-wheel heights of various aircraft and of the threshold crossing heights, refer to "Instruction Manual - Precision Approach Path Indicator". Type L880 and L881, Document No. 96A00S7, ADB-ALNACO Inc. Figure 1.3 graphically depicts the location of the runway reference point and other pertinent documentation.

Position of ASI Units with Respect to Runway Centreline

The APAPI units (2) are placed at a distance D2 from the runway threshold and 10 (±1) metres and 16 (±1) metres to the left of the runway edge. Figure 1.4 shows this. The PAPI units (4) are placed at a distance D2 with the innermost light unit at 15 m from the runway edge and the three outer units spaced 9 m

apart. In locating the units, it is important that the area on which they rest be level and that the actual light units remain above the elevation of the centreline of the runway (adjacent to where they are to be located). It is important to recognize that the difference in elevation between the light unit and the centreline elevation, known as e, should be noted and is to be used in calculating the longitudinal placement of the units.

Theoretical Distance of ASI Unit from Threshold

Refer to Figure 1.5. The ideal distance D1 can be found either graphically or algebraically. For APAPI systems, the distance D1 is 126 metres.

Solving for APAPI systems involves using graph paper and an appropriate scale, the threshold crossing height of 6 metres is plotted on the vertical scale and the ideal distance D1 of 126 metres is plotted on the horizontal scale. The resultant hypotenuse line would be the lowest on course signal, i.e., the theoretical approach path of the aircraft.

Since the APAPI units are placed to the left of the runway and, more importantly, the light units are a height **e** (m) above the elevation of the centreline, this height **e** is also plotted on the sketch (See Figure 1.5).

Where this line intersects the lowest on course signal is the location of the units and is referred to as distance D2 (the adjusted distance of the APAPI units from the threshold).

Similar graphical methods can be used to determine the theoretical distance of PAPI system units. Refer to Transport Canada Standard TP312E.

Placement of ASI Units for Positive or Negative Runway Slopes

This procedure is similar to that previously described in that a triangle is drawn with one side being the threshold crossing height and the base being the ideal distance D1. The lowest on course signal line is then extended below the base line. The runway profile is then plotted. The intersection of the runway profile and the on course signal line is the runway reference point (RRP). The elevation difference **e** is plotted above the runway profile line. The intersection of this line and the on course signal line is again distance D2, the adjusted distance of the ASI units from the threshold. Figures 1.6 and 1.7 respectively show the effect of the change of runway slope on calculating the adjusted distance for APAPI units.

The adjusted distance of the ASI units from the threshold increases as the runway longitudinal slope becomes negative and decreases with a positive slope.

In all cases, when calculating these distances, careful attention and adherence to the detailed instructions provided in the previously mentioned reference and to

Transport Canada standards TP 312 is a must. Any deviations from the calculated sittings of the units must be approved by Transport Canada.

Given the importance of these units and the possible consequences of an error in calculating the distances, it is recommended that all calculations be re-done by a second person and then compared to the first calculations to ensure that they agree.

ASI location calculations should be submitted to the Transport Canada
Aerodromes and Air Navigation Office
Civil Aviation Ontario Region
4900 Yonge Street, Suite 300
Toronto, Ontario M2N 6A5
tel (416) 952-0248
fax (416) 952-0050

Remote Northern Transportation Office-Electrical Section staff in Thunder Bay can be consulted if additional information is required.

1.7.12.02 Siting of ASI Units, Numerical Calculation Method

The recommended practice for siting of APAPI units based on numerical calculation is as follows (see Figure 1.8).

1. Determine approach slope angle Q.

   Example: Q = 3°

2. Calculate the lower boundary of the on-slope indication.
   For APAPI system:

   A = Q - 15'

   Example:
   A = 3° - 15' = 2°45'

3. Calculate angle M
   Angle M is related to the lowest height at which the pilot will perceive an on-slope indication over the threshold.

   M = A - 2'

   Example:
   M = 2°45'-2' = 2°43'

4. Determine maximum eye to wheel height (EWH) of the critical aircraft.
   Example:

EWH = 3m minimum

5. Determine minimum wheel clearance over the threshold.

   This distance shall be not less than:

   a) for a PAPI system - 9m where the code number is 3 or 4 or

   b) for a PAPI system where the code number is 1 or 2, and for APAPI system - 3m or the aircraft eye-to-wheel height in the approach altitude, whichever is greater.

      Example: 3m minimum

6. Calculate the minimum eye height over the threshold (MEHT)

   MEHT = EWH + minimum wheel clearance over threshold

   Example: MEHT = 3m + 3m = 6m minimum

7. Calculate the optimum location for APAPI wing bar as follows:

   D_1 - distance of APAPI from threshold

   MEHT = D_1 x tan (M)

   Example: 6m = D_1 x tan (2°43')
   D_1 = 126m

8. Calculate the Obstacle Clearance Surface (OCS)

   OCS = M - 1°
   Example:
   OCS = 2°43' - 1° = 1°43'

   Point of origin for runway where the code number is 2 shall be 60m downwind of the units, i.e. the distance from threshold is:
   126m - 60m = 66m

9. Determine obstacle limitation surface (OLS) and ensure that OCS is not penetrated by any object within approach divergence angle.

10. Make correction of APAPI location for runway longitudinal slope. (Figure 1.9)

    a) establish runway slope : a°

b) calculate difference in elevation based on the distance of APAPI's from threshold

$e = D_1 \times \tan(a)$

Where there is a difference in excess of 0.3m between the elevation of the runway threshold and the elevation of the runway centreline adjacent to the APAPI, there will be a need to displace the APAPI from its nominal distance from threshold. The distance would be increased if the centreline is lower than the threshold and reduced if it is higher.

The corrected distance can be calculated as follows:

$D_2 = D_1 + e \times \tan(M)$

Example:
a = 0.5°, threshold higher than runway centreline adjacent to the APAPI
$e = 126m \times \tan(0.5°) = 1.1m$
$D_2 = 126m + (1.1m \times \tan 2°43') = 126m + 21m = 147m$

But the difference in elevation between runway centreline at this new location and threshold is:

$e_1 = 147 \times \tan 0.5° = 1.28m.$

The difference in elevation of runway centreline at the distance from threshold of 126m and 147m respectively is:

$e_2 = e_1 - e = 1.28m - 1.1m = 0.18m$
which is less than 0.3m, thus further adjustment is not essential.

11. Correction for difference in elevation between the units themselves and adjacent runway centreline.

If the units are higher or lower than the adjacent runway centreline by 0.3m or more, further adjustment shall be calculated in the same way as in item 10, to establish APAPI final position.

However, normally this adjustment will not be required since the standard mounting height for APAPI light sources is 0.275m above the runway centreline.
Calculations shall be prepared for each APAPI siting at each approach separately.

1.7.13 Mini Power Centre Location

Mini power centre shall be located at the runway centre and at the minimum distance from runway centreline of 45m.

At the airport where apron is located approximately at the runway centre, the 5kVA step-up transformer can be eliminated and the mini power centre can be replaced by a panel mounted in the airport building. In this instance, the surge protector shall be rated at 208 Volt, single phase.

1.7.14 Power Source and Branch Circuits

1.7.14.1 Series Systems

Power sources and circuits for all loads are shown on standard drawings MTO-E04, MTO-E77. Equipment shown on construction plan drawings shall be labelled with corresponding power source i.e. panel number and circuit number.

1.7.14.2 Parallel Systems

Power source and branch circuits for all loads are shown on the following Standard Drawings: MTO-E72 - Power Distribution System-Wiring Diagram Parallel Connection, MTO-E74 - Mini Power Centre Wiring Diagram. Equipment shown on construction plan drawings shall be labelled with corresponding power source i.e. panel number and circuit number.

The typical parallel edge lights circuit arrangement is shown on figure 1.10. It is important that adjacent lights are always supplied from alternate circuits.

THIS SYSTEM WILL NOT BE USE IN NEW DESIGN
However, the existing parallel system will be maintained as is.

1.7.15 Aerodrome Beacon

This is a standard aerodrome equipment. It requires power supply as shown on standard drawing MTO-E72 and shall be mounted in such a location that its light beam is visible from the air. Standard location for the beacon is on the roof of the airport building. It is important to verify obstacle limitations around the airport building to ensure the unobstructed light visibility from the air. The beacon shall be of rotating or flashing strobe type in conformance with Transport Canada and MTO approved equipment lists.

1.7.16 ARCAL Unit

This is a standard aerodrome equipment. It requires power supply as shown on standard drawing MTO-E72. The equipment shall be installed in the equipment room with its antenna mounted on the roof as shown on standard drawing MTO-E50: Roof Top Equipment Mounting Detail.

The ARCAL Unit shall be factory set to the specific radio frequency required for the particular aerodrome. This frequency shall be specified in a bill of material or the contract documents.

1.7.17 Airfield Lighting Control

Standard configuration of the airfield lighting controls including layout of panel and schematic are provided on standard drawings MTO-E76: Parallel Connected Edge Lighting Control Schematic and MTO-E78: Parallel Connected Edge Lighting Control Panel Equipment Layout. The control system supports automatic operation of airfield lighting with manual override functions as described in the Operation and Maintenance Chapter of this manual.

If modification of airfield lighting operation is required, the standard drawings need to be revised accordingly and included in the design package.

1.7.18 Apron Floodlighting

1. General

The purpose of illuminating the apron area is to provide lighting at the aircraft stand to facilitate loading and unloading of passengers and cargo including other general service activities.

2. Design Criteria

The following minimum levels of illumination shall be provided for illuminating an area of the apron:

(1) The area of illumination shall be 30m by 20m on the apron

Generally this area shall usually be 15m each side of the waiting room and 20m into the apron.

(ii) The minimum average illumination level will be 20 lux within the area specified.

3. Controls and Wiring

Apron floodlighting shall be controlled with the ARCAL and photoelectric controller complete with a time delay relay and a bypass switch for manual control during maintenance.

#12 AWG, 600 V, TECK cable shall be used for power supply wiring to the luminaire.

4. Luminaire

Floodlighting luminaire shall be high cutoff type and suitable for use with Metal Halide lamps.

Floodlighting luminaires shall be aimed so that the aircraft stand does not cast shadows in the passenger loading and unloading area as well as considering glare especially with respect to the approaching pilot.

Orientation of luminaire shall be performed to achieve the levels specified in the design criteria. A twin lamp luminaire shall be considered so that if one lamp is burntout the other one will still be in operation.

5. Poles

1. Pole height shall be 9.14m maximum, complete with a lowering device to enable servicing of the luminaire at ground level.

2. Sectional steel poles shall be provided for ease of transportation to the sites. Each section shall not be longer than 3.5m.

3. Poles shall be located at a minimum distance of 5.0m from the edge of the apron usually in front of the waiting room.

1.8 DESIGN CHECK LIST

The Remote Northern Transportation Office in Thunder Bay will ensure that the following Design Check List is completed by the Design Team.

Date:
Project Title:
Job Number:
Airport Location:

Preliminary Investigation:

___ Obtain airside layout.

___ Obtain airport building drawings.

___ Obtain surface details, slopes, profiles, etc.

___ Review soil investigation report, particularly the frost penetration information.

___ Determine availability of suitable cable bedding materials (ie. sand)

Select:

___ method of trenching _____

___ ground electrodes _____

___ field equipment foundations _____

___ series or parallel connected edge lighting _____

___ select type of underground raceway where bedding materials are unsuitable

Runway Classification:

___ letter code _____

___ number code _____

OLS Surfaces:

___ Approach 1 _____

___ Approach 2 _____

Approach Slope Angle:

___ Approach 1 _____

___ Approach 2 _____

___ Eye-to-wheel height for critical aircraft. _____

___ Aircraft minimum wheel clearance over the threshold. _____

Site Investigation

___ Check location of electrical service entrance.

Service Size:

___ volts _____

___ amps _____

___ phase _____

___ wire _____

___ splitter rating _____

___ existing power demand _____

Power Supply Quality:

___ minimum volts _____

___ maximum volts _____

___ Select proposed location for new distribution equipment.

___ Distance from splitter to proposed airfield eg. switch._____m

___ Check existing grounding

___ adequate ___ inadequate system.

Check obstacle limitations re: visibility of:

___ rotating beacon

___ wind direction indicator

Determine location of:

Aerodrome beacon:

___ distance from apron edge of

maintenance building _____ m

Mini Power Centre: (Parallel Edge Lighting only)

___ distance from runway threshold _____ m

Wind Direction Indicator Assembly:

___ Distance from mini power centre (Parallel system only) _____ m

___ Check proposed routes for installation of cables in maintenance building and in the air side.

___ Check existing service road location.

___ Visually check site for dangerous and confusing lights.

Preparation of Construction Documentation

Calculate exact longitudinal distances of ASI units from thresholds.

___ Approach 1 _____m

___ Approach 2 _____m

___ Prepare voltage drop calculations for parallel systems.

___ Determine edge light regulator power rating for series connected edge lighting systems

___ Prepare power demand calculations and review with power supply authority.

___ Prepare site plan layout drawing.

___ Prepare maintenance building layout drawing.

Modify standard drawings and specifications if required.

a) Standard Drawings

___ Modifications not required:

Modifications required:
Section No. _____
_____
_____

b) Material Specifications

___ Modifications not required

Modifications required :
Section No. _____
_____
_____

c) Construction Specifications

___ Modifications not required

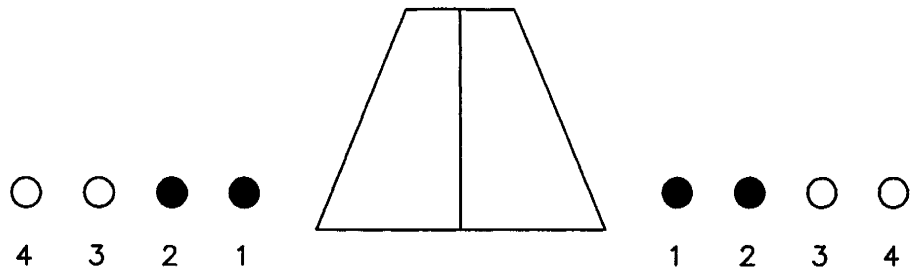
Modifications Required :
Section No. _____
_____
_____

___ Obtain Remote Northern Transportation Office approval of the design.

___ Prepare bill of material.

___ Prepare documentation to be maintained at Airport Site.

___ Prepare documentation to be maintained in MTO Thunder Bay, Remote Northern Transportation Office.



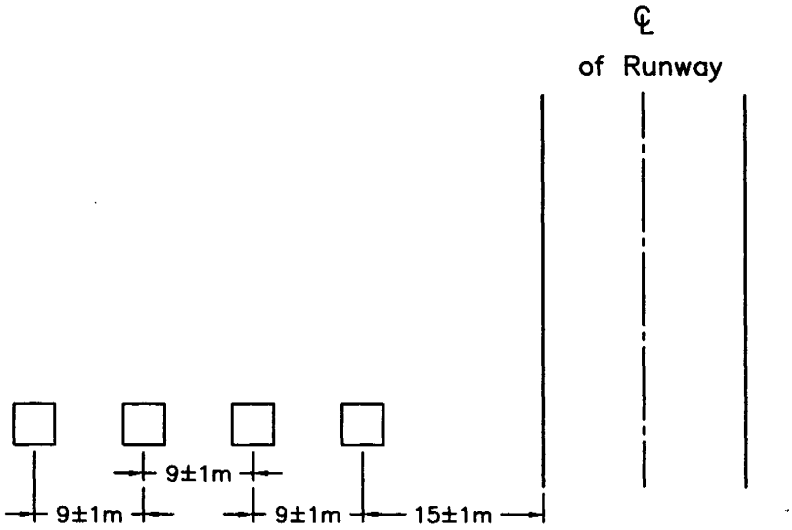
● RED

○ WHITE

UNIT ANGLE SETTING

1 Q+30'
2 Q+10'
3 Q−10'
4 Q−30'
Q – Approach slope angle

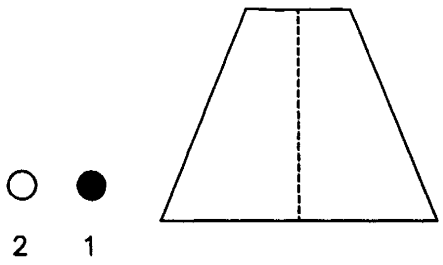
PAPI ON SLOPE APPROACH INDICATION



LOCATION OF PAPI UNIT FROM RUNWAY EDGE

PAPI UNITS ARRANGEMENTS

Figure 1.1



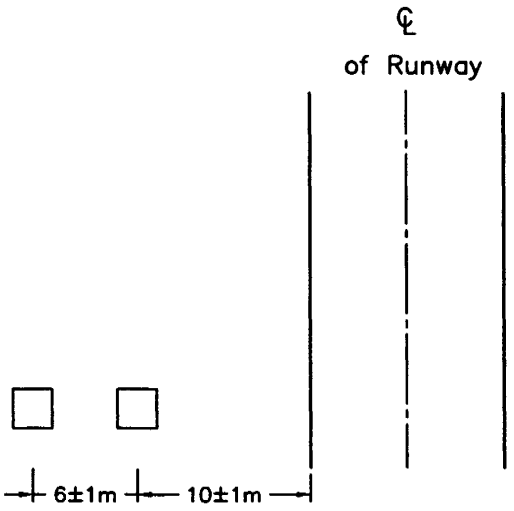
● RED

○ WHITE

UNIT ANGLE SETTING

1 Q+15'
2 Q−15'
Q – Approach slope angle

APAPI ON SLOPE APPROACH INDICATION



LOCATION OF APAPI UNIT FROM RUNWAY EDGE

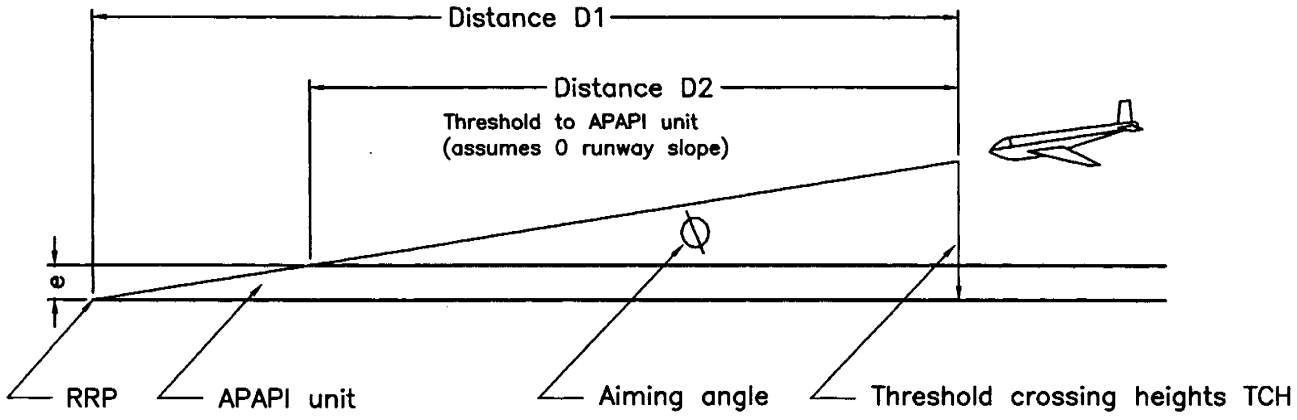
APAPI UNITS ARRANGEMENTS

Figure 1.2

SITING OF ADB–ALNACO L881 APAPI UNIT

For aircrafts having cocpit–to–wheel heights 3m

Assumes 0% runway slope



LEGEND

RWY – Runway longitudinal gradient
TCH – Threshold crossing height (20 feet) 6m
RRP – Runway reference point (where aiming angle or visual approach path intersects runway profile
D1 – Ideal distance
D2 – Adjusted distance of APAPI units from threshold
e – elevation difference between runway CL and APAPI units

Aiming angle – 2 degrees 43' 30"
* Allows 10' EWH + 10' wheel to lowest on slope indication

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file apapi

Figure 1.3

LOCATION OF APAPI UNIT WITH RESPECT TO THRESHOLD

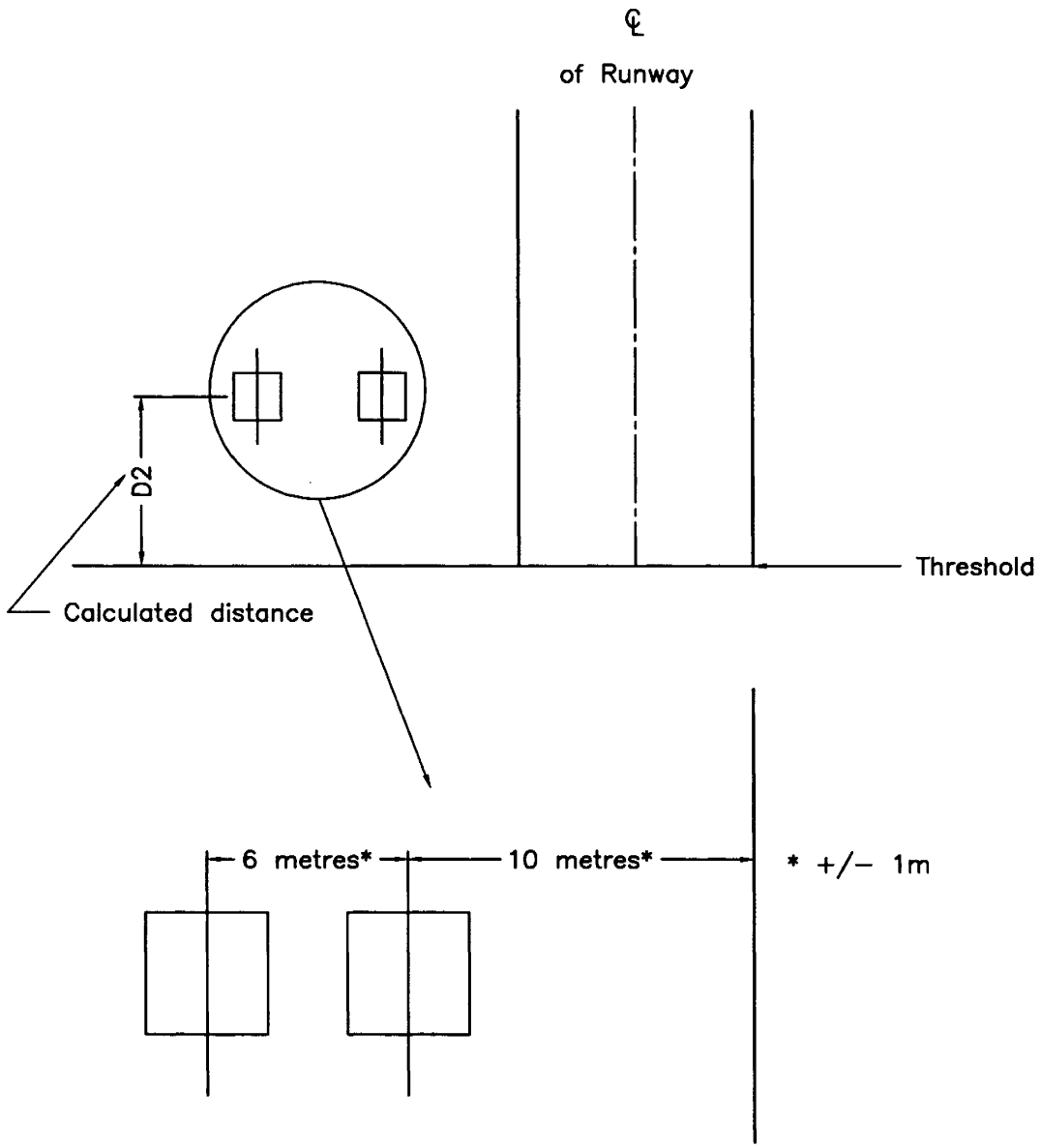

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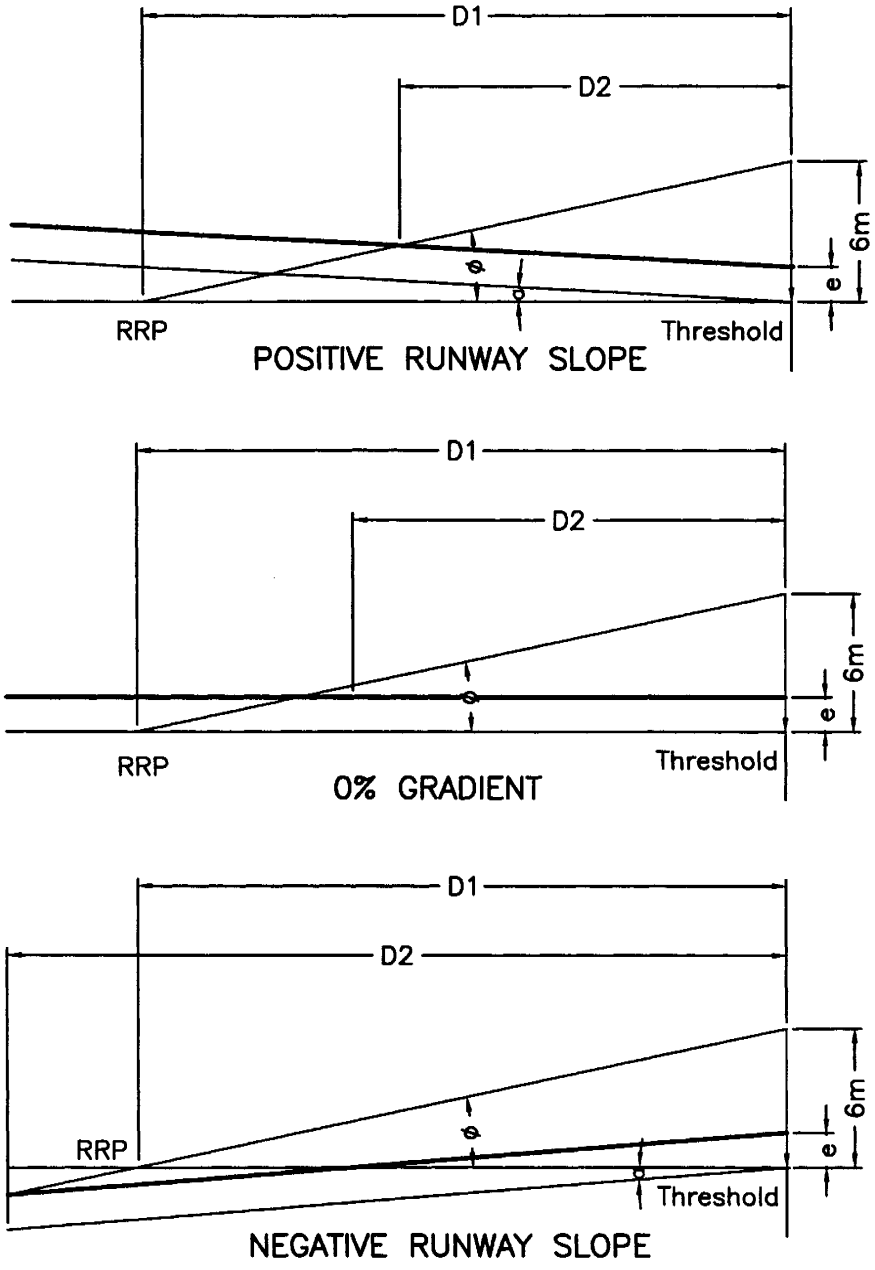
Figure 1.4

CALCULATING APAPI DISTANCE TO TRESHOLD



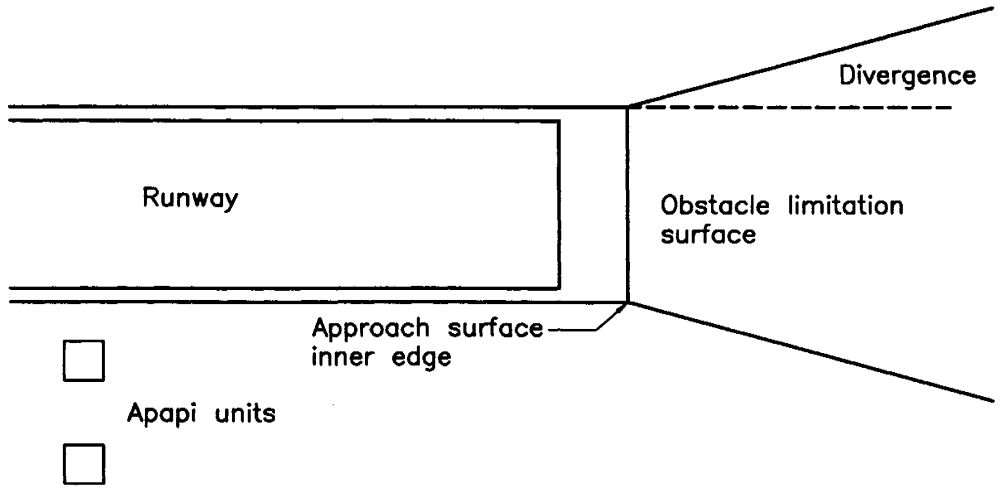
LEGEND

RRP – Runway reference point
D1 – Ideal distance – 126m
D2 – Adjusted distance of APAPI units from threshold
e – elevation difference between runway centreline and APAPI units

ø – 2°43'30"
Tanø – 6/D1
D1 – 126m

Figure 1.5

APAPI LIGHTS AND ANGLES OF ELEVATION



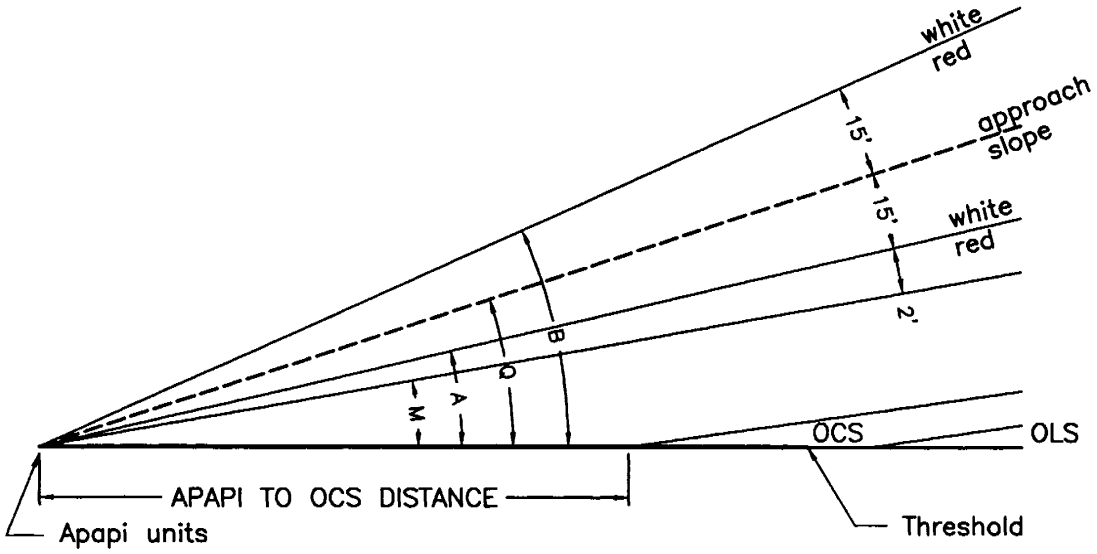
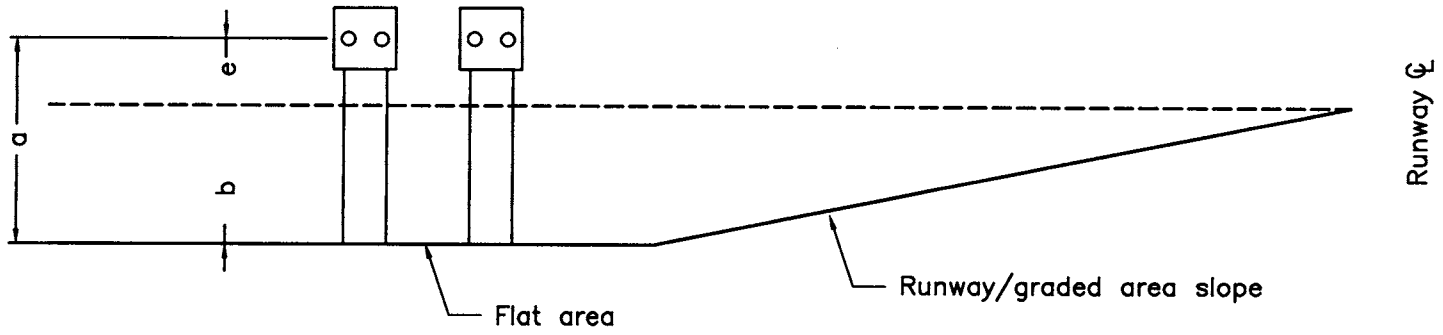


Figure 1.8

POSITION OF APAPI UNITS WITH RESPECT TO RUNWAY CENTRE LINE



a – distance base plate to CL of lights
b – distance base plate to runway crown datum
e – distance light unit to runway crown datum

file apapi 3

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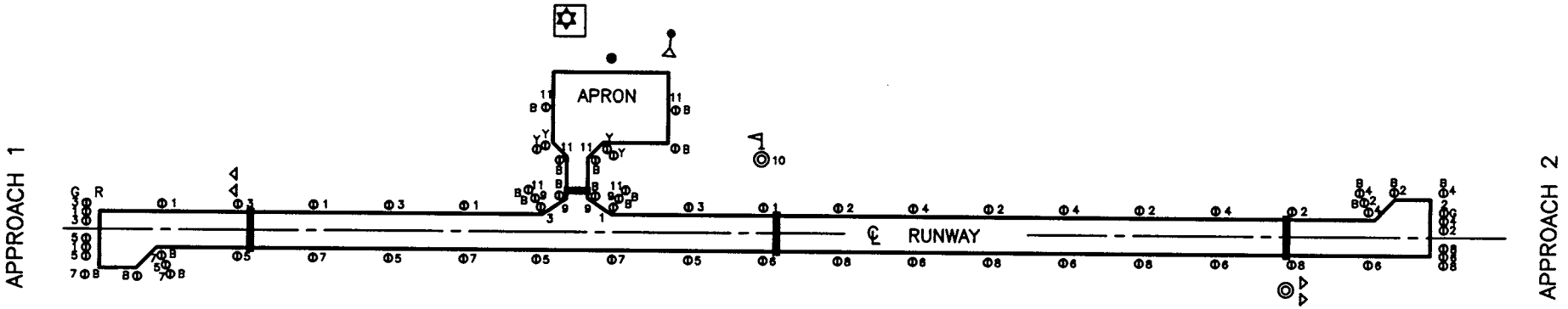
Figure 1.9

TYPICAL EDGE LIGHT CIRCUIT ARRANGEMENT



Note

Number beside each light indicates branch circuit number at mini power centre (Panel LP2)

Figure 1.10

CHAPTER 2

Operation and Maintenance

TABLE OF CONTENTS

2.6.7 APRON FLOODLIGHTING

Figures

Tables

2.1 GENERAL

2.1.1 INTRODUCTION

This chapter establishes the maintenance guidelines and procedures for the Airfield Lighting Equipment. The objective of this chapter is to provide description of the operation and general maintenance instructions for airfield lighting equipment installed at remote airports.

Maintenance personnel should refer to manufacturer's instruction manuals for equipment shop drawings and service instruction details.

2.1.2 PREVENTIVE MAINTENANCE PROGRAM

Reliable functioning of airport lighting equipment is essential to airport operation. Therefore, it is essential that a Preventive Maintenance Program be established to ensure reliable service and proper equipment operation. Airport lighting is usually dependable and may continue to operate for long periods of time even if maintenance is neglected, however, some portion of it will eventually fail. When failure occurs at a critical time, lives and property may be jeopardized. Maintenance of airport lighting equipment should receive high priority to prevent equipment failure, false signals, and deterioration of the system.

2.1.2.01 Installation and Materials

High quality and properly installed equipment is essential for a satisfactory Preventive Maintenance Program. Preventive Maintenance is difficult on equipment that has been installed hap-hazardly without consideration of maintenance requirements. When such conditions exist, they should be brought to the attention of the proper authority and corrected rather than trying to establish a Preventive Maintenance Program around the condition.

2.1.2.02 Personnel

Maintenance personnel should have a thorough knowledge of the equipment, and should be able to make careful inspections and necessary repairs. Special training may be desirable, but most well-qualified electricians can be trained on-the-job. All maintenance of electrical equipment and most of the inspections and tests shall only be done by qualified maintenance electricians. Only simple maintenance work, as further specified, can be performed by other trained personnel.

2.1.2.03 Tools and Test Equipment

Necessary tools and test equipment shall be provided for the maintenance personnel to adequately perform the required maintenance. This includes the proper tools, adequate working space, adequate storage space, spare parts, and applicable technical manuals.

2.1.2.04 Preventive Maintenance Inspection Program

The Preventive Maintenance Inspection Program is to establish an effective inspection schedule for each item of airfield lighting equipment. The Preventive Maintenance Inspection schedule (PMI) is the foundation for the successful maintenance of the equipment. If the PMI's are performed properly as scheduled, it will ensure top efficiency and will minimize unwarranted interruptions and breakdowns. A review of the inspection records, checks, tests, and repairs accomplished provides a constant awareness of the equipment condition and provides maintenance personnel with advanced warning of impending trouble.

2.1.3 SAFETY PRECAUTIONS

Safety and maintenance are indivisible; the observance of safety requirements is as an important part of any job as the performance of the actual work itself. No job is so small that it cannot cause an accident, and one accident can waste more time and cost more money than can possibly be saved by taking unsafe short-cuts.

Extreme care must be taken that no circuits are shorted or grounded and that the inspector experiences no personal harm. Any defect which is discovered shall be immediately corrected.

Do not work around live parts except in extreme emergencies. If work must be performed on live equipment, take every precaution to guard against accidents. Rubber gloves and insulating mats should be used, and all tools should be insulated.

Each man working on electrical equipment should personally assure himself that the equipment is de-energized and the circuit is dead. He should also ensure himself that there is no possibility of re-energizing the circuit or equipment while he is working on same. Switches shall be locked or blocked OPEN and a suitable WARNING sign placed on same.

Before attempting inspection, maintenance, or adjustment of any device such as circuit breakers, relays, or instruments each part of this chapter shall be carefully read as well as the detailed information provided by the manufacturer.

2.2 DEFINITIONS

AIRFIELD LIGHTS

There are many different kinds of lights on the airfield. You must know a few things about each kind so that you can do your Daily Safety Check of the Airport and make minor repairs. The definitions below tell you what you will need to know about each kind of light. Standard drawings: MTO-E01: Legend and MTO-E04 or MTO-E05: Master Key Plan show you where to find each kind.

2.2.1 Rotating Beacon

A rotating bright light that helps the pilot find the airport from a long distance when it is dark or in the daytime when the weather is bad.

2.2.2 ASI (Approach Slope Indicator)

Special lights on the sides of the runway near the threshold, that show the pilot if he is too high or too low on his landing approach. ASI lights may be on one or both ends of the runway.

2.2.3 Illuminated Wind Direction Indicator

A lighted nylon cone on a tower near the runway that shows the pilot the wind direction and speed.

2.2.4 Runway Edge Lights

Lights with **clear lenses** that mark both sides of the runway. These lights are **white** when lit.

2.2.5 Taxiway and Apron Lights

Lights with **blue lenses** that are on both sides of the taxiway and around the edge of the apron.

NOTE: Where the taxiway joins the runway two lights with **blue lenses** are placed close together.

2.2.6 Apron Turn-off Lights

Two lights with **yellow lenses** placed close together that show where the taxiway meets the apron.

2.2.7 Threshold Lights

Lights with the **red** and **green lenses** that mark both ends of the runway. The **red** part of the lens faces the runway and the **green** part faces the pre- threshold area.

2.2.8 Apron Floodlighting

Building or pole mounted lights, similar to street lighting to illuminate area of apron for safe aircraft parking and people movement.

2.3 RECOMMENDED SPARE PARTS AND TOOLS

2.3.1 RECOMMENDED TOOL LIST (at each airport)

2.3.1.1 Hand Tools

1	Half Round File
1	Ball Peen Hammer
1	Hacksaw
1	Knife
6	Screwdrivers, Robertson Philips and Standard Types
2	Pliers; Diagonal, Channelock
1	Medium Level
1	Open End Wrench
1	Pipe Wrench

2.3.1.2 Special Tools

1	Breakable Coupling Wrench
1	Edge Light Anchor Stake Pounding Block
1	Electric Vacuum Cleaner
1	3/8" Electric Drill

2.3.2 RECOMMENDED TOOL LIST (maintenance electrician)

2.3.2.1 Hand Tools

1	Centre Punch
1	1/2" Cold Chisel
1	Half-round File
1	Ball Peen Hammer
1	Adjustable Hacksaw
1	Knife
1	Medium Level
5	Pairs of Pliers -- 8" Sidecutters, Diagonal, Longnose and 2 pairs of Channelock
6	Screwdrivers, Robertson Philips and Standard types
1	6" Square or Combination Square
1	Steel Tape, 10 or 12-foot
1	Small Tap Wrench
1	Tool Box
1	600-Volt Tester (CSA approved)

2.3.2.2 Special Tools

1	1000V and 5000V Meggers
2	Primary and Secondary Cable Connector Crimpers
1	AC/DC Clamp-on Multimeter
1	Acoustic Detector and/or Cable Locator (for location of faults in underground cables)
1	Ground Resistance Tester
1	Portable Radio Transmitter
1	ASI Aiming Device

2.3.3.1 RECOMMENDED SPARE PARTS AND MATERIALS AIRPORTS WITH PARALLEL LIGHTING

Max.	Min.	
5	1	Insulation Tape
2	1	Anti-seize Compound for Breakable Couplings
3	1	100A Fuses
2	1	Replacement Fuses for ARCAL, Constant Current Regulator and Rotating Beacon (2 of each kind)
30	5	25 W, 130 V lamps
10	5	60 W, 130 V lamps
5	2	Anchor Stake Assemblies
10	5	Elevated Edge Light Units including Plug, Cord and Breakable Coupling and/or Column.
12	6	Runway Edge Light Lenses, Clear
6	3	Runway Threshold Light Lenses, Red/Green
12	3	Taxiway/Apron Edge Light Lens, Blue Symmetrical
2	1	150W, PAR 38 or 300W, Par 56 Lamp for Illuminated Wind direction indicator
2	--	Windsock
2	1	Lamp for Rotating Beacon
2	1	Lamps for ASI Units
2	--	Lamps for Apron Floodlighting
1	--	200W Series Isolating Transformers.
2	1	Wire Connectors Vibration Proof Electrical Insulation Putty
1kg	--	Sealing Compound - Protexulate Powder
4	1	External Ground Lug for underground Splice Box
4	1	U/G Splice Box Gasket
.5kg	--	Low Temperature Grease
3	0	SO Cable Connector Kits (Female)
10	2	Edge Light Lens Gaskets
5	3	Edge Light Columns
2	0	Underground Splice Boxes
5m	--	2/c #12 SOOW Cable
2	--	Water Tight Connector for SOOW Cable
2l	0.5 L	Lens Cleaning Agent

2.3.3.2 RECOMMENDED SPARE PARTS AND MATERIALS AIRPORTS WITH SERIES LIGHTING

Max.	Min.	
5	1	Insulation Tape
2	1	Anti-seize Compound for Breakable Couplings
3	1	100A Fuses
2	1	Replacement Fuses for ARCAL, Constant Current Regulator and Rotating Beacon (2 of each kind)
30	5	30W, T10, 1P, 6.6A Lamps
10	5	100W, T10, 1P, 6.6A Lamps
5	2	Anchor Stake Assemblies
10	5	Elevated Edge Light Units including Plug, Cord and Breakable Coupling and/or Column.
12	6	Runway Edge Light Lenses, Clear
6	3	Runway Threshold Light Lenses, Red/Green
12	3	Taxiway/Apron Edge Light Lens, Blue Symmetrical
2	--	Windsock
2	1	Lamp for Rotating Beacon
2	1	Lamps for ASI Units
2	--	Lamps for Apron Floodlighting
5	2	30/45W Series Isolating Transformers
5	2	100W Series Isolating Transformer
2	1	200W Series Isolating Transformers.
2	1	Wire Connectors Vibration Proof Electrical Insulation Putty
4	2	Primary cable connector assemblies
10	2	Primary cable splice kits
3	0	SO Cable Connector Kits (Female)
10	2	Edge Light Lens Gaskets
5	3	Edge Light Columns
5m	--	2/c #12 SOOW Cable
2	--	Water Tight Connector for SOOW Cable
2l	0.5 L	Lens Cleaning Agent
.5 kg		Low Temperature Grease

2.4 INSPECTION PROCEDURES AND MAINTENANCE RECORDS

2.4.1 INTRODUCTION

This section describes the Inspection Procedures and various types of Maintenance Records and Technical Documentation that should be maintained for the Airfield Lighting Equipment.

2.4.2 MAINTENANCE RECORDS

Maintenance records are an important part of an effective Maintenance Management System. They provide historical documentation, standardization and maintenance guidelines, as well is prevent duplication of effort. When records are properly used, an effective maintenance program can be established. Without records, knowledge gained from regular inspection will not be retained, and preventive maintenance will be difficult. An effective records system should allow for the recording and retrieval of information with a minimum of effort.

2.4.3 REFERENCE LIBRARY

A Reference Library should be established to maintain a master copy of all Equipment Technical Manuals (ETM's), Transport Canada Advisory Circulars, and manufacturer's technical data. It is recommended that the MTO Thunder Bay, Remote Northern Transportation Office (RNTO), be charged with the responsibility for establishing and maintaining the Reference Library.

2.4.4 AS-BUILT DRAWINGS

It is recommended that the master copy of all "as-built" drawings be maintained by the RNTO. Modifications to the equipment should be incorporated into the drawings as soon as the modification is completed. A copy of the "as-built" lighting plan, showing the location of all cable runs, runway lights, etc., including the wiring diagrams for the airfield lighting system should be provided to the Electrical Shop to use as a working copy. In addition, a copy of the as-builts shall be provided to the Electrical Engineering office. When an extension or modification is made, the RNTO should provide the Airport Site with a revision of the applicable drawings.

2.4.5 DOCUMENTATION MAINTAINED AT AIRPORT SITE

The following documentation shall be maintained at each airport site.

1)* Airfield lighting master key plan modified to particular site conditions with numbers identifying all lamps.

2) Construction "As-Built" record drawings.

3) Equipment Inventory Schedule

4) MTO Remote Airport Lighting Manual

5)* Emergency Telephone List and Safety Procedures

6)* Daily Inspection Check List

7)* Monthly Inspection Check List

8) Lamp Replacement Record Book

9) Equipment Failure Report Book

*Asterisks identify documentation that is recommended to be displayed in the airport maintenance office.

2.4.6 DOCUMENTATION MAINTAINED IN RNTO ELECTRICAL SHOP, THUNDER BAY

The following documentation shall be maintained:

1) MTO Remote Airport Lighting Manual
2) Transport Canada Advisory Circulars
3) Maintenance Records for each airport as follows.

   a) As-built Drawings
   b) Airfield Lighting Key Plan (with numbers identifying all lamps)
   c) Equipment Inventory Schedule
   d) Annual Inspection Records
   e) Insulation Resistance Test Reports
   f) Grounding Resistance Test Reports
   g) Lamp Replacement Records
   h) Equipment Failure Reports
   i) Record of Notices to Airmen (NOTAM) related to failure of airfield lighting.

2.4.7 STAFF REQUIREMENTS

The airport lighting system maintenance duties have been grouped in the following procedures:

a) Daily Inspections
b) Monthly Inspections
c) Annual Inspections

Daily and monthly inspections can be performed by trained airport personnel who do not necessarily have an extensive electrical background. These inspections are limited to visual inspections of the systems and observation of their operation, and also replacement of burned-out lamps. Specially trained personnel, approved by RNTO, may also be assigned for periodical checking of APAPI aiming angles.

Any equipment failure will be immediately reported to RNTO Electrical Shop, Thunder Bay for their corrective maintenance action.

Daily inspection will require approximately 1/2 to 1 man-hour and can be performed by a single maintenance person such as a trained airport operator.

Annual inspections will involve extensive electrical equipment checking, tests, etc. and will require one licensed electrician and one assistant, such as an electrical apprentice or trained airport operator. Inspections to take approximately 2-3 days.

Annual inspections will include checking and repairing (if necessary) all system components to ensure the electrical systems reliable operation. Any major maintenance work required shall be scheduled to be performed as soon as possible, preferably immediately after the inspection.

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

PARALLEL EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
1.	Power Distribution	Airfield Lighting Main Switch			
2.		- 100 A Switch type - 100A Fuses			
3.		Panel LP1 - panel tab - breakers			
4.		- 15A - 1P			
5.		- 30A - 2P			
6.		Surge protector			
7.		5 KVA transformer			
8.		Mini power centre (LP2)			
9.		- assembly			
10.		- primary breaker (15A - 2P)			
11.		- secondary breaker (25A - 2P)			
12.		- branch breaker (15A - 1P)			
13.		- transformer			
		Underground splice box			
14.	Lighting Control	Relays - R1 to R4 & PCR			

PARALLEL EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
15.		- TRI			
16.		- R1A - R3A			
		Relay Contacts			
17.		- normally open (NO)			
18.		- normally closed (NC)			
19.		Selector Switches - 2 position			
20.		- 4 position			
21.		Contactors - C1			
22.		- C2			
23.		- C3			
24.		- C4			
25.		Contractor contacts - normally open (NO)			
26.		- normally closed (NC)			
27.		Photocell			
28.		Frost Prevention Control			
29.		Timer			
30.		Thermostat			
31.	Grounding	Ground Lug - cable to rod			
32.		- ground post			
33.		Ground Inspection Box			

PARALLEL EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
34.	Airfield Lighting Systems	Edge Lights - lighting fixture			
35.		- runway edge light lense			
36.		- threshold light lense			
37.		- taxiway light lense			
38.		- apron turn-off lense			
39.		- breakable coupling			
40.		- mounting column			
41.		- mounting stake			
42.		Wind Direction Indicator - assembly			
43.		- wind socket			
44.		- lamp			
45.		Rotating Beacon - assembly			
46.		- lamp			
47.		ASI system - light unit			
48.		- lamp			
49.		- mounting			
50.		- series isolating transformer			

PARALLEL EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
51.		Regulator - assembly			
52.		- output relays			
53.		ARCAL			
54.		Apron Floodlighting - fixture			
55.		- lamp			
56.		- pole			
57.		- mounting			

MINISTRY OF TRANSPORTATION, ONTARIO REMOTE AIRPORTS	Location:

LAMP REPLACEMENT RECORD

Date	Lamp Number (refer to airfield lighting key plan)	Lamp Size (W) and Type	Replaced By

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared By:**

EQUIPMENT FAILURE REPORT

Item	System or Equipment	Observation

Service Technician:	**Date:**
Identification of Cause: **Remedy:**	

MINISTRY OF TRANSPORTATION, ONTARIO

REMOTE AIRPORTS

PARALLEL EDGE LIGHTING AIRPORTS
DAILY INSPECTION CHECK LIST

Item	Action Taken	Chk (√)
1.	Visually check all electrical equipment located in the electrical room for damage, abnormal noise and heat.	
2.	Key a microphone switch of a portable radio transmitter 5 times. Where a radio is not available, turn the runway switch to APPROACH 1. Check operation of all lamps (edge lights, rotating beacon, wind direction indicator ASI. Observe operation of apron floodlighting if testing is performed after sunset. Return selector switch to "Auto".	
3.	Observe rotation of beacon. Should be 12 RPM or 20-30 flashes per minute.	
4.	Observe current output on constant current regulator. Should be 6.6A during day light operation.	
5.	Replace all burned out bulbs, broken lenses and broken fixtures. Make sure to turn off power and to lock out circuits before doing any maintenance on the electrical equipment.	
6.	Check lamp operation after replacement.	
7.	Clean dirty lenses. Remove snow from around all lights so they can be seen from the ground or the air. Remove snow from the top of APAPI light units. This should be done by hand.	
8.	Replace wind sock if it is torn or damaged. Remove any debris from inside of wind sock.	
9.	Report to MTO Thunder Bay about any lights you cannot repair and about any equipment failure.	
10.	Make certain that the selector switch at regulator is in "remote" position and all switches at airfield panel are in "auto positions".	

MINISTRY OF TRANSPORTATION, ONTARIO

REMOTE AIRPORTS

MONTHLY INSPECTION CHECK LIST

Item	Action Taken	Chk (√)
1.	Check ground elevation around fixtures.	
2.	Check for grass, dirt and weeds around the light units. Remove when necessary.	
3.	Check wind direction indicator assembly to see that it swings freely.	
4.	Check the condition of wind sock fabric.	
5.	Make sure that ASI mounting is rigid.	
6.	Check outer surface of ASI protective glass. Clean if dirty.	
7.	Check elevation angle of ASI units. (Only by authorized personnel.)	
8.	Review spare parts stock. Order new if required.	

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

ANNUAL INSPECTION CHECK LIST

Item	System or Equipment	Description	Remarks
1.	Power Distribution	Main disconnect switch	
2.		Airfield lighting panel LP1	
3.		Mini Power Centre LP2	
4.		- Panelboard	
5.		- Transformer	
6.		5 kVA Transformer	
7.		Surge protector	
8.		Conduits	
9.		Wires and cables	
10.		Supports	
11.		Wire insulation	Refer to insulation resistance test report
12.	Lighting Controls	General	
13.		Switches	
14.		Contractor and relays	
15.		Wiring	
16.		Control panel operation test	

ANNUAL INSPECTION CHECK LIST

Item	System or Equipment	Description	Remarks
17.	Grounding	Connections	
		Grounding resistance	Refer to Grounding Resistance Test Report
18.	Airfield Lighting Systems Edge Lights		
19.		Fixture housing	
20.		Peeling paint	
21.		Moisture	
22.		Lamp contacts	
23.		Wire connections	
24.		SO Cable & connections	
25.		Gaskets and seals	
26.		Light brightness and correctness of lamp size	
27.	Wind Direction Indicator	Rotary swivel	
28.		Bearing shields	
29.		Lubrication	
30.		Pole level	
31.		Securing bolts	
32.		Wiring	
33.		Corrosion, cracks, paint	
34.		Light brightness and correctness of lamp sizes	

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

ANNUAL INSPECTION CHECK LIST

Item	System or Equipment	Description	Remarks
35.	Rotating Beacon	Clutch torque	
36		Lubrication	
37.		Motor	
38.		Heater	
39.		Thermostat	
40.		Level	
41.		Elevation angle	
42.		Mounting platform, belts, etc.	
43.		Voltage	
44.		Cleaning, paint, corrosion	
45.		Light brightness & correctness of lamp sizes	
46.		Beacon operation	
47.	ASIs	Inspection of housing, filters, lenses, etc.	
48.		Cleaning, painting , corrosion	
49.		Low and high brightness levels and correctness of lamp sizes	
50.		Mounting, belts, etc.	
51.		Wire connections	
52.		SO Cables and connectors	
		Light unit alignment	
53.		- alignment of units faces	

ANNUAL INSPECTION CHECK LIST

Item	System or Equipment	Description	Remarks
54.		- parallel alignment to the runway centreline	
55.		- longitudinal levelling	
56.		- transverse levelling	
57.		Flight Check (if possible)	
58.		Condition of transformers	
59.	Constant Current Regulator	Input voltage	
60.		Wire connection	
61.		Output current, brightness settings	
62.		Cleaning, corrosion, painting	
63.		Contactors	
64.		Overvoltage protection	
65.		Overcurrent protection	
66.		Remote/local operation	
67.	ARCAL	Antenna mounting	
68.		Antenna cable	
69.		Wire termination	
70.		Input voltage	
71.		Cleaning, corrosion, painting	
72.		Remote/local operation	

ANNUAL INSPECTION CHECK LIST

Item	System or Equipment	Description	Remarks
	Apron Floodlighting		
73.		Cleaning, corrosion, painting	
74.		Level	
75.		Wire connection	
76.		Lamp operation	
	Miscellaneous		
77.		Check inventory of spare parts and materials and order new as required	

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

INSULATION RESISTANCE TEST REPORT

Item	Circuit	Measurement Value	Remarks
1.	Power Distribution Panel (LP-1) cct 1		
2.	cct 3		
3.	cct 5		
4.	cct 7 (beacon cable)		
5.	cct 9		
6.	cct 2		
7.	cct 4		
8.	cct 6		
9.	cct 8		
10.	cct 10 (floodlighting cable)		
11.	cct 12 (floodlighting cable)		
12.	ASI 1 Cable Feeder		
13.	ASI 2 Cable Feeder		
14.	Mini Power Centre Cable Feeder		
	Mini Power Centre (LP-2)		
15.	cct 1		
16.	cct 3		

INSULATION RESISTANCE TEST REPORT

Item	Circuit	Measurement Value	Remarks
17.	cct 5		
18.	cct 7		
19.	cct 9		
20.	cct 11		
21.	cct 2		
22.	cct 4		
23.	cct 6		
24.	cct 8		
25.	cct 10		
26.	cct 12		
27.	Series Edge Lighting Systems Edge Lighting Circuit		

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

GROUNDING RESISTANCE TEST REPORT

Item	Circuit	Measurement Value	Remarks
1.	Panel LP-1		
2.	Panel LP-2 (Parallel Only)		
3.	Surge protector		
4.	Wind direction indicator		
5.	ASI 1 - light unit 1		
6.	- light unit 2		
7.	Light Unit 3 (if PAPI)		
8.	Light Unit 4 (if PAPI)		
9.	- isolating transformers		
10.	ASI 2 - light unit 1		
11.	- light unit 2		
12.	Light Unit 3 (if PAPI)		
13.	Light Unit 4 if (PAPI)		
14.	- isolating tranformers		
15.	Floodlighting Pole 1		
16.	Floodlighting Pole 2		
17.	Edge Light Fixture # _____		
18.	Fixture # _____		
19	Fixture # _____		
20.	Fixture # _____		

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

SERIES EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
1.	Power Distribution	Airfield Lighting Main Switch			
2.		- 100A Switch type - 100 A Fuses			
3.		Panel LP1 - panel tab - breakers			
4.		- 15A - 1P			
5.		- 30A - 2P			
6.		Surge protector			
7.	Lighting Control	Relays			
8.		Time Delay Relay			
		Relay Contacts			
9.		- normally open (NO)			
10.		- normally closed (NC)			
11.		Selector Switches - 2 position			
12.		- 4 position			
13.		Contactors - C1			
14.		Contactor contacts - normally open (NO)			

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

SERIES EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
15.		- normally closed (NC)			
16.		Photocell			
17.		Frost Prevention Control			
18.		Timer			
19.		Thermostat			
20.	Grounding	Ground Lug - cable to rod			
21.		- ground post			
22.		Ground Inspection Box			
23.	Airfield Lighting Systems	Edge Lights - lighting fixture			
24.		- runway edge light lense			
25.		- threshold light lense			
26.		- taxiway light lense			
27.		- apron turn-off lense			
28.		- breakable coupling			
29.		- mounting column			
30.		- mounting stake			
31.		- isolating transformer			
32.		Wind Direction Indicator - assembly			
33.		- wind socket			

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

SERIES EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
34.		- lamp			
35.		- isolating transformer			
36.		Aerodrome Beacon - assembly			
37.		- lamp			
38.		ASI - light unit			
39.		- lamp			
40.		- mounting			
41.		- series isolating transformer			

MINISTRY OF TRANSPORTATION, ONTARIO **REMOTE AIRPORTS**	**Location:** **Date:** **Prepared by:**

SERIES EDGE LIGHTING AIRPORTS
EQUIPMENT INVENTORY SCHEDULE

Item	System	Equipment	Size	Manufacturer	Part Number
39.		Edge Light Regulator - assembly			
40.		- output relays			
41. 42. 43.		ASI Regulator - assembly - output relays ARCAL			
44.		Apron Floodlighting - fixture			
45.		- lamp			
46.		- pole			
47.		- mounting			

_____

_____

MINISTRY OF TRANSPORTATION, ONTARIO

REMOTE AIRPORTS

SERIES EDGE LIGHTING AIRPORTS
DAILY INSPECTION CHECK LIST

<table>
<tr><th>Item</th><th>Action Taken</th><th>Chk (√)</th></tr>
<tr><td>1.</td><td>Visually check all electrical equipment located in the electrical room for damage, abnormal noise and heat.</td><td></td></tr>
<tr><td>2.</td><td>
<table>
<tr><th colspan="3">Table 2 Series System</th></tr>
<tr><td colspan="3">ARCAL LIGHTING EQUIPMENT STATUS (DAYLIGHT)</td></tr>
<tr><td>3 clicks</td><td>- all edge lighting</td><td>ON at 10% brightness</td></tr>
<tr><td></td><td>- approach slope indicators</td><td>ON at 10% brightness</td></tr>
<tr><td></td><td>- wind direction indicators and guidance signs lighting</td><td>ON</td></tr>
<tr><td></td><td>- apron floodlighting</td><td>OFF</td></tr>
<tr><td></td><td>- beacon</td><td>ON</td></tr>
<tr><td>5 clicks</td><td>- all edge lighting</td><td>ON at 30% brightness</td></tr>
<tr><td></td><td>- approach slope indicators</td><td>ON at 30% brightness</td></tr>
<tr><td></td><td>- wind direction indicators and guidance signs lighting</td><td>ON</td></tr>
<tr><td></td><td>- apron floodlighting</td><td>OFF</td></tr>
<tr><td></td><td>- beacon</td><td>ON</td></tr>
<tr><td>7 clicks</td><td>- all edge lighting</td><td>ON at 100% brightness</td></tr>
<tr><td></td><td>- approach slope indicators</td><td>ON at 100% brightness</td></tr>
<tr><td></td><td>-wind direction indicators and guidance signs lighting</td><td>ON</td></tr>
<tr><td></td><td>- apron floodlighting</td><td>OFF</td></tr>
<tr><td></td><td>- beacon</td><td>ON</td></tr>
<tr><td colspan="3">ARCAL LIGHTING EQUIPMENT STATUS (DARKNESS)</td></tr>
<tr><td>3 clicks</td><td>- all edge lighting</td><td>ON at 10% brightness</td></tr>
<tr><td></td><td>- approach slope indicators</td><td>ON at 10% brightness</td></tr>
<tr><td></td><td>- wind direction indicators and guidance signs lighting</td><td>ON</td></tr>
<tr><td></td><td>- apron floodlighting</td><td>ON</td></tr>
<tr><td></td><td>- beacon</td><td>ON</td></tr>
<tr><td>5 clicks</td><td>- all edge lighting</td><td>ON at 30% brightness</td></tr>
<tr><td></td><td>- approach slope indicators</td><td>ON at 30% brightness</td></tr>
<tr><td></td><td>- wind direction indicators and guidance signs lighting</td><td>ON</td></tr>
<tr><td></td><td>- apron floodlighting</td><td>ON</td></tr>
<tr><td></td><td>- beacons</td><td>ON</td></tr>
<tr><td>7 clicks</td><td>- all edge lighting</td><td>ON at 100% brightness</td></tr>
<tr><td></td><td>- approach slope indicators</td><td>ON at 100% brightness</td></tr>
<tr><td></td><td>- wind direction indicators and guidance signs</td><td>ON</td></tr>
<tr><td></td><td>- apron floodlighting</td><td>ON</td></tr>
<tr><td></td><td>- beacon</td><td>ON</td></tr>
</table>
Where portable radio is not available, use the selector switches on the control panel.
</td><td></td></tr>
</table>

MINISTRY OF TRANSPORTATION, ONTARIO

REMOTE AIRPORTS

SERIES EDGE LIGHTING AIRPORTS
DAILY INSPECTION CHECK LIST

Item	Action Taken	Chk (√)
3.	Confirm regulator output current is as follows for each regulator: 10% brightness 4.6 - 4.9 A 30% brightness 5.3 - 5.7 A 100% brightness 6.4 - 6.7 A	
4.	Observe rotation of beacon. Should be 12 RPM or 20-30 flashes per minute.	
5.	Replace all burned out bulbs, broken lenses and broken fixtures. Make sure to turn off power and to lock out circuits before doing and maintenance on the electrical equipment.	
6.	Check lamp operation after replacement.	
7.	Clean dirty lenses. Remove snow from around all lights so they can be seen from the ground or the air. Remove snow from the top of ASI light units. This should be done by hand.	
8.	Replace wind sock if it is torn or damaged. Remove any debris from inside of wind sock.	
9.	Report to MTO Thunder Bay about any lights you cannot repair and about any equipment failure.	
10.	Make certain that all switches at airfield control panel are in "auto positions".	

2.5 POWER DISTRIBUTION AND GROUNDING

2.5.1 INTRODUCTION

This section contains the Preventive Maintenance Inspection Schedule for Airfield Lighting Power Distribution and Grounding Systems.

The Preventive Maintenance Inspection schedule establishes the minimum requirements. Inspection intervals should be increased if local conditions warrant.

2.5.2 OPERATION

Power for airfield lighting system is supplied from a maintenance building service on the load side of a check meter. Typically, there is a 100A panel with a main breaker dedicated for airfield lighting system, installed at the building's power distribution splitter.

Also, there is a surge protector installed in the Airport Building. Its function is to protect the power distribution equipment from damage caused by any high voltage transients, such as lightning, which may occur in an underground feeder cable to the Mini Power Centre.

Usually, the power source voltage is 120/208 volt, 3 phase, 4 wire, grounded neutral. However, some airport sites receive power at the voltage level of 120/240 volt, 1 phase, 3 wire, grounded neutral.

Most of the power distribution equipment for airfield lighting is located in the airport building electrical room.

Typical arrangement of panels, transformers and control equipment is illustrated on the Standard Drawings MTO-E70 and MTO-E71 - Power distribution equipment layout. All equipment is equipped with identification labels.

In the normal operation mode, the power supply to various airfield loads is controlled automatically, by signals received from the ARCAL system and the photocell.

There are two types of airfield lighting - parallel connected (voltage powered) and series connected (current powered).

For parallel connected systems, power to field lighting is distributed using direct buried TECK cables from a mini power centre. The remotely located Mini Power Centre is a self contained distribution centre complete with a distribution transformer, main, primary and secondary breakers and a breaker panel. It distributes power to all edge lights and an illuminated wind direction indicator. Power to Mini Power centre is distributed at the voltage level of 600 volt to allow for a voltage drop compensation. There is one 5kVA, 208 - 600 volt transformer installed in the Airport

Building and one 5 kVA, 600V - 120/240 volt transformer installed at Mini Power Centre to increase the line voltage to 600 volts.

For series connected systems, power to field lighting is distributed from a constant current regulator in the maintenance building using 5KV cables. A direct buried transformer at each edge light isolates each fixture from the main series loop.

Approach slope indicator systems operate on a series circuit powered by a separate current regulator regardless of which type of edge lighting is installed.

Airfield lighting power distribution equipment, devices, lighting fixtures, etc. are grounded in accordance with the Code. Main service equipment receives grounding from a maintenance building service entrance. Additional ground electrodes are provided at the Mini Power Centre, APAPI units and the wind direction indicator.

The lighting control panel contains selector switches, relays, contactors and wiring to facilitate simple and reliable switching of airport lighting circuits and devices.

The panel receives signals from the radio controller (ARCAL) unit.

All input - output signals are transmitted through dry contacts.

Normally the system operates in automatic mode which provides for all airport lighting being controlled by pilots.

For airports equipped with parallel edge lighting, the system, the operation is shown in Table 1:

Table 1 Parallel System		
ARCAL LIGHTING EQUIPMENT STATUS **(DAYLIGHT)**		
3 clicks	- all edge lighting, wind direction indicator and guidance signs lighting	ON
	- approach slope indicators	ON at 10% brightness
	- apron floodlighting	OFF
	- beacon	ON
5 clicks	- all edge lighting,wind direction indicator and guidance signs lighting	ON
	- approach slope indicators	ON at 30% brightness
	- apron floodlighting	OFF
	- beacon	ON
7 clicks	- all edge lighting, wind direction indicator and guidance signs lighting	ON
	- approach slope indicators	ON at 100% brightness
	- apron floodlighting	OFF
	- beacon	ON
ARCAL LIGHTING EQUIPMENT STATUS **(DARKNESS)**		
3 clicks	- all edge lighting,wind direction indicator and guidance signs lighting	ON
	- approach slope indicators	ON at 10% brightness
	- apron floodlighting	ON
	- beacon	ON
5 clicks	- all edge lighting, and wind direction indicator and guidance signs lighting	ON
	- approach slope indicators	ON at 30% brightness
	- apron floodlighting	ON
	- beacon	ON
7 clicks	- all edge lighting, wind direction indicator and guidance signs lighting	ON
	- approach slope indicators	ON at 100% brightness
	- apron floodlighting	ON
	- beacon	ON

For airports equipped with series connected edge lights, the operation is shown in Table 2.:

Table 2 Series System		
ARCAL LIGHTING EQUIPMENT STATUS (**DAYLIGHT**)		
3 clicks	- all edge lighting	ON at 10% brightness
	- approach slope indicators	ON at 10% brightness
	- wind direction indicators and guidance signs lighting	ON
	- apron floodlighting	OFF
	- beacon	ON
5 clicks	- all edge lighting	ON at 30% brightness
	- approach slope indicators	ON at 30% brightness
	- wind direction indicators and guidance signs lighting	ON
	- apron floodlighting	OFF
	- beacon	ON
7 clicks	- all edge lighting	ON at 100% brightness
	- approach slope indicators	ON at 100% brightness
	-wind direction indicators and guidance signs lighting	ON
	- apron floodlighting	OFF
	- beacon	ON
ARCAL LIGHTING EQUIPMENT STATUS (**DARKNESS**)		
3 clicks	- all edge lighting	ON at 10% brightness
	- approach slope indicators	ON at 10% brightness
	- wind direction indicators and guidance signs lighting	ON
	- apron floodlighting	ON
	- beacon	ON
5 clicks	- all edge lighting	ON at 30% brightness
	- approach slope indicators	ON at 30% brightness
	- wind direction indicators and guidance signs lighting	ON
	- apron floodlighting	ON
	- beacons	ON
7 clicks	- all edge lighting	ON at 100% brightness
	- approach slope indicators	ON at 100% brightness
	- wind direction indicators and guidance signs	ON
	- apron floodlighting	ON
	- beacon	ON

The airfield lighting will turn off automatically 15 minutes after being activated by a pilot's microphone. Apron floodlighting will stay on for an additional 15 minutes.

The airport lighting control panel is equipped with selector switches to enable bypass of the automatic functions. Positioning the apron floodlighting switch in "MANUAL" will turn on the apron floodlighting (during darkness only). This

manual selection can be used for any activities on the apron. Similarly, the edge lights can be turned on manually to facilitate night time snow clearing operations. The wind direction indicators and any illuminated guidance signs are energized with the runway edge lights. The beacon and the approach slope indicators also have selector switches for manual operation.

2.5.3 INSPECTIONS

2.5.3.1 Daily Inspections

Power distribution equipment is highly reliable and does not require special maintenance. However it is recommended that the equipment be periodically observed for abnormal noise, heat or vibration.

Power distribution equipment can be serviced only by a certified electrician.

2.5.3.2 ANNUAL INSPECTIONS

2.5.3.2.1 Disconnect Switch

1) Clean enclosure interior.
2) Check enclosure mounting - tighten bolts, nuts, etc.
3) Check cable fittings and bushings entering enclosure.
4) Check condition of cable or wire insulation.
5) Tighten wiring connections.
6) Clean switch blades and contacts, replace worn out parts.
7) Lubricate moving parts.
8) Check fuse clip tension.
9) Check operation of the switch.
10) Keep enclosure cover closed.

2.5.3.2.2 Panelboard

1) Clean interior of panel.
2) Check for heat damage to wiring due to loose connection.
3) Check breaker connections to buswork (look for discoloration).
4) Check to ensure solid vibration free mounting.
5) Check cover or door installation for locking device. Inspect, clean and lubricate operating parts.
6) Check conduit locknuts and bushings for tightness.
7) Check grounding.
8) Check current of each breaker and record.
9) Check line voltage on main busses.
10) Check phase current and record.
11) Check line connection to panel. Tighten lugs.

2.5.3.2.3 Transformers

1) Thoroughly clean interior of transformer. (if dry type transformer)
2) Check the temperature; check for unusual noises, defective grounding and primary and secondary windings.
3) Check tightness of high and low voltage connections.
4) Check neutral to ground connection.
5) Check the laminations and report any abnormal discoloration.
6) Check voltage of high and low voltage connections.
7) Check coil blocking for looseness. (if dry type transformer)

2.5.3.2.4 Electric Controls

General

1) Clean enclosure interior.
2) Check enclosure mounting - tighten bolts, nuts, etc.
3) Check cable fittings and bushings entering enclosure.
4) Check tightness of wire connections.
5) Lubricate moving parts if applicable.
6) Check condition of cable or wire insulation.

Switch

1) Check operation of switch.
2) Check arc chute condition.

Contactor

1) Check operation of magnetic mechanism.
2) Check condition of coil, megger.
3) Check condition of contacts, replace if necessary.
4) Check conditions of arc chutes.

Airfield Lighting Control Panel Performance Test (Parallel Edge Lighting)

For parallel connected airfield lighting, perform the following system operation tests:

i) Position the ASI system selection switch to "10%" and observe that both ASI systems operate at low intensity. Move the selector switch to "30%" and confirm that the intensity of both ASI systems increase. Position the switch to "100%" and confirm that the intensity of both ASI systems increases to full brightness.

ii) Position the ASI system selector switch in "ARCAL" and edge lighting selector switch in "MANUAL". Observe that edge lighting and wind direction indicator turn "ON".

iii) Position the edge lighting selector switch in "AUTOMATIC" and the beacon selector in "MANUAL". Observe that the beacon operates.

iv) Position the beacon selector switch in "AUTOMATIC" and the apron floodlighting selector switch in "MANUAL". Obscure the photocell and observe that apron floodlighting turns "ON".

v) Position the apron floodlighting selector switch in "AUTOMATIC". With the photocell obscured and all selector switches in "AUTOMATIC", confirm the following operation of the airport lighting via ARCAL as per Table 1.

vi) Allow the photocell to sense daylight and with all selector switches in "AUTOMATIC" confirm the following operation of the airport lighting via ARCAL as per Table 1.

vii) Ensure all selector switches are left in automatic positions.

Airfield Lighting Control Panel Performance Test (Series Edge Lighting)

i) Position the airfield lighting selector switch to "10%" and verify that:
   a) both ASI systems operate at low intensity
   b) all edge lighting operates at low intensity
   c) wind direction indicators and guidance signs operate at full intensity

ii) Position the approach selector switch to "30%" and verify that:
   a) both ASI systems operate at medium intensity
   b) all edge lighting operates at medium intensity
   c) wind direction indicators and guidance signs operate at full intensity

iii) Position the approach selector switch to "100%" and verify that:
   a) both ASI systems operate at full intensity
   b) all edge lighting operates at full intensity
   c) wind direction indicators and guidance signs operate at full intensity

iv) Position the airfield lighting selector switch in "ARCAL" and the beacon auto/manual selector switch in "MANUAL". Observe that the beacon operates.

v) Position the beacon selector switch in "AUTOMATIC" and the apron floodlighting selector switch in "MANUAL". Obscure the photocell and observe that the apron floodlighting turns "ON".

vi) Position all airfield lighting equipment selector switches in "AUTO". Obscure the photocell (during daylight hours) and confirm the following operation via ARCAL as per Table 2.

vii) Repeat the above procedure with the photocell uncovered during daylight hours. Confirm the following operation via ARCAL as per Table 2.

2.5.3.2.5 Conduits

1) Inspect conduit for loose supports and connections.
2) Replace broken brackets.

2.5.3.2.6 Wiring

1) Inspect for abrasions, breaks and loose connections.
2) Check terminal lugs for tight electrical connection.
3) Measure wire insulation. Compare to previous records.
4) Repair or review wiring when necessary.

2.5.3.2.7 Weatherproofing and Gaskets

Check the condition of the weatherproofing and gaskets of all outdoor enclosures. Gaskets should be replaced when cracked and deteriorated. Before installing new gasket, clean the gasket channels and seats thoroughly. When it is necessary to secure the gasket with rubber cement, both the gasket and seat should be coated with appropriate cement and permitted to dry until tacky before the gasket is positioned.

2.5.3.2.8 Surge Protector

Measure insulation resistance. Compare with the value provided by the manufacturer.

2.5.3.2.9 Grounding

1) Check all connections and tighten as necessary.
2) Apply electrically conductive -- anti-seize compound.
3) Measure resistance to ground (reading should not exceed 10 ohms).

2.6 AIRFIELD LIGHTING EQUIPMENT

2.6.1 ELEVATED LIGHT UNITS

2.6.1.1 GENERAL

This section contains the Preventive Maintenance Inspection schedule and maintenance procedures for the Runway and Taxiway Edge Lighting System.

The Preventive Maintenance Inspection schedule establishes the minimum requirements. Inspection intervals should be increased if local conditions warrant.

2.6.1.2.1 OPERATION - PARALLEL EDGE LIGHTING SYSTEMS

THE PARALLER SYSTEM SHALL NOT BE USED FOR NEW INSTALLATION.
EXISTING PARALLER SYSTEMS MAY BE MAINTAINED.

Power for all edge lights is supplied from Mini Power Centre (panel LP2) located approximately at centre between runway thresholds.

Runway lights are grouped in four sections: two sections on each side of the runway with a split point at Mini Power Centre. Taxiway edge lights are grouped in a fifth section. Each section is served with a 3 wire cable and there are two circuit breakers assigned for it in the mini power centre. Every second edge light is connected to the same circuit. It is extremely important to remember that in the instance when the edge light is turned off there might be "live" wires in the underground splice box. Mini Power Centre main breaker must be locked in OFF position before proceeding with any work on the edge lights or wiring.

In normal operation circumstances the edge lights are controlled automatically and they can be turned on by a pilot. When a signal is received, contactor C1 (see standard drawing MTO-E72) will close contacts 1 and 2 and power will be supplied from panel LP1, located in the maintenance building, to energize 5kVA transformer and 600 V underground cable to Mini Power Centre. All edge lights are turned on simultaneously. They will turn off automatically after approximately 15 minutes. Automatic operation can be by-passed, for example for lighting maintenance inspection purposes, by the edge light selector switch or the runway approach selector switch in Lighting Control Panel.

2.6.1.2.2 OPERATION - SERIES EDGE LIGHTING SYSTEMS

ALL NEW INSTALLATIONS AND COMPLETE RENOVATION OF AIRPORT LIGHTING SYSTEMS SHALL BE DONE USING THE SERIES LIGHTING SYSTEM

Power for all edge lights is supplied from a constant current regulator located within the maintenance building.

It is extremely important to recognize that when an edge light is not lit, there could be "live" wires in the underground isolating transformer buried just behind the edge light. The current regulator must be turned off and its supply circuit breaker in panel LP-1 locked off before commencing any work on the edge lights or wiring.

2.6.1.3 INSPECTIONS

2.6.1.3.1 Daily Inspections

1) Perform a visual inspection of the system preferably before sunrise or after sunset each working day. This check should consist of a driving patrol to visually check for dimly burning lamps, burned-out lamps, and for fixtures out of alignment. The locations of such fixtures should be recorded and corrections should be made as soon as possible. Replace dimly burning lamps and burned-out lamps when system is deactivated.

   Record which lamps have been changed.

2) Replace broken lenses with proper type and colour. Ensure lenses are properly orientated to the runway according to marking on top of lenses. Split lenses or filters should be installed, where required.

3) Check all control equipment. Remote switches, photocell, and/or radio controls should be operated through all positions to ensure proper function.

2.6.1.3.2 Monthly Inspections

1) During the growing season, check for grass, dirt, and weeds around the lighting units. The necessity of keeping the vegetation well cut around all lighting units should be readily evident. Grass in the vicinity of lights greatly reduces the effectiveness of the units.

2) Check each lens for cleanliness. Dirty lenses decrease the light output and efficiency; they look unkept, and affect the safety of the airport operation. Clean and polish reflectors and colour screens. Be sure to reassemble so that the colour screens are on the correct side, and the lenses properly aligned.

3) Check the ground elevation around lighting fixtures. The stakes should be at the ground elevation. Grade around fixture, where necessary to maintain this fixture/grade relationship. Also, maintain the elevation of all lights the same height above the runway/taxiway pavement edge. This height should not exceed 350 mm.

2.6.1.3.3 Annual Inspections

1) Check light bases and housings for evidence of moisture penetration and seepage. Check gaskets, seals, and clamps for deterioration and damage.

2) Check each light fixture carefully for peeling paint, cracking, corrosion, or shorts.

3) Check lamp sockets for cleanliness and for proper electrical connections.

4) Clean dust and insects from light fixtures.

5) Clean the contacts and assure that lamp fits firmly into receptacle.

6) Check condition of all connections.

7) Check that the lighting circuit is not improperly grounded.

8) Check the condition of the cable connectors. Moisture will enter around the ends of cable connectors if not of proper size and will also enter between connections if not properly mated. Connectors should be of the proper size for cables used and connections should be taped with two layers of plastic tape.

9) Check runway cable insulation.

10) Check all gaskets on a leaky unit and replace with new rubber/neoprene gaskets.

11) Observe brightness of lights at night. For each light which seems to be dimmed, check the lamp size and measure voltage at the lamp socket. Repair as required.

2.6.1.3.4 Unscheduled Maintenance

1) Snow Removal

Remove snow from around the lighting fixtures as soon as possible after a snowfall to prevent obscuring light fixtures. If heavy snowfalls are predicted, red flags or sticks of sufficient length should be planted adjacent to the edge lights to mark their location. The flags will facilitate in removing snow more quickly and will lessen the damage to fixtures by snow removal equipment.

2) Light Cleaning

Lights should be cleaned before their intensity decreases noticeably. The cleaning schedule will vary at each location dependent upon such factors as environment, geographical location, and the types of lighting units. Each light should be cleaned thoroughly at least once a year.

2.6.1.4 MAINTENANCE PROCEDURES

The following paragraphs discuss general maintenance procedures for the Edge Lighting System.

2.6.1.4.1 Lamp Replacement

With the lights operating, make a visual check to positively identify the lighting unit or units that are out.

CAUTION

De-energize the circuit and lock out the circuit so that circuit cannot be energized before starting work on the lights.

1) Turn off lights and lock out circuits.

2) With the replacement lamp at hand, open up the fixture and remove old lamp.

   i) Examine the old lamp to make certain that the lamp is at fault.

   ii) Compare the identification markings on the replacement lamp with those on the old lamp to assure proper replacement.

   iii) Inspect the lamp socket, the connections, and the wire and installation.

   iv) Check the light unit or the base for evidence of water or moisture problems and remove any water present.

   v) Install new lamps and adjust level of light fixture, when necessary.

3) Check filters, when applicable, for cracks and positioning, and replace or adjust, as required.

4) Clean all reflectors, globes, filters, and covers, as required. When hood or shield is used, check adjustment.

5) When closing the light, make certain the gaskets and other weatherproofing are properly sealed. Tighten all screws, clamps, and fasteners.

6) For the frangible couplings used, check for cracks.

7) Check the horizontal and vertical alignment of the lights for proper adjustment.

8) When all outages have been corrected, energize the circuit and make a visual check of the repaired units for operation and beam operation and record the repairs.

2.6.1.4.2 Cleaning Procedures

Glassware, reflectors, lenses, filters, lamps and all optical surfaces should be washed. Washing may increase the intensity as much as 15 percent as opposed to wiping with a dry cloth which also may seriously scratch reflective surfaces.

Use a soft cloth and cleaning agents that do not require rinsing and do not leave a residue on reflectors or optical surfaces that cannot be removed.

2.6.1.4.3 Protection From and Removal of Water

Water is the most common cause of problems in airfield lighting fixtures. In bases, water may cause grounding of the lamp or circuit, or may submerge optical components reducing useful light intensity, causing corrosion and deterioration, forming condensation on optical surfaces, and accelerate the accumulation of dirt on surfaces. Preventing water from entering bases is very difficult. The alternate heating and cooling of the lights can create a strong "breathing" effect, especially when the base is located in saturated ground. The water may also enter through conduits, along the conductor of the cable, through gaskets and seals, through damaged glassware, or through fine holes in the walls of the bases.

The immediate problem of water in lights and bases is removal and prevention of re-entry. In the light bases, the accumulated water can usually be drained out or soaked up with rags. Drain holes should be drilled, if required, or cleaned out, if already present. Gaskets, seals, and clamps that may admit water, should be checked. Chipped, cracked, or broken glassware should be replaced.

Operation of lights should dry up any condensation. Careful sealing of entrance hubs around the cable can stop this water source.

2.6.1.4.4 Light Unit Repair and Replacement

Damaged light units should be repaired or replaced immediately. A careful check should be made following damage of this type because the attaching cable may also be damaged.

CAUTION

De-energize and lock out the circuit so that circuit cannot be energized before starting work on the light.

When possible, the entire damaged unit should be replaced. Simple repairs that can be accomplished are as follows :

1) Remove the broken frangible coupling from the base cover.

2) Connect the new light to the secondary connector.

3) Install new light on a new frangible coupling.

4) Check for correct alignment.

5) Inspect and align, as required.

2.6.1.4.5 Frangible Coupling Replacement

Frangible couplings are used primarily to reduce damage to aircraft in case of a strike. They provide an intentional weak point and aid in preventing damage to other components. An open end wrench, pipe wrench, cold chisel, and punch hammer, are usually sufficient to remove and install frangible couplings.

1) Remove damaged coupling.

2) Use anti-seize compound on new coupling threads.

3) Tighten by hand and use wrench to snug down.

2.6.1.4.6 Scheduled Painting

1) Clean and remove rust, corrosion, dirt, and loose paint.

2) Apply suitable primer coat.

3) Apply finish.

2.6.1.5 TROUBLESHOOTING CHART FOR ELEVATED LIGHT UNITS

SYMPTOM	PROBABLE CAUSE	TEST AND REMEDY
1. Lamp does not energize	Defective lamp	Replace lamp
	Defective secondary cable.	Check cable and connectors for shorts, continuity and grounds. Repair
	Defective isolating transformer	Replace transformer
	Loose connections at lamp secondary cord, isolating transformer or in underground splice box.	Tighten
	Moisture present in fixture. Damaged part.	Open up and dry. Inspect lens for cracks. Replace lamp.
	Moisture present in secondary cable connector	Open up and dry.
2. Section of runway or taxiway does not energize. (Parallel connected system only)	Breaker tripped	Reset breaker
	Loose connection of wire at breaker or at transformer	Tighten.
	Ground fault in the circuit.	Disconnect light fixtures by opening secondary connectors. Inspect secondary cables. Check insulation of wires. Locate and replace faulty light or cable. Locate faulty splice box and reseal.
	Faulty contactor	Repair or replace contactor
3. Runway edge lighting does not energize	Regulator fault Series loop open circuit	Investigate regulator and reset. Locate open circuit and repair

2.6.2 WIND DIRECTION INDICATOR ASSEMBLY

2.6.2.1 GENERAL

This section contains the Preventive Maintenance Inspection schedule and maintenance procedures for the Wind Direction Indicator Assembly.

The Preventive Maintenance Inspection schedule establishes the minimum inspection requirements. The inspection interval should be increased if local conditions warrant.

2.6.2.2 OPERATION

The wind direction indicator is used at the airport to provide visual surface wind direction and give an indication of wind velocity. Fabric sock is attached to a cage which shall be able to rotate freely about pole for indication of true wind direction in any type of temperature condition ($\pm$ 55^{O} C) and with wind velocity in excess of 4 km/hr.

There is a light source mounted inside or at the top of the wind direction indicator which illuminates the fabric sock and is usually used during periods of darkness and low visibility conditions. The light is operated automatically by pilots or manually with the edge light selector switch. On parallel connected runways, the wind direction indicator can also be energized manually using the runway lighting selector switch located in the Lighting Control Panel. On parallel connected runways, the power for the wind direction indicator is supplied from Mini Power Centre. On series connected runways, the power for the wind direction indicator is supplied from the constant current regulator. In either case, its light will turn on and off simultaneously with runway edge lights.

2.6.2.3 INSPECTIONS

2.6.2.3.1 Daily Inspection

1) Check light for operation. Ensure both lamps are lit.
2) Check condition of windsock fabric.
3) Remove debris from inside of windsock if required.

2.6.2.3.2 Monthly Inspection

1) Check the cone assembly to see that it swings freely. If the wind is not sufficient, swing the cone down to the servicing position and manually check the freedom of movement. If the cone assembly does not move freely, the bearings are probably bad and need replacing.

2) Check the condition of the Wind Direction Indicator fabric. The fabric of the cone should be carefully examined at close range. The fabric should be

completely replaced when it is badly worn, rotted, or when it has become badly soiled.

2.6.2.3.3 Annual Inspection

1) Check the Wind Direction Indicator Assemblies to ensure that the bearings do not bind or hamper the swing of the wind direction indicator throughout the required 360^{O} travel.

2) Inspect bearing weather shield. Replace shield if it is cracked, deformed or missing.

3) Take an insulation reading of the underground feeder cable. Record the reading on the Insulation Resistance Test form and compare with previous reading. When the readings fall below 25,000 ohms, the cables must be repaired or replaced.

4) Check level of the drop pole and adjust as required.

5) Check the assembly base securing bolts for tightness. Tighten, as required.

6) Check the wiring at the hinged and at the swivel area. If frayed, repair or replace wiring. Remove brushes, realign slipper rings if required.

7) Check the ground system for loose connections.

8) Test ground resistance using Insulation Resistance Tester. The resistance-to-ground must be 10 ohms or less. Record the measurement on Insulation Resistance Reading test form. Compare the results with the previous reading. If the resistance is out of tolerance, correct the grounding problem.

9) Check all parts for corrosion, cracks, etc. Replace as required.

10) Check the condition of the paint on the Wind Direction Indicator structure. Touch up or repaint, if necessary.

11) Check input voltage. Adjust transformer taps as required.

12) Clean the lamps.

2.6.2.4 MAINTENANCE PROCEDURES

CAUTION

De-energize the circuit and lock out the circuit so that the circuit cannot be energized before proceeding with any work on the wind direction indicator.

2.6.2.4.1 Wind Sock Fabric

In the event that the Wind Direction Indicator fabric is worn, rotted, or badly soiled, lower the Wind Direction Indicator Assembly for servicing. Replace the Wind Direction Indicator fabric with a new Wind Direction Indicator. Return to upright position.

Replace broken or missing sock ties which secure sock to cage.

2.6.2.4.2 Rotary Swivel

In the event the Wind Direction Indicator does not rotate properly, lower the Wind Cone Assembly for servicing. Check the ball bearings for the Wind Direction Indicator Assembly. Replace bearings, as required. Return to upright position.

2.6.2.4.3 Wind Direction Indicator Lamp

In the event the lamp burns dimly, check the input voltage. Ensure that it is 120 volts ±6 volts AC for parallel connected wind direction indicators and 15 volts $\pm$ 2 volts AC for series wind direction indicators. If the lamps burn out too frequently, check for power line disturbances or excess voltage or contamination on lamp.

Do not touch the halogen bulbs of series wind direction indicators with bare hands or skin.

Wear cotton gloves when handling the lamps. Touching the quartz bulb with bare fingers may seriously shorten the lamp life. If the quartz bulb has been touched, wipe it carefully with lens cleaning tissue or similar material moistened with isopropyl alcohol.

2.6.2.5 TROUBLESHOOTING CHART FOR WIND DIRECTION INDICATOR

SYMPTOM	PROBABLE CAUSE	TEST AND REMEDY
1. Lamp does not energize	Defective lamp.	Replace lamp.
	Loose connection of wires at breaker, hinged area or rotary swivel.	Tighten wires Realign slipper rings and brush gear
	Tripped breaker.	Reset breaker
	Ground fault in the circuit	Disconnect underground cable at wind direction indicator and check insulation of cable.
	(Parallel system)	Locate fault in cable and repair. Check for presence of moisture in fixture or swivel.
	Loose connection at isolating transformer	Check and tighten connectors
	Defective isolating transformer	Replace transformer
2. Wind sock does not rotate	Stiff Swivel	Check bearing and replace as required.
	Pole not level	Adjust level

2.6.3 AERODROME BEACON

2.6.3.1 GENERAL

This section contains the Preventive Maintenance Inspection schedule and maintenance procedures for the Aerodrome Beacon.

The Preventive Maintenance Inspection schedule establishes the minimum requirements. The inspections should be increased if local conditions warrant.

2.6.3.2 OPERATION

There are two power circuits provided for the aerodrome beacon. One supplies power to the beacon heater. The heater is controlled by a built-in thermostat. Its function is to warm the gear box lubricant. This facilitates rotation of the beacon when the temperature drops below $+10^{O}C$.

Second circuit supplies power to two beacon lamps and a gear motor. Both lamps must operate when beacon is energized. The beacon shall rotate clockwise with an approximate speed of 12 RPM. The power is turned on and off automatically by a pilot or manually with the edge light selector switch, or the runway approach selector switch, located at the lighting control panel. The beacon switches on and off simultaneously with runway edge lights. It is extremely important to turn off and lock out both circuit breakers at Panel LP1 supplying power to the beacon, so that circuits cannot be energized before starting any work on the beacon.

2.6.3.3 INSPECTIONS

2.6.3.3.1 Daily Inspections

1) Check the operation of beacon lights. Replace burned out lamps immediately.

2) Count the RPM of beacon; should be 12±1 RPM. (You should see 24 light flashings in one minute).

2.6.3.3.2 Annual Inspections

1) Check the condition of the slip rings and brushes. Realign if required

2) The beacon may be equipped with a torque limiting clutch designed to reduce the force against the motor in severe wind loading conditions. As a result, the clutch may need adjustment periodically to insure its proper performance.

   Test the clutch torque. Adjust to factory preset value.

3) Remove the old grease from the gears by washing with approved cleaner if needed.

   CAUTION

   The use of an excessive amount of grease will result in its dropping down upon the slip rings and causing poor contact and arcing.

Gears should be greased with a high quality, low temperature grease to prevent gear wear.

WARNING

GEAR LUBRICATION SHOULD BE ACCOMPLISHED WHILE THE BEACON IS NOT OPERATING. ROTATING GEARS CAN SERIOUSLY INJURE HANDS CAUGHT IN THE MERGING TEETH.

5) Inspect electrical motor.

6) Verify operation of heater and thermostat. Apply ice cubes at thermostat to activate the heater.

7) Check the level of the beacon by placing a level on the top of the beacon. Remove all paint or other material to assure a true level. Loosen hold-down bolts and insert or remove spacers as required for proper level. Check the level of the beacon in four directions. Be sure to tighten down the base.

8) Beacon Elevation

Check the beacon light to determine if the beam elevation is 5^{O} above horizontal. Then check the adjustment of the unit place, the flat edge of the protractor level against the back of each beacon head assembly.

9) Check the input voltage at beacon lamp terminals and record the reading. The measurement should be made with all field equipment energized. The reading should be within 5% of the rated lamp voltage.

10) Check wire connections.

11) Clean and polish all glassware, both inside and outside, using a type of cleaner which does not scratch the lens.

12) Check the assembly base and mounting platform, securing bolts for tightness. Tighten as required.

13) Check parts and mounting platform for corrosion, cracks, etc. Replace as required.

13) Check the condition of the paint on the mounting platform and beacon assembly. Touch up or repaint, if necessary.

2.6.3.4 MAINTENANCE PROCEDURES

2.6.3.4.1 Lamp Replacement

Open the hinged lens cover. Remove the lamp from the socket and then carefully plug in the new lamp. Clean lens and close lens cover. Check beacon operation after the lamp replacement.

CAUTION

Be sure the beacon has been turned off for one-half hour before opening lens cover or touching lamps, as the temperature of the lens could be as high as 190^{O} C.

2.6.3.4.2 Cleaning

1) Lenses

Clean lenses with glass cleaner and soft cloths. Wipe dry with clean soft cloth.

2) Lamp Housing Assemblies

Remove dust and dirt from the lamp housing assemblies using a soft cloth, or a sponge with soap and water.

3) Vents

Make certain that all vents in the lamp housing assemblies and motor box are clean and not plugged with dust and dirt. This is necessary to ensure adequate cooling of the quartz lamps and motor.

2.6.3.4.3 Slip Rings and Brushes

Clean the slip rings and brushes with a cloth moistened with approved cleaner. Never use emery cloth. If sparking or pitting occurs, rings may be smoothed with 420 sandpaper. Avoid sanding if possible. Sanding produces a raw copper surface which shortens brush life. Replace brushes showing excessive wear. It is recommended that all three brushes be replaced at the same time to provide even wear.

WARNING

If brushes are worn down to brush bracket, the bracket may damage the slip rings. Replace brushes worn to 30% of the usable length.

2.6.3.5 TROUBLESHOOTING CHART FOR AERODROME BEACON

SYMPTOM	PROBABLE CAUSE	TEST AND REMEDY
1. Short lamp life	Loose connections.	Tighten
	Excess vibration	Replace bearing or shaft
	Brush pressure is too little causing arcing.	Adjust brush bracket or replace brush assembly
	Bad socket	Replace socket
	High voltage (>126 VAC or voltage spike	Check input voltage
2. Lamp will not light	Defective lamp	Replace lamp
	Blown fuse or tripped breaker	Replace fuse, reset breaker
	Brush assembly	Replace or repair brush assembly
	Loose or broken wire	Replace feed through or socket
3. Poor beacon visibility	Lamp filament not vertical	Align socket so lamp filament is vertical
4. Motor will not run	Blown fuse	Replace fuse F1
	Defective relay	Replace relay
	Defective motor	Replace motor
	Shaft bearing seized	Replace defective bearing
	Loose or broken wire	Repair or replace
	Clutch out of adjustment	Check and adjust

SYMPTOM	PROBABLE CAUSE	TEST AND REMEDY
5. Motor will not turn during cold weather	Inoperable heater	Check heater operation
6. Heater will not operate	Blown fuse or tripped breaker	Replace fuse, reset breaker
	Defective thermostat	Replace thermostat
	Defective heater	Replace heater
	Loose or broken wire	Repair or replace

2.6.4 Approach Slope Indicators (ASI)

2.6.4.1 GENERAL

This section contains the Preventive Maintenance Inspection schedule and maintenance procedures for the ASI units.

The Preventive Maintenance Inspection schedule establishes the minimum requirements. The inspections should be increased if local conditions warrant.

2.6.4.2 OPERATION

The ASI system is a very sensitive aviation instrumentation. The light units indicate to pilots if they approach the airport at correct height. Precise setting and maintaining reliable operation at all times is essential.

The power is supplied from the airfield lighting panel LP1 through current regulator and underground cables. There are special transformers at ASI light unit locations installed underground in Electrical Handholes. The transformers are connected together in a loop. Each transformer supplies one lamp in a lighting unit. The supply cable and transformers are considered as high voltage circuit and it is dangerous to touch them while energized. Also, the voltage on the transformer secondary sides and in light units might exceed 120 volts. The power supply to regulator circuit must be turned off and the circuit must be locked out so that the circuit cannot be energized before starting any work on underground cabling, transformers or light units.

ASI units can be activated automatically by pilots or manually by the selector switch in the Lighting Control Panel. It is important to remember that a pilot may change his ASI selection or override manual setting of the selector switch instantly. The units will turn off automatically together with runway edge lights. When in "ARCAL", the lights will adjust their intensity as requested by a pilot who clicks his microphone 3, 5 or 7 times to increase the brightness.

The ASI lamps are of a special rating. They can be replaced only with identical units. It is important to replace any burned out lamp immediately.

WARNING

There is a hot spot 300mm in front of the lenses at full brightness which will burn holes in clothing. Viewing lighting sources from close distance could damage eyes.

2.6.4.3 INSPECTION

2.6.4.3.1 Daily Inspections

1) Check to ensure that all lamps are lighted and illuminated evenly. Replace burned out lamps. Record which lamps have been changed. Clean dirty glassware as required.

2) Check for any apparent evidence of damage to units and cables.

3) During the winter season remove snow from the top and around all units so they can be seen from the ground or the air.

2.6.4.3.2 Monthly Inspections

1) Clean outer surface of protective glass.

2) Make sure the mounting is rigid. Tighten any loose hardware; nuts, screws, etc. Realign unit if hardware has loosened.

3) Check elevation angle of units. Use aiming device and bubble level. Reset any units out of alignment. (Inspection of elevation may be done more or less frequently depending on local conditions and may be performed by approved personnel only.)

4) During the growing season, check for grass, dirt and weeds around the light units. The necessity of keeping the vegetation well cut around all lighting units should be readily evident.

2.6.4.3.3 Annual Inspections

1) Inspect housing and closure system, lamps, electrical connections, reflectors, filters and protective glass for damage, breakage or warpage. Repair or replace any damaged parts.

2) Check the condition of the paint. Touch up or repaint if necessary.

3) Clean interior. Remove any foreign matter. Clean both sides of protective glass, colour filters, lenses and reflectors. Use soft cotton cloth moistened with approved glass cleaner.

4) Make sure mounting is rigid.

5) Check longitudinal, horizontal and elevation angle setting of units. Use aiming device and bubble level. Reset any unit out of alignment.

6) Arrange for flight check of the system if possible. Verify unit aimings as required.

7) Check the condition of the secondary cable and connectors. Open Electrical Handholes and visually check the condition of connectors and isolating transformers.

8) Measure and record primary cable insulation. Compare to previous measurement records. If measurement is low disconnect all isolating transformers and check insulation level of each transformer separately. Replace faulty transformers or repair damaged cable as required.

9) Check the ground system for loose connection. Test ground resistance using Grounding Resistance Tester. Record the measurement. If the resistance is above 10 ohms correct grounding problem immediately.

10) Check all control equipment for proper operation. Repair or replace any damaged components.

CAUTION

Wear cotton gloves when handling the lamps. Touching the quartz bulb with bare fingers may seriously shorten the lamp life. If the quartz bulb has been touched, wipe it carefully with lens cleaning tissue or similar material moistened with isopropyl alcohol.

2.6.4.4 MAINTENANCE PROCEDURES

2.6.4.4.1 Lamp Replacement (ADB Alnaco Units)

De-energize circuit and lock it in OFF position. Remove the unit cover or access panels and remove the electrical slip-on fitting on burned-out lamp. Swing back the spring-loaded fork and remove lamp from the reflector. A new lamp can be installed by reversing this procedure. Ensure fork is properly seated and the lamp wires are still fastened to the terminal block.

Use 6.6A/200W halogen lamps as specified by the equipment manufacturer.

2.6.4.4.2 Objective Lens Replacement

The objective lenses are precisely positioned in the unit and are not field repairable since the optical centre of the lens must be realigned after replacement. Whenever an objective lens is damaged, the ASI light unit must be returned to the factory for repair and adjustment.

2.6.4.4.3 Positioning of Filters

The filters must be perfectly clean. Use a soft cotton cloth moistened with alcohol to clean filters, and wear cotton gloves when handling filters. To position filters in unit, loosen the spring-loaded holder and place filter in the holder with the lower edge (dull edge) down. Make sure each filter is returned to the filter holder from which it was removed.

2.6.4.4.4 Elevation Angle Checking

Remove unit cover or sighting device access cover. Adjust aiming device setting (ADB Alnaco units) or use the correct preset sighting platforms (GEC units) as follows.

APAPI:	
UNIT #1 (Closer to Runway)	$3^{O}15'$
UNIT #2 (Further From Runway)	$2^{O}45'$
PAPI:	
UNIT #1 (closest to runway)	$3^{O}30'$
UNIT #2 (next furthest from runway)	$3^{O}10'$
UNIT #3 (next furthest from runway)	$2^{O}50'$
UNIT #4 (furthest from runway)	$2^{O}30'$

Place aiming device on unit. Place an accurate bubble level - supplied with the unit. If bubble level shows that the platform is not level, to within ±3 divisions, adjust the level.

2.6.4.4.5 Elevation Setting (ADB Alnaco Unit)

Fine elevation adjustment will require the following steps using the differential (Item 7, Figure 2.1):

1) Adjust aiming device to desired angle.

   Place aiming device on unit so that it rests on the screws of reference adjusting blocks A, B, C and D.

2) Make sure the locking screw (Item 8, Figure 2.1) for differential on right front leg F is tightened. The locking screws for the differentials on the other legs have to remain loose.

3) See Figure 2.2, Step 2. Place level on the aiming device arm resting on reference blocks A and B. Level by turning differential on left front leg E in the proper direction. Tighten locking screw on the differential on leg E when levelled.

4) See Figure 2.2, Step 3. Place bubble level on bar of aiming device resting on reference blocks B and C. Proceed with the levelling procedure by adjusting the differential on rear legs G and H, turning both differentials in the same direction with equal amplitude. Tighten locking screw on differential on leg G when levelling completed.

5) See Figure 2.2, Step 4. Place level on movable arm resting on reference blocks C and D. Level by turning ring of left rear leg H in the appropriate direction. Tighten locking screw on differential on leg H when levelling is completed.

After these operations are completed, the unit will be accurately set both in azimuth and elevation.

2.6.4.4.6 APAPI Frost Control

APAPI units are energized 3-times per night at 22:00, 02:00 and 06:00 for 20 minutes at 100% intensity when temperature is below 0^{o} Celsius, in order to clear lamps from frost accumulating.

If unit fails to turn on, check the thermostat settings.

If problem continues, replace thermostat.

Reset new thermostat to correct settings and re-test.

2.6.4.5 TROUBLESHOOTING CHART FOR ASI SYSTEM

SYMPTOM	PROBABLE CAUSE	TEST AND REMEDY
1. Entire system inoperative.	No input power.	Check input connections and power source.
	Regulator failure.	Check circuit breakers and fuses and replace if necessary.
	Transformer or underground cable failure.	Check output relays.
		Test transformers and cables for continuity and ground fault. Replace transformer and repair cable as required.
2. No intensity changes	Fuse blown.	Check fuse and replace if blown.
	Regulator inoperative	Check regulator operation and repair.
	ARCAL inoperative	Check ARCAL operation and repair
3. Lamps or lamp inoperative	Lamp burned out.	Replace burned out lamp.
	Transformer shorted or open	Check transformer for continuity and shorts. Replace if necessary.
		Check secondary cord and connectors. Replace if necessary.
4. Lamps burn out frequently	Voltage too high	Check the input current level. The current should not be higher than 6.6A at 100% brightness. Make adjustment at the regulator
		Install lighting surge protector equal to Telecommunications, Ins., NO. 317C, at input terminal of adapter unit and to ground.

2.6.5 CONSTANT CURRENT REGULATOR

2.6.5.1 GENERAL

This section contains the Preventive Maintenance Inspection schedule and maintenance procedures for the constant current regulator.

The Preventive Maintenance Inspection schedule establishes the minimum requirements. Inspection/test intervals should be increased if local conditions warrant.

2.6.5.2 OPERATION

Constant current regulator supplies power for a series lighting circuit.

The circuit elements of series circuits are connected in a string with the same current flowing in each element. The circuit is one continuous loop starting and ending at the regulator. If a fixed input voltage were connected to the load, the current in the circuit would vary with the connected load; however, constant-current regulators will maintain a constant current independent of the load on the circuit. Thus the same current will flow in a long circuit as in a shorter circuit and will remain the same even if some of the lamps fail.

The loads connected in series are supplied via special lamp transformers to prevent failure of one lamp interrupting the whole circuit.

The lamp intensity is adjusted by changing current value flowing through a series circuit. Constant-current regulator for airport lighting system utilizes thyristor elements. The current in the series circuit is regulated by changing the firing angle of thyristors in anti-parallel connection (phase angle control).

When the selector switch on the lighting control panel is positioned in "ARCAL", the regulator will adjust its intensity as requested by a pilot who clicks his microphone 3, 5 or 7 times to increase the brightness.

The regulator contains certain self protective devices, relays and fuses, and it may lock-out automatically (for example under overload condition). Also, there are local control switches installed in the unit which allow the bypass of all automatic functions.

2.6.5.3 INSPECTIONS

2.6.5.3.1 Daily Inspections

The equipment does not require special maintenance. However, it is recommended that the regulator meters be periodically observed for abnormal indication.

Check the output current of regulator to ensure that the maximum current does not exceed 6.6 Amperes as excessive current reduces the lamp life of the fixtures.

Make certain that the regulator is in "remote" control before leaving the assembly area.

2.6.5.3.2 Annual Inspections

Yearly visual inspection of the interior is recommended. During this inspection any mechanical damage should be repaired. Excessive dust should be removed. The contactor contacts and relay contacts should be examined. Inspections shall include the following tasks.

1) Check regulators input voltage and input current. Record voltage - must be ±5% of design voltage.

2) Check load on regulator at full brightness setting. Record the value and compare to previous measurement records.

3) Check output current on the brightness steps. Change taps to adjust secondary current.

4) Check for burned relay contacts, frayed or burned insulation and loose connection. Replace or clean contacts as necessary. Tighten loose connection.

5) Check performance of over-voltage circuit.

   Make an over-voltage protection test. If the circuit does not operate satisfactorily re-adjust the circuit.

6) Check performance of over-current circuit.

   Make an over-current protection test. Re-adjust circuit if necessary.

7) Check switching action of remote/local selector switch.

8) Check for rust spots on equipment. Clean and repaint as necessary.

9) Check circuits for continuity and insulation resistance.

10) Record the hour-meter reading.

2.6.5.4 MAINTENANCE PROCEDURES

Normally, if faults occur within the constant current regulator (CCR), the complete CCR should be replaced and repair carried out in the manufacturer's facilities.

Only trained technicians may replace components and modules.

All spare parts used must be tolerance-tested parts supplied by the manufacturer.

Tests and adjustments shall be performed in strict accordance with the manufacturer's instructions.

2.6.5.5 TROUBLESHOOTING CHART FOR CONSTANT CURRENT REGULATOR

SYMPTOM	PROBABLE CAUSE	TEST AND REMEDY
1. Regulator tripped overvoltage	Open field circuit.	Examine airfield lighting cables. overvoltage. Repair and replace as required.
	Overvoltage protection set to low	Adjust the setting
	Regular internal defect	Contact manufacturer
2. Regulator tripped on overcurrent	Overcurrent protection set to low	Adjust the setting
3. Regulator is energized and no output.	Input voltage to low.	Check input voltage. It should be 208V ± 10Volt. Notify power company or adjust MTO generators of to low.
	Control fuses blown	Check and replace blown fuses
	Regular internal defect	Contact manufacturer
4. Slave light fails to operate	No input power voltage	Check breakers at airfield lighting and at regulator. Reset breakers if required.
	Regulator failed to operate	Check control fuses and replace if required.
	Regulator circuit selector switch does not operate.	Check circuit selector switches Replace failed switches.
	Lamp failure.	Replace lamp.
	More than one ground fault in the circuit	Check and adjust output current
		Check cables and repair.

SYMPTOM	PROBABLE CAUSE	TEST AND REMEDY
4. Slave light fails to operate	Open field circuit	Check position of sector switches at airfield lighting control panel, ARCAL system and regulator. Change settings.
		Check operation of airfield lighting control panel and ARCAL system. Repair or replace if required.
		Examine airfield lighting cables and transformers. Repair or replace if required.
5. No brightness change night to day	Defective photocell	Check wiring and the photocell. Replace photocell as required.
	Control circuit lighting panel	Check operation of airfield lighting. Check control fuses and replace if required.
	Loose connections	Tighten all connections

2.6.6 Aircraft Radio Control Aerodrome Lighting (ARCAL SYSTEM)

2.6.6.1 GENERAL

This section contains the Preventive Maintenance Inspection schedule and maintenance procedure for the ARCAL Radio Controller.

The Preventive Maintenance Inspection schedule establishes the minimum inspection requirements. The inspection interval should be increased if local conditions warrant.

2.6.6.2 OPERATION

The ARCAL Unit is a completely self-contained system for controlling lighting functions on an airport from a remote radio transmitter. The transmitter is usually the communications transmitter in an aircraft.

The radio control has three output relays. The relays may be energized by keying the transmitter in specific sequences. If a pilot sets his communications transmitter on the frequency to which the ARCAL is tuned, he can energize these relays at will.

ARCAL relay contacts are used for the control of other power relays installed in the airfield lighting control panel.

The relay functions are programmed as follows for airports with parallel edge lighting as shown in Table 1

The relay functions are programmed as follows for airports with series edge lighting as shown in Table 2

Only one output relay may be closed at a time, but the status of the relays may be changed any time by subsequent pulses.

The built-in timer will hold the relay closed for 15 minutes and is reset for 15 minutes any time 3, 5 or 7 pulses are received within a 5 second time interval.

The radio control unit antenna is mounted on the airport building roof and connected to the unit with coaxial cable.

2.6.6.3 INSPECTIONS

2.6.6.3.1 Daily Inspections

The equipment does not require special maintenance. However it is recommended that the unit be periodically observed for abnormal indication.

2.6.6.3.2 Annual Inspections

Check the presence of primary line voltage, as measured between input terminals and neutral, is within the acceptable limits. Check to see that the power supply operation is proper.

Check mounting of antenna and antenna cable. Apply small amount of silicone grease around antenna cable connector. Check the assembly base securing bolts for tightness. Tighten as required. Check all parts for corrosion, cracks, etc. Replace as required.

Perform the following operation testing.

1) Complete all power and controls equipment installation. Position airfield lighting control panel selector switches in "AUTO".

2) Place the POWER switch to ON. Observe that the POWER indicator illuminates.

3) Set the TIMER switch to FAST. Wait 5 seconds.

4) Depress TEST pushbutton three times within 5 seconds; 3 pulse relay should close. Wait approximately 15 seconds; 3 pulse relay should open.

5) Depress TEST pushbutton five times within 5 seconds; 5 pulse relay should close. Wait approximately 15 seconds; 5 pulse relay should open.

6) Depress TEST pushbutton seven times within 5 seconds; 7 pulse relay should close. Wait approximately 15 seconds; 7 pulse relay should open.
Each time TEST pushbutton is depressed, carrier light should turn on.

7) Return Timer Test switch to NORMAL.

Set the portable transmitter to the radio control frequency. Key the microphone and observe that the CARRIER indicator illuminates each time the microphone is keyed.

8) For airports using parallel wired TYPE K edge lighting, verify the operation of the following field equipment under daylight conditions. Ensure all selector switches are positioned in "AUTO". See Table 1

For airports using parallel wired TYPE K edge lighting, verify the operation of the following field equipment under darkness or with photocell obscured, see Table 1

9) For airports using series connected edge lighting, verify the operation of the following field equipment under daylight conditions. Ensure all selector switches are positioned in "AUTO". See Table 2

For airports using series connected edge lighting, verify the operation of the airfield lighting equipment under darkness (or with photocell obscured): See Table 2

10) Check and adjust the sensitivity of ARCAL receiver as required.

2.6.6.4 MAINTENANCE PROCEDURES

Technician level personnel may maintain the radio controller. The receiver module, decoder module and relays are plug-in components, and it is recommended that repairs be made by substitution of spare modules and relays.
Adjustments shall be made in a strict accordance with the manufacturer's instructions.

SYMPTOM	POSSIBLE CAUSE	TEST AND REMEDY
1. Input voltage present but POWER indicator not illuminated	Open fuse	Replace fuse
	Faulty POWER switch	Replace switch
	Defect in power transformer, filter capacitor or power supply located on decoder module	Return decoder module for repair
	Indicator lamp failure	Replace the lamp
2. Carrier lamp does not illuminate when transmitter is keyed	Defective receiver module	Return receiver module for repair
	Defective antenna	Check coaxial cable and connections or replace antenna
	Defective lamp	Replace lamp
	Low sensitivity	Increase sensitivity
3. Relay indicators illuminate but equipment control does not operate	Check power to relay contacts	Repair power or relay
	Defective relay	Replace relay
	Indicator lamp failure	Replace the lamp
4. Relay indicators do not illuminate when transmitter is keyed or when TEST switch is pressed	Verify the remote switch connected is closed	Turn switch ON
	Defective decoder module	Return decoder module for repair
5. TIMER indicator does not illuminate when transmitter is keyed. LED indicator operates normally	Defective decoder module	Return decoder module for repair
6. Fails to turn off after 15minutes	Defective decoder module	Return decoder module for repair
7. One or more relay remain energized	Defective relay	Replace relay
	Defective decoder board	Replace or repair
8. One or more relay fail to energize.	Defective relay	Replace relay
	Defective decoder board	Check contacts on decoder board. Repair or replace board as required

2.6.7 APRON FLOODLIGHTING

2.6.7.1 General

This section contains the Preventive Maintenance Inspection schedule and Maintenance procedures for the Apron Floodlighting System.
This Preventive Maintenance Inspection schedule establishes the minimum requirements. Inspection intervals should be increased if warranted by local conditions.

2.6.7.2 Operation

All maintenance functions are performed at ground level. Each pole has one disconnecting and lowering device on each arm to enable servicing of the luminaire at ground level.

2.6.7.3 Inspections

2.6.7.3.1 Daily Inspections

1. Perform a visual inspection at sunset to make sure the light is in operation. If the light is off or if the bulb is dim, report to Remote Northern Transportation Office-Electrical Section, in Thunder Bay.

2.6.7.3.2 Annual Inspections

1. Check lens for cleanliness
2. Check for luminaire and lamp operation by overriding the photocell
3. Check the conditions of all connections and the luminaire ballast.

2.6.7.4 Maintenance Procedures

The following subsections provide a guide to general maintenance procedures for the Apron floodlighting system.

2.6.7.4.1 Lamp Replacement

Make sure the lamp is 400W, 120V Metal Halide (MH)

2.6.74.2 Cleaning Procedure

Lenses, reflectors and louvres shall be cleaned whenever the luminaire is lowered for service. Make sure all seals and gaskets are in good condition before closing the luminaire.

2.6.7.4.3 Painting

1. Clean and remove rust, corrosion and dirt.
2. Apply suitable primer coat.
3. Apply finish paint.

APAPI UNIT – LEG ASSEMBLY

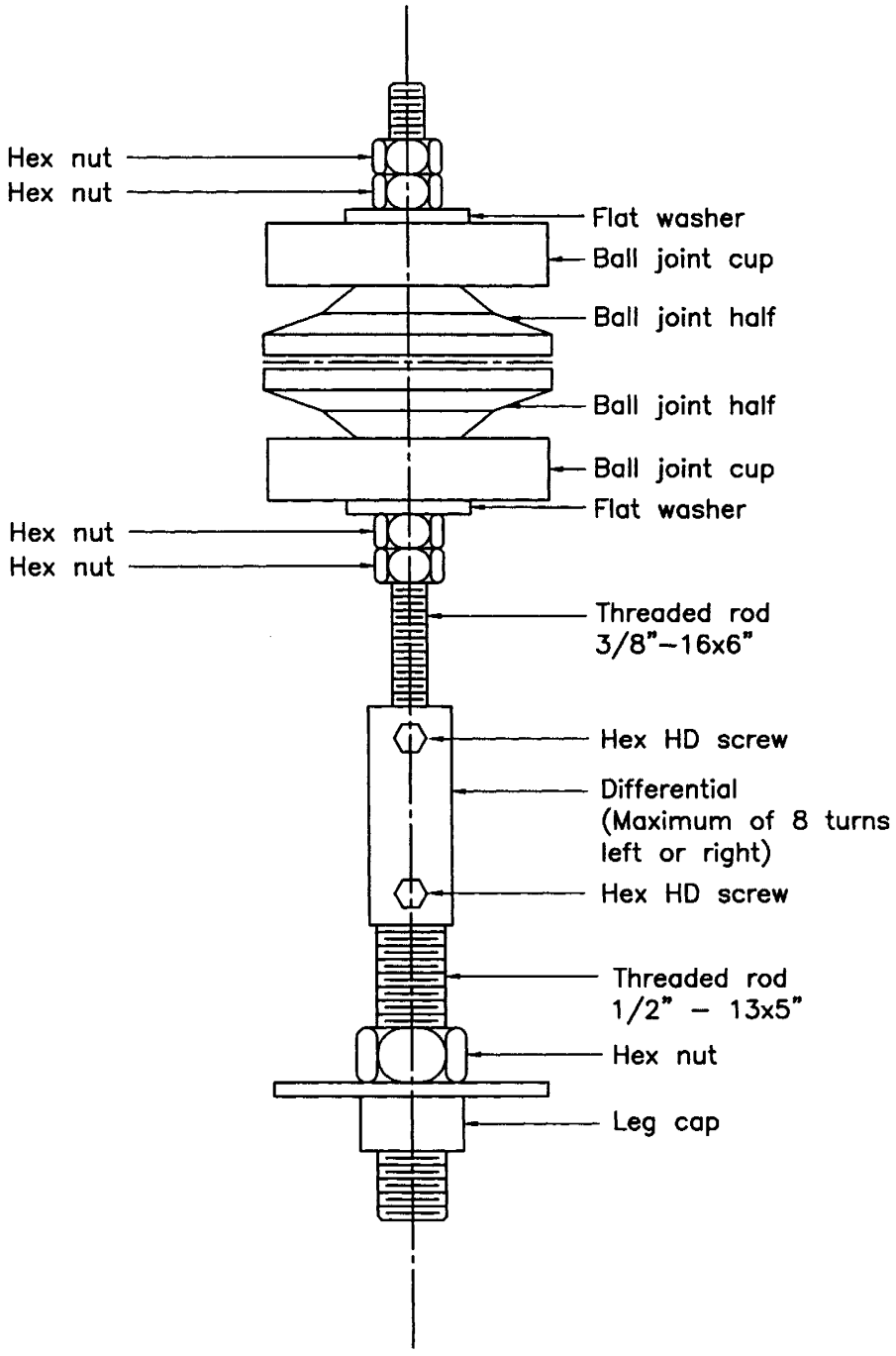
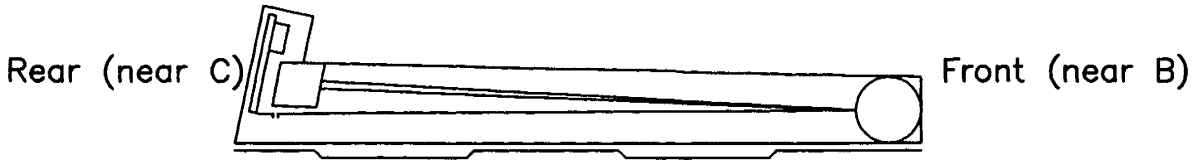
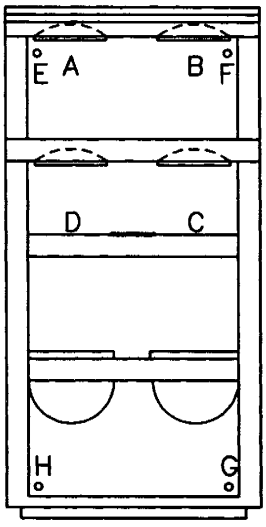


Figure 2.1



STEP 1

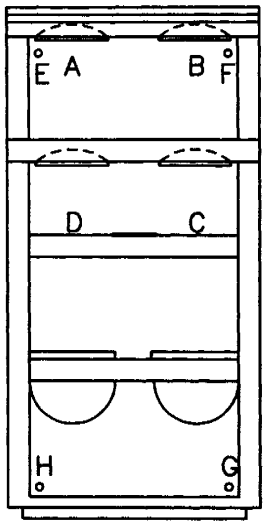


– Set and block Leg F

– Line of objective lenses at height 'D' as required

– Aiming at azimuth

STEP 2

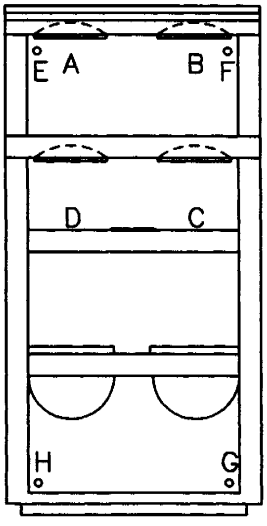


– Bubble level between AB

– Set and block Leg E

– Line of objective lenses levelled

STEP 3

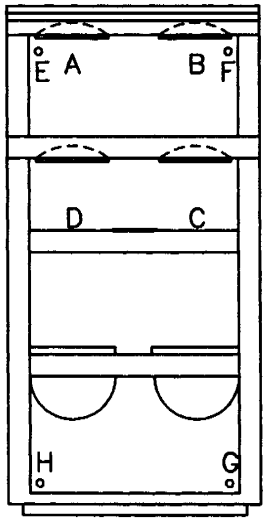


– Bubble level between BC

– Set and block Leg G

– Angle of sight as required

STEP 4



– Bubble level between DC

– Set and block Leg H

– Planing the bottom of the light unit

ADB ALNACO, ELEVATION SETTING SEQUENCE

Figure 2.2

APAPI UNIT ASSEMBLY

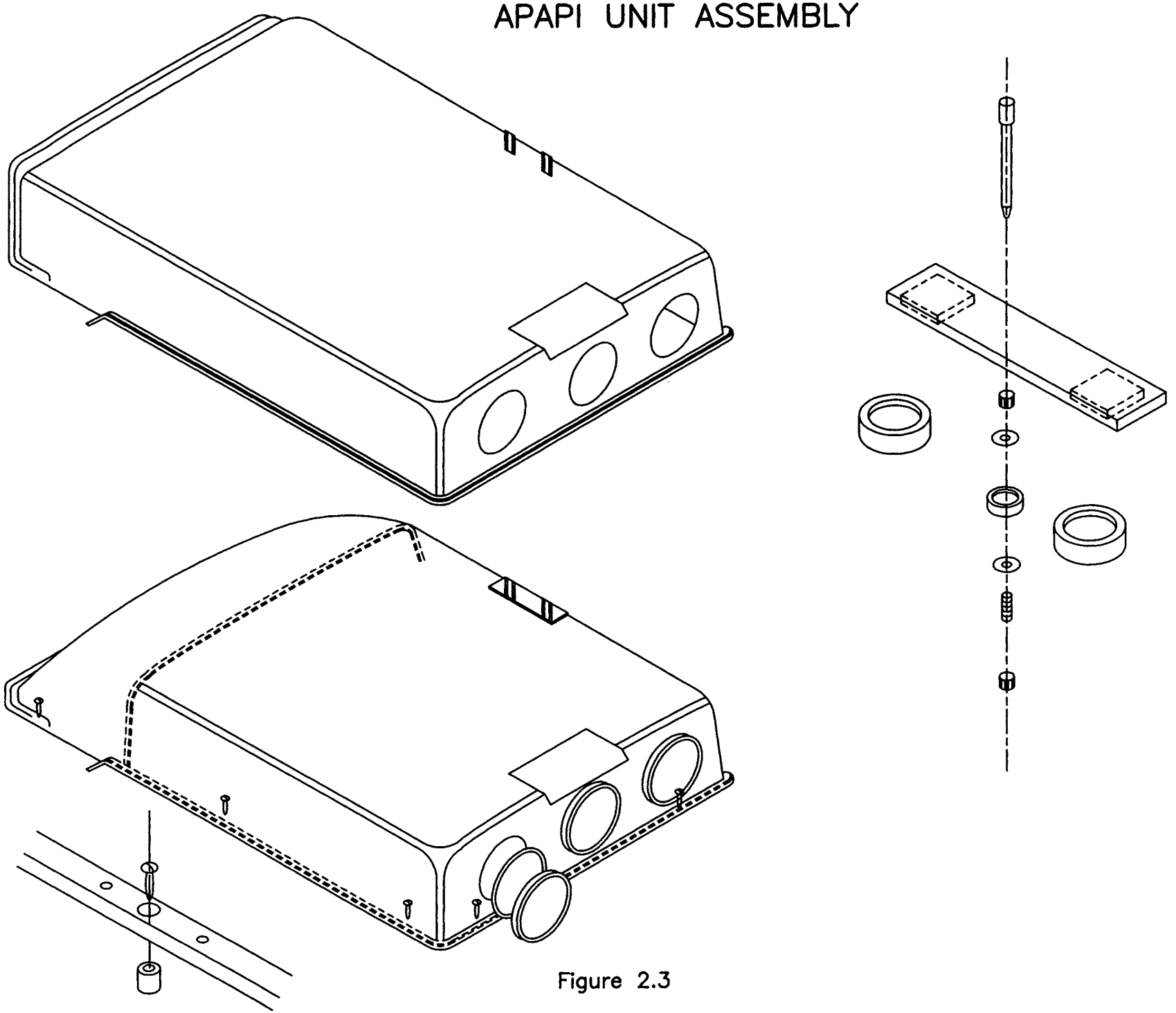
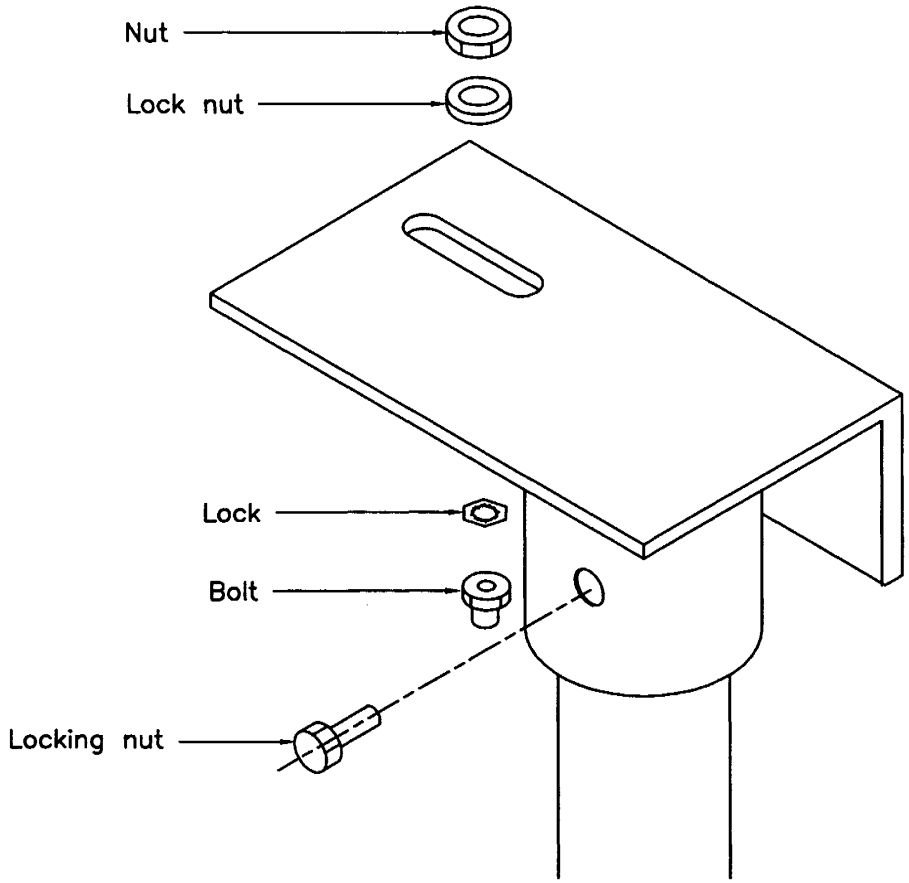
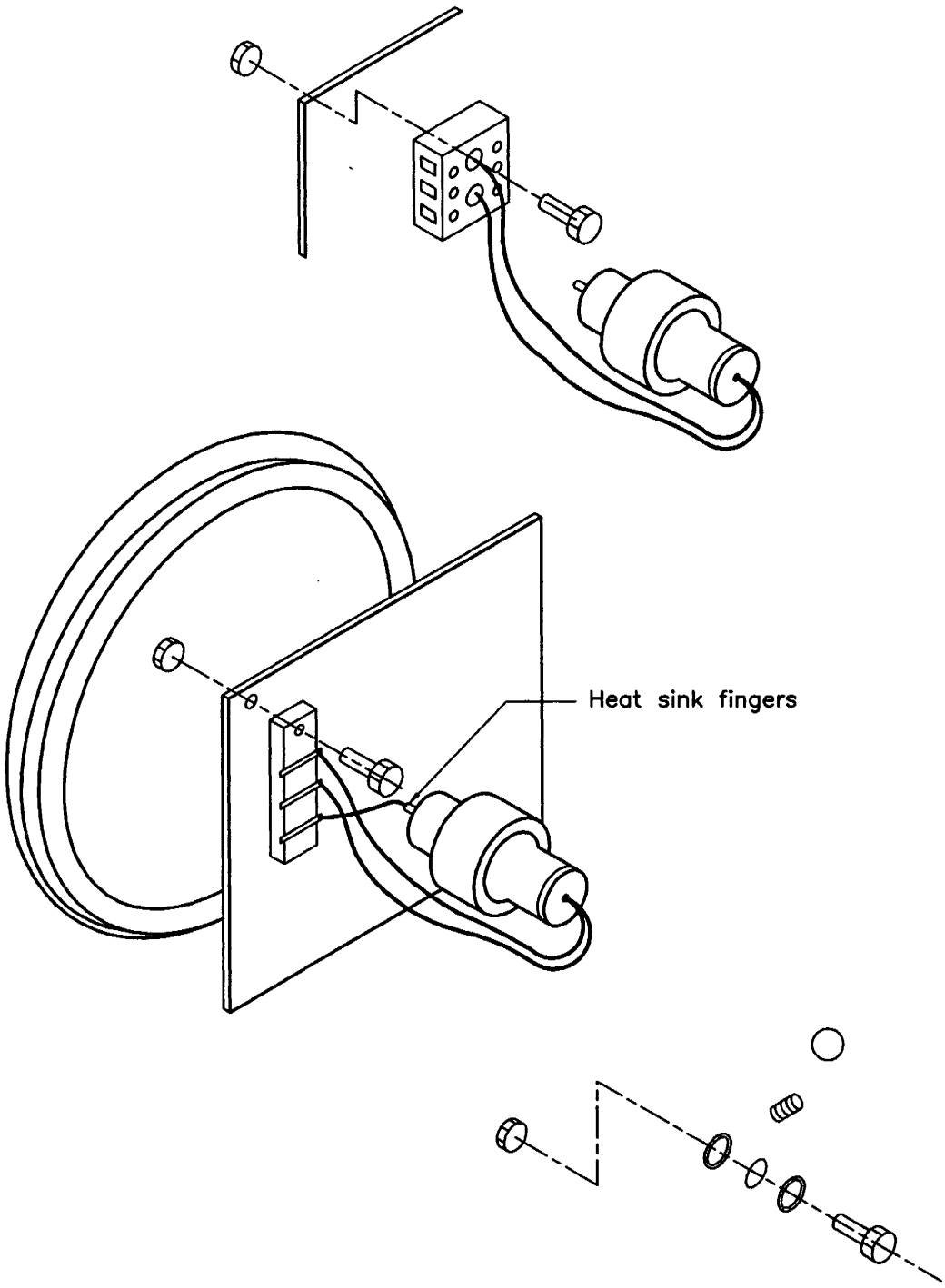


Figure 2.3



ZA 737/2/3 & ZA 757/2 REAR LEG ATTACHMENT ASSEMBLY

Figure 2.4



ZA 737/2/3 & ZA 757/2 REFLECTOR ASSEMBLY

Figure 2.5

CHAPTER 3

Material Specifications

TABLE OF CONTENTS

MATERIAL SPECIFICATION FOR ELECTRICAL SITE WORK AND MISCELLANEOUS MATERIALS

TABLE OF CONTENTS

600.01 SCOPE

This specification covers miscellaneous materials for electrical site work for Remote Airport Lighting Systems.

600.02 REFERENCES

This specification refers to the following standards, specifications or publications:

OPSS 1004	-	Aggregates -Miscellaneous
OPSS 1010	-	Aggregates - Granular A,B,M and select subgrade material
OPSS 1350	-	Concrete (Materials and Production)
OPSS 1440	-	Steel Reinforcement for concrete.
OPSS 1506	-	Timber posts and blocks
ANSI/ASTM A325M		Specification for high strength bolts for Structural Steel Joints.
CSA Standard 080-M1989		Wood Preservative
CSA Standard G164-M1981		Hot Dip galvanizing of irregularly shaped articles.
ANSI/SAE Standard J403h	-	Chemical composition of SAE carbon steels.
NLGA Standard	-	Grading Rules for Canadian Lumber (75)

Federal Specification PPP - C - 1752C - Cushioning Material, Packing

600.04 SUBMISSION AND DESIGN REQUIREMENTS

The suppliers shall submit 2 sets of shop drawings, product data and/or samples for the contract administrator’s review and acceptance prior to the shipment of equipment and material.

The drawings shall include dimensions, capacities, weights and electrical performance characteristics of equipment or material, and where applicable they shall include wiring, single line and schematic diagrams.

The following is a minimum list of equipment and material for which shop drawings/product data shall be provided.

Electrical Handholes

Steel footing
Steel poles

600.05 MATERIALS

Where materials conforming to the OPS specifications cannot be obtained, the Contractor shall submit alternate materials to the Remote Northern Transportation Office in Thunder Bay for their review and approval.

600.05.01 Concrete

Concrete shall meet the requirements of OPSS 1350, 20 MPa class.

600.05.02 Reinforcing Steel

Reinforcing steel shall meet the requirements of OPSS 1440.

600.05.03 Granular Backfill and Granular Pads

Granular materials shall meet the requirements of OPSS 1010.

600.05.04 Sand Bedding (Selected Backfill)

Sand bedding material for electrical cables shall be mortar sand where available, and shall conform to OPSS 1004.

600.05.05 Anchorage Assemblies

Anchorage assembly struts and coils shall conform to the requirements of material grade SAE 1020 steel as detailed in ANSI/SAE standard J403h. Anchorage studs shall be high tensile stress proof studs - yield strength 689.47 MPa, tensile strength 861.84 MPa. Steel Hex nuts and flat washers shall be in accordance with ANSI/ASTM A325M.

The complete anchorage assembly shall be hot dipped galvanized in accordance with CSA standard G164.

600.05.06 Pressure Treated Wood Products

Pressure treated wood shall meet the requirements of OPSS 1506.

600.05.06.01 Protection Planks

Protection planks shall be 150mm x 50mm P.T. Wood which shall meet the requirement of OPSS 1506.

600.05.06.02 Wood Post

Post shall be Jack Pine or Red Pine and, except for maximum allowable wane, shall be "No. 1" Grade. Structural Post and Timbers shall be graded in

conformance with the requirements of the NLGA Standard Grading Rules for Canadian Lumber (75).

Post shall be pressure preservative treated in accordance with the current requirements of CSA Standard 080. Size as shown on the drawings.

600.05.07 Fish Line

Fish line shall be nylon or polypropylene material with minimum test strength of 400N.

600.05.08 Electrical Handholes

Electrical Handholes shall be fabricated from high density polyethylene and constructed to withstand the pressures of frost heave when installed in the ground.

Refer to Standard Drawings MTO-E21, MTO-E22, MTO-E24 for handholes dimensions and installation details.

600.05.09 Equipment Identification and Warning Labels

Lamicoid, plasticengraving sheet shall be 3mm thick, white face, black core, mechanically attached with self tapping screws or plastic ties.

Letter size -8mm high letters for equipment identification and warnings.

-5mm high letters for general information and instructions.

-3mm high letters for wire identification.

Wording to be as specified on the drawings.

600.05.10 Steel Footings

Steel footing shall conform to the following specifications. (Unless otherwise shown on detail drawings).

Baseplate to Helix Length	2700mm
Nominal Diameter of Shaft	152mm
Shaft Wall Thickness	6.35mm
Helix Diameter	292mm
Helix Pitch	75mm
Helix Thickness	9.5mm
Base Plate Thickness	32mm
Baseplate Holes	Variable Type (2 slots, 28mm wide)

The shaft shall be galvanized after fabrication.

Mounting hardware for steel shaft foundation shall include a machine bolt, 25mm NCT, 125mm long complete with fastening nuts and round washers.

600.05.11 Roof Top Equipment Platform

Equipment mounting platform shall be as shown on the drawings.

600.05.12 Polyethylene Foam

Polyethylene foam cushioning material (unicellular) shall conform Federal Specification PPP - C - 1752C and it shall be class 2, Grade A, type 1.

MATERIAL SPECIFICATION FOR
POWER DISTRIBUTION SYSTEM

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601.05.04 Surge Protector

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601.05.08 Mini Power Centre Assembly

601.01 SCOPE

This specification covers the equipment requirements for electrical power distribution for Remote Airports Lighting System.

601.02 REFERENCES

This specification refers to the following standards, specifications and publications:

ANSI-61 Colour Grey baked enamel (Finish Systems for Outdoor Metal Equipment).

CSA Standard:

C22.1 -	Canadian Electrical Code Part I
C22.2 No.5.1-M91(R1997)	Moulded Case Circuit Breakers
C22.2 No.14-95-	Industrial Control Equipment
C22.2 No.18-98(R2003)	Outlet Boxes, Conduit Boxes & Fittings
C22.2 No.29-M1989(R1995)	Panelboards and Enclosed Panelboards
C22.2 No.38-95	Thermoset Insulated Wires and Cables
C22.2 No.42-M1984(R1996)	General Use Receptacles, Attachment Plugs, and Similar Wiring Devices
C22.2 No.45-M1981(R2003)	Rigid Metal Conduit
C22.2 No.47-M90(R2001)	Air Cooled Transformers (Dry Type)
C22.2 No.49-98(R2003)	Flexible Cords and Cables
C22.2 No.58-M1989(R1999)	Isolating Switches
C22.2 No.83-M1985(R2003)	Electrical Metallic Tubing
C22.2 No.106-M92(R1997)	HRC Fuses
C22.2 No.123-96(R2005)	Aluminum Sheathed Cable
C22.2 No.131-M89(R2004)	Type TECK 90 Cable
C22.2 No.179-M1987(R2000)	Airport Series Lighting Cables
C22.2 No.197-M1983(R2003)	PVC Insulating Tape
C22.2 No.211.2-06 -	Rigid PVC Unplasticized Conduit
C22.2 No.211.3-M90 -	Rigid Fibreglass Reinforced Epoxy Conduits and Associated Fittings

Electrical Safety Code 26-248 - Dry Core, Open Ventilated Type Transformers

FAA Specification L823
FAA Specification L824

OPSS 1506 - Ontario Provincial Standard Specification.

Transport Canada Specification K-255

601.04 SUBMISSIONS AND DESIGN REQUIREMENTS

The suppliers shall submit 2 sets of shop drawings, product data and/or samples for the contract administrator's review and acceptance prior to the shipment of equipment and material to the construction site.

The drawings shall include dimensions, capacities, weights and electrical performance characteristics of equipment or material, and where applicable they shall include wiring, single line and schematic diagrams.

The following is a minimum list of equipment and material for which shop drawings/product data shall be provided.

Splice Boxes
Transformers
Mini Power Centre
Panel Boards
Breakers
Contactors
Relays
Selector Switches
Photocell
Surge Protector

601.05 MATERIALS

601.05.01 Wires and Cables

601.05.01.01 **RW90** - Single copper conductor with low temperature, moisture resisting, cross-linked polyethylene insulation, 600V rating.

CSA Specification C22.2 No. 38.

601.05.01.02 **SOOW** - Stranded copper conductor, paper separator, ethylene propylene rubber insulation, conductors twisted with fillers, hypalon jacket, conductors colour coded, 600V rating.

CSA Specification C22.2 No. 49.

601.05.01.03 **TECK** - Multi copper conductors with RW-90 XLPE (-40°C) insulation, stranded bare copper grounding conductor, PVC inner jacket, enclosed in a liquid and vapour tight solid corrugated aluminum sheet and PVC overall covering. Cable shall be suitable for installation at temperature ±40°C. Voltage rating 600V or 1000V as specified.

CSA Specification C22.2 No 131.

Conductors: Stranded for #10 AWG and larger, colour code to CSA Specification C22.1.

601.05.01.04 **ASLC** **Airport Series Lighting Cable**

The primary 5KV cable shall be manufactured in accordance with Transport Canada Spec. No. K304 and CSA C22.2 No. 179.

The cable shall be suitable for use in metallic or non-metallic raceways or direct burial in wet or dry locations.

Cable construction to be as follows:

Conductor: Bare, 7 wire, compressed standard copper Size: #8 AWG.
Insulation: black cross-linked polyethylene with a minimum average thickness of 2.8 mm
Conductor: Shield: extruded semi-conducting cross-linked polyethylene, 0.5 mm thick
Rated voltage: 5000 Volts

601.05.02 Wiring Devices and Accessories

601.05.02.01 Raceways

601.05.02.01.01 EMT conduit to CSA Specification C22.2 No. 83.
601.05.02.01.02 FRE conduit to CSA Specification C22. No. 211.3
601.05.02.01.03 Rigid PVC conduit to CSA Specification C22.2 No. 211.2
601.05.02.01.04 Galvanized rigid steel conduit to CSA Specification C22.2 No. 45.
601.05.02.01.05 Polyethylene tubing to be low density, Schedule 40, 75 PSI strength
601.05.02.01.06 PVC duct to CSA Specification C22.2 No. 211.1
601.05.02.01.07 Electrical non-metallic tubing to CSA Specification C22.2 No. 227.1
601.05.02.01.08 High pressure poly pipe CAN/CSA-B137.1-M89, Polyethylene Pipe, Tubing, and Fittings for Cold Water Pressure Services.

601.05.02.02 Connectors and Fittings

601.05.02.02.01 Water tight TECK connector shall be complete with sealing ring to waterproof connection with a fitting, size as specified.

CSA specification C22.2 No. 18.

601.05.02.02.02 Water tight connector for portable cords type SOOW cable shall be complete with sealing ring and of a size as specified.

CSA specification C22.2 No. 18.

601.05.02.02.03 Conduit fittings to CSA specification C22.2 No. 18.

601.05.02.02.04 Conduit boxes shall be electro-galvanized sheet steel, surface mounted 100mm (4") square, 54mm (2 1/8") deep.

CSA Specification C22.2 No. 18.

601.05.02.03 Wire Joints, Insulation Tape.

601.05.02.03.01 Hand twist plastic insulated pressure connectors shall have expandable tapered spring and extended skirt (for conductors up to and including #10 AWG).

CSA Specification C22.2 No. 42.

601.05.02.03.02 Compression type splice sleeve for 1 #10 AWG to 1 #8 AWG copper, stranded conductor splice suitable for system voltage of 600V.

CSA Specification C22.2 No. 42.

601.05.02.03.03 All Weather (-30°C) Vinyl Plastic Electrical tape shall be in 19mm x 33m (3/4" x 36 yd.) rolls (8.5 mils thickness). Tape to have a minimum insulation resistance of 10^6 megohms, a breaking strength of 20 lbs/in and is to be ULC listed as flame retardant, cold and weather resistant.

CSA Specification C22.2 No. 197.

601.05.02.03.04 Putty Electrical Insulation tape shall be in 38mm x 1.5m (1.5" x 5') rolls (thickness 125 mils). Putty like electrical grade compound shall be in a tape form with a dielectric strength of 575 V/mil minimum and an insulation resistance of 10^6 megohms

601.05.02.03.05 Airfield lighting primary cable connection shall be, waterproof connection between a non-screened, 5 KV primary airfield cable and an isolating transformer or in a non-screened 5 KV primary series circuit cable using butt splice.

Butt splice detail include compressed barrel connector, 2 layers of rubber splicing tape, 2 layers of premium vinyl electrical tape cover with insulated heat shrink. MTO-E19.

601.05.02.03.06 Airfield lighting cable secondary connector to be factory moulded cable assembly. Cable shall be two conductor, copper, size and length as specified, type SOOW-heavy duty rubber insulated with a hypalon jacket, rated to 600V.

Plug (male) connector to be Class A, style 1, Receptacle (female) connector to be Class A, style 7.

Connectors: FAA Specification L823 and/or
Transport Canada Specification K255

601.05.02.03.07 Heat shrink TCSN 0800 600V to be part of the butt splice which complete 2 layers of 130C rubber splicing tape and 2 layers of super 88 premium vinyl electrical tape butt splice.

601.05.02.04 Protexulate Powder

Protexulate insulation is to be a loose fill, fine calcium carbonatic powder specially treated to repel moisture. Electrical performance: Dielectric constant 2.7, resistivity - 1014 ohms/m/cm².

601.05.02.05 Splice Boxes

Underground splice boxes are to be 100 mm diameter x 56 mm deep, cast aluminum with a ground screw inside and 2 threaded holes to accept grounding post (stud size

5/16-18 in.) on the outside of the box housing. Box shall be complete with neoprene gasket, cast aluminum cover and stainless steel screws.

CSA specification C22.2 No. 18

601.05.03 Distribution Transformers

Transformers shall be of the size and voltage rating as indicated, single phase, dry type insulation class H or resin encapsulated insulation class F, CSA type 1 enclosure, wall mounted, with 4-2½% taps, 2 FCAN, 2 FCBN, and finished with ANSI No. 61 light grey baked enamel.

Transformer cores shall be constructed with high permeability silicon steel using stacked laminations to provide quiet operation and minimize size and weight. Sound level rating shall not exceed 45 dB.

Transformers shall be listed and labelled in accordance with CSA Specification C22.2 No. 47 and built in accordance with Ontario Electrical Safety Code 26-248.

601.05.04 Surge Protector

Surge protector shall be a complete factory assembled unit containing a properly selected lightning arrester, surge capacitor, circuit breaker and indicating light.

The unit shall be rated at 600 volts single phase 2 or 3 wire and be housed in CSA type 1 enclosure. Enclosure shall be finished with ANSI No. 61 light grey baked enamel.

601.05.05 Panelboards, breakers and disconnect switches

601.05.05.01 Panelboard

Panelboard shall have a hinged door with concealed hinges and combined lock and latch. Tubs and trims of surface mounted panel shall be finished with ANSI No. 61 light grey baked enamel.

Panelboard shall have a provision for a directory description mounted in a metal frame with a clear plastic cover on inside of panel door.

Enclosure to be CSA type 1, surface mounted.

Panelboard shall be complete with copper buses. Neutral bus shall be of same ampere rating as mains. Mains shall accept bolt on breakers.

Panelboard shall be of a size and rating as specified and shall be complete with main and branch breakers as specified.

CSA Specification C22.2 No. 29.

601.05.05.02 Breakers

Moulded case circuit breakers shall be bolt-on, quick-make, quick-break suitable for switching duties with overcurrent protection combining thermal time delay and instantaneous magnetic trip, clearly marked with their respective trip rating. The quick-make, quick-break trip-free mechanism shall have an operating handle which will visually indicate "ON", "OFF", or "TRIPPED" position.

Minimum magnetic trip for 30A-2P breaker shall be 1200% of its rating.

Interrupting capacity: 10,000A Sym. minimum.

Breakers to conform to CSA Specification C22.2 No. 5.

601.05.06 Disconnect Switches

Disconnect switch shall be fused or unfused as specified, horsepower rated, quick-make, quick-break, with handle interlocked so that switch door cannot be opened unless switch is in de-energized position. Switch shall be heavy duty, having visible blade construction, and silver plated current carrying parts.

Switch shall have a CSA type 1 enclosure finished with two coats of baked-on ANSI No. 61 light grey enamel.

CSA specification C22.2 No. 58.

Fuses shall be type HRC1-R, time delay to CSA specification C22.2 No. 106.

Switch and fuse sizes shall be as specified.

601.05.07 Controls

601.05.07.01 Contactors

Electrically held, continuous duty coil shall be complete with auxiliary contacts as specified. Size and rating as specified.

CSA Specification C22.2 No. 14.

601.05.07.02 Relays

Relay shall be electrically held. Coil rating of 120V AC, 60Hz, continuous duty. Contacts shall be plug-in, convertible, 10A rating, quantities as specified.

Contact switching shall be momentary or time delay as specified.

Time delay relay shall be instant close, adjustable delay 'off' 1 to 30 min. after de-energization.

CSA specification C22.2 No. 14.

601.05.07.03 Photocell

Photocell shall be weatherproof construction and operational within a temperature range of -40°C to +70°C. The photocell shall be suitable for termination of 3 #12 AWG conductors cables and for operation at 120 VAC. It shall be factory set to turn on at about 580 lux and off at about 350 lux. It shall be twistlock. The photocell shall be specified on the bill of materials as normally open or normally closed. The unit shall be CSA approved.

601.05.07.04 Selector Switch

Selector switch shall be non-illuminated, 2, 3 or 4 position as specified, manual return, EEMAC 4, complete with black knob and NO/NC contacts rated 120 VAC, 10A minimum. Quantity of contacts as specified.

CSA specification C22.2 No. 14.

601.05.07.05 Enclosure

Control panel enclosure shall be CSA type 1 non-ventilated c/w flanged inner panel for use with industrial control equipment in ordinary locations.

The box shall be 14 galvanized steel and inner panel 12 galvanized steel. The enclosure shall be finished with two coats of baked on ANSI No. 61 light grey enamel. The inner panel shall be finished with white baked enamel.

CSA specification C22.2 No. 14.

601.05.08 Mini Power Centre Assembly

The Mini-Power centre shall combine a resin encapsulated dry-type transformer with primary and secondary breakers in a single panel board unit and a non-ventilated weatherproof CSA enclosure type 4 for outdoor mounting.

The transformer shall include 2-5% FCBN taps and shall be of insulation type F, 115°C temperature rise.

Transformer size 5KVA, 600 V-120/240V, single phase.

CSA Specification C9.

Mini Power Centre panel board shall be 120/240V, single phase, 3 wire and shall have a hinged door with concealed hinges and lock. Panel board shall have provision for a directory description mounted in a metal frame with clear plastic cover on inside of panel door.

Mini Power Centre shall include a 15A - 2 pole primary breaker, a 25A - 2 pole secondary main breaker and 12-15A, 1 pole branch breakers.

Breakers interrupting rating: 10,000A Sym.

Breakers to conform to CSA Specification C22.2 No. 5.

MATERIAL SPECIFICATION FOR GROUNDING SYSTEM

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602.01 SCOPE

This specification covers grounding equipment for the electrical power distribution system for Remote Airports Lighting System.

602.02 REFERENCES

This specification refers to the following standards, specifications and publications:

CSA Standards:

C22.2 No. 0.4 – 1982(R1999) Bonding and Grounding of Electrical Equipment

C22.2 No. 41 - 1987(R2004) Grounding and Bonding Equipment

602.05 MATERIALS

602.05.01 Ground Electrode

602.05.01.01 Steel Ground Rod

Ground electrode shall be a solid galvanized steel ground rod, 19mm dia. x 3.0 m long or galvanized steel ground plate. This ground electrode shall be approved by the Electrical safety Authority or by an organization that has been accredited by the Standards Council of Canada.

602.05.01.02 Electro-Chemical Ground Electrode

The electrode shall be straight or L-shaped rod as required of copper walls filled with moisture activated chemical electrolyte, outside diameter: 54mm, length 3m.

602.05.02 Cable to Rod Connector

Cable to rod connector to accommodate 19mm dia. ground rod and #8 solid to #2/0 stranded ground wire and it shall consist of a single piece of non-ferrous casting with a set screw for direct burial applications.

CSA Specification C22.2 No. 41.

602.05.03 Splice Box Ground Post

Underground splice box external ground post shall be of non-ferrous material to provide copper cable to flat connection. Stud diameter shall be 5/16-18 in. and suitable for #10 AWG to #6 AWG solid copper ground wire.

CSA Specification C22.2 No. 41.

602.05.04 Electrically Conductive - Anti-Seize Compound

Electrically conductive and anti-seize compound for metal surfaces shall be a homogenized blend of colloidal copper, rust and corrosion inhibitors to facilitate an anti-seize feature and to enhance the conductivity of contacts.

It shall be CSA listed for use on electrical cables in cable connector assemblies.

602.05.05 Ground Inspection Box

Ground Inspection Box shall be made up of half-round 14 gauge hot-dip galvanized steel sections with an open bottom and removable cover.

Size: 254 mm dia x 305 mm deep.

602.05.06 Ground Wire

601.05.03.01 #8 AWG solid soft drawn bare copper ground wire.
601.05.03.02 #6 AWG stranded bare copper ground wire.

ANSI/ASTM Standard B3

SPECIFICATION FOR
AIRFIELD LIGHTING EQUIPMENT

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603.01 SCOPE

This specification covers Airfield Lighting Equipment for Remote Airports.

603.02 REFERENCES

This specification refers to the following standards, specifications and publications:

CSA Standard C22.2 No. 180-M1983(R2004) Series Isolating Transformers for Airport Lighting.

ANSI S51WA - Floodlighting Luminaires.
FAA Specification AC150/5345-12 - Rotating Beacon.
FAA Specification AC150/5345 - 28 - APAPI
FAA Specification L802 - Runway edge and threshold lights.
FAA Specification L822 - Taxiway and apron edge lights.
FAA Specification L823 - Series Isolating Transformer for Airport Lighting.
FAA Specification L828 - Constant Current Regulators for Airport Lighting.

OPSS 2423 - Steel Poles - Base Mounting
OPSS 2432 - High Pressure Sodium Luminaires for Highway Lighting.

Transport Canada Specification K255 - Plug and Receptacle for Light Fixtures and Isolating Transformers.
Transport Canada Specification K305 - Wind Direction Indicator
Transport Canada Specification K308 - Aerodrome Beacon, Rotating Type
Transport Canada Specification K407 - Aerodrome Beacon, Strobe Type
Transport Canada Specification K311 - Elevated Edge Lights for Runway and Taxiway.
Transport Canada Specification K321 - Constant Current Regulator
Transport Canada Specification K342 - PAPI

603.04 SUBMISSIONS AND DESIGN REQUIREMENTS

The supplier shall submit 2 sets of shop drawings, product data and/or samples for the contract administrator’s review and acceptance prior to the shipment of equipment.

The drawings shall include dimensions, capacities, weights and electrical performance characteristics of equipment or material, and where applicable they shall include wiring, single line and schematic diagrams.

The following is a minimum list of equipment and material for which shop drawings/product data shall be provided:

ARCAL Unit
Regulator
Edge Lights
Threshold Lights
Wind direction indicator Assembly

Rotating Beacon
Floodlighting Poles and Luminaires
Isolating Transformers
Airfield Lighting Primary and Secondary Connector Kits
Illuminated Guidance Signs
Approach Slope Indicators

603.05 MATERIALS

603.05.01 Edge Lights

603.05.01.01 Edge light Assembly

Edge lights are used to clearly delineate the edges of runways, taxiways and aprons during periods of darkness or low visibility. Different coloured lenses are used to distinguish between a runway, taxiway or to indicate an intersection.

Fixture construction shall include a two-piece cast aluminum housing suitable for angle adjustment. The fixture lens is to be held in place by a single latch or spring loaded stainless steel clamping band. Fixture shall be equipped with a gasket between the lens and the housing to ensure a tight seal.

Housing shall fasten to a 50mm diameter steel mounting column supported by a 50 mm frangible (breakable) coupling. The edge light assembly is to be suitable for stake mounting.

Edge light fixture shall have a provision for the mounting of an optional day cone. Threshold light fixture shall be complete with metal cones 154 mm x 457 mm painted to FAA specifications.

Photometric distribution for fixture lens shall be to FAA Specifications L-802 for runway edge and threshold and L-822 for taxiway and apron edge turn off.

Fixture cable lead shall be two conductor #16 AWG SOOW cable with moulded male plug connector, length 200 mm. The wiring shall exit slip the fitter from the side of the unit. The slot to be complete with rubber grommet.

All non-optical components of the fixture assembly shall be finished with aviation yellow or orange gloss alkyd enamel paint. Fixtures to be suitable for operation during exposure to rain, ice, snow or standing water and over a temperature range of -55^{o}C to $+55^{o}$C

Light fixtures to be approved under FAA Specifications L-861 (runway), L-861T (taxiway/apron) and L-861E (threshold). The units shall conform to Transport Canada Specification K-311. Fixture shall be equipped with CSA product approval label or Ontario Hydro special inspection approval.

Fixture height shall be 350 mm (14 inches).

Edge lights for parallel connection to operate at 120V complete with standard medium screw base incandescent non-prefocus lamp. Edge lights for series connection to operate at 6.6A complete with incandescent prefocus base suitable for T10, 1P lamp.

603.05.01.02 Edge Light Lens and Lamp Selection

Refer to the following table for edge light lens and lamp selection.

EDGE LIGHT CHARACTERISTICS			
TYPE OF EDGE LIGHT	**SERIES WATTAGE**	**PARALLEL WATTAGE**	**LENS**
Runway	30	25	clear symmetrical
Threshold	100	60	red/green symmetrical
Taxiway	30	25	blue symmetrical
Apron	30	25	blue symmetrical
Turning button	30	25	blue symmetrical
Apron/taxiway junction	30	25	yellow symmetrical
Junction/intersection	30	25	blue symmetrical
Access Road	30	25	red symmetrical

603.05.02 Breakable Coupling

Breakable coupling shall be as per Transport Canada Specifications and shall be aluminum with a 60mm outer diameter and standard 50mm pipe thread, set screw, nut shape shoulder, break-off groove and drain hole.

Breakable couplings of 38mm diameter, if required to support particular edge light fixtures, shall be provided with reducers to fit 50mm diameter stake adapter.

Breakable couplings shall be of suitable length to result in an overall edge light height of 350 mm (14 inches).

603.05.03 Edge Light, Anchor Stake

Stake assembly shall consist of a 19mm diameter steel rod welded to 4mm thickness, 50mm x 50mm x 250mm iron angle and 50 mm dia. threaded adapter. Total length to be 1000mm. The stake shall be galvanized.

A cast aluminum coupling shall be attached at the top to accept standard 50mm pipe thread as shown on the drawings.

Pounding block shall be as detailed on the drawings.

603.05.04 Wind Direction Indicator Assembly

603.05.04.01 Mast Assembly

The mast assembly shall be made of aluminum or galvanized steel as detailed on the drawings.

Wind sock mounting height shall be 6.0m (20 ft.)

The hinged support, tank ballast and hinged leg (or similar) for drop pole shall permit one man ground level servicing.

For parallel connected wind direction indicators, the light assembly shall provide internal illumination of the sock fabric using two 90W, 125 VAC Par 38 halogen lamps or one 300W, 125 VAC Par 56 incandescend lamp.
For series connected wind direction indicators, the light assembly shall provide internal illumination of the sock fabric using one 200W, 6.6A halogen lamp.

Rotary swivel mechanism shall incorporate ball bearings sealed against dust and moisture penetration. The swivel assembly must permit full 360^{O} rotation with precision vaning for wind direction indication.

The 610mm square base plate shall be complete with four anchor bolt holes and one 50mm conduit sleeve hole. Galvanized steel anchor bolts (25mm dia.) and nuts for mast installation on concrete base shall be supplied with the assembly.

The electrical fitting for incoming power connection on parallel wired wind direction indicators shall be suitable for 2/C #10 AWG TECK cable.

Series connected wind direction indicators shall be equipped with an integrally mounted constant output transformer in a weatherproof enclosure. The constant output transformer shall be complete with a 1.2 m long type SOOW connection cord and moulded secondary plug for connection to the nearby isolating transformer buried at the base of the wind direction indicator.

All wind direction indicators are to be equipped with a factory installed and wired weatherproof toggle type isolating switch for lamp servicing.

Transport Canada Specification K-305.

603.05.04.02 Fabric Wind Sock

Wind sock shall be 3.71m (12 feet) long, painted international orange with white stripes.

It shall conform to Transport Canada Specification K-305.

603.05.05 Aerodrome Beacon

603.05.05.01 Rotating Type

The light unit shall consist of 2 sealed beam 500 watt, Par 56 Q NSP, spot quartz lamps housed in weather-proof cast aluminum housing mounted 180° apart. Both lenses shall be clear. Lamp housings shall have an adjustable elevation angle (2° to 5°). Lamp rated life 4000 hours minimum. Rotation speed approximately 12 RPM.

The motor drive housing shall be weatherproof cast aluminum type complete with removable side panel. The drive system shall consist of heavy duty motor, gear case, shaft and slip rings. All moving parts are to be permanently lubricated.

The unit shall include a thermostatically controlled gear box heater to facilitate rotation of beacon at temperatures below +10°C. The unit shall be suitable for 120 VAC, ±10%, 60Hz power supply.

The unit shall be suitable for mounting on horizontal platform, be painted yellow or international orange, and be CSA approved.

Beacon shall conform to FAA Specification AC 150/5345-12 and Transport Canada Specification K-308.

603.05.05.02 Strobe Type

The strobe type aerodrome beacon shall consist of a flashhead, power converter and interconnect cable.

Flashhead shall produce 16000 - 24000 effective candelas with 360^{o} horizontal coverage, 11^{o} vertical beam and 20-30 flashes per minute.

Power converter shall be 120 VAC with 75 watts maximum power consumption, 250 VA peak and a status relay using form C contacts to indicate strobe failure.

603.05.06 Approach Slope Indicators (ASI)

603.05.06.01 Light Units

Code 1 and code 2 runways are to be provided with abbreviated precision approach path indicators (APAPI). An APAPI system consists of two light units at each end of the runway. Code 3 runways are to be provided with precision approach path indicators (PAPI). The PAPI system consists of four light units at each end of the runway.

Each light unit shall contain at least two prefocused lamps, two conductor #12 AWG SOOW secondary cords c/w moulded male connectors, reflectors, filters, lenses and lens shields housed in a frangible weatherproof box mounted on adjustable mounting legs complete with frangible couplings, galvanized base plate, and galvanized anchor bolts for installation on a concrete base or screw-in type anchor.

The unit base plate shall be galvanized, size and strength to suit the ASI light unit (minimum thickness 12mm). Baseplate shall have 4 - 22 mm dia holes on 300 mm centres for anchorage to foundation.

Legs shall allow unit mounting height adjustment from 0.6m to 1.20m.

ASI light unit enclosure shall be complete with cover and gasket, and a quick access shall be provided for replacement of lamps.

The light units shall be provided with integral adjustments to permit accurate vertical positioning of the centre of the light beam at any elevation between 2 and 8 degrees.

SOOW type cable, 1.2m long with moulded secondary connectors, Class A, style 1 shall be provided for each lamp.

The units shall be suitable for use on series lighting circuits powered by a constant current regulator. Lamps shall be 200 watt, 6.6 amp quartz halogen type. Lamps shall achieve full intensity within 5 seconds after a cold start.

Environmental operating conditions - 55°C to + 55°C, relative humidity up to 100 percent, wind exposure up to 160 km per hour.

Rated lamp life 1000 hours minimum. Units shall be painted international orange or yellow and be CSA and Transport Canada approved.

FAA Specification AC 150/5345-28, L881, Class II
Transport Canada Specification K-342.

603.05.06.02 Aiming Device

603.05.06.03 APAPI Frost Prevention Control Unit

APAPI units are energized 3-times per night at 22:00, 02:00 and 06:00 for 20 minutes at 100% intensity when temperature is below 0^{o} Celsius
Frost Control Unit consist of:

- Thermostat with capillary tube to outside
- Electronic programmable timer up to 8 events
- 12 pin 10A 120V relay
- Terminal strip
- Enclosure 30x30x15cm

603.05.07 Isolating Transformers

Series circuit isolating transformers shall be epoxy encapsulated, 5 KV insulated, 6.6A primary/6.6A secondary, 60 Hz. The transformer secondary lead length shall be 1.2m (4ft.) and primary lead length shall be 0.6 m (2ft.) The secondary lead shall have FAA style 7 (female) connector configuration.

The transformer shall be complete with factory terminated moulded, primary and secondary leads. All connectors shall be in accordance with FAA Specification L-823 and Transport Canada Specification K-255.
Transformers and all connections to be completely waterproof and suitable for direct burial or for mounting in any type of pullpit. Transformers must be designed to allow continuous operation with the secondary open circuited, short circuited or with a lamp in place.

The transformer shall be supplied with factory tests certificate. The tests shall include:
- physical and electrical tests and inspections.
- 15,000 Volts direct current insulation resistance test.

CSA Specification C22.2 No. 180.

Transformers power rating:

i)	Edge lights	30/45W
ii)	Threshold lights	100W
iii)	Illuminated wind direction indicators	200W
iv)	Approach slope indicators	200W (per lamp)

603.05.08. Regulators

Free standing, CSA enclosure type 1, solid state thyristor constant current regulator.

The regulator shall have the following electrical characteristics:

Voltage (Rated)	208V/240V ± 10%, single phase
Frequency (Rated)	60 Hz
Efficiency	98%
Power Output	Minimum regulator size: 4 KW
Maximum regulator size:	7.5 kw (unless otherwise specified)
Current	Constant Current, 6.6 Amps.
Brightness Steps	Minimum 3 selectable steps, each adjustable in the field.

The brightness steps shall be set in the factory as follows:

B1	4.8 ± 0.1A	10% brightness.
B2	5.5 ± 0.1A	30% brightness.
B3	6.6 ± 0.1A	100% brightness.

Accuracy of output current.	±1% for ±10% of input voltage variation. ±1% for ±10% of frequency fluctuations.

Environmental Operating Conditions	• -55°C to 40°C • Relative humidity up to 100 percent.
Protection	• overcurrent (manufacture recommendation)

	• overvoltage (manufacture recomendation) • auto lock-out • fault protection • lightning and voltage surge protection.
Local Control	• ON/OFF selector switch • local/remote control switch set at remote • brightness level selector switch • Brightness level indicator
Remote Control	• ON/OFF selection • brightness selection

The regulator shall be equipped with a service hour meter and an ammeter.

The hour meter shall indicate the duration that the regulator is "on" and in use.

Control wiring shall be brought to terminal blocks for connection of remote cables. Each block shall be clearly labelled with an identification number for respective function that it is designated for and appropriate voltage.

Regulator shall utilize one source of power supply (ie. 208V, 1 phase) for both: power supply to the load and control functions.

Transport Canada Specification K-321.

FAA Specification L-828.

Regulator power ratings:

i) Series connected edge lighting: 4 KW (minimum);
7.5 KW (recommended)

ii) Approach slope indicator systems: 4KW APAPI (two ends) approach
7.5KW PAPI (two ends) approach

603.05.09 Aircraft Radio Control Aerodrome Lighting Unit (ARCAL)

Air-to-ground radio control panel shall be complete with power supply suitable for 120 VAC, 60 Hz, receiver, remote antenna and interfaces necessary to turn on aerodrome lighting on receipt of appropriate number of pulses from the aircraft transmitter. The control panel to be complete with timer to reset the system in 15 minutes after the system is turned on, unless subsequent pulses are received to change the activated relays.

Radio receiver shall be mounted in a metal CSA type 4 enclosure with a lockable door latch.

The receiver shall be solid state, plug-in circuit board, fixed frequency preset and tuned to the frequency assigned by the Department of Communications (to be provided by the Ministry). The assembly shall include 3, 5 and 7 pulse relays; contacts rated 120 VAC/3A. Relays shall be programmed to operate sequentially.

The 3 pulse relay is to be interlocked with the airport photocell to prevent energization of the runway lighting circuit (edge lights, wind direction indicator(s) and guidance sign(s)) during daylight hours. This prevents nuisance energizing of the runway edge lighting by stray radio traffic during the day.

Radio control unit shall be supplied with a remote antenna mounting bracket and 20m of lead-in cables.

The unit shall be equipped with the system testing and manual control functions.

ARCAL control unit shall be FAA or Transport Canada and CSA approved.

603.05.10 Apron Floodlighting

603.05.10.01 Luminaire

Floodlighting luminaires shall be 400W, 120V METAL HALIDE (MH) high vertical cut-off type complete with integral epoxy encapsulated ballast (for grounded system).

603.05.10.02 Hinged Pole

The hinged pole shall consist of (a) flanged base and, (b) lower swing section, with separate upper extension (c) bolted to it:
a) 150mm x 50mm x 3m-twin steel channel section.
b) 100mm x 100mm x 3m steel channel with additional ballast and safety chain
c) 100mm dia x 6m aluminum pole, ending with 50mm reducer and with high flexing movement resistance
d) Safety chain, connecting a and b above see MTO-E62

Poles shall be base mounted, 9m in length. Bolt circle diameter for base mounting shall suit steel or concrete footing.

603.05.10.03 Lowering Device

Lowering device on a + b shall consist of stopper plate, counter weight and safety chain.
The safety chain shall be connected to sections a + b with chain length adjusted to provide safety stop for luminaire to enable servicing at ground level.

CHAPTER 4

Construction Specifications

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CONSTRUCTION SPECIFICATION FOR ELECTRICAL GENERAL PROVISIONS

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700.07.11 Construction Safety

700.07.12 Cleaning

700.07.13 As Built Drawings

700.07.14 Maintenance Manual

700.01 SCOPE

This specification covers the general requirements for electrical work and is applicable to all electrical work for Remote Airport Lighting Systems.

700.02 REFERENCES

This specification refers to the following standards, specifications and publications:

Ontario Electrical Safety Code.
CSA Standard C22.1 - Canadian Electrical Code Part 1
CSA Standard C22.3 No. 7-06 - Underground Systems
Environmental Protection Act R.S.O.
Occupational Health and Safety Act.
Construction Safety Act.

700.03 DEFINITIONS

The following definitions apply:

'AASHTO' - American Association of State Highway Transportation Officials
'ANSI' - American National Standards Institute
'ASTM' - American Society for Testing and Materials Standards
'ESA' - Electrical Safety Authority
'IPS' - International Pipe Standards
'NLGA' - National Lumber Grading Agency
'OPSS' - Ontario Provincial Standard Specifications
'SAE' - Society of Automotive Engineers

Bonding Jumper

Means a conductor connecting two or more metal parts to maintain electrical continuity.

Cable

Means a solid or stranded, bare or insulated metal conductor or wire or group of conductors or wires enclosed in a common jacket or twisted or connected to form a group.

Cable System

Means a complete system of cables required for the operation of electrical equipment installations.

Code

Ontario Electrical Safety Code, and CSA Standard C22.1

Direct Buried

Means directly buried in native or imported material without substantial auxiliary works or protection.

Distribution Assembly

Means low voltage equipment within an enclosure with switching and control devices used to provide a source of power for electrical systems.

Electrical Work

Means any work associated with the installation, modification or removal of electrical equipment including work required for all auxiliary concrete, mechanical, metallic or non-electrical components or equipment.

Electrician

Means a person in possession of a certificate of qualification for the trade of "Electrician, Construction and Maintenance", (309A or 309D) issued by the Ministry of Training, Colleges and Universities, Ontario, or "Master Electrician", issued by an Ontario municipality.

Energized

Means electrically live.

Luminaire

Means a complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply.

Power Supply Equipment

Means electrical equipment installed to provide a low voltage or extra low voltage source of power for electrical systems and includes transformation, switching and control equipment.

Sleeve

Means a duct installed so as to provide a cavity for the purposes of installing other ducts within.

Specialist

Means a person who is competent, knowledgeable and experienced in the special work to be performed.

Splice

Means a mechanical device connecting two or more conductors, establishing an electrical contact and insulated equal to or better than the cable in which it is installed.

Underground Electrical Provisions

Means any works, which require underground installation such as duct banks, conduits, concrete footings and pads, electrical manholes, junction boxes and associated equipment and installed for the purpose of providing facilities for future electrical work.

700.05 MATERIALS

Unless otherwise indicated, all electrical materials shall be new and of a uniform pattern throughout the work. All materials, components or completed assemblies of components shall be CSA approved or shall comply with the requirements for Special Approval of the Electrical Safety Authority Department.

700.07 CONSTRUCTION

700.07.01 Codes, Rules and Regulations

All work shall be performed in accordance with the Ontario Electrical Safety Code, including all appending bulletins issued by the Electrical Safety Authority Department which are applicable to the work. All underground work shall be in accordance with C22.3 No. 7 unless noted otherwise.

All work shall be governed by regulations stated in any CSA Standards referred to in the specifications, which are pertinent to the work.

700.07.01.01 Work Requiring Qualified Worker

Electricians shall be employed to do the following (minimum) work:

- Cable installation, termination and splicing

- Installation of conduit, conduit fittings and boxes

- Installation of power distribution equipment including: transformers, panels, surge protectors, switches, mini power centre, etc.

- Grounding system installation

- Luminaire installation

- Airport lighting and associated equipment installation

- Calibration, testing and commissioning of electrical systems.

700.07.02 Co-ordination with Electrical Safety Authorities

700.07.02.01 Work to be Inspected by Electrical Safety Authority

Arrangements shall be made for designated work included in Airport Lighting Systems and Associated Electrical Work to be inspected by Electrical Safety Authority.

700.07.02.02 Permits, Certificates

For all work requiring Electrical Safety Authority inspection, permits shall be obtained and applications for inspection filed with Electrical Safety Authority Department as necessitated by the progress of the work. All fees related to permits, applications and inspections shall be paid.

All defects in workmanship and electrical equipment shall be corrected within such time and in such a manner as indicated by notices of deficiency from the Electrical Safety Authority.

Upon completion of all work, a final certificate of approval from the Electrical Safety Authority shall be obtained and one copy of the certificate furnished to the Contract Administrator.

700.07.03 Shop Drawings

Shop drawings, product data and samples shall be obtained from respective suppliers and shall be reviewed in accordance with the requirements indicated in each section.

The drawings shall include dimensions, capacities, weights and electrical performance characteristics of equipment or material, and where applicable they shall include wiring, single line and schematic diagrams.

The following is a minimum list of equipment and material for which shop drawings/product data shall be reviewed and the Engineer's approval obtained, prior to shipment of equipment and material to the construction site:

Electrical Handholes
Splice boxes
Transformers
Mini Power Centre
Panel Boards
Breakers
Contactors
Relays
Selector Switches
Photocell
Surge Protector
ARCAL
Constant Current Regulator
Edge Lights
Threshold Lights

Wind Direction Indicator Assembly
Aerodrome Beacon
Approach Slope Indicator
Steel Shaft Foundations
Floodlighting Poles and Luminaires
Isolating Transformers
Airfield Lighting Primary and Secondary Connector Kits
Primary Cable
Illuminated Guidance Signs

700.07.04 Manufacturer's Instructions

Manufactured equipment or products carrying specific installation instructions by the manufacturer shall be installed in strict accordance with such instructions.

700.07.05 Unpacking of Equipment

Unpacking of equipment shall be handled carefully to prevent component damage. Upon receipt, cartons shall be unpacked and the condition of the contents checked. Any exterior damage to cartons, which might lead to detection of equipment damage, shall be noted.

Packing list shall be checked against parts list to verify that all parts are present before proceeding.

If damage to any equipment is noted, a claim form shall be filed with the carrier immediately. Inspection of equipment by the carrier may be necessary.

700.07.06 Layout of Equipment

The electrical layout drawings are a schematic representation of the requirements. All equipment shall be installed in locations and at elevations detailed on the standard drawings or on detail drawings.

The Contract Administrator prior to the installation shall approve any proposed variation from standard drawings.

700.07.07 Adjustment of Equipment

Luminaires, optical lens assemblies, photocell and other devices, which may require adjustment to give optimum performance, shall be adjusted in the presence of the Contract Administrator.

700.07.08 Open Excavations

Excavations within the edge of the runway shoulder shall not be left open overnight unless permission is obtained from the Contract Administrator.

700.07.09 Testing

Tests on electrical equipment shall be done in accordance with the appropriate specifications covering the work.

700.07.10 Environmental Protection

700.07.10.01 Transport of Dangerous Goods Act, Liquid, Industrial, and Hazardous Waste Regulation

Ensure compliance with Federal Regulation "Transport of Dangerous Goods Act" administered in the Province by the Ministry of Transportation Ontario and Ontario Regulation 309 "Liquid, Industrial, and Hazardous Waste" under the jurisdiction of the Ministry of the Environment.

700.07.10.02 Spills Reporting

Spills or discharges of pollutants or contaminants that are a result of the Construction operations and that cause or are likely to cause adverse effects shall forthwith be reported immediately to the Ministry of the Environment and to the Contract Administrator. Such spills or discharges and their adverse effects shall be as defined in the Environmental Protection Act R.S.O.

700.07.11 Construction Safety

The construction activities shall be carried out in compliance with the Occupational Health and Safety Act and the Construction Safety Act.

700.07.12 Cleaning

At the completion of construction, lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt shall be cleaned.

700.07.13 As Built Drawings

Three (3) clearly marked up sets of construction drawings and detail drawings reflecting the "as-built" conditions shall be maintained. One (1) set shall remain at the job site at all times. One (1) set shall be maintained by the RNTO Electrical Shop in Thunder Bay and one (1) set shall be provided to the MTO Electrical Engineering

office. These drawings shall show the dimensioned locations of all buried cables and cable splices, locations and termination points of underground ducts and locations of Electrical Handholes.

Any variations from installation detail drawings shall be identified on respective standard detail drawings.

700.07.14 Maintenance Manual

Two sets of maintenance manuals shall be submitted to the Contract Administrator upon completion of the project.

The manuals shall be bound in vinyl hard covered, 3 ring loose-leaf binders suitable for 215 x 280mm size paper. A title sheet labelled "Operation Data and Maintenance Manual" which includes project name and date, and a list of contents shall be enclosed. The contents shall be organized into applicable sections and shall duplicate the project specification breakdown. Each section shall be labelled with tabs, protected with celluloid covers, fastened to hard paper dividing sheets.

The following information shall be included:

- description, operation and maintenance instructions for material, equipment and systems including complete list of equipment and parts.
- nameplate information such as make, size, capacity and serial number.
- names, addresses and phone numbers of suppliers.
- complete sets of final shop drawings.
- complete set of "as built" construction drawings and detail drawings.
- field measurements and testing records.

CONSTRUCTION SPECIFICATION FOR ELECTRICAL SITE WORK

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701.01 SCOPE

This specification covers the electrical site work requirements for installation of Remote Airport Lighting Systems.

701.02 REFERENCES

This specification refers to the following standards, specification and publications:

OPSS 501	-	Compacting
OPSS 603	-	Underground Ducts
OPSS 616	-	Concrete Footings and Concrete Pads for Electrical Equipment
OPSS 905	-	Steel Reinforcement for Concrete
OPSS 1004	-	Aggregates - Miscellaneous
MTO 703	-	Grounding System Installation
MTO 600	-	Electrical Site Work
MTO 601	-	Power Distribution Equipment

701.05 MATERIALS

Refer to the following Specifications:

MTO 600	-	Electrical Site Work
MTO 601	-	Power Distribution Equipment

701.07 CONSTRUCTION

701.07.01 Excavating Trenching and Backfilling

701.07.01.01 Earth Excavation

Contact the Local Community Authorities, the Contract Administrator and/or the Utility Companies for information regarding the exact location of existing underground utilities. Exercise the necessary care in construction operations and take any other such precautions as are necessary to safeguard the utilities from damage.

Trenches shall be excavated to the widths, depths, and alignments as detailed on the construction drawings and standard detail drawings. Such widths, depths and alignments shall be adjusted to obtain proper clearances with utilities or other works.

Where unsuitable earth materials are encountered in the trench bottom they shall be removed and replaced with suitable materials as directed by the Contract Administrator.

The trench bottom shall be undisturbed earth or suitable imported materials, which shall be compacted in accordance with the requirements of OPSS 501.
The trench bottom shall be free of sharp rock fragments or debris and shall be uniformly graded.

701.07.01.02 Sand Bedding

Sand bedding (selected backfill) for direct buried electrical cables shall conform to OPSS 1004 where available. Obtain RNTO Thunder Bay approval for any bedding materials not conforming to OPSS 1004.

701.07.01.03 Backfill

Except for sand bedding material, material used for backfilling trenches and pits shall correspond in quality and depth with the material in the faces of the trenches or pits. Backfill materials within 300mm of the duct or cable shall not contain rock fragments or stones larger than 50mm diameter.

Backfill shall be compacted in accordance with the requirements of OPSS 501.

701.07.01.04 Restoration Work

Restoration work necessary for the installation of work described herein shall be carried out so as to restore the surface to original or better condition. Such work shall be done in accordance with the requirements of applicable specifications related to the work.

701.07.02 Underground Ducts

701.07.02.01 Ducts - General

Rigid ducts crossing the aircraft manoeuvring surface shall be fibreglass reinforced epoxy (FRE) and be installed in locations detailed on the standard drawings or on layout drawings. Rigid ducts shall be installed to a depth of 1.0 meter beyond the finished grade and with a minimum slope of 3 mm/m. Ducts shall be installed such that water will not accumulate in the ducts.

FRE ducts shall also be used instead of polypipe in areas where cable damage has occurred or is likely to occur due to extreme frost heaving.

701.07.02.02 Terminations

Rigid ducts shall be cleaned immediately after installation and terminated with end bells. All ducts shall be temporarily plugged or sealed until wiring is installed.

Where ducts are indicated as 'spare' or intended for future use, a fish line shall be installed and the duct ends shall be plugged with plastic plugs.

701.07.02.03 Fish Line

Where fish line is required, a 1.5m length of line shall be brought out of the duct beside the plastic plug, left coiled and tied in an accessible location at each end of the duct.

701.07.03 Electrical Handholes

Electrical Handholes are required at the following locations:

- Approach slope indicator light units (one per two light units) to house the associated isolating transformers.
- Illuminated wind direction indicators to house the isolating transformer.
- At each light location on the runway.
- At strategic pulling points to facilitate the installation of cable through polypipe or duct.
- At the four corners which define the outside of the threshold. (One handhole to supply three light units)
- At locations as specified on layout - design drawing.

Install Electrical Handholes on undisturbed soil or on fill compacted to 95% of Standard Proctor density.

Electrical Handholes shall be positioned as indicated on the drawings. Top of handhole shall be 150 mm below finished grade. Cover material over handhole to be granular, no larger than 19mm dia.

Handhole cover shall be connected to the system ground wire in accordance with MTO 703.

701.07.04 Concrete Footing for Electrical and Airfield Lighting Equipment

701.07.04.01 Grading

Excavation and fill material shall be placed up to the finished grade elevation in accordance with the footing details of the Electrical and airfield lighting equipment as per the drawings.

701.07.04.02 Earth Excavation

Where unsuitable earth materials are encountered in the excavation, they shall be removed and replaced with suitable compacted materials.

701.07.04.03 Rock Excavation

Where rock is encountered, the excavation shall be carried out in accordance with requirements at OPSS 603. The Contract Administrator shall determine the need for all rock excavation and identify any alternatives.

701.07.04.04 Sleeves and Ducts

Where required, sleeves and ducts shall be installed as shown on the drawings and shall be suitably aligned for connection to exterior duct or cable systems.

Sleeves or conduit assemblies for footings shall be accurately located to suit incoming duct or cable systems and shall be securely tied to steel reinforcement prior to placing concrete.

All sleeves or ducts shall be cut off cleanly above the footing or pad.

Sleeves or ducts shall be temporarily plugged or sealed until wiring is installed.

701.07.04.05 Anchorage Assemblies

Anchorage assemblies of the size and type indicated in the drawings shall be accurately positioned in foundation, such that the alignment of the studs is parallel to the edge of the foundation. Anchorage assemblies shall be securely tied to reinforcing steel and shall be provided with a wood template to maintain the position of the studs during the placing of concrete.

701.07.04.06 Reinforcing Steel

Reinforcing steel shall be installed in accordance with the requirements of OPSS 905.

701.07.04.07 Concrete

Concrete shall be placed, cured, protected and finished in accordance with the requirements of OPSS 616.

In earth, concrete may be placed either directly against undisturbed materials or may be formed leaving a minimum width of 300mm around the concrete for the placing of granular backfill. The upper most 150mm of the footing shall be the minimum amount to be formed.

In rock, concrete shall be placed directly against the excavated rock surfaces and dowelled into place. Portions of footings above the top of the rock surface shall be formed leaving a 300mm minimum wide area around the footing for the placing of granular backfill.

Formwork shall be removed to a minimum depth of 150mm below finished grade prior to placing granular backfill.

701.07.04.08 Granular Backfill

Granular backfill shall be placed around footings and compacted in accordance with the requirements of OPSS 616.

701.07.05 Steel Footing Installation

Steel footing shall be installed in accordance with the following installation procedure:

Drive tool assembly and kelly bar assembly shall be attached to the foundation and using a digger-derrick, manoeuvre the kelly bar until the point of foundation is over the marked installation location.

Kelly bar shall be lowered until the point of foundation is forced into the ground. As the foundation is installed, check to ensure that it is plumb.

Footing shall be continually installed, applying downward pressure and correcting the kelly bar's orientation, so that the footing embeds itself in one smooth continuous motion. When the base plate of the footing is flush with the groundline, the digger shall be stopped, kelly bar and installation tool removed.

Where applicable, equipment mounting base shall be attached to the footing base plate using the bolts and nuts as per standard detail drawings.

CONSTRUCTION SPECIFICATIONS FOR POWER DISTRIBUTION EQUIPMENT INSTALLATION

TABLE OF CONTENTS

702.01 SCOPE

This specification covers the requirements for the installation of Power Distribution Equipment for Remote Airport Lighting Systems.

702.02 REFERENCES

This specification refers to the following standards, specifications and publications:

CSA Standard		
C22.1	-	Canadian Electrical Code Part I
MTO 601	-	Power Distribution Equipment
MTO 701	-	Electrical Site Work
MTO 703	-	Grounding System Installation
MTO 704	-	Airfield Lighting Equipment Installation

702.05 MATERIALS

Refer to the following Material Specifications:

MTO 601	-	Power Distribution Equipment

702.07 CONSTRUCTION

702.07.01 Wire and Cables (Parallel Systems)

702.07.01.01 Underground Cables in Trenches

Earth and rock excavation, installation of sand bedding and backfilling and compacting for direct buried cables shall conform to MTO 701.

Underground cables shall be installed along the routes and at depths as shown on the drawings.

Cable shall be laid maintaining 80mm clearance from sides of trench and between adjacent cables. Offsets shall be provided for thermal expansion and contraction and minor earth movements. Minimum offset shall be 150mm per 3m of run. Minimum permitted bending radius shall be 8 times cable diameter for rubber and plastic covered cable, and 12 times cable diameter for metallic TECK cables.

Trench shall be widened at each cable offset, as specified above, maintaining minimum separating and bending radius requirements.

The cable shall be unreeled and placed carefully in the trench bottom without changing relative position and crossing. At crossovers a minimum vertical separation of 80mm shall be maintained. Pulling the cable into, or dragging along the trench, shall not be permitted.

Where indicated, leave coils of cable for future extension. Coils shall be neatly taped and left in a readily accessible location. Cable ends shall be sealed with heat shrink tubing boots.
A minimum 500mm length of lighting and power cables shall be left at all accessible pulling points, splicing points or cable termination points. A coil length of low voltage cables shall be left at all electrical Handholes such that a minimum total length of 500mm of cable may be pulled out above finished grade.

Cables for runway and taxiway edge lighting shall be installed in a continuous run, with a 1500mm dia buried loop left at each location where lighting fixtures are to be installed.

Cables shall be covered with bedding sand compacted to 95% Standard Proctor density as determined by AASHTO method T99-70. Balance of backfilling up to grade level shall be an approved backfill and compacted to a minimum of 95% Standard Proctor density.

Where indicated on construction drawings, cable protection tiles (Pressure Treated lumber planks) shall be installed over direct buried cables in trenches.

702.07.01.02 Cables in Ducts

Cables installed in ducts shall be installed using CSA approved lubricants compatible with the cable jacket. Multiple cable runs shall be installed simultaneously. After installation, ducts shall be sealed with duct sealing compound. Pulling tension shall not exceed the safe tension recommended by the cable manufacturer.

Cables of different voltages shall be installed in separate ducts.

Spliced cables shall not be pulled inside ducts.

702.07.01.03 Cable Terminations in Underground Splice Box

Liquid tight connectors shall be connected to SOOW and TECK cables and an approved gasket shall be applied in order to waterproof the joint between the cable connector and splice box.

Wire connections shall be as shown on the drawings, and shall be connected with vibration proof wire connectors, covered with insulation putty, followed by two coats of vinyl plastic electrical tape.

TECK cable ground wire shall be connected to splice box internal ground lug. #8 AWG solid soft drawn copper ground wire shall be extended from splice box external lug to lighting anchor stake.

Cables shall be tagged with identification labels, indicating power source. Each conductor in splice box shall be provided with circuit identification number.

Splice box shall be filled with protexulate powder.

702.07.01.04 Cable Terminations - General

Feeder cable terminations in Electrical Handholes and splice boxes for multi-conductor cables shall be made with compression connectors insulated with putty and covered with two layers of electrical vinyl tape and protected with waterproof splices installed in accordance with the manufacturer's recommendations.

All conductors, insulation and jackets shall be carefully cleaned prior to installing connections, splices and terminations. All ground shields braids or tape shall be connected securely to a ground wire in accordance with the requirements of MTO 703.

Lugs, terminals and screws used for termination of wiring shall be suitable for copper conductors.

Wiring shall be identified with permanent indelible identifying markings either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

Phase sequence and colour coding shall be maintained throughout.

Colour code: to CSA C22.1
Underground cable splices are not allowed unless otherwise shown.

702.07.01.05 Cable Splicing Procedure

Perform splicing only during acceptable weather condition; i.e., dry air temperature as recommended by insulation tape manufacturer.

Clean and dry conductors.

Apply approved wire joint (compress barrel connector).

Apply rubber tape over conductors and entire joint. Stretch rubber tape to a recommended tension.

Apply two layers of premium vinyl electrical tape.

Apply insulated heat shrink

Test insulation level of each splice.

If splice box is required, remove any moisture from splice box. Refill and compress protexulate powder. Also compress powder while closing box cover.

702.07.02 Wire and Cables (Series Systems)

702.07.02.01 Primary Cables

Earth and rock excavation, installation of sand bedding and backfilling and compacting for series circuits shall conform to MTO 701.

Underground primary cable (and raceway) shall be installed along the routes and at depths as shown on the drawings.

The following separations must be maintained from the series cable(s) in a trench.

(a) 75 mm lateral separation between cables of different series circuits;
(b) 300 mm lateral separation from low-voltage and control cables; and
(c) 75 mm vertical separation in cross-overs on the same system and;
(d) 300 mm vertical separation from low-voltage cables crossings over, with the low-voltage cables in the upper position.

In non-vehicular areas, the primary cable may be direct buried provide that sand or other approved bedding material is available. Where sand or other approved bedding materials are not available, the primary cable must be installed in one of the following raceways:

(i) 50 mm type 2 PVC duct (DB2) with solvent welded joints;
(ii) 32 mm (minimum) poly pipe, or
(iii) 50 mm (minimum) electrical non-metallic tubing.

Where the primary cable crosses under traffic areas, it must be installed in direct buried rigid FRE conduit.

The cable and raceway shall be installed in accordance with the trench profiles shown in the Standard Drawings. Cables shall be laid maintaining 80mm clearance from sides of trench and 75mm clearance between adjacent series circuits. Offsets in direct buried cables shall be provided for thermal expansion, contraction and minor earth movements. Minimum offset shall be 150mm per 3m of run.

Moisture repellent cable caps are to be used on the cable ends during construction and until cables are terminated.

CSA approved lubricants compatible with the cable jacket must be used to reduce pulling tension when the cable is installed in raceway.

Pulling tension shall not exceed the allowable tension recommended by the cable manufacturer. Provide Electrical Handholes as required to ensure maximum pulling tension is not exceeded.

Primary cables are to be continuous between edge lights or Electrical Handholes. Splicing of cables shall be avoided but when absolutely necessary, the splices shall be performed in a handhole. Spliced cables shall not be pulled inside raceways.

The ends of the raceways shall be kept plugged during construction. The raceway shall be cleaned of any sand, earth or foreign matter immediately prior to primary cable installation. Plug ends with duxseal after cable installation.

A 600 mm loop of slack cable is to be left on each cable end at isolating transformer locations to avoid mechanical tension on the transformer connectors.

A ground counterpoise shall be installed with all primary conductors. Refer to MTO 703.07.02.

702.07.02.02 Primary Cable Terminations

Primary cables are to be terminated using butt splice as specified in MTO 601.05.02.03.05.
Refer to Standard Drawing MTO-E19 and MTO-E21 and follow the splicing procedure.

702.07.03 Raceways in or on Buildings

Conduits and TECK cables shall be installed in a neat and orderly fashion, and in accordance with the Ontario Electrical Safety Code

Conduits shall be surface mounted in electrical service room and in unfinished areas.

Rigid galvanized steel threaded conduit shall be used in areas subject to mechanical injury.

Electrical metallic tubing (EMT) shall be used where not subject to mechanical injury.

FRE conduit shall be used underground when installed under aircraft and vehicle movement surfaces. Rigid PVC conduits can be used in other underground locations.

Metallic conduit shall be bent cold and replaced if kinked or flattened more than 1/10th of its original diameter. Ensure that the field threads on rigid conduits are of sufficient length to draw conduits up tight.

Conduits shall be run parallel or perpendicular to building lines.

Conduits or TECK cables shall be located behind infrared or gas fired heaters with 1.5m clearance.

Conduits or cables shall be grouped wherever possible on suspended or surface channels.

Conduits or cables shall not pass through structural members except as indicated.

Conduits or TECK cables shall not be located less than 75mm parallel to steam or hot water lines with a minimum of 25mm at crossovers.

Exposed conduit or cables shall be fastened to building construction or support system using straps or clamps.

702.07.04 Equipment Mounting

Electrical equipment shall be mounted in compliance with the Ontario Electrical Safety Code.

Plywood backboards of 19mm thick shall be provided for wall mounted equipment.

Mount cabinets with top not higher than 2m above finished floor.

Identify electrical equipment with nameplates and labels as shown on detail drawings.

Correct size of openings in equipment enclosures shall be provided for conduit and TECKcable connections.

702.07.05 Distribution Transformers

Transformers shall be wall mounted. Grounding shall conform to MTO 703.

Adequate clearance around transformer for ventilation shall be ensured. Transformers shall be installed in a level, upright position. Shipping supports shall only be removed after transformer is completely installed and just before putting into service.

Primary and secondary connection shall be made as indicated on the drawings.

The transformers shall be energized and secondary voltage checked under no load. Taps shall be adjusted as necessary to produce rated secondary voltage at no load condition.

702.07.06 Surge Protectors

Surge protector shall be connected to the secondary bus and ground bus in accordance with Manufacturer's Specification.

702.07.07 Distribution Panels

Panels shall be mounted as indicated on the drawings.

Panels shall be mounted securely, plumb, true and square, to adjoining surfaces.

Make primary and secondary connections as indicated on the drawings.
Make field connections as indicated on the drawings.

Connect neutral conductors to common neutral bus with respective neutral identified.

Each load circuit shall be identified with typewritten legend showing location of each circuit.

Panels shall be grounded to external grounding terminal provided.

Ensure circuit protective devices are installed to the required values and setting as indicated on the drawing.

702.07.08 Assembly and Installation of Airfield Lighting Control Panel

Lay the control panel components down as indicated on the drawings and fasten to a back plate. Label relays, contractors and terminal blocks with respective identification numbers.

Punch holes in control panel front door and fasten selector switches and labels.

Install internal wiring as shown on the drawings. Maintain wire colour coding and provide a wire number at each termination point. Terminate wires at terminal blocks TB1 and TB2 for connection to remote devices.

Install the panel on the wall in the equipment room as shown on the drawings. Complete raceways and external wiring.

Install photocell unit on roof as detailed on the drawings. The light sensor shall be positioned to face in the north direction.

702.07.08.01 Control Panel Verification - Parallel Lighting

For parallel connected airfield lighting, perform the following system operation tests in addition to ARCAL system tests specified in MTO Construction Specification Section 704.07.07.

i) Position the ASI system selector switch to "10%" and observe that both ASI systems operate at low intensity. Move the selector switch to "30%" and confirm that the intensity of both ASI systems increase. Position the switch to "100%" and confirm that the intensity of both ASI systems increases to full brightness.

ii) Position the ASI system selector switch in "ARCAL" and edge lighting selector switch in manual. Observe that edge lighting and wind direction indicator turn 'ON'.

iii) Position the edge lighting selector switch in "AUTOMATIC" and the beacon selector in "MANUAL". Observe that the beacon operates.

iv) Position the beacon selector switch in "AUTOMATIC" and the apron floodlighting selector switch in "MANUAL". Obscure the photocell and observe that apron floodlighting turns "ON".

v) Position the apron floodlighting selector switch in "AUTOMATIC". With the photocell obscured and all selector switches in "AUTOMATIC," confirm the following operation of the airport lighting via ARCAL, as per Table 1, Chapter 2

vi) Allow the photocell to sense daylight and with all selector switches in "AUTOMATIC" confirm the following operation of the airport lighting via ARCAL, as per Table 1, Chapter 2

vii) Ensure all selector switches are left in automatic positions.

702.07.08.02 Control Panel Verification - Series Lighting

For series connected airfield lighting, perform the following system operation tests in addition to the ARCAL system tests specified in MTO Construction Specification Section 704.07.07:

i) Position the airfield lighting selector switch to "10%" and verify that:
   a) both ASI systems operate at low intensity
   b) all edge lighting operates at low intensity
   c) wind direction indicators and guidance signs operate at full intensity

ii) Position the airfield lighting selector switch to "30%" and verify that:
   a) both ASI systems operate at medium intensity
   b) all edge lighting operates at medium intensity
   c) wind direction indicators and guidance signs operate at full intensity

iii) Position the airfield lighting selector switch to "100%" and verify that:
   a) both ASI systems operate at full intensity
   b) all edge lighting operates at full intensity
   c) wind direction indicators and guidance signs operate at full intensity

iv) Position the airfield lighting selector switch in "ARCAL" and the beacon auto/manual selector switch in "MANUAL". Observe that the beacon operates.

v) Position the beacon selector switch in "AUTOMATIC" and the apron floodlighting selector switch in "MANUAL". Obscure the photocell and observe that apron floodlighting turns "ON".

vi) Position all airfield lighting equipment selector switches in "AUTO". Obscure the photocell (during daylight hours) and confirm the following operation via ARCAL: as per Table 2, Chapter 2.

vii) Repeat the above procedure with the photocell uncovered during daylight hours. Confirm the following operation via ARCAL, as per Table 1, Chapter 2.

702.07.09 Testing

Power distribution testing shall include phasing, insulation, voltage, grounding and load balancing.

Testing shall be performed in accordance with instructions given in the respective Construction Specifications.

For insulation resistance testing the following instruments shall be used:

500V instrument, for feeders and equipment up to 350V.
1000V instrument, for feeders and equipment rated 350-600V.
5000V instrument, for all series circuit conductors

The following performances shall be demonstrated:

All circuits are continuous and free of short circuits and grounds.

All circuits are free of unspecified grounds; the resistance to ground of all circuits is not less than 50 megohms.

All circuits are connected according to applicable wiring diagrams.

All circuits are operable in the specified manner. Each control shall be operated not less than ten (10) times and each circuit not less than eight (8) hours.

List phase and neutral currents on panelboards and transformers operating under full load.

A list of test results showing the location at which each test was made, the circuit tested, and the result of each test shall be provided at the project completion.

CONSTRUCTION SPECIFICATIONS FOR GROUNDING SYSTEM INSTALLATION

TABLE OF CONTENTS

703.01 SCOPE

This specification covers the requirements for the installation of electrical grounding equipment for Remote Airport Lighting Systems.

703.02 REFERENCES

This specification refers to the following standard specifications and publications:

CSA Standard

C22.2 No. 0.4-04	Bonding and Grounding of Electrical Equipment
C22.2 No. 41-M1987(R2004)	Grounding and Bonding Equipment
C22.3 No. 2	General Grounding Requirements and Grounding Requirements for Electrical Supply Stations.

Ontario Electrical Safety Code.

MTO 602 - Grounding System Equipment

703.05 MATERIALS

Refer to the following Materials Specifications:

MTO 602 - Grounding System Equipment

703.07 CONSTRUCTION

703.07.01 Grounding General

All metallic electrical enclosures, housings and raceways and all metal poles shall be grounded in accordance with the requirements of the following codes: CSA Standard C22.2 No. 0.4, CSA Standard C22.2 No. 41, CSA Standard C22.3 No. 2, Ontario Electrical Safety Code, or as indicated in this specification. All surfaces shall be cleaned to bare metal prior to making ground connections.

Low voltage systems for lighting shall have a #12 AWG system ground wire unless otherwise shown on detail drawings. Resistance to ground on all grounded equipment shall not exceed 10 ohms. All low voltage services and sub-services shall be grounded and the neutral bonded to ground at the main disconnecting means. Low voltage systems for airfield lighting shall be provided with service ground wire and component connection ground wire or with metallic raceway meeting the requirements of the Code.

703.07.02 GROUND WIRES

703.07.02.01 Ground Wires (Parallel Systems)

Ground wire for parallel connected airfield lighting systems shall be electrically continuous throughout the system.

The following equipment shall be grounded through Teck cable ground conductor and local ground electrodes bonded at equipment:

- edge lights
- mini power centre
- wind direction indicator

For elevated edge light, ground shall be obtained by a jumper wire from underground splice box external lug to anchor stake ground lug.

Ground bonding wire shall be provided for transformer neutrals, surge protectors and where specifically required by the equipment manufacturers or by the electrical code.

703.07.02.02 Ground Counterpoise (Series Systems)

The ground counterpoise associated with a series lighting system is a grounding conductor installed over the primary cables for the purpose of interconnecting the system ground electrodes and providing lightning protection for the cables.

The ground counterpoise conductor shall be soft drawn copper sized #8 AWG.

Where installed in earth above the series cables the counterpoise shall be solid, bare wire. Where installed in raceways the counterpoise conductor shall be stranded, insulated (green).

A ground counterpoise conductor shall be installed with all series circuits.

The ground counterpoise shall be installed 75 mm above the primary cable when a single series cable is buried in a trench.

For trenches containing multiple runs of primary cables, the counterpoise is to be placed 80 mm above the cables in a zigzag pattern. The counterpoise conductor shall cross the series cables every 300 mm.

An insulated counterpoise conductor shall be installed with primary cables pulled in raceways under paved areas.

The ground counterpoise conductor shall be connected to the following equipment using an approved solderless ground connector:

(a) The ground anchor of each stake mounted edge light
(b) The grounded secondary conductor of each series isolating transformer
(c) Each ground rod

703.07.03 Ground Electrode

The installation of ground electrodes shall be according to the Ontario Electrical Safety Code.
Install copper clad steel ground rods at the following airfield lighting equipment:

i) mini power centre
ii) illuminated wind direction indicator
iii) approach slope indicator light unit

Ground rods are not required for equipment installed on steel shaft foundations since the steel shaft acts as a suitable ground electrode.

Copper clad ground rods shall be installed in locations as indicated on construction and standard detail drawings.

Ground wire connecting the system ground wire to the ground rod shall be installed in accordance with the requirements of sub-section 703.07.02.

703.07.03.01 Steel Ground Rod

Ground rods shall be driven in a vertical position where soil conditions allow. Where rocks, stones or similar materials are encountered, ground rods may be driven at a maximum angle of 45^{O} to the vertical.

Where soil of low conductivity is encountered, additional ground rods shall be provided of such quantity to meet the maximum resistance to ground requirements.

Ground rods shall be driven so that the top of the ground rod is 75mm below finished grade. All ground wire connections to ground rods shall be made with ground connectors.

Where bedrock, rock fill or similar materials are encountered at less than 450mm below finished grade, the ground electrode shall be relocated to where driving of a ground rod is possible.

Where bedrock, rock fill or similar materials prevent the installation of a ground rod as described above, an alternate method approved by the Contract Administrator may be used.

703.07.03.02 Electro-Chemical Ground Electrode

The electro-chemical ground rods shall be installed in accordance with the manufacturer's installation instructions.

703.07.03.03 Ground Plates

Ground plates shall be installed in accordance with the Ontario Electrical Safety Code.

703.07.04 Ground Wire on Poles

Ground wire connections to pole mounted enclosures shall be run in rigid PVC conduit or it shall be installed inside the pole. The conduit shall be aligned in straight runs complementing the taper of the pole.

Stainless steel strappings, spaced at 1.8m intervals, shall be installed to secure conduit on metal poles.

703.07.05 Ground Inspection Boxes

Ground inspection box shall be installed at each ground electrode location. Box cover shall be flush with finished grade.

Installation shall be as shown on the drawings.

703.07.06 Ground Connectors

Ground connectors shall be installed as shown on standard drawings.

Electrically conductive, anti-seize compound shall be applied to all underground bolted connectors.

703.07.07 Testing

Ground continuity and resistance tests shall be performed using methods appropriate to site conditions. Tests shall be performed before energizing of electrical system. A written report of results shall be provided.

Where grounding of equipment or structure is specified, the resistance between the equipment or structure and ground shall be less than 10 ohms.

CONSTRUCTION SPECIFICATIONS FOR AIRFIELD LIGHTING EQUIPMENT INSTALLATION

TABLE OF CONTENTS

704.01 SCOPE

This specification covers the requirements for installation of Airfield Lighting Equipment for Remote Airports.

704.02 REFERENCES

This specification refers to the following standards, specifications and publications:

MTO 603 Airfield Lighting Equipment
MTO 701 Electrical Site Work
MTO 702 Power Distribution Equipment Installation
MTO 703 Grounding System Installation

704.05 MATERIALS

Refer to the Material Specifications:

MTO 603 Airfield Lighting Equipment

704.07 CONSTRUCTION

704.07.01 Light Unit Anchor Stake Mounting

Excavate 800mm deep trench from edge light location to electrical handhole for isolating transformer (for series systems) or for underground splice box (for parallel systems) .

Attach ground wire to stake, apply anti-seize compound in accordance with MTO 703.

Install stake by driving it down with a pounding block to a depth such that the break line of the frangible column will be at the finished grade or no more than 25 mm below . Maintain the installation within one degree of the vertical.

Install breakable coupling. Apply anti-seize compound on threads. Tighten the coupling to the stake head - do not overtighten but ensure fixture will not swivel.

For parallel systems, install the factory moulded cable assembly in trench from the splice box to the stake. Bring the cable tight to the stake column and leave approximately 250mm of cable with a female connector above ground.

For series systems, install the factory moulded secondary extension cable in trench from the isolating transformer to the stake. Bring the cable up tight to the stake column and leave approximately 250 mm of cable with a female connector above ground.

Backfill trench in accordance with MTO 701.

704.07.02 Edge Light Fixture Installation

Elevated edge light fixtures shall be installed in accordance with the following installation instructions.

Place edge light cord set into the slot of column head assembly if required. Secure the support column to the base by tightening the locking screw located on the side of the base.

Install lamp in a socket.

Place lenses cap on the upper base of the head assembly and secure to head assembly by tightening the lens clamp.

Ensure the following lamp rating and lens type:

EDGE LIGHT CHARACTERISTICS			
TYPE OF LIGHT	**SERIES WATTAGE**	**PARALLEL WATTAGE**	**LENSES**
Runway Edge	30	25	Clear Symmetrical
Threshold	100	60	Red/Green Symmetrical
Taxiway	30	25	Blue Symmetrical
Apron	30	25	Blue Symmetrical
Turn Button	30	25	Blue Symmetrical
Apron/Taxiway Junction	30	25	Yellow Symmetrical
Junction/Intersection	30	25	Blue Symmetrical
Access Road	30	25	Red Symmetrical

Insert end of support column into frangible coupling and secure by tightening hex bolt.

Runway edge, apron, taxiway lights shall be correctly oriented for proper light distribution as per the manufacturer's specifications and Transport Canada Specifications.

Threshold light fixture shall be positioned in such a way, that green filters are visible from runway approach, and red filters from runway end.

Verify level of light fixture column.

Connect plug connector from light fixture to the receptacle of the cable from the underground splice box or isolating transformer.

Energize individual circuits and perform a visual check to ensure correct circuiting.

Energize all circuits for 8 hours. Examine lights and replace failed lamps.

704.07.03 Wind Direction Indicator Assembly Installation

Construct concrete base or steel shaft foundation as outlined in Standard Drawings MTO-E35 and MTO-E36 and specified in MTO 701.

Review assembly drawings supplied by manufacturer before proceeding with mast assembly. Install mast assembly as per manufacturer's instructions.

Install stationary mast on the foundation. Adjust studs to level the mast.

For parallel connected wind direction indicators, terminate TECK cable at pole cable fitting. A cable ground wire shall be bonded to the pole at a ground lug. Complete pole wiring as necessary.

For series connected wind direction indicators, plug the factory installed input power cable into the isolating transformer in the handhole at the base of the wind direction indicator.

Examine if swivel can rotate freely.

Attach ground wire from a local ground electrode to the pole base plate (if concrete foundation is used).

For parallel connected wind direction indicators, the light assembly shall provide internal illumination of the sock fabric using two 150 watt, 125 VAC Par 38 incandescent lamps or one 300 watt, 125 VAC Par 56 incandescent lamp.
For series connected wind direction indicators, the light assembly shall provide internal illumination of the sock fabric using one 200W, 6.6A halogen lamp. **Do not touch lamps with bare hands or fingers as per manufacturer's instructions.**

Follow manufacturer's instructions regarding filling of counter weight tank. Secure tank end and attach to the drop pole.

Raise the drop pole to an upright position and secure with wing nut. Verify level of the drop pole and adjust if required.

Attach circuit identification labels.

Apply power to the wind direction indicator for 8 hours. Observe and ensure its continuous operation.

704.07.04 Aerodrome Beacon Installation

704.07.04.01 Rotating Beacon

Handle beacon with care. Do not pick beacon up by its heads or upper rotating assembly. This may damage the beacon.

Remove the cover plate from the motor box. Inspect the interior to make sure all parts are tight and have not been loosened in shipment. Re-install the cover plate.

Attach lamp canopy to the lamp housing.

Erect beacon-housing platform. Ensure that the platform is level and secure to the building roof.

Mount beacon on a platform as shown on drawings. Drill platform by using the holes in the beacon feet as a drilling template.

Place level on top of motor box and use level adjustment rods supplied with the unit or use shims as necessary under the four corners to bring the beacon to level. Tighten the mounting bolts.

Examine beacon-wiring diagram. Identify termination points for light unit and gear mechanism power supply, and for beacon heater. Terminate teck cable wires accordingly. Ensure correct circuiting and proper termination of ground wire.

Check if light projection has been pre-set at angle of 5^{o} Make adjustment if necessary by loosening the screw holding head in place, adjusting of pointer to the 5^{o} angle and tightening the screw.

Attach circuit identification labels.

Energize beacon for 8 hours. Observe unit operation during testing. Check rotation speed. Make a visual check of the gear mechanism immediately after testing. Ensure that the beacon is in continuous operating condition.

Apply a "cold pack" on heater thermostat. Observe that the heater circuit closes.

704.07.04.02 Strobe Beacon

Construct flash-head platform. Ensure that the platform is level and secure to the building roof.

Mount flash-head on platform. Drill platform by using the holes in the beacon feet as a drilling template.

Place the flash-head on top of the platform and use shims as necessary under the four corners to bring the unit to level. Tighten the mounting bolts.

Mount the power converter cabinet adjacent to the airport lighting control panel. Connect 120V power wiring from appropriate contactor to the beacon's power converter cabinet.

Examine beacon-wiring diagram. Identify termination points for light unit and terminate the manufacturer supplied interconnect cable accordingly. Ensure correct circuiting and proper termination of ground wire.

Attach circuit identification labels.

Energize beacon for 8 hours. Observe unit operation during testing. Check flash rate. Ensure that the beacon is in continuous operating condition.

704.07.05 Approach Slope Indicator

704.07.05.01 Lighting Units Installation

Survey exact locations for ASI unit. The distance from runway centre line shall be as shown on the drawings.

Construct ASI unit concrete foundation or steel shaft foundation as outlined in MTO 701.

Verify runway shoulder slope as shown on the drawings. Install the units at finished grade elevations.

The front face of the light units shall be aligned perpendicularly to the runway centreline within 150mm.

The distance of ASI unit from runway threshold shall be as indicated on construction plans. The acceptable tolerance is 0.5 m.

Review assembly drawings supplied by manufacturer before proceeding with ASI unit installation. Install the units as per manufacturer recommendations.

Place ASI unit mounting base plate on foundation.

Install ASI unit on legs and frangible couplings or frangible alloy legs. In the case of frangible alloy legs, legs shall be cut or adjusted to a mounting height at which unit light beam centre is 375mm above elevation at runway centreline (850 mm above finished grade).

The beam centres of all light units shall be within the tolerance of 25mm to the horizontal plane.

Each light unit shall be aimed outward into the approach zone on a line parallel to the runway centreline within a tolerance of $\pm 0.1^{o}$

Aim light units to specified approach aiming angles by adjustment of legs or mounting brackets. Follow manufacturers instructions for aiming procedure.

Level the unit longitudinally and transversely using an accurate level. Adjust and tighten locking screws where levelling is complete.

Tolerance of transverse and longitudinal levelling is ± 1 minute of a degree.

With the unit top covers removed, make connection of secondary cable leads, check filters functional condition and install the lamps.

For ASI unit utilizing quartz lamps, care shall be taken not to touch the lamp with bare fingers. Touching quartz lamp with bare fingers may seriously shorten lamp life. If the quartz lamp has been touched, clean lamp with tissue moistened with isopropyl alcohol.

Attach circuit identification labels.

704.07.05.02 Series Circuit Connections

Before making any wire connections, make sure that the constant current regulator is turned off.

An isolating transformer is required for each lamp in each ASI unit to provide power from series lighting circuit.

Isolating transformers and cables shall be installed in Electrical Handholes in a manner that minimizes congestion, and shall be installed in layers, in the following order:
Secondary cables on the top
Primary cables in the middle zone
Transformers and grounding on the bottom

Terminate primary underground cable in handhole in accordance with Section 702.07.02.02.

Connect transformers primary leads to form a series circuit.

Install a secondary lighting extension cable c/w moulded male and female connector of sufficient length to extend from isolating transformer to the light unit.

Apply two layers of vinyl electrical tape over cable connection below grade.

Complete grounding as per MTO 703. Apply electrically conductive anti-seize compound.

Apply power to the ASI units observe and ensure its continuous operation at full brightness for 8 hours.

Observe switching from full to reduced brightness.

704.07.06 Constant Current Regulator

Place or mount regulator allowing sufficient clearances for personnel to inspect and maintain the unit.

Refer to regulator wiring diagram supplied by manufacturer. Before proceeding with electrical wiring, observe and maintain all safety precautions.

Ground regulator shall be as recommended by the manufacturer.

Verify voltage tap setting on the control transformer. Also verify settings of protection devices. Overcurrent protection shall be set at 7.2A and overvoltage protection shall be set to suit site conditions.

Connect supply line to input terminals.

Inspect all wiring to be sure it is correct, that terminal connections are tight, and that no wires are shorting across each other.

Check if plug-in relays are seated properly.

Prior to applying load, perform the regulator testing.

When testing or servicing the regulator, observe the precautions that are applicable when servicing high voltage equipment.

Make a short circuit test as follows:

Remove input power to regulator.

Short output bushings S1 and S2 by connecting across them with #12 AWG or larger wire.

Check the regulator ammeter to insure that it is zeroed. If it is not, zero it by the screw in the face cover.

Energize regulator input circuit.

Turn the control panel selector switch to 10%, then to 30%, and 100%, checking the output current on the ammeter at each step. The ammeter readings should be as listed below.

BRIGHTNESS CONTROL SWITCH POSITION	NOMINAL RMS OUTPUT (AMPERES)	OUTPUT CURRENT LIMITS (AMPERES)
100%	6.5	6.40-6.70
30%	5.5	5.33-5.67
10%	4.8	4.66-4.94

Make allowance for input voltage variation. Refer to the factory calibration chart for ammeter correction.

Switch to "ARCAL" control and follow procedure of checking the output current for all brightness settings.

Check operation of the open circuit protection. With the regulator off, remove all leads from the output. Switch the regulator on, and it should automatically de-energize within 2 seconds.

Switch regulator off and put the shorting jumper back on. Turn the regulator back on. Operation should be the same as in short output case.

Connect the control wiring to the regulation as shown on MTO drawings MTO-E76 or MTO-E77.

Connect airfield lighting feeder cables to regulator.

Attach equipment identification labels.

Perform airfield lighting control tests as described in MTO 702.07.07.

Set the control panel selector switch on the "ARCAL" position. The regulator may then be turned on and off, and the brightness selected only from the ARCAL.

704.07.07 Installation of ARCAL Unit

Examine supplied equipment. Observe, output relay ratings, and external wiring termination points. Verify the correctness of radio frequency setting.

Mount the cabinet using mounting holes. Use suitable fasteners for mounting.

Terminate power, grounding and control wiring at the appropriate terminals.

Install an antenna cable from ARCAL unit to the antenna mounting location on roof. A minimum separation of 300mm shall be maintained between antenna cable and any power wires to reduce interference.

Avoid sharp bends in the antenna cable, and leave a drip loop at any place that the antenna cable changes from a vertical direction to a horizontal direction. Secure the antenna cable to the platform with plastic straps, so that it does not move in the wind, to prevent fatigue failure of the cable.

Bolt the antenna bracket to the side of beacon platform on roof as shown on the drawings. Assemble antenna and attach to the bracket.

Put a small amount of silicone grease around the connector threads and connect the antenna cable plug to the antenna connector.

Encapsulate all antenna hardware with a silicone rubber compound to prevent atmospheric deterioration.

Remove any unnecessary slack from antenna cable and use the field attachable connector (supplied) to connect the end of the cable to the antenna connector of the radio controller.

Perform the following operation testing.

Complete all power and controls equipment installation. Position airfield lighting control panel selector switches in "AUTO".

Place the POWER switch to ON. Observe that the POWER indicator illuminates.

Set the TIMER switch to FAST. Wait 5 seconds.

Depress TEST pushbutton three times within 5 seconds; 3-pulse relay should close. Wait approximately 15 seconds; 3-pulse relay should open.

Depress TEST pushbutton five times within 5 seconds; 5-pulse relay should close. Wait approximately 15 seconds; 5-pulse relay should open.

Depress TEST pushbutton seven times within 5 seconds; 7-pulse relay should close. Wait approximately 15 seconds; 7-pulse relay should open.

Each time TEST pushbutton is depressed, carrier light should turn on.

Return Timer Test switch to NORMAL.

Set the portable transmitter to the radio control frequency. Key the microphone and observe that the CARRIER indicator illuminates each time the microphone is keyed.

For airports using parallel wired TYPE Kedge lighting, verify the operation of the following field equipment under daylight conditions. Ensure all selector switches are positioned in "AUTO", as per Table 1, Chapter 2

For airports using parallel wired TYPE K edge lighting, verify the operation of the following field equipment under darkness or with photocell obscured, as per Table 1, Chapter 2.

For airports using series connected edge lighting, verify the operation of the following field equipment under daylight conditions. Ensure all selector switches are positioned in "AUTO", as per Table 2, Chapter 2.

For airports using series connected edge lighting, verify the operation of the airfield lighting equipment under darkness (or with photocell obscured), as per Table 2, Chapter 2.

704.07.08 Apron Floodlighting

Review assembly drawings and installation instructions supplied by the manufacturer before proceeding with pole and luminaire installation.

Luminaires shall be aimed using the vertical and horizontal angles indicated.

Power supply cable and pole wiring shall be connected as per manufacturer's instructions. Ground wire shall be bonded to the pole at a ground lug.

CHAPTER 5

Standard Drawings

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MTO-E70	Parallel Connected Edge Lighting Power Distribution Equipment Layout	Rev.3
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MTO-E72	Power Distribution System-Wiring Diagram Parallel Connection	Rev.3
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MTO-E74	Mini Power Centre Wiring Diagram	Rev.2
MTO-E76	Parallel Connected Edge Lighting Control Schematic-Siemens	Rev.2
MTO-E77	Series Connected Edge Lighting Control Schematic-Siemens	Rev.2
MTO-E77.1	Series Connected Edge Lighting Control Schematic	Rev.0
MTO-E78	Parallel Connected Edge Lighting Control Panel Equipment Layout	Rev.2
MTO-E79	Series Connected Edge Lighting Control Panel Equipment Layout	Rev.2

Aerodrome beacon

Abbreviated Precision Approach Path Indicator (APAPI)

Precision Approach Path Indicator (PAPI)

Illuminated Wind Direction Indicator

Threshold light, green/red

Runway edge light, white

Taxiway edge light, blue

Taxiway/apron junction light, yellow

Mini power centre

Cable underground

Underground splice box

Underground electrical handhole

Underground poly pipe

Underground duct

Flood lighting luminaire

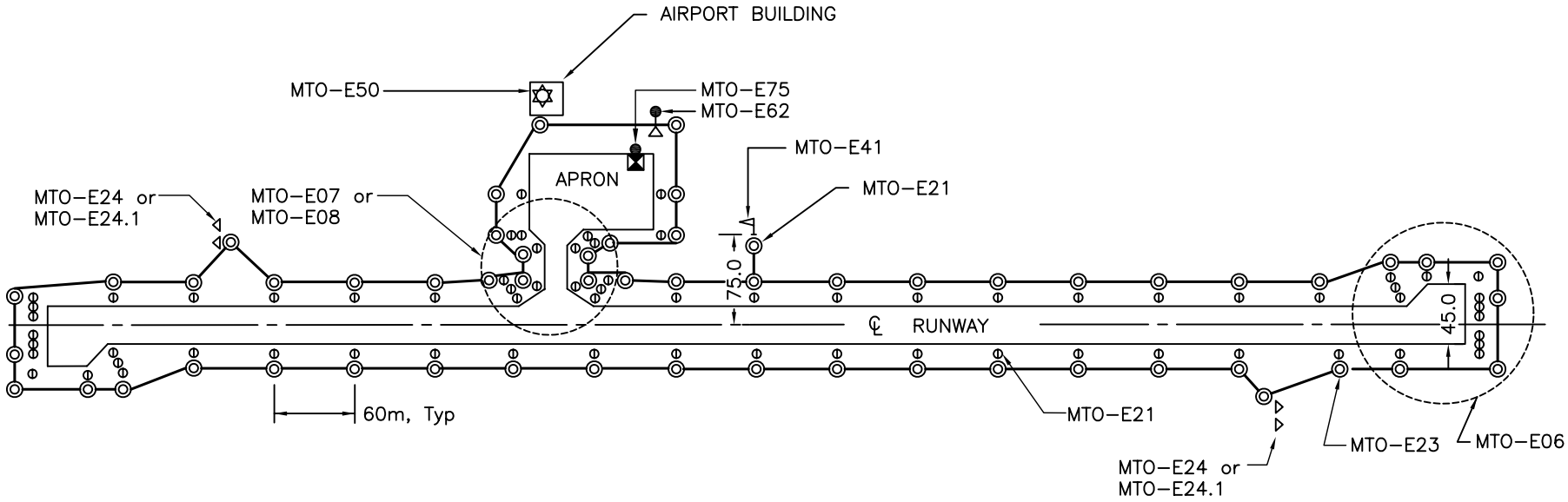
Pole

Ground electrode

Cable protection plank

Apron panel

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev 5
LEGEND			MTO–E01



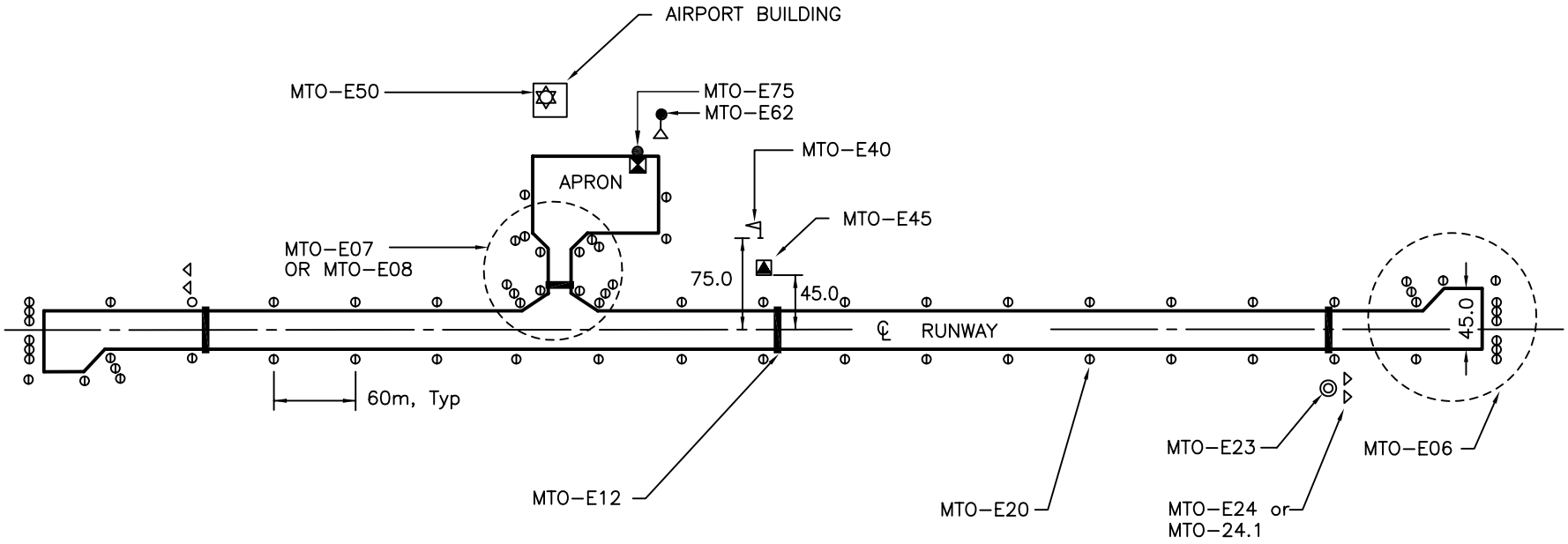
NOTES:

A For locations and quantities of equipment refer to contract documents.

B Placement of all usual guidance lights shall conform to Technical Publications 312 (TP312).

C All dimensions are in metres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev 2
MASTER KEY PLAN **SERIES CONNECTED AIRPORT LIGHTING**			**MTO–E04**



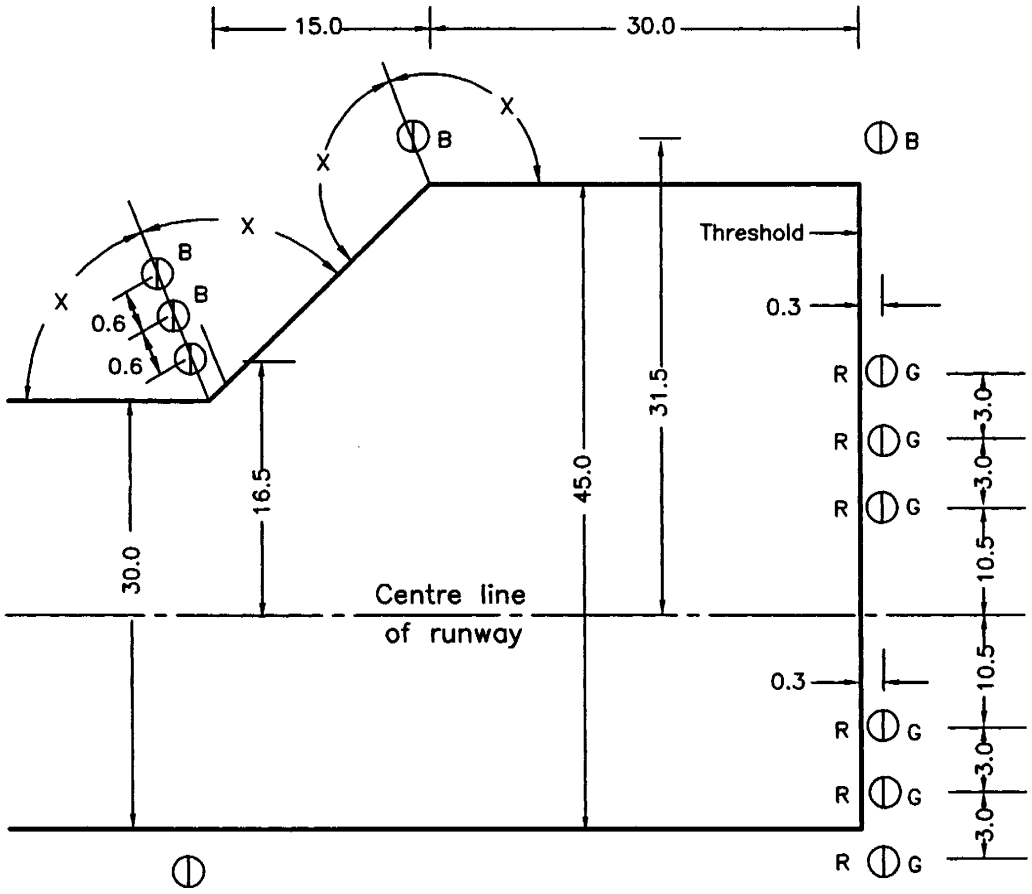
NOTES:

A For locations and quantities of equipment refer to layout drawings.

B Placement of all usual guidance lights shall conform to Technical Publications 312 (TP312).

C All dimensions are in metres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	3
MASTER KEY PLAN PARALLEL CONNECTED AIRPORT LIGHTING				**MTO–E05**



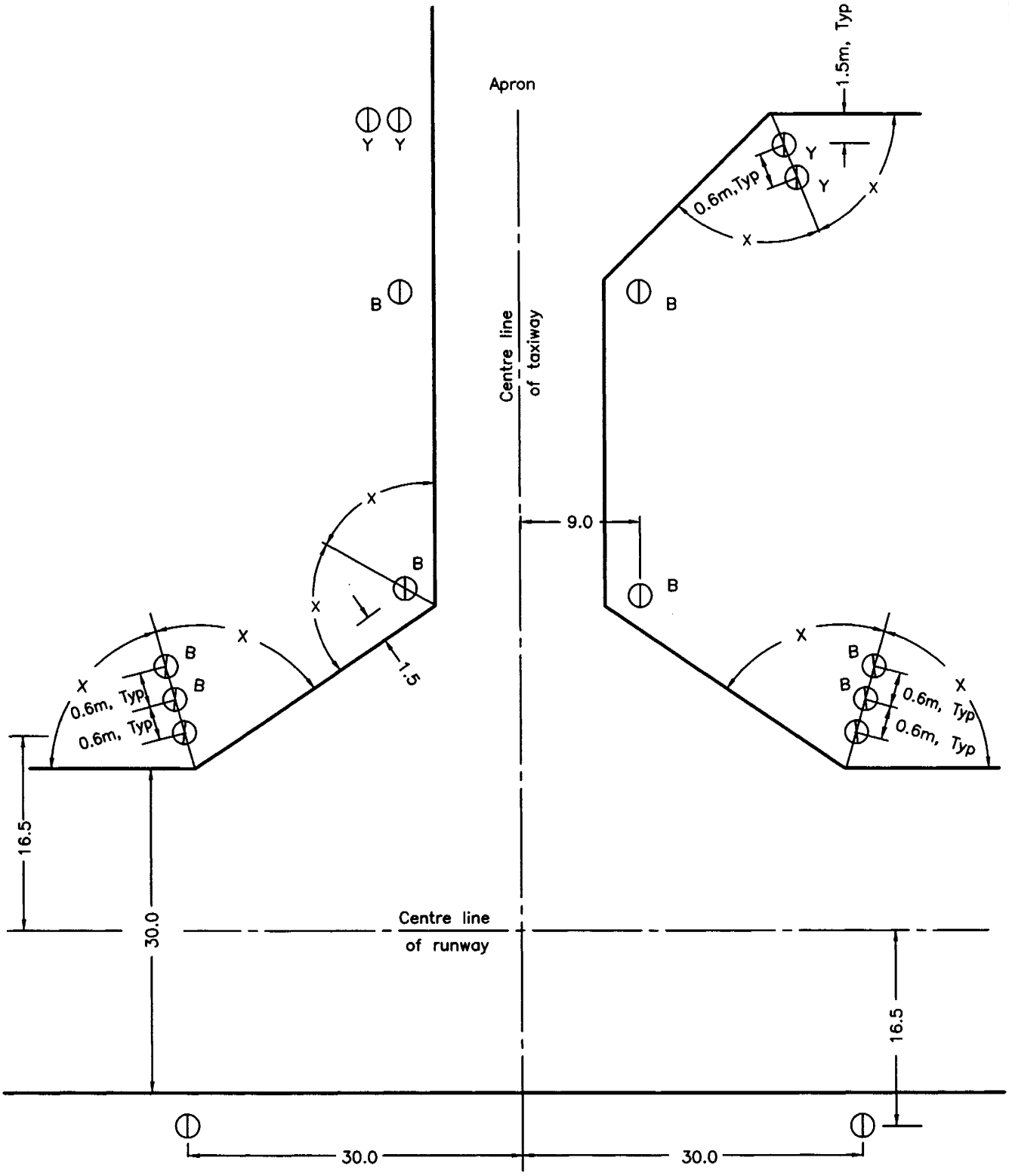
NOTES:

A For locations and quantities of equipment refer to layout drawings.

B Placement of all usual guidance light shall conform to Technical Publications 312 (TP312)

C All dimensions are in metres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2001	Rev	2
RUNWAY THRESHOLD EDGE LIGHTING LAYOUT				
	MTO-E06			

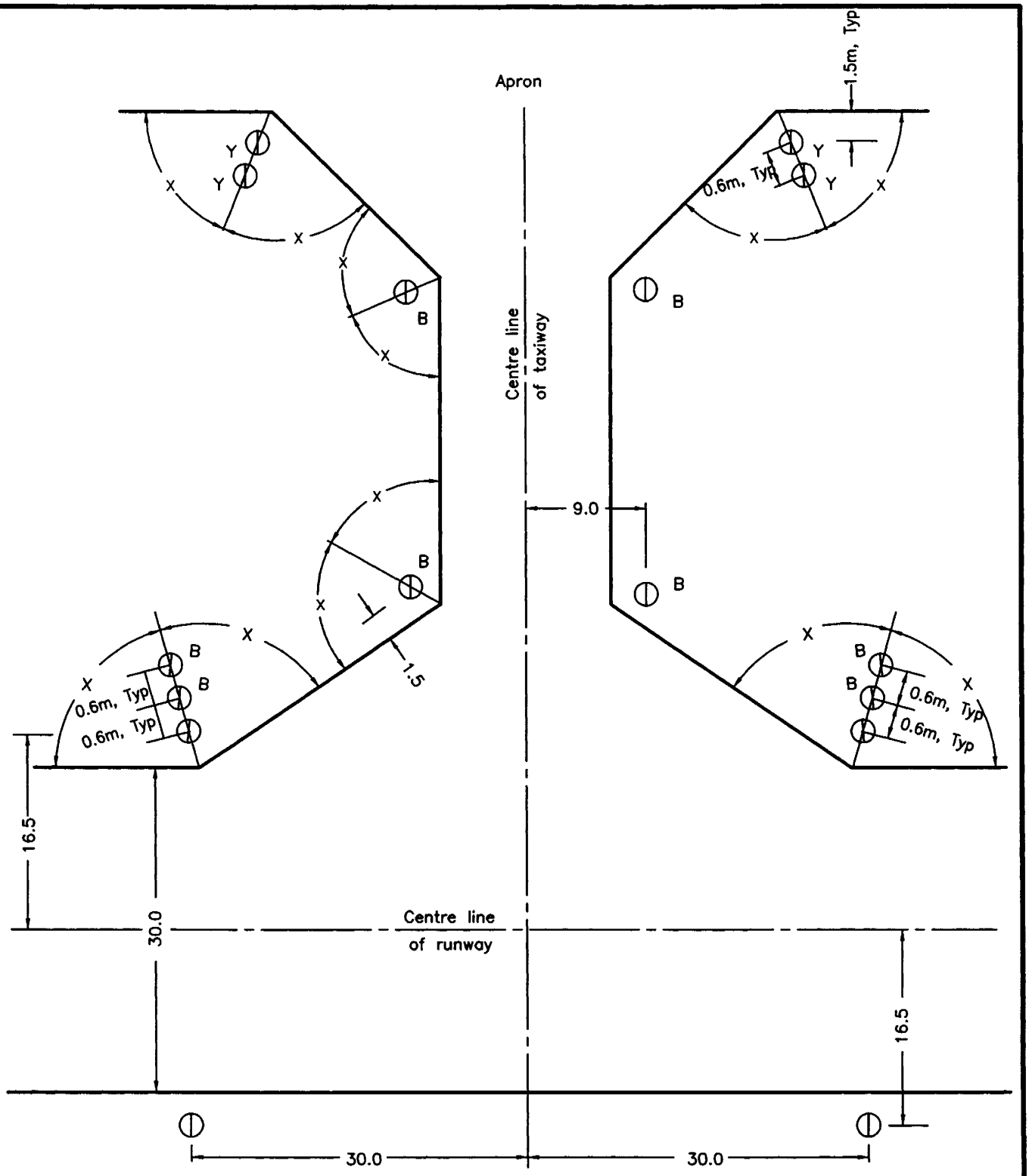


NOTES:

A For locations and quantities of equipment refer to layout drawings.

B All dimensions are in metres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2001	Rev	2
RUNWAY/TAXIWAY EDGE LIGHTING LAYOUT SIDE APRON ENTRANCE				MTO-E07

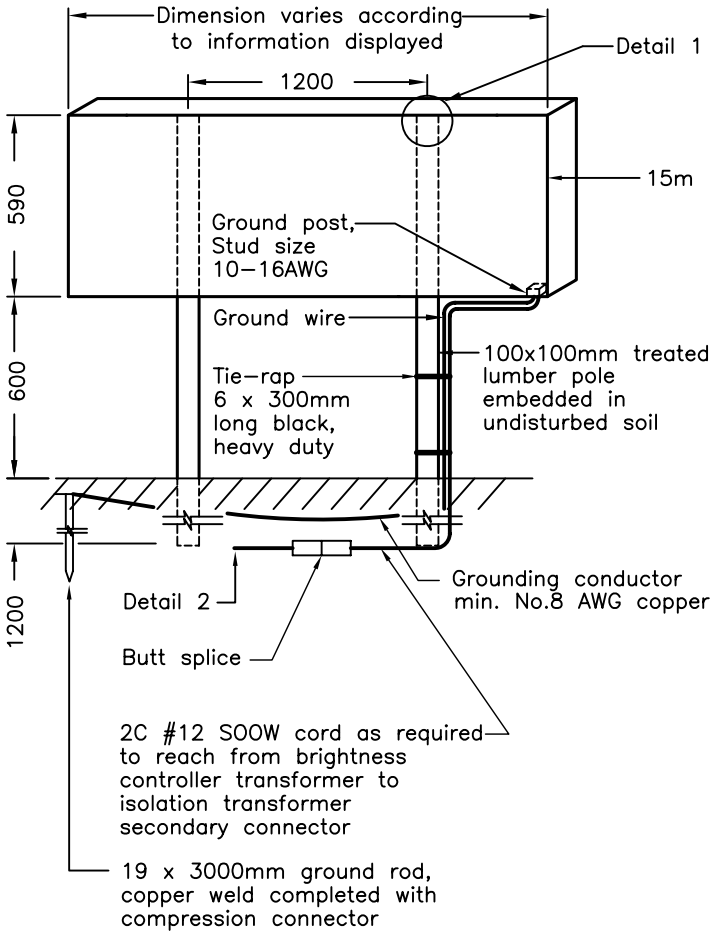


NOTES:

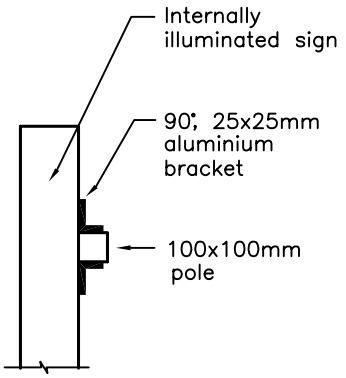
A For locations and quantities of equipment refer to layout drawings.

B All dimensions are in metres unless otherwise shown.

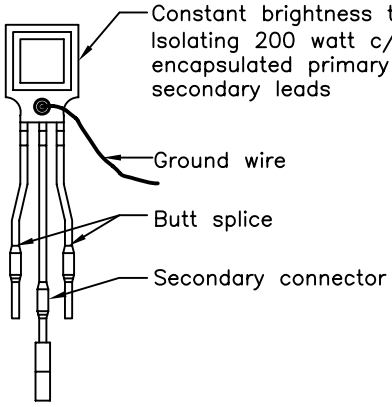
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2001	Rev 2
RUNWAY/TAXIWAY EDGE LIGHTING LAYOUT MIDDLE APRON ENTRANCE			MTO-E08



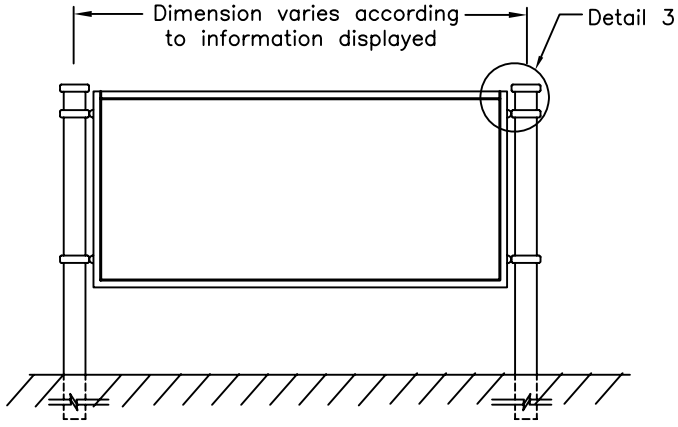
FRONT VIEW



DETAIL 1

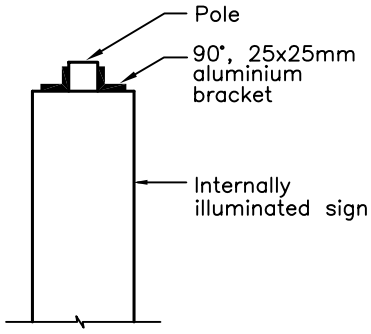


DETAIL 2



ALTERNATE POLE MOUNTED POSITION

FRONT VIEW

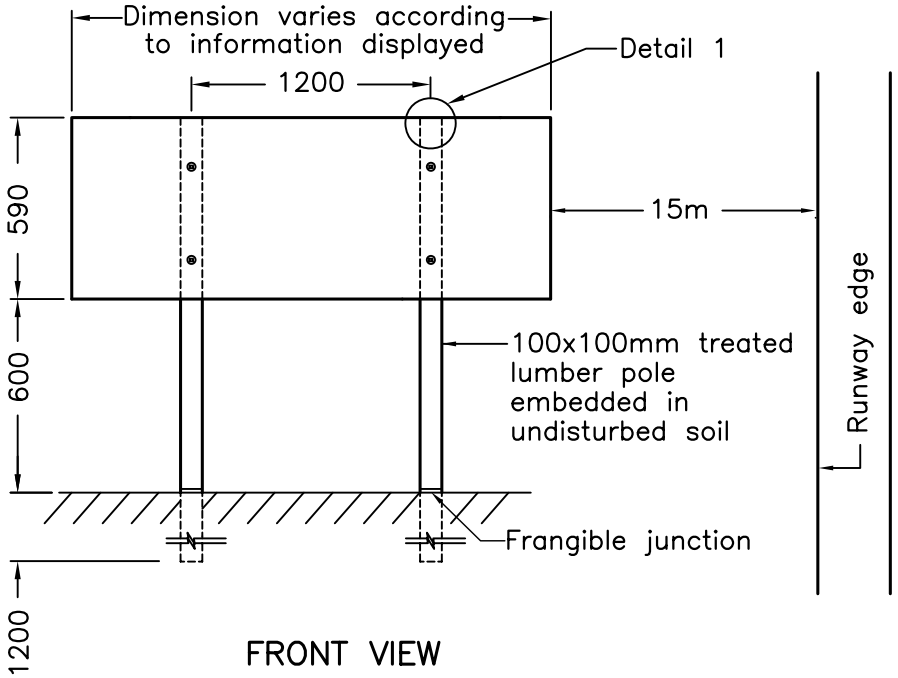


DETAIL 3

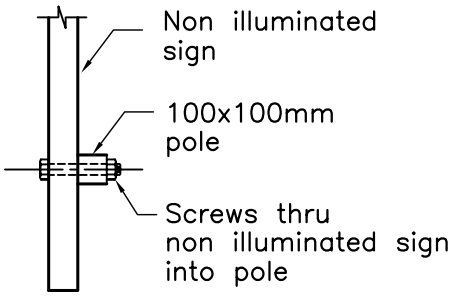
NOTE:

A All dimensions are in millimetres unless otherwise shown.

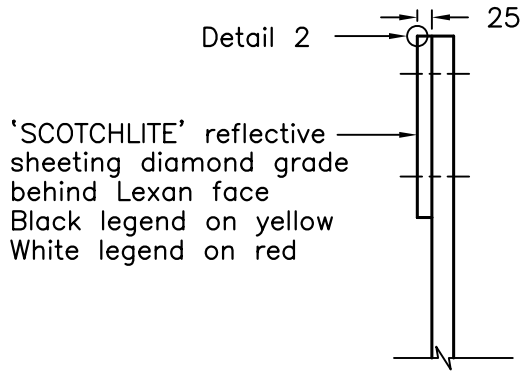
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	2
INTERNALLY ILLUMINATED GUIDANCE SIGN ON WOODEN POLE				**MTO–E09**



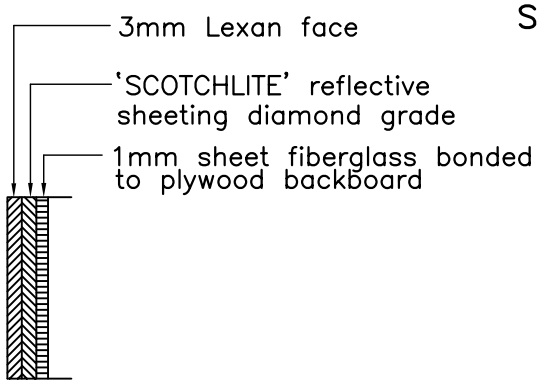
FRONT VIEW



DETAIL 1



SIDE VIEW

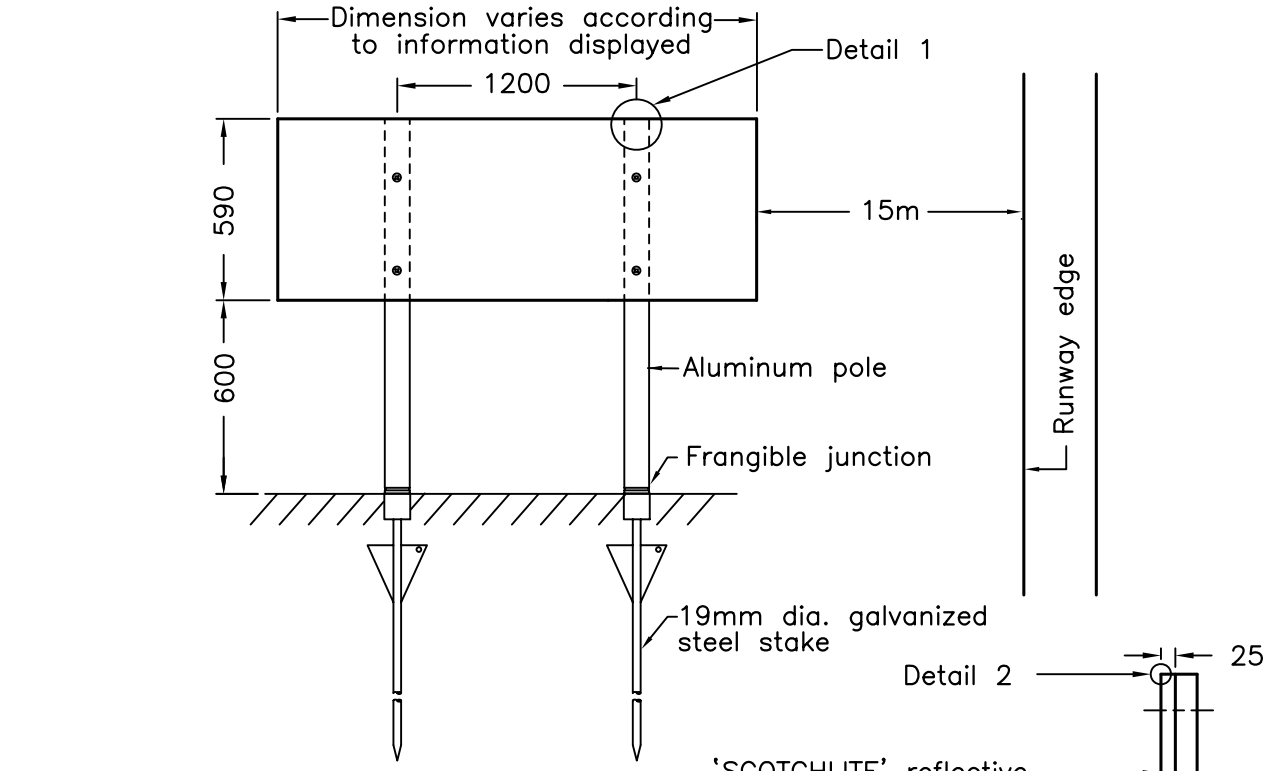


DETAIL 2

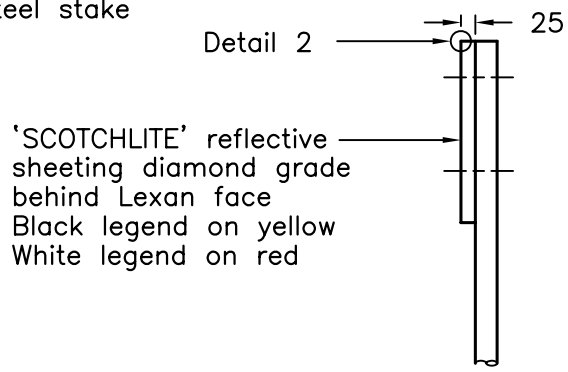
NOTE:

A All dimensions are in millimetres unless otherwise shown.

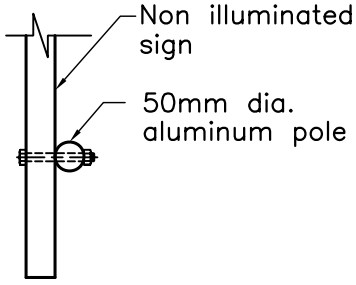
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	2
NON ILLUMINATED GUIDANCE SIGN ON WOODEN POLE	MTO–E10			



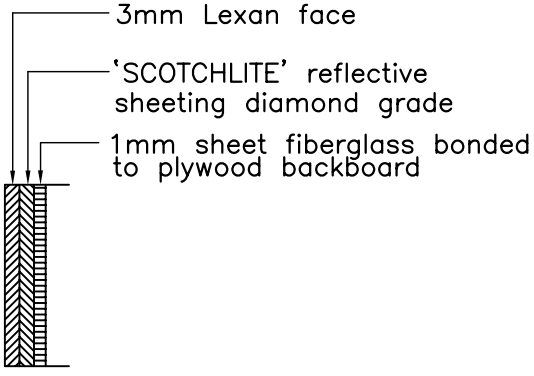
FRONT VIEW



SIDE VIEW



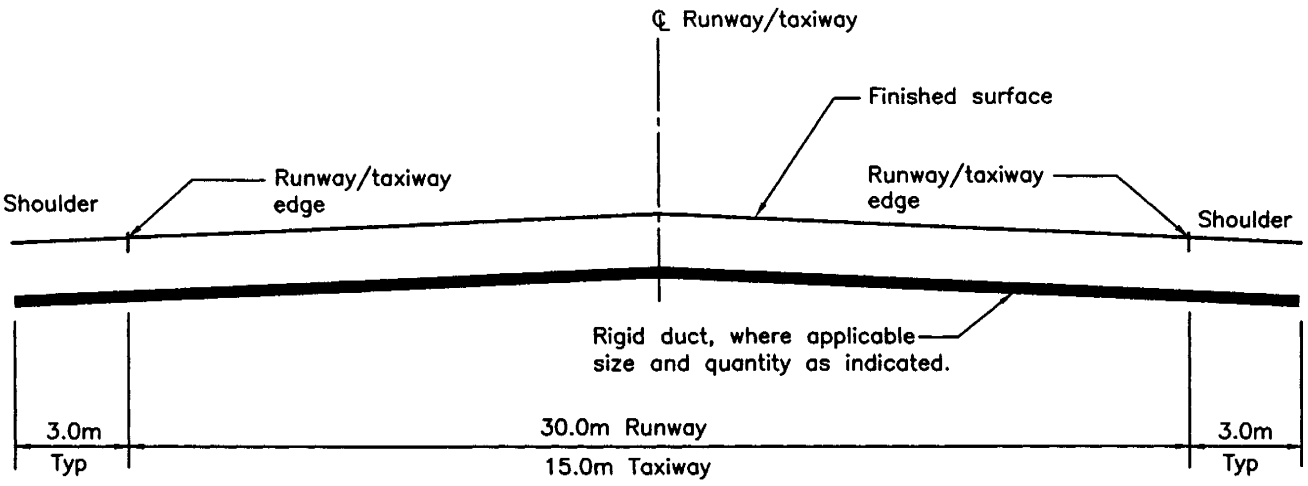
DETAIL 1



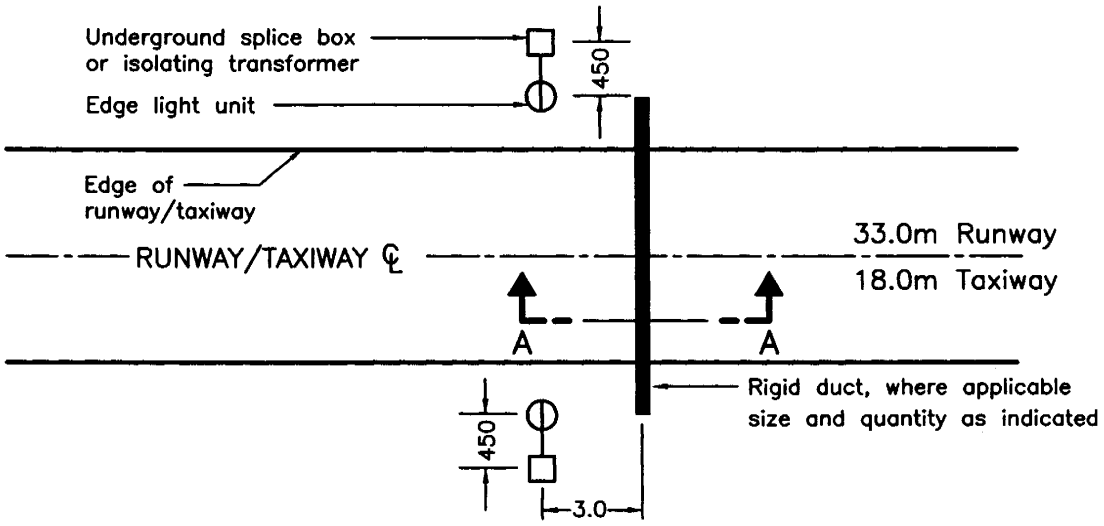
DETAIL 2

NOTE:
A All dimensions are in millimetres unless otherwise shown.

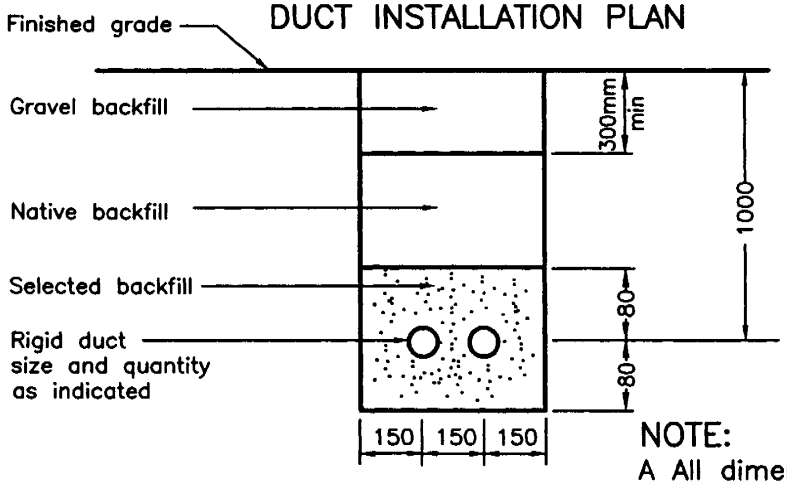
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev 1
NON ILLUMINATED GUIDANCE SIGN ON FRANGIBLE ALUMINUM POLE	MTO–E11		



DUCT INSTALLATION ELEVATION



DUCT INSTALLATION PLAN



SECTION A – A

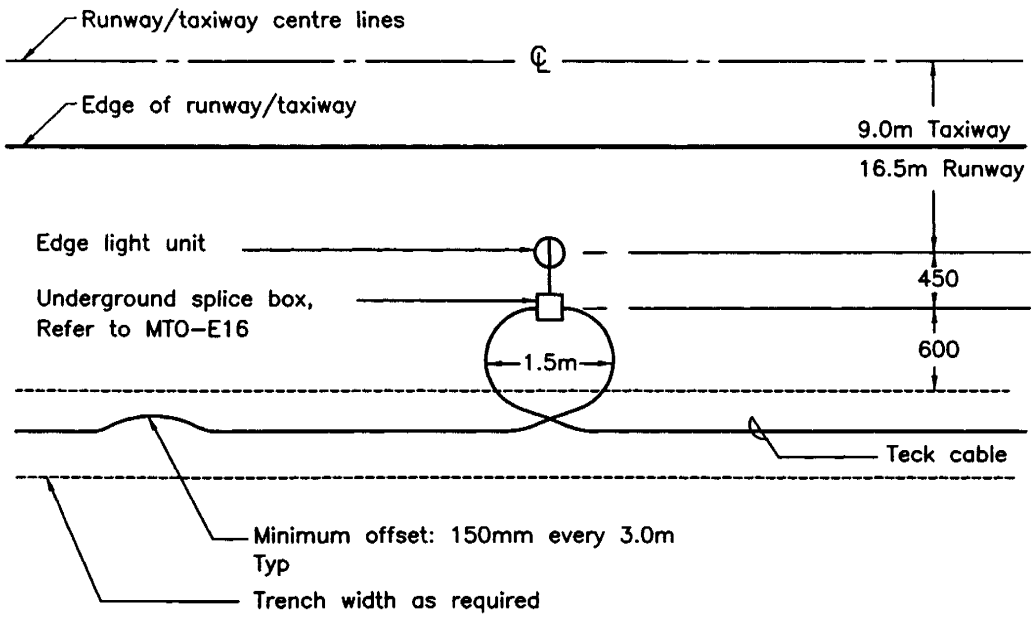
NOTE:
A All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

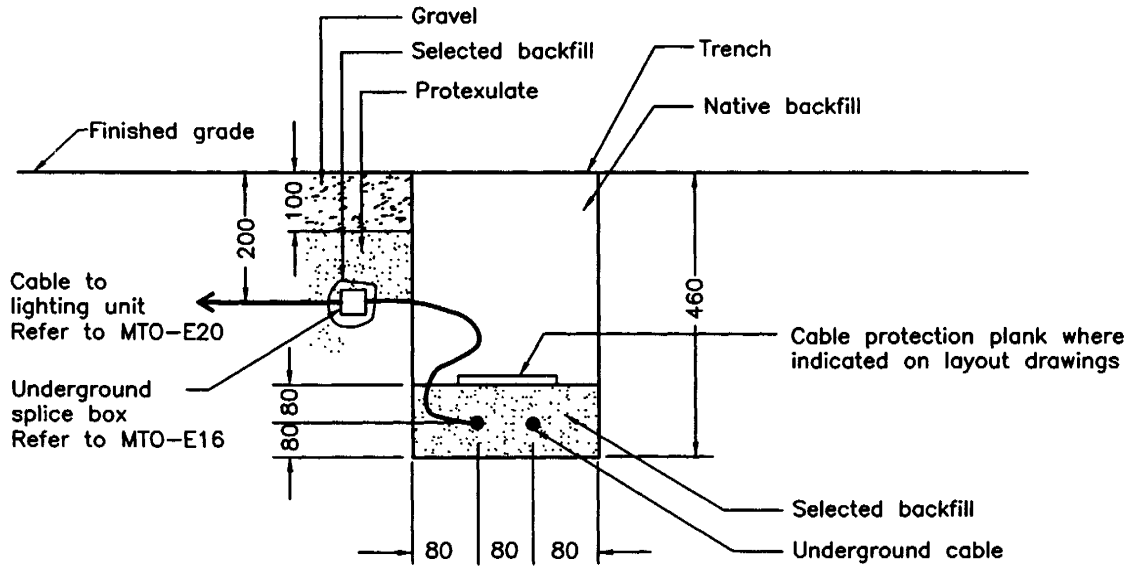
RIGID DUCT INSTALLATION DETAILS

Date	March 2001	Rev	3

MTO-E12



TRENCH AND EDGE LIGHT ARRANGEMENT LAYOUT

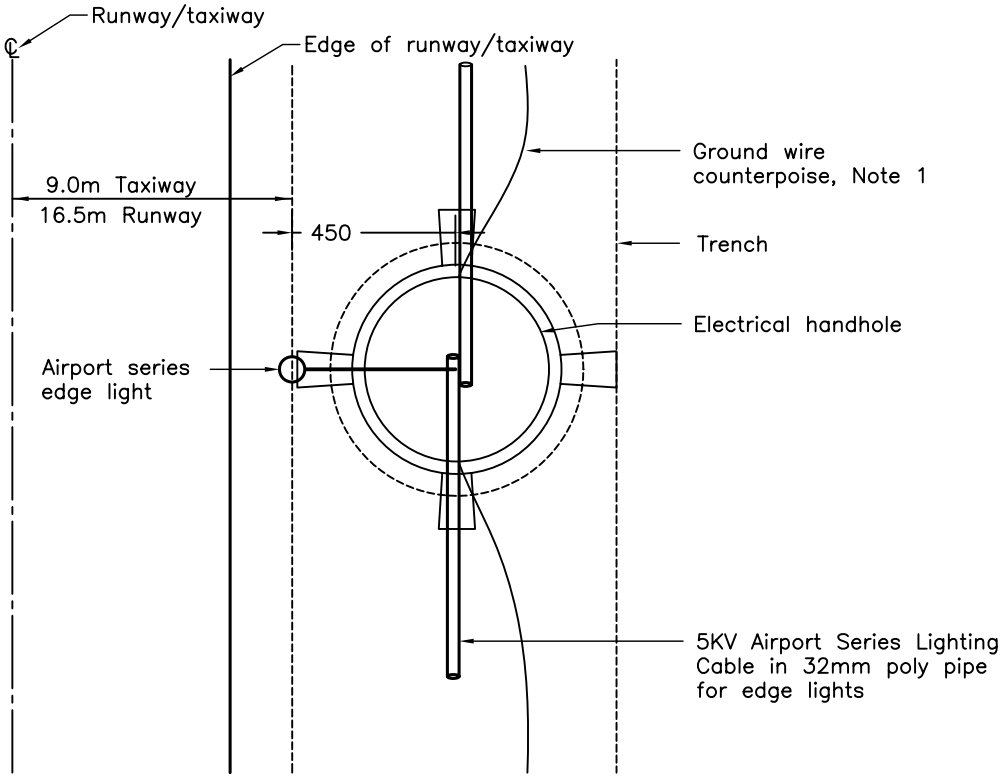


TRENCH PROFILE

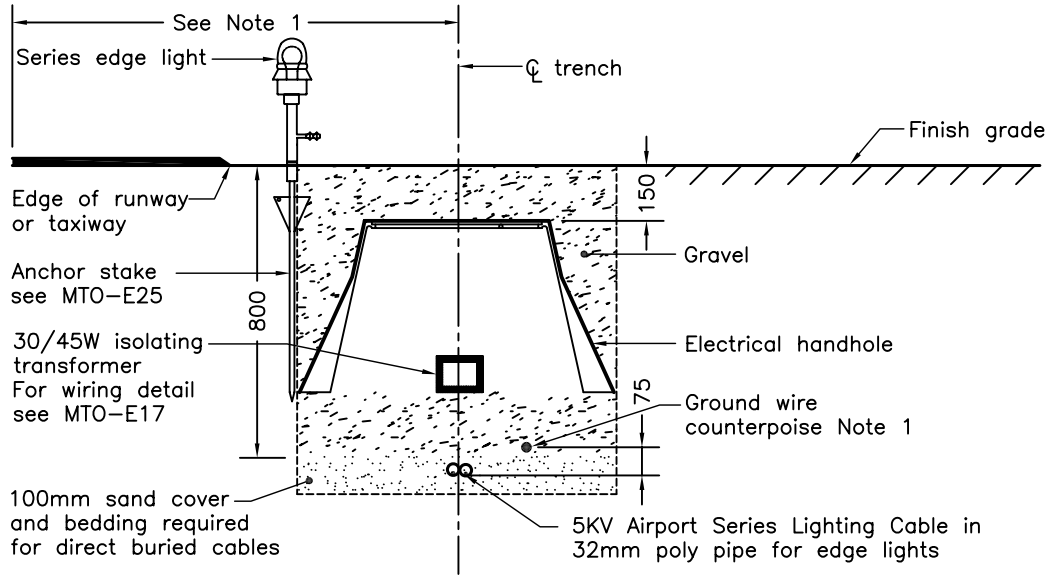
NOTE:

A All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2001	Rev 1
PARALLEL CONNECTED EDGE LIGHTING CABLE INSTALLATION			**MTO–E13**



TRENCH AND EDGE LIGHT ARRANGEMENT

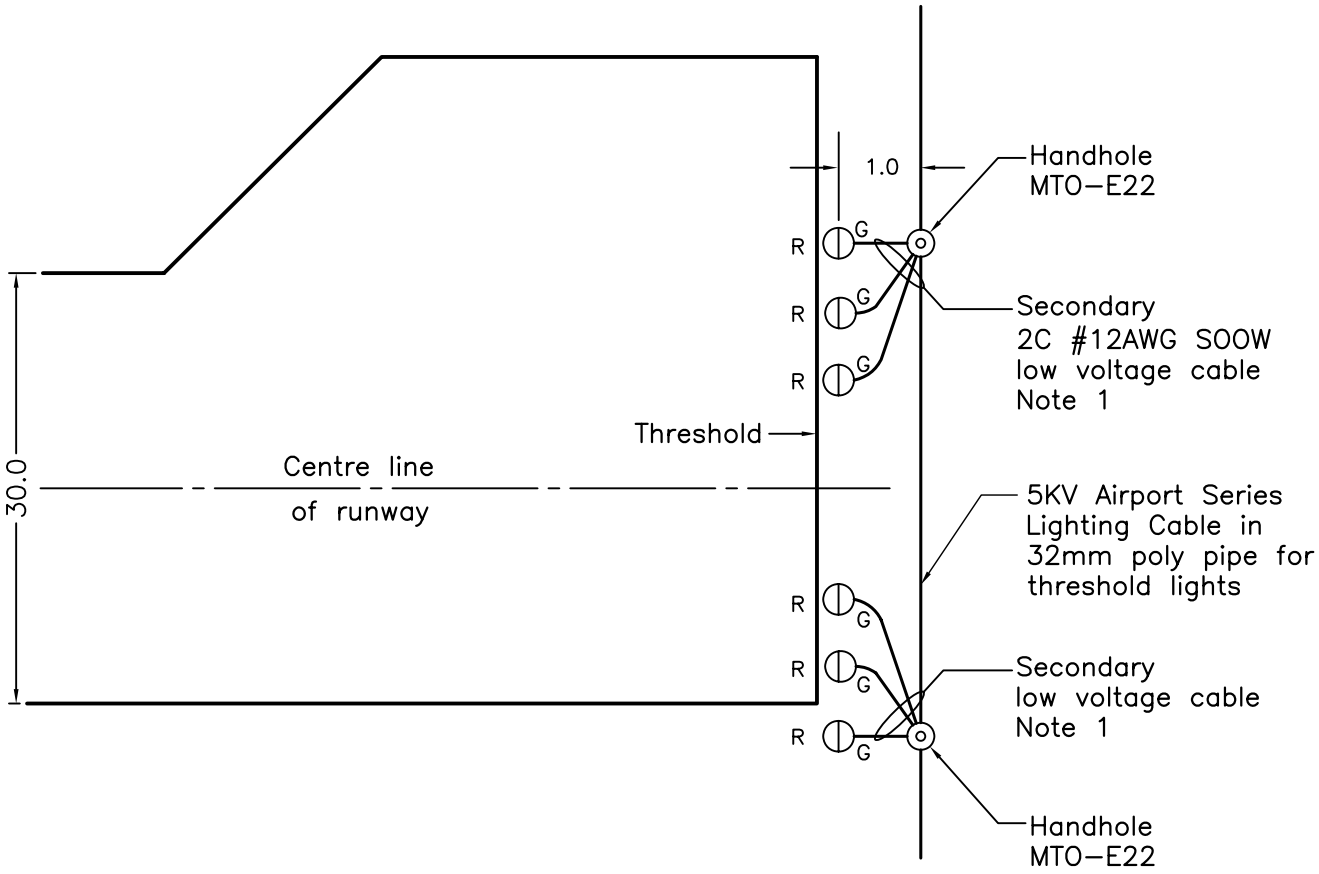


TRENCH AND EDGE LIGHT ARRANGEMENT PROFILE

NOTES:

1 Where trench contains both edge light and ASI circuits, zig–zag the ground counterpoise over the cables.
A Where more than one series circuit is present, install each circuit in separate 32mm poly pipe.
B Locate edgelight series cable on runway side of trench.
C Series cable and counterpoise to conform to latest C.E.S. section 74.
D All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev 2
SERIES CONNECTEDEDGE/THRESHOLD LIGHTING GENERAL ARRANGEMENT			MTO–E14

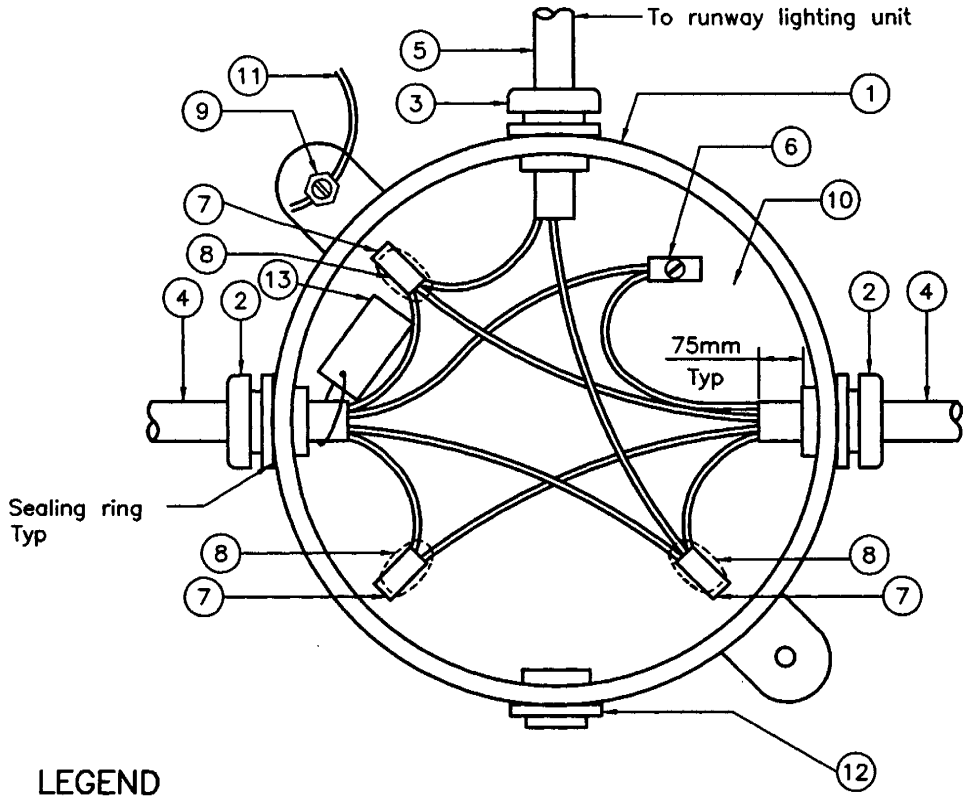


NOTES:

1 Cables shall be installed in 32mm poly pipe (3 lights per handhole).

A All dimensions are in meters unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	1
THRESHOLD LIGHTING **CABLE IN DUCT INSTALLATION LAYOUT**	**MTO–E15**			



LEGEND

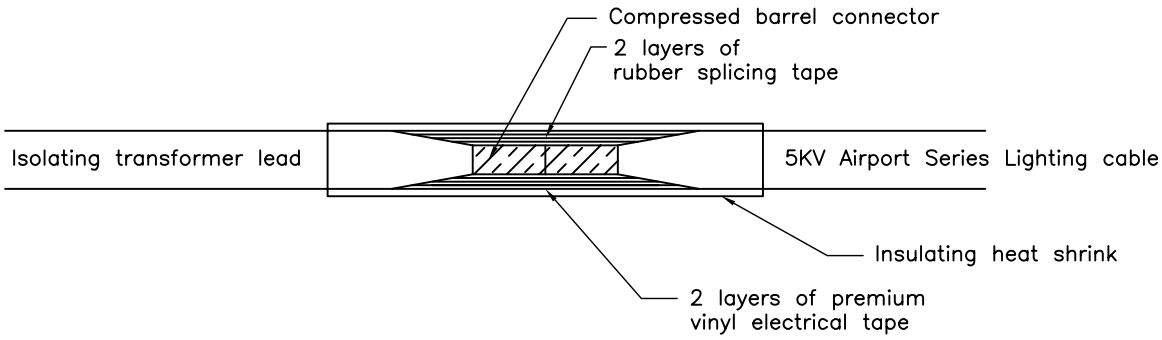
1. Aluminum splice box
2. Watertight connectors for teck cable c/w sealing ring
3. Liquid tight strain relief connector for 2/C No.12 AWG sow cable
4. Teck cable , 3/C No.10 AWG or as otherwise noted
5. 2/C No.12 AWG sow cable
6. Ground lug
7. Wire connectors vibration proof
8. Electrical insulation putty covered with two layers of vinyl plastic electrical tape.
9. External ground lug
10. Sealing compound –protexulate powder
11. No.8 AWG solid soft drawn copper ground wire to lighting anchor stake.
12. Waterproof threaded cap
13. Power source identification label

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

UNDERGROUND SPLICE BOX

Date	March 2001	Rev	1

MTO–E16

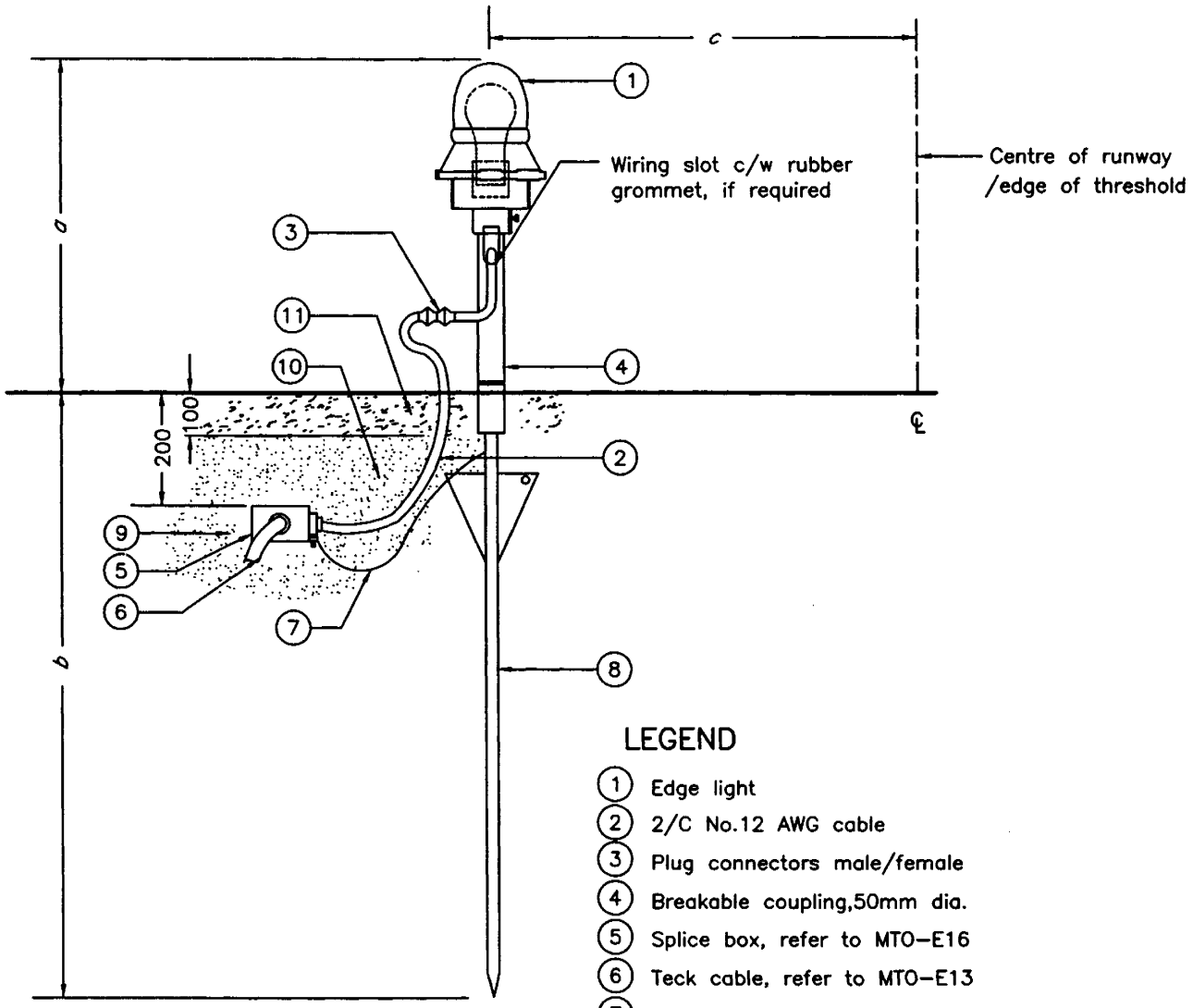


MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

BUTT SPLICE DETAIL

Date	March 2007	Rev	

MTO-E19



LEGEND

1. Edge light
2. 2/C No.12 AWG cable
3. Plug connectors male/female
4. Breakable coupling,50mm dia.
5. Splice box, refer to MTO–E16
6. Teck cable, refer to MTO–E13
7. No.8 AWG solid,soft drawn bare copper ground wire
8. Lighting anchor stake, refer to MTO–E25
9. Protexulate powder, approximatly 75mm around splice box
10. Selected backfill
11. Gravel

TABLE

	a	*b*	*c*
THRESHOLD LIGHT	.35m	1.0m	.3m
EDGE LIGHT	.35m	1.0m	16.5m

NOTE:

A All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

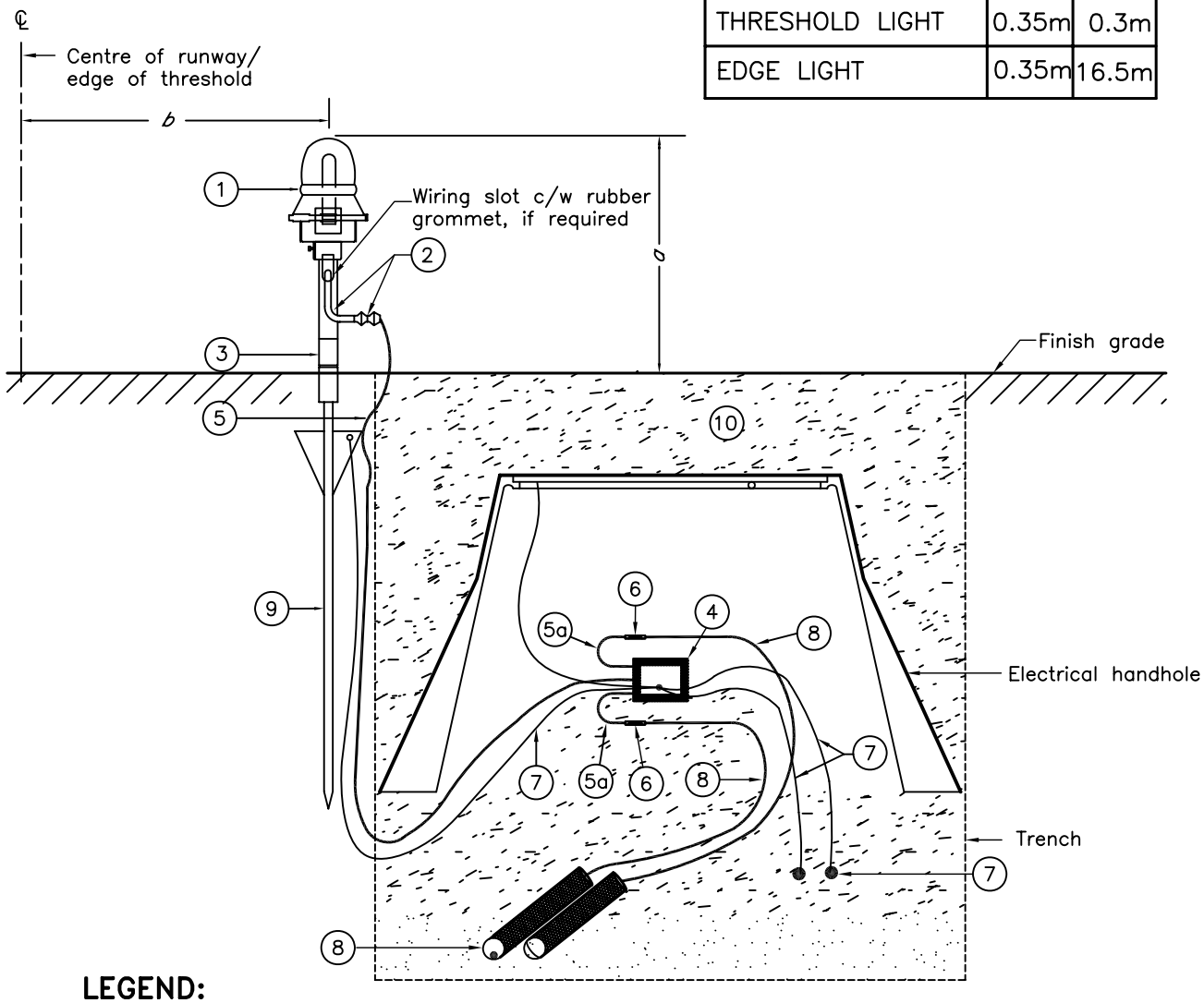
PARALLEL CONNECTED EDGE LIGHT INSTALLATION

Date	March 2001	Rev	3

MTO–E20

TABLE

	a	*b*
THRESHOLD LIGHT	0.35m	0.3m
EDGE LIGHT	0.35m	16.5m



LEGEND:

1. 6.6A, T10, 1P series lamp
2. Edge light fixture lead assembly with moulded male connector
3. Breakable coupling, 50mm dia.
4. Isolating transformer, 30/45W for edgelights/100W for threshold lights.
5. Transformer secondary lead, 1.2m long c/w moulded female connector

5a. Transformer primary leads, 0.6m long

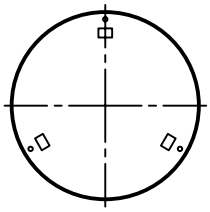
6. Series lighting cable, butt splice
7. Series circuit ground counterpoise, #8 AWG solid soft drawn bare copper wire
8. 5KV Airport Series Lighting Cable in 32mm poly pipe for edge lights
9. Lighting anchor stake, refer to MTO–E25
10. Gravel

NOTES:

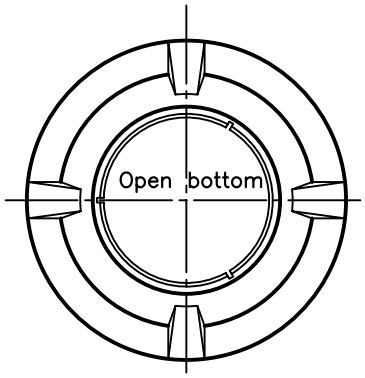
A For threshold lighting connection, 3 isolating transformers inside the bigger handhole are required.

B All dimensions are in millimetres unless otherwise shown.

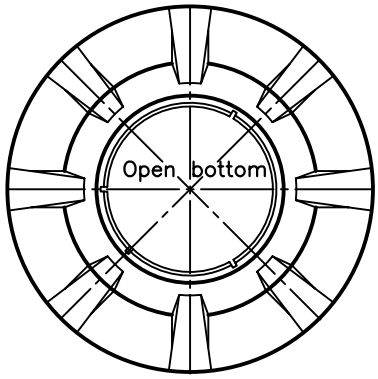
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	2
SERIES CONNECTED EDGE/THRESHOLD LIGHTING GENERAL CABLE ARRANGEMENT				MTO–E21



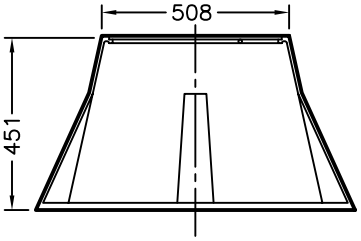
STEEL LOCKING COVER
bottom view



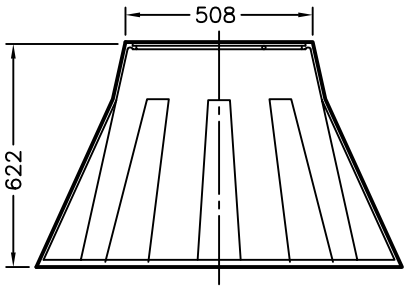
PLAN VIEW



PLAN VIEW



FRONT VIEW



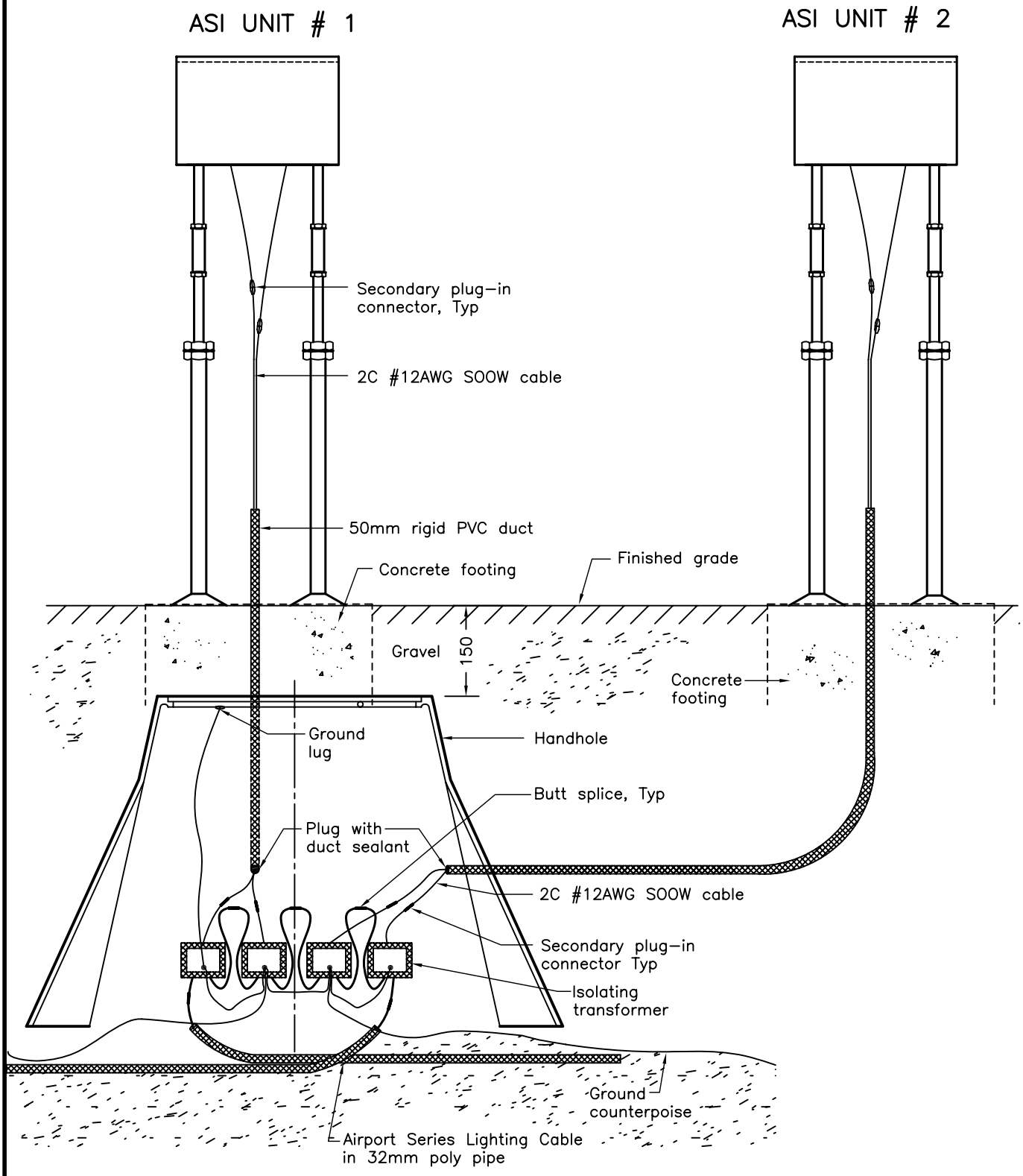
FRONT VIEW

NOTES:

A Small handhole is used for edge light, sign lighting and wind direction indicator. Bigger handhole is for approach slope indicator, threshold lighting, taxiway intersection.

B All dimensions are in milimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	1
ELECTRICAL HANDHOLE POLYETHYLENE				
	MTO–E22			



NOTES:

A Diagram shown is for APAPI installation. For PAPI installation see MTOD–E24.1.
B All dimensions are in millimetres unless otherwise shown.

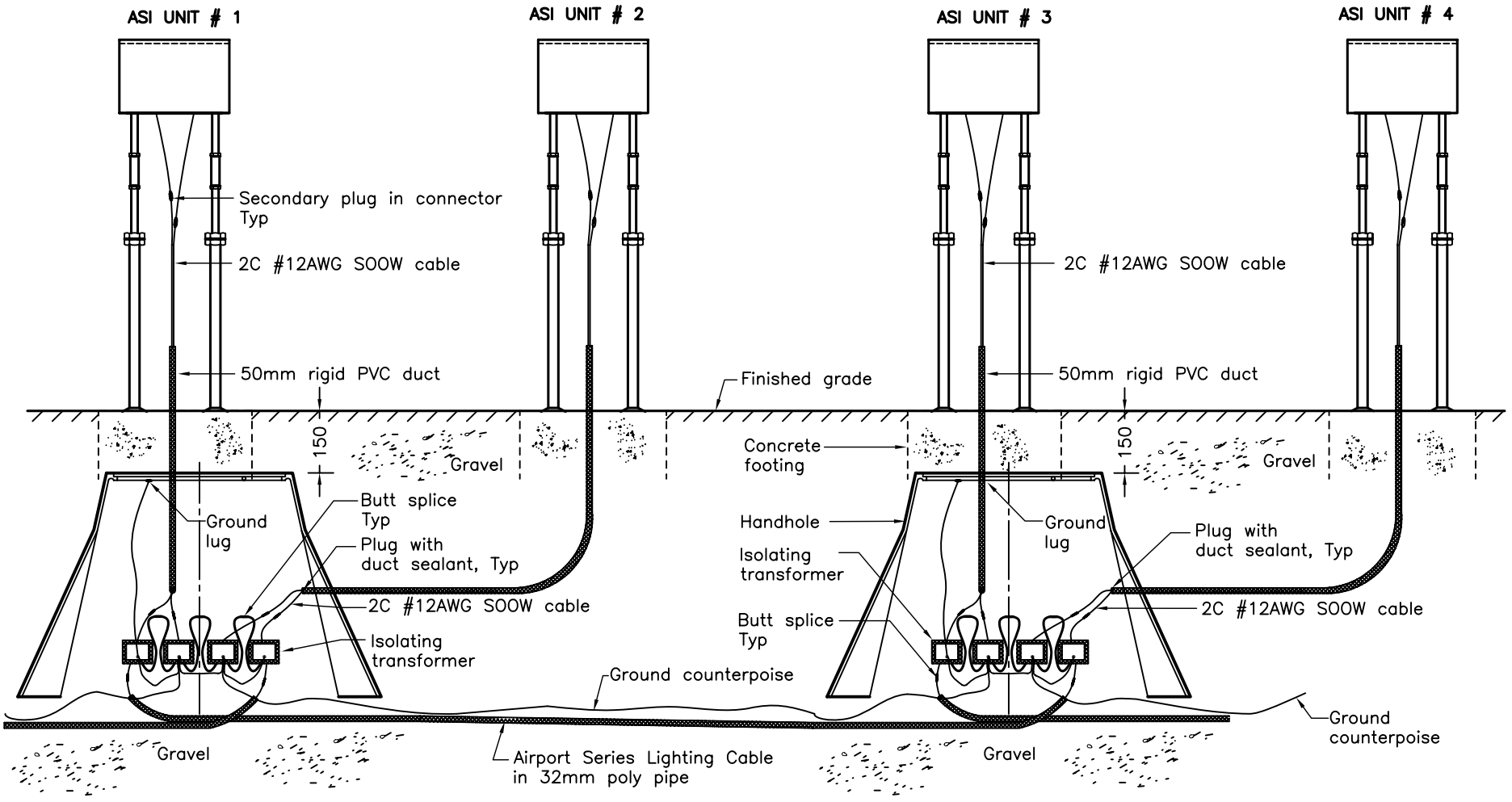
MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

APPROACH SLOPE INDICATOR (ASI)

APAPI UNIT INSTALLATION

Date	March 2007	Rev	2

MTO–E24



NOTE:

A All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO

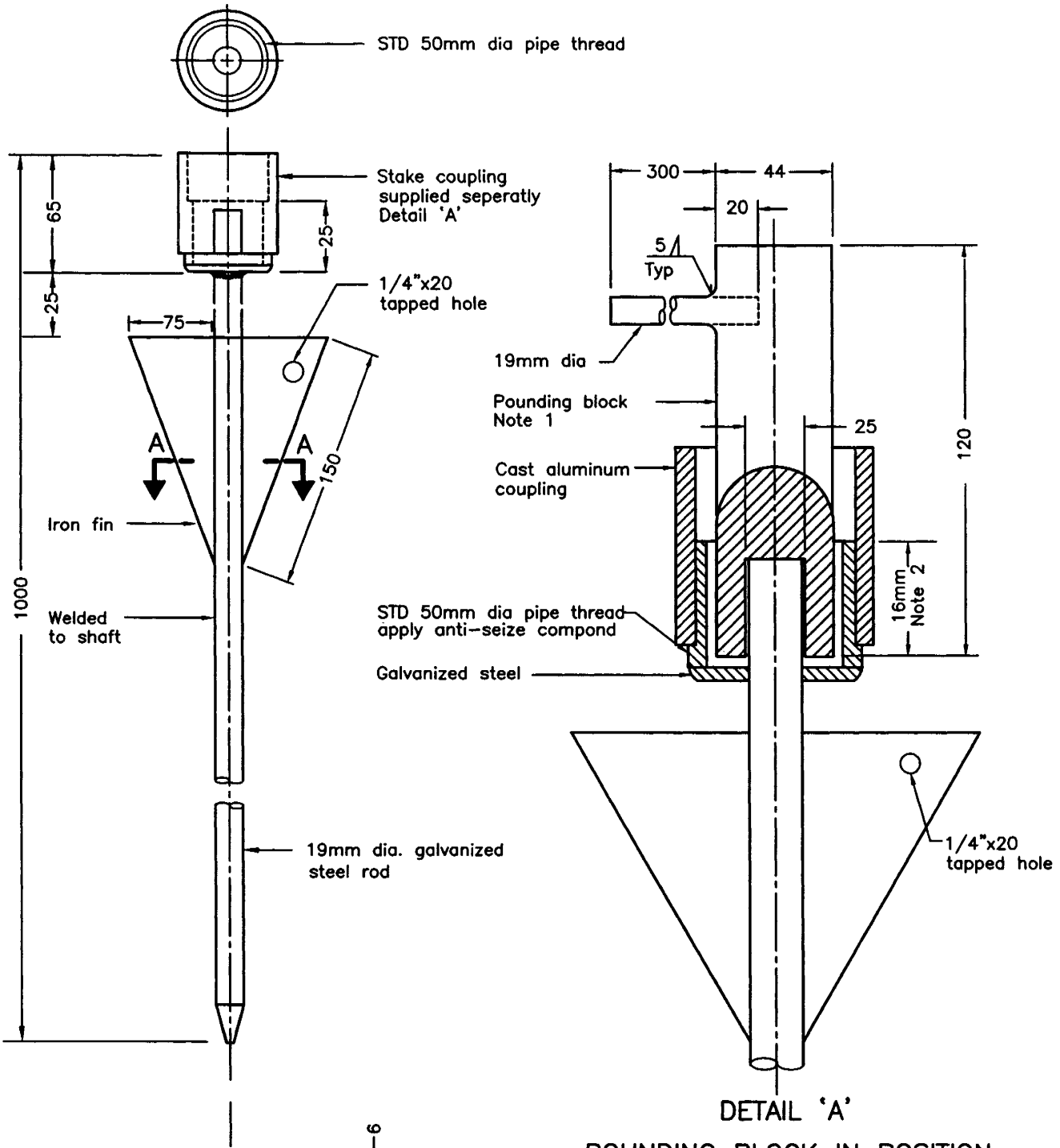
AIRPORT STANDARD DRAWING ELECTRICAL

APPROACH SLOPE INDICATOR (ASI)

PAPI UNITS INSTALLATION

Date	March 2007	Rev	

MTO–E24.1



SECTION A–A

DETAIL 'A'

POUNDING BLOCK IN POSITION

NOTES:

1 Pounding block to be supplied as a separate item. steel type: ASTM A325, refer to CSA standard CAN3–S16.1

2 Thread length shall be 16mm above weld joint.

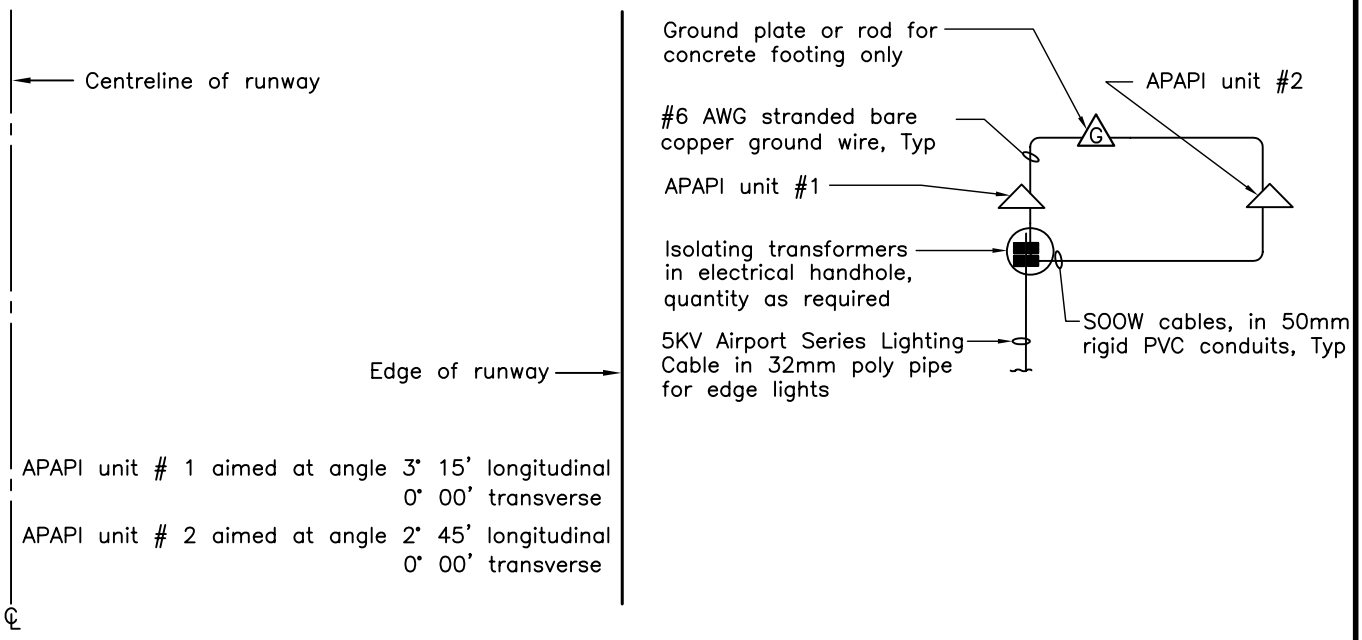
A All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

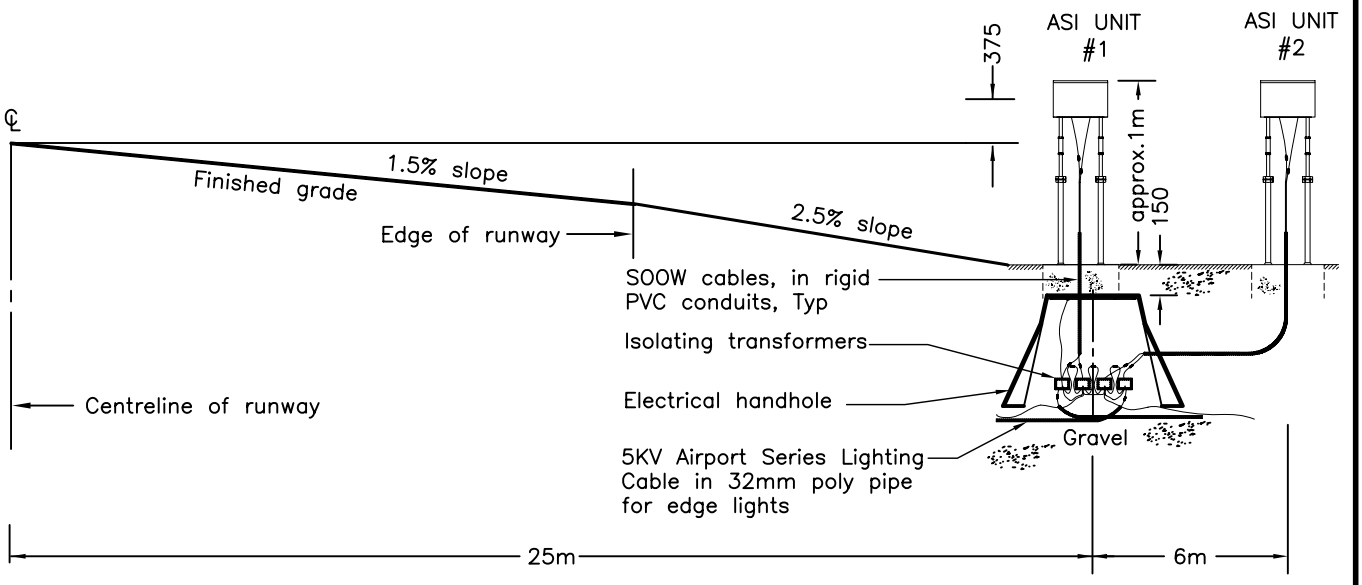
Date	March 2001	Rev	3

EDGE LIGHT ANCHOR STAKE

MTO–E25



LAYOUT

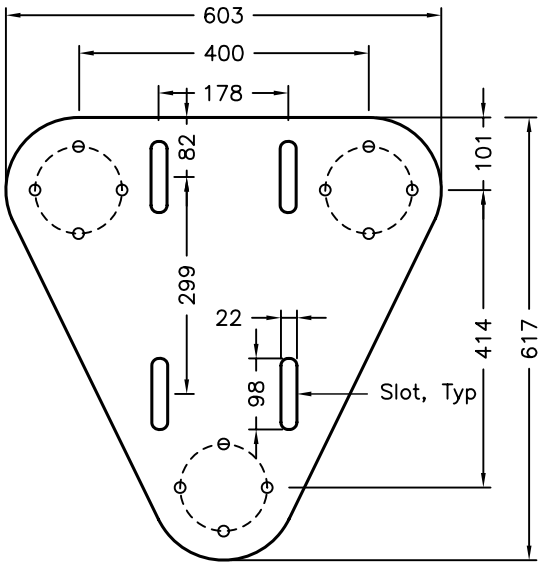


ELEVATION

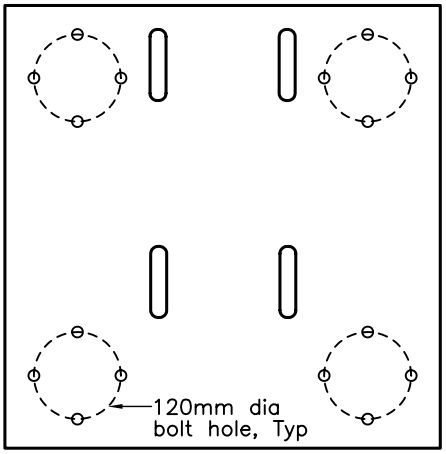
NOTES:

A Refer to MTO–E33 and MTO–E35 for installation and footing details.
B Refer to MTO–E24 for electrical handhole installation details.
C For location and quantities of equipment refer to layout drawings.
D All dimensions are in metres unless otherwise shown.

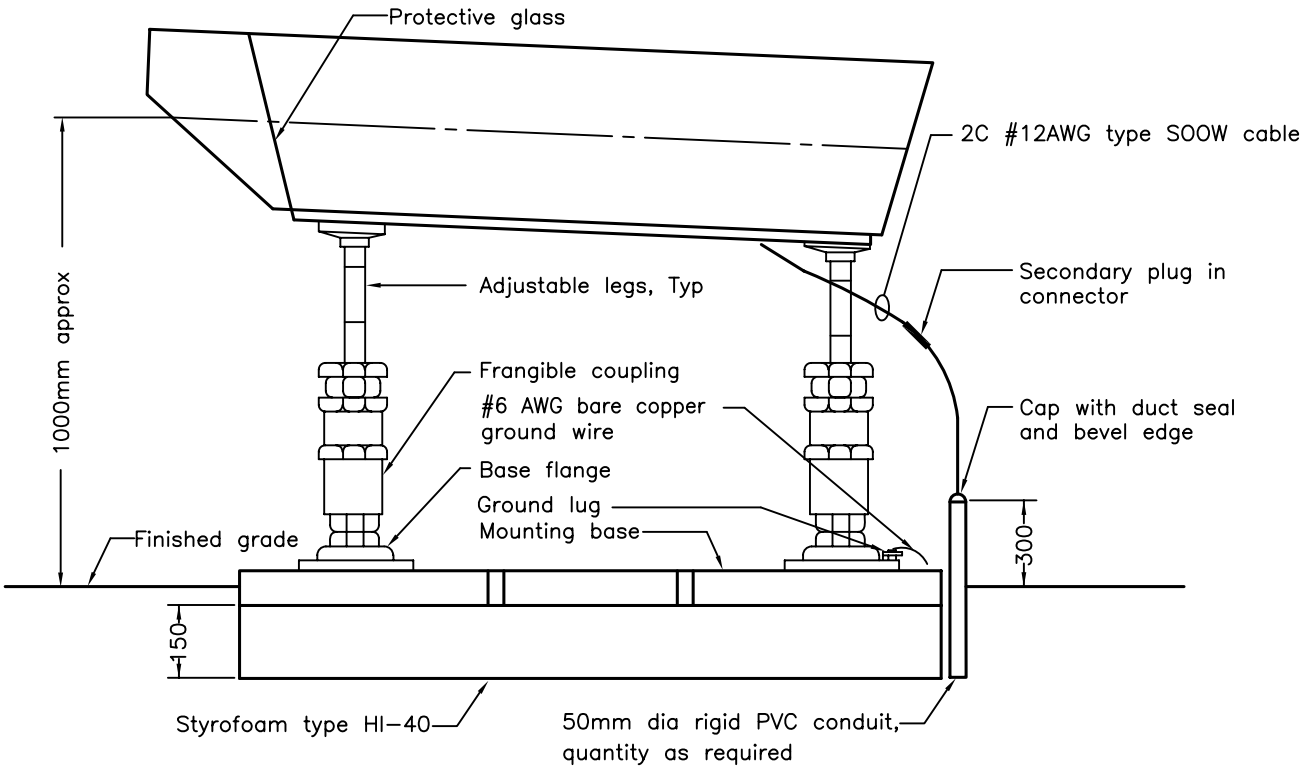
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	3
ASI UNIT LAYOUT DETAIL				
	MTO–E30			



BASE ONE
THREE LEGS UNIT



BASE TWO
FOUR LEGS UNIT

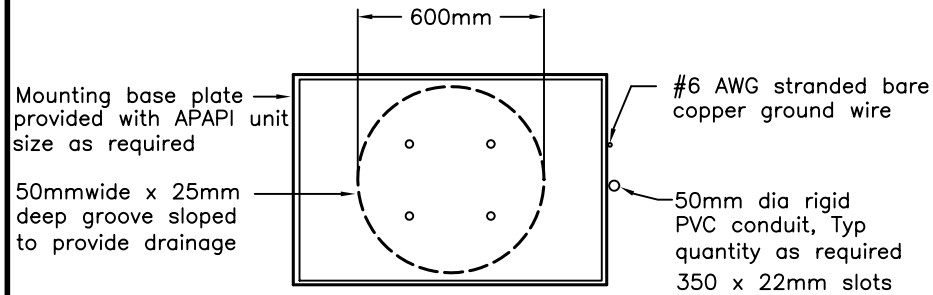


NOTES:

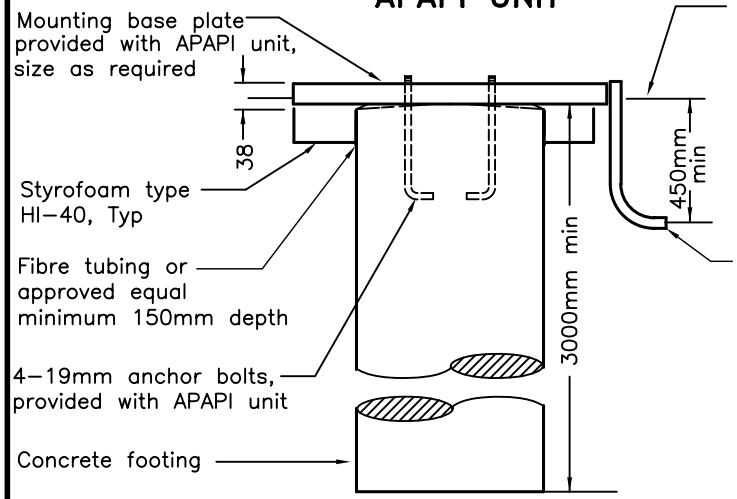
A For ASI footing details refer to drawing MTO-E35.

B All dimensions are in millimetres unless otherwise shown.

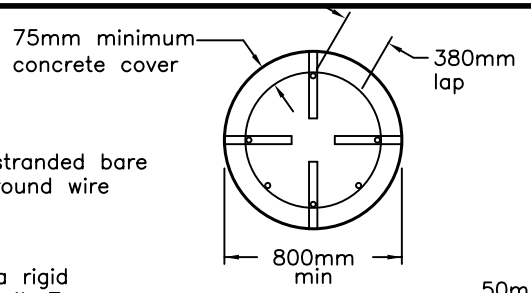
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	3
ASI UNIT MOUNTING DETAIL				
	MTO-E33			

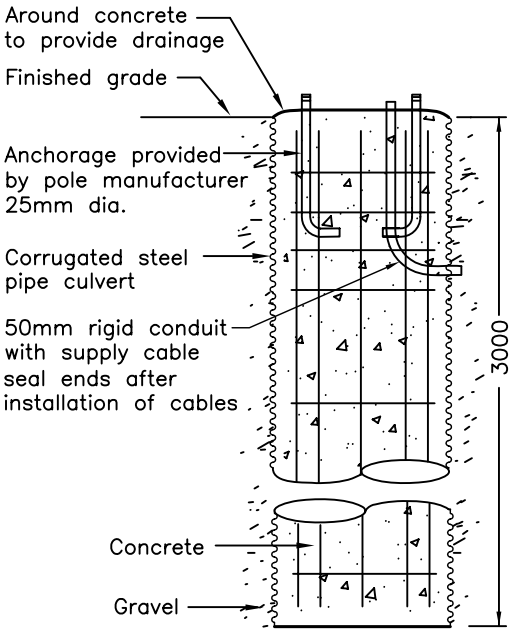


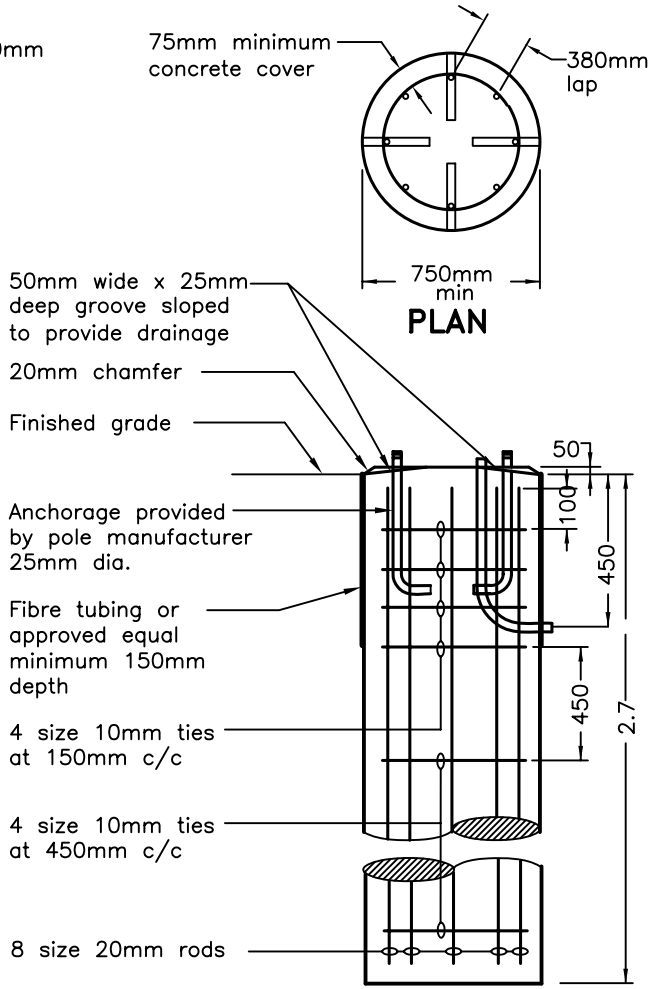
BASE PLATE FOR APAPI UNIT



APPROACH SLOPE INDICATOR







WIND DIRECTION INDICATOR OR LIGHTING POLE

NOTES:

A The manufacturer of the equipment, must supply the base plate to match the footing assembly.

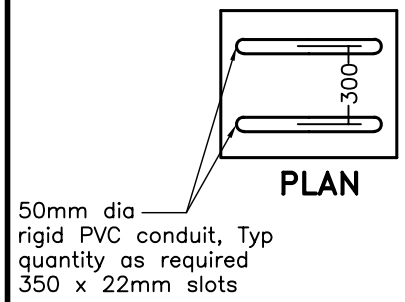
B All dimensions are in millimetres or metres unless otherwise shown.

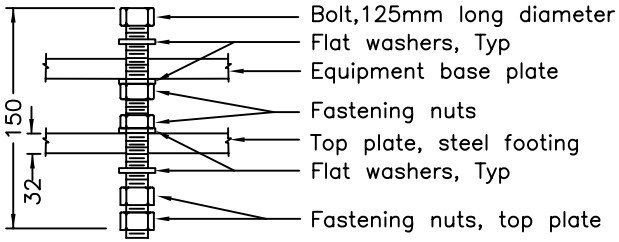
MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

CONCRETE FOOTING FOR ASI UNIT WIND DIRECTION INDICATOR AND LIGHTING POLE

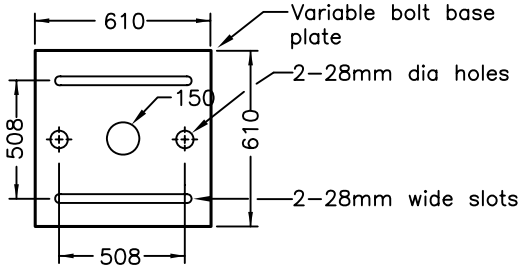
Date	March 2007	Rev	3

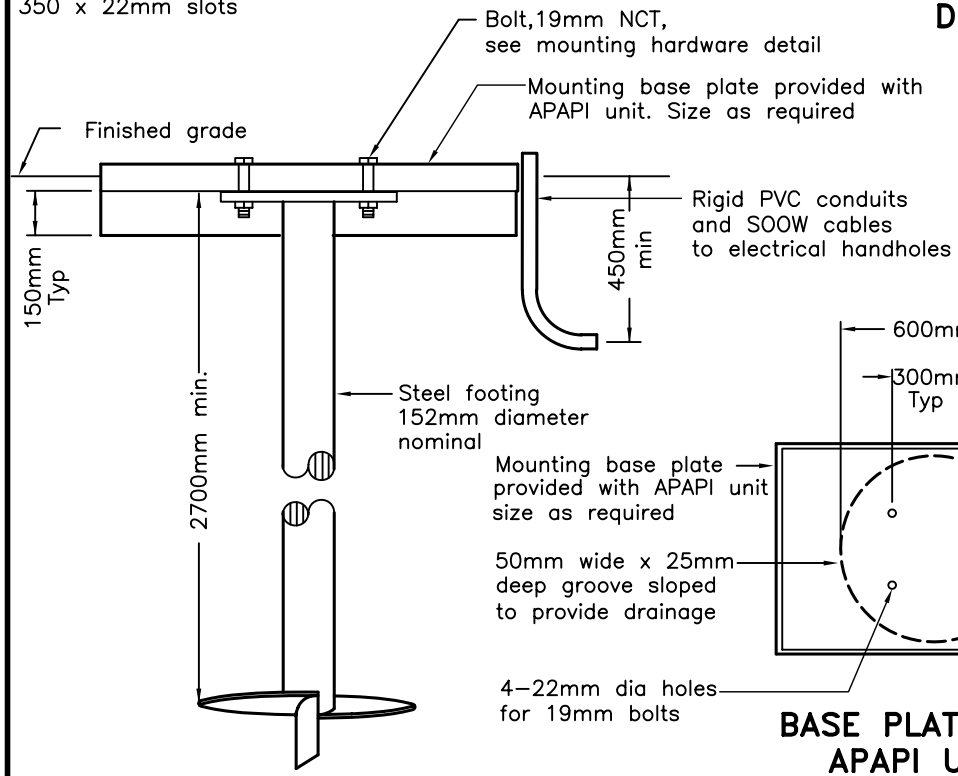
MTO–E35





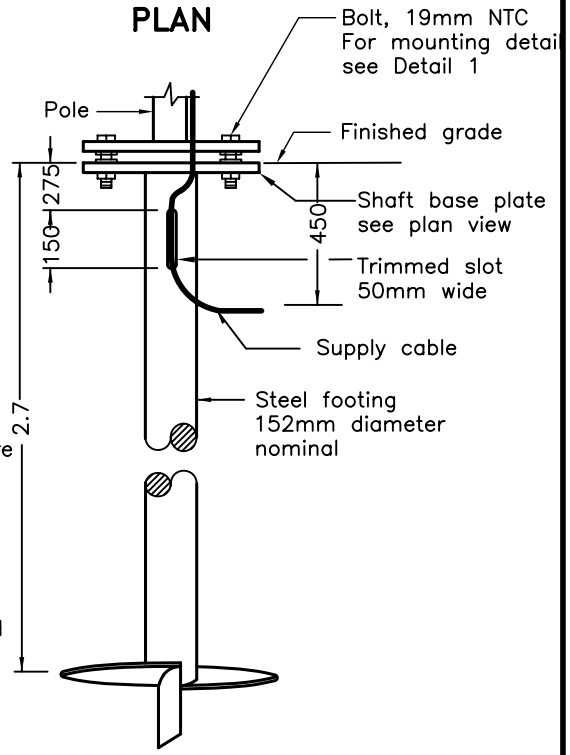
MOUNTING HARDWARE
FOR STEEL FOOTING
DETAIL 1





APPROACH SLOPE INDICATOR

BASE PLATE FOR
APAPI UNIT



WIND DIRECTION INDICATOR AND LIGHTING POLE

NOTES:

A The manufacturer of the equipment, must supply the base plate to match the steel footing assembly.

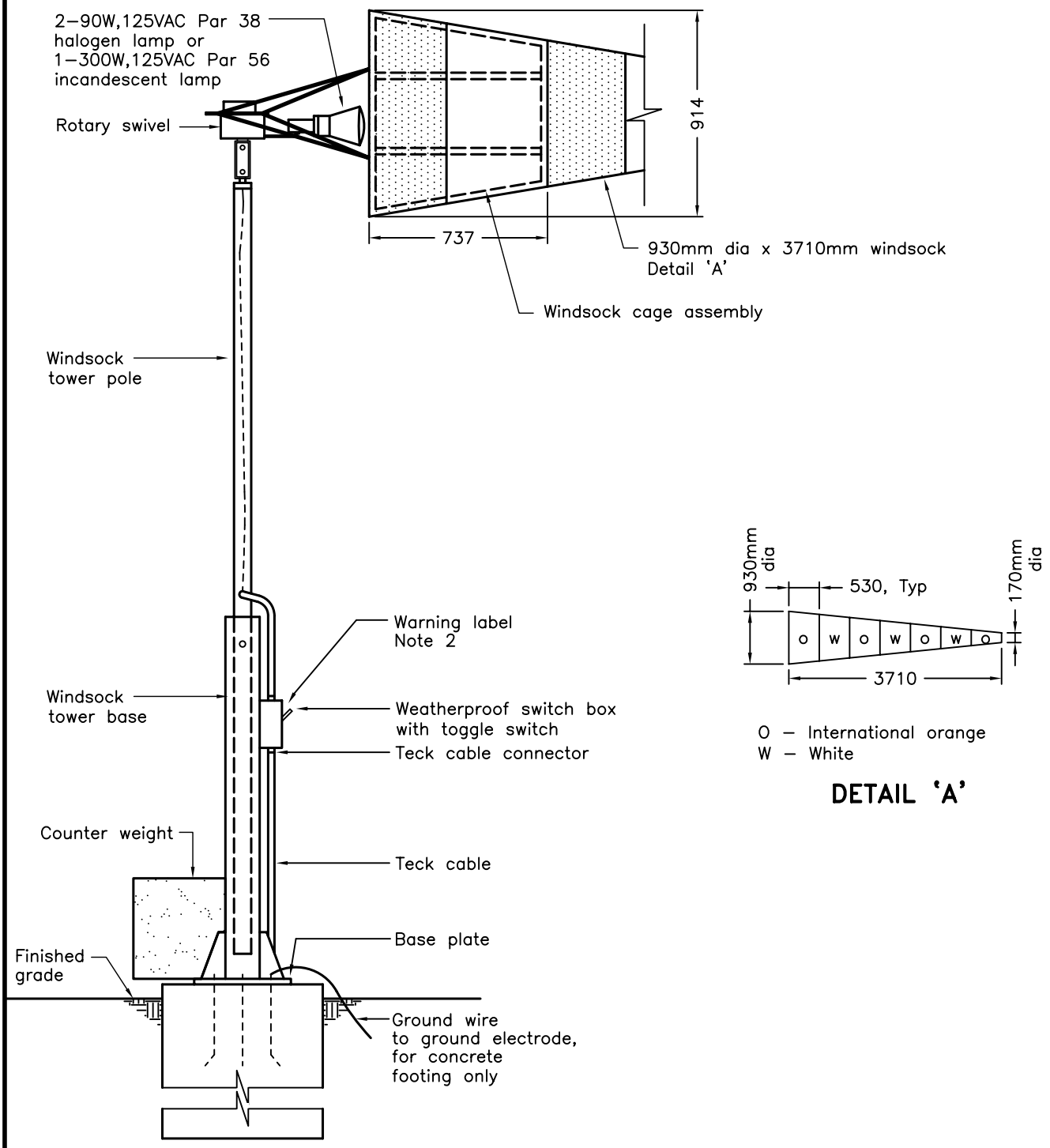
B All dimensions are in millimetres or metres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

STEEL FOOTING FOR ASI UNIT WIND DIRECTION INDICATOR AND LIGHTING POLE

Date	March 2007	Rev	

MTO–E36



O – International orange
W – White

DETAIL 'A'

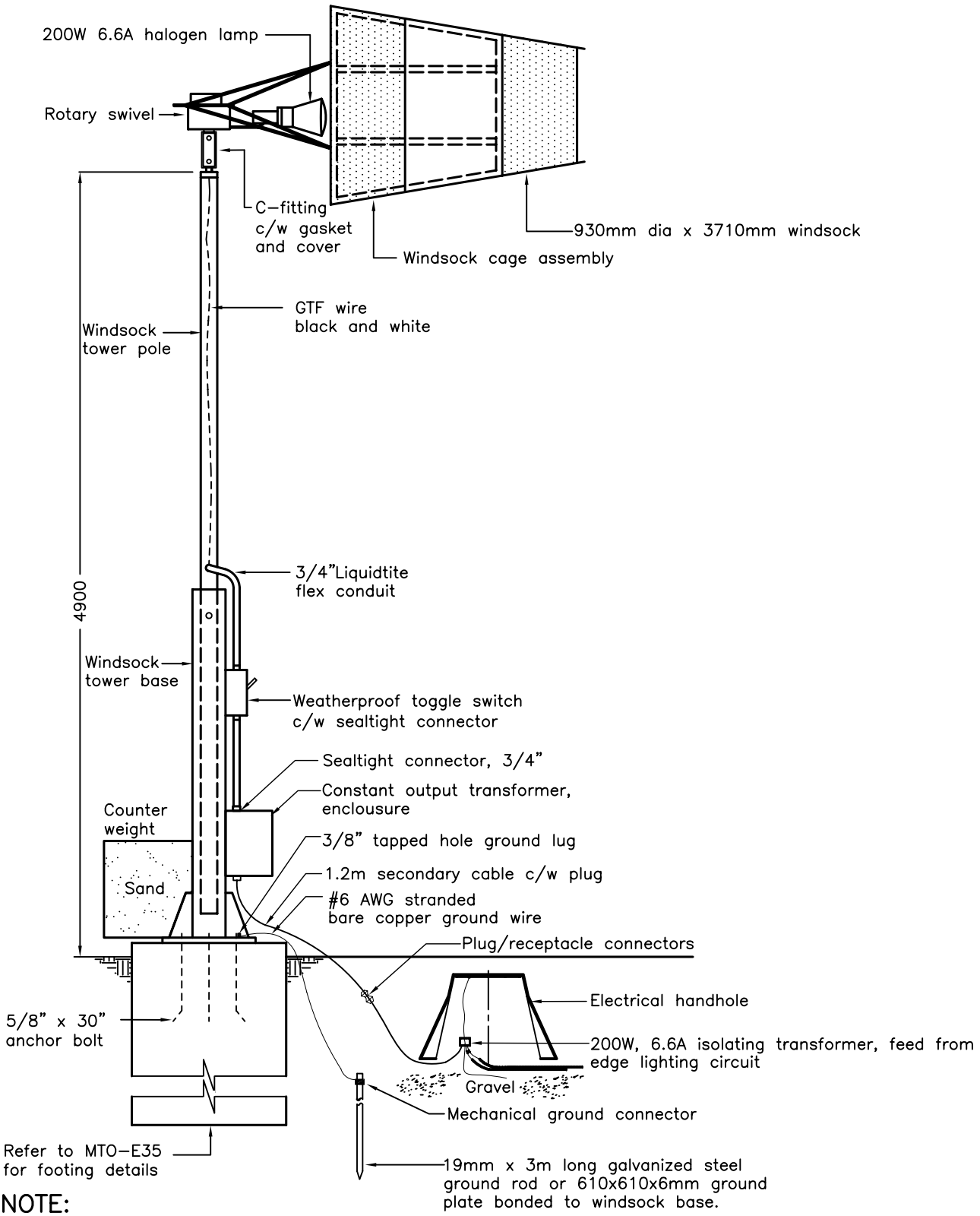
NOTES:

1 Refer to MTO–E35 for wind direction indicator footing details.

2 Warning label to read: 'Warning:120Volts
CCT.LP2–10'

A All dimensions are in millimetres unless otherwise shown.

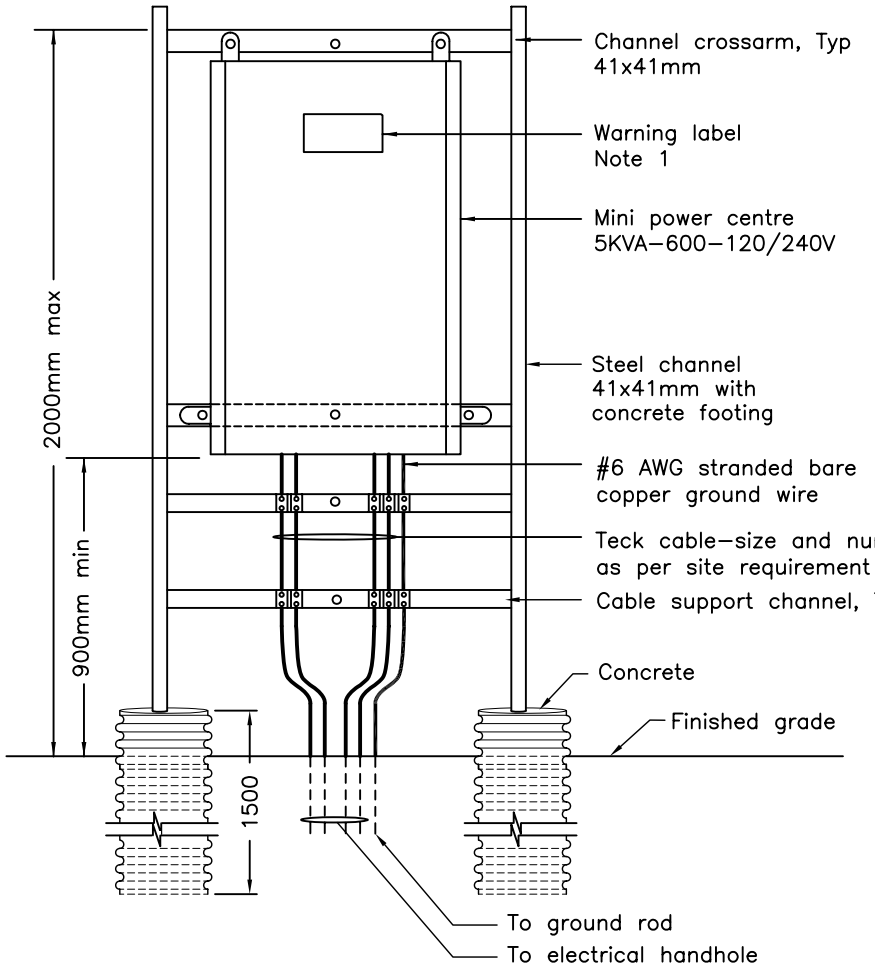
MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev 3
120V WIND DIRECTION INDICATOR DETAIL PARALLEL CIRCUITS			MTO–E40



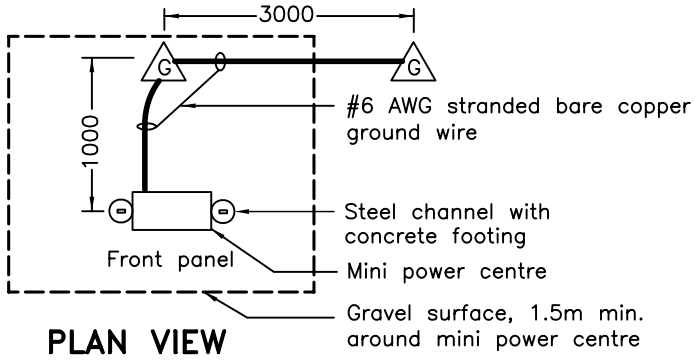
NOTE:

A All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	3
WIND DIRECTION INDICATOR DETAIL SERIES CIRCUITS				MTO–E41



ELEVATION – MOUNTING ON STEEL CHANELS



PLAN VIEW

NOTES:

1 Warning label to read:
'MINI POWER CENTRE, PANEL LP2.
WARNING: 600VOLTS DISCONNECT POWER SUPPLY, CCT.LP1–2,4 BEFORE OPENING'

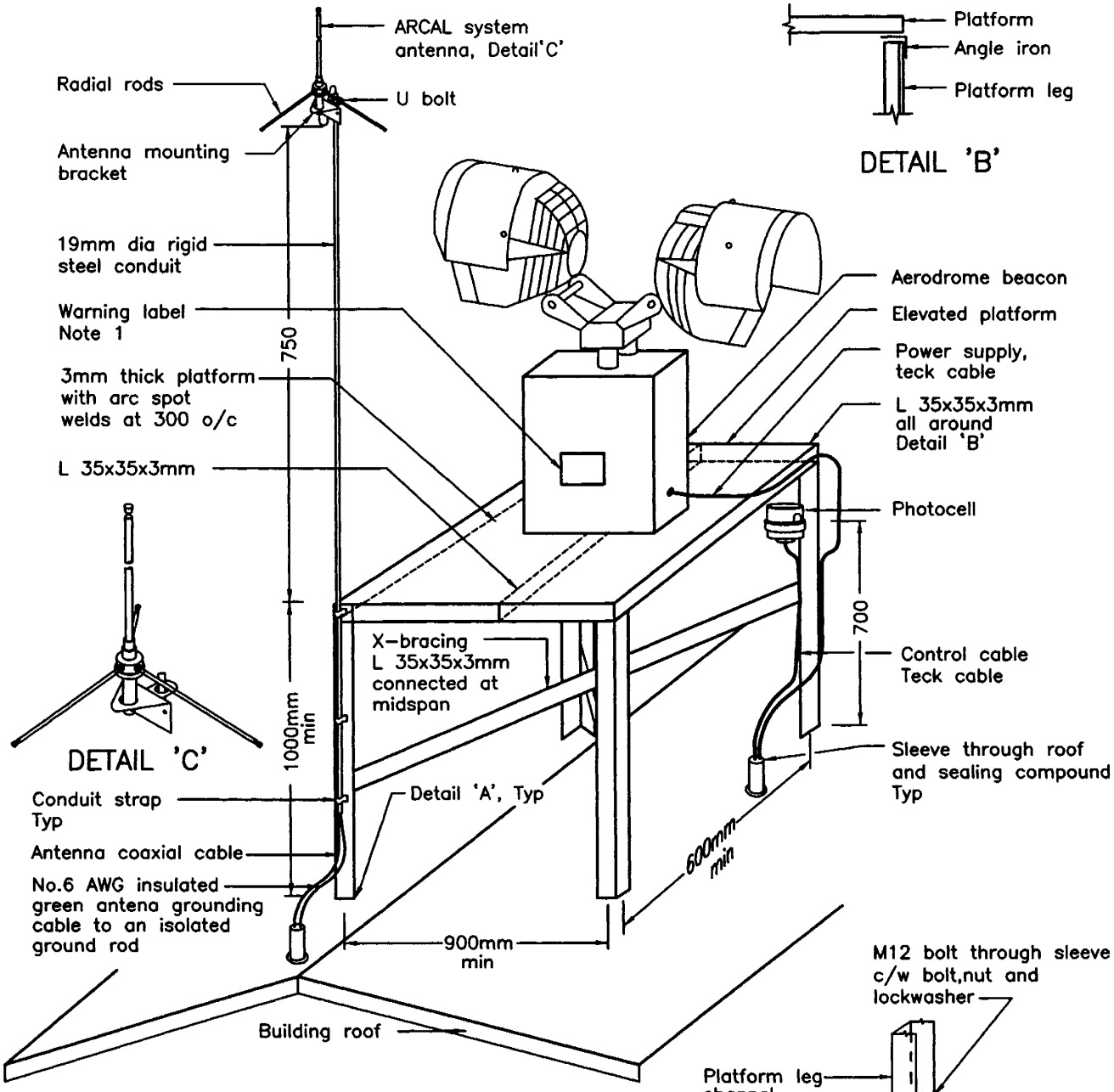
A All dimensions are in millimetres unless otherwise shown.

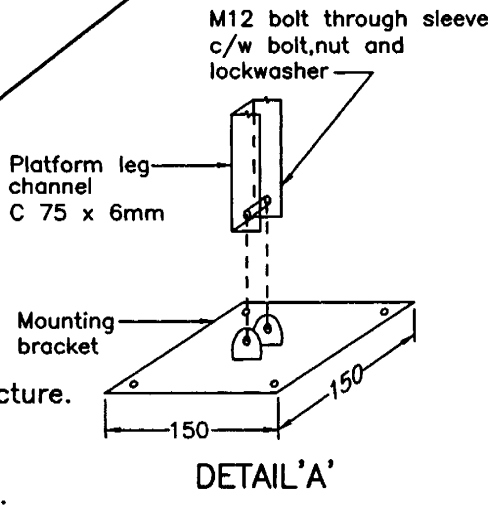
MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

MINI POWER CENTRE MOUNTING DETAIL

Date	March 2007	Rev	2

MTO–E45





NOTES:

1 Warning label to read:
WARNING: DISCONNECT POWER SUPPLY
CCT. LP1-7 AND CCT. LP1-9 BEFORE OPENING.

A All cables shall be securely fastened to platform structure.

B Cable penetrations through roof and platform mounting bracket attachments, shall be waterproof.

C Mounting platform assembly shall be finished in black. apply 3 coats of rust protection paint

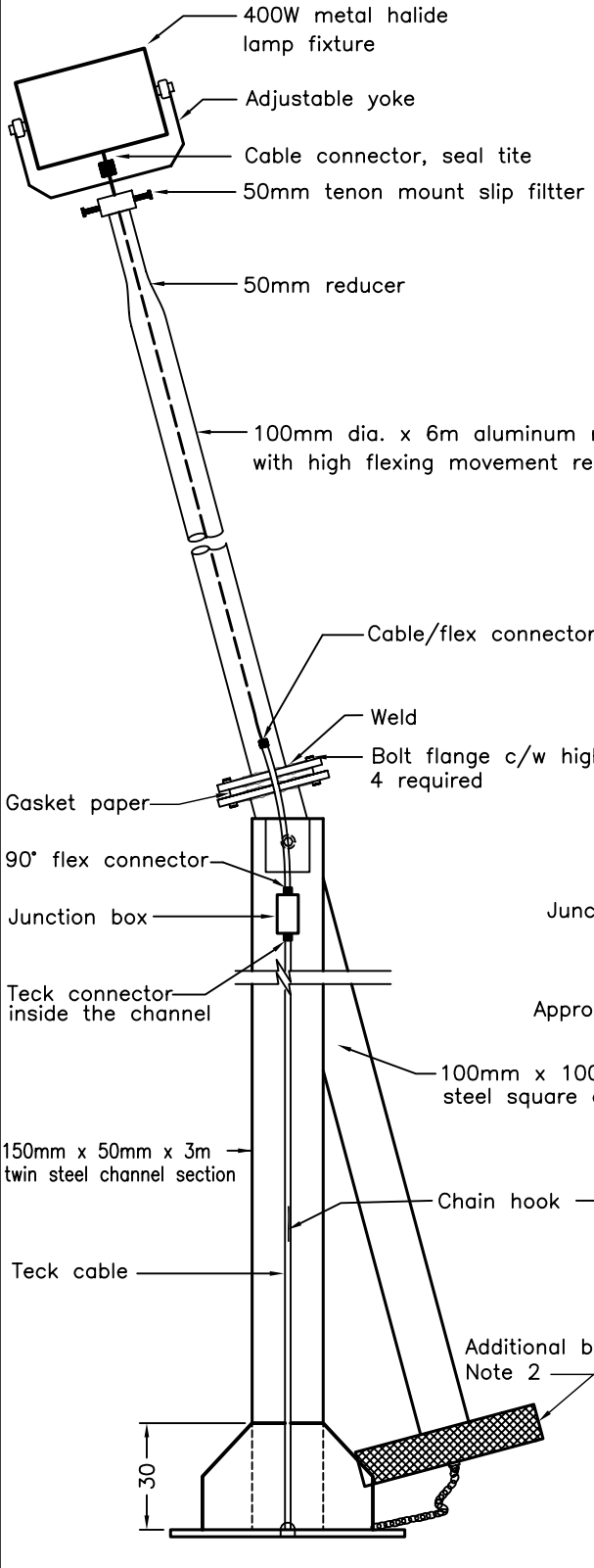
D All dimensions are in millimetres unless otherwise shown.

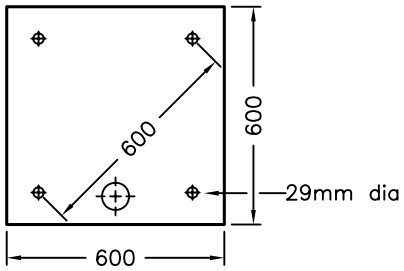
MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

Date	March 2001	Rev	1

ROOF TOP EQUIPMENT MOUNTING DETAIL

MTO-E50





BASE PLATE

NOTES:

1 Base plate and counter weight to have eyelet welded or bolted, with appropriate length of chain connected to act as a safety stop. Fixture to be held to 75 to 100mm arm

2 Additional ballast affixed to 100mm square channel to allow to raise or lower the pole with no more than 15kg external force.

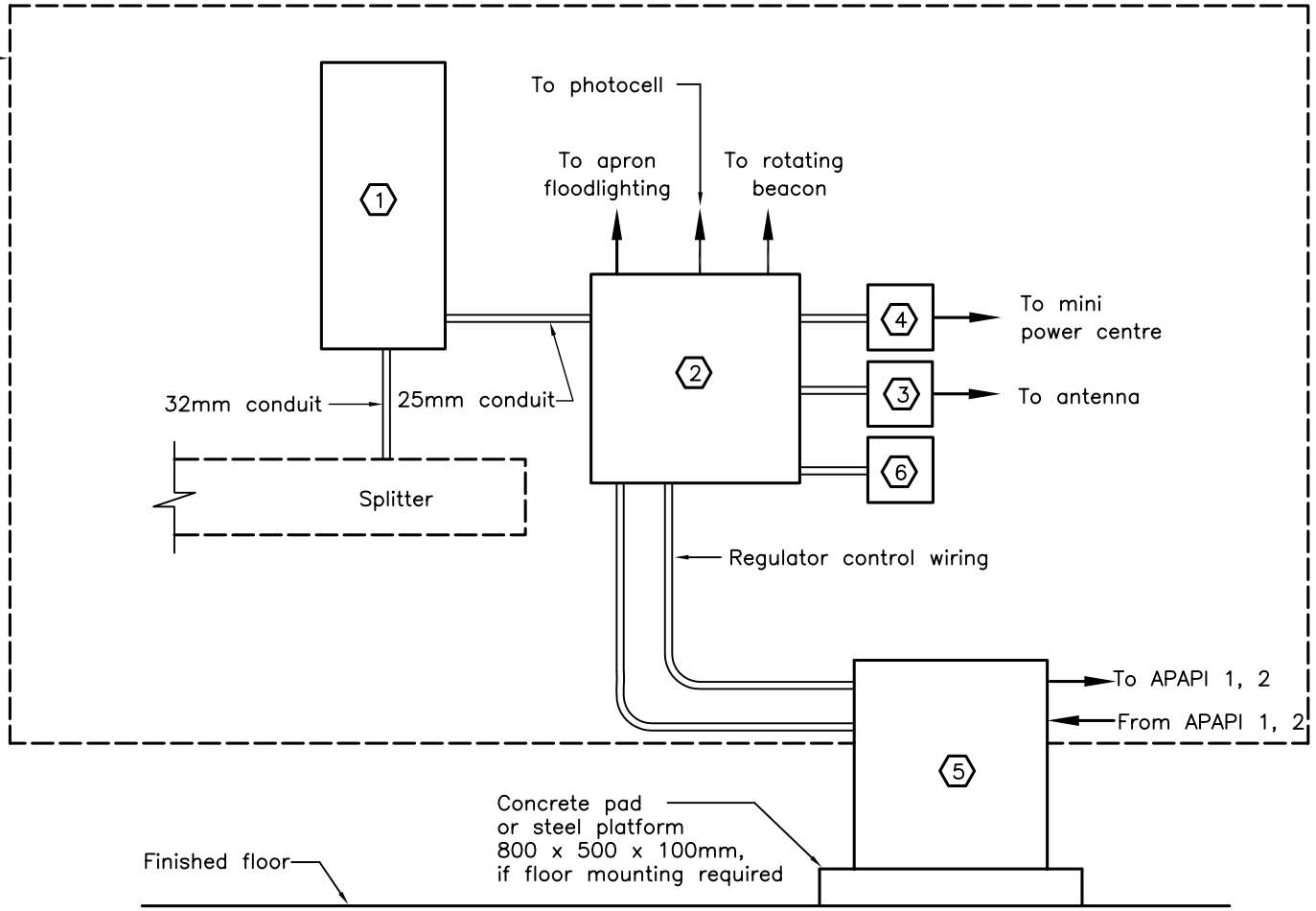
A All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

FLOOD LIGHTING
POLE ASSEMBLY

Date	March 2007	Rev	2

MTO–E62



LABEL LIST

1. Airfield lighting panel LP1
2. Airfield lighting control panel WARNING: BEFORE OPENING THIS PANEL DISCONNECT AIRFIELD LIGHTING MAIN BREAKER.
3. ARCAL panel CCT # LP1–1
4. 5KVA transformer CCT # LP1–2,4 WARNING: 600V
5. Current regulator CCT # LP1–6,8 WARNING: 1000V
6. APAPI frost prevention unit

NOTES:

A All conduits are 19mm dia. unless otherwise shown.

B Refer to drawing MTO–E72 and MTO–E76 for wiring requirements.

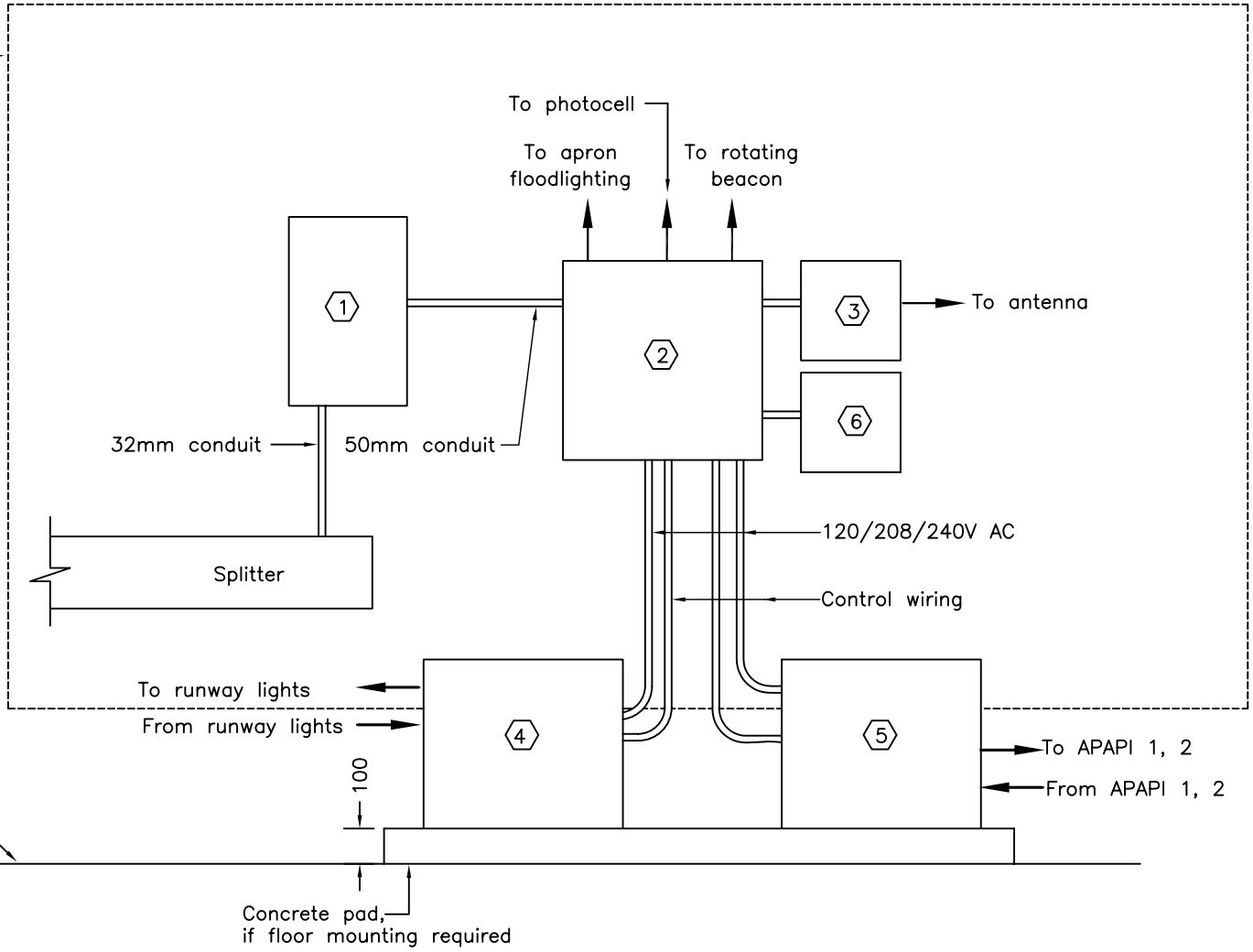
C All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

PARALLEL CONNECTED EDGE LIGHTING POWER DISTRIBUTION EQUIPMENT LAYOUT

Date	March 2007	Rev	3

MTO–E70



LABEL LIST

1. Airfield lighting panel LP–1
2. Airfield lighting control panel
   WARNING: BEFORE OPENING THIS PANEL DISCONNECT AIRFIELD LIGHTING MAIN SWITCH.
3. ARCAL panel CCT # LP1–1
4. Current regulator CCT #LP1–2,4
5. Current regulator CCT # LP1–6,8
   WARNING:1000V
6. APAPI Frost Prevention Unit

NOTES:

A All conduits are 19mm dia. unless otherwise shown.

B Refer to drawings MTO–E73 and MTO–E77 for wiring requirements.

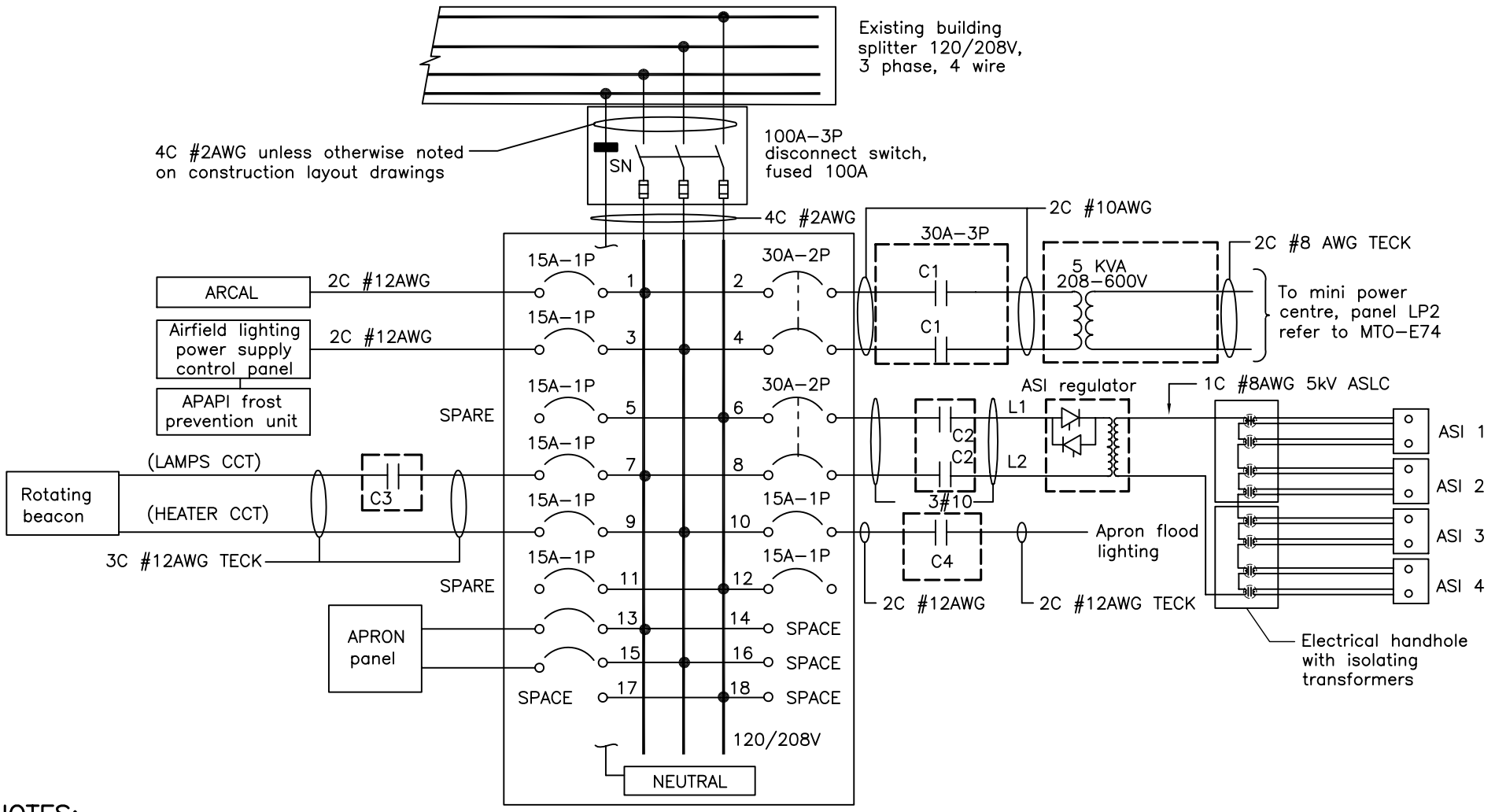
C All dimensions are in millimetres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

SERIES CONNECTED EDGE LIGHTING
POWER DISTRIBUTION EQUIPMENT LAYOUT

Date	March 2007	Rev	2

MTO–E71



NOTES:

A Refer to MTO–E76 for lighting control schematic diagram.
B Refer to MTO–E70 for distribution equipment layout and conduit requirements.
C Refer to MTO–E78 for lighting control panel equipment layout.
D Install a neutral to regulator.

AIRFIELD LIGHTING PANEL (PANEL LP1)

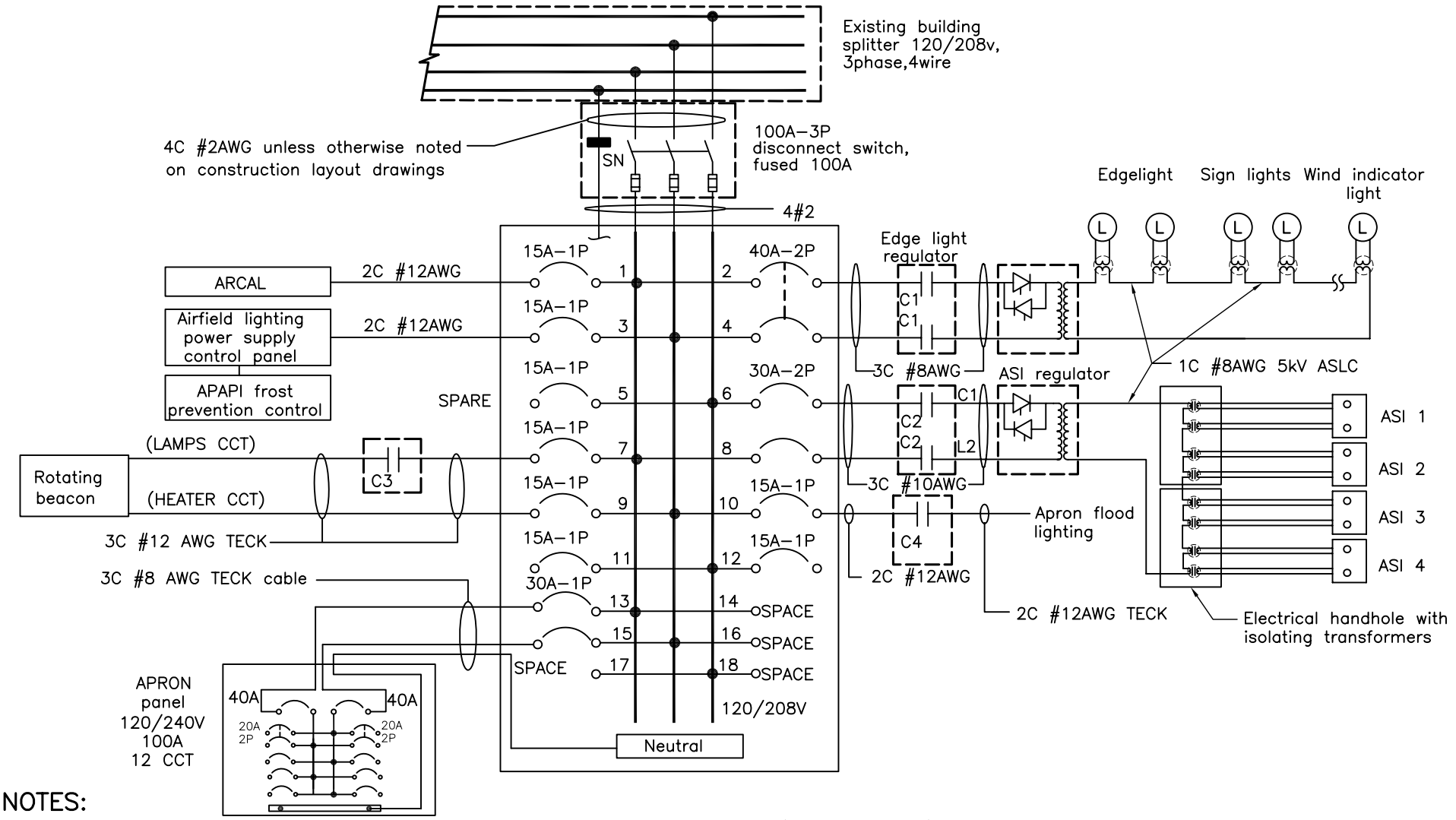
MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

POWER DISTRIBUTION SYSTEM

WIRING DIAGRAM – PARALLEL CONNECTION

Date	March 2007	Rev	3

MTO–E72



AIRFIELD LIGHTING PANEL (PANEL LP1)

NOTES:

A Refer to MTO–E77 for lighting control schematic diagram.

B Refer to MTO–E71 for distribution equipment layout and conduit requirements.

C Refer to MTO–E79 for lighting control panel equipment layout.

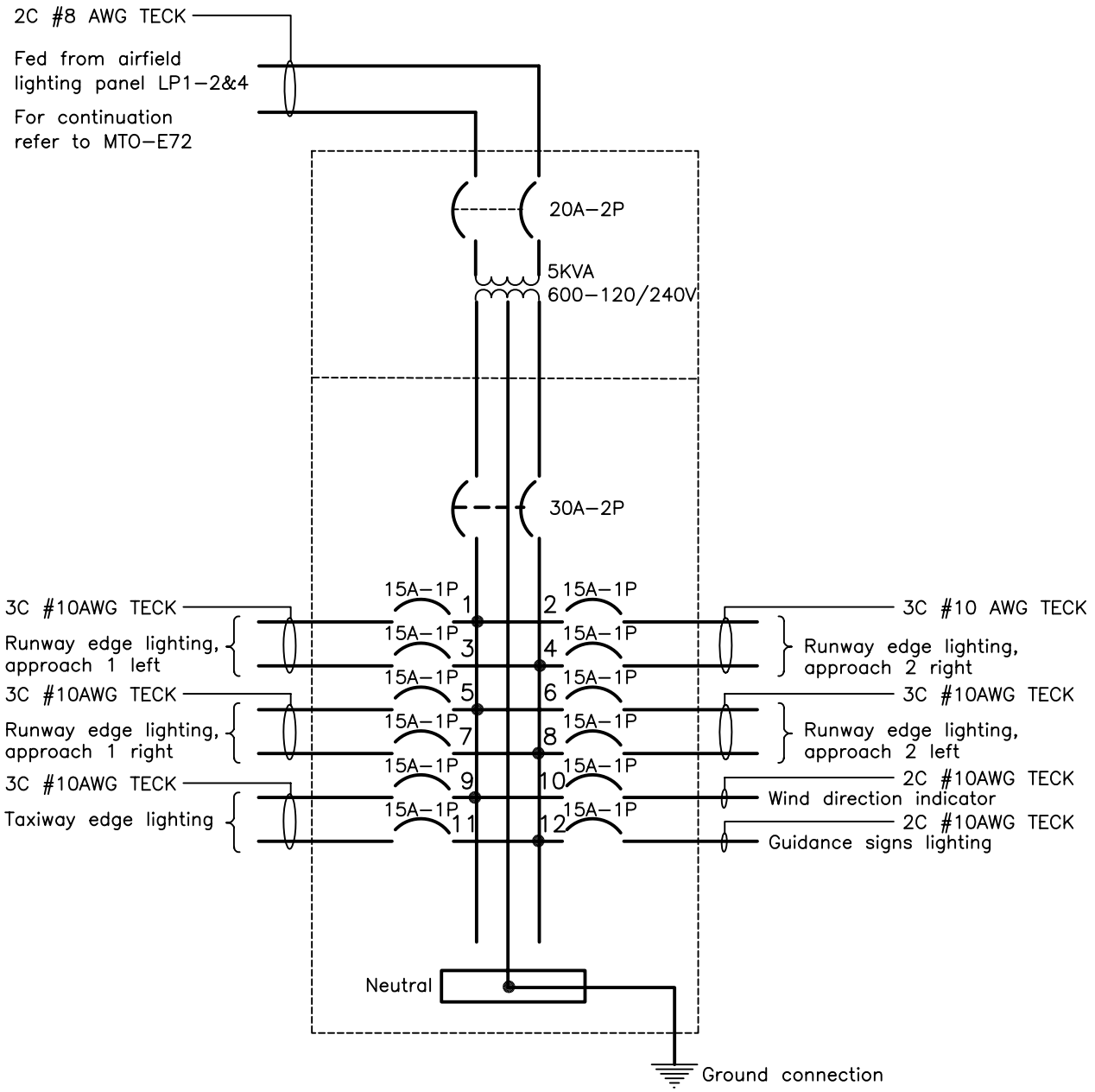
C Install a neutral to each regulator.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

POWER DISTRIBUTION SYSTEM
WIRING DIAGRAM–SERIES CONNECTION

Date	March 2007	Rev	2

MTO–E73



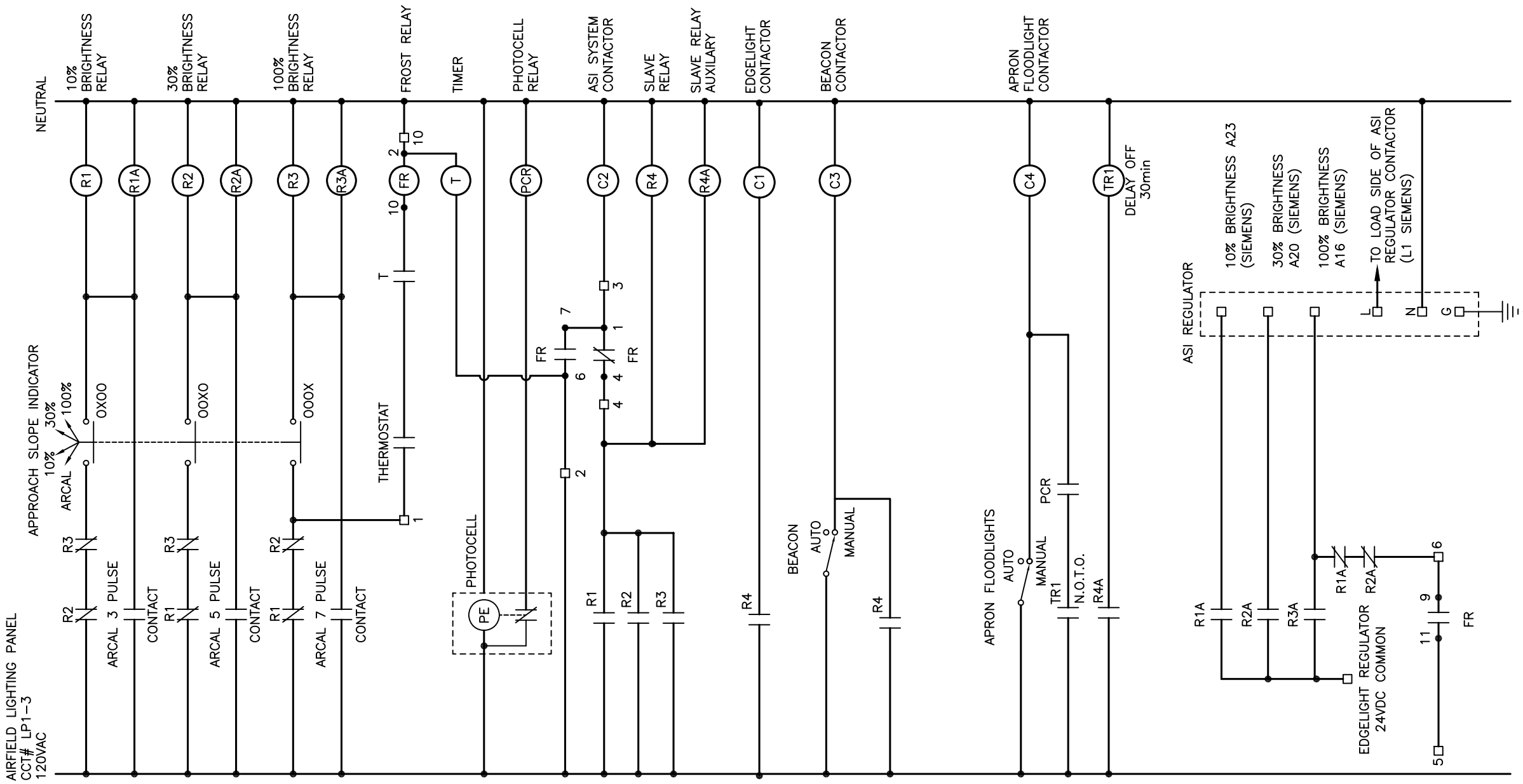
MINI POWER CENTRE

(PANEL LP2)

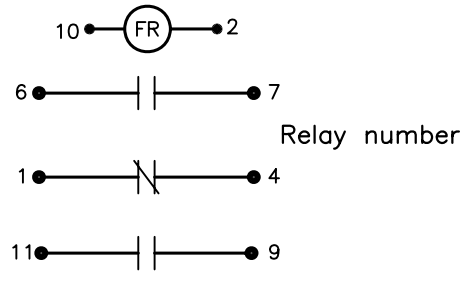
NOTE:

A Each cable in mini power centre pannel shall be equipped with lamicoid label to identify the area it serves i.e. approach number and size.

MINISTRY OF TRANSPORTATION ONTARIO AIRPORT STANDARD DRAWING ELECTRICAL	Date	March 2007	Rev	2
MINI POWER CENTRE WIRING DIAGRAM				
	MTO–E74			



LEGEND:



□1 Terminal block number.

NOTES:

A All control wiring shall be #14AWG, RW90.

B Refer to single line diagram, drawing MTO–E72. Refer to MTO–E78 for panel layout.

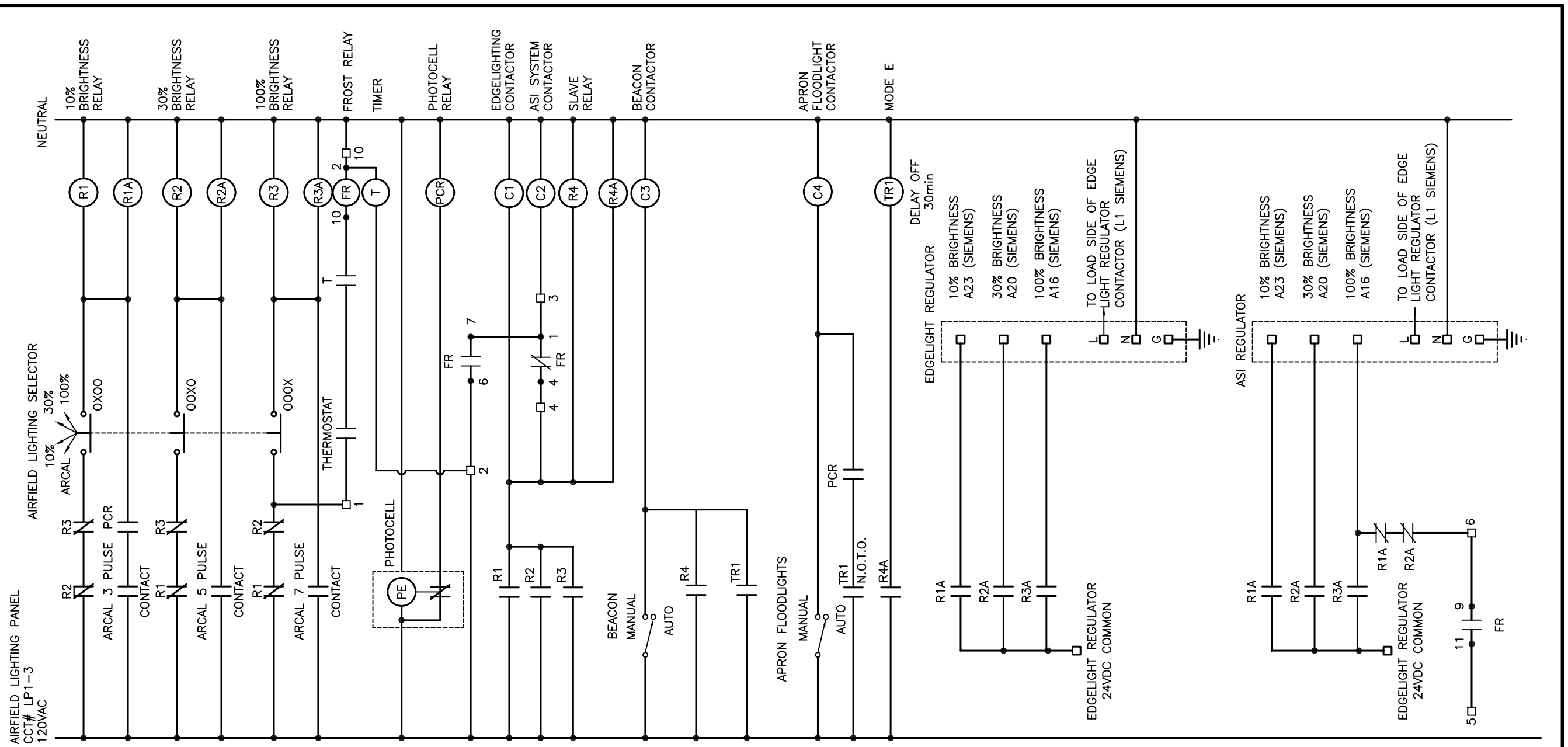
WIRE COLOUR CODING	
WIRE No.	COLOUR
0	WHITE
AC CONTROL	RED
DC CONTROL	BLUE

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

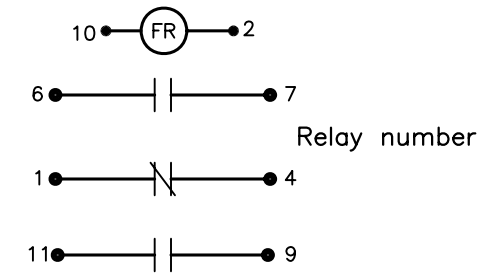
PARALLEL CONNECTED EDGE LIGHTING CONTROL SCHEMATIC

Date	March 2007	Rev	2

MTO–E76



LEGEND:



□1 Terminal block number.

NOTES:

A All control wiring shall be #14AWG, RW90.

B Refer to single line diagram, drawing MTO–E73. Refer to MTO–E79 for panel layout.

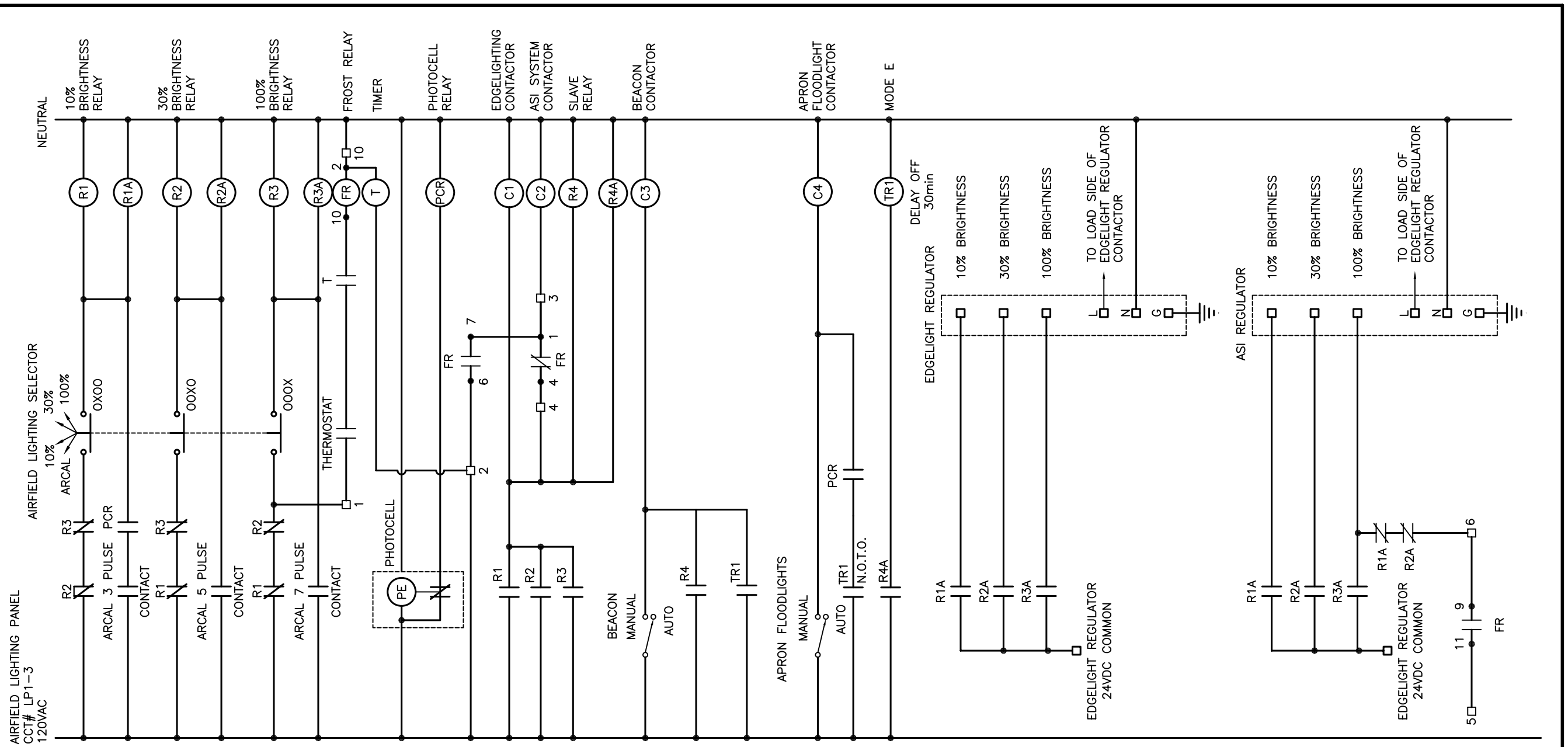
WIRE COLOUR CODING	
WIRE No.	COLOUR
0	WHITE
AC CONTROL	RED
DC CONTROL	BLUE

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

SERIES CONNECTED EDGE LIGHTING CONTROL SCHEMATIC

Date	March 2007	Rev	2

MTO–E77



LEGEND:

10 — FR — 2

6 — 7

Relay number

1 — 4

11 — 9

□1 Terminal block number.

NOTES:

A All control wiring shall be #14AWG, RW90.

B Refer to single line diagram, drawing MTO–E73.
Refer to MTO–E79 for panel layout.

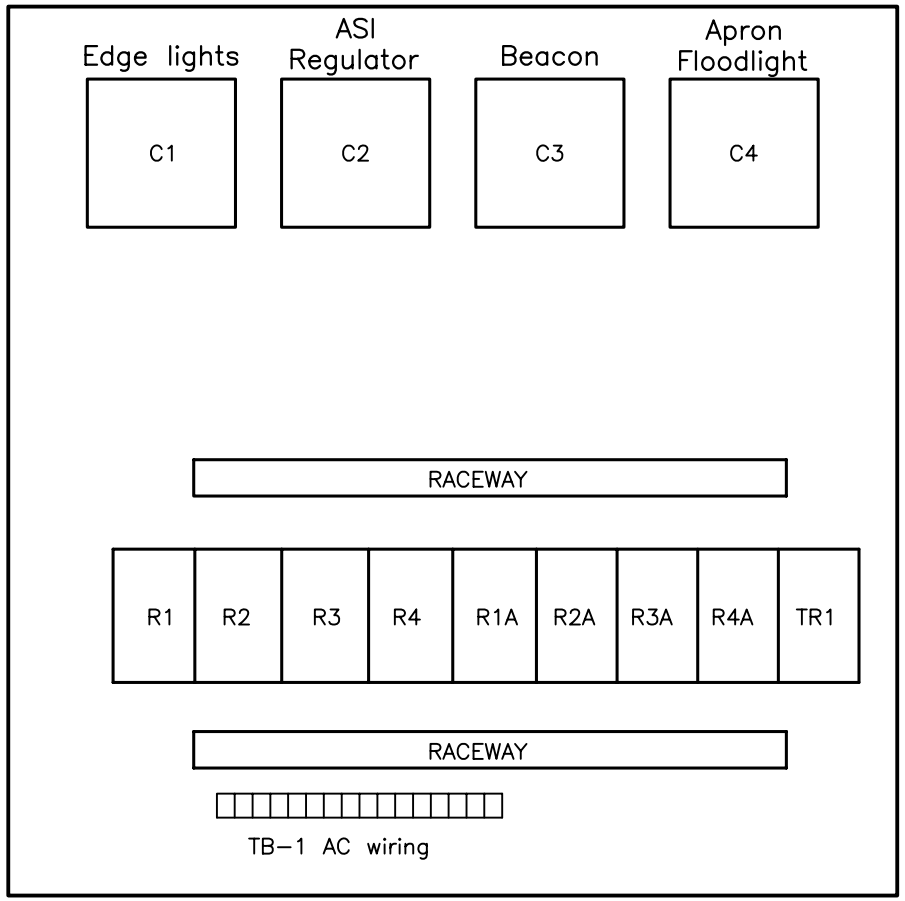
WIRE COLOUR CODING	
WIRE No.	COLOUR
0	WHITE
AC CONTROL	RED
DC CONTROL	BLUE

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

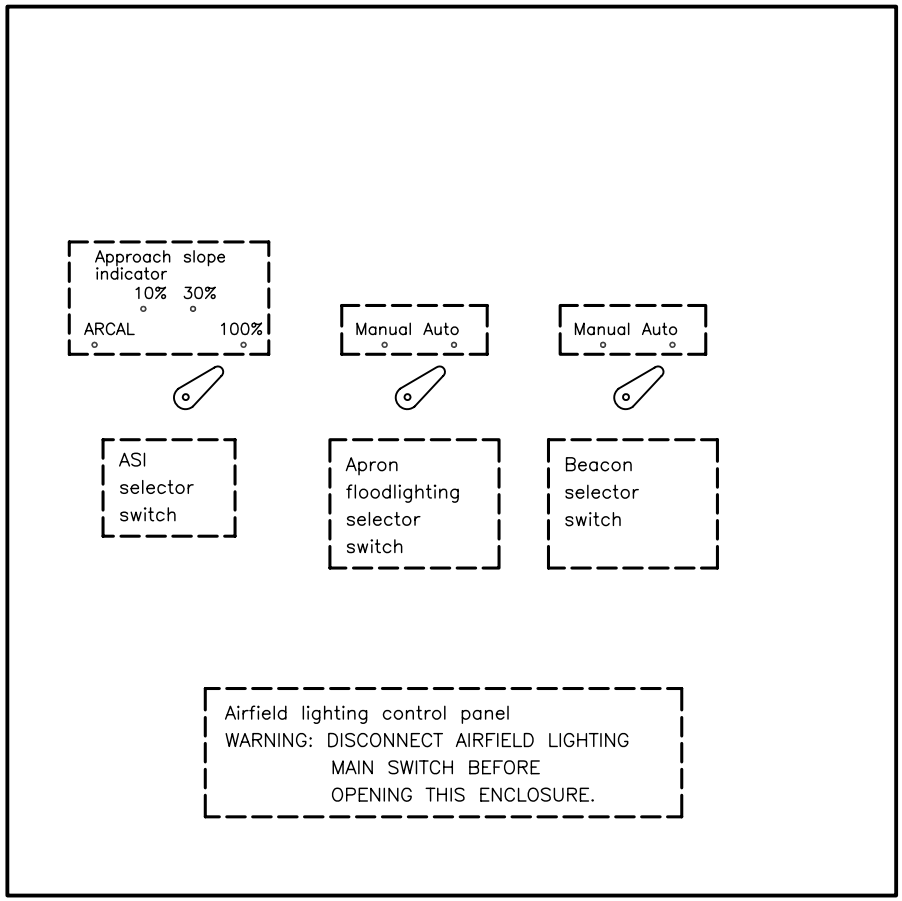
SERIES CONNECTED EDGE LIGHTING CONTROL SCHEMATIC – GENERIC

Date	March 2007	Rev	

MTO–E77.1



CONTROL PANEL BACK PLATE



CONTROL PANEL FRONT PLATE

NOTES:

A Provide lamicoid name plates for each position of the selector switches to show functions depicted on panel front plate.
B Refer to MTO–E76 for schematic wiring diagram.

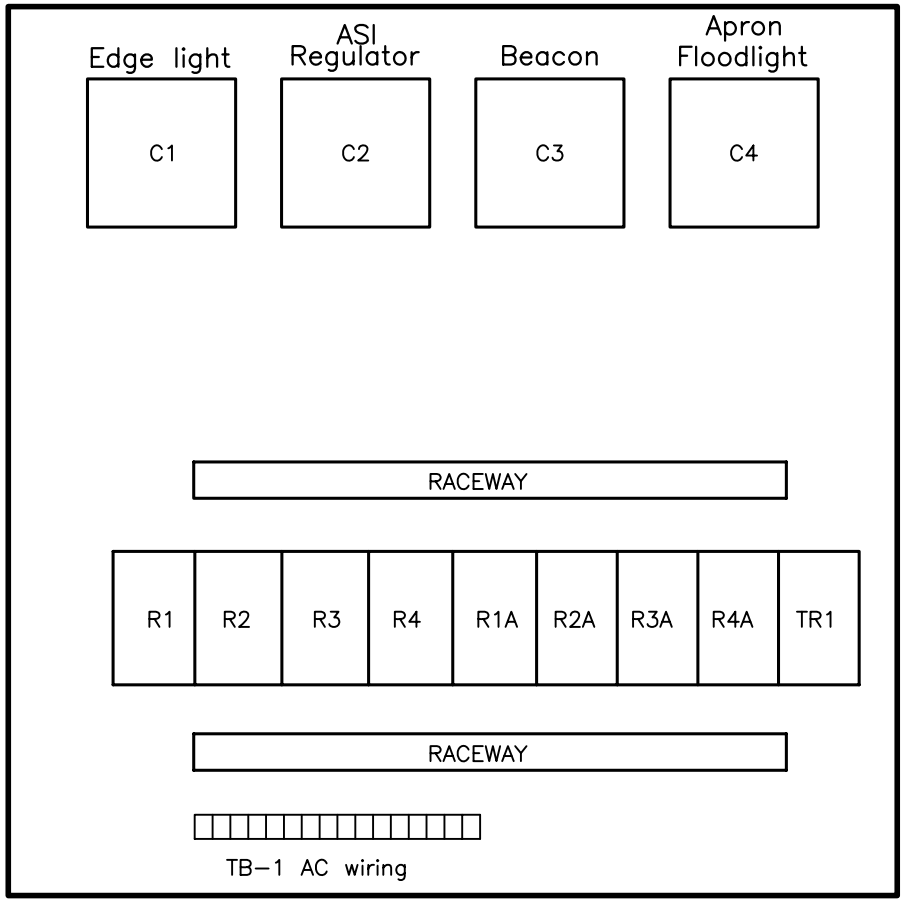
MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

PARALLEL CONNECTED EDGE LIGHTING

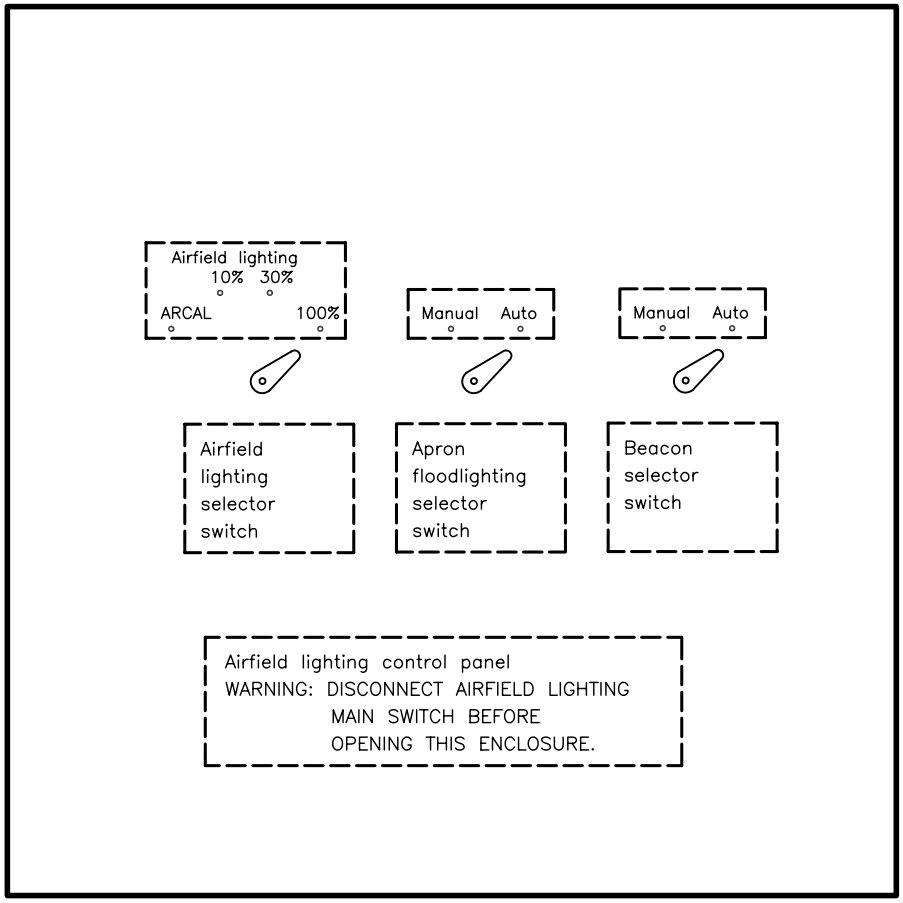
CONTROL PANEL EQUIPMENT LAYOUT

Date	March 2007	Rev	2

MTO–E78



CONTROL PANEL BACK PLATE



CONTROL PANEL FRONT PLATE

NOTES:

A Provide name plates for each position of the selector switches to show functions depicted on panel front plate.

B Refer to MTO–E77 for schematic wiring diagram.

MINISTRY OF TRANSPORTATION ONTARIO
AIRPORT STANDARD DRAWING ELECTRICAL

SERIES CONNECTED EDGE LIGHTING
CONTROL PANEL EQUIPMENT LAYOUT

Date	March 2007	Rev	2

MTO–E79