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Part 1 - Principles
1. Infrastructure Electrical Engineering

1.1 Introduction

1.1.1 Aeronautical Ground Lighting (AGL) is a generic term used to describe the various lighting systems that are provided on an aerodrome for the guidance of pilots operating aircraft by day or night and in low visibility conditions.

1.1.2 AGL systems provide location, orientation and alignment information necessary to give pilots the required visual guidance for approaching, landing, taking off and operating on the aerodrome. The AGL systems vary in complexity from the basic patterns found at small aerodromes to the more advanced systems used in support of instrument precision approach procedures.

1.1.3 In the context of this manual AGL is to be taken to incorporate the entire mandatory and advisory lighting systems for approach, runway, visual slope guidance, taxiway and apron lighting systems, aerodrome beacons, illuminated wind indicators, Movement Area Guidance Signs (MAGS) and their associated control including normal and emergency power supplies.

1.2 Aim

1.2.1 The aim of this manual is to provide a comprehensive reference for the design, construction and maintenance of AGL systems at permanent military aerodromes. It contains policy, guidance and detailed technical material as necessary to define the performance requirements and the standards to be applied to Defence AGL systems.

1.2.2 The content of reference standards, regulations and other publications, has not been repeated in this manual unless necessary for descriptive purposes.

1.2.3 Where it is considered necessary and appropriate, reference is made to these documents.

1.3 Application

1.3.1 The criteria contained in this manual are to be applied to all permanent aerodromes under the control of the Department of Defence. The manual does not replace the standards and regulations pertaining to AGL however specific differences are identified. Unless a specific Defence distinction is identified, for differences between the information described herein and those defined in the standards or regulations, the standards and regulations shall take precedence.

1.3.2 This manual covers the AGL requirements for non-instrument, instrument non-precision and instrument precision approach Category 1 aerodromes.

Existing Aerodrome Facilities

1.3.3 This Manual applies to a new facility that is brought into operation, and to an existing facility that is being replaced or improved. The Manual also applies to maintenance of AGL. Subject to formal agreement by Infrastructure Development Agency - Air Force (IDA-AF), changes to an existing facility of a minor or partial nature may be exempted.

1.3.4 Where existing facilities were designed and constructed to lesser criteria than those contained herein, IDA-AF will determine whether upgrading of such facilities shall be undertaken. In general, unless specifically directed by IDA-AF, existing aerodrome facilities do not need to be immediately modified in accordance with the new standards until the facility is replaced or upgraded such as to accommodate a more demanding aircraft.

1.3.5 An existing facility that does not meet the standard specified in this Manual must continue to comply with the standard that was applicable to it at the time of installation. These facilities must be identified and recorded in the Aeronautical Ground Lighting Configuration Manual (refer Chapter 3.2) and must include the date or period when that facility was first introduced or last upgraded and an indication of the plan or timescale to bring the facility in compliance with current regulations.
1.4 Structure

Manual of Infrastructure Engineering – AGL

1.4.1 This manual is structured into six separate parts which are further described below:

**Part 1 – Principles**

1.4.2 This part introduces the manual and provides guidance of a general nature on the aim and background of the manual and its application to existing and new aerodromes. Change management is also described in this part.

**Part 2 – Planning and Documentation**

1.4.3 This part details planning requirements associated with AGL design with cognisance of airfield master planning and future development strategies. It also introduces the AGL Configuration Manuals which summarise the AGL configuration, as well as as-constructed and maintenance manual documentation requirements.

**Part 3 – Certification, Verification, Design and Construction**

1.4.4 This part describes the designer’s responsibility including the general and specific design/performance criteria for the design of an AGL system. Testing and commissioning regimes for AGL systems is also described.

**Part 4 – Performance and Installation Criteria**

1.4.5 This part defines the design and manufacturing criteria of the equipment installed within the AGL system, and configuration and installation criteria for each AGL system. Design and performance requirements for ALERs and AGL Control Systems is also detailed within Part 4.

**Part 5 – Maintenance Requirements**

1.4.6 This part summarises the AGL maintenance regime to be applied for Defence AGL systems.

**Appendices**

1.4.7 The various appendices provide examples of design compliance guides, preventative maintenance schedules, procedures and checklists, proforma forms for the maintenance diary, permits to work, ground check certificates, spares procurement; and maintenance guides.

1.4.8 Parts 1 to 3 of this manual have been established to allow correlation to Parts 1 to 3 of the Manual of Infrastructure Engineering – Electrical (MIE-E). Information detailed in Parts 4 and 5 and the Appendices of this manual are AGL specific and do not directly correlate to the MIE-E.

1.4.9 This manual is a supplement to the MIE-E and should only be used in conjunction with the MIE-E.

1.5 Documentation Change Management

1.5.1 The IDA-AF and the Directorate of Estate Engineering Policy (DEEP) jointly sponsor this manual that is issued and amended under the Defence Support Group (DSRG) Infrastructure Management documentation.

1.5.2 The need to amend the manual may be generated by a number of causes. These may be to:

   a. Ensure safety;
   
   b. Ensure standardisation;
   
   c. Respond to changes in standards; or
   
   d. Accommodate new initiatives or technologies.

1.5.3 Requests for any change to the content of the manual may be initiated by formal request to DEEP.
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABN</td>
<td>Aerodrome Beacon</td>
</tr>
<tr>
<td>ADATS</td>
<td>Advanced Defence Air Traffic System</td>
</tr>
<tr>
<td>ADFP</td>
<td>Australian Defence Force Publication</td>
</tr>
<tr>
<td>AGL</td>
<td>Aeronautical Ground Lighting</td>
</tr>
<tr>
<td>AGLCM</td>
<td>AGL Configuration Manual</td>
</tr>
<tr>
<td>AGLCS</td>
<td>AGL Control System</td>
</tr>
<tr>
<td>AGLMA</td>
<td>AGL Maintenance Agent</td>
</tr>
<tr>
<td>AGLMM</td>
<td>AGL Maintenance Manager</td>
</tr>
<tr>
<td>AGLMP</td>
<td>AGL Maintenance Personnel or Contractor</td>
</tr>
<tr>
<td>AIP</td>
<td>Air Services Australia – Aerodrome Information Packages</td>
</tr>
<tr>
<td>AL</td>
<td>Approach Light (Other than HIAL, SFL or SAL)</td>
</tr>
<tr>
<td>ALER</td>
<td>Aeronautical ground lighting Equipment Room</td>
</tr>
<tr>
<td>AS or AS/NZS</td>
<td>Australian Standard or Australian and New Zealand Standard</td>
</tr>
<tr>
<td>ASCC</td>
<td>Air Standardisation Coordinating Committee</td>
</tr>
<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
</tr>
<tr>
<td>BCP</td>
<td>Base Command Post</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>BSP</td>
<td>British Standard Pipe</td>
</tr>
<tr>
<td>°C DB</td>
<td>degrees Centigrade dry bulb</td>
</tr>
<tr>
<td>CAA</td>
<td>??? see 21.3.1</td>
</tr>
<tr>
<td>CAP</td>
<td>Civil Aviation Authority – United Kingdom</td>
</tr>
<tr>
<td>CASA</td>
<td>Civil Aviation Safety Authority</td>
</tr>
<tr>
<td>CCR</td>
<td>Constant Current Regulator</td>
</tr>
<tr>
<td>cd</td>
<td>Candela (unit of light intensity)</td>
</tr>
<tr>
<td>CDR</td>
<td>Concept Design Report – 30% completion</td>
</tr>
<tr>
<td>CEPS</td>
<td>Central Emergency Power Station</td>
</tr>
<tr>
<td>CMC</td>
<td>Comprehensive Maintenance Contract</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processor Unit</td>
</tr>
<tr>
<td>CSG</td>
<td>Combat Support Group</td>
</tr>
<tr>
<td>CTAF</td>
<td>????? see 27.3.4</td>
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<tr>
<td>CWY</td>
<td>Clearway</td>
</tr>
<tr>
<td>DADM</td>
<td>Defence Aerodrome Design Manual – currently under development and as yet not promulgated.</td>
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DDR Detailed Design Report – 90% completion
DEEP Directorate of Estate Engineering Policy
DESN Defence Engineering Services Network
DESTR Directorate of Engineering Services and Technical Regulation
DME Distance Measuring Equipment
DRSG Defence Support and Reform Group
DTRM Distance to Run Marker
EMI Electro-magnetic Interference
EPA Environmental Protection Authority
ER Emergency Runway
ERSA En-Route Supplement Australia
FAA Federal Aviation Authority (USA)
FDB Functional Design Brief
FDR Final Design Report – 100% complete
FOD Foreign Object Damage
FRB Functional Requirement Brief refer to FDB
GTE ????? see 27.3.4
HCM Hook Cable Marker
HIAL High Intensity Approach Lights
HIRL High Intensity Runway Lights
HMI Human Machine Interface
HSL Hold Short Light
IAD Infrastructure Assets Development Branch – Is this now CFI ??????
I/O Inputs/Outputs
ICAO International Civil Aviation Organisation
IDA-AF Infrastructure Development Agency - Air Force
IEC International Electrotechnical Commission
ILS ????? see 2.1
IMC Instrument Meteorological Conditions
ISD Information Systems Division – see 28.6 who is this??
ITE Information Technology Equipment
IWI Illuminated Wind Indicator
LAHSO Land and Hold Short Operation
LEG Local Emergency Generator
MAGS Movement Area Guidance Sign
MBZ Mandatory Broadcast Zone
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>MFPE</td>
<td>Manual of Fire Protection Engineering</td>
</tr>
<tr>
<td>MIEE</td>
<td>Manual of Infrastructure Engineering - Electrical</td>
</tr>
<tr>
<td>MIRL</td>
<td>Medium Intensity Runway Lighting</td>
</tr>
<tr>
<td>MIT</td>
<td>Mains Isolation Transformer</td>
</tr>
<tr>
<td>MLS</td>
<td>??????? see 2.1</td>
</tr>
<tr>
<td>MOWP</td>
<td>Method of Work Plan</td>
</tr>
<tr>
<td>MOS</td>
<td>????? see 2.1</td>
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<tr>
<td>MSB</td>
<td>Main Switch Board</td>
</tr>
<tr>
<td>MTBM</td>
<td>What is this see 10.2 ?????</td>
</tr>
<tr>
<td>NATA</td>
<td>National Association of Testing Authorities, Australia</td>
</tr>
<tr>
<td>NATO</td>
<td>North Atlantic Treaty Organisation</td>
</tr>
<tr>
<td>NB</td>
<td>Nominal Bore</td>
</tr>
<tr>
<td>NOD</td>
<td>National Operations Division</td>
</tr>
<tr>
<td>NOTAM</td>
<td>??? see C.1</td>
</tr>
<tr>
<td>OLA</td>
<td>Ordnance Loading Apron</td>
</tr>
<tr>
<td>OLS</td>
<td>Obstacle Limitation Surface</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operations &amp; Maintenance</td>
</tr>
<tr>
<td>ORP</td>
<td>Operational Readiness Pad</td>
</tr>
<tr>
<td>OTDR</td>
<td>What is this ??? see 8.5.1</td>
</tr>
<tr>
<td>PAL</td>
<td>Pilot Activated Lighting</td>
</tr>
<tr>
<td>PALC</td>
<td>Pilot Activated Lighting Control</td>
</tr>
<tr>
<td>PAPI</td>
<td>Precision Approach Path Indicator</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
</tr>
<tr>
<td>QRAF</td>
<td>Quick Reaction Alert Facility</td>
</tr>
<tr>
<td>RAAF</td>
<td>Royal Australian Air Force</td>
</tr>
<tr>
<td>RCD</td>
<td>Residual Current Device</td>
</tr>
<tr>
<td>RCL</td>
<td>Runway Centreline Lights</td>
</tr>
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<td>RESA</td>
<td>????? see 23.4.3</td>
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<tr>
<td>RMS</td>
<td>Root Mean Squared</td>
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<td>RTIL</td>
<td>Runway Threshold Identification Lights</td>
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<td>RTZL</td>
<td>Runway Touchdown Zone Lights</td>
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<td>RVR</td>
<td>Runway Visual Range</td>
</tr>
<tr>
<td>RWY</td>
<td>Runway</td>
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<tr>
<td>SALS</td>
<td>Simply Approach Lighting System</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
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<td>SDR</td>
<td>Schematic Design Report – 50% completion</td>
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<tr>
<td>Abbreviation</td>
<td>Definition</td>
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<td>SFAL</td>
<td>Sequential Flashing Approach Lighting</td>
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<td>SIT</td>
<td>Series Isolating Transformer</td>
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<td>STNA</td>
<td>?????? see 21.3.1</td>
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<td>SWL</td>
<td>Safe Working Load</td>
</tr>
<tr>
<td>TACAN</td>
<td>???????? see 2.1</td>
</tr>
<tr>
<td>TCH</td>
<td>Threshold Crossing Height</td>
</tr>
<tr>
<td>TIE</td>
<td>Tower Interface Equipment (air traffic control)</td>
</tr>
<tr>
<td>TP</td>
<td>Tangent Point (of curve)</td>
</tr>
<tr>
<td>TWY</td>
<td>Taxiway</td>
</tr>
<tr>
<td>VESDA</td>
<td>Very Early Smoke Detection Apparatus</td>
</tr>
<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VMC</td>
<td>Visual Meteorological Conditions</td>
</tr>
<tr>
<td>WHS</td>
<td>Work Health Safety (applicable Commonwealth, State or Territory legislation)</td>
</tr>
<tr>
<td>WSO</td>
<td>Works Safety Officer</td>
</tr>
</tbody>
</table>
1.7 Regulations and Standards – Background

1.7.1 The Department of Defence promulgates aviation standards for Defence airfields in the Defence Aerodrome Design Manual (DADM). The Department of Defence is a member of the Air Standardisation Coordinating Committee (ASCC), which promotes standardisation in many areas between the Defence forces of the United States of America, the United Kingdom, Canada, New Zealand and Australia. Relevant ASCC Air Standards will normally take precedence over other agreements and are reflected in the criteria provided in the DADM.

1.7.2 The Commonwealth through the Civil Aviation Safety Authority (CASA) subscribes to ICAO Annex 14 and to the conventions of the International Civil Aviation Organisation (ICAO), which promulgates international standards and recommended practices in relation to aerodromes. CASA promulgates the Manual of Standards (MOS) that defines required aviation standards for civilian aviation in Australia. To achieve national standardisation, the Department of Defence has accepted these standards and practices as forming the basic criteria for AGL applicable to its aerodromes.

1.7.3 Any conflict between the DADM and CASA standards or obligations to ICAO at Joint User Aerodromes (defined aerodromes where there is joint use of the facilities by military and regular public transport [RPT] services), IDA-AF will determine which criteria shall be used.

1.8 Reference standards

1.8.1 The design, construction and maintenance of AGL systems shall meet the requirements of this manual together with those of applicable legislation and standards such as, but not limited to:

Department of Defence

1.8.2 Defence Aerodrome Design Manual (DADM);
   a Volume 1: Aerodromes for Fixed Wing Aircraft;
   b Volume 2: Aerodromes for Helicopter/Rotary Wing Aircraft;
   c Volume 3: Ground Telecommunications Equipment;

1.8.1 Infrastructure Management Documentation;
   a The Defence Infrastructure Management (IM) documents promulgate policy and procedures for the management of the Defence estate, including the procurement of capital facilities. The IM is the prime reference document for all infrastructure activities and processes. The provisions of the IM are mandatory.

1.8.2 Manual of Infrastructure Engineering Electrical;
   a The Manual of Infrastructure Engineering Electrical (MIEE) is the primary policy document when determining electrical services and infrastructure requirements for Defence facilities.

1.8.3 Manual of Fire Protection Engineering;
   a The Manual of Fire Protection Engineering (MFPE) is the primary policy document when determining fire safety requirements for Defence facilities.

Australian Standards

- AS 1102 Graphical Symbols series
- AS 1170.2 Structural Design Action – Wind Actions
- AS 1768 – Lightning Protection
- AS 2053 Conduits and fittings for Electrical Installations, series
- AS 2700 Colour Standards for General Purpose
- AS/NZS 3000 Wiring Rules;
- AS 3100 Approval and test specification – General requirements for electrical equipment;
- AS 4070 Recommended practice for protection of low voltage electrical installations and equipment in MEN systems from transient over voltages;
- AS/NZS 5000.1 Electric Cables –Polymeric insulated – for working voltages up to and including 0.6/1 kV
- AS/NZS 61000 Electromagnetic Capability (EMC) series
AS/NZS CISPR Radio Disturbance series

British Standards
- BS 3224 - 4 Light Fittings for Civil land Aerodromes. Specification for Elevated Lighting Units
- BS 3224 -6 Light Fittings for Civil land Aerodromes. Specification for Obstacle Lighting Units

Authorities
- Local Network Service Provider and Industry Regulator;
- Australian Communications Authority (ACA).

1.9 Related Documents

1.9.1 The following documents are listed and may be read in conjunction with this manual as they contain technical reference material that is applicable to the design, maintenance and operation of AGL systems.

Civil Aviation Safety Authority Australia (CASA)
- Manual of Standards Part 139 – Aerodromes (MOS Part 139);
- Advisory Circulars (AC);
- Civil Aviation Advisory Publications (CAAP).

International Civil Aviation Organization
- ICAO Aerodromes Annex 14 Volume I - Aerodrome Design and Operations;
- ICAO Aerodromes Annex 14 Volume II – Heliports;
- ICAO Doc 9157/AN 901: Aerodrome Design Manuals (all parts);
- ICAO Doc 9157: Aerodrome Design Manual Part 4 - Visual Aids;
- ICAO Annex 4 Aeronautical Charts;

International Electrotechnical Commission
- IEC 61821 – Electrical Installations for Lighting and Beaconing of Aerodromes – Maintenance of Aeronautical Ground Lighting Constant Current Series Circuits;
- IEC 61822 – Electrical Installations for Lighting and Beaconing of Aerodromes – Constant Current Regulators;
- IEC 61823 – Electrical Installations for Lighting and Beaconing of Aerodromes - Aeronautical Ground Lighting Series Transformers;

US Department of Transport Federal Aviation Administration (FAA)
- Advisory Circulars; in particular the 150/5340 series.

Civil Aviation Authority, United Kingdom
- CAP 168 – Licensing of Aerodromes;
1.10 Differences between DADM, MOS Part 139 and ICAO

1.10.1 Compliance with the standards and procedures specified in this manual does not absolve the obligation in respect of standards prescribed by other government or statutory authorities. Where another statutory standard conflicts with this manual, the matter must be referred to IDA-AF through DEEP for resolution. Notwithstanding the above, the differences specifically identified by this manual shall prevail.

1.11 Dispensations

1.11.1 Dispensation from any of the requirements contained within this manual, or the requirements of regulations and standards, shall be sought from IDA-AF through DEEP. The request shall be fully documented by the proposer, and suitably argued with compensating factors clearly identified.

Exemptions to Standards

1.11.2 Exemptions to standards shall be sought from IDA-AF through DEEP. At Joint User Aerodromes exemption may need to be sought from both IDA-AF and CASA.

1.11.3 An exemption granted to an existing facility continues to apply until its expiry date. Application for new exemptions must be supported, in writing, by cogent reasons including, where appropriate, an indication of when compliance with the current standards can be expected. Those standards which include phrases such as “if practicable”, “where physically practicable”, etc., still require an exemption to standards when aerodrome operators wish to take advantage of the non-practicability of full compliance.

Records

1.11.4 Exemptions to standards, granted to an aerodrome, must be suitably recorded in the aerodrome operating procedures and the AGL Configuration Manual (AGLCM). The Manual must contain all relevant information including details of the exemption, reason for granting and any resultant limitations.

1.12 Agencies and Responsibilities

1.12.1 Agencies both from within and outside Defence with responsibility for aspects of AGL systems are:

Infrastructure Development Agency - Air Force

1.12.2 Infrastructure Development Agency - Air Force (IDA-AF) is the sponsor of the Defence aerodrome design criterion published in the DADM. The Director Infrastructure Development Agency - Air Force (DIDA-AF) is also responsible for authorising dispensations to the DADM.

44 Wing Base Detachment Commander

1.12.3 The 44 Wing Base Detachment Commander, is the appointed authority responsible to the Senior Air Defence Force Officer (SADFO) for operations at the aerodrome.

Defence Support and Reform Group (DSRG)

1.12.4 Defence Support and Reform Group (DSRG) is responsible for the provision of and maintenance of facilities and services in support of Defence capability. DSRG carries the responsibility for the construction and maintenance of AGL systems. DSRG responsibilities are summarised as follows:

a. Assistant Secretary Estate Policy and Environment (ASEPE) is the DSRG Technical Authority for Directorate of Estate Engineering Policy (DEEP) issues pertaining to AGL systems, DSRG Business Rule DSRG 11 Engineering Policy and Planning Management refers;

b. DEEP is the subject matter expert responsible for developing technical engineering policy, and for providing technical engineering support pertaining to the management and development of the Defence AGL systems. DEEP jointly sponsors this manual with IDA-AF;

c. National Operations Division (NOD) is responsible for the implementation of engineering policies at base level for regionally delivered projects, operations and maintenance. Joint User Deeds incorporating maintenance agreement are in place for the two joint use airfields; RAAF Base Darwin and RAAF Base Townsville, whilst the remainder are maintained through the Comprehensive Maintenance Contract (CMC); and

d. Infrastructure Asset Development (IAD) Branch is responsible for the implementation of engineering policies for centrally delivered projects.
Combat Support Group (CSG)
1.12.5 CSG is jointly responsible with NOD for the implementation of engineering policies at Base level through the RAAF Electricians for operations and maintenance at RAAF Base Curtin and RAAF Base Tindal.

Civil Aviation Safety Authority (CASA)
1.12.6 CASA is responsible under the Civil Aviation Act for developing and promulgating aviation safety standards for civilian airfields.
2. Aeronautical Ground Lighting Overview

2.1 Lighting Systems

2.1.1 Various lighting systems are provided on an aerodrome for the guidance of pilots. High intensity lighting systems are provided in support operations in low Visual Meteorological Conditions (VMC) by day or night, whereas low and medium intensity lighting systems are normally used only by night, with the exception of the approach slope indicator that is high intensity.

2.1.2 Aerodromes have runways with different operational performance as described below:

2.1.3 **Non-Instrument Runway** A runway intended for the operation of aircraft using visual approach procedures; normal visibility of not less than 1400m. It may be noted that with current technology many non-instrument runways may now be considered, and utilised, as instrument runways.

2.1.4 **Instrument Runway** One of the following types of runways intended for operation of aircraft using instrument approach procedures:

2.1.5 **Non-Precision Approach Runway.** An instrument runway served by visual aids and a non-visual aid (such as TACAN, etc) providing at least directional guidance adequate for a straight in approach. Normally visibility of not less than 1400m.

2.1.6 **Precision Approach Runway, Category 1** An instrument runway served by ILS/MLS/GPS and visual aids intended for operations with a decision height not lower than 60m and either a visibility not less than 800m or runway visual range not less than 550 metres.

2.1.7 The precision approach categories II and III are defined in MOS Part 139 and ICAO Annex 14. They are not addressed in this Manual as the requirement for these categories are not applicable to Defence aerodromes within Australia.

**Requirement for Visual Aids**

2.1.8 Visual aids need not necessarily be matched to the scale of non-visual aids provided. The criterion for the selection of visual aids is the conditions in which operations are intended to be conducted.

2.1.9 Table 2.1 below provides guidance on the facilities required to meet the operational category of the aerodrome.

2.2 Visual Aids System Description

2.2.1 The following paragraphs provide a basic outline for each lighting system.

2.2.2 **An Aerodrome Beacon** is provided to assist pilots locating or identifying an aerodrome at night. A beacon is required where IDA-AF determines a beacon is operationally necessary. Aerodrome beacons are normally located on the ATC Tower and alternate white and green coloured light (for land based aerodromes) through 360 degrees.

2.2.3 **Approach Lighting** provides alignment, roll guidance and limited distance to go and circling guidance information. There are three basic forms of approach lighting systems as follows:

a **High Intensity Approach Lighting (HIAL)** Required for instrument precision approach, Category 1 operations. HIAL consists of 120 high intensity uni-directional white lights on the extended runway centreline over a distance of 900 metres. The lights are arranged to form a linear converging pattern (arrow) to meet the runway centreline 300 metres upwind of the threshold.

i Older Defence installations standardised on the Modified Calvert coded centreline system that consists of 105 lights. These installations are to be upgraded to the standard Calvert coded centreline system when their replacement is undertaken.

b **Simple Approach Lighting System (SALS)** SALS is an optional aid provided where IDA-AF determine SALS is operationally necessary. SALS consists of 17 lights, either high intensity unidirectional white lights or medium intensity omni-directional red lights on the extended centreline of the runway extended over a distance of 420 metres. The lights are arranged with a cross bar at 300 m on the extended centreline.

c **Sequential Flashing Approach Lighting (SFAL)** SFAL is an optional aid provided where IDA-AF determine SFAL is operationally necessary to enhance recognition of approach lighting system in poor visibility conditions. SFAL consists of a row of lights located on the extended centreline of a runway. The lights are uni-directional when used in conjunction with a HIAL or omni-directional lights when used in conjunction with a SALS. They flash in sequence beginning with the outermost light and progressing to the innermost light.
2.2.4 **Approach Slope Indicators** provides pilots with information on the aircraft approach slope angle and hence clearance over approach obstacles. Approach Slope Indicators are required mainly for turbo-jet aircraft operations. Precision Approach Path Indication (PAPI) systems provide aircraft approach slope indicated by the pattern of red and white light emitted from the light units. A standard PAPI installation consists of 4 light units located as a wing bar on the port side of the runway. The unit direct a beam of light, red in the lower half and white in the upper, towards the approach in a recognisable pattern as shown in Figure 2.1.

![Figure 2.1: Visual Approach Slope Indication - PAPI](image)

2.2.5 **Runway Lighting** is provided on all runways intended for use at night and for precision approach runways for poor visibility conditions. Runway lighting incorporates edge, threshold and end lighting. Runway lighting is located around the area declared for use as the runway and can be either elevated or inset lights.

2.2.6 Runway lighting can be High Intensity Runway Lighting (HIRL) or Medium Intensity Runway Lighting (MIRL). Low Intensity Runway Lighting (LIRL) is not normally used on Defence bases.

2.2.7 Runway edge lighting is white except for the last 600 m or one third of the runway that may show yellow for HIRL systems. The yellow ‘caution zone’ so formed gives a visual warning of the approaching runway end. Runway end lights emitting red light and runway threshold lights emitting green light provide visual indication of the runway end and threshold.

2.2.8 There are additional runway lighting systems such as Runway Centreline lighting, Runway Threshold Identification Lights, and Land and Hold Short lights which provide additional guidance in support of low visibility operations or under certain runway arrangements. Pre-Threshold lighting and Stopway lighting may be provided to complement runway lighting systems. Lighting is also provided around the perimeter of runway turning areas Operational Readiness Platforms.

2.2.9 **Emergency Runway Lighting** is provided on all emergency runways designated for use at night. Emergency runway lighting incorporates edge, threshold and end lighting. Emergency runway lighting systems typically utilise inset lights.

2.2.10 **Illuminated Wind Indicator(s)** are provided near each runway threshold to provide surface wind movement information to pilots and Air Traffic Control (ATC) staff for all aerodromes used at night. Some aerodromes have a central IWI which may have been retained.

2.2.11 **Distance to Run and Hook Cable Markers (DTRM) and (HCM)** provide information on the remaining runway length and the location of aircraft arrestor hook cables. The DTRM and HCM are located on each side of the runway.

2.2.12 **Taxiway Lighting** is provided for guidance of aircraft movement along taxiways at night or day in poor VMC. Taxiway lighting can be either inset centreline lights or elevated edge lights. Taxiway centreline lights show green except on runway exit taxiways where the lights leading from the runway are coloured...
green and yellow alternately. All centreline lights leading to a runway show green. Taxiway elevated edge lights emit blue light.

2.2.13 Access taxiways to fighter dispersal areas, Ordnance Loading Aprons (OLAs) and Quick Reaction Alert Facility (QRAF) are provided with taxiway lighting of modified layout geometry to suit the applicable Defence aircraft and facilitate Defence operations.

2.2.14 **Intermediate Holding Position Lights** are required to identify the location of runway holding positions on a taxiway where runway guard lights are not installed, at taxiway/taxiway intersections where it is necessary to identify the aircraft holding position and where a designated intermediate holding position needs to be identified. The lights are either inset where inset taxiway lights are installed or elevated where elevated taxiway edge lights are installed. The light emitted is coloured yellow and is unidirectional for centreline lights so that they are only visible to aircraft entering a runway.

2.2.15 **Runway Guard Lights** may be provided at intersections of a taxiway with an instrument precision approach runway if stop bars are not provided at the intersection and the runway is a precision approach Category I runway and the traffic density is heavy. Runway guard lights consist of either two elevated lights located on each side of the taxiway or a line of inset lights across the taxiway at a runway holding position. The elevated runway guard lights display an alternate “wig wag” illumination and the inset lights illuminate in an alternate pattern to their adjacent light. The light emitted for both patterns is yellow and is unidirectional so that they are only visible to aircraft entering a runway. Runway guard lights must be on when the runway is active; day or night.

2.2.16 **Movement Area Guidance Signs (MAGS)** are provided to assist pilots manoeuvring on runways and taxiways. MAGS are located adjacent runways and taxiways and display either mandatory or other information. Mandatory signs display white lettering on a red background, information signs display black lettering on a yellow background on civil pavements and white lettering on a green background on a military pavements.

2.2.17 **Apron Edge Lighting** identifies the edges of aprons where taxiway lights or apron floodlighting is not sufficient to guide aircraft whilst manoeuvring on the apron. Apron edge lights emit yellow light on military aprons and blue light on civil aprons.

2.2.18 **Apron Floodlighting** illuminates aircraft apron pavements for the manoeuvring and servicing of aircraft and service vehicles. Apron floodlights are typically pole mounted however some existing installations have lights mounted to adjacent buildings or structures such as aircraft hangars. Apron floodlighting systems are classified into two categories based on the classification of the aircraft intended to use the apron, each with different illumination and performance requirements.
## Runway Operational Classification

### Visual Aid

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerodrome Beacon (ABN)</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>NA</td>
</tr>
<tr>
<td>Approach Lighting System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Intensity Approach Lighting (HIAL)</td>
<td>NA</td>
<td>R</td>
<td>O</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Simple Approach Lighting System (SALS) - Hi Intensity</td>
<td>NA</td>
<td>NA</td>
<td>O</td>
<td>O</td>
<td>NA</td>
</tr>
<tr>
<td>SALS - Low Intensity</td>
<td>NA</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>NA</td>
</tr>
<tr>
<td>Sequential Flashing</td>
<td>NA</td>
<td>O</td>
<td>O</td>
<td>NR</td>
<td>NA</td>
</tr>
</tbody>
</table>

### Approach Slope

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAPI</td>
<td>NA</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>NA</td>
</tr>
</tbody>
</table>

Approach slope indication is required for jet operations.

### Runway

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Intensity Runway Lighting (HIRL)</td>
<td>R</td>
<td>R</td>
<td>O</td>
<td>O</td>
<td>NA</td>
</tr>
<tr>
<td>Medium Intensity Runway Lighting (MIRL)</td>
<td>NA</td>
<td>NA</td>
<td>R</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Low Intensity Runway Lighting (LIRL)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>High Intensity (HI) - Centreline</td>
<td>R</td>
<td>O</td>
<td>O</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Turning Node</td>
<td>NA</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>ORP</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>LAHSO</td>
<td>NA</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

### Illuminated Wind Indicator (WI)

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illuminated Wind Indicator (WI)</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>NA</td>
</tr>
</tbody>
</table>

Located at each runway threshold.

### DTRM/HCM Boards

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required for all sealed runways &gt;1500m in accordance with DADM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Taxiway

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI Centreline</td>
<td>O</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>LI Centreline</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>NA</td>
</tr>
<tr>
<td>Edge</td>
<td>NA</td>
<td>NR</td>
<td>NR</td>
<td>O</td>
<td>NA</td>
</tr>
<tr>
<td>Stop bars</td>
<td>O</td>
<td>O</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

### Hold Points

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hold Points</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>NA</td>
</tr>
</tbody>
</table>

Not required if stop bars provided.

### Runway Guard

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runway Guard</td>
<td>R</td>
<td>Required at International Airports where traffic density is High, otherwise optional</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Movement Area Guidance Signs (MAGS)

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement Area Guidance Signs (MAGS)</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

### Navigation Check Signs

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation Check Signs</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

### Apron

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge</td>
<td>R</td>
<td>R</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

May be omitted when apron floodlighting exists.

<table>
<thead>
<tr>
<th>Visual Aid</th>
<th>Take Off RVR &gt; 350m</th>
<th>Precision Approach Category 1 RVR &gt; 550m</th>
<th>Instrument Approach</th>
<th>Non-Instrument Approach</th>
<th>Emergency Runway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodlighting</td>
<td>R</td>
<td>R</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

Note: R = Required, O = Optional, NA = Not Applicable, NR = Not Recommended

Table 2.1 Aeronautical Ground Lighting Facilities against Runway Operational Classification
2.3 Lighting Supply/Control System Description

2.3.1 A Pit and Duct System facilitates the installation and maintenance of cabling systems. Pits are provided for each light location to house the associated Series Isolating Transformer (SIT), and for under pavement crossings, changes of direction and at defined intervals to allow cable installation and access.

2.3.2 AGL Cabling fed from the AGL Control System supplies each of the visual aid systems. The majority of AGL systems are fed from series circuits that utilise two cable types as follows:

a. **Primary Cable** is a single core cable used to supply a circuit’s primary series circuit and is connected to a SIT at each light location. Primary cable is suitably rated for the circuit’s operating voltages that typically range between 1,000 and 1,800 volts subject to the circuit loading.

b. **Secondary Cable** consists of a two core cable, connecting between each light and it’s associated SIT.

2.3.3 **Series Isolating Transformers (SIT)** are provided at each visual aid to isolate a visual aid’s secondary circuit from its primary circuit allowing the circuit to remain serviceable in the event of a failure of the secondary circuit (visual aid, lamp, secondary cable or secondary joint). SITs also step down the primary voltage to a lower, safer and more manageable voltage in the secondary circuit.

2.3.4 An Airfield Lighting Equipment Room (ALER) houses the control and power equipment for the AGL systems. The equipment located within the ALER includes Constant Current Regulators (CCRs) or Mains Isolating Transformers (MITs) that supply power to the individual lighting circuits, the control and monitoring system, switchboards and emergency power equipment. The ALER may be a separate building or incorporated as part of another building that may also include separate rooms for a substation and Local Emergency Generator (LEG).

2.3.5 AGL Control Systems (AGLCS) consists of supply and control equipment that energises each of the visual aids systems in accordance with user requirements and instructions. CCRs and MITs supplying the primary circuits interface with control equipment where they are controlled and monitored with software or via hardwired control panels. The AGLCS can provide control and monitoring of the AGL facilities from several control location across the aerodrome to facilitate operations and maintenance, these typically include:

a. **Air Traffic Control Tower (ATC Tower)** houses the primary control panel for the aerodrome from which the Air Traffic Controllers operate.

b. **Approach Control Panel** located in the Approach Control facility at the interface between the AGLCS and the Advanced Defence Air Traffic System (ADATS) provides an alternate control location for ATC Tower personnel in the event of an ADATS failure. This panel also assists with the identification of system faults.

c. **ALER Control Panel** provides a control location within the ALER. The ALER Control Panel also facilitates the monitoring of the AGL systems and is considered to be the AGL Maintenance Agent’s main point of reference for AGLCS fault rectification.

d. **Local Manual Control** is provided within the ALER via the CCR Control Cubicles or Panels or the control panels that are integral with each CCR.
Part 2 - Planning and Documentation

3.1 Airfield Master planning

3.1.1 An airfield master plan is a stand-alone document that provides a framework within which the future development of airfield infrastructure at a Defence aerodrome may take place. Airfield master plans typically address the needs of the airfield in the areas of:

a. Aircraft pavement layouts;
b. Navigational aids;
c. Visual aids;
d. Operational capability;
e. Operational requirements including obstacle limitation surfaces; and
f. Location of airside infrastructure (buildings, towers, maintenance facilities, etc) or facilities that may impact on airside operations.

3.1.2 The purpose of the airfield master plan is to:

a. Ensure adequate infrastructure capacity is available for new and current developments;
b. Prevent impacting on airfield operations or operational capability;
c. Minimise redundant or abortive works;
d. Provide a framework for the planning of longer-term infrastructure projects.

3.1.3 The design of AGL systems is required to take cognisance of the master planning requirements for the airfield in particular the following AGL facilities:

a. Siting of ALERs and associated primary cable trunk feeder routes;
b. Connection of ALER services including electrical connections, drainage and systems and communications cabling;
c. Siting of IWIs;
d. Type and configuration of AGLCS interfaces; and
f. Allowance for future expansion of AGL control and supply systems and its impact on the sizing of ALERs.

3.2 Aeronautical Ground Lighting Configuration Manual (AGLCM)

3.2.1 AGL Configuration Manuals are available for each Defence aerodrome and incorporate the following:

a. Roles and responsibilities of aerodrome stakeholders;
b. Dispensations applicable to the aerodrome;
c. Overview of the AGL visual aids provided at the aerodrome;
d. Overview of the aerodrome’s ALER(s) and equipment within;
e. Overview of the aerodrome’s AGL control system;
f. Details of the aerodrome’s AGL maintenance requirements;
g. Preventative maintenance schedule and procedures; and
h. Spare parts inventory and management system.

3.2.2 The existing AGLCM and AGL layout drawing will be provided by DEEP. AGL Configuration Manuals to enable efficient operation and maintenance of the installation shall be provided or updated by the project.

AGLCM Updates

3.2.3 Updates of the AGLCM are typically required due to:

a. Changes made to the installed AGL system due to project requirements or changes in capability;
i The design consultants are responsible (unless otherwise advised by DEEP) for ensuring that the installed AGL system is appropriately documented and that the revised AGLCM incorporates all elements of the project;

b Modification or amendment of the installed AGL system required due to maintenance requirements, and or activity eg. spares availability;

c The AGL Maintenance Agent (AGLMA) shall ensure that the revised AGLCM has been updated as necessary to incorporate any changes to the AGL system.

3.2.4 The AGLCM modifier/amender/maintenance agent shall submit an electronic copy of the updated AGLCM to DEEP for review and undertake any further updates as necessary.

3.2.5 Four complete hard copies of the finalised AGLCM shall be printed and typically distributed to the following stakeholders:

a Base AGL Maintenance Agent;

b Local Defence Support;

c Base 44 Wing Detachment Commander (44 WG DET CDR); and

d DEEP.

3.2.6 Additional copies of the AGLCM may be required at joint user aerodromes. Confirmation of appropriate stakeholders shall be determined in consultation with DEEP.

3.2.7 The printed hard copies of the AGLCM shall include all chapters of the document as well as an A3 sized drawing of the layout of AGL at the airfield. The format of the document and drawings shall match existing. A separate laminated A3 sized layout drawing shall also be provided for the base AGLMA.

3.2.8 Electronic copies of the documents (PDFs) shall also be provided to all stakeholders with the original document (Word Doc) to be supplied to DEEP.

3.3 AGL Asset Inspection and Compliance Audit

3.3.1 A biennial inspection regime is currently being implemented by DEEP for Defence airfields in Australia. The purpose of the inspections is:

a To undertake a condition assessment of the AGL installed;

b To undertake a compliance audit of the AGL installed; and

c To audit the existing maintenance regime implemented for the AGL installed.

3.3.2 The reports are prepared following an audit inspection at a Defence airfield. The audit inspection shall be undertaken with the following stages:

a Pre-Inspection Briefing;

b Audit Inspection;

c DEEP Workshop;

d Base Stakeholders Workshop; and

e Release of Report.

Audit Report

3.3.3 AGL Assets Inspection and Compliance Reports shall incorporate the following:

a Recommended Maintenance Works;

b Introduction;

c Compliance Assessment;

d Condition Assessment;

e Maintenance Regime Assessment;

f Spares Assessment;

g Other Recommendations;

h Appendix A – Detailed Findings;

i Appendix B – Maintenance Practices;
j Appendix C – Industry Support;
k Appendix D – Previous Works and Recommendations;
l Appendix E – In-Brief and Out-Brief Minutes;
m Appendix F – Documentation Obtained During Assessment;
n Appendix G – Photographs;
o Appendix H – Routine Maintenance Works;
p Appendix I – Recommended Risk Managed Works Program; and
q Appendix J – Dispensations.

3.3.4 The report shall detail the recommended works to be undertaken by the AGLMA as well as recommended risk managed works that should be undertaken as part of a complex project by DSRG-DNAP (Directorate of National Airfields Projects) to improve the condition of the AGL asset or to provide compliance with current applicable standards.

3.3.5 The author of the report shall submit an electronic copy of the report to DEEP for review. Any further updates shall also be carried out as required following the Base Stakeholders Workshop.

3.3.6 Four complete hard copies of the finalised report shall be printed and distributed to the stakeholders listed in Section 3.2. The format of the document shall match existing.

3.3.7 Electronic copies of the report (PDFs) shall also be provided to all stakeholders.
4. Documentation Standards

4.1 Requirements

4.1.1 Defence attaches considerable importance to the provision of proper documentation of the design and constructed works (including specification, drawings, datasheets, as-constructed documentation, O&M manuals etc) and due regard shall therefore be paid to the detail and completeness of such documents. Documentation shall be clear, concise and precise.

Specification of Equipment

4.1.2 Unless special circumstances exist or where required by the FDB, equipment and materials shall not be specified by make and model number but shall be selected on the basis of their performance, suitability, maintainability and cost effectiveness. Any proposal to specify equipment by make and model shall be formally documented for approval by the Defence Project Director.

Design Documentation

4.1.3 In addition to the MIEE requirements for design documentation the following additional documentation shall be prepared for AGL systems.

4.1.4 General Drawings

4.1.5 Drawings of AGL and ALER shall include, where appropriate:

a. Layout drawings showing location, orientation, set out data for AGL lights (in engineering/measuring layout rather than easting/northing co-ordinates);

b. Cable wiring arrangements for all AGL;

c. Approach slope indicator set out and circuiting plans and set out data;

d. Approach lighting system set out and circuiting plans and set out data;

e. Runway and taxiway system set out and circuiting plans and set out data;

f. Set out and circuiting plans and set out for other AGL systems such as IWI, MAGS, floodlighting, etc;

g. ALER layout drawing to scale showing overall dimensions and equipment layouts;

h. Site layout drawings to scale where appropriate; and

i. Assembly drawings detailing construction and installation requirements.

4.1.6 Electrical Drawings

4.1.7 Electrical drawings for the installation shall be drafted in accordance with the MIEE and AS 1102, and shall include the following:

a. Single line diagrams;

b. Surge diverter panel set out;

c. Cable schedules;

d. SCADA screens or control system arrangement;

e. Control system topology and control drawings;

f. Overall system diagrams, for communication showing cable types and system components; and

g. Block cabling diagrams.
Shop Drawings
4.1.8 Detailed shop drawings shall be prepared in accordance with the MIEE covering the following additional AGL specific elements:
   a All switchboards including distribution boards;
   b Control boards, panel and cubicles including internal and external layouts;
   c Surge diverter panels;
   d Indicator panels;
   e SCADA screens or control panel layouts; and
   f Cable schedules.

As-Constructed Documentation
4.1.9 As constructed documentation including Operation and Maintenance (O&M) manuals for the AGL installation and control system equipment; PLC/SCADA, control panels (method of operation, spare parts etc), lights (maintenance procedures, spare parts etc), MAGS etc shall be provided at the completion of the project and be certified to correctly reflect the as installed works.

4.1.10 The operational instructions are to be comprehensive and include descriptions of the operation and logic for remote (HMI) operation and local/manual control from the CCR control boards and CCR front panels.

4.1.11 Backup and restoration of the PLC/SCADA logic/programs is to be fully documented to assist in the restoration of the AGL after failure of a computer or PLC.

As-Constructed Drawings
4.1.12 Provide “As Constructed” drawings that show as a minimum:
   a The installed locations and orientation of AGL lights, cables, pits, cable joints etc;
   b Wiring diagrams for all equipment installed including cable management plan and termination diagrams;
   c SCADA Display Screens;
   d I/O schedules;
   e General arrangement drawings showing details of all equipment installed, including internal and external panel layouts; and
   f All information required to facilitate operation and maintenance of the equipment.

As-Constructed Survey
4.1.13 As-Constructed site survey of AGL works shall be conducted to update the overall layout of the Defence facility within which the works are situated. This shall include as a minimum:
   a Location and orientation of all installed lights, signs, etc;
   b Location of cable pits;
   c Location of underground services;
   d Primary cable routes;
   e Extent of mounting pads (as installed to mount PAPIs, MAG signs, etc); and
   f ALER facilities and infrastructure (eg. Building outlines, roadways and kerb lines, aboveground and underground services).
5. Reserved
Part 3 - Certification, Verification, Design and Construction
6. Certification and Verification

6.1 Certification

6.1.1 All new Defence AGL installations are required to be certified by the designer, contractor or maintainer as meeting the requirements detailed in this manual and the MIEE.

6.1.2 All facilities and infrastructure are to be certified as fit for service, safe and environmentally compliant prior to their acceptance into service and ongoing use within Defence.

6.1.3 Certification shall be provided in accordance with the requirements of the MIEE for the following items:
   a Design and construction certification;
   b Maintenance or modification certification; and
   c Certification of electrical installations.

6.1.4 Certification associated with the maintenance or modification of AGL systems shall incorporate the certification requirements specified within AGL Configuration Manuals.

6.1.5 Ground check and flight check certification shall also form part of certification procedures for AGL systems.

6.2 Verification

6.2.1 Verification of AGL systems shall be undertaken in accordance with the requirements of the MIEE.

6.2.2 The designer is to provide written confirmation in the form of a Compliance Report for all AGL installations. The report is to certify that the installation has met the requirements of the applicable regulations and standards and this manual.

6.2.3 Requirements for the MIE-AGL Compliance Report are provided at Appendix A which comprises:
   a MIE-AGL compliance statement;
   b MIE-AGL compliance statement summary checklist; and
   c Design considerations checklist.
7. Design Requirements

7.1 Designers Responsibility

7.1.1 The general design framework for electrical services including the designer’s responsibilities are detailed in the MIEE.

7.1.2 The AGL installation shall be designed and arranged to meet all appropriate and relevant Australian standards and legislation for the type of installation or equipment to be used, irrespective of their status. Where Australian standards are not available, recognised International or overseas national standards shall be used where they are relevant to the type of installation or equipment and to the installation conditions in Australia. The designer shall detail in the design report all standards and legislation adopted together with clear indication of the extent and field of application.

7.1.3 The Designer shall select, after comparing all design options available, the most cost effective design solution that will meet the requirements of this chapter and those specific to the establishment or facility.

Augmenting existing installations

7.1.4 The augmentation of existing aerodromes by construction of additional facilities or the deletion of redundant facilities may require augmentation or modification of existing AGL systems.

7.1.5 Where augmentation of an existing AGL system is required, the designer shall consider the general design requirements identified in the FDB and the following:
   a. Compatibility of light fittings with regard to their photometric performance when compared to the characteristics of the existing light performance. The designer must ensure compatibility with existing AGL system particularly where connected to the same circuit and may require the specification of identical light types from the original light manufacturer;
   b. Suitability of existing lighting systems and the possible need to upgrade;
   c. The interface to existing ALER including the control system, the loading of existing CCRs; and
   d. Availability of spares that may be required for future maintenance of the existing equipment.

7.1.6 The Designer must assess the serviceable life remaining and provide economic analysis of the existing equipment considering its replacement/retirement in favour of a reduced operational life cost.

7.2 Scoping Study

7.2.1 A scoping study shall be performed to identify options for AGL works and provide initial cost estimates for consideration by the client and user groups to enable sign off on the scope of works to be included in a FDB.

7.2.2 Scoping studies include the following processes:
   a. Review of any previous scoping studies prepared for the airfield’s AGL systems;
   b. Consideration of recent AGL works undertaken;
   c. Identification of required AGL works, design options and their estimated costs;
   d. Production of a scoping study report including recommended works packages. The use of drawings to detail the identified options and recommended works is considered to be an effective method to supplement the report; and
   e. Participation in a project scope review and value management study with client and users groups.

7.2.3 The works identified in the scoping study shall use cost effective design solutions that will meet the requirements of this document and those specific to the establishment or facility identified by Defence, the DSRG Regional office, project sponsor and user groups.

7.3 Project Identification and Development

FDB Requirements

7.3.1 The FDB is required to identify the functional requirements of the project elements together with the philosophy to be implemented.
7.3.2 The FDB is to include the following:

- a) Introduction;
- b) Existing installation descriptions;
- c) General site and service conditions data, taking into account data from the Bureau of Meteorology and any special site requirements;
- d) Scope of Works;
- e) Facility role and operation;
- f) Details of any investigations to be carried out as part of the design process;
- g) Any specific requirements of the installation including the regional requirements;
- h) Any required changes to the standard system arrangements;
- i) The requirements for passive defence measures;
- j) General design criteria;
- k) ALER building elements design requirements, engineering services;
- l) Aeronautical Ground Lighting;
- m) Commissioning; and
- n) Any processes which must be followed as part of the design.

**Design Considerations Checklist**

7.3.3 Provided at Appendix A are Defence design considerations which are a checklist of items that require consideration during the design phase. The designer shall ensure that, in addition to demonstrating in the design report that the design has met all applicable requirements, that all elements of the checklists have been adequately addressed and documented in the design report.

**Design Report Requirements**

7.3.4 The design report requirements are provided in the MIEE and include commentary on the design considerations as detailed in Chapter 1 and Appendix A.

7.3.5 The Designer shall submit design reports as a minimum at the following stages as required in the MIEE:

- a) 30%; Concept Design Report (CDR);
- b) 50%; Schematic Design Report (SDR);
- c) 90%; Detailed Design Report (DDR); and
- d) 100%; Final Design Report (FDR).

7.3.6 The design report shall be prepared and continually developed in accordance with the requirements of the MIEE. The AGL design report shall:

- a) Identify the scope of works;
- b) Identify all major regulations and standards including Defence policy, standards and guidance and detail extent and field of application;
- c) Document general electrical requirements for substations, LEG, UPS, switchboard labelling, MGLB, etc as detailed in the MIEE;
- d) Certify that the design meets the requirements of the FDB and any other requirements as mentioned above;
- e) Where the design deviates from any of the stated requirements, provide fully justified submissions in the design report for Defence agreement;
- f) Detail the AGL system design including detailed descriptions of each element;
- g) Detail the existing and proposed CCR loadings;
- h) Detail the ALER arrangement;
- i) Summarise the control arrangement;
j Detail the ATC Tower interfacing;
k Report the basis for sizing/selecting of major equipment;
l Detail the requirements for updating of AGLCM and O&M manuals;
m Detail the requirements for commissioning; and
n Include suitable layout drawings and single line diagram for the proposed arrangement including:
  i Discrete drawings for light layout and cabling showing engineering (measuring) layouts rather than easting/northing co-ordinates;
  ii Circuit diagrams;
  iii Light set outs;
  iv Single line diagrams;
  v SCADA screens;
  vi ALER layouts;
  vii Control system and communications network diagrams; and
o Include indicative cost estimates for the procurement and construction of the works.

7.3.7 The drawings shall provide sufficient layout, orientation and circuiting information to allow consideration of the design.

7.3.8 Further guidance is provided on the drawings and detail required in the design report throughout this document.
8. Construction Requirements, Project Controls and Commissioning

8.1 Procurement of Components

8.1.1 As detailed in the MIEE, the Defence IM promulgates mandatory policy and procedures for the procurement of capital facilities.

8.1.2 Where the project delivery method and procurement processes allow, it is preferable to assess and nominate specific specialised AGL equipment in consultation with DEEP as part of the design process. Specialist AGL equipment typically includes:

a Aerodrome beacons;
b Approach slope indicators;
c Inset and elevated lights including approach, runway, taxiway and apron;
d Approach light masts;
e Installation jigs and alignment tools;
f IWIs;
g MAGS, DTRMs, HCMs and navigation aid check signs;
h Primary and secondary cable;
i Series Isolating Transformers and associated plug socket connectors; and
j Constant Current Regulators.

8.1.3 The selection of specific AGL equipment facilitates:

a The detailed technical assessment with respect to performance and compliance with standards and design documentation;
b The evaluation of commercial aspects including whole of life costs independently of Contractor installation costs; and
c Consideration of existing installed equipment types.

8.1.4 As the majority of specialist AGL equipment is manufactured overseas with long manufacture and delivery lead times, commencing the procurement process prior to engaging installation contractors will assist with achieving short construction programmes.

8.1.5 The calling of tenders, assessment/selection and placing of equipment orders may therefore be better suited to procurement (in a suitable contract framework) separate to the installation contract.

8.1.6 To mitigate risks associated with delayed delivery of AGL equipment, the option may exist to novate the AGL equipment supply contract to the installation; implementing this option shall be subject to the requirements of established project procurement plan.

Standardisation

8.1.7 Electrical/Electronic equipment shall, as far as practicable, be standardised on a site-by-site basis to:

a Maximise interchangeability;
b Minimise necessary spare holdings;
c Reduce extent of maintenance training; and
d Maintain any existing standards wherever appropriate.

8.1.8 Standardised AGL systems are to be adopted to allow the application of consistent design and operating practices across each Defence establishment and, where appropriate, across a Defence region. Consideration of the locally available equipment and support from outside organisations is important.

8.1.9 Application may be made to the relevant DSRG Project Officer for use of trade names where matching of existing equipment is required.
Supportability

8.1.10 All equipment shall be selected from product ranges that are current and likely to be supported well into the future. Product ranges that are dated or likely to be at the end of the product cycle shall be avoided.

8.1.11 All equipment shall be readily and adequately supported in Australia and preferably in the local region. Adequate spares for important equipment shall be available in Australia and all equipment shall be fully supported by the equipment manufacturers and suppliers.

8.1.12 For major equipment, a Statement of Supportability shall be obtained from the Supplier addressing their commitment to support the equipment though the prospective life of the equipment and equipment guarantees/warranties. This Statement of Supportability is to be assessed as part of the tender assessment and is to be included in the operation and maintenance manuals.

Maintainability

8.1.13 Consider the maintenance requirements when determining the most appropriate equipment performance specifications and electrical system arrangement. This shall be based on the required performance, maintenance, reliability and the availability of comprehensive manufacturer’s product support locally.

8.2 Technical Assessment Report

8.2.1 The designer must undertake a detailed technical assessment of AGL equipment tender submissions to confirm suitability and compliance and provide a detailed Technical Assessment Report to support deliberations of the Tender Assessment Board. The Technical Assessment Report, as required by the MIEE is a detailed report which confirms compliance or otherwise to the specified requirements and provides through life assessment of the offered systems.

8.2.2 The Technical Assessment Report shall as a minimum include the following:

a Technical analysis of compliance or otherwise to the specified requirements, such as;
   i Photometric performance of lights including photometric intensity ratios;
   ii Mechanical performance of lights;
   iii Electromagnetic Interference requirements of CCRs;
   iv Compatibility of CCRs with Circuit Selector Switches and Emergency Generators;
   v Power factor and harmonic voltage characteristics of CCRs;

b Analysis of capital and whole of life cycle costs including spare parts.

8.2.3 The technical assessment process shall also review and confirm the validity of photometric and mechanical performance certification provided by the equipment manufacturers.

8.3 Staging

Method Of Working Plan (MOWP)

8.3.1 The MOWP is to be developed as part of the project design phase in accordance with the requirements of the DADM and Section 10.10 of the MOS Part 139 and in consultation with the 44 Wing Detachment Commander, operational personnel and the designer. Suitable documentation and plans shall be prepared to support the implementation of the MOWP.

8.3.2 The Installation Contractor is to develop detailed program information for all aspects of this project, including the provision, and commissioning of the new ALERs and AGL systems/elements and all associated works that are required by the project to support the development of the MOWP.

Cut-Over to new AGL Systems

8.3.3 The method of changing over from an existing AGL Control System and field equipment (lights) to a new installation shall be in accordance with the MOWP.

8.3.4 The new ALERs, AGL Control System and field equipment shall be established and operational prior to decommissioning of the existing equipment and systems.
8.3.5 In order to ensure the AGL remains operational, progressive transfer of the field circuits from existing AGL control equipment/lights to the new equipment/lights may be required. This may necessitate the new and existing control equipment to operate in parallel for the transfer period.

8.3.6 Short periods when sections of the AGL is unavailable will be permitted. However, these periods are to be scheduled in accordance with the MOWP to suit flying operations and weather conditions. Requirements associated with outages of the AGL shall be coordinated with the relevant authorities (e.g. 44 Wing Detachment Commander, Airfield Manager, Civil Operator (where applicable) etc).

8.4 Retention of redundant materials

8.4.1 All AGL equipment made redundant at the completion of the works shall be identified to DEEP for possible retention by the Commonwealth.

8.4.2 An inventory shall be prepared detailing the type, quantity and condition of redundant equipment including spare parts held by the AGL Maintenance Agent.

8.4.3 Equipment to be retained shall be suitably packaged for transport and storage and relocated to a location as directed by DEEP. Pack all fragile equipment (e.g. optical components) in packaging such that they will be protected during long-term storage or transport.

8.5 Testing and Commissioning

8.5.1 AGL systems shall undergo testing and commissioning activities necessary to prove their safety and correct operation.

8.5.2 Commissioning of AGL systems occurs in four stages;

a) Testing and inspections – routine testing and inspections undertaken during the construction works in accordance with the Contractor’s inspection and test plans to validate quality assurance compliance;

b) Pre commissioning – checks and testing of each element of the system to validate relevant functionality and compliance against the specification;

c) Commissioning – testing of the system as a whole to validate co-ordinated functionality and compliance against the specification; and

d) Acceptance testing and handover – testing of the system after completion of the Commissioning, in the presence of the ultimate client, to validate functionality against the original briefing and project design criteria.

Testing

8.5.3 Testing shall be conducted in accordance with the relevant Australian, IEC, or other appropriate standard and to the requirements of DSRG.

8.5.4 Testing shall occur on the equipment procured with suitable test records provided including the following:

a) Factory inspection and testing for major items of plant and equipment;

b) Factory Acceptance Testing of the Control System;

c) Site Acceptance Testing of the Control System; and

d) At completion of individual systems or groups of systems.

8.5.5 As a minimum, the following testing shall be conducted for the site installation:

a) All tests required by AS/NZS 3000;

b) Insulation and continuity testing for AGL primary cabling systems;

c) OTDR measurements of all optical fibre communications cables;

d) Correct operation of protection relays and other protective devices;

e) Instrument configuration and calibration; and

f) Functional tests.

8.5.6 Copies of the test records shall be incorporated in the Operations and Maintenance Manual.
Pre-commissioning

8.5.7 Pre-commissioning will include checks, tests and the collation of all compliance records of all elements including:

a. Pit and duct system;

b. Lights;
   i. Structural and Photometric tests including factory batch testing results;
   ii. Site installation test; level, orientation, aiming, colours, circuit connection;

c. Series Isolating Transformers;
   i. Electrical tests including compliance testing results;

d. Cables/Field circuits;
   i. Electrical characteristics including batch testing results of cables;
   ii. Site installation records including drum and meter cable marking for each circuit;
   iii. Circuit connections;
   iv. Insulation and Circuit Resistance Testing test results;

e. Constant Current Regulators;
   i. Electrical characteristics test sheets on each CCR;
   ii. Site commissioning records including initial energisation, integration with control system, individual setup parameters (intensity settings and alarm set points);

f. CCR Control Boards/Cubicles;
   i. Factory test sheets;
   ii. Site commissioning records including integration with control system;

g. SCADA/PLC control system;
   i. Factory acceptance test sheets;
   ii. Factory test sheets;
   iii. Site commissioning records including validation of PLC I/O with field points, validate integration with control boards/cubicles to confirm PLC programming and system functionality, individual setup parameters (intensity settings and alarm set points);

h. ALER Installation;
   i. Insulation resistance measurements before the connection of equipment;
   ii. Earth resistance measurement to AS/NZS3000;
   iii. Confirmation of effective earthing of the exposed metal of electrical equipment;
   iv. Carry out all necessary tests before energising newly installed or reconnected wiring or equipment;
   v. Ensure the correct phase sequence at each switchboard after connection of the supply;
   vi. Balance the load as evenly as practicable. Allow rechecking and, where necessary, re-balancing the load at completion of Defects Liability Period;
   vii. Confirm that circuit protective devices are sized and adjusted, where necessary, to protect the installed circuits;
   i. Sign of all Quality Documentation including sign off of all test plans and non-conformance corrective actions; and

j. Submission of Operation and Maintenance Manuals and as built drawings excluding the Commissioning results.

Commissioning

8.5.8 The results and documented records of the pre-commissioning activity together with the commissioning plan will validate the system ready for commissioning.
8.5.9 Commissioning shall include selected critical inspection of randomly selected elements as nominated. Commissioning tests shall include but not limited to:

a Field installation;
   i That all lights are operating correctly when their respective circuit is connected and over the range of CCR intensity stages for all control locations;
   ii That all lights are correctly orientated with correct filters and lenses fitted;
   iii That lights are operating at the correct intensities;
   iv The correct operation of the AGL systems when fully connected to the control system;
   v Undertake testing as stipulated above at night;

b AGL control system compliance and full functional and operational checks on energised control equipment and circuits, including:
   i SCADA control; operation of each circuit and intensity selection with validation of required revertive, validation of alarm and event logging and reporting;
   ii Transfer of control location;
   iii Validation of system response to anticipated failure modes of control system to confirm fail safe operation;
   iv Configuration and operation (selection) of Pilot Activated Lighting control mode;
   v Connectivity and operation of maintenance workstation;
   vi Adjustments for the correct operation of safety devices;

c ADATS/ATC Tower interface; validation of control system response and intensity selection;

d Manual control of CCR’s and field circuits;

e Operation on emergency power, including:
   i The adjustment of control system timers to stagger the connection of AGL loads; and
   ii The simulation of a mains power failure (disconnection of mains supply) to ensure that the system reactivates within the required time limit. Testing shall be undertaken on the system at maximum load (all AGL facilities energised at maximum intensity).

8.5.10 Commissioning of the AGL systems shall be undertaken in accordance with the requirements of the MOS Part 139 Section 9.1.15 including ground checks and flight checks. Ground and flight checks shall be undertaken in accordance with the requirements of CASA AC 139-04(0).

8.5.11 Commissioning shall occur prior to placing the completed installation into service. The designer will need to ensure that an appropriate commissioning plan is provided either by the designer or the contractor to ensure that the system is adequately proven and with minimum disruption to the Base or establishment.

8.5.12 Adequate notice of site testing and commissioning activity shall be provided to DSRG so that they can attend commissioning if required. Visual inspection for light location, orientation and visual performance is to be undertaken by Defence, the project manager, design consultant and the construction contractor.

8.5.13 Commissioning results shall be included in the “As-Constructed” documentation and associated manuals.

Acceptance Testing and Handover

8.5.14 The AGL system shall be tested in the presence of the ultimate client to validate the system’s functionality against the original briefing and project design criteria. The results and documented records of the commissioning activity together with the acceptance testing plan will validate the system ready for acceptance testing with the client.

8.5.15 Before the plant and equipment may be handed over to the DSRG Region, the following minimum requirements shall be achieved:

a All required tests have been undertaken with results provided to the DSRG Region;

b All necessary compliance certificates are provided;

c All lights, switchgear and equipment is correctly labelled and that the new labels for any existing cables, lights, plant and equipment are ready for change or changed as required;

d All required safety equipment is provided, including all signs and barriers;
operator training has been conducted to the level that the operators are qualified to operate and maintain the installation;
f. All appropriate operating and maintenance information is provided;
g. Revised documentation reflecting the new system arrangement; and
h. Certification has been received that the new installation meets the requirements of all appropriate legislation and standards and the requirements of the FDB.

8.5.16 The DSRG Region has the right to refuse acceptance of any installation, plant and equipment where it could compromise safety or the above requirements have not been met.

8.6 As-Constructed Information and Operation and Maintenance Manuals

8.6.1 The production of as-constructed information and Operation and Maintenance (O&M) manuals shall be undertaken as part of each project. The documentation of the AGL systems will be used as a management tool for the future planning and maintenance of the systems.

8.6.2 Required documentation includes:
a. As-Constructed drawings – Hard and soft copies of drawings detailing the “As Constructed” information;
b. O&M manual(s) containing data, test results, certification and information regarding the equipment and systems installed; and
c. Data, test results and manuals supplied with AGL specific equipment for inclusion in the O&M manual(s).

8.6.3 Draft copies of the manuals and drawings shall be delivered for review by the design consultant prior to the acceptance testing and commissioning phase of the AGL system.

8.6.4 The manuals shall be further amended to reflect the final “As Constructed” details and incorporate additional testing and certification prior to the end of the Defect and Liabilities period.

As Constructed Drawings

8.6.5 The production of as-constructed drawings shall be in accordance with the requirements of the MIEE.

Operation and Maintenance Manuals

8.6.6 O&M manuals shall detail the configuration of the installed AGL and contain technical information sufficient to maintain all equipment. Included in these manuals will be technical descriptions, configuration drawings, single line drawings, control system schematics, equipment schedules, airfield layouts, test results, certification, etc.

8.6.7 The manuals shall be prepared as stand alone documents and may be separated in various volumes to suit the configuration of the installed systems, such fieldworks, ALER, control system, etc.

8.6.8 Information to be included with O&M manuals shall include, but not be limited to the following:
a. Equipment schedules for installed and spare equipment including parts listings;
b. Details of installed equipment including installation, use and maintenance requirements;
c. Functional description of installed systems;
d. Details of installed systems including installation, operation and maintenance requirements; and

e. Testing and commissioning results including certification, ground and flight check reports and quality assurance documentation.
9. Reserved
Part 4 - Performance and Installation Criteria
10. General Requirements

10.1 General

10.1.1 This section discusses the design criteria for the photometric properties and configuration of lighting systems. The requirements will identify current standards where they are applicable and any additional or overriding Defence criterion. The order precedence used for the requirements below is as follows:

a) DADM;

b) MOS Part 139;

c) ICAO Annex 14 including the Aerodrome Design Manuals; and

d) Other recognised international standards and guidance such as IEC and FAA.

Standardisation

10.1.2 Standardisation of AGL systems assists pilots with the recognition and interpretation of the guidance provided by the standard configurations and colours used in the separate components of AGL. The pilot always views the aerodrome lighting systems in perspective, never in plan, and has to interpret the guidance provided, while travelling at high speed, often with only a limited segment of the lighting visible. As time to see and react to visual aids, particularly in the lower visibilities is limited, simplicity of pattern in addition to standardisation is extremely important.

10.1.3 Pilot visual workload is best moderated by standardisation, balance and integrity of elements. A ragged system with many missing lights can break the pattern from the pilot's eye position, restricted as that position is by cockpit cut-off angles and possibly by patchy fog or other conditions.

10.1.4 Four main elements comprise the character of the complete AGL system. These are conveniently referred to as the “four Cs” configuration, colour, candela, and coverage. Configuration and colour provide information essential to dynamic 3-dimensional orientation. Configuration provides guidance information, and colour informs the pilot of the aircraft’s location within the system. Candels and coverage refer to light characteristics essential to the proper functioning of configuration and colour. These four elements apply to all AGL in varying degrees, dependant on the classification of the aerodrome/runway and the visibility conditions in which operations are envisaged. Refer ICAO Aerodrome Design Manual Part 4 Visual Aids Chapter 1 for further detail on their application to AGL systems.

Photometric Performance and Configuration

10.1.5 The following paragraphs describe the photometric performance and configuration of AGL light systems.

10.1.6 Intensity of lights

10.1.7 Unless otherwise indicated, AGL systems emit a steady light. AGL systems have the facility for the independent control of intensity of each system. Intensity control is normally undertaken by Air Traffic Control (ATC) personnel; and simpler systems can be automatically controlled with reference to the output of a photometric cell to yield Day, Night or Twilight conditions. The intensities are selected in order to suit the prevailing Visual Meteorological Conditions (VMC) and a pilot may ask ATC to adjust the intensities if they are found to be inappropriate. There are three basic illumination categories used to designate AGL systems; High intensity to provide guidance by day and in low visibility conditions where the highest intensity settings are normally used and Medium and Low intensity to provide guidance at night.

10.1.8 Luminous intensity

10.1.9 AGL incorporating high intensity lights may be used in varying visibility and ambient lighting conditions. In certain conditions inset supplementary approach lighting at displaced thresholds and touchdown zone lighting at higher luminous intensity settings can cause unacceptable levels of glare to flight crew lining up for take-off. The final choice of AGL luminous intensity setting rests with the pilot; therefore the luminous intensity of AGL should be individually and independently controllable in accordance with the luminous intensity stages detailed in Table 10.1.
<table>
<thead>
<tr>
<th>Lighting</th>
<th>Stages</th>
<th>Minimum</th>
<th>Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIRL, HIAL, PAPI, HI SALS</td>
<td>1%, 4%, 11%, 33%, 100%</td>
<td>Additionally 0.4%</td>
<td></td>
</tr>
<tr>
<td>SFAL</td>
<td>100%</td>
<td>Additionally 11%, 33%</td>
<td></td>
</tr>
<tr>
<td>LAHSO</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer Threshold</td>
<td>11%, 33%, 100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DTRM/HCM</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IWI</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIRL, MI SALS</td>
<td>11%, 33%, 100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORP and runway turning area</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxiway centreline and stop bars</td>
<td>33%, 100%, 300%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low intensity systems and taxiway edge exceeding 5 candelas output</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10.1 Luminous intensity

10.1.10 The above percentages of luminous intensity are nominal percentages of the luminous intensity defined in the isocandella diagrams within DADM. The primary circuit current shall be adjusted to achieve these nominal percentages.

10.1.11 Intensity Ratio

10.1.12 The intensity ratio between respective elements of AGL systems shall be as detailed in the DADM.

10.1.13 It is noted that the reference average intensity for comparison of intensity ratios is the average main beam intensity of the runway edge light installed and not, for example, the minimum required value of 200 cd for a medium intensity system or 10,000 cd for a high intensity system.

10.1.14 Colour filters reduce the light output and the best balance between coloured and white lights may be obtained by either of the following means:

a Separate electrical AGL circuits operated at current settings for the different elements so that, for example, the green threshold and red runway end lighting may be operated with current values that differ from the runway edge lights so that the required intensity ratio with the white edge lighting is achieved; and

b Higher output lights or the use of increased wattage lamps in the existing lights for the coloured lighting. With this method the whole system can remain on a common AGL circuit, but care has to be exercised in order to ensure that the increased heat generated by higher wattage lamps does not damage the colour filters or increase the temperature of the light with the potential to damage aircraft tyres.

10.1.15 The combined light and lamp manufacturing tolerance of the average main beam intensity associated with the light and lamp needs to be considered in the selection of compatible lighting system. The intensity ratio between the separate elements may require selection of lights from different suppliers as not all suppliers offer lighting systems that comply with all of the ratio requirements when operated at the same current.

Colour of AGL elements

10.1.16 The colour of AGL elements is system dependant; details of the colour of the components of each system are included in the detailed requirements for each element.

10.1.17 To ensure uniformity of visual appearance as required by the DADM, light fittings using different manufacture shall not be mixed on any circuit or interleaved circuit of a common element. IS THIS STATEMENT VALID NOTING PROCUREMENT PROCESS REQUIREMENTS?
10.2 Design Life

10.2.1 All equipment shall be designed and installed to operate continuously at full load for 24 hours per day, 365 days per year at the extremes of temperature, humidity and environmental conditions (eg corrosive atmospheres) applicable for the installation location with a design life of: Ø WHAT IS "DESIGN LIFE"? IS THIS MAINTAINABLE?

a 50 years for non-electronic components;
b 20 years cables and inset lights;
c **XX years for elevated lights**;
d 15 years for electronic components Ø EXCESSIVE?;
e 5 years for SCADA and computers Ø WHAT IS EXCESSIVE? IE. REPLACING O-RINGS?

10.2.2 The Mean Time Between Maintenance (MTBM) value for electronic equipment shall be 5 years without excessive maintenance.

10.3 Corrosion Protection

10.3.1 Consideration shall be given to corrosion protection to prolong the life of the AGL asset. All equipment and fixings shall be selected and installed so that they are suitable for the corrosive effect of the environment in which they are installed without excessive maintenance. Suitable corrosion inhibiting compounds shall be applied to dissimilar metal fixings Ø IMPLICATION WITH INTERNAL CORROSION OF LIGHTS AT ALBATROSS.

10.4 Safety in Design

General

10.4.1 The design of AGL systems shall incorporate the guidelines and principles detailed within the Australian Safety and Compensation Council’s “Guidance on the Principles of Safe Design for Work” and the Association of Consulting Engineer Australia’s “Safety in Design” pocket guide.

10.4.2 The Designer shall be acquainted with the site procedures for access and operating requirements and make all necessary allowances in the design. In particular, ensure that appropriate requirements are included for the following:

a Access arrangements including permits, Foreign Object Damage (FOD) procedures, etc;
b Method of Working Plan (MOWP);
c Requirement for the Contractor to have all necessary skills and training such as radio procedures training;
d Requirement for standard keying arrangements;
e Access to the AGL systems including method of works and constraints in any configurational changes effecting continuity of AGL services either directly or by subsequent fault;
f Required commissioning and acceptance procedures for new installations including the completion of all required tests and proving the system is safe to the requirements of the operating authority before connection; and
g Requirement under certain circumstances for flight inspections or certified inspections prior to commissioning.

10.5 Electromagnetic Compatibility (EMC)

10.5.1 The AGL system shall not cause radiated or conducted electromagnetic interference to other systems such as information technology equipment (ITE), or radio navigational aids that may be located on or near the aerodrome, or that may use the same power supply. All equipment included in the electrical installations shall have immunity to electromagnetic phenomena and electromagnetic fields such as from radio transmitters, transients on power lines, atmospheric discharges, etc.
10.5.2 An aerodrome movement area is generally considered an uncontrollable electromagnetic environment. EMC levels (emission and immunity limits) should be assessed in order to ensure that existing or expected disturbance levels would not increase when new equipment is installed and that such equipment is sufficiently immune.

10.5.3 The Design shall limit interference in accordance with the requirements of AS/NZS CISPR and AS 61000.

10.6 Keying

10.6.1 Entry or access into ALERs by unauthorised personnel is not permitted. Doors shall be fitted with suitable locks and all locks supplied shall be master keyed to Defence requirements.

10.6.2 All AGL external electrical cubicles shall be keyed on a common system for access by authorised AGL personnel only.

10.7 Spares to be provided with Project

10.7.1 Spares required for routine and operational maintenance of the AGL asset shall be procured by the project and made available prior to practical completion. Minimum spares holdings are to include:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamps</td>
<td>100%</td>
</tr>
<tr>
<td>Lights</td>
<td>5 % for each light type as a complete unit (light and mounting base)</td>
</tr>
<tr>
<td>Light Tops</td>
<td>10% for each light type (complete units)</td>
</tr>
<tr>
<td>Lens/filters</td>
<td>10% for each light type</td>
</tr>
<tr>
<td>Gaskets</td>
<td>50% of each type eg Light top to base, cover to photometric compartment.</td>
</tr>
<tr>
<td>Mounting masts</td>
<td>5% of common components</td>
</tr>
<tr>
<td>Miscellaneous lighting components</td>
<td>5% for each component</td>
</tr>
<tr>
<td>CCR</td>
<td>2 of each rating</td>
</tr>
<tr>
<td>CCR components</td>
<td>As recommended by the CCR manufactures, minimum of one for each PC card and thyristor pack,</td>
</tr>
<tr>
<td>Cable</td>
<td>1 drum length of each type</td>
</tr>
<tr>
<td>Cable joints</td>
<td>50 for both Primary and Secondary cable</td>
</tr>
<tr>
<td>SITs</td>
<td>10 of each load rating</td>
</tr>
<tr>
<td>Control system equipment</td>
<td>10% of all componentry (switches, indicator lamp and sockets, relays, active devices including PLC modules, modems, media converters etc.)</td>
</tr>
</tbody>
</table>

10.7.2 Suppliers shall nominate recommended spares and those essential spares shall be provided as part of the installation for retention onsite by Defence. The suppliers shall also submit a Statement of Supportability for inclusion in the Manuals.

10.8 Hazardous Areas

10.8.1 Specific taxiways and aprons may be designated as Hot Refuelling Aprons or may be used for servicing aircraft including explosive ordinance activities. These areas shall be considered for classification as hazardous areas in accordance with relevant standards for electrical installations installed accordingly. The classification of the area may preclude the installation of AGL systems.

10.9 Reliability Issues

10.9.1 The AGL system shall minimise the vulnerability to a single event or particularly any event that could disable the whole AGL system or large portions of the AGL system. Any single point failures shall be identified and documented in the design report for Defence agreement.

10.9.2 Critical systems, particularly those with higher failure rates, shall be duplicated.
Dedicated Control Equipment

10.9.3 The AGL shall be capable of operating independently following a failure of the communication switches or their associated systems. In the event of failure of the local AGL Controller or systems it is expected that manual mode operation of the CCRs and circuit selection will be required.

Segregation of Equipment

10.9.4 Elements shall be adequately separated so that a failure in one system does not affect adjacent elements. Particular attention shall be paid to separation of elements in and near the ALER or other central locations. To the maximum extent that is practical, all components within the ALER and the field cabling shall be located or arranged to minimise the impact of failure.

10.9.5 Field cabling of elements which have more than one circuit shall be arranged to ensure that a single failure of one circuit will not affect the other.

10.9.6 Wiring from one control panel to another shall not generally pass through other control panels.

Communications Segregation

10.9.7 A dedicated communications network, independent of the Defence Engineering Services Network (DESN) or any other network, shall carry all internal traffic between the elements of the AGLCS.
11. Aerodrome Beacon

11.1 Requirement

11.1.1 An aerodrome beacon shall be provided where IDA-AF determines a beacon is operationally necessary. Guidance on the application of beacons is given in MOS Part 139 and ICAO Annex 14 which requires a beacon where the aerodrome is to be used at night by aircraft navigating predominately by visual means and the aerodrome is difficult to locate due to the presence of surrounding lights or terrain.

11.2 Characteristics

11.2.1 Light intensity, colour, flash rate and distribution shall be as detailed in the DADM.

11.3 Configuration

11.3.1 Beacons are generally to be located on the roof of ATC Towers, or in a location that will provide clear unobstructed observation of the beacon, when observed from the air, from a distance of 20 nautical miles.

11.4 Installation Details

11.4.1 Aerodrome beacons shall be mounted on a flat horizontal that facilitates the levelling of the equipment and provides access to levelling points, electrical connections and switches, surge protection devices and drive motors.

11.4.2 Beacons shall be supplied from a local electricity supply with connection to a secondary power supply in the event of primary supply failure.

11.4.3 Safe access in accordance with the relevant WHS regulations shall be provided for aerodrome beacons to facilitate maintenance.
12. Approach Lighting

12.1 Requirement

12.1.1 Approach lighting shall be provided as part of an overall AGL system that is applicable to a instrument precision approach Category I lighting system or where IDA-AF determine an approach lighting system is operationally necessary for a particular aerodrome.

12.1.2 Approach lighting may consist of a Simple Approach Lighting System (SALS) or a High Intensity Approach Lighting (HIAL) system.

12.1.3 HIAL may be supplemented by the provision of capacitor discharge Sequential Flashing Approach Lighting (SFAL) lights that are flashed in sequence beginning from the outermost light and progressing toward the threshold.

High Intensity Approach Lighting

12.1.4 High Intensity Approach Lighting (HIAL) is required for instrument precision approach runways or where IDA-AF determine a HIAL is operationally necessary.

Simple Approach Lighting System

12.1.5 SALS shall be provided where IDA-AF determine that a SALS is operationally necessary. This may be where a Precision Approach Category 1 compliant (HIAL) lighting system cannot be justified or to provide additional guidance for circling approach operations or other visual approach operations.

Sequential Flashing Approach Lighting

12.1.6 Sequential Flashing Approach Lights (SFAL) shall be provided where IDA-AF determine a SFAL is operationally necessary. SFAL are provided as a high intensity system to supplement HIAL systems during poor visibility conditions by day and at night and may be provided to supplement SALS or as a separate system.

12.2 Characteristics

High Intensity Approach Lighting

12.2.1 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

Simple Approach Lighting System

12.2.2 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

Sequential Flashing Approach Lighting

12.2.3 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

12.3 Configuration

Installation Tolerances

12.3.1 The installation tolerances for approach lighting systems are detailed in the DADM. ICAO Annex 14, Volume 1, Attachment A, Section 11.2 provides further guidance on installation tolerances to compensate for the aerodrome topology and existing obstacles and structures, and to avoid presenting a misleading impression to approaching aircraft.

Clearance of Obstacles

12.3.2 The guidance provided by ICAO Annex 14, Volume 1, Attachment A, Section 11.3 regarding the clearance of obstacles shall be applied for all Defence aerodromes. This includes clearance requirements associated with fixed and stationary obstacles such as roads, railways, and ILS and MLS equipment.
Consideration of the Effects of Reduced Lengths

12.3.3 The full length of approach lighting shall always be provided whenever possible however there are some runway locations where this cannot be achieved. In such cases, the designer shall consider the effects of reduced lengths as detailed in ICAO Annex 14, Volume 1, Attachment, Section 11.4.

12.4 Installation Details

12.4.1 Light mounting structures for approach lighting systems shall be selected to facilitate access to the light for maintenance purposes. Lights mounted above a safe and practicable working height shall incorporate a lowering mechanism or elevated work platform.

12.4.2 A typical HIAL and SFAL installation is illustrated below in Figure 12.1.

Figure 12.1  Typical HIAL and SFAL Installation
13. Approach Slope Indicators

13.1 Requirement

13.1.1 Approach slope indication systems shall be provided where the runway is regularly used by jet propelled aircraft or where IDA-AF determine approach slope lighting is operationally necessary for a particular aerodrome.

13.1.2 Approach slope indication systems consist of a Precision Approach Path Indicator (PAPI). Defence adopts the solution of installing a PAPI on both port and starboard sides of the runway being approached.

13.2 Characteristics

13.2.1 Light intensity, beam characteristics, colour and aiming shall be as detailed in the DADM.

13.3 Configuration

13.3.1 Defence adopts the practice of installing four PAPI boxes on both port and starboard sides of the runway to increase conspicuity and provide roll guidance.

13.3.2 For Defence airfields with arrestor hook wire, the optimum Threshold Crossing Height (TCH) shall be determined considering the need of aircraft required to engage the hook wire and also the design aircraft.

13.4 Installation Details

13.4.1 Approach slope indicators shall be mounted upon concrete footings designed to provide a stable mounting platform and minimise the level of required maintenance (i.e. realignment) with consideration of the geotechnical conditions.

13.4.2 The concrete footings shall be sized to provide suitable clearance around the approach slope indicator equipment and prevent accidental damage by grass cutters.

13.4.3 The identification number and design angle of elevation for each approach slope indicator light unit (i.e. PAPI box) shall be permanently marked on concrete footing or associated light number identification label.

13.4.4 All exposed cabling shall be provided with suitable mechanical protection such as UV stabilised or stainless steel flexible conduit to prevent exposure to UV degradation and damage by birds whilst allowing maintenance and realignment of the lights.

13.4.5 A typical HIAL and SFAL installation is illustrated below in Figure 13.1.
Figure 13.1  Typical PAPI Installation
14. Runway Lighting

14.1 Requirement

14.1.1 A runway lighting system includes edge, threshold and end lights and for Defence airfields may be of the following types:

a Low Intensity Runway Lighting (LIRL) – a single-stage intensity lighting system suitable for a non-instrument runway or an instrument non-precision approach runway. The minimum average main beam intensity for a LIRL runway edge light is 100 candelas, with an maximum average main beam intensity of less than 200 candelas.

b Medium Intensity Runway Lighting (MIRL) – a 3-stage intensity lighting system suitable for a non-instrument runway or a instrument non-precision approach runway. The minimum average main beam intensity for a MIRL runway edge light is 200 candelas, with Defence choosing not to specify a maximum average main beam intensity.

c High Intensity Runway Lighting (HIRL) – a 5 or 6 stage intensity lighting system which is suitable for non-instrument, instrument non-precision approach or instrument precision approach runways to Category 1 approach standard. The minimum average main beam intensity for a MIRL runway edge light is 200 candelas.

14.1.2 The installation of runway lighting for emergency runways shall be determined by IDA-AF where deemed operational necessary. Where provided, emergency runway lighting shall be a 3 stage MIRL system. Consideration should be given to the installation of inset lights in lieu of elevated lights for emergency runway lighting systems where the width of the emergency runway (typically a taxiway) is less than that specified in the DADM for the applicable aircraft classification or lights are susceptible to damage.

Runway Edge Lighting

14.1.3 Runway lighting shall be provided for runways intended for use at night and for precision approach runways intended for use by day or night.

Runway Threshold and Outer Threshold Lights

14.1.4 Runway threshold lights shall be provided on a runway equipped with runway edge lights. Defence places considerable importance on outer threshold lights that provide essential circling guidance.

Runway Threshold Identification Lights

14.1.5 RTILs shall be provided during the day to mark a temporarily displaced threshold of a runway at International aerodromes serving jet propelled aeroplanes, or where IDA-AF determine they are operationally necessary for a particular aerodrome. RTILs may also be used to mark the temporarily displaced thresholds of other runways.

14.1.6 RTILs may be installed at an aerodrome where it is difficult to locate a runway threshold from the air during the day such as in the case of a displaced threshold or an aerodrome with complex runway/taxiway layout in the vicinity of the threshold.

Runway End Lights

14.1.7 Runway end lighting shall be shall be provided on a runway equipped with runway edge lights.

Supplementary Circling Guidance

14.1.8 Supplementary circling guidance shall be provided where IDA-AF determines that it is operationally necessary for a particular aerodrome.

Runway Turning Area and Operational Readiness Platform (ORP) Lights

14.1.9 Where a runway turning area or an Operational Readiness Platform (ORP) is provided on a runway with runway lighting, the edge of the area shall be provided with blue edge lights if the runway is provided with runway edge lights.
Pre Threshold and Stopway Lights
14.1.10 Pre-threshold and stopway lights shall be provided on a runway equipped with runway edge lights with pavement directly in front of a threshold or directly beyond the end that is longer than 180m.

14.1.11 In the case of a displaced threshold, the lights between the beginning of the runway strip and the threshold shall show red in the approach direction.

Land and Hold Short Lights
14.1.12 Hold short lights shall be provided on a runway that is intended to accommodate Land and Hold Short Operations (LAHSO) where IDA-AF determines that it is operationally necessary for a particular aerodrome.

14.1.13 LAHSO lighting and associated Distance-to-Go signage is provided to facilitate simultaneous operations on bisecting runway vectors.

Runway Centreline Lights
14.1.14 Runway centreline lights shall be provided where IDA-AF determine that runway centreline lights are operationally necessary. Guidance on the application of runway centreline lights is given in MOS Part 139 and ICAO Annex 14.

14.2 Characteristics

Runway Edge Lighting
14.2.1 Light intensity, beam characteristics, colour, configuration and aiming of runway lighting shall be as detailed in the DADM.

14.2.2 Inset runway edge lights shall have an average main beam intensity within 1.2 and 0.8 of the corresponding elevated edge lights.

14.2.3 The omni directional component for combined HIRL/MIRL edge lights shall be not less than 10 percent of the nominated minimum average main beam intensity for HIRL with a distribution characteristics as detailed for a medium intensity omni directional runway edge light.

Runway Threshold and Outer Threshold Lights
14.2.4 Light intensity, beam characteristics, colour and aiming shall be as detailed in the DADM.

Runway Threshold Identification Lights
14.2.5 Light intensity, beam characteristics, colour and aiming shall be as detailed in the DADM.

Runway End Lights
14.2.6 Light intensity, beam characteristics, colour and aiming shall be as detailed in the DADM.

14.2.7 Attention must be given to the gradient of pavement surfaces and the presence of obstructions in front of runway end lights to ensure that they are visible from the required distance at the specified height above the runway as detailed in the DADM (600 metres prior to runway end at a height of 3 metres above the runway). Where these visibility requirements can not be met with lights installed in accordance with the manufacturer’s instructions, direction shall be sought from DEEP.

Supplementary Circling Guidance
14.2.8 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

Runway Turning Area and Operational Readiness Platform (ORP) Lights
14.2.9 Light intensity, beam characteristics, colour and aiming shall be as detailed in the DADM.

14.2.1 Pre Threshold and Stopway Lights
14.2.2 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.
Land and Hold Short Lights
14.2.3 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

Runway Centreline Lights
14.2.4 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

14.3 Configuration

Runway Edge Lighting
14.3.1 Preference shall be given to elevated edge lights where possible. Where elevated edge lights cannot be installed (eg due to an intersecting runway or taxiway).
14.3.2 Inset bi-directional lights shall be installed to shield in the direction of other runways or taxiways, all other location can have omni directional inset lights.
14.3.3 Runway edge lights in the vicinity of permanent and temporary Hook Cable Arrestors shall be inset to prevent damage to these lights and the arrestor tape. The run-out length of the Hook Cable Arrestor shall be considered when installing runway edge lights noting that arrestor systems are often operational for both runway vectors.

Runway Threshold and Outer Threshold Lights
14.3.4 Outer threshold lights and wing bars may be either elevated or flush with preference for elevated lights. Displaced threshold lights shall be located at the displaced threshold with a tolerance of ± 1m.
14.3.5 Defence adopts the use of inset lights for runway threshold applications to prevent damage to aircraft that land short on approach, or over run the runway end.

Runway Threshold Identification Lights
14.3.6 Runway Threshold Identification Lights (RTIL) are provided to assist pilot acquisition of a threshold during day, twilight and at night. Care needs to be taken to ensure the flashing lights will not dazzle an approaching pilot, particularly at twilight and night.
14.3.7 When RTILs are used, the need for temporarily displaced threshold V-bar markings is normally waived.

Runway End Lights
14.3.8 Defence adopts the use of inset lights for runway end applications to prevent damage to aircraft that over run the runway end, or land short on approach. The installation of inset runway end lights also reduces the amount of jet blast to optical surfaces when compared to elevated lights.
14.3.9 In some circumstances where the runway end lights, within the installation tolerances allowed by the DADM, are not visible from the specified distance due to the pavement profile, consideration may be given to the use of elevated lights. The use of elevated runway end lights shall be approved by DEEP.

Supplementary Circling Guidance

Runway Turning Area and Operational Readiness Platform (ORP) Lights
14.3.11 As detailed in the DADM.

Land and Hold Short Lights
14.3.12 As detailed in the DADM.
Pre Threshold and Stopway Lights
14.3.13 As detailed in the DADM.

Runway Centreline Lights
14.3.14 As detailed in the DADM.

14.4 Installation Details
14.4.1 Refer Chapters 20 and 21 for installation details of inset and elevated runway lights.
15. Illuminated Wind Indicators (IWIs)

15.1 Requirement

15.1.1 IWI shall be installed at all aerodromes provided with AGL.

15.1.2 Additional IWI shall be provided where IDA-AF determines they are operationally necessary for a particular aerodrome.

15.1.3 Runways less than 1500 m in length only require a single IWI in a suitable central location.

15.2 Characteristics

15.2.1 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

15.3 Configuration

15.3.1 As detailed in the DADM.

15.3.2 IWIs shall be located such that they do not infringe runway obstacle limitation surfaces and are clear of ILS/MLS critical areas where appropriate.

15.3.3 Obstruction lights are not required to be installed upon the IWI unless where requested by aerodrome operational personnel to facilitate visually locating them on the airfield from the ATC Tower.

15.3.4 Contrasting ground markings shall be provided for all IWIs to enhance their visibility from the air for approaching aircraft pilots.

15.4 Installation Details

15.4.1 IWIs shall utilise mid-hinged counter balanced see-saw masts to facilitate their lowering for maintenance purposes. A rope of sufficient strength to support the weight of the counter balanced mast shall be provided to lower the mast. The mast shall be provided with a locking mechanism to secure it in its upright position.

15.4.2 The IWI shall be installed with consideration of the environmental and geotechnical conditions for wind loadings in accordance with AS 1170.2. IWI footings shall be designed and certified by a qualified structural engineer (CPEng).

15.4.3 The IWI mast shall be earthed in accordance with AS/NZS 3000 and AS 1768.

15.4.4 The IWI luminaires shall be aimed such that an even illumination of the extended windsock is achieved.

15.4.5 For IWIs comprising a single lamp per quadrant, each SIT including those supplying obstruction lights shall be installed within a separate SIT pit. Two SITs may be installed within a single SIT pit for IWIs comprising two lamps per quadrant; the SITs shall be installed such that the two SITs supplying an IWI quadrant or the obstruction lights are not installed within the same pit.

15.4.6 All exposed cabling shall be provided with suitable mechanical protection such as UV stabilised flexible conduit to prevent exposure to UV degradation and damage by birds whilst allowing maintenance and realignment of the lights.

15.4.7 The ground markings at the base of the IWI shall be durable and minimise the amount of maintenance associated with reinstatement and removal of vegetation regrowth. White marker cones, where provided, shall be adequately secured to the ground.

15.4.8 A typical IWI installation is illustrated below in Figure 15.1.
Mid-hinged pole.
Concrete footing.
Secondary cable and conduit.
Wind sock.
Secondary cabling to IWI lamps within pole.
Floodlights.
Obstruction lights (where required).
Earth electrode pit.
Reinforcement fabric.
Earth electrode pit.
Earth electrode.
Concrete footing.
SIT pits (max. 5).
Primary cables in conduit.
Drain hole and gravel under SIT pit.

Figure 15.1  Typical IWI Installation
16. Distance to Run Marker (DTRM) and Hook Cable Marker (HCM)

16.1 Requirement

Distance to Run Markers (DTRM)

16.1.1 DTRMs are to be provided for all sealed runways 1,500 metres in length or greater or where IDA-AF determines they are operationally necessary for a particular aerodrome.

Hook Cable Markers (HCM)

16.1.2 HCMs are to be provided at all airfields that have hook arrestor cable equipment install or where IDA-AF determines they are operationally necessary to mark temporary hook arrestor cable equipment or a particular aerodrome.

16.2 Characteristics

Distance to Run Markers (DTRM)

16.2.1 Inscription, size, location, colour, illumination, configuration and location shall be as detailed in the DADM.

Hook Cable Markers (HCM)

16.2.2 Inscription, size, location, colour, illumination, configuration and location shall be as detailed in the DADM.

16.3 Configuration

Distance to Run Markers (DTRM)

16.3.1 As detailed in the DADM.

16.3.2 DTRMs shall be internally illuminated with a preference for the use of retro reflective inscriptions.

Hook Cable Markers (HCM)

16.3.3 As detailed in the DADM.

16.3.4 DTRMs shall be internally illuminated with a preference for the use of retro reflective inscriptions.

16.4 Installation Details

16.4.1 DTRMs and HCMs shall be installed upon a concrete footing of sufficient size to achieve the specified wind loadings and prevent accidental damage to the marker boards by grass cutters. The footings shall meet the deflection requirements of FAA AC 150/5345-45.

16.4.2 The marker board shall be installed upon frangible couplings and secured to the footing by a chain that tethers the board in the event of it being dislodged. Supporting feet for DTRMs and HCMs shall meet the frangibility requirements of ICAO Aerodrome Design Manual Part 4 Chapter 15.

16.4.3 Marker boards with a lamp operating voltage of 50V or greater shall be provided with an isolation switch either mounted externally or at the point of entry into the marker board body. An earthing arrangement in accordance with AS/NZS 3000 shall earth each of the signs.

16.4.4 For marker boards supplied with multiple halogen lamps internally illuminating the inscription panel from above, the lamps shall be sired across two interleaved secondary circuits such that alternate lights are connected in series.

16.4.5 Each marker board shall be provided with bird spikes along the full length of the sign to prevent soiling of each of the board’s inscription panels.

16.4.6 Secondary cable shall be installed within the mast or frangible coupling so that the secondary cable is completely enclosed. Where the cable must exit a mast to enter a marker board the exposed section of
the secondary cable shall be enclosed within a UV stable flexible conduit thus allowing maintenance of the board.

16.4.7 A typical DTRM installation is illustrated below in Figure 16.1.
17. Taxiway Lighting

17.1 Requirement

Taxiway Lighting
17.1.1 Taxiway lighting provides guidance for taxiing aircraft in low visibility conditions and at night, therefore the layout design for taxiway lighting needs to consider the ability of a pilot to clearly observe the installed installation.

17.1.2 Separate runway entry lights as depicted in MOS Part 139 Chapter 9 Section 9.13 Figure 9.15-1 Detail A are not mandatory for Defence. Where not provided, the curve section lighting shall be bi-directional.

Intermediate Holding Position Lights
17.1.3 Holding position lights shall be located at the boundary of the Runway Strip. IDA-AF may approve an alternate location where this is found impractical.

Runway Guard Lights
17.1.4 Runway guard lights may be provided at the intersection of a taxiway with a precision approach runway if stop bars are not provided at the intersection, and the runway is a precision approach Category I runway where the traffic density is heavy; where IDA-AF determines it is operationally necessary. Where introduced runway guard lights shall be installed at all taxiways that provide access onto the runway.

17.1.5 Where a taxiway is used for exit only and cannot be used for entry to the runway, runway guard lights are not required.

17.2 Characteristics

17.2.1 Light intensity, beam characteristics, colour, spacing, configuration and aiming shall be as detailed in the DADM.

17.3 Configuration

17.3.1 The layout of taxiway lights shall be arranged so that a pilot will be provided with guidance whilst taxiing for all aircraft types that will use the particular pavement. The taxiway light layout shall allow a pilot whilst seated in the normal command position (normally left hand seat for fixed wing aircraft and right hand seat for rotary wing aircraft helicopters) to have a direct line of sight to observe the main beam component of the required number of taxiway lights.

17.3.2 Defence require that new taxiway lighting systems utilise inset taxiway centreline lights. Taxiway edge lights may be provided to supplement the taxiway centreline lights.

17.3.3 Inset centreline lights shall be installed with their photometric axis directed (rotated about the taxiway centreline) to present the main beam area to the direction of viewing to achieve the most economic layout of lights. Where more than one light is required to achieve a light distribution pattern that will allow it to be observed from all approach angles the lights shall be installed equi spaced 500 mm longitudinally about the TP associated with the curve or the required light location. Where the distribution a light required cannot be met by the installation of 2 lights the installation of one omni directional light may be considered. MAINTAIN CURRENT PRACTICE

17.3.4 Specific taxiways may be used for servicing aircraft including explosive ordnance activities. These areas shall be considered for classification as hazardous areas in accordance with relevant standards for electrical installations installed accordingly. The classification of the area may preclude the installation of AGL systems.

17.3.5 The spacing of taxiway lights shall be arranged where possible to coincide with Hold Point locations thus economising on the number of lights.

17.3.6 Taxiways leading from large aprons shall utilise an omni-directional taxiway centreline light at the first light position to assist pilots locating the taxiway from any point on the apron. Omni-directional taxiway centreline lights may also be utilised on complex taxiway intersections where economy of number can be justified.
Ordnance Loading Apron (OLA) Taxiway Lighting

17.3.7 The layout geometry for taxiways that provide access to fighter dispersal areas and OLAs normally include “tight” radius curves and have minimum taxiway width. The design for the layout of centreline taxiway lighting systems for these taxiways may be relaxed such that the pilot's position will not be displaced laterally by more than 1 m from taxiway centreline marking and the requirement to observe 3 lights ahead may be reduced to 2 lights ahead.

Quick Reaction Alert Facility (QRAF) Taxiway Lighting

17.3.8 The layout geometry for taxiways that provide egress from QRAF facilities normally includes the requirement for the pilot to taxi at high taxi speeds whilst undertaking pre-flight checks. The design for QRAF exit taxiway lighting must allow the aeroplane to accelerate to the required taxiing speed with minimum curves or changes in direction in as direct a path to the runway as practicable. The taxiway lighting design shall maintain a minimum visual segment of five lights beyond the cockpit cut-off for areas where the aircraft is at maximum taxiway speed.

Intermediate Holding Position Lights

17.3.9 The layout geometry for some taxiways leading into an intermediate holding position may not allow the required intermediate holding position light distribution pattern to be achieved from a single set of lights. Where more than one set of light is required to achieve the required distribution pattern that will allow it to be observed from all approach angles the two sets of lights shall be adequately separated along the alignment of the taxiway centreline by a distance of 500 mm.

Design Aircraft and Cockpit Cut-Off Angles

17.3.10 The physical characteristics of aircraft differ with respect to:

a. The ability of the pilot and crew to observe AGL from their normal operation position within the aircraft;

b. The operational manoeuvrability of aircraft whilst under their own power; and

c. Aeroplane reference code letter.

17.3.11 The taxiway lighting layout is required to accommodate the most onerous viewing restriction of any aircraft that is to utilise the taxiway. Table 17.1 details the minimum field of view of the pavement for a pilot taxiing when seated in the normal operational position.
<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Distance to Centreline (m)</th>
<th>Distance to pavement (m) viewing LHS of aircraft for field of view from the centreline (0-35°)</th>
<th>Distance to pavement (m) viewing RHS of aircraft for field of view from the centreline (0-35°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>737-700 (AEW&amp;C)</td>
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<tr>
<td>747-400</td>
<td>27</td>
<td>27</td>
<td>27</td>
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<tr>
<td>A380</td>
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<tr>
<td>A330</td>
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<tr>
<td>AP-3C (Orion)</td>
<td>15</td>
<td>&lt; 15</td>
<td>26 max at 35°</td>
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<tr>
<td><strong>Blackhawk</strong></td>
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<tr>
<td>C130 (Hercules)</td>
<td>15</td>
<td>&lt; 15</td>
<td>26 max at 30°</td>
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<tr>
<td>Heron UAS</td>
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Table 17.1 Minimum Field of View

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Distance to Centreline (m)</th>
<th>Distance to pavement (m) viewing LHS of aircraft for field of view from the centreline (0-35°)</th>
<th>Distance to pavement (m) viewing RHS of aircraft for field of view from the centreline (0-35°)</th>
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</thead>
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<tr>
<td>EA-18 Growler</td>
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<tr>
<td>Squirrel AS350BA</td>
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<td></td>
<td></td>
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<tr>
<td>Bell 429</td>
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<tr>
<td>C-27</td>
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<td>P-8</td>
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<tr>
<td>LADS DAS8</td>
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<td></td>
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<tr>
<td>CT4B</td>
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</tbody>
</table>

17.4 Installation Details

17.4.1 Taxiway centreline lights should normally be located on the centreline of the taxiway. Taxiway centreline lights installed on concrete pavements shall be located to avoid concrete construction joints; accordingly the row of lights may be spaced 300 mm from the taxiway centreline as per the allowances detailed in the DADM.

17.4.2 Refer Chapters 20 and 21 for installation details of inset and elevated taxiway lights.
18. Movement Area Guidance Signs (MAGS)

18.1 Requirement

18.1.1 MAGS include mandatory instruction signs, information signs and Navigation Check Point signs.

Mandatory and Information Signs

18.1.2 Mandatory and Information MAGS are to be provided where IDA-AF determines they are operationally necessary for a particular aerodrome.

18.2 Characteristics

Mandatory and Information Signs

18.2.1 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

Navigation Aid Check Point Signs

18.2.2 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

18.3 Configuration

Mandatory and Information Signs

18.3.1 As detailed in the DADM.

18.3.2 Mandatory and Information signs shall be internally illuminated.

Navigation Aid Check Point Signs

18.3.3 As detailed in the DADM.

18.3.4 Navigation Aid Check Point signs shall be internally illuminated.

18.4 Installation Details

MAGS shall be installed upon a concrete footing of sufficient size to achieve the specified wind loadings and prevent accidental damage to the signs by grass cutters. The footings shall meet the deflection requirements of FAA AC 150/5345-45.

The marker board shall be installed upon frangible couplings and secured to the footing by a chain that tethers the board in the event of it being dislodged. Supporting feet for MAGS shall meet the frangibility requirements of ICAO Aerodrome Design Manual Part 4 Chapter 15.

Signs with a lamp operating voltage of 50V or greater shall be provided with an isolation switch either mounted externally or at the point of entry into the sign body. An earthing arrangement in accordance with AS/NZS 3000 shall earth each of the signs.

For MAGS supplied with multiple halogen lamps internally illuminating the inscription panel from above, the lamps shall be sired across two interleaved secondary circuits such that alternate lights are connected in series.

Each marker board shall be provided with bird spikes along the full length of the sign to prevent soiling of each of the board’s inscription panels.

Secondary cable shall be installed within the mast or frangible coupling so that the secondary cable is completely enclosed. Where the cable must exit a mast to enter a sign the exposed section of the secondary cable shall be enclosed within a UV stable flexible conduit thus allowing maintenance of the board.

A typical MAGS installation is illustrated below in Figure 18.1.
Frangible couplings.

Isolating switch.

Earth connection enclosed in a
Earth cable bonded to MAG sign

Secondary cable access via MAG sign legs.

Re-inforcement fabric.

Figure 18.1 Typical MAGS Installation
19. Apron Edge Lighting

19.1 Requirement

19.1.1 Apron edge lighting shall be provided where there is insufficient conspicuity to delineate the extremities of an apron area to a pilot when manoeuvring an aircraft or where IDA-AF determines apron edge lighting is operationally necessary.

19.2 Characteristics

19.2.1 Light intensity, beam characteristics, colour, configuration and aiming shall be as detailed in the DADM.

19.3 Configuration

19.3.1 As detailed in the DADM.

19.3.2 Apron edge lights shall be located with a light located to mark any change in direction along the side of the apron.

19.3.3 Defence adopts the use of inset apron edge lights to prevent damage caused by service vehicles. Where practical the lights shall be located within the sealed shoulder of the apron with consideration of their visibility from all angles on the apron. In some circumstances where the lights, within the installation tolerances allowed by the DADM, are not visible from the required angles due to the pavement profile, consideration may be given to the use of elevated lights. The use of elevated runway end lights shall be allowed only with the prior written approved by DEEP.

19.3.4 Apron edge lights shall be located such that they are not aligned with aircraft parking positions to prevent damage caused by jet blast.

19.3.5 Specific aprons may be designated as Hot Refuelling Aprons or may be used for servicing aircraft including explosive ordinance activities. These areas shall be considered for classification as hazardous areas in accordance with relevant standards for electrical installations installed accordingly. The classification of the area may preclude the installation of AGL systems.

19.4 Installation Details

19.4.1 Refer Chapters 20 and 21 for installation details of inset and elevated apron edge lights.
20. Apron Floodlighting

20.1 Requirement

20.1.1 Apron floodlighting shall be provided where IDA-AF determine floodlighting is operationally necessary for a particular aerodrome.

20.2 Characteristics

20.2.1 Illumination levels, spectral distribution, configuration, supply arrangement and aiming shall be as detailed in the DADM.

20.3 Configuration

20.3.1 The floodlighting shall be sited such that it cannot obstruct the viewing of the apron from the control tower. The guidance of ICAO Design Manual 4 Chapter 13 shall apply.

20.3.2 The flood lights shall be mounted at a height of not less than one sixth of the distance to be illuminated and a height of one quarter of this distance is preferred. The construction of the light masts shall be sufficiently rigid to prevent the floodlight beam moving more than five degrees out of line in the prevailing wind conditions.

20.3.3 Apron floodlighting masts shall not penetrate the obstacle limitation surfaces. The masts shall be located such that they will not constitute an obstruction to aircraft manoeuvring on the apron or adjacent taxiways. In any case the masts shall be located a minimum of 7.5m from the apron edge.

20.3.4 Maintenance access to the lights shall be provided by lowerable headgear or hinged masts.

20.3.5 Obstruction lights are not required to be installed upon floodlight poles unless where requested by aerodrome operational personnel.

20.3.6 MONITORING AND CONTROL REQUIRED FROM ALER, TOWER OR OTHER FOR APRON FLOODLIGHTS?

20.4 Installation Details

20.4.1 Floodlight control gear shall be enclosed within a switchboard located at the base of the floodlight pole.

20.4.2 Footings provided to mount floodlight poles shall be designed for the local geotechnical and environmental conditions including relevant wind loading conditions. Footings shall be designed and certified by a qualified structural engineer (CPEng).

20.4.3 Floodlight poles shall not be located adjacent to security fences in such a manner that may facilitate entry into the secured areas. The location of each pole shall also take into consideration the orientation of the pole when in its lowered position including any allowance for the back lift of the counter balanced arm.

20.4.4 For floodlights located in the vicinity of areas trafficked by apron service vehicles provide bollards around the perimeter of the floodlight pole and switchboard. The spacing of the bollards shall take into consideration access into the switchboard and the orientation of the pole tilt or alignment of mechanical lowering equipment such as hydraulic lifters.

20.4.5 A typical apron floodlight installation is illustrated below in Figure 20.1.
Mid-hinged floodlighting highmast pole.

Headframe and floodlights.

Support cabling on catenary from cable access door to top of pole.

Lightning finial bonded to pole.

NOTE: Conduits and cabling not shown.

Floodlight pole footing.

GL

Floodlight control panel.

Cable access door.

Protection bollards.

Earth electrode pit.

Mowing strip.

Earth electrode.

Figure 20.1  Typical Apron Floodlight Installation
21. Inset Lights

21.1 Requirement

21.1.1 Inset lights are typically installed where it is not practicable to use elevated light due to trafficking aircraft or potential damage by jet blast, aircraft arrestor systems service vehicles.

21.2 Characteristics

21.2.1 The lights required for the visual aids shall meet International standards for structural and photometric performance to withstand normal operating conditions of a wide variety of Military and Civilian aircraft.

21.2.2 Particular emphasis is to be placed on the following when selecting the lights for installation:

a. Through life costs;

b. Watertight seal between the base and the light top assembly and of the photometric chamber of the light top;

c. Modern design including the use of LED illuminated lights;

d. Photometric characteristics and intensity ratios between the respective AGL systems; and

e. Availability of spares within Australia.

21.2.3 The following design aspects shall be considered:

a. Structural integrity;

b. Static load;

c. Shear load;

d. Hydraulic impact;

e. Water leakage/ingress;

f. Surface temperature;

g. Temperature shock;

h. Resistance to salt laden atmosphere;

i. Jet blast; and


21.2.4 The mechanical criteria shall be based on relevant DADM, IEC and FAA requirements.

21.3 Configuration

21.3.1 All components offered shall be of current manufacture and of current design.

21.3.2 All components of each particular light shall be part of the original manufacturer’s design. Modification to standard light components to affect/improve their photometric performance shall be in a manner that does not result in non-standard un-proven lights (eg defocusing lamp) or cause significant increase in the long-term maintenance requirements (eg additional filters). The intent is that the acceptable change is, for example, by the use of a suitable alternate lamp with guaranteed long-term availability.

21.3.3 Glass lens shall have a smooth external surface and shall be shaped to minimise dirt collection on all surfaces.

Construction Form

21.3.4 The mechanical performance of the fittings shall comply with the current revision of FAA Advisory Circular No. 150/5345-46 for in-pavement base mounted lights or an equivalent standard, for example BS 3224-6.

21.3.5 The light assemblies shall be CAA, FAA, STNA, NATO or BS certified for the application or shall have been submitted to a NATA registered laboratory for certification to any of the above standards.
21.3.6 The materials used to manufacture the lights including all castings, optical components, fixings and fasteners shall be suitable for their intended purpose and operating environmental conditions. All components shall be adequately protected against corrosion.

21.3.7 No special tools shall be required for assembly, disassembly or maintenance purposes.

21.3.8 The light assemblies shall be designed for a “dry” system as defined in current revision of FAA Advisory Circular No. 150/5345-46.

21.3.9 Electrical connection between the top and the base shall be by FAA type twin pin plug and socket connection. The secondary cables shall be directly connected to the base socket terminals from the SIT.

21.3.10 The base shall incorporate a method to provide watertight sealing of the entry of the secondary cable to the base.

Markings

21.3.11 Lights shall be durably and indelibly marked with the manufacturer’s name or identification mark and the light type and individual serial number.

21.3.12 Directional lights shall be marked to indicate the correct orientation with respect to the runway/taxiway.

Maintenance

21.3.13 All interior components of the light must be easily removable for cleaning or replacement. The optical components shall be keyed so that they may not be reassembled incorrectly. The lamp shall be accurately and firmly positioned at the proper focal point. Any interior lenses or filters shall be securely positioned. After reassembly, all components shall be properly aligned, original water resistance shall be restored and the required photometric characteristic shall be reproduced.

21.3.14 On the top of inset lights, pry slots, threaded holes or other means shall be incorporated to assist in removing light tops from their bases.

21.3.15 The optical assembly shall where possible, be provided with a suitable valve to enable it to be pressurised to test for leaks by pressurisation and immersion following reassembly.

Inset Light Bases

21.3.16 The base for inset lights shall be classified as a shallow inset type. The bases be shall compliant with the mechanical requirements for load and flange torque tests as detailed in current revision of FAA AC 150/5345-42 for Type L-868 Class 1A light bases. The base shall provide a “dry” system and meet the air pressurisation test as detailed in Clause 4.1.1 of the current revision of AC 150/5345 – 42 when assembled with the light top assembly.

21.3.17 The secondary cable entry shall be arranged to provide side entry through the base via a factory installed sealing arrangement. Where multiple lamps are required, eg runway edge lights, individual secondary cables shall be provided for each lamp. The insulation and size of the secondary cable tails shall be compatible with the connecting secondary cable.

21.3.18 The bases shall incorporate fixing studs secured into the base which include self-locking nuts and/or “vibration proof” washers. Stainless steel anti rotation pins or other fixtures shall be provided to prevent rotation of the light top assembly.

Installation Jigs

21.3.19 Installation jigs shall be suitable for retaining the light unit base during its installation.

21.3.20 The jigs shall be dimensioned such that the base can be aligned, and will then remain in the aligned position, during installation of the base to meet the specified tolerances. Consideration shall be made for the location of jacking screws such that they clear the cored hole and will bear against the firm pavement surface. The installation jigs shall include a bubble level with accuracy suitable to maintain the level of the light base within 0.5 degrees of level.

21.4 Installation Details

21.4.1 Lights shall be installed in a manner that is recommended by the supplier of the particular light type.

21.4.2 Corrosion inhibiting compound shall be applied to the threads of all external fixings that will be exposed to the atmosphere.
Survey

21.4.3 The design location and orientation (deviation angle) details for lights shall be accurately surveyed and marked on the pavement to indicate the location of the base and the respective orientation of the light. Painted marking for survey shall be kept to a minimum and shall not be overly conspicuous and shall be short life water based.

21.4.4 Nails or pins shall not be used to mark the surveyed locations.

21.4.5 Where the design location of inset lights fall upon construction joints the light shall be relocated such that the edge of cored holes has a minimum distance of 150 mm from the edge of concrete paving joints. Relocation from the design light position should generally be along the centreline of the taxiway or alignment of the lighting system. The relocation along the centreline/alignment shall not be greater that 500 mm or the light shall not be relocated off the centreline/alignment.

Installation of Light Base

21.4.6 Inset lights shall be located within a cored or preformed recess and fixed in position with an epoxy or similar adhesive sealed to prevent the ingress of moisture. The hole shall be dimensioned to provide:

a A void for the epoxy grouting material to provide a base to support the light and to provide adequate adhesion of the sides of the light base to the pavement; and

b Sufficient depth to ensure that the projected height above the pavements will be in accordance with DADM requirements.

21.4.7 A typical inset light installation is illustrated below in Figure 21.1.

![Inset Taxiway Light Installation](image)

**Figure 21.1 Typical Inset Light Installation**

21.4.8 The coring and installation of inset lights shall be programmed to ensure that unsecured or removed pavement cores do not impact on airside operations.

21.4.9 The light installation shall not damage the surrounding pavement.

21.4.10 The installation method shall ensure that the light will support the loads imposed by aircraft landing or trafficking the runway or taxiway.

21.4.11 The light base shall be adequately prepared ready for fixing the cored hole including cleaning and degreasing the outside of the light base.
21.4.12 Where the secondary cable is jointed to the light tails outside the base ensure that the joint remains clear of the light base when installed by a minimum of 100 mm to allow suitable access if the secondary joint fails without the need to remove the light fitting.

21.4.13 Where the secondary cable is to be installed through the light base the cable shall be installed so that the inset light unit when installed will not damage it, and that the base cable entry hole is adequately after installation of the secondary cable, to prevent ingress of moisture into the base and to maintain a watertight base. Particular attention shall be given to ensure a watertight seal and that moisture cannot migrate through the cable construction or its Nylon jacket.

21.4.14 A jig shall be used to install, locate and level the inset light unit base in position in the core hole and maintain the base in position during the curing of the grout. The final installed orientation of the centreline of the output beam of the inset light unit shall be within plus or minus 0.5 degree of the designed orientation. Light bases shall be installed such that the light is installed within 0.5 degrees of level.

21.4.15 Where the pavement is not level, the light base shall be installed such that the level of the top of the installed light base is midway between the high and low sides of the cored hole.

21.4.16 The epoxy grout for fixing the light fitting bases shall be suitable for the purpose. Masterflow 622 or approved equivalent is considered an acceptable product for this application. Excess epoxy shall not be allowed to spill onto the pavement.
22. Elevated Lights

22.1 Requirement

22.1.1 Elevated lights are preferred for most visual aids except where trafficked or exposed to potential damage by jet blast, aircraft arrestor systems service vehicles.

22.2 Characteristics

22.2.1 The lights required for the visual aids shall meet International standards for structural and photometric performance to withstand normal operating conditions of a wide variety of Military and Civilian aircraft.

22.2.2 Particular emphasis is to be placed on the following when selecting the lights for installation:
   a Through life costs;
   b Modern design including the use of LED illuminated lights;
   c Frangibility of mounting masts and bases;
   d Photometric characteristics and intensity ratios between the respective AGL systems; and
   e Availability of spares within Australia.

22.2.3 The following design aspects shall be considered:
   a Structural integrity;
   b Static load;
   c Shear load;
   d Hydraulic impact;
   e Water leakage/ingress;
   f Surface temperature;
   g Temperature shock;
   h Resistance to salt laden atmosphere;
   i Jet blast; and
   j Solar radiation.

22.2.4 The mechanical criteria shall be based on relevant DADM, IEC and FAA requirements.

22.3 Configuration

22.3.1 All components offered shall be of current manufacture and of current design.

22.3.2 All components of each particular light shall be part of the original manufacturer’s design. Modification to standard light components to affect/improve their photometric performance shall be in a manner that does not result in non-standard un-proven lights (eg defocusing lamp) or cause significant increase in the long-term maintenance requirements (eg additional filters). The intent is that the acceptable change is, for example, by the use of a suitable alternate lamp with guaranteed long-term availability.

22.3.3 Glass lens shall have a smooth external surface and shall be shaped to minimise dirt collection on all surfaces.

Construction Form

22.3.4 The mechanical performance of the fittings shall comply with the current revision of BS 3224-4 (Lighting fittings for civil land aerodromes. Specification for elevated lighting units ) or FAA Advisory Circular No. 150/5346-46.

22.3.5 The electrical connection shall be provided by plug and socket without compromising the performance of the light frangibility. The plug socket shall be arranged such that the socket is retained in the light mounting below the frangible break point so that the electrical connection is covered in the event of the light being displaced from its mounting.
22.3.6 The light’s construction shall facilitate levelling of the fitting. Provision shall be made in the light mounting to allow adjustment to obtain true vertical and azimuth alignment.

22.3.7 The materials used to manufacture the lights including all castings, optical components, fixings and fasteners shall be suitable for their intended purpose and operating environmental conditions. All components shall be adequately protected against corrosion.

22.3.8 No special tools shall be required for assembly, disassembly or maintenance purposes.

22.3.9 The light body shall be coloured golden yellow (colour Y14 to AS 2700). The paint system shall have a design life of a minimum of 10 years when installed.

Marking
22.3.10 The light shall be durably and indelibly marked with manufacturer’s name or identification mark and light type.

22.3.11 Directional lights shall be marked to indicate the correct orientation with respect to the runway.

Maintenance
22.3.12 The light components shall be capable of being easily removed for cleaning, repair or replacement. Individual items shall be keyed to ensure easy reassembly and that all components are aligned correctly. The lamp shall be accurately and firmly positioned at the required focal point. Any interior lenses or filters shall be securely positioned. After reassembly, all components shall be properly aligned, original water resistance restored and the required photometric characteristics shall be produced.

Elevated Light Mounting Bases
22.3.13 The light mounting shall have an approved frangible coupling where it attaches to the light. The frangible coupling shall comply with the requirements of ICAO Aerodrome Design Manual Part 4 - Visual Aids Chapter 15.

22.3.14 The mounting base shall be manufactured from a corrosion resistant UV stabilised material and be suitable for installation on a concrete pad.

22.3.15 The mounting base shall be finished in a durable paint system with a design life of a minimum of 10 years. The colour of the base and components shall be aviation yellow.

Approach Light Masts
22.3.16 Masts for approach lights shall be lightweight and meet the frangibility requirements of ICAO Aerodrome Design Manual Part 4 – Visual Aids Chapter 15.

22.3.17 The criteria for frangibility shall apply to masts installed within 300 metres of the threshold. The top 1.8 metres of masts installed beyond 300 metres from the threshold shall also meet the frangibility requirements.

22.3.18 The masts shall meet the deflection requirements of FAA AC 150/5345-45 (current revision).

22.3.19 A frangible mast shall be provided for each light.

22.3.20 Masts shall be installed on concrete bases designed and certified for structural adequacy for the terrain category and wind loading due to the number and size of the installed lights.

22.3.21 Where the masts are located outside the perimeter fence of an establishment then suitable fencing shall be provided to protect the masts.

Installation and Alignment Tools
22.3.22 Installation and alignment tools shall be suitable for accurately levelling and aligning the elevated lights. The installation tool shall include a bubble level with accuracy suitable to maintain the level of the light base within 0.5 degrees of level.

22.3.23 Alignment tools shall be suitable for mounting on individual lights so that the light can be aligned with adjacent lights and in the case of approach lights, aimed to the required elevation and azimuth.

22.4 Installation Details
22.4.1 Lights shall be installed in a manner that is recommended by the supplier of the particular light type.
22.4.2 Elevated lights shall be mounted that they will maintain their position and aiming point. The mounting shall incorporate frangible couplings.

22.4.3 A typical elevated light installation is illustrated below in Figure 22.1.

![Elevated Light Installation](image)

22.4.4 Corrosion inhibiting compound shall be applied to the threads of all external fixings that will be exposed to the atmosphere.

22.4.5 Elevated lights shall be installed such that a maximum height of 50 mm is maintained above the pavement in the event of a broken coupling. The secondary cable plug/socket shall disengage such that the socket portion is retained within the remaining light base and no live uncovered conductors are exposed.

22.4.6 The maximum height of an elevated light when mounted on a trafficable pavement shall not exceed that detailed in the DADM.

22.4.7 The mounting base for elevated lights shall be installed on a concrete mounting base that includes a recess for the secondary socket and its retaining clamp that will retained the socket in the event of the light being dislodged thus preventing live cable ends being exposed.

22.4.8 Alternatively the mounting base may be fixed directly to the pavement (with suitable anchor fixings) above a cored hole that will provide a void for the secondary socket. The secondary socket-retaining clamp would, in this case, be fixed by use of the base mounting fixings.

22.4.9 Where lights are installed on, hinged or lowerable masts eg approach lights the lights shall be installed such that they will obtain the required aiming orientation and vertical angle when the mast is raised. The secondary cables shall be installed within the mast components or within flexible conduits that have characteristics suitable for the purpose. Masts shall be installed on concrete bases designed and certified for structural adequacy for the terrain category and wind loading due to the number and size of the installed lights.
23. Pit and Duct System

23.1 Requirement

23.1.1 All AGL circuits shall be installed in a pit and duct system.

23.1.2 Pits are required for cable access to major duct banks, under pavement duct crossings, pulling pits and at significant changes in direction.

23.2 Characteristics

23.2.1 Pit and duct systems provided at Defence aerodromes consist of the following components:

a. Ducts – located adjacent to aircraft pavements and beneath aircraft pavements for under pavement crossings;

b. SIT pits – provided for each light location to house the light’s SIT;

c. Pull pits – located at defined intervals to facilitate installation and maintenance of the cabling system;

d. 25 Tonne rated pits – located within runway and taxiway strips, suitably rated for trafficking by aircraft, and typically used at along trunk feeder cable routes and to terminate under pavement duct crossings; and

e. 7 Tonne rated pits – located outside runway and taxiway strips and suitably rated for trafficking by emergency services vehicles and grass cutters, and typically used at along trunk feeder cable routes and to terminate under pavement duct crossings.

23.3 Configuration

23.3.1 The designer must develop a duct network plan that provides capacity for the immediate and the master planned requirements of the aerodrome. The duct and pit layout shall be designed to provide an economic, reliable and readily extendable network.

Location of Pit and Duct Systems

23.3.2 The alignment of the pit and duct system adjacent runways shall be located a minimum of 5 metres clear of the runway shoulders and preferably within Zone II as defined in ICAO Airport Services Manual Part 6 Control of Obstacles. Cable routes when located within Zone II allow greater access during the initial installation period and subsequent maintenance activities; however, this needs to be balanced against ensuring adequate access for servicing during varying soil and weather conditions.

23.3.3 The alignment of the pit and duct system adjacent taxiways and aprons shall be located a minimum of 5 metres clear of the taxiway shoulders with due consideration for the possible requirement for civil works for strengthening and or widening the taxiway shoulders to suit larger aircraft.

Separation of Circuits

23.3.4 Cables shall be separated so that in the event of a cable “burn up” within a duct, minimum disruption of AGL systems will occur. Adequate diversity shall be employed to minimise the impact of a single fault (e.g., a single cable fault shall not cause all runway circuits to be impacted). Multiple circuits of an interleaved system shall be distributed over multiple ducts.

23.3.5 Trunk routes shall incorporate multiple duct banks installed to provide physical separation between the duct banks and thereby the interleaved circuits. Typically, the physical separation shall be 2 metres.

Segregation from other Services

23.3.6 AGL primary cables shall be located such that there is separation from other services. The separation shall be in accordance with applicable codes and regulations. Particular emphasis shall be placed on the separation of the AGL primary cables from copper communications cables and navigation aids services.

23.3.7 Refer DADM Volume 3 for the separation and particular requirements for installation of cabling in sensitive navigation areas (e.g., ILS/MLS).

Depth of Cover for Primary Cabling
23.3.8 Primary cables installed within the restricted areas of the runway and taxiway strips (Movement Area) shall be installed within a pit and duct system with a 450 mm depth of cover. Compliance with AS/NZS 3000 shall be achieved by invoking Clause 1.9.4 “Compliance by Specific Design and Installation” of the standard, AS/NZS 3000.

23.3.9 The depth of cover for cables and the method of their installation in areas outside the runway and taxiway strips shall meet the requirements for HV installations as prescribed in AS/NZS 3000 – Wiring Rules.

Cable Density Ratio

23.3.10 Not more than 10 cables shall be installed within a single duct.

23.3.11 The minimum diameter for individual duct shall not be less than 20 mm, the maximum diameter for an individual duct shall not be greater than 100 mm.

23.3.12 The number of cables permitted in individual ducts shall not exceed the following ratio of the sum of the effective cross-sectional areas of the cables to the minimum internal cross-sectional area of the duct:

- For one cable in duct: 0.5
- For two cables in duct: 0.33
- For three or more cables in duct: 0.4

Spare capacity

23.3.13 The design of ducts and pits shall allow for foreseeable "Master Planned" extension to the airfield AGL system. Sufficient spare capacity within ducts or additional ducts shall be provided to suit the installation of additional AGL systems or the upgrade of existing systems.

Drainage

23.3.14 The duct and pit system shall be designed to minimise the retention of water. There shall be suitable low point connections to allow water to readily drain from the duct network systems. Drain holes shall be included in each pit where the duct entry does not provide free draining of the pit.

Duct Types

23.3.15 All ducts used for the enclosure of the primary cables shall be Electrical Heavy Duty type to AS 2053 coloured orange and installed in accordance with AS/NZS 3000.

Labelling

23.3.16 A 100 mm x 60 mm nominal size 3 mm thick stainless steel or brass plate shall be engraved (lettering height 5 mm) to identify the primary circuits that are accessible from the pit. Figure 23.1 illustrates a typical label as provided for a taxiway light.

![Figure 23.1 Typical Engraved Stainless Steel or Brass Plate Label](image)

**NOTE:**
Text shall be engraved or punched.
Minimum character depth 1mm.
(Superficial etching/engraving is not acceptable.)

23.3.17 The label shall be located within a recess in the top of the pit or concrete collar and fixed with two countersink screws (of material suitable for the installation environment). The identification number of the light fitting that is supplied from the SIT installed within the pit shall be painted on the collar of all SIT pits with 50 mm high lettering. As illustrated in Figure 23.2 the lettering shall be orientated so that it faces the pavement thus enabling it to be read from a vehicle that is located on the pavement.
Figure 23.2  Typical Painted Light and Pit Label

Pit Design

23.3.18 Where pits are located within airfield pavements and are subjected to regular aircraft movements the bearing capacity of the pit and cover shall be sufficient for the most onerous aircraft characteristic.

23.3.19 Pits installed within runway and taxiway strips shall have a bearing capacity to support the wheel load as presented by an aircraft that has left the pavement. The unpaved ground conditions shall be considered in that its bearing capacity may not be sufficient to support the wheel load during wet conditions.

23.3.20 Pits installed outside runway and taxiway strips shall have sufficient bearing capacity to support grass-mowing tractors and similar equipment under all conditions of surrounding soil conditions. Grass mowing will not be undertaken during conditions where the tractor or grass mower may become “bogged”.

23.3.21 Guidance on the width of the runway and taxiway strips may be obtained from the DADM and ICAO Annex 14. The actual width of the runway and taxiways for a particular location shall be obtained from the Aerodrome Information Package (AIP) – En route Supplement Australia (ERSA), AIP – Runway Distances Supplement (RDS) and AIP – Departure and Approach Procedures (DAP) or the Aerodrome Manual.

23.3.22 The pit shall support the designated wheel load without failure; bending of lids is permissible.

23.3.23 The pit design shall be designed to meet the requirements and incorporate all accessories that are applicable to WHS regulations.

SIT Pits

23.3.24 SIT pits provide ready access for installation and servicing of SITs. SIT pits shall be designed and manufactured to provide the following performance criteria:

a  Design load of 25 Tonne distributed over the top surface of the pit collar and lid;

b  Minimum throat dimension of 250 mm x 350 mm;

c  Lid secured to collar;

d  A transformer stand shall be provided to protect the cables from a SIT “burn up”;

e  The pit base may be constructed from glass fibre reinforced concrete or similar light weight material;

23.3.25 The general form of SIT pits shall be as per Figure 23.3.
25 Tonne Pits

23.3.26 Pits that are located within the runway and taxiway strips shall be designed and manufactured to provide the following performance criteria:

a Withstand a 25 tonne static wheel load and a tyre pressure of 1500 kPa; and
b Have a minimum dimension of 600 mm x 1000 mm and a depth to suit the installed ducts.

7 Tonne Pits

23.3.27 Pits that are located outside the runway and taxiway strips shall be designed and manufactured to provide the following performance criteria:

a Withstand a 7 tonne static wheel load and a tyre pressure of 700 kPa; and
b Have a minimum dimension of 600 mm x 1000 mm and a depth to suit the installed ducts.

23.4 Installation Details

Duct Installation

23.4.1 Where cables cross open drains, lower the ducts to pass under the drains to maintain the minimum specified depth of cover. Encase the conduits in a concrete mix across the drain.

23.4.2 The buried entries to ducts and conduits shall be sealed to prevent the ingress of water.

Pit Installation

23.4.3 No ramps ("de lethalisation") to deflect a wheel that is ploughing through soft ground are required.

23.4.4 Pits shall be constructed on site or may be pre-cast units delivered to the site for installation.

23.4.5 The pits shall be installed such that the bearing capacity of the pit is maintained and that the pit cover is installed level with the finished surface level of the surrounding area.

23.4.6 The buried entries to pits shall be adequately sealed to prevent the ingress of backfill material.
23.4.7 Prior to cable installation, ensure that the duct or conduit is of constant cross-section throughout and free from concrete, loose stones and the like.

SIT Pits

23.4.8 SIT pits shall not be installed in the pre-threshold area or RESA. Figure 23.4 illustrates the typical layout of SIT pits for threshold and end lights.

23.4.9 Generally, not more than one SIT shall be installed within a SIT pit. Where it is necessary and practical to install a second SIT within a pit dispensation from the general rule shall be sought from DEEP.

23.4.10 SIT pits shall generally be located along the alignment of the primary cables such that the secondary cable route supplying the light is a straight run from the SIT pit location. The secondary cable route shall generally be perpendicular to the pavement edge and run radially to the light locations on curves.

23.4.11 The pits shall be installed as detailed in Figure 23.5 with particular attention to installing the pit such that its lid is horizontal and level with the finished surface level of the adjoining area. Where the adjoining area has a significant slope then the pit surface shall be installed such the lid is level with the high side of the slope adjacent the pit location.
23.4.12 The cement stabilised sand shall be compacted such that the collar will be supported on this material rather than the pit base.

23.4.13 Conduits shall be inserted into pre-cut holes in the pit base such that there is a minimum clearance whilst allowing the conduit to enter at small angles from perpendicular to the pit walls.

23.4.14 The conduit for the secondary cable shall not prevent the transformer stand from being installed such that its legs can rest on the bottom of the pit.

23.4.15 Where SIT pits are installed on sealed pavements and subjected to regular vehicle traffic the pit shall be provided with suitable reinforcement such that the pit will support the loads presented by the vehicular traffic. Structural calculations shall be prepared detailing the design for the pits when installed in these locations.

**Draw lines**

23.4.16 A draw line shall be installed in all ducts; whether cables are installed or not. Draw lines shall be installed after the installation of cables and shall be secured at each end so that the loose ends remain accessible from within pits or duct ends.
24. AGL Cabling

24.1 Requirement

24.1.1 The power supply for AGL systems shall be derived from constant current series circuits with a maximum current of 6.6 amps with the following exceptions:

a) Aerodrome Beacons. - The primary source of electricity supply for aerodrome beacons is to be supplied from a local electricity supply at 230 V 50 Hz. A secondary power supply shall be provided to energise the aerodrome beacon automatically in the event of primary supply failure;

b) Sequential Flashing Approach Lights - Power supply for SFAL may be arranged as a constant current series circuit or a constant voltage system supplied from the Airport Lighting Equipment Room (ALER);

c) Runway Threshold Identification Lights - Power supply for RTIL may be arranged as a constant current series circuit or a constant voltage system supplied from the ALER; and

d) Apron Flood Lighting - The primary source of electricity supply for apron floodlighting is to be supplied from a local three-phase electricity supply at 400 V 50 Hz. Apron floodlights shall be distributed across the phases of the three-phase electricity to avoid stroboscopic effects associated with the illumination of rotating propellers.

24.1.2 The constant current series circuits for AGL are not to be referenced to earth. No counterpoise earth or earthing stakes as detailed in the FAA Advisory Circulars are required. No separate earth is required for the earthing of installed elevated or inset lights.

24.2 Characteristics

Primary Cable

24.2.1 The primary cable shall be 6 mm² copper single core 5 kV grade insulated cable with appropriate termite protection.

24.2.2 Defence has adopted a standard of EPR (Ethylene Propylene Rubber) insulation because it allows increased confidence in joint construction with the jointing kit material bonding to the insulation.

24.2.3 The cable shall be suitable for installation in a pit and duct system that may contain water such that the cable will be submersed for long periods of time.

24.2.4 The primary cable shall be provided with indelibly printed (contrasting colour) unique drum identification and sequential metre marking along its length. The markings shall be printed on the outer sheath of the cable or on the surface of the inner insulation or protecting layers and be visible through a clear oversheath.

24.2.5 The cable design will meet International standards for series AGL cable eg US Department of Transport, Federal Aviation Administration (FAA) AC 150/5345-7 (latest revision).

24.2.6 The primary cable shall be batch tested by a NATA registered testing authority to certify the cable design and each drum shall be tested to verify the insulation resistance and conductor continuity resistance. The results of these tests shall be included in the "As Constructed" documentation.

24.2.7 The manufacturer / supplier shall guarantee any defect in material or workmanship that may occur during proper and normal use during a period of 5 years from the date of manufacture / supply will be corrected or replaced.

Secondary Cable

24.2.8 Secondary cable shall normally be flat twin 2.5 mm² copper multi-strand (50/0.25) flexible PVC 0.6 kV grade insulation, nylon sheathed, cable. The individual cores shall be coloured one white and the other black.

24.2.9 The cable design shall meet Australian or International standards for electric cables – polymeric insulated eg AS 5000.1.

24.2.10 Secondary cables with a larger copper conductor cross sectional area eg 4 mm² may be required where the route length is such that the burden applied to a SIT warrants the larger secondary conductor. The large cross sectional conductor cable shall be insulated and protected in the same manner specified for the 2.5 mm² cable.
24.2.11 The manufacturer / supplier shall guarantee any defect in material or workmanship that may occur during proper and normal use during a period of 5 years from the date of manufacture / supply will be corrected or replaced.

**Termite Protection**

24.2.12 Termite protected cable shall be specified for all AGL cables.

24.2.13 The Australian industry standard for AGL cables incorporates a Nylon jacket, providing termite protection, which is protected with a PVC sacrificial sheath to protect the Nylon during installation. Alternative termite protection systems include the use of termite resistant additives into the outer sheath eliminating the requirement for an additional sacrificial sheath.

**24.3 Configuration**

**Primary Cable Circuitry**

24.3.1 Each separate visual aid system shall be arranged on a separate circuit. The circuits shall be routed to the ALER from which they will be controlled and powered.

24.3.2 Separate circuits to facilitate control/selection are required for each HIAL, SALS, SFAL, PAPI, HIRL, MIRL, IWI, Outer Threshold where provided with HIRL, DTRM/HCM and each taxiway and apron segment or zone requiring individual control. MAGS will normally be powered from the respective taxiway circuit, however, where there are a significant number of MAGS at an airfield, consideration shall be given to providing separate circuits for MAGS.

**Interleaved circuits**

24.3.3 Every approach, approach slope indicator and runway lighting system shall be connected as constant current series circuits with the lights distributed over a minimum of two interleaved circuits. The distribution of the lights is to be arranged so that in the event of a failure of one circuit the remaining pattern of lights portrays a recognisable pattern to a pilot and will not portray a misleading pattern.

24.3.4 Interleaved primary circuits shall also be provided for taxiway centreline lighting systems where deemed necessary by DEEP for a particular aerodrome. OR CURRENT POLICY? WHEN TO APPLY?

24.3.5 Guidance on the requirement and application of interleaved circuitry is provided in ICAO Design Manual 5.

**Runway Circuits**

24.3.6 LIRL and MIRL installations including the runway edge, threshold, outer threshold and end lights shall be distributed over a minimum of two interleaved circuits. The threshold, outer threshold and end lights or edge lights may be evenly distributed over separate additional interleaved circuits so that the intensity ratios between the separate light types (i.e. threshold/end and runway edge) can be better matched. Where installed, preference shall be given to connecting ORP and runway turning area lights to a fixed single stage intensity circuit that is energised with the runway circuits, such as the DTRM/HCM circuit.

24.3.7 A HIRL installation shall be distributed over a minimum of 4 circuits. The runway edge lights shall be evenly distributed over a minimum of 2 interleaved circuits and the threshold and end lights evenly distributed over a minimum of 2 interleaved circuits. This arrangement will allow the intensity ratios between the separate light types to be better matched. In addition, HIRL shall have additional separate single circuits; one each for the outer threshold lights and the DTRM/HCM. Where installed, preference shall be given to connecting ORP and runway turning area lights to a fixed single stage intensity circuit that is energised with the runway circuits, such as the DTRM/HCM circuit.

**High Intensity Approach Lights**

24.3.8 The lights for a HIAL shall be distributed over a minimum of three interleaved circuits in a manner similar to that illustrated in ICAO Design Manual Part 5 Figure 3-1. The lights shall be distributed over the three circuits to provide a recognisable pattern in the event of failure of one or two of the circuits.

**SALS**

24.3.9 There is no requirement to provide multiple interleaved circuits for SALS. OR VALID?

**PAPI**

24.3.10 A PAPI system shall be provided with a minimum of two circuits per runway threshold, each supplied from a separate CCR, and arranged in accordance with ICAO Design Manual 5.

**IWI**
24.3.11 A runway provided with two IWIs may be supplied from a common circuit or from individual CCRs where there is more than one ALER.

### Taxiway

24.3.12 The design of new taxiway lighting systems should consider the interleaving of taxiway centreline lighting circuits in accordance with ICAO Design Manual 5. Such a design solution shall be considered in conjunction with the overall taxiway lighting control philosophy and the implementation of taxiway zone control (as opposed to taxiway segment control).

24.3.13 Taxiway zone control shall be implemented by using an individual (or multiple where loadings require) CCR for each taxiway zone. Selector relays and contactors shall not be used to facilitate the supply of multiple taxiway zones from a single CCR.

24.3.14 Determination of the number of circuits and the distribution of lights across these circuits shall consider the quantity of lights, circuit loadings and associated CCR ratings, and desired control functionality.

24.3.15 Figure 24.1 illustrates a typical interleaved section of taxiway lighting configured for control as part of a taxiway zone.

![Interleaved Taxiway Centreline Lights](image)

**Figure 24.1  Interleaved Taxiway Centreline Lights**

### Distribution of Circuits between ALERs

24.3.16 Where more than one ALER is provided at an aerodrome, runway and PAPI circuits shall be routed so that the circuits can be energised from either of the two ALERs.

24.3.17 The runway circuits, which include HIRL, MIRL, Outer Threshold, DTRM/HCM and IWI circuits shall be routed to each ALER. The normal operation will be arranged such that half of the circuits are controlled and powered from each ALER, however when operationally required, all circuits may be powered from either ALER. Interlocking shall be incorporated to inhibit controlling and powering a circuit from more than one ALER.

24.3.18 Approach lighting circuits shall be routed to the nearest ALER.

24.3.19 PAPI systems shall be arranged with the PAPI light units for each runway threshold routed from separate ALERs. Each ALER will supply the port side for one runway end and the starboard from the other. Failure of an ALER would leave a runway with one functioning PAPI system for each runway. Interlocking shall be incorporated to inhibit controlling and powering PAPI systems for the same runway end at different intensity selections. Circuitry shall also allow for the independent selection of each approach vector PAPI system.

24.3.20 Taxiway circuits shall be logically distributed between ALERs with each ALER supplying the taxiways that are located closest to it, nominally half of the taxiway lighting system for each ALER. Alternatively, where taxiway lighting is supplied on interleaved circuits, consideration should be given to supplying the interleaved circuits from different ALERs.

### 24.4 Installation Details

#### Cable Management Plan

24.4.1 A cable management plan shall be produced so that a logical arrangement of primary cables is installed and a record of their installation including their drum and sequential metre marking may be recorded for inclusion in the “As Constructed” documentation.

#### Primary Cables

24.4.2 All primary cables shall be installed within a pit and duct system.
24.4.3 Primary cables shall be installed in single unjointed lengths; joints will only be permitted where the single route length is more than a cable drums length (1000 metres). A joint can only be made within a pit; no inline joints are permitted in a duct run.

24.4.4 Cable installation within ducts shall not be taped together or installed such that they will be intertwined or tangled thus preventing a single cable from being with drawn from a duct.

24.4.5 Primary cables shall be drawn into ducts in a logical manner and their pulling tension monitored to ensure that the tension applied to individual cables does not exceed the manufacturers' recommended pulling tension.

24.4.6 All cables shall be supported by rollers and or other aids to:
   a Ease the installation of cables round bends and along straight sections where the cable is exposed; and
   b Prevent damage to the outer surface of the cables and damage caused by bending the cable at a smaller radius than recommended by the cable manufacturer.

24.4.7 Where cables are drawn in long runs and or the cable ducts system includes bends apply a cable lubricant or friction modifier as recommended by the cable manufacturer. Lubricants shall comply with the environmental and WHS requirements.

24.4.8 All unterminated cable ends shall be sealed against moisture penetration.

Allowance for Future Re-Termination.

24.4.9 To allow for future joints and fault rectification a single 500 mm diameter loop shall be made in each primary cable where they pass through a pit other than a SIT pit. The coiled loops shall be tied and installed within the pit such that the coil is in the vertical plane and fixed to the wall of the pit.

24.4.10 The coiled loops are required at pits as follows:
   a Where there is a change in direction or the cable route of more than 45 degrees; and
   b And there is not another requirement for a loop of that cable within 75 metres of a loop (a SIT pit with cable tails to the SIT is considered a loop of cable).

24.4.11 To allow for future cutting and re-terminating of SITs a length of primary cable extending a minimum of 500 mm above ground level (both legs) should be provided at each SIT location.

24.4.12 Primary Cable Joints

24.4.13 Primary cable joints shall be suitable for jointing the primary cable, and the primary cable to the SIT plug and socket “connecting leads” where utilised. The primary cable joint shall maintain the insulation and dielectric properties of the primary cable when installed in any location within the AGL system. The joint shall be waterproof and shall allow the jointed cable to be installed within the SIT pits without causing damage or undue strain on the joint.

24.4.14 Primary cable conductors at primary cable joints and at SIT plug and socket “connecting leads” where utilised shall incorporate a tinned copper crimp links compressed with hexagonal die generally.

24.4.15 In-line heat shrink cable jointing kits shall be used to insulate and protect the joint. The joints shall:
   a Incorporate HV putty over the crimp to alleviate electrical stresses;
   b Include two layers of heat shrink sleeves, the outer sleeve lined with a material that will homogeneously bond to the inner sleeve and cable primary insulation; and
   c Provide sufficient overlap between heat shrink layers and cable insulation to achieve an effective waterproof seal.

24.4.16 Existing cable requiring rejointing cable shall be carefully stripped and the various layers of insulation (particularly the primary insulating layer) thoroughly cleaned to ensure the best possible surface conditions for adherence of the joint components.

24.4.17 Typical primary cable joint constructions for various cable types are provided in Figure 24.2 and Figure 24.3.
24.4.18 Primary cables are to be joined to the pre-moulded connecting “leads” where connection is required to be made to a SIT. Where an inline joint is required in the cable, this is to be effected in a similar manner as the SIT joints with pre-moulded sockets and integral 600 mm tail. The joint between the “lead” and the primary cable shall be an approve in-line insulated crimped link. 

DEFENCE PREFERENCE FOR LEADS VERSUS PUSH-ON PLUG/SOCKETS?

Labelling
24.4.19 All primary cables shall be labelled as detailed in Figure 24.4. The basic concept of the label nomenclature is that each label describes the destination of a cable form the location of the label. Labels shall be placed on cables at each location that they are visible eg at pits and terminations. Nomenclature shown is typical only. Change to suit actual circuit cabling.

Figure 24.4 Primary Cable Labels

24.4.20 All primary cabling and any other equipment where specified shall be adequately labelled to facilitate maintenance.

24.4.21 Labels shall be manufactured from minimum thickness 1 mm Polymeric material. The lettering shall be not less than 4 mm high, regularly spaced and permanently placed such that the information cannot be removed by normal abrasion and service conditions. A sleeve shall not cover the label lettering. Attach labels to cables with nylon wire ties such that the label is retained by 2 ties; one at each end of the label. The lettering shall display the circuit description and the identification of its source and destination. Refer drawings for details.

24.4.22 All cable ties used to label AGL cables shall be made from UV stabilised material that will not damage the cable.

24.4.23 Label all primary cables for new and existing circuits remaining in service at every access location eg. SIT pits, 7 tonne rated pits, 25 tonne rated pits, duct crossings, pull-in pits and ALER. Position the labels such that they can be read without displacement of the cables.

Secondary Cable

24.4.24 Secondary cables are to be run in straight and single length unjointed runs in a direct route from individual SITs to individual lights. Not more than one lamp is to be supplied or connected to a SIT. Generally the cable route shall be perpendicular to pavement edge and radial to lights on curves. Slots shall be the shortest direct routes.

24.4.25 Secondary cables are to be installed within conduits in open non-pavement areas and within cut slots where the final cable route is within sealed pavements. Where the final secondary cable route is within concrete paved areas the cable route shall follow the construction joints where possible.

24.4.26 Particular attention shall be given to specifying adequate compaction and cover over the installed secondary cable at the transition between the sealed pavement/shoulder and unsealed areas.

24.4.27 A 2 metre length of secondary cable shall be coiled within each SIT pit to allow for withdrawal of the SIT from the pit and provide sufficient length to re-terminate the secondary cable.

24.4.28 Where the route length of a secondary cable is long the effect of the additional burden placed on the SIT shall be considered with the light lamp load. The consideration may require the installation of a SIT with a higher power rating or the installation of secondary cable with a large cross sectional area.

Slots in Pavements
24.4.29 Slots shall be sawn into bituminous and concrete pavements where the secondary cables are required to traverse sealed pavements. The slot shall be located such that a minimum angle of 45 degrees is maintained between the pavement edge or construction joint and the slot and any joining slot and a minimum distance of 250 mm is maintained between the slot and the corner of a concrete pavement slab.

24.4.30 The depth to width ratio of the slot shall meet the slot sealant manufacturers recommended ratio. Slots shall not be more than 12 mm wide.

24.4.31 Where 2 or more light units are located in close proximity, up to a maximum of 3 secondary cables may be installed in a single slot and in these cases the depth of slot shall increased to a maximum depth of 35 mm.

24.4.32 Including additional cables in the slot shall not compromise the required depth of the sealing material. A secondary cable that shares a common slot shall not be installed under any light base.

24.4.33 Figure 24.5 illustrates the typical installation detail for a secondary cable within a pavement slot.

24.4.34 Slots shall be sealed with a self-levelling, fuel resistant bitumen modified moisture-curing polyurethane sealant. The sealant shall;
   a. Seal the slot from the ingress of water;
   b. Be flexible to suit the expansion and movement of pavements;
   c. Withstand the effects of aircraft fuels; and

24.5 Withstand high temperatures due to aircraft jet engine exhausts.

24.5.1 Sonolastic Sonomeric 1 has been applied with satisfactory results. PROVIDE DETAIL ON RECENT TINDAL EXPERIENCE?

24.5.2 Apply primers and the sealant in accordance with the manufacturer’s recommendation. Particular attention shall be paid to the preparation of the slot and the use of non bonding backer rods to prevent three-point bonding.

24.5.3 The top surface of the sealant shall match the surrounding pavement level. The pavement shall be cleaned of all spilled or surplus sealant.

24.5.4 Where secondary cables are installed in existing rigid pavement (concrete) areas the existing joint sealant shall be removed and the new secondary cables installed in the slot. The slot shall then be back filled with an appropriate sealant; Thioflex 600 has been used in this application and found to be suitable.

Secondary Cable Joints

24.5.5 Secondary cable joints shall be suitable for jointing the secondary cable together, to the SIT secondary plug/socket lead and to secondary cables factory installed in light units. The secondary cable joint shall maintain the insulation and dielectric properties of the secondary cable. The joint shall be waterproof and shall allow the jointed cable to be installed within the SIT pits without causing damage or undue strain on the joint.
24.5.6  Joints in secondary twin core cabling shall be of the in-line compression link type.

24.5.7  Secondary cable joints shall consist of two heat shrink layers of insulation as follows:
   a  The inner sleeve shall be lined with a material that will homogeneously bond to the cable insulation; and
   b  A further heat shrink tube lined with a material that will homogeneously bond to the cable and inner heat shrink sleeves shall be fitted over the initial layer.

24.5.8  Where the secondary cable is required to be joined to the factory installed secondary cables the compression links shall be staggered hence reducing the overall diameter of the joint and each link insulated using a length of heat shrink material.

24.5.9  Certified test certificates detailing the electrical characteristics of the completed joint shall accompany the joint details.

24.5.10 Final connections to the light top assembly shall be by FAA style plugs and sockets to facilitate the removal of the light top assembly for maintenance activities.

Cable Markers

24.5.11  Where the route of underground AGL cabling is not clearly identified by pits, cable route markers shall be installed at changes of direction and at intervals of 100m. Refer Figure 24.6 for a typical underground cable marker installation detail.
25. Series Isolating Transformers (SIT)

25.1 Requirement

25.1.1 Series Isolating Transformers (SITs) provide power to AGL lights and ancillary equipment from their secondary circuits. The SITs provide continuity of the series circuit in the event of a loss of the load on the transformer, and electrical isolation between the primary circuit supplied by a Constant Current Regulator (CCR) or Mains Isolating Transformer (MIT) and the secondary circuit connected to the load (generally a light).

25.1.2 SITs shall be installed in pits along the primary cable route adjacent each light location.

25.2 Characteristics

25.2.1 SITs shall be 5kV insulated 6.6 A to 6.6 A manufactured generally in accordance with the requirements of IEC 61823 ED 1.0 E (2002) AGL Series transformers and the current revision of FAA AC 150/5345-47 – Isolating Transformers for Airport Lighting Systems.

25.2.2 The SITs shall consist of primary and secondary coils wound upon a core and shall be permanently encapsulated without voids to produce a watertight assembly.

25.3 Configuration

25.3.1 The SITs shall be fully encapsulated and be designed for installation direct in ground without further protection.

25.3.2 The exact shape and design of the SITs is optional provided that they can easily be installed within a space defined as a cylinder, 200 mm in diameter by 250 mm high.

25.3.3 The SITs shall be designed and manufactured to operate indefinitely and under full load, short circuit, or open circuit conditions of the secondary with normal series circuit operating currents and frequency in the primary. The wave form of the primary current may include a high harmonic content such as that produced by phase controlled thyristor Constant Current Regulators when operating at low current selections for an optimised tap setting to suit the full current (intensity) selection for a given circuit condition.

25.3.4 The SITs shall be designed and manufactured to operate indefinitely and efficiently without loss of electrical characteristics when installed in any combination of the following conditions:

a. Installed within pits;

b. Fully immersed in water; and

c. Direct sunlight.

25.3.5 The thermal and electrical ratings of the SIT shall be maintained throughout the design life of 20 years withstanding the effects of:

a. Temperature build up within pits;

b. Depth of laying of up to 1200 mm;

c. Thermal resistivity of the soil of up to 2.5°C.m/W; and

d. Direct sunlight.

25.3.6 Primary and secondary circuit connecting tails shall be fitted with FAA style plugs and sockets as follows:

a. The primary tails plug and socket shall be FAA type L-823, Type 1 Class A specification AC 150/5345-26 plug Style 2 and socket Style 9;

b. Secondary tail connector shall be FAA L-823 Type 2 Class A Style 8.

Plug and Socket Connectors

25.3.7 Plug and sockets, compliant with FAA specifications, shall be utilised to connect the primary and secondary cables to SITs and lights.
25.3.9 Primary cable plug and sockets may be one of the following configurations:

a. FAA type L-823, Type 1 Class A specification AC 150/5345-26 - Preformed, pre-terminated factory moulded plugs and socket provided with connecting “leads” of minimum length of 600 mm. The insulating material on the leads shall be compatible with the primary and secondary cable insulation and the inline cable joints;

b. FAA type L-823, Type 1 Class B specification AC 150/5345-26 - Field attached cable connectors that include the use of silicone compounds to provide a watertight seal and ensure electrical insulation.

25.3.10 The two types of primary plug and socket connectors are illustrated in Figure 25.1.

25.3.11 Secondary cable plug and sockets shall consist of FAA L-823 Type 2 Class A twin conductor secondary leads.

![Figure 25.1 Primary Cable Plug and Socket Connectors (Factory Moulded and Field Attached)](image)

25.4 Installation Details

SIT Installation

25.4.1 The SITs shall be installed in pits along the primary cable route adjacent each light location. The pits will house the SIT and a suitable coiled length of primary and secondary cables to facilitate maintenance activities (normally 2 metres). A typical installation detail is illustrated in Figure 25.2.

![Figure 25.2 SIT Installation with Connection to Primary Circuit and Inset Light](image)
Plug and Socket Connector Installation

25.4.2 Factory moulded plug and socket leads shall be connected to primary and secondary cables with in-line joints construction in accordance with the requirements of Chapters 0 and 0.

25.4.3 Field attached plug and socket connections shall be constructed in accordance with the manufacturer’s instructions paying particular attention to ensure the rubber housing and insulating silicone remains free from moisture, dirt and debris.

Secondary Cable Retention

25.4.4 The secondary cable shall be retained so that in the event of the light being dislodged from its mounting the secondary cable plug socket connection will be readily disconnected with the socket retained within the mounting base thus presenting no bare secondary conductor.

25.4.5 A typical secondary cable retention for an elevated light application is illustrated in Figure 25.3.

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Figure 25.3 Elevated Light Secondary Cable Retention
26. Constant Current Regulators (CCR)

26.1 Requirement

26.1.1 Defence preference is for the use of CCRs, however a Designer may propose the use of Mains Isolation Transformers (MIT) to utilise, or integrate with, existing AGL control systems or supply equipment.

26.1.2 CCRs interface with the AGLCS via CCR Control Cubicle or Board which facilitates the connection and control of each circuit. Various configurations exist across Defence aerodromes of differing age, size, functionality and complexity.

26.2 Characteristics

26.2.1 The CCRs will be solid-state equipment meeting the requirements of the IEC, FAA 150/5345-10E and ICAO Aerodrome Design Manual Chapter 5 - Electrical Systems.

26.2.2 CCR performance shall be specified with specific electromagnetic interference criteria, both susceptibility to and creation of conducted and radiated interference, to ensure satisfactory operation of the CCRs and any other equipment/systems installed.

26.2.3 Particular emphasis will be made to ensure that the CCR load will be suitable for supply from the LEG. CCRs with a sinusoidal output current waveform will be reviewed during the design period for installation rather than the universal phase-controlled thyristor type that is more commonly employed. These CCRs are likely to present a higher power factor load to the LEG when the visual aids circuits are selected for low intensities.

26.2.4 The CCRs will be provided with the following features/functionality:
   a. Rollers to assist with their movement within the CCR room;
   b. Control system providing both local and remote modes of control;
   c. Control signalling interfacing with the AGLCS;
   d. Ability to plug in to interfacing control cubicles/panels;
   e. Supply connection;
   f. Primary cable connection;
   g. Suitable earthing connection;
   h. Surge protection; and
   i. Sized to suit CCR room configuration.

26.3 Configuration

26.3.1 Defence adopt a maximum CCR rating of 15 kVA.

26.3.2 The design CCR loading must not exceed 70% without DEEP’s written prior agreement. There shall be no more than 6 circuits from a single CCR, with an initial design utilisation not exceeding 4 circuits.

26.3.3 The CCR load shall be calculated based on the lamp load, SIT losses, primary and secondary circuit cabling losses.

26.3.4 Where field circuit switching is incorporated the CCRs shall be suitable for the intended switching operations.

26.3.5 There shall be a minimum of two spare CCRs per CCR size for each ALER or 10% whichever the greater. Where larger CCRs can directly substitute for smaller ones the spare shall be the larger size.

26.4 Installation Details

General

26.4.1 CCRs that supply interleaved circuits shall be fed from separate Distribution Boards. The separate CCRs will not be located adjacent each other.

26.4.2 Wheel restraints will be installed to prevent movement of the CCRs in the event of an earthquake or ground shock.
CCR Control Equipment

26.4.3 CCRs shall interface with the control and supply systems via CCR control equipment. Two general configurations of CCR control equipment exist at Defence aerodromes:

a CCR Control Cubicle which includes the use of modular field control panels to monitor and control individual circuits connected to a CCR. Two field control panels options are available:

i ‘Type 1 Multiple Circuit’ panel incorporating contactor switching to provide control of the field primary circuit;

ii Type 2 Single Circuit’ panel where there is no requirement for contactor control of the circuit.

26.4.4 The Control Cubicles also house other distributed controllers and associated power supply, communications modules, relays, etc

a CCR Control Boards are provided as a connection point for the CCRs without all the control and monitoring functionality provided by CCR Control Cubicles. CCR Control Boards are smaller in size, contain fewer control components and are typically significantly cheaper to manufacture and install.

CCR Control Equipment General Requirements

26.4.5 The following general requirements shall be provided for the installation of CCRs and associated CCR Control Cubicles or Boards.

26.4.6 Arrangement

26.4.7 CCR Control Cubicles and Boards are typically arranged in rows where the ALER contains sufficient space and its internal geometry permits. Typically the configuration may be two rows of CCRs facing each other with the distance between the rows allowing for the manoeuvring the CCRs. CCRs supplying interleaved circuits shall not be located adjacent each other or be arranged from the same row of CCR Control Cubicles/Boards (eg runway CCRs shall be located opposite each other and not adjacent).

26.4.8 Allowance shall be made for sufficient access to all operator panels and access doors to facilitate operation and maintenance.

26.4.9 CCR Control Cubicles and Boards shall be constructed from materials suitable to their operating environment. Each Cubicles/Boards shall be isolated from each other by a full height metal barrier to prevent the spread of fire and smoke.

26.4.10 Entry for power supply and control cables may be from above or below, with a preference from above for new installations. All cable entry to the individual Cubicles and Boards shall be via cable glands installed in fully sealing escutcheon plates. The escutcheon plates shall be fabricated in multiple parts that will allow the removal of a section to facilitate the installation and replacement of terminating cables.

26.4.11 The controls shall be arranged in a logical and ergonomic manner with commonality of all control switches, indicators, meters and the like. Devices shall be of the type most suitable to convey their purpose.

26.4.12 The internal layout shall present all control equipment such as terminal blocks, relays, meters, etc in a logical manner that provides ready access for installation and servicing. Relays and plug in devices shall be retained by clips to prevent their inadvertent dislodgement due to vibration or the effects of an earthquake.

Provision for Future

26.4.13 Spare control locations shall be installed for possible future requirements allowing installation of additional CCRs and field circuits.

Indication

26.4.14 The front panel shall include indicating lights and control switches to provide control and indication of the circuits supplied.

CCR Energisation Timers

26.4.15 An adjustable timer shall be provided in the control circuitry of each CCR to allow a small delay in powering up the CCR. This timer will be provided to allow a staged connection of CCRs in the event of power failure, and the CCRs being resupplied from the generator, to avoid overloading the emergency generator.

26.4.16 Grouped restoration of CCRs will be possible thus allowing all of the runway and approach circuits to be re-established as a group and then the taxiway/apron circuits re-established as a second group. This arrangement may be required to assist the LEG in the reestablishment of a power supply. The timer will
be set so as to not extend the restoration of lighting beyond the 15-second reestablishment period as required by DADM.

Isolation, Earthing and Testing of Field Circuit

26.4.17 CCR control locations shall be provided with the ability to isolate, earth and test their respective field circuits.

26.4.18 The configuration of this isolation, earthing and testing capability may vary between each installation and will be dependant on the type of CCR Control Equipment installed.

26.4.19 The isolation, earthing and testing of field circuits may be achieved by the use of proprietary “plug cut-out” devices or a custom plug and socket arrangement (typically provided as part of a field control panel arrangement within a CCR Control Cubicle).

CCR Connections

26.4.20 The following connections shall be provided for each CCR:

a. Mains power supply to CCR utilising industrial plug socket connection;

b. Earth connection to bond CCR frame to the common earth rail;

c. AGL primary cable connection to CCR incorporating military specification single pin HV plug/socket;

and

d. Control connection to CCR including military specification multi pin plug socket for low lever interface, or Ethernet fly lead(s) for high level interface.

26.4.21 **STANDARDISE ON CONTROL PIN ALLOCATION ACROSS ALL BASES (PROVIDE PIN DIAGRAM)**

Current Monitoring

26.4.22 Field circuit current shall be monitored for input into the AGLCS. Monitoring may include real-time measurement of the circuit current or indication of a defined minimum current threshold subject to the AGLCS configuration.

26.4.23 The field circuit operating current shall be monitored by transducers that are suitable for measurement of the distorted waveform provided by phase controlled thyristor CCRs. The measured current shall be the true analogue RMS value providing a stable input to the AGLCS. The transducers shall maintain accuracy over the full range of operating currents. Hall Effect devices have been used in this application and found to be suitable.

Labelling

26.4.24 CCR control locations shall be labelled such that it is clear as to which CCR and controls on the panel are relevant.

CCR Control Cubicles

26.4.25 CCR Control Cubicles consist of a cantilever top section that is typically fabricated as a separate unit that is bolted to the main cubicle. The rear doors and front panel shall removable and be provided with lifting handles to facilitate access.

26.4.26 The typical configuration of CCR Control Cubicles is detailed in Figure 26.1 and Figure 26.2.

26.4.27 Controllers and Associated Hardware

26.4.28 The distributed controllers and associated power supplies, communications and I/O modules shall be located within each control cubicle. Provision for expansion of I/O shall be made such that a single circuit cubicle could be modified to become a 6-circuit multi circuit control cubicle.

26.4.29 Communications between the distributed controllers shall be via a self-healing communications link that will not be affected by a failure of one of its connected nodes.

26.4.30 The power supply to the controllers and control circuits shall be provided by a UPS system that is distributed to each cubicle from separate fused final circuits.

Bistable Relays

26.4.31 Bistable relays shall be incorporated in the control system to retain the last selected state in the event of loss of control functionality.

Field Control Panels

26.4.32 Individual field control panels are required to monitor and or control individual circuits connected to a CCR. The panels shall be modular in form and shall be constructed such that any panel could be installed in any CCR cubicle. The control circuits shall be affected by a multiple pinned fixed socket on
the cubicle and “fly lead” plug on the panel with a consistent pin connection. The primary circuit shall also be effected by “fly lead” single pin plugs on the panel that will mate with sockets fixed to the cubicle. The socket layout shall be consistent and as detailed on Figure 26.3 and Figure 26.4.

26.4.33 The individual field control panels shall also incorporate plug and socket arrangement for the field circuits configured to readily by-pass any faulted equipment on the panel as well as providing an earthing and shorting facility for testing of primary circuits.

26.4.34 Locating pins shall be provided to retain the panel in position whilst its fixing nuts can be removed to facilitate removal and installation of the panel. The panel shall be manufactured from “TYPANEL typex” or similar insulating sheet. Individual panel types shall be designed as follows:

**Type 1 Multiple Circuit**

26.4.35 The multiple circuit control panel shall include contactor switching to provide control of the field primary circuit. The primary circuit shall always remain continuous; “shorting” during contactor operation must be provided. This may require the use of 2 contactors with electrical interlock being provided and the contacts arranged such that in the event of a contactor-operating coil failure the field circuit remains continuous.

26.4.36 The field circuit operating current shall be monitored by transducers that are suitable for measurement of the distorted waveform provided by phase-controlled thyristor CCRs. The measured current shall be the true analogue RMS value providing a stable input to the Controller for use in comparing the field circuit current with the required set point current to determine revertive indication and acceptable operation of the AGLCS.

26.4.37 The typical layout for this type of panel shall be as detailed in Figure 26.3.

**Type 2 Single Circuit**

26.4.38 Where only one circuit is supplied from a CCR there is no requirement for contactor control of the circuit. The field circuit operating current shall be monitored as detailed for a Multiple Circuit type panel (Type 1 panel).

i The typical layout for this type of panel shall be as detailed in Figure 26.4.

**HV Contactors**

26.4.39 1000 V rated contactors shall be incorporated in the Type 1 multiple circuit field control panels. Clear isolation barriers shall be incorporated over the contactors. 🚧 CONSIDER USE OF SINGLE CONTACTOR?

**Contactor Control Sequencing**

26.4.40 To minimise the possibility of damage to the CCRs through open or short circuit switching the following switching sequences shall be adopted.

26.4.41 Operation of all contactors and CCRs is to be verified via auxiliary contact feedback of the device status prior to execution of the next step in the sequence.

**a Circuit ‘ON’**

1. Circuit selection request received
2. Set intensity input to the required CCR (no feedback required at this stage)
3. If the CCR supplies multiple field circuits then
4. If the CCR is presently de energised (all contactors de-energised, all circuits connected) then
5. Close the ‘CCR shorting’ contactors for all circuits connected to this CCR except those now required to be energised and
6. Open the ‘field’ contactors for all contactors connected to this CCR except those now required to be energised then
7. Close the ‘field’ contactors for the circuits required to be energised then
8. Open the ‘CCR shorting’ contactor for the circuits required to be energised then
9. Energise the CCR and provide revertive feedback of circuit status
10. Otherwise, if the CCR is presently energised then
11. Close the ‘field’ contactor for the circuits required to be energised then
12. Open the ‘CCR shorting’ contactor for the circuits required to be energised
13. Otherwise, energise the CCR and provide revertive feedback of circuit status
b **CCR ‘OFF’**

1. Circuit de selection request received
2. If the CCR supplies multiple field circuits then
3. If this circuit is the only circuit energised
4. De energise the CCR then
5. De energise all contactors
6. Otherwise, if other circuits connected to this CCR are to remain energised then
7. Close the ‘CCR shorting’ contactor for the circuit required to be de energised
8. Open the ‘field’ contactor for the circuit required to be de energised
9. Otherwise, de energise the CCR.

**Local Circuit Control**

26.4.42 Local controls for individual field circuits shall be provided. An operator interface for control on the CCR control cubicle providing circuit selection in conjunction with the intensity selection and control switch that is integral with the CCR shall enable the operator to select the required facilities.
Figure 26.1  Typical CCR Control Cubicle

TB1: Control voltage
TB2: TB2 mains power supply
TB3: Revertive indication
TB4: ADATS interface
TB5: Primary field circuits
Circuit designation. eg RWY 03/21 A

Indicator light (Green) label: "CIRCUIT ENERGISED"

Push button (Black) label: "LAMP TEST"

Indicator light (Green) label: "LOCAL CONTROL ON"

Switch and light label as shown.

Local on/off control switch.

Circuit designation. eg TWY A2

a) SINGLE CIRCUIT PANEL

Circuit designation. eg TWY A1

Indicator light (Green) label: "CIRCUIT ENERGISED"

Push button (Black) label: "LAMP TEST"

Indicator light (Green) label: "LOCAL CONTROL ON"

b) MULTIPLE CIRCUIT PANEL

Figure 26.2  Typical CCR Control Cubicle Front Control Panel
Removable translucent cover over HV contactors.

HV contactors.

Field sensing relay.

‘Flying’ multi-core control cable with multi-pin plug.

Multi-pin socket for all control cabling on pre-wired panel.

Holes in panel with grommets to facilitate cabling.

Coloured laminated strips under sockets.

PVC coloured strips in addition to receptacle colour coding.

Links with single point plugs.

Panel mounted HV single point sockets for insulated plug-in links.

Circuit designation label. eg TWY A1

Fixed panels.

Engraved labels showing patching options. Refer label detail 1.
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Figure 26.4  Field Control Panel (Type 2 - Single Circuit)
CCR Control Boards

26.4.43 CCR Control Boards are installed above each CCR, either wall mounted or secured to a support frame. The boards are typically constructed as a single unit with front hinged access to the fixed internal wiring. External handles may be provided to facilitate the removal of the “plug-out” device. A typical CCR Control Board installation is illustrated below in Figure 26.5.

26.4.44 To minimise the physical size and construction cost of the CCR control equipment, field contactors that provide the ability to individually select/control discrete taxiway segments cabled from a single CCR are not be provided. Instead, taxiway zones shall be established with each of its individual taxiway segments cabled as separate circuits within the field and connected in series; this can be achieved within surge diverter cubicles provided with patching connections.

26.4.45 A criterion identified for the development of the CCR Control Board arrangement is whether individual monitoring of the current is required in each circuit element to ensure that any “patching” has not inadvertently left a portion of the taxiway lighting out of circuit. It may be considered that in the event that a portion of a circuit is patched out, then the revertives to the ATC Tower should ignore the failed segment temporarily removed from circuit so that the revertive remains healthy and any subsequent problem may be alarmed. It is expected that the removal of a segment from service will be coordinated with the tower and be easily identified to the airfield safety inspector during routine inspections.

![Figure 26.5 Typical CCR Control Board](image-url)
27. Airfield Lighting Equipment Room

27.1.1 Airfield Lighting Equipment Rooms house the supply and control equipment that supplies, controls and monitors AGL systems. This includes the following equipment and systems typically dedicated to AGL systems:

a CCRs and/or MITs including associated control cubicles/panels;
b Control boards and/or SCADA workstations;
c Communications and PLC equipment including back up power systems;
d Cabling systems;
e Surge diverter cubicles;
f Local Emergency Generator including associated control, monitoring and fuel systems;
g Load bank including associated controls;
h Mobile generator link panel;
i Electrical main switchboards and distribution boards; and
j Spares storage cabinets.

27.1.2 Other auxiliary equipment and systems, such as HVAC and fire detection systems, are provided to support and monitor the AGL dedicated elements.

27.1.3 An ALER is typically a purpose-built facility that provides the following operational functionality:

a Control and monitoring of AGL facilities;
b Alternate control location(s) from primary point of control;
c Maintenance access and activities; and
d Various forms of operational redundancy including circuiting, physical separations, control functionality, etc.

27.2 Requirement

27.2.1 IDA-AF will determine the number of ALERs required at an aerodrome. As a guide, a minimum of two ALERs is required at aerodromes provided with HIAL. Where more than one ALER is provided at an aerodrome, an ALER is to be located near each runway threshold for the predominant runway or near the threshold for each approach lighting system.

ALER Site Selection

27.2.2 The ALER shall be located in an area that is generally clear of other services, except those directly related to the ALER. The selected site shall be clear of any obstruction that could interfere with any part of the earthing system and must not penetrate the Obstacle Limitation Surface (OLS) of runways (including emergency runways). The ALER must be located clear of radio navigation installations eg ILS Glide path transmitters and associated antenna propagation patterns.

27.2.3 ALERs must not be in an area that is a hazardous area or explosive area as defined by the appropriate regulations.

27.2.4 ALERs shall be located at ground level, nominally not more than 0.5m above finished ground level, to facilitate equipment access into the ALER. The ALER must have at least one frontage on an external wall of the building that faces an uncovered open area providing a direct route out of the ALER for primary cabling systems. Preference shall be given to locating the ALER in an outer corner of a building to provide two (2) frontages.

27.2.5 The ALER must not have services such as drains, sewers or water services that pass through or encroach on the ALER chamber or the access paths. The access and egress paths must not be located in areas that unduly impede the unrestricted access or escape.

27.2.6 Where practicable, ALERs shall be located in areas that are level, well drained and clear of underground and overhead obstructions. The local soil conditions shall be stable and free from steep batters.
Retaining walls shall only be utilised where absolutely necessary and must be of robust concrete or block-work construction.

27.2.7 ALERs should not be located in close proximity to any natural or man-made watercourses to minimise the effect of fuel oil spillage and the impact of flooding.

27.2.8 When siting ALERs the following issues shall be considered:

a. Flood Level - The final siting of all installations shall ensure that flooding shall not occur under a Q50 flood situation;

b. Primary Cable Routes – ALERs should be located in a manner that minimises the amount of primary cabling, keeping feeder circuit lengths as short as practical;

c. Suitable all weather vehicular access with minimum conflict to aircraft traffic for repairs and maintenance;

d. Where HIAL is installed or a possible future requirement, locating the ALER near the threshold of the respective runway;

e. Security Zones - Bases have defined security zones that generally divide the site into low, medium and high security zones. These zones are determined by Defence with the knowledge of the work to be carried out in each facility and its level of priority. As far as practical, ensure that ALER will be located in the same security zone as the airfield;

f. Electrical Requirements – ALERs should be located in a manner that minimises electrical reticulation system augmentations;

g. Communications Requirements – ALERs should be located in a manner that minimises communications system augmentations; and

h. Ventilation System Requirements – In corrosive locations (e.g. sites subjected to salty air) consideration shall be given to the isolation of equipment from the corrosive atmosphere.

27.3 Characteristics

27.3.1 The building design needs to be undertaken with due consideration to:

a. Architectural design to harmonise with the adjacent buildings and/or area;

b. Access for installation and withdrawal of equipment and safety;

c. Wind loading for the particular location;

d. Weather proofing particularly for cyclonic regions;

e. ALER structures intended for use at Bases subjected to cyclonic conditions shall be fully cyclone rated to facilitate post cyclone operations;

f. Dust and water ingress protection;

g. Non reflective roof;

h. Bird and vermin proofing;

i. Floor and wall finishes;

j. Requirement for ceilings;

k. Requirement for windows;

l. Services penetrations;

m. Two hour fire rating of the separate rooms;

n. Air-conditioning and vapour barriers;

o. VESDA fire detection systems;

p. A grading ring and earth system. **CONFIRM REQUIREMENT, ONLY REQUIRED AS PART OF LIGHTNING PROTECTION SYSTEM?**

q. Acoustic separation from the diesel generator where incorporated;

r. Acoustic separation from the aerodrome flight operations;

s. Adequate allowance for the installation of the ultimate number of CCRs/MITs, controllers, HMI and Control cubicles;
t Have adequate space for the CCRs and cubicles and permit the installation and withdrawal of the CCRs;

u The facility to remove/install the ALER equipment via the access doors;

v Suspended cable trays for inter cubicle cabling and primary circuit cables;

w Adequate storage provision for AGL spares holding;

x Passive defence requirements, including type of wall material. Where earth covered ALERs are provided the spacing limitations within the ALERs such as those with arch type structures needs to be addressed when determining the equipment layout;

y Diesel fuel storage;

z Environmental considerations;

aa Entry for cables including pits adjacent the ALER;

bb Communication facilities including appropriate DESN equipment; and

c c VHF ground radio and transceiver antenna suitable for CTAF communications.

27.4 Configuration

27.4.1 ALERs can either be free standing structures or constructed as part of another larger facility such as the ATC Tower complex.

27.4.2 Design parameters for the ALER Building include:

a Provision shall be made when allocating space within the ALERs for the CCRs based on the master planned requirements for the airfield and 25 percent spare capacity;

b CCR withdrawal and insertion shall be with the CCR wheels without the CCR being required to pass over any in-floor trenches. It shall be possible to move a CCR from an external hardstand and wheel or skate the CCR into position from that location;

c The LV Switchroom should be provided with separate direct access externally of the building and also be readily available to the HV Switchroom or any LEG or Uninterruptible Power Supply (UPS) room and the ALER. In the case of large facilities the LV Switchroom may also form the building or area MSB;

d It is envisaged that all ALER will be communications nodes for the DESN. Appropriate space for the connection to the DESN is required;

e Allowance for the installation and connection of communications equipment and cabling associated with the AGLCS;

f The LEG room is to house the generator and associated services such as day fuel supply, batteries and chargers. The LEG room is to have internal access to the LV Switchroom;

h CCR cabling can be either overhead on cable trays. Overhead cable runs shall maintain suitable minimum clearance for personnel and equipment access and provide direct access from the CCR control location to the surge diverter cubicles on the external wall of the ALER;

i Cable entries shall be sealed to prevent the entry of water; and

j ALERs are to allow generally for operations and maintenance indoors in all weather conditions.

27.4.3 The ALER may be supplemented by separate rooms as follows;

a The substation room(s) in accordance with the Defence MIEE Substation Requirements;

b The LEG room in accordance with the Defence MIEE LEG Requirements;

c LV switchroom shall house the LV switchboard, LEG controls load bank control, where required, and provision for the Defence Engineering Services Network (DESN);  

27.4.4 Typical ALER building layouts as installed at a number of Defence aerodromes are provided in Figure 27.1 and Figure 27.2.
Figure 27.1  Typical ALER Building Layout for CCR Control Cubicles

Figure 27.2  Typical ALER Building Layout for CCR Control Boards
**Circulation and Access Requirements**

**Circulation**

27.4.5 Circulation space around electrical equipment, switchboards, control panels, etc shall be in accordance with Australian Standards. Circulation around desks and HMI terminal shall be 1.2 metres.

**Personnel Entry**

27.4.6 Each ALER shall be provided with two separate means of unimpeded access for personnel. Personnel access must be available at all time and shall be located where they cannot be obstructed by any means which includes vehicles, equipment or other impediments.

27.4.7 Within the ALER, access points should be diagonally opposite and positioned such that unimpeded access is maintained to all points that will be normally accessed by personnel.

**Site Access**

27.4.8 The requirements for access include those for entry, exit and escape.

27.4.9 Access into ALERs is limited to authorised personnel, controlled through the implementation of a suitable keying system.

27.4.10 The design of the equipment layout shall provide adequate access for the installation and erection of the equipment.

27.4.11 The equipment layout shall provide adequate access for operation with all controls placed for ready access and with all indicators and instrumentation in easy to read locations.

27.4.12 Major equipment items shall not be located in such a manner that would prevent the safe removal and replacement of any other major item of the installation.

27.4.13 Particular attention shall be given to allowances for vehicular access to all ALERs. Vehicles shall be assumed to be of the large flat bed truck types or reticulated diesel delivery tankers.

**Access Requirements for ALERs within a Facility**

- Where an ALER is constructed as part of another facility, it shall not be possible to gain access to the attached facility from the ALER. 📋 CONFLICT REQUIREMENT – ALB & OAK DON'T COMPLY WITH THIS

**Equipment Access**

27.4.14 A suitable equipment handling area needs to be established to permit the installation and removal of equipment from the ALER. Equipment access can be provided by suitable double sized door. Equipment access shall be arranged such that equipment removal or installation can be performed without impacting on other major items of equipment. Equipment access can be used as one personnel access point.

27.4.15 External clearance requirements for ALERs shall allow for access of a large flat bed truck and forklift and easy installation and removal of all equipment.

**Power Supply**

27.4.16 To meet safety and operational requirements, the ALER shall be provided with both mains power and standby power to supply all AGL equipment provided for aerodrome operations. The equipment includes; AGL control system, visual aids, runway approach aids, communication equipment, and ATC facilities. It may also incorporate aircraft arresting systems, navigation aids and other aerodrome services where the ALER is suitably located to support these.

27.4.17 Refer MIEE for Local Emergency Generator (LEG) requirements, standard electrical FDB requirements, low voltage switchboard labelling requirements and Substation requirements. The ALER substation shall be supplied from a suitable high voltage ring arrangement, providing a mains power supply capable of full alternate supply through switching the ring supplying the substation.

27.4.18 All equipment installed within the ALER building including the surge diverters are to be earthed in accordance with the requirements of AS/NZS 3000 and AS 1768.

**Emergency Supply Generator**

27.4.19 The generator supply is required to be established within specified times that are also dependant on the AGL equipment response to power interruptions and time to restore. There must be sufficient time to allow the visual aid system to re-establish to 100 percent of the selected intensity within the specified period.

27.4.20 Operations which require the alternate supply to re-establish within one second will normally be achieve by running the LEG as the prime source and using the normal source (mains supply) as the alternate
source. The designer must ensure that the switchover times are achieved as part of testing and that the specified and installed equipment is capable of meeting the required changeover and restoration times.

27.4.21 Consideration also needs to be given to the characteristics of the emergency generator with regard to the class of governor and voltage regulator and the ability of the engine to accept large step loads and possible high harmonic content of the load. When assessing the output capacity of the alternator consideration needs to be given to the non-linear load characteristics associated with phase controlled thyristor type Constant Current Regulators (CCRs), the low power factor presented by the CCRs when supplying low loads and future load growth.

27.4.22 A suitable Mobile Generator Link Box connection must be provided to cater for LEG failure as detailed in the MIEE.

Low Voltage Distribution

27.4.23 All loads within the ALER are to be considered essential and the whole system needs to be switched from “Mains” to “Generator” supply by automatic change over or transfer switches in the event of a mains failure. Design of the circuitry shall include for the supply of equipment such that single points of supply failure are eliminated.

27.4.24 The supply to CCRs shall be distributed over 2 separate Distribution Boards and the supply to Controllers and SCADA systems shall be from an Uninterruptible Power Supply (UPS). The CCRs for interleaved circuits shall be distributed over the Distribution Boards such that a failure of one board would only impact on half of the interleaved circuits.

27.4.25 Circuit breakers shall be selected with a fault current capacity to suit the prospective short circuit fault and with time current characteristics to suit the CCRs (as recommended by the manufacturer); motor start time current curve CBs may be required.

27.4.26 The final circuit’s cable routes shall be arranged such that in the event of a failure the minimum number of final circuits would be affected.

UPS System

27.4.27 The AGL controls must be maintained during power supply interruptions (period between the loss of “mains” supply and the connection of the LEG) and shall be supplied from a UPS that provides a 10 minute backup period. The UPS system can be either a dedicated system for the AGLCS, or other suitable UPS system provided as part of a complex such as for the ATC complex. UPS systems shall meet the Defence IM UPS Requirements.

27.4.28 Power supplies to the distributed Controllers located in the respective CCR control cubicles shall be arranged such that a single circuit failure or protective trip device shall not de-energise multiple CCRs serving a single visual aid;

27.4.29 Circuit breakers and fuses will be selected to provide protection coordination for all individual circuits. The UPS protection circuit breakers shall be graded to discriminate with the main supply circuit breaker such that a cubicle fault would not cause the main circuit breaker to open. Power supplies to the control circuits for each CCR shall be separately fused within each CCR contactor cubicle.

Control Relay Power Supply

27.4.30 230 Volt control shall not be used.

27.4.31 Control circuit voltage for supply to the control circuitry associated with a CCR control location shall be derived from a separate power supply located at each respective location. Power supplies to the control circuits for each CCR will be separately fused within each CCR control location.

Furniture and Racking

27.4.32 Furniture and racking shall be provided where sufficient space exists within the ALER to facilitate maintenance including the following:

- Desk of minimum size to allow the locating of a SCADA workstation (where applicable);
- Chair with height providing clearance under desk;
- Book shelf sized to store operation and maintenance documentation;
- Mobile pedestal or cabinet with preference for ability to locate beneath desk or away from general access routes; and
- Racking or cabinets to allow the storage of field equipment and control system spares.

VHF Transceiver
27.4.33 A fixed rack mounted ground radio with VHF frequency selection for Air Band Frequency selected to comply with GTE approval requirements will be provided within the ALER complete with its associated antenna. The radio will provide communications over the VHF frequency band to the ATC tower and during CTAF operations.

**Surge Diverter Cubicles**

27.4.34 All circuits leaving an ALER shall be protected from voltage surges.

27.4.35 A suitably rated surge diverter connected to the ALER perimeter earth via an appropriate surge diverter panel shall protect each primary series circuit "leg". No other circuit type shall be intermixed with the primary series circuits within a surge diverter panel; other power and communications circuits shall be suitably surge protected with surge diverters located in separate panels to the series circuit surge diverter panels.

27.4.36 Surge diverters are housed within dedicated surge diverter cubicles with primary circuits distributed from separate cubicles so that a single failure will not affect interleaved circuits for the same system.

27.4.37 Two surge diverter cubicle configurations are installed at Defence aerodromes as follows:

a. Hardwired 'permanent' primary cable connections for each AGL field circuit with a dedicated connection to its supplying CCR. This configuration of cubicle is typically provided for AGL facilities supplied/controlled as a single entity such as runway circuits, PAPI, IWI, DTRM/HCM, etc.

b. Patching connections for AGL circuits that contain multiple sub-circuits supplied from a single CCR, such as taxiway circuits. Patching connections and leads facilitate patching out of sub-circuits (i.e. taxiway segments) in case of circuit failure or for maintenance. The additional cost of cabling the circuits in this configuration may be justified against the operational impact of loosing a major portion of visual aids for a particular circuit when the faulty sub-circuit may be "patched out of circuit" thereby minimising the impact during repairs; for example, placing temporary taxiway edge lights over a reduced section.

27.4.38 The surge diverter cubicles shall provide access to the surge diverter elements and field primary cable terminations. The surge diverter elements shall be easily removed without the need for tools and arranged so that they can be withdrawn from their respective circuits without opening the circuit. Fuse carrier bases with modified fuse carriers are typically used.

27.4.39 The surge diverter element shall be rated to suit the maximum operating voltage of the primary circuit (based on the output capacity of the CCR) and the prospective lightning surge characteristic. The minimum surge capacity shall be 70 kA for a standard 8/20 micro second pulse. Consideration of the high voltage spikes associated with the output voltage waveform produced by phase controlled thyristor operated CCRs shall be included in the selection of surge diverter elements.

27.4.40 **Suitable condition monitoring through the DESN or equivalent must be provided**, surge counters may be provided to record the operation of the surge diverters. 😔 STILL A CURRENT REQUIREMENT?

27.4.41 The general form and construction of surge diverter cubicles shall be as detailed in Figure 27.3 and Figure 27.4, and the requirements of the MIEE for switchboards.
Figure 27.3  Typical Surge Diverter Cubicle (Hard Wired Connections)
Figure 27.4  Typical Surge Diverter Cubicle (Patching Connections)
27.5 Installation Details

ALER Floor

27.5.1 The floor shall be designed to withstand the loadings of the equipment to be installed. The uniformity of the floor shall facilitate the movement of wheeled equipment.

27.5.2 All personnel or equipment access ramps shall be cast integrally with the ALER floor slab. A suitable hardstand shall be provided outside the ALER to allow unloading and subsequent rolling of the CCRs into the ALER.

Surface Treatment

27.5.3 The internal floor surface of the ALER shall be coated with a suitable concrete sealer.

27.5.4 The internal wall surfaces of the ALER shall be coated with a suitable sealer and paint coating system. The walls shall be coloured to aid light reflectance and room illumination.

27.5.5 All un-galvanised metal surfaces shall be coated with a suitable rust inhibitor.

Conduits

27.5.6 All conduits shall be HD uPVC to AS/NZS 2053.2 with all joints being solvent welded.

27.5.7 Where conduits penetrate into the ALER through walls etc and protrude into the ALER the conduit fixing shall be selected to facilitate connection by other trades. This is typically provided by a conduit socket.

27.5.8 All conduits exiting the ALER shall extend to pits located 1500 mm away from the building footing. Any conduits for future shall have draw wires installed and be suitably sealed.

Sound Attenuation

27.5.9 Special consideration needs to be paid to sound attenuation when an LEG is provided adjacent.

27.5.10 The ALER shall be appropriately sound attenuated from other rooms and to the outside with appropriate measures incorporated for all service penetrations between rooms. It must be possible for an operator to use radio communications within the ALER without any adverse impact from aircraft operations or any other services such as the LEG.

Ventilation and HVAC

27.5.11 Where practical, the ALER shall employ natural ventilation using weatherproof and vermin proof vents or louvers. Due consideration shall be given to the impact of heat from the CCRs on the internal operating temperatures and also the need to ensure the life of the electronic equipment such as the CCRs is maintained.

General Power and Emergency Lighting

27.5.12 Battery backed general lighting (2 hour minimum) shall be provided in the ALER to allow operations to be performed during power outages. 

27.5.13 Provide power outlets in each ALER as convenience outlets for maintenance purposes.
28. AGL Control System

28.1.1 The role of the control system is to enable control of the AGL by operators at the ATC facility (where provided) or the ALER in accordance with established control techniques.

28.2 Modes of Control

28.2.1 The AGLCS shall incorporate the following modes of control as applicable for the control system configuration:

<table>
<thead>
<tr>
<th>Control Mode</th>
<th>Typical Configuration</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>ATC Tower console</td>
<td>Control of AGL faculties within the ATC Tower via ADATS or alternatively an AGLCS SCADA Control HMI.</td>
</tr>
<tr>
<td></td>
<td>AGL control panel in operational area</td>
<td></td>
</tr>
<tr>
<td>Alternate</td>
<td>ALER HMI</td>
<td>Control of AGL facilities from alternate control location(s) via AGLCS SCADA Control HMI or control panel incorporating control switches and push buttons.</td>
</tr>
<tr>
<td></td>
<td>HMI located at the base of the ATC Tower (at interface with ADATS)</td>
<td></td>
</tr>
<tr>
<td>Local Manual</td>
<td>CCR</td>
<td>Local manual control of AGL facilities from within the ALER via switches, dials and push-buttons integral with CCR and its associated Control Cubicle.</td>
</tr>
<tr>
<td></td>
<td>CCR Control Cubicle</td>
<td></td>
</tr>
<tr>
<td>Pilot Activated</td>
<td>Typically incorporated through ADATS</td>
<td>Control of predefined AGL facilities by pilots via a radio transmission.</td>
</tr>
<tr>
<td>Lighting</td>
<td>Alternate configuration incorporated through AGLCS</td>
<td></td>
</tr>
</tbody>
</table>

Table 28.1 AGLCS Control Modes

Primary Control

28.2.2 This mode of control provides control of the AGL systems via the software and rules established within the ADATS system together with the logic established within the AGLCS system. The AGLCS will respond to all selections made from the ADATS system.

28.2.3 Some Defence aerodromes do not have permanent ATC Towers or control the AGL facilities independently of ADATS. At these locations the primary point of control may consist of one of the other control modes, such as an ALER HMI or PAL.

Alternate Control

28.2.4 This mode of control acts as an alternate control location to the primary control mode and provides control of all AGL facilities via a HMI located within the ALER and/or at the base of the ATC Tower.

28.2.5 The HMI may take the form of either an AGLCS SCADA system or an AGL Control Panel with control of AGL facilities provided via the logic embedded within the systems.

Local Manual Control

28.2.6 Local manual control is undertaken at the respective CCR and associated CCR Control Cubicle. Local manual control is available at any time within the ALER. In local manual control, the remote operation shall be inhibited.

28.2.7 Local manual control permits control of individual AGL CCRs and hence the associated field circuits, to be taken away from and operated independently to the AGLCS. Indication of a manual selection will be displayed on the AGLCS HMI.
28.2.8 Under Local Manual Control circuit selection will be made in one of two ways:

a Single Circuit per CCR;
   i Select Local Control at the Local/Remote selector on the CCR;
   ii Select an intensity setting via the switch on the CC;

b Multiple Circuits per CCR;
   i Select Local Control at the Local/Remote selector on the CCR
   ii Select an intensity setting via the switch on the CCR
   iii Select the individual circuit via switches located on the front panel of the CCR control cubicle. The local control switches shall only be operable when the CCR is selected in manual mode.

28.2.9 Indication will be provided on the CCR Control Cubicle/Board to indicate minimum current flow in the field circuit.

28.2.10 It is essential that under all conditions that an experienced operator in the ALER is permitted to carry out the AGL control functions on a manual “as needed” basis without restriction by the AGLCS.

Pilot Activated Control
28.2.11 Pilot Activated Lighting includes the selection of predefined AGL elements by pilots via a radio transmission. The requirements for the radio transceiver and general operation and commissioning of PAL shall comply with the requirements of the DADM.

ADATS PAL
28.2.12 When ADATS control is provided, the selection to enable PAL will typically be integrated within ADATS together with the required PAL receiver. Selection of PAL operation via ADATS will allow receipt of a valid PAL request via radio transmission and cause the pre-selected visual aids to illuminate for the pre-determined period and cause the IWI to occult at the specified rate.

28.2.13 Provision will be made for a signal from ADATS to flash the IWI during the final stage of a PAL selection.

AGLCS PAL
28.2.14 Normally PAL is to be incorporated through the ADATS system, however where it is required to be incorporated with the AGLCS the following will apply.

a The AGLCS will incorporate the ability to pre-select the desired visual aids and intensities for day and night conditions via a separate sub-panel of the AGL Control Board or SCADA control screen;

b A photocell input at the ALER will enable automatic selection of day, twilight or night mode.

c Receipt of a PAL trigger input from the PAL system will activate the AGL facilities for an adjustable time period (initially set to 30 minutes) for day, twilight and night modes. The facilities activated will be as preset by the user at the predetermined intensities; and

d the IWIs lighting will flash at a rate of 50 cycles per minute (approximately 0.6 seconds ON and 0.6 seconds OFF) for the last 10 minutes of the cycle.

Active Operator Control Location
28.2.15 Selection of the active operator control location shall be through the AGLCS. Under all circumstances, operator control of the AGL shall only be available from one location and it shall not be possible for the active operator control to be selected at two locations.

28.2.16 Control of the entire AGL system shall be available from the selected location and control from other locations shall be inhibited. The non-active location(s) shall have a monitoring only function. The AGLCS shall permit selection of the active control location from a non-active location but shall inhibit control until the non-active location becomes the active location.

28.2.17 Each AGLCS HMI shall clearly indicate the active control location. For SCADA based HMI the screen header shall display the current control location and will provide push button selection for each of the possible control locations in the Control Page. The push button selection shall require confirmation of the selection or cancellation of the request.
28.2.18 Where more than one control location is provided at an aerodrome where a SCADA based HMI is provided, each location shall be provided with a key operated switch that will return active control to the ATC Tower or alternate control location in the event of failure of the AGLCS at the active location.

Changing Between Control Locations

28.2.19 On transfer of operator control location from any location to another location, excluding ADATS, no change of status of the AGL facilities shall occur.

28.2.20 On transfer of operator control location to the ATC Tower (ADATS) control the system shall adopt the status set by ADATS control at the time of transition.

28.2.21 On selection of local manual control at any CCR in an ALER, the AGL connected to that CCR will first be de-energised by the CCR before being set to the local manually controlled state. Individual control of the multiple circuits supplied from a CCR shall be possible from the local controls switches located on the CCR control cubicle front panel. These switches shall be ineffective when the CCR is under remote control. No local control switch is required on the CCR control cubicle front panel where only one circuit is supplied from a CCR; control of a single circuit supplied from a CCR will rely on the control switch associated with the CCR.

28.3 AGLCS Element Control

Approach Lighting

HIAL

28.3.1 The HIAL shall consist of three circuits, each connected to a separate CCR with six stages of intensity control.

28.3.2 HIAL control from the active operator location will be via a single selection and five/six stage intensity selection inputs. A single HIAL select instruction from the active operator location will energise all three HIAL circuits for a particular approach.

28.3.3 Revertive indication for HIAL selection and intensity shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current.

SALS

28.3.4 The Simple Approach Lighting System (SALS) shall consist of one circuit connected to a separate CCR with three or six stages of intensity control. Three intensity stages are applicable for Medium Intensity application with a six-stage selection being required for High Intensity.

28.3.5 SALS control from an active operator location will be via a single selection control input and three or five/six stage intensity control inputs.

28.3.6 Revertive indication for SALS selection and intensity shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current.

SFAL

28.3.7 The Sequential Flashing Approach Lighting (SFAL) shall consist of either a series or parallel powered circuit to supply the master and slave control equipment required for a SFAL. SFAL control from the active operator location shall be via a single selection control input and three stage intensity control inputs.

28.3.8 Revertive indication for SFAL selection and intensity shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current.

Runways

28.3.9 Runway lighting shall consist of minimum of 2 interleaved circuits, each on a separate CCR. The edge, threshold and end lights may be distributed on separate interleaved circuits each on a separate CCR.

28.3.10 Runway circuits shall have selection for intensity stages as follows;

a  HIRL – 5 or 6 stages; and

b  MIRL – 3 stages.

28.3.11 An indicating light at each CCR Control Cubicle/Board front control panel will indicate if the circuit is energised.
28.3.12 A single runway select signal from the active operator location will energise all runway circuits (edge, threshold and end), Outer Threshold, DTRM/HCM and IWI for the selected runway.

28.3.13 Revertive indication for runway selection and intensity shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current.

Outer Threshold Lighting

28.3.14 Outer threshold lighting lights for each runway shall be connected via separate circuit to a separate CCR within each ALER for each HIRL. The Outer Threshold lights may be integrated with MIRL.

28.3.15 Where HIRL incorporates outer threshold or separate omni directional MIRL edge lights, the outer threshold and omni-directional edge lights shall be energised with the runway lighting circuit via software interlock with intensity set at 11% and 33% for intensity stages 1 and 2 and 100% intensity for intensity stages 3,4,5 and/or 6 of a five or six stage system.

28.3.16 No selection from an active operator location is required for the Outer Threshold lights

28.3.17 Revertive feedback from the outer threshold circuit shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current.

Land And Hold Short

28.3.18 Land and Hold Short lights for each runway shall be controlled from a single selection input at the active operator location. This single selection input will select the bar of LAHSO lights associated with the respective runway. Each bar of LAHSO lights shall be individually controlled and monitored for serviceability, at the operator position of the ATC operator controlling the LAHSO operation.

28.3.19 Intensity selection shall be via an input from a PE cell to automatically set the intensity level for day, twilight and night conditions.

Illuminated Wind Indicator

28.3.20 Illuminated Wind Indicators for each runway shall be supplied from a dedicated CCR.

28.3.21 The IWIs for each runway shall be controlled from a single selection input at the active operator location. This single selection input will select the IWI associated with the respective runway. In addition, IWI circuits associated with a runway shall inter locked such that they are energised with the respective runway lighting circuits. Each runway may be provided with 2 IWI that may be supplied from a common circuit or from individual CCRs where there is more than one ALER.

28.3.22 The IWI circuit’s selection button/switch shall operate for ON and OFF when the associated runway lighting has not been selected and shall be inoperative when the runway circuits have been selected ON.

28.3.23 For SCADA HMIs the selection button shall display the letters “MAN” when operated “ON” to select the IWI circuit separate to the runway; the letters shall extinguish when the IWI circuit is selected “OFF”.

28.3.24 The IWI circuits shall flash to signal the last period of a PAL request.

28.3.25 Revertive indication for runway selection and intensity shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current. The revertive will monitor minimum current only during the PAL warning period.

28.3.26 The IWIs shall typically require two intensity levels; a black current and full intensity. These intensities will be required for PAL operation to flash the IWIs and their obstacle lights to indicate the last period of PAL operation.

DTRMs & HCM

28.3.27 Distance to Run Markers (DTRMs) and the Hook Arrestor Cable Markers (HCM) shall be connected to a separate common circuit supplied from a single CCR for each runway.

28.3.28 DTRMs and HCM shall be energised with a runway lighting selection at a single intensity stage (6.6A).

28.3.29 No selection from an active operator location is required for the DTRMs and HCMs.

28.3.30 Revertive feedback from the combined DTRM and HCM circuit shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current.

PAPI
28.3.31 The PAPI installation for each runway shall be connected to two CCRs located within an ALER, one each for the left and right hand side of the runway. Alternatively, two CCRs may be located in each ALER where more than one ALER is provided at an aerodrome.

28.3.32 A PAPI select instruction for an approach vector from the active operator location shall be via a single selection control input. The alternate approach vector shall also have a selection control input and these two selection buttons shall share a common six-stage intensity control.

28.3.33 Revertive indication for PAPI selection and intensity shall be provided. Intensity revertive indication may be obtained by measurement of the field circuit current.

Taxiway and Apron Edge Lights
28.3.34 Taxiway circuits shall be selected individually from the active operator location, providing either individual segment or zone selection as required. The intensity selection shall be three-stage for taxiway centreline systems and single stage for taxiway edge lighting systems. The selected intensity is common for all taxiways on an aerodrome.

28.3.35 An indicating light at each CCR panel will indicate if the circuit is energised.

28.3.36 Taxiway intensity revertive feedback logic shall be provided and may be obtained from measurement of the field circuit.

28.3.37 Taxiway intensity selection by an operator shall be available at three stages.

Aerodrome Beacon
28.3.38 The ABN shall be selected ON from a single selection input at the active operator location.

28.3.39 Revertive feedback indicating the status of the ABN shall be provided.

Pilot Activated Lighting
28.3.40 PAL setup and intensity selection for day, twilight or night operations shall normally be available for pre-selection through the ADATS system. The ADATS system interface with the AGLCS shall provide suitable I/O for the selected visual aids and a specific I/O to cause the IWI to occult during the last remaining period of a PAL operation (normally 10 minutes).

28.3.41 Where PAL control is to be established through the AGLCS the following applies:
   a Agreement to using the AGLCS for PAL selection and initiation must be obtained from DEEP;
   b SCADA HMI Interface – The Active Operator Location HMI touch screen will include a setup page to enable the pre-selection of respective AGL circuits, operational time for a single PAL request and a warning sequence (flashing of IWI) and a selection button to activate a PALC operation. The PAL transceiver will input to the AGL control upon the receipt of a radio PAL request thus causing the pre-selected AGL to energise for the predetermined time provide a second specific I/O to cause the IWI to occult during the last remaining period of a PALC operation; and
   c AGL Control Board Pushbutton Interface – The manually operated switches will pre-select the respective AGL circuits through either the controller where provided or as hard wired inputs to the respective element. The PAL transceiver will input to the AGL controller or directly to the element upon the receipt of a radio PAL request thus causing the pre-selected AGL to energise for the predetermined time provide a second specific I/O to cause the IWI to occult during the last remaining period of a PAL operation.

28.4 Control Logic

28.4.1

Maintained State
28.4.2 In the event of a communications failure or other equipment failure that results in loss of communications between the active operator control location and the ALER, the circuits shall maintain their current configuration.

Preselected Intensity
28.4.3 The system shall be designed such that the last operator-selected intensity prevails.
Illegal Circuit Combination

28.4.4 Illegal selections shall be inhibited by logic embedded into the control system. Examples of illegal selections are the selection of runway edge lights but not the associated runway threshold lights.

28.4.5 Control combinations shall be vetted such that only valid selections will be actioned. Generally there are no illegal circuit configurations used in Defence AGL installations. Where required this will be advised by the FDB or as part of the design review process.

Simultaneous Intensities

28.4.6 The AGLCS logic will be configured to prevent the selection of two intensities simultaneously.

28.4.7 The logic will be configured to accept the last intensity selection. If under some circumstance, two intensity settings are requested simultaneously, the lower intensity setting will prevail.

Simultaneous Selection

28.4.8 The AGLCS logic shall be configured to respond to only one input when two or more inputs are made on a SCADA HMI interface within a 100 m second period. The first detected input shall prevail.

Primary Current Monitoring and Revertive Indication

28.4.9 Where revertive current monitoring is provided as an input to the AGLCS the current flowing in the circuit shall be measured and compared to a look-up table to verify the magnitude of the current within preset limits. This method of current monitoring is typically provided as part of an AGLCS that incorporates CCR Control Cubicles and SCADA HMI terminals.

28.4.10 Minimum current conditions shall be monitored in each circuit of multiple circuit applications in addition to the series circuit revertive current. These inputs will provide input to the AGLCS for monitoring of the status of selected multiple circuits.

28.4.11 Revertive monitoring of the primary circuit current may be achieved by:
   a Analogue current sensing transducers, suitable for monitoring high distortion waveforms (e.g. hall effect devices), may be used to capture real time signals for analysis by AGLCS;
   b Minimum current relays may be used to provide a signal to the AGLCS;
   c Low-level interface signals may be acquired from the CCR to confirm/alarm that the CCR is generating a series current in tolerance of the selected intensity; and
   d High level protocol interface to the CCRs may directly communicate with the CCRs for selection and control and interrogate them for revertive information; status, operation, faults, field currents etc.

Failure Modes

28.4.12 The AGLCS shall be designed to be fail-safe so that any single point failure does not affect more than one field circuit or CCR. Failure mode responses shall be incorporated into the system as follows:

28.4.13 Controller I/O Card Fault or Controller Power Failure

28.4.14 In the event of an AGLCS Controller or distributed Controller I/O card fault or Controller power supply failure the outputs will be released to their de-energised state. Further control will be available in local manual mode only.

28.4.15 Where the Controller interface to a Constant Current Regulator (CCR) is implemented via latching or bistable relays, discrete pulse ON and pulse OFF signals from the Controller will latch each relay. In the event of a Controller I/O card fault or Controller power supply failure the relay will maintain the last selected state.

Contactor Coil Failure - Multiple circuit connected to a single CCR

28.4.16 The contactor arrangement shall be selected so that, on failure of a contactor coil the CCR circuit will not become open circuit.

28.4.17 As local manual control relies on the serviceability of the CCR circuit contactor arrangement control of the AGL circuit(s) connected via the contactor will be unavailable without manual HV patching around the failed contacts.

Control Circuit Voltage Failure

28.4.18 In the case of a failure of the control voltage within a CCR, all circuits will maintain their current selected state and intensity with the exception of the taxiway lighting circuits. All taxiway circuits will be energised ON via the de-energised Normally Open/Normally Closed status of the CCR and field circuit contactors.
28.4.19 Within the Controller, contactor auxiliary contact status will be monitored and internal fail safe and sequential contactor operation logic will parallel electrical interlock logic.

28.4.20 Manual arrangement of the field circuits will require patching via the HV single point links/patch cables.

28.5 Remote Control System Interfaces

28.5.1 In developing a control system solution various options within the system need to be evaluated to facilitate selection of the most appropriate control system configuration to meet program, technical, procedural and budget requirements; these options are summarised as follows:

<table>
<thead>
<tr>
<th>ATC Tower Control Interface (Options 1A, 1B &amp; 1C)</th>
<th>Aeronautical Ground Lighting Control System (AGLCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1A:</strong> Stand alone AGLCS HMI solution within ATC Tower.</td>
<td><strong>2A:</strong> Local control of AGL facilities via control switches and push buttons on control panel</td>
</tr>
<tr>
<td>Solution may incorporate hardwired solution or alternatively a PLC device to reduce hard wired relay logic</td>
<td></td>
</tr>
<tr>
<td><strong>1A:</strong> Low level interface via discrete multi core cabling to ATC Tower Control System (eg ADATS)</td>
<td><strong>2B:</strong> Local control of AGL via PLC/SCADA based touch screen</td>
</tr>
<tr>
<td><strong>1B:</strong> High level interface via network based communications (eg Ethernet) to ATC Tower Control System (eg ADATS)</td>
<td><strong>3B:</strong> High level interface via network based communications (eg Ethernet) over twisted pair cabling</td>
</tr>
</tbody>
</table>

Table 28.2 AGLCS Remote Control System Interfaces

28.6 ATC Tower Control Interface

Option 1A – Stand Alone AGLCS HMI Solution

28.6.1 At aerodromes where the AGLCS does not interface with ADATS, a stand alone AGLCS HMI shall be provided for the control of all AGL facilities. The HMI may take several forms subject to the configuration of the AGLCS and presence of a permanent ATC Tower. Example configurations as currently installed at Defence aerodromes include the following:

a SCADA based graphical HMI suitable provided with the ATC Tower for interfacing with a PLC based AGLCS;
b SCADA based graphical HMI suitable provided with the ATC Tower for interfacing with an AGLCS incorporating hard wired relay logic;
c Portable HMI control panel incorporating control switches and push buttons for connection to a PLC based AGLCS at an mobile air traffic system site; and
d Portable HMI control panel incorporating control switches and push buttons for connection to a hard wired relay logic AGLCS at an mobile air traffic system site.

28.6.2 SCADA based graphical HMIs typically replicate the appearance and control functionality provided at the alternate AGLCS control locations without the additional engineering and maintenance features such as indication of equipment status, alarm and event history, etc.

28.6.3 The control and monitoring functionality provided by portable HMI control panels will be dependant on the installed AGL facilities, size and weight constraints and required operational capability from the ATC Tower control location. An example of a portable HMI control panel is shown below in Figure 28.1.

28.6.4 The interface between a stand alone HMI and the AGLCS shall reflect the general philosophy of discrete selection and intensity signals for each AGL facility as provided for ADATS to provide a level of commonality between the various aerodrome installations.
Figure 28.1   Typical Portable HMI Control Panel

Option 1B – Low Level Interface with ADATS

28.6.5 The ADATS includes a touch screen HMI located within the ATC Tower similar to the ALER SCADA based HMI that is used to select the various visual aids and their required intensity.

28.6.6 For an AGLCS that is required to interface with ADATS, the interface includes discrete Inputs and Outputs (I/O) using voltage free mechanical relays (within each system equipment) with dedicated returns, i.e. no common returns, facilitating the connection in series or parallel of the I/O as required.

28.6.7 The interface circuits will typically be powered at 24VDC by each system.

Selection

28.6.8 ADATS will provide a maintained contact closure as long as any AGL facility is selected ON and a corresponding closed contact for the intensity selection.

28.6.9 The AGLCS shall provide a revertive return contact (closure whenever a facility or group of AGL facilities has been activated (regardless of the requested and actual intensity). This revertive indication from the AGLCS will be signalled regardless of whether the ATC Tower or another location has initiated activation of the AGL facility.

28.6.10 Where a revertive indication relates to a group of AGL facilities, the revertive indication shall be signalled only if all facilities in the group are energised.

28.6.11 If two circuits are selected as part of a single facility and one or both circuits fail to energise at the correct intensity, and there is minimum current detected in the circuit that failed to energise at the correct
current, a healthy revertive indication will still be provided for that selection (but not for the selected intensity).

**Intensity**

28.6.12 ADATS provides a maintained contact closure corresponding to the required intensity of each facility or group of AGL facilities.

28.6.13 The AGLCS will provide a revertive return contact closure whenever that facility of group of AGL facilities is activated at the common intensity selected. This revertive indication from the AGLCS will be signalled regardless of whether the ATC Tower or another location has initiated activation of the AGL facility.

**Fault**

28.6.14 ADATS currently makes no provision for receipt of fault signals. However, a common ALER fault shall be available for interface to the ADATS in the future should it be required/accommodated. The common fault shall include selection, correct revertive current and faults from all equipment.

**Option 1C – High Level Interface with ADATS**

28.6.15 The ADATS includes a touch screen HMI located within the ATC Tower similar to the ALER SCADA based HMI that is used to select the various visual aids and their required intensity.

28.6.16 The interface between ADATS and the AGLCS consists of a serial connection to interrogate data registers within the opposing system’s PLC to obtain system requests (in the form of facility and intensity selections) and revertives.

**Selection**

28.6.17 ADATS will provide a discrete maintained control variable closure as long as any AGL facility is selected ON and a corresponding discrete maintained closed variable for the intensity selection.

28.6.18 The AGLCS shall provide a revertive return control variable closure whenever a facility or group of AGL facilities has been activated (regardless of the requested and actual intensity). This revertive indication from the AGLCS will be signalled regardless of whether the ATC Tower or another location has initiated activation of the AGL facility.

28.6.19 Where a revertive indication relates to a group of AGL facilities, the revertive indication shall be signalled only if all facilities in the group are energised.

28.6.20 If two circuits are selected as part of a single facility and one or both circuits fail to energise at the correct intensity, and there is minimum current detected in the circuit that failed to energise at the correct current, a healthy revertive indication will still be provided for that selection (but not for the selected intensity).

**Intensity**

28.6.21 ADATS provides a maintained closure of the control variable corresponding to the required intensity of each facility or group of AGL facilities.

28.6.22 The AGLCS will provide a revertive return control variable closure whenever that facility of group of AGL facilities is activated at the common intensity selected. This revertive indication from the AGLCS will be signalled regardless of whether the ATC Tower or another location has initiated activation of the AGL facility.

**Fault**

28.6.23 ADATS currently makes no provision for receipt of fault signals. However, a common ALER fault shall be available for interface to the ADATS in the future should it be required/accommodated. The common fault shall include selection, correct revertive current and faults from all equipment.

**28.7 ALER Human Machine Interface**

28.7.1 The ALER HMI provides an interface between the operator and the AGLCS. The HMI shall be configured in a manner presenting an operator with a consistent interface and representation of the AGL system status. The HMI shall be in the form of either control switches and push buttons or a PLC/SCADA based touch screen.

28.7.2 The number of HMI units depends on the complexity of the facility and the requirement for redundancy, but generally, one HMI is required in each ALER and at the base of the ATC Tower (in the vicinity of the Approach Control facility) which may be utilised as the alternate control location to the ATC Tower operator console.

**Option 2A – Local Control via Control Switches and Push Buttons**
28.7.3 Control of the AGL facilities is provided by control switches and push buttons located on a control panel. The control shall provide:
   a The ability to transfer control of the AGL facilities between control locations i.e. between the ATC Tower and the AGLCS;
   b Selection of individual AGL facilities including taxiway segment/zone selection;
   c Intensity selection for each facility; and
   d Revertive feedback.

Revertive Feedback
28.7.4 Revertive feedback shall be provided in the form of lights/LEDs and illuminated push buttons on the control panel. Facility and intensity selections shall be indicated for all AGL facilities on the control panel.
28.7.5 Each CCR location shall have indication of its operation and faults as communicated by the CCR. An audible alarm may also be required.
28.7.6 A typical control panel layout is shown below in Figure 28.2.
Figure 28.2 Typical Local Control Panel incorporating Switches and Push Buttons
Option 2B – Local Control via PLC/SCADA Based Touch Screen

28.7.7 The HMI shall be a touch screen that displays an airport graphic with “push button” touch points that control the various CCRs and related AGL circuits for runway, taxiway etc selection and control equipment. A HMI is to be associated with the control system at each AGLCS control mode.

28.7.8 The general presentation of AGL controls shall be via interactive mimic diagram in the case of taxiway lighting and touch screen based push button panel in the case of runway and approach lighting.

28.7.9 The HMI touch screen forms part of a PC hosted SCADA terminal. This computer located near each HMI, receives the commands from the HMI and converts them to digital format for transmission over a fibre optic cable, wireless network or copper wire to the computers at each control location.

28.7.10 The control system is hosted on a programmable logic controller (PLC). Control functional requirements will be implemented in a safe, interlocked and traceable fashion within the PLC logic.

Operator Access

28.7.11 There will be a minimum of 2 levels of operator access to SCADA HMI as follows.

a Mimic Mode - At the Mimic Level, control functionality is not available. The operator can view the AGL Mimic diagram, the CCR Status, Alarm, Event and Miscellaneous screens only;

b Control Mode - In addition to the Mimic Level functions above, at the Control Level the operator will be able to access and perform;

i Runway/Approach and Taxiway Control;

ii Selection of operator location;

iii Equipment setup; and

iv Miscellaneous Control including selection of Active Operator Control Location.

28.7.12 The AGLCS SCADA Operator Workstations will provide access to both Mimic and Control Modes.

Control Page Selection

28.7.13 HMI touch screen 'button' shall incorporate a suitable means to indicate to the operator the request is being processed due to inherent lag to get the revertive back; for example, the button may flash whilst processing a selection/command.

Control Page Revertive Feedback

28.7.14 Revertive feedback will be signalled via a change in colour of the HMI touch screen 'button'. For 'control' displays the colours shall be implemented as follows:

a GREEN = operating correctly, revertive received and within tolerance (ON);

b GREY = when the controlled function is OFF;

c GREY/GREEN flashing = controlled function has been activated ON but a feedback (revertive) has not been received and the action has not timed out;

d RED = FAULT (including timeout to ON request); and

e GREEN Border = Intensity selection buttons only indicating the last selected intensity when the control function is deactivated.

28.7.15 For the airfield ‘mimic’ display the colours shall be implemented as follows:

a GREY (Background) = OFF;

b WHITE/GREEN/YELLOW/BLUE/RED - Not flashing = Operating correctly, revertive received (ON), colour dependant upon actual AGL colour for that element selected (eg. Runway - white, Threshold - green, Taxiway centreline - green etc.) Lighting systems shall be represented by coloured dots to match the actual colour of the lighting system. Symbolic representation only required; not a coloured dot for every light;

c Flashing = colour of the respective element, FAULT or manual selection of the visual aid via local control outside the AGLCS; and

d BLACK = Pavement outlines.
In general revertive indications will be derived as detailed in Table 28.3.

<table>
<thead>
<tr>
<th>FACILITY</th>
<th>SELECTION of Circuit</th>
<th>INTENSITY of Circuit</th>
</tr>
</thead>
</table>
| PAPI     | CCR AVAILABLE for all¹  
            CCR ON for all³ | MINIMUM circuit INTENSITY (current) for all¹,⁴  
            CCR output CURRENT IN TOLERANCE for all¹,³ |
| RUNWAY   | CCR AVAILABLE for all¹  
            CCR ON for all³ | MINIMUM circuit INTENSITY (current) for all¹,⁴  
            CCR output CURRENT IN TOLERANCE for all¹,³ |
| DTRM²    | CCR AVAILABLE  
            CCR ON  
            MINIMUM circuit intensity (current)⁴  
            CCR output CURRENT IN TOLERANCE³ | |
| IWI²     | CCR AVAILABLE  
            CCR ON  
            MINIMUM circuit intensity (current)⁴  
            CCR output CURRENT IN TOLERANCE | |
| TWY, Apron Edge, | CCR AVAILABLE for all¹  
            CCR ON for all³ | CCR output CURRENT IN TOLERANCE for all¹,³  
            MINIMUM circuit INTENSITY¹,⁴ |

**Notes:**

1. For all circuits selected as part of this single control function (excluding DTRM/IWI when selected as part of RWY – these revertives displayed separately)
2. Selection of these visual aids are interlocked for selection with the runway and energise at a single intensity; as such there is no revertive indicates the aid is operating correctly rather being a specific selection/intensity revertive.
3. CCR output CURRENT IN TOLERANCE – Is defined as the current revertive detected in the primary circuit being within the programmed current band for the selected intensity.
4. MINIMUM circuit INTENSITY (current) - Is defined as the current revertive detected in the field circuit current exceeding 1.8 amperes.
5. If two circuits are selected as part of a single facility and one or both circuits fail to energise at the correct intensity, and there is minimum current detected in the circuit that failed to energise at the correct current, a healthy revertive indication shall still be provided for that selection (but not for the selected intensity).
Fault

28.7.17 A Fault shall be signalled via a RED revertive on the HMI touch screen ‘button’ and flashing mimic diagram element (coloured to suit the element) and by a distinctive tone at the ALER PC. A fault shall annunciate if following operator initiation one of the following occurs:

a) A correct revertive signal (Selection and/or Intensity) is not received within a set time out period;

b) A CCR fault exists;
   i) CCR switched OFF on open secondary circuit;
   ii) CCR switched OFF on over current;
   iii) CCR general regulation error;

c) The CCR is not available.

28.7.18 All alarms, faults and events are to be logged by the AGLCS.

AGLCS HMI SCADA Screens

28.7.19 Display screens will be developed in a logical and consistent manner showing system information and providing touch screen based control over the AGL system from each HMI. The display pages shall comprise a screen header and footer in addition to the main page area.

28.7.20 Cognisance shall be taken of AGLCS SCADA systems previously developed at various Defence aerodromes to achieve a consistent approach to facilitate operator familiarity.

28.7.21 The screen header will display the Active Operator Control Location and information common to the selected Active Operator Control Location.

28.7.22 Buttons common to each page will permit navigation through the displays in a logical consistent fashion. Navigation through successive screens will include:

a) One button for selection of the airfield mimic each runway and taxiway control page;

b) Equipment status with links to subsidiary configuration pages (CCR set-up parameters, system maintenance, communications status, etc);

c) Control setup;

d) Alarm History; and

e) Event log.

28.7.23 The footer shall provide at each ALER location an alarm panel (red flashing when unacknowledged alarm exists) and an Alarm acknowledge.

28.7.24 Where additional pages are required to display information eg Equipment status then additional buttons shall be provided to navigate through these pages.

28.7.25 A button “area” shall be provided to provide sufficient area for operator control targeting.

28.7.26 The system will be designed to prevent unauthorised access to the underlying operating system for:

a) Selection and control of visual aids;

b) Display rebuilding;

c) System reconfiguration; and

d) Maintenance or archive functions.

28.7.27 Monitoring access to the SCADA terminals in each location shall not require the operator to ‘log on’.

28.7.28 Where a selection is made and the SCADA system requires a time delay to ascertain the revised status of equipment to display the revertive, the revertive shall flash green/grey for this period; the period shall be an adjustable system variable set to the minimum possible. The revertive shall not momentarily take a solid green or red state after a green/grey period and then update to the alternate state (without a change of state in the field).

28.7.29 Separate display pages shall be implemented for individual system elements as follows (the illustrations are provided as examples only).
Airfield Mimic Page

28.7.30 The AGL Mimic Display shall be an active AGL plan displaying current selection and intensity settings for all facilities in the colours of the applicable AGL elements it represents. The Airfield Mimic shall provide monitoring functions only. The mimic shall indicate healthy circuit selection revertives by indicating each visual aid; unhealthy revertives shall cause the indication to occult. The intensity table on the mimic shall indicate healthy intensity revertives as green (for the selected intensity); unhealthy revertives shall be indicated as red.

28.7.31 Figure 28.3 details a typical Airfield Mimic Page layout and appearance.

Runway/Approach Control Page

28.7.32 A separate runway control page shall be provided. Where more than one runway is provided at an airfield and the control cannot be incorporated onto the one page, then separate control pages shall be provided for each runway. Common visual aids such as an aerodrome beacon or IWI shall be available on each runway/approach page.

28.7.33 Runway/Approach/PAPI control for each runway will be presented as a matrix of pushbuttons at the top of the display area immediately below the header, with one row consisting of a selection button plus intensity buttons for each AGL facility, for example:

a Selection and six intensity buttons for each AGL facility requiring six intensity settings such as:
   i HIAL;
   ii HIRL;
   iii PAPI;

b Selection and three intensity buttons for each AGL facility requiring only three intensity settings including:
   i SFAL;
   ii Medium intensity SALS; and
   iii MIRL.
28.7.34 A single button shall be presented below the matrix of pushbuttons for each facility that requires a separate selection to the runway and no intensity selections. These facilities shall incorporate intensity and selection to the one revertive. Examples include:

- Aerodrome Beacon
- IWIs

28.7.35 Note that while the IWI is automatically selected when a runway selection is made, provision shall also be made to select the IWI independent of RWY selection. When this occurs the deselecting ability is removed. Manual operation of the IWI facility and shall be indicated on the IWI pushbutton.

28.7.36 During the last remaining period of a PAL operation, when a specific signal to cause the IWI to occult is present, “PAL TIMEOUT INITIATED” shall annunciate on the SCADA terminal approach/runway control pages.

28.7.37 Indication only of the operational status of software interlocked visual aids that are controlled by a selection of a runway eg Outer threshold lights and DTRM/HCM are displayed in a vertical column to the right of the matrix of pushbuttons.

28.7.38 Pushbuttons for each operator control location shall also be provided above the matrix of runway/approach control buttons allowing selection and indication of the active operator control location selection (whilst operating in control mode only). Selection of the active operator control location will require confirmation via a ‘popup ’control confirmation’ window. It shall not be permissible to transfer control to an alternate operator control location other than the ATC Tower/ADATS and only one location may provide control of the AGLCS at any one time.

28.7.39 Figure 28.4 details a typical Runway/Approach Control Page layout and appearance.

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**Figure 28.4** Runway/Approach Control Page
Taxiway and Apron Control Page

28.7.40 The Taxiway and Apron Control shall be based on a plan layout of the AGL including throw-out text boxes/selection buttons for each taxiway zone/segment and apron selection. The selection buttons will display the operational status of their respective taxiway segment and/or apron.

28.7.41 Taxiway and apron control will generally be based on a common taxiway and apron zone selection, rather than segment selection.

28.7.42 A common 3-stage intensity selection shall apply to all of the taxiways and aprons. The intensity selection buttons shall indicate the status of the revertive indication for the respective circuits.

28.7.43 As shown in Figure 28.5 the taxiway /apron display will indicate the individual taxiway segments and/or aprons by solid infill of the taxiway and/or apron; breaks in the solid fill delineate the taxiway and/or apron selection segments. No visual indication of the status of the taxiway or apron lighting is required on the pavement mimic associated with the taxiway and apron control page; visual indication is presented on the airfield mimic page only.

Figure 28.5 Taxiway and Apron Control Page
28.7.44 An Equipment Status page or pages (with additional pages to suit the number of CCRs) shall display the operational status of each CCR similar to that shown in Figure 28.6. Where more that one ALER is provided there shall be an Equipment status page for each ALER.

28.7.45 The desired information is as follows, subject to what information can be obtained from the CCR interface and field sensed information:

a Connected (CCR able to supply common circuit based on primary cable connection field signal; not applicable for circuits not able to be supplied from multiple locations);
b On (feedback from CCR);
c CCR trip;
d CCR communications fault;
e CCR regulation fault;
f CCR current in tolerance (with inset intensity stage number);
g Primary current (RMS) (in Amperes to 2 decimal places);
h Minimum current sensed (from field);
i Operating in local mode

28.7.46 The status of the indication shall be green for healthy, flashing red for the transition period between a selection and the receipt of a healthy revertive and red for fault. The status shall be grey when not applicable or off. Yellow status indication may be used to indicate the failure of a single communications channel when two redundant communications channels are provided.

28.7.47 CCR locations within the ALER that are fitted out with CCR Control Cubicles/Boards for future circuit allocations (i.e. for future runway upgrade from MIRL to HIRL) shall be represented on the Equipment Status pages.

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**Figure 28.6  Equipment Status Page**
28.7.48 A supplementary CCR status screen may be provided similar to that shown in Figure 28.7 to indicate parameters as ascertained by polling the CCR (typically achieved over a high level interface with the CCR). Parameters may include:

a. Operating hours  
b. Input voltage  
c. Input current  
d. Input power  
e. Input power factor  
f. Output voltage  
g. Output current  
h. Output power  
i. Failure/fault indications (these shall also be recorded in the event/alarm logs):
   i. Open circuit  
   ii. Overcurrent  
   iii. Regulation fault  
   iv. Low circuit insulation resistance
Communications Status Page

28.7.49 A network/communications status page shall be developed for the communications network detailing the active hardware that may be addressed on the network including SCADA terminals, network switches, routers, PLCs and CCRs.

28.7.50 Clear indication (change of object colour) shall be provided where a communications fault results in an item of equipment not being able to be controlled / interrogated or a portion of the network being isolated. Figure 28.8 details a typical Communications Status Page layout.
28.7.51 The Current Alarm display will show a time and date stamped list of all outstanding alarm conditions in chronological order, as shown in Figure 28.9. The alarm will remain on the list until the alarm condition no longer exists in the field and has been acknowledged by the operator. An audible alarm shall annunciate for each new alarm occurrence. A single acknowledge action by the operator will permit muting of the audible annunciation for all existing alarms. Additional alarms raised after the last acknowledge action will re-trigger the audible annunciation.

28.7.52 Alarms shall be stored for a period of 30 days and then be automatically archived to the hard drive of the SCADA PC. The archived alarm files shall be sequentially numbered to assist retrieval in chronological order.

28.7.53 Provision shall be made to access and interrogate the current and archived alarm logs (both current and archived databases); with reports being generated, viewed on screen and printed.

28.7.54 The AGLCS will annunciate all system faults at each HMI SCADA terminal on the:
   a Mimic and control screens;
   b Current alarm list; and
   c Event log.

28.7.55 These faults include single point failures which affect a single item of equipment (CCR, contactor etc.) and would be registered if, following circuit activation, the required feedback signals were not received eg. :
   a CCR x failed to energise;
   b Minimum current in field circuit x not registered;
   c Current for intensity x on CCR y out of range (actual current = z);
   d Contactor x failed to open;
   e Contactor x opened when required to be closed;
   f Contactor x failed to close; and
   g Contactor x closed when required to be open.

28.7.56 Alarm logic shall be configured so that suppression of consequential alarms occurs (eg. If a CCR fails then the circuit current alarms shall be suppressed).

28.7.57 Alarms shall be configured using standard nomenclature and abbreviations to enable searching the log/database with ease for alarms that relate to a system, piece of equipment or type of alarm.
28.7.58 The Event Log display shall show a time and date stamped list of all system events in chronological order. An entry will appear in the Event Log for each Alarm ON and OFF transition and for each operator acknowledge action. The event log will be archived to a history file by the SCADA PC. Typical Event Log and Event Setup pages are provided in Figure 28.10 and Figure 28.11.

28.7.59 All AGLCS events shall be logged to the Event Log at the SCADA PC for a period of 30 days and then be automatically archived to the hard drive of the SCADA PC. The archived event files shall be sequentially numbered to assist retrieval in chronological order.

28.7.60 Events occur as a result of any:
   a. Normal system control action;
   b. Field action (eg., CCR x in Local);
   c. Fault;
   d. Fault return to normal;
   e. Operator acknowledge;
   f. Controller or communications fault;
   g. PLC or communications fault; and
   h. Field circuit out of tolerance for set intensity.

28.7.61 Consequential events shall be suppressed (eg, operator action to energise the runway lighting would result in the entries ‘03/21 runway Select ON’ & ‘03/21 runway Intensity x’, but not entries for CCR, contactor and field current state.)

28.7.62 Provision shall be made to access and interrogate the current and archived event logs (both current and archived databases); with reports being generated, viewed on screen and printed.

28.7.63 Events shall be configured using standard nomenclature and abbreviations to enable searching the log/database with ease for events that relate to a system, piece of equipment or type of event.
Figure 28.10  Event Log Page

Figure 28.11  Event Setup Page
System Setup Page

28.7.64 A System Setup page shall provide AGLCS status and control functions including:

a) CCR revertive current setup parameters;
   i) Nomination of revertive current bandwidth set-up parameters for each CCR and its intensity level – refer Figure 28.12 for typical appearance;

b) SCADA user profiles;
   i) Definition of user profiles for each operator user level – refer Figure 28.13 for typical appearance;

c) Miscellaneous parameters;
   i) Nomination of various engineering parameters that configure the SCADA operation including time delay to await healthy revertive, enable/disable SCADA terminal audible alarm, “CCR fail to energise” timeout, “Contactor fail to operate” timeout, “CCR minimum current” timeout, IWI occult rate during PAL timeout;

d) Button to transfer to a PALC configuration page (where PALC is incorporated into the AGLCS).

![Figure 28.12 CCR Revertive Current Setup Parameter Page](image-url)

Figure 28.12 CCR Revertive Current Setup Parameter Page
Figure 28.13  SCADA User Profile Setup Page
PAL Configuration Page

28.7.65 Where the PAL is incorporated into the AGLCS the PAL configuration page shall allow pre selection of facilities and intensities for all lighting systems whilst operating under pilot activated lighting control.

28.7.66 A matrix of pushbuttons shall be provided for the pre selection of all lighting systems in a similar manner to those provided on Runway/Approach Control page. Individual facility and intensity selection shall be provided for each of the Runway, Approach and PAPI elements, with taxiway and apron facilities provided with a common intensity selection.

28.7.67 Configuration for “DAY”, “TWILIGHT” and “NIGHT” modes of operation shall be provided. Separate default selections of all lighting systems shall be possible for each mode.

28.7.68 A typical page layout is provided in Figure 28.14.

![Figure 28.14 PAL Configuration Page](image)

Maintenance Interface

28.7.69 A capability to provide a maintenance interface connection may be provided. This facility may be configured as a dial-in capability established by physical connection between the AGLCS SCADA terminal and a suitable telephone socket. The system shall be limited to monitoring only access to the AGLCS HMI. The location and arrangement of the maintenance interface shall be in accordance with the Region’s requirements.

28.7.70 Maintenance Workstation(s) when provided shall incorporate a screen based AGLCS HMI with graphical interface annunciation similar in presentation to the AGLCS HMI terminal.

28.7.71 The Maintenance Workstation shall incorporate dialup and monitoring software; the dial up configuration must be agreed by Information Systems Division (ISD).

28.7.72 The Maintenance Workstation connected via a dialup link will permit a remote operator to view the current status of the AGLCS. Control of AGL facilities will not be permitted from the Maintenance Workstation.
28.8 CCR Interface

28.8.1 CCRs will be connected into the power and communications systems via CCR Control Cubicles/Boards as detailed in Chapter 0.

28.8.2 Communications cabling enables the passing of CCR facilities/intensity information and revertives between the CCR and its associated control system.

Option 3A – Low Level Interface via Discrete Multi core Cabling

28.8.3 The interface between the AGLCS and CCR will be via multi core cabling incorporating a multi-pin plug and socket arrangement to facilitate quick replacement of failed CCRs.

Option 3B – High Level Interface via Network Based Communications

28.8.4 Twisted pair serial cabling will provide the link between the CCRs and the CCR control board enabling high level communications.

28.8.5 Provision of a high level interface to the CCRs will require a control network within each the ALER. It is intended that this would be an extension of the Ethernet VPN established for the AGLCS.
28.9 AGLCS Communications

28.9.1 A dedicated communications network, independent of the DESN or any other network, may carry all internal communications traffic between each of the AGL operator control locations and elements of the AGLCS. This type of communications network utilises serial data links and is distinct from hardwired multi core control cabling provided in some AGLCS applications.

28.9.2 An AGLCS will typically comprise two interfacing communications networks:
   a. ALER Communications Network for signalling between control equipment within each ALER; and
   b. AGLCS Communications Network to link each of the spatially separated AGL operator control locations.

28.9.3 Each network shall comprise redundant communications links in the form of separate and distinct channels (i.e. multiple cable runs to provide redundancy in the event of a cable failure) configured in a geographically redundant loop arrangement. Each of the redundant cable runs shall take different routes and be installed within separate duct systems to prevent impacting the network's operation in the event of an accidental excavation.

28.9.4 The general configuration of the two networks shall be as shown in Figure 28.15, however the design of each installation requires consideration of existing infrastructure, operational capability and remote control system interfaces detailed in the previous sections.

28.9.5 Communications equipment shall typically be installed with communications racks or control panels subject to the AGLCS configuration. Such equipment may include:
   a. Programmable Logic Controllers (PLCs);
   b. Fibre optic break out trays;
   c. Network switches;
   d. Network routers; and
   e. Associated power supplies.

28.9.6 PLCs or other suitable technology provides the required process control for the AGLCS. Controllers are required in each ALER and at the ATC Tower and may be provided at other locations around the aerodrome for monitoring of the AGL equipment. The controllers shall be connected to a dedicated AGLCS network utilising the appropriate network interface equipment and arranged to suit the communications environment.

28.9.7 Network communications shall be provided with back up power to allow the continued AGLCS operation in the event of a power cutage (whether momentary until the connection of an alternate power supply or for a predetermined period where an alternate power supply does not exist).

ALER Communications Network

28.9.8 Within the ALER of an AGLCS incorporating SCADA HMI and PLC equipment the communications between the AGLCS equipment such as CCR Control Cubicles/Boards, CCR and PLC may be via a suitable Local Area Network (LAN).

28.9.9 This LAN may optimise cabling between the AGLCS and the ALER equipment. The LAN shall be suitable open protocol and shall not be supplier dependant.

AGLCS Communications Network

28.9.10 Communications between the ALERs and the ATC Tower or alternate control location shall generally be via a fibre serial data link or Ethernet. This link shall be in accordance with the Defence communications infrastructure requirements.

28.9.11 Communication between the AGLCS and a remote maintenance station will take the form of a dial-up or leased line connection.
Figure 28.15  Typical ALER and AGLCS Communications Network
Part 5 - Maintenance Requirements
29. Maintenance Requirement

29.1 Introduction

29.1.1 The contractor responsible for the AGL maintenance contract shall undertake the responsibilities of Aeronautical Ground Lighting Maintenance Agent (AGLMA) for the AGL system at the respective Defence facility.

29.1.2 The AGLMA responsibilities encompass:
   a. Ensuring the availability, safety and condition of the AGL system;
   b. Managing and undertaking the inspections, maintenance, servicing, overhaul and repairs of the AGL system;
   c. Complying with Aerodrome Works Safety requirements; and
   d. Complying with the reporting and documentation requirements.

29.2 Standards and Codes

29.2.1 Electrical installations in Defence establishments shall be installed and maintained to the requirements of all applicable legislation, codes of practice and guidance publications relevant to the State or Territory where the installation or facility is located.

29.2.2 Electrical installations shall comply with the requirements of AS/NZS 3000 and applicable Industry Regulator requirements and the local Network Service Provider’s requirements such as the Service and Installation Rules or equivalent.

29.2.3 All materials and workmanship shall be of the best standard and shall comply with relevant legislation and Australian Standards. In addition, electrical installations and equipment shall comply with all appropriate and relevant Australian standards, for the type of installation or equipment to be used, irrespective of their status. Where Australian standards are not available, recognised international or overseas national standards shall be used where they are relevant to the type of installation or equipment and to the installation conditions in Australia.

29.2.4 Unless stated otherwise by these documents, the maintenance as a whole shall comply with the following reference publications detailed in Chapters 1.8 and 1.9.

29.3 Defence Requirements

29.3.1 Infrastructure Management: The Defence Infrastructure Management (IM) promulgates policy and procedures for the management of the Defence estate, including the procurement of capital facilities. The IM is the prime reference document for all Infrastructure procedures and requirements. The provisions of the IM are mandatory.

29.4 Technical References

29.4.1 The IEC standards identified in Chapter 0 define AGL maintenance regimes and are referenced as a guide only. The absolute adoption of these standards is not possible because the maintenance organisation model is not suited to Defence AGL installations.

29.5 Conflicts Between Regulations and Standards

29.5.1 Clarification, if necessary, of the application of any of the above standards must be sought from DEEP. Additionally, where a statutory standard conflicts with a Defence standard or this requirement, the matter must be referred to DSRG-DEEP for resolution.
30. Maintenance of the AGL System

30.1 Airfield Ground Lighting (AGL) System

30.1.1 The AGL system consists of the luminaires, field equipment and the ALER as detailed in this manual. This includes the beacon, sequential and steady approach, PAPI, runway, taxiway and apron lighting, primary and secondary cabling, SITs, cable pits, cable ducts, and the ALER equipment such as Constant Current Regulators (CCRs), control system and power supply equipment.

30.1.2 The items covered by separate maintenance requirements and not included in these procedures are the control tower equipment (i.e. beyond the marshalling panel), the Local Emergency Generators (LEG), the control and monitoring system cabling, obstacle lighting (where these are associated with a respective building and are not part of AGL system) and floodlighting.

30.2 Extent of Maintenance Requirement

30.2.1 The AGLMA shall manage all maintenance activities and appoint appropriate personnel to manage, supervise and undertake the specific maintenance tasks.

30.2.2 Maintenance of the AGL system includes, but is not limited to:
   a) Preventative maintenance of the AGL system in accordance with this manual;
   b) Breakdown maintenance of the AGL system in accordance with the AGL maintenance contract;
   c) Holding the defined schedule of spare parts in good condition and keeping an inventory of available spares;
   d) Manually operate the AGL system when required;
   e) Operate and configure the Base AGL system in the event of an equipment failure in order to restore AGL;
   f) Switch, isolate and earth the AGL system to allow safe access for all persons requiring access, such as maintenance personnel, Defence personnel and contractors including the setting out of temporary lighting systems and markings;
   g) Accept, take into service and maintain newly commissioned AGL equipment;
   h) Monitor and record system performance information; and
   i) Documentation and reporting in accordance with this manual.

30.3 Preventative Maintenance Schedules

30.3.1 The AGLMA shall implement the routine preventative maintenance schedule and associated procedures as detailed in Appendix C. The AGLMA shall monitor the condition of the AGL system and make suitable recommendations to DEEP through the Regional Manager for any necessary improvements to assure the condition of the AGL and also when required to optimise maintenance.

30.4 Maintenance System Procedures

30.4.1 The AGLMA shall develop and maintain suitable maintenance procedures that instruct on the correct and safe method of maintenance for each activity that is to be undertaken on the AGL system. The maintenance procedures shall be contained in a suitable document (e.g. AGL Maintenance Plan) and shall be provided and used at all times. A copy of the procedures shall be made available to Defence on request.

30.4.2 The AGLMA shall determine which activities require authorisation, who is able to give such authorisation and how the authorisation, including written permission, is to be obtained. See also Chapter 30.5 regarding issue of permits/sanctions.

30.4.3 The AGLMA must perform suitable risk/hazard assessments (refer Chapter 30.7) for all work to be performed on AGL constant current series circuits. The completed risk/hazard assessments shall be used to form the maintenance procedures and must be retained by the AGLMA and be made available on request.
Pre-work Procedures

30.4.4 The following procedures shall be carried out prior to any work commencing:

a Where necessary, permission to commence work shall be obtained from the 44 Wing Detachment Commander with the issue of suitable authorisation;

b A pre-work visual inspection shall be carried out prior to commencing work in order to;
   i Locate and identify equipment, including safety devices;
   ii Locate applicable documentation;
   iii Locate tools, test and safety equipment;
   iv Identify any potential hazards;

c Permanent and temporary earth connections shall be checked and applied where necessary (noting that for testing purposes an earth may be temporarily removed);

d Where necessary, safety signs shall be placed in the correct position;

e Where necessary the equipment or circuit to be worked on shall be electrically isolated by the following procedure;
   i The relevant AGL electrical equipment shall be positively identified;
   ii The remote control of AGL equipment shall be disabled;
   iii The input power to all relevant CCRs shall be removed and secured. An appropriate method of preventing the re-energising of circuits or equipment that is under maintenance shall be incorporated. To secure against re-connection of power the operating mechanism shall be either lockable, or be in a secure area (Note: the use of a safety key or mechanical interlock system may be considered an effective method of preventing unauthorised re-energisation of equipment);
   iv The primary series circuit shall be disconnected from the CCR output terminals. The conductors at the open ends of the primary series circuit shall be shorted together and earthed;
   v All applicable equipment shall be proved dead by using appropriate current and voltage test equipment. The test equipment shall be proved operative before and after the test;
   vi Isolators shall be securely locked in an electrically isolated and earthed condition.

Completion of Work

30.4.5 A post-work inspection shall be carried out on the completion of any work and prior to returning the equipment to operational service in order to verify that:

a The equipment, including the operation of system interlocks, has been tested for correct operation, is fully serviceable and in an operational state;

b The remote control of AGL equipment has been restored;

c All relevant organisations and persons have been informed of the re-energisation and serviceability of the equipment;

d All the maintenance activities and any changes to the AGL are recorded in the appropriate documentation and the documentation is stored in the appropriate location;

e Safety signs have been removed;

f All test and safety equipment are serviceable and returned to their correct storage location;

g Earth connections are removed or re-installed as appropriate, equipment covers and safety devices are re-installed;

h The area is clean and tidy and clear of all non-essential equipment and potential Foreign Object Debris (FOD) hazards.

30.4.6 If applicable, any relevant work authorisation issued shall be cancelled and the equipment shall only be re-connected and re-energised on the satisfaction and instruction of the person appointed by the AGL Maintenance Manager, AGLMM, to be responsible for the work.

Safety Requirements and Procedures

30.4.7 The AGLMA shall detail and enforce appropriate measures to ensure operational safety, safety to aircraft and the safety to personnel engaged in maintenance activities on or near AGL constant current series circuits and equipment.
30.4.8 In addition to the requirements of Commonwealth, State and Territory legislation and regulations the AGLMA shall develop and implement the procedures in accordance with this manual.

30.4.9 The AGLMA shall perform a risk assessment of all work to be performed on the AGL asset (refer Chapter 30.7). A risk assessment shall include the determination of the required manning levels to complete the work safely. Care should be taken to ensure that maintenance equipment and other materials do not present a hazard to aircraft. The completed risk assessments shall be contained in a suitable document and retained by the AGLMA and be available for Defence review. The risk assessments shall be reviewed and updated regularly or whenever necessary, particularly after a hazardous event.

30.4.10 Safety work procedures shall be developed by the AGLMA that take into account the completed risk assessments for the work and shall address the following requirements:

a. AGL Equipment is exposed to weather and moisture and may develop electrical shock hazards through damage from lightning or insulation deterioration from exposure;

b. Work shall not be performed on live electrical conductors or equipment, except where suitable risk assessment has been undertaken and special procedures implemented to prevent harm;

c. Authorisation to perform work or testing on the AGL electrical equipment shall be obtained prior to that work commencing and that authorisation shall remain valid for the duration of the work. Routine work such as inspection and minor maintenance can be covered by suitable blanket authorisation and risk assessment;

d. Power shall always be assumed to be on and electrical equipment live until the true condition is determined;

e. Unless determined safe to do so by risk assessment, at least two persons shall be assigned to carry out maintenance work on AGL electrical equipment. Refer AS4836 for guidance on the use of safety observers;

f. Maintenance procedures shall only begin after a visual inspection has been made and possible hazards have been identified, evaluated in a risk assessment and recorded, refer AS4836;

g. Equipment shall not be returned to operational service without verifying that it is functioning correctly and that all the maintenance activities have been satisfactorily complete;

h. Specific safety training for personnel;

i. Safety protection devices. Deliberate disconnection of safety protection devices shall only occur when authorised in accordance with specific safety instructions;

j. Use of appropriate Personal Protective Equipment (PPE), safety equipment, safety signs and instructions;

k. Availability of earth terminals and other safety facilities;

l. All tools and equipment shall be appropriate for the task; and

m. All tools, test equipment and safety equipment shall be periodically inspected and tested in accordance with appropriate Australian standards and have suitable certificate of currency.

Live Working

30.4.11 No work of any kind shall be performed on live AGL constant current series circuits unless a risk assessment has been undertaken and suitable procedures prepared that have been assessed by the AGLMM as safe. In this case, all practical precautions to prevent harm shall be taken. Fault finding or testing on live electrical equipment shall only be undertaken when it is unavoidable for the equipment to be made dead. Any subsequent repair shall not be performed on live equipment.

30.4.12 Cables shall be positively identified, isolated and proved dead before cutting or disconnection. Whenever practical, cables that are no longer in use shall be positively identified, proven dead using appropriate current and voltage test equipment and removed. The test equipment shall be verified before and after the test. Cables that cannot be removed immediately shall be appropriately marked at both ends and at any point of access. The ends of the conductors shall, where possible, be shorted together and earthed.

Securing the Work Area

Safety Checks

30.4.13 Equipment covers shall be replaced and doors closed whenever equipment is left unattended. If equipment door locks are provided they shall be left locked with keys made available for authorised use.
Any electrical equipment in the vicinity of the work in progress that cannot be made dead shall be identified and appropriate precautions shall be taken to prevent any additional hazard.

**Safety Protection Devices**

30.4.14 Fault diagnosis may require defeating interlocks or the removal of covers to give access to live equipment. On such occasions testing shall be limited to the use of appropriate test equipment and shall follow a formalised procedure. This procedure may include a written checklist, agreed routines or any other precautions deemed necessary to maintain safety. Where interlocks have been defeated or covers removed for test purposes, the interlocks shall be re-instated and covers replaced at the earliest opportunity. The safety protection devices shall be re-set, tested and verified as operating correctly before the equipment is returned to operational service.

**Safety Signs**

30.4.15 The working area shall be screened off by suitable barriers and indicated by appropriate signs. Caution signs shall be affixed to all switchgear controlling the equipment which has been made dead and on which work is progressing. Hazard signs shall also be attached on, or adjacent to, live equipment and at the limits of the area in which work may be carried out. In all cases a safety or job tag shall be securely attached at the point of isolation giving the name of the person who carried out the isolation procedure, essential contact telephone number(s) and date and time of isolation. If any test equipment or equipment under test cannot be placed within the screened area it shall be separately screened. Any safety signs that are not in use shall be stored in the appropriate place. A sign or placard, giving details of emergency resuscitation in the event of electric shock and first aid, shall be displayed in AGL indoor work areas where persons may be at risk of electric shock.

**Earthing Facilities**

30.4.16 Earth connections shall be installed and maintained in conformance with the original installation requirements. Earth connections, including devices for providing the temporary connection of an earth, shall be tested and the measurement recorded on a regular basis.

30.4.17 NOTE This test should take into account seasonal variations in the soil and should be performed on a nine-month cycle.

**Proving Circuit is Dead**

30.4.18 Where necessary appropriate measures shall be taken to assure that the circuit on which work is to be performed is dead. The circuit should be earthed during the time taken to do the work.

30.4.19 NOTE: A constant current series circuit may be live even when no voltage is detected at the test point through induction.

**Environmental Factors**

30.4.20 Equipment that is normally covered but has to be exposed as a necessary result of the maintenance activities shall be protected from water and other undesirable elements. Work in exposed areas shall take account of adverse weather conditions, flora and fauna. No work on an AGL constant current series circuit shall take place in the presence of lightning.

**Tools and Test Equipment**

30.4.21 Appropriate tools and test equipment shall be used at all times. All test equipment shall be calibrated and be in good working order.

**Safety Equipment**

30.4.22 Safety equipment shall be provided, worn and used wherever necessary. Adequate training in the use, safekeeping and inspection of safety equipment shall be given to the user. Before and after each occasion of use, the user shall inspect safety equipment for visible defects and any suspect item shall be withdrawn and replaced. Periodic inspections shall be recorded in a suitable document.

**30.5 Permits**

30.5.1 A maintenance permit system is intended to control hazardous activities and to ensure that every care is taken to provide and maintain a safe working environment.

30.5.2 Not all work will require the isolation of electrical circuits or live testing and may be undertaken under the authority of an authorised person and in accordance with a standing instruction. A standing instruction would, typically, consist of a written authority:

a Issued by the AGLMM;

b Be valid for a specified period of not more than 12 months; and
c Be accompanied by a detailed procedure, which includes coordination with operational requirements (i.e. 44 Wing Detachment Commander).

30.5.3 However, where specific work on live circuits or in potentially hazardous situations is to be undertaken, a safe work system such as the issuance of permits shall be employed. Permits shall outline the safety procedures and ensure that they are carried out and that risk is minimised.

30.5.4 Permits shall be issued for the disconnection and isolation of live circuits, electrical distribution works and live testing (a sanction to test) and shall be issued only by the AGLMM. (See proforma in Appendix)

30.5.5 The AGLMM shall determine which activities require the issue of a permit and the procedure to issue it, for example:

a A permit to work/sanction to test shall be issued before any work is undertaken on an AGL constant current series circuit. Note that the permit to work and the sanction to test may be on different forms;

b Only the AGLMM shall issue a permit to work/sanction to test;

c A permit to work/sanction to test shall be issued to the prospective person-in-charge of the work/test who, after reading its contents and agreeing to them, shall sign a receipt and a duplicate;

d The person in charge of the work/test should retain the permit to work/sanction to test in their position at all times whilst work is carried out. The AGLMM retains that duplicate copy;

e The AGLMM shall cancel the permit to work/sanction to test before the equipment is made live;

f A permit to work/sanction to test may be suspended. The suspension is initiated on the signature of the person-in-charge of the work/test and the authorised person. The suspension shall only be cancelled on the signatures of both the AGLMM and the person-in-charge of the work/test; and

g Records of all permits to work/sanction to tests that are issued shall be recorded in appropriate documentation. A record of ongoing, suspended and cancelled permits/sanctions shall be kept in the same document. Records shall include:

i The serial number, date and time of issue of the permit to work/sanction to test;

ii The name of the person the permit/sanction is issued to (the person-in-charge of work/test) and any team members;

iii The name of the authorised (issuing) person and

iv Date and time of suspension/re-instatement or cancellation (as applicable).

Procedures for 3rd Party Access and Isolation

30.5.6 The AGLMA shall document and enforce suitable access, isolation and acceptance procedures to ensure electrical isolation and safe hand over when dealing with 3rd parties that may require access to the AGL system.

30.5.7 Wherever possible the procedures shall be displayed at the worksite for reference by personnel and at the ALER.

30.5.8 These procedures shall cover:

a Notification of intended works to relevant authorities (44 Wing Detachment Commander, Regional Manager);

b Suitable system of authorisation including all required checks;

c Competencies required by the 3rd party before any works commence including designation of responsible person for the works and all members of the work party (name and contact);

d Suitable safety and PPE requirements;

e Procedures for the issuing and cancellation of permits;

f Use of suitable tags and procedure for their use/display; and

g Procedures for checking completed works and restoration/notification requirements.

Fault Reporting Procedures

30.5.9 Regular fortnightly AGL visual and functional inspections shall be made by the AGLMP to determine the operational status. Deficiencies found during these inspections that are not corrected immediately shall be recorded identifying the disposition and timing of rectification.
30.5.10 The 44 Wing Detachment Commander and Rescue and Fire Fighting Service (RFFS) may carry out independent inspections and faults may also be reported to the ATC Tower by aircraft using the system. Any deficiencies shall be reported by telephone to the Help Desk (operated by the AGLMA) where a W/O will be raised.

30.5.11 Faults reported to the Help Desk by 44 Wing Detachment Commander or RFFS are always actioned accordingly.

30.5.12 The objective of the maintenance program shall be to limit 44 Wing Detachment Commander/RFFS initiated W/Os to a minimum.

30.5.13 A flow chart summarising the fault reporting procedure is included in Appendix H.

30.6 Significant Works – Requirement for MOWP and Works Safety Officers (WSOs)

30.6.1 All works are to comply with the procedures stipulated in Section 10.10 of the MOS Part 139. For extensive maintenance or project work the AGLMA shall assess the need for NOTAM and Works Safety Officers. Guidance on their application is given in MOS Part 139 Section 10.10. Issues to consider include:

a Local procedures for the preparation and authorisation of a suitable MOWP including:
   i Identifying the person/position responsible for writing and authorising the MOWP;
   ii Identifying areas affected and staging of works;
   iii Distribution of the MOWP;
   iv The arrangements for communicating with ATC and aircraft during the carrying out of the works;

b The arrangements for carrying out time-limited works;

c Arrangements for providing and setting out temporary visual aids for works; and

d Where Works Safety Officers (WSO) will be required, arrangements for providing suitably trained WSO for aerodrome work.

30.7 Operations and Maintenance Risk/Hazard Assessment Requirements

30.7.1 The AGLMA shall perform a risk/hazard analysis in accordance with AS/NZS 4360 to identify the safety requirements for the AGL system and shall consider the following aspects:

a Mandatory safety requirements (State and Local);

b Conformance to all design and manufacturing standards;

c Test procedures for hazards and failure modes that can only be performed in the factory or by simulation; and

d Each failure mode that may cause a hazardous event.

30.7.2 Since the AGL is to be used by aircraft and vehicles and operated by a person(s) with defined responsibilities at the aerodrome, there are several generic hazards associated with the AGL system, including

a The display of an incorrect or misleading pattern, including colours;

b An unexpected or unintended change in luminous intensity from maximum to minimum or vice versa; and

b An unintended activation or deactivation of the AGL, especially AGL associated with a runway.

30.7.3 Risks and hazards apply to the entire AGL system. Other hazards may exist that depend upon the type of control system, the technology employed and its complexity. These generic hazards relate to the operational requirements of the safe movement of aircraft and vehicles at the aerodrome. They should be assessed in the risk/hazard analysis within the context of the operations at the aerodrome and safety requirements for the AGL system should be derived.

30.7.4 Safety assessment techniques, including availability, reliability and redundancy calculations, shall be employed in order to ensure that the allocation of system safety requirements has not degraded the required overall level of safety.

30.7.5 Mitigation by alternative means shall be determined where any safety requirements cannot be met by the system design and operation as installed.
31. AGL Maintenance Agent Personnel and Equipment

31.1 AGL Maintenance Manager

31.1.1 The AGLMA shall appoint, in writing, an AGL Maintenance Manager (AGLMM) as the central point of contact for all AGL maintenance activities. The AGLMM will report directly to the Regional Manager and 44 Wing Detachment Commander or their representatives. The main role of the AGLMM is to ensure AGL maintenance procedures are correctly applied and implemented for all AGL maintenance activities. The AGLMM is to:

a. Implement, administer, monitor and audit the application of AGL maintenance rules and procedures; including issue of maintenance permits;
b. Provide in-depth experience and professional support to the AGLMA, Regional Manager and 44 Wing Detachment Commander;
c. Nominate and re-nominate sufficient authorised maintenance persons to provide the necessary cover for the AGL installation(s);
d. Ensure that the prospective authorised maintenance persons have appropriate qualifications and training, are familiar with the aerodrome and are able to demonstrate adequate knowledge of each system, installation and type of equipment for which authorisation is envisaged;
e. Issue each authorised maintenance person, on appointment or re-appointment, a certificate of appointment as an authorised maintenance person for a pre-determined period;
f. Define in writing, using drawings and diagrams as appropriate, the exact extent of the AGL installations for which each authorised maintenance person is responsible, keeping appropriate records for the aerodrome;
g. Maintain a register of all authorised maintenance person and their areas of responsibility. The register is to include details of the persons with whom the authorised maintenance persons are to communicate and co-operate;
h. Audit the performance and record the operational experience of each authorised maintenance person at regular intervals. The audits are to pay particular attention to the operating and permit systems records;
i. Suspend, if considered necessary, the appointment of an authorised maintenance person and withdraw the certificate of appointment;
j. Investigate all reported hazardous events involving electrical systems and installations within the area of appointment;
k. Act as a focal point for health and safety information and other guidance material;
l. Co-operate and co-ordinate with the Regional Manager and 44 Wing Detachment Commander for the release of equipment for maintenance works and if necessary, access to operational areas;
m. Inspect any protective equipment for satisfactory and safe operation;
n. Inform authorised maintenance persons of any defects in equipment or hazardous events, conditions or practices; and
o. Supervise or undertake electrical isolation, cable detection or location work as required.

31.2 AGL Maintenance Personnel and Contractors

31.2.1 Authorised AGL Maintenance Personnel (AGLMP):

a. Must be authorised by the AGLMM;
b. Undertake work in a safe manner in accordance with the approved AGL maintenance rules and procedures;
c. Be aware of the extent and limits of the work to be undertaken and of any constraints on the sequence or method of working;
d. Be able to demonstrate competence to perform the required work activities and take reasonable care of their own and other people’s health and safety;
e. Work only on, or test, equipment that is listed on his/her certificate of appointment;
f  Be familiar with the types of installation and equipment that they are required to work on, or test; and

g  Have an adequate knowledge of emergency first aid, rescue and resuscitation.

31.3  Manning Levels

31.3.1 Unless determined safe to do so (refer to 0), a person shall not work on AGL electrical equipment unaccompanied.

31.4  Competency

31.4.1 All persons involved in the maintenance activities, shall have appropriate and verifiable training, technical knowledge, experience and qualifications relevant to the specific duties they have to perform. In particular, where involved in work on constant current series circuits, they shall be knowledgeable of the specific risks and the safety procedures involved in the work. The training, experience and qualifications of all persons involved in any activity shall be justified taking into account all relevant competencies. The justification shall be recorded in appropriate documentation and must be made available on request to Defence.

31.4.2 The following competencies are required as a minimum for all personnel:

a  The Basic and Advanced AGL course;

b  Radio Telephony Certificate of Competency (required for airside communications with Control Tower);

c  Airside driving course applicable to the Base;

d  The following additional competencies are required for Electrical Workers:

i  Electrical Trade Persons are required to hold a current Electrical Workers License; only these qualified individuals shall undertake electrical works on the AGL. Competent persons may be permitted to undertake simple works, such as lamp changing, provided the system is de-energised and made safe for such works by qualified persons; and

ii  Where AGLMP are required to work on Constant Current Regulators, suitable CCR course must also be attained.

31.5  Test Equipment, Tools and Calibration

31.5.1 It is a requirement that the AGLMA shall have available to them suitable test and ancillary equipment and tools for maintenance of the AGL system. Electrical test equipment suitable for the measurement of DC, AC and high-energy circuits, as a minimum must include the following:

a  Current meter(s), true RMS with a measurement capability suitable to assess input and output current of CCRs;

b  Voltage meter(s), with a measurement capability of 5000V;

c  Insulation Resistance tester (Megger) with an output capability of 5000V. The unit shall have the capability for timing of the measurement (usual measurement time is minimum 1 minute) and a minimum measurement capability of 0.01 nA. Accuracy shall be +/- 5%; and

d  Test equipment shall be regularly inspected and calibrated for accuracy and there shall be sufficient documentation held by the AGLMA to demonstrate currency of all equipment.

31.5.2 Ancillary equipment and tools shall include, but not be limited to:

a  A vehicle (either van or trailer) suitable for airside manoeuvring and holding all required spares and tools;

b  Yellow hazard light fitted to the vehicle;

c  VHF transceiver suitable for aviation band communications (fixed or hand held);

d  Air compressor;

e  Vacuum cleaner with wet/dry capability;

f  230V AC generator (for AC powered equipment such as soldering iron, vacuum cleaner, air compressor etc);

g  Heat gun (gas or electric) with changeable heat setting for primary and secondary cable jointing;

h  Circumferential crimp tool (non indentation), suitable for primary cable joint ferrules;
31.5.3 Note that Defence may make special tools available. These may have been procured as part of the original equipment installation and shall remain the property of Defence. A schedule of such equipment made available shall be maintained and audited and may include:

- PAPI aiming tool (clinometer);
- HIRL levelling/aiming tool;
- HIAL levelling/aiming tool; and
- HV megger.

31.6 Personal Protection Equipment (PPE)

31.6.1 Employers have a duty of care obligation to ensure the health, safety and welfare of their employees and others at their workplace.

31.6.2 PPE is safety clothing and equipment for specified circumstances or areas, where the nature of the work involved or the conditions under which people are working, requires its wearing or use for their personal protection to minimise risk.

31.6.3 The AGLMA has an obligation to meet the WHS requirements for PPE, which includes:

- Reflective vests (Hi-Vis) suitable for day and night works;
- Non-synthetic protective clothing to AS 2919 (not less than 185 gsm cotton drill with coverage to neck, wrist and ankle, as appropriate);
- Ear and/or face protection to AS/NZS 1336:1997 and/or AS/NZS 1337:1992;
- Suitable footwear to AS/NZS 2210.1:1994;
- Insulating gloves to AS225:1994 (with appropriate voltage class rating), and
- Isolating mats as required.
32. Documentation and Reporting

32.1 Notification

32.1.1 The AGLMA shall make arrangements with the 44 Wing Detachment Commander prior to undertaking any maintenance and shall obtain the necessary clearances from the appropriate duty Air Traffic Control (ATC) staff before working on any AGL facility.

32.1.2 The AGLMA shall understand and observe the regulations concerning the movement of vehicles, machinery and personnel on aerodrome operating areas.

32.1.3 The AGLMA shall fully co-operate with the ATC staff and keep them informed on all matters relating to the reliability and availability of the AGL system. The Maintenance Agent shall notify the 44 Wing Detachment Commander or duty ATC staff of the need, and obtain prior approval to disconnect or disrupt any AGL facility.

32.1.4 The AGLMA shall immediately notify the Regional Manager and the 44 Wing Detachment Commander where required, of any AGL equipment which is found to be unserviceable or unsafe.

32.1.5 The AGLMA shall establish a procedure whereby faults, or deficiencies likely to cause faults, are promptly reported back to the Regional Manager.

32.1.6 The AGLMA is also required to forward to the Regional Manager and DEEP any suggestions or recommendations that may improve the maintenance procedures for the AGL system.

32.2 Records and documentation

32.2.1 The AGLMA is required to fulfil all documentation and reporting requirements outlined in this manual and also any additional reporting required by the AGL maintenance contract and standards or legislation. The documentation and reporting required by this manual includes:

Documentation

a AGL Maintenance Plan incorporating work procedures, safety plans, risk assessments, authorisation and permits (refer Chapter 32.3 AGL Maintenance Plan);
b Maintenance Diary/ALER Log Book;
c Maintenance Records and Data;
d Spares inventory and usage; and

e System Documentation such as as-constructed information and software management.

Reports

f Six Monthly AGL Certification Report
g Reporting as required of system deficiencies and defects.

32.2.2 In addition to the above, the AGLMA is required to input as required into other documentation such as the Aerodrome Emergency Plan.

32.3 AGL Maintenance Plan

32.3.1 The AGLMA shall prepare an AGL maintenance plan, which shall specify:

a The results of a hazard analysis performed in order to determine the routine actions;
b Safety requirements which need to be carried out to maintain the “as designed” safety of the AGL system and its operational use;
c The actions and constraints that are necessary to prevent an unsafe state or to reduce the likelihood of an accident;
d The records that need to be maintained;
e The scope of the maintenance activities, including safety requirements;
f The actions to be taken in the event of hazards occurring;
g Those responsible for the operation and maintenance of the AGL system;
h Maintenance system procedures, including maintenance safety procedures and the maintaining of records;

i Maintenance schedules and associated procedures; and

j Audits in order to ensure that safety is maintained.

32.4 Maintenance Diary/Logbook

32.4.1 The AGLMA shall keep adequate records in an AGL maintenance diary; all activities and work carried out on the AGL asset shall be recorded in a suitable log or other form of documentation. The purpose of the diary is to provide a true indication of the AGL equipment performance and reliability. Each entry shall be identified by a reference that allows traceability of all coherent activities that have taken place. It is therefore essential that accurate entries are made in the diary in sufficient detail to record the activity. The entries shall record the following:

a The activity that has taken place;

b The results of any measurements or tests that have been performed;

c Details of any repair or corrective action;

d Details of any work that has been carried over to another task;

e The date and time of the activity;

f The name of the persons who carried out the activity; and

g The parts replaced.

32.4.2 The AGLMA shall not only fulfill the basic requirements for diary reporting, but shall also comment on the causes and effects of any irregularities.

32.4.3 Where the maintenance task has not been complete at the end of each working day, the diary shall show the progress reached at that stage.

32.4.4 The AGLMA shall keep the AGL Maintenance Diary and copies of the as-constructed drawings in the ALER. All documents remain the property of Defence.

32.4.5 The Maintenance Diary/ALER Logbook must be in suitable paper format (bound book, not loose leaf pages) and a sample pro forma is provided at Appendix C. Also, an electronic copy of the diary shall be captured and provided on DEMS or other system as required by the Regional Manager. This electronic copy shall be allocated a suitable identifier for incorporation into DEMS.

Fault Recording

32.4.6 All faults shall be recorded in the Maintenance Diary by the AGLMA together with the cause of the fault and the corrective actions.

32.5 Spares Inventory

32.5.1 The AGLMA is to maintain an accurate spares inventory for the AGL system, including usage. Where appropriate the spares inventory is to identify Defence owned spares separately.

32.6 System Documentation Management

32.6.1 The AGLMA is responsible for managing the AGL system information such as the as-constructed information, operating and maintenance manuals and software management. The AGLMA shall accept and maintain the system configuration documentation to ensure the safe operation and maintenance of the system and that the information is an accurate representation of the installed AGL equipment.

32.6.2 The following documentation shall be maintained and made available at all times in the ALER:

a Complete set of “as-constructed” drawings, size A1 where applicable;

b Set of printed Operation and Maintenance Manuals. Also copies of same on CD-ROM;

c Copy of the AGLCM;

d Contact list of AGL personnel (Operator/Maintainer/Stakeholder);

e AGL Layout Drawing. This is to be laminated, size A1 and mounted on a suitable wall; and

f Copy of all software (on CD-ROM) and set of instructions for data recovery.
32.7 Software Management

32.7.1 All software utilised by the AGL control system shall be maintained in a manner that keeps the software in a readable and recoverable form. Backup copies shall be separate to the ALER.

32.7.2 Software management responsibilities include:
   a. Maintaining printed copies of the latest version of software code;
   b. Maintaining and archiving CD-ROM backup copies;
   c. Procedures for restoring data;
   d. Procedures for data recovery in the event of hardware failure;
   e. A register of hardware required to run and operate the software; and
   f. Software management is a requirement of contract compliance and will be audited.

32.8 AGL Certification Report

32.8.1 The AGLMA is to provide an AGL Certification Report to the Regional Manager, DESTR Technical Advisor - Air and DEEP on a six-monthly basis. The report is to certify that the AGL system is being maintained to the requirements of this manual. It also identifies the maintenance performed and provides system performance information such as inspection and test results, faults, spares usage and a copy of the Maintenance Diary/ALER logbook for the reporting period. The report is also to identify any issues with the AGL system and all unserviceability’s so that appropriate management action can be initiated as appropriate. The AGL Certification Report template is provided in Appendix F.

32.9 Other Reports

32.9.1 Other reporting as required on deficiencies, defects or potential maintenance issues. This reporting also includes identifying any necessary or recommended changes to the AGLCM.

32.10 Records and Maintenance Data Management

32.10.1 The AGLMA shall keep true and accurate records of the inspections and testing undertaken on the AGL system. All details are to be suitably recorded on Defence Estate Management System (DEMS) or other suitable arrangements agreed by the Regional Manager or his representative.

32.10.2 DEMS is also to be used to store and access electronic copies of manuals and documentation, both the latest issues and historic copies. AGL information, such as the “as installed” drawings, manufacturer’s manuals and copies of AGL maintenance records are to be made available via DEMS.

Record and Data Deficiencies

32.10.3 Deficiencies found in the gathering, recording or keeping of records or maintenance data shall be reported by the AGLMA to the Regional Manager and DEEP. Corrections shall be made and DEMS updated at suitable intervals.
33. Handover and Takeover

33.1.1 The Regional Manager must ensure continuity is maintained between an outgoing and an incoming maintenance agent. It is important that appropriate procedures be implemented and guidance is provided below.

33.2 Transfer of Maintenance Records and AGL System Data

33.2.1 Maintenance Records and AGL System Data records maintained by the AGLMA shall be made available and transferred to a new AGLMA in a manner such that the historical records of the AGL asset condition, faults and deficiencies, corrective action, etc are available and accessible. This will allow the ongoing effective and efficient maintenance of the asset and maximise its operational availability.

33.3 Transfer of Defence Spares

33.3.1 Defence owned spares (in the quantity as scheduled in the minimum spares holding register) shall be provided to and received by the incoming AGLMA. Certification of receipt of the minimum spares holding shall be provided by the incoming AGLMA who has the ongoing responsibility of maintaining the inventory.

33.4 Transfer of Defence AGL Tools and Test Equipment

33.4.1 Defence owned AGL Tools and Test Equipment (in the quantity as scheduled in the register) shall be provided to and received by the incoming AGLMA. The outgoing AGLMA is responsible for providing calibration certificates of equipment to ensure that the equipment is in good condition. Certification of receipt of the AGL Tools and Test Equipment in working order shall be provided by the incoming AGLMA who has the ongoing responsibility of maintaining the equipment in good condition.

33.5 Acceptance of New AGL Assets

33.5.1 Where the existing AGL asset is redeveloped or augmented by project works delivered by other parties including DSRG-IAD or DSRG-NOD, then agreement is required as to when the routine preventative and breakdown maintenance of the asset becomes the responsibility of the AGLMA.

33.5.2 From the time that the AGL asset is available for use in service, and Practical Completion is issued to the installing contractor with the asset transferred to the local DSRG, it is likely that the routine preventative maintenance will become the responsibility of the AGLMA. To facilitate this responsibility it is vital that the necessary training and documentation has been provided to the AGLMA.

33.5.3 Typically the installing contractor will have a responsibility to rectify defects during a defects liability period; however there may be occasions when urgent repairs need to be undertaken to restore the operation of the AGL that may otherwise constitute rectification of a defect. A procedure or arrangement for this contingency is required that will allow the AGLMA to respond in such an event and recover their costs associated with such action.
Part 6 - Appendices
1. Design Considerations

1.1 The Defence electrical design considerations are list of items that must be demonstrated in the design report at each stage (CDR, SDR, DDR and FDR). The list is not to be considered exhaustive but forms a basic checklist of items requiring consideration during the design phase (refer Design Considerations).

1.1.2 The designer shall ensure that, in addition to demonstrating in the design report that the design has met all applicable requirements, that all elements of the checklists below have been adequately addressed and documented in the design report.

1.2 General Considerations

1.2.1 General design considerations include the following:
   a) Determination of existing AGL systems for their augmentation or replacement;
   b) Determination of the future master planned pavement development and associated AGL requirements;
   c) Consideration of whether the final design is the most appropriate cost-effective solution that meets all the relevant requirements;
   d) Confirmation of the standards and codes applied including the extent and field of application;
   e) Verify the installation design complies with all relevant legislation and standards;
   f) Consideration of the use of compatible equipment including standardisation, supportability, and maintainability;
   g) Energy management and ESD implications;
   h) Checking that the installation complies with environmental legislation and that environmental control measures have been appropriately incorporated;
   i) Consideration of the maintenance requirements and the availability of the appropriate spare parts. Equipment selection shall be determined based on the required performance and the criteria for maintainability, reliability and the availability of comprehensive manufacturer’s product support locally;
   j) Determination of the required spares;
   k) Signage and labelling requirements;
   l) Training requirements;
   m) Impact to other loads or systems;
   n) Verification of the installation including inspection testing and commissioning;
   o) Documentation of the installation;
   p) Standardisation, maintainability and supportability; and
   q) Servicing and maintenance requirements incorporating adequate flexibility and versatility for these tasks.

1.3 Aeronautical Ground Lighting Design Considerations

1.3.1 Aeronautical Ground Lighting (AGL) design considerations include the following:
   a) Confirmation of the category and physical characteristics of the aerodrome including required clearances from obstacle limitation surfaces, clearances from navigational aids antenna and ground planes;
   b) Consideration of all configuration options to enable the selection of the most suitable solution on a cost effectiveness, reliability, and availability basis, particularly where redundancy is required in the circuiting configuration;
   c) Identify the characteristics of the load and the load profile;
   d) Identify the harmonics present and confirm LEG suitability for both harmonic performance and resonance;
   e) Failure modes and effects;
   f) Determining the aircraft characteristics or any special characteristics that need to be catered for;
   g) Maintenance and spares requirements;
   h) Monitoring of the system during operation including the interfacing requirements;
Appendix A - AGL Design & Construction Compliance Guide

i) Energy consumption and energy efficiency;
j) Transient and surge suppression that may be required;
k) Installation complies with Australian Standards, Defence Standards and service provider requirements; and
l) Verification, commissioning and testing of the installation including required flight testing and also proving equipment compliance (ensure the required detailed technical assessment of the tendered equipment).

1.4 Airfield Lighting Equipment Room Design Considerations

1.4.1 Airfield Lighting Equipment Room design considerations include the following:
a) Number of, built form (conventional, earth covered etc.) and location of the ALER Building including the reuse of existing buildings and locations as well as new buildings and locations;
b) Interface between the ALER and other facilities;
c) Availability of power, communications, hydraulic and access roadways;
d) Effect of the AGL on the mains and emergency power supplies. Implement measures to ensure compatibility;
e) Environmental requirements of the AGL system and the implementation of the appropriate measures when environmental conditions are outside of the normal operational range;
f) Fire protection and fire separation aspects of ALER Building systems to ensure system’s integrity, reliability and redundancy where required;
g) Interfacing requirements with other monitoring systems;
h) Servicing and maintenance requirements incorporating adequate flexibility and versatility for these tasks;
i) Ongoing reporting requirements including the requirement for energy management reports;
j) Determination of the system capacity and anticipated load profile;
k) Voltage regulation performance requirements;
l) Fire protection requirements;
m) Check the effect of the LEG on the normal and emergency supplies. Take measures to ensure compatibility is maintained;
n) Electromagnetic compatibility and the requirement to suppress electromagnetic radiation and radio frequency interference;
o) Transient/surge suppression is required;
p) Lightning protection requirements;
q) Earthing system requirements;
r) Documentation of the installation and the provision of suitable verification;
s) Identify the characteristics of the critical load;
t) Determine the required input supply capacity to allow for the AGL system losses and battery charging requirements for static systems. Allow to size switchgear and sub-mains to take into account these plus any de-rating due to the harmonic content;
u) Identify any critical air conditioning loads;
v) Determine maintenance and spares requirements;
w) Determine the system monitoring requirements. Identify associated ADATS interfacing requirements to monitoring and alarm systems; and
x) Determine the through life cost of the proposed solution. Where required, provide cost benefit analysis for options.
### 1.5 AGL Control System Design Considerations

1.5.1 AGL Control System design considerations include the following:

a) Type and choice of control system;

b) System design and application including location, arrangement and system performance;

c) Consideration of how the system will be monitored;

d) Control philosophy and user requirements;

e) Management of the control system and the ability to implement changes;

f) Identification of all failure scenarios and their consequences;

g) Recover strategies (e.g. on power failures);

h) Human Machine Interface: e.g. SCADA/PLC driven from personal computer;

i) Reporting including usage, energy consumption, faults and monitoring;

j) Consideration of what lightning protection is required including the transient and surge suppression requirements; and

k) Interfacing requirements with ADATS or other monitoring systems.
2. Design Phase MIE-AGL Compliance Report

2.1.1 The MIE-AGL compliance report comprises:
   a. MIE-AGL compliance statement;
   b. MIE-AGL compliance statement summary checklist; and
   c. Design Considerations checklist.

2.1.2 The contents of each are described below.

2.2 MIE-AGL Compliance Statement

2.2.1 This Compliance Statement shall confirm that:
   a. The design is in accordance with the Regulations and Standards and the requirements of the Manual of Infrastructure Engineering Electrical (MIEE) including the Manual of Infrastructure Engineering Aeronautical Ground Lighting (MIE-AGL); and
   b. The design report submission has met all the requirements of the MIEE and MIE-AGL.

2.2.2 The MIE-AGL Compliance Statement is to be completed by the Designer at each stage of the design reporting phase and attached to the relevant design report (CDR, SDR, DDR, and FDR). The MIE-AGL Compliance Statement shall be in the form of a minute as detailed below.
3. MIE-AGL Compliance Statement

<Insert project details>

<CDR/SDR/DDR/Final> Design Submission

Date: 

Prepared by: 

Reviewed by: 

Details of installation

Location: __________________________________________________________

Building: _________________________________________________________

Area: _____________________________________________________________

I/we being the person(s) responsible for the design of the installation, particulars of which are described later in this report, hereby certify that:

a) the design is in accordance with the Regulations and Standards and the requirements of the Manual of Infrastructure Engineering Electrical (MIEE) and the Manual of Infrastructure Engineering Aeronautical Ground Lighting (MIE-AGL) and

b) that the design report submission has met all the requirements of the MIEE and MIE-AGL.

Details of those items not in accordance with the above are listed in the compliance statement summary checklist attached.

Name of designer: ________________________________________________

Company: _________________________________________________________

Address: _________________________________________________________

Signature _________________________________________________________

Date _____________________________________________________________
4. MIE-AGL Compliance Statement Summary Checklist

The following checklists summarise key compliance elements that must be addressed by the Designer. Where an item is non-compliant, clarification must be provided.

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<tr>
<td>Pit and Duct System</td>
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<tr>
<td>AGL Cabling</td>
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<td>Series Isolating Transformers</td>
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<tr>
<td>Constant Current Regulators</td>
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<tr>
<td>CCR Control Cubicles/Boards</td>
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<tr>
<td>Airfield Lighting Equipment Room</td>
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<tr>
<td>ALER Location</td>
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<tr>
<td>ALER Design and Configuration</td>
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<tr>
<td>Power Supply</td>
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<td>Furniture and Auxiliary Equipment</td>
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<tr>
<td>Surge Diverter Cubicles</td>
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</table>
## Manual of Infrastructure Engineering Aeronautical Ground Lighting – Compliance Report Summary

<table>
<thead>
<tr>
<th>Field</th>
<th>Key Reference Standards</th>
<th>Comply (Y/N/NA)</th>
<th>Reference Clause</th>
<th>Comment/Clarification/Justification if no</th>
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<tbody>
<tr>
<td>AGL Control System</td>
<td>Control Modes</td>
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<td></td>
<td>Element Control</td>
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<td></td>
<td>Control Logic</td>
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<tr>
<td>Remote Control System</td>
<td>Interfaces</td>
<td></td>
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</tbody>
</table>
5. Design Considerations Checklist

All of the following elements below have been adequately addressed and documented in the design report:

<table>
<thead>
<tr>
<th>General</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Determination of existing AGL systems for their augmentation or replacement.</td>
<td></td>
</tr>
<tr>
<td>Determination of the future master planned pavement development and associated AGL requirements.</td>
<td></td>
</tr>
<tr>
<td>Consideration of whether the final design is the most appropriate cost-effective solution that meets all the relevant requirements.</td>
<td></td>
</tr>
<tr>
<td>Confirmation of the standards and codes applied including the extent and field of application.</td>
<td></td>
</tr>
<tr>
<td>Verify the installation design complies with all relevant legislation and standards.</td>
<td></td>
</tr>
<tr>
<td>Consideration of the use of compatible equipment including standardisation, supportability, and maintainability.</td>
<td></td>
</tr>
<tr>
<td>Energy management and ESD implications.</td>
<td></td>
</tr>
<tr>
<td>Checking that the installation complies with environmental legislation and that environmental control measures have been appropriately incorporated.</td>
<td></td>
</tr>
<tr>
<td>Consideration of the maintenance requirements and the availability of the appropriate spare parts. Equipment selection shall be determined based on the required performance and the criteria for maintainability, reliability and the availability of comprehensive manufacturer’s product support locally.</td>
<td></td>
</tr>
<tr>
<td>Determination of the required spares.</td>
<td></td>
</tr>
<tr>
<td>Signage and labelling requirements.</td>
<td></td>
</tr>
<tr>
<td>Training requirements.</td>
<td></td>
</tr>
<tr>
<td>Impact to other loads or systems;</td>
<td></td>
</tr>
<tr>
<td>Verification of the installation including inspection testing and commissioning.</td>
<td></td>
</tr>
<tr>
<td>Documentation of the installation.</td>
<td></td>
</tr>
<tr>
<td>Standardisation, maintainability and supportability.</td>
<td></td>
</tr>
<tr>
<td>Servicing and maintenance requirements incorporating adequate flexibility and versatility for these tasks.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aeronautical Ground Lighting Design</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmation of the category and physical characteristics of the aerodrome including required clearances from obstacle limitation surfaces, clearances from navigational aids antenna and ground planes.</td>
<td></td>
</tr>
<tr>
<td>Consideration of all configuration options to enable the selection of the most suitable solution on a cost effectiveness, reliability, and availability basis, particularly where redundancy is required in the circuiting configuration.</td>
<td></td>
</tr>
<tr>
<td>Identify the characteristics of the load and the load profile.</td>
<td></td>
</tr>
<tr>
<td>Identify the harmonics present and confirm LEG suitability for both harmonic performance and resonance.</td>
<td></td>
</tr>
<tr>
<td>Failure modes and effects.</td>
<td></td>
</tr>
<tr>
<td>Determining the aircraft characteristics or any special characteristics that need to be catered for.</td>
<td></td>
</tr>
<tr>
<td><strong>Appendix A - AGL Design &amp; Construction Compliance Guide</strong></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Maintenance and spares requirements.</td>
<td></td>
</tr>
<tr>
<td>Monitoring of the system during operation including the interfacing requirements.</td>
<td></td>
</tr>
<tr>
<td>Energy consumption and energy efficiency.</td>
<td></td>
</tr>
<tr>
<td>Transient and surge suppression that may be required.</td>
<td></td>
</tr>
<tr>
<td>Installation complies with Australian Standards, Defence Standards and service provider requirements.</td>
<td></td>
</tr>
<tr>
<td>Verification, commissioning and testing of the installation including required flight testing and also proving equipment compliance (ensure the required detailed technical assessment of the tendered equipment).</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Airfield Lighting Equipment Room Design</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of, built form (conventional, earth covered etc.) and location of the ALER Building including the reuse of existing buildings and locations as well as new buildings and locations.</td>
</tr>
<tr>
<td>Interface between the ALER and other facilities.</td>
</tr>
<tr>
<td>Availability of power, communications, hydraulic and access roadways.</td>
</tr>
<tr>
<td>Effect of the AGL on the mains and emergency power supplies. Implement measures to ensure compatibility.</td>
</tr>
<tr>
<td>Environmental requirements of the AGL system and the implementation of the appropriate measures when environmental conditions are outside of the normal operational range.</td>
</tr>
<tr>
<td>Fire protection and fire separation aspects of ALER Building systems to ensure system’s integrity, reliability and redundancy where required.</td>
</tr>
<tr>
<td>Interfacing requirements with other monitoring systems.</td>
</tr>
<tr>
<td>Servicing and maintenance requirements incorporating adequate flexibility and versatility for these tasks.</td>
</tr>
<tr>
<td>Ongoing reporting requirements including the requirement for energy management reports.</td>
</tr>
<tr>
<td>Determination of the system capacity and anticipated load profile.</td>
</tr>
<tr>
<td>Voltage regulation performance requirements.</td>
</tr>
<tr>
<td>Fire protection requirements.</td>
</tr>
<tr>
<td>Check the effect of the LEG on the normal and emergency supplies. Take measures to ensure compatibility is maintained.</td>
</tr>
<tr>
<td>Electromagnetic compatibility and the requirement to suppress electromagnetic radiation and radio frequency interference.</td>
</tr>
<tr>
<td>Transient/surge suppression is required.</td>
</tr>
<tr>
<td>Lightning protection requirements.</td>
</tr>
<tr>
<td>Earthing system requirements.</td>
</tr>
<tr>
<td>Documentation of the installation and the provision of suitable verification.</td>
</tr>
<tr>
<td>Identify the characteristics of the critical load.</td>
</tr>
<tr>
<td>Determine the required input supply capacity to allow for the AGL system losses and battery charging requirements for static systems. Allow to size switchgear and sub-mains to take into account these plus any de-rating due to the harmonic content.</td>
</tr>
<tr>
<td>Identify any critical air conditioning loads.</td>
</tr>
</tbody>
</table>
### Airfield Lighting Equipment Room Design

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine maintenance and spares requirements.</td>
<td></td>
</tr>
<tr>
<td>Determine the system monitoring requirements. Identify associated ADATS interfacing requirements to monitoring and alarm systems.</td>
<td></td>
</tr>
<tr>
<td>Determine the through life cost of the proposed solution. Where required, provide cost benefit analysis for options.</td>
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</tbody>
</table>

### AGL Control System Design

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and choice of control system.</td>
<td></td>
</tr>
<tr>
<td>System design and application including location, arrangement and system performance.</td>
<td></td>
</tr>
<tr>
<td>Consideration of how the system will be monitored.</td>
<td></td>
</tr>
<tr>
<td>Control philosophy and user requirements.</td>
<td></td>
</tr>
<tr>
<td>Management of the control system and the ability to implement changes.</td>
<td></td>
</tr>
<tr>
<td>Identification of all failure scenarios and their consequences.</td>
<td></td>
</tr>
<tr>
<td>Recover strategies (e.g. on power failures).</td>
<td></td>
</tr>
<tr>
<td>Human Machine Interface: e.g. SCADA/PLC driven from personal computer.</td>
<td></td>
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<tr>
<td>Reporting including usage, energy consumption, faults and monitoring.</td>
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</tr>
<tr>
<td>Consideration of what lightning protection is required including the transient and surge suppression requirements.</td>
<td></td>
</tr>
<tr>
<td>Interfacing requirements with ADATS or other monitoring systems.</td>
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</table>
6. Construction Phase Compliance Report

6.1.1 The Construction phase compliance report comprises:
   a. Construction phase compliance statement; and

6.1.2 In addition, these compliance statements shall detail the compliance requirements for high voltage installations and for all electrical installation works within hazardous areas and explosives areas. The contents of each are described below.

Defence High Voltage Installations

6.1.3 In addition to any statutory requirements, provide a Defence High Voltage Compliance Statement, prepared by a responsible person, covering all high voltage works.

6.1.4 This Compliance Statement shall confirm that the design and works complies with the required regulations and standards, the installation complies with the design and that the installation has been commissioned and tested to prove compliance.

6.1.5 An integral part of the certification and verification is the completion of all relevant documentation and training to ensure the system when handed over is functioning correctly and safely and that the users have the required documentation and training to operate the installation safely.

6.1.6 The Compliance Statement is to be completed by the Designer. The High Voltage Compliance Statement shall be in the form of a minute as detailed in ?????-

6.1.7 It must be noted that Defence installation requirements are in addition to the regulations and standards applicable to electrical installations. The installation must comply with all relevant regulations and standards unless formal exemption is granted by the appropriate regulator.

Hazardous Areas and Explosives Area Installations

6.1.8 The designer is to certify all electrical installations in hazardous areas and explosives areas in accordance as meeting the requirements of the applicable regulations and standards in accordance with Chapter 15 of the MIEE. This includes certification of explosives area installations to the Defence licensing agencies requirements and any relevant regulations and standards.

6.1.9 Certification involves all statutory obligations as required by the regulations such as the Notification of Electrical Works/Certificate of Electrical Safety or equivalent and accredited certifier’s certificates where required. In addition, a Defence Hazardous/Explosives Area Certificate is required as outlined below.

6.1.10 Certification and verification must be completed before connection to electricity supply and energising the installation. All certification and verification documents must be provided in the verification dossier.

6.1.11 The Defence Hazardous/Explosives Area Compliance Statement is in addition to statutory requirements and is required to confirm the design, construction, commissioning and the satisfactory completion of the works.

6.1.12 The purpose of this report is to ensure that the designer certifies that the design complies with the required regulations and standards, the installation complies with the design and that the installation has been commissioning and tested to prove compliance.

6.1.13 An integral part of the Defence Compliance Statement is the completion of all relevant documentation and training. This is to ensure the system when handed over is functioning correctly and safely and that the users have the required documentation and training to operate the installation safely.

6.1.14 The report is to be completed by the designer, however, for minor works where no designer is involved the licensed electrical installation contractor can complete the certificate. An example of the Hazardous/Explosives Area Compliance Statement and checklist is provided in the sections below. The report is to be included with the Verification Dossier.

6.1.15 These certificates must be completed for all new works or any alteration or addition to an existing installation.

6.1.16 It must be noted that Defence explosives area installation requirements are in addition to the regulations and standards applicable to hazardous area installations and the Defence Contracts. These installations
must also comply with all relevant hazardous area regulations and standards with the only exception being under formal exemption granted by the Defence licensing agent and other appropriate regulatory authority as appropriate.
7. Construction Phase Compliance Statement

Details of installation

Location:______________________________________________________________________

Building:_____________________________________________________________________

Area:_________________________________________________________________________

I/we being the person(s) responsible for the design of the installation, particulars of which are described later in this report, hereby certify that:

- the installation has been thoroughly tested and inspected and that the works are in accordance with the requirements of the Manual of Infrastructure Engineering – Aeronautical Ground Lighting and
- That all the Aeronautical Ground Lighting works are in full compliance with all applicable statutory and regulatory obligations.

Name of designer:_________________________________________________________________________

Company:___________________________________________________________________________

Address:____________________________________________________________________________

Signature____________________________________________________________________________

Date_________________________________________________________________________________

This compliance report must also have attached for each installation a signed and completed copy of:

a) All statutory obligations as required by the regulations (such as the Notification of Electrical Works/Certificate of Electrical Safety) or equivalent and;

b) The accredited auditor's and or inspection certificates where required.
8. Construction Phase Compliance Statement Summary Checklist

The following checklists summarise key compliance elements that must be addressed by the Designer following construction. Where an item is non-compliant, clarification must be provided. Note: Customise to suit project. Include preliminary checklist in design reports.

<table>
<thead>
<tr>
<th>Item</th>
<th>Completed (Y/N/NA)</th>
<th>Comment/clarification/justification if no</th>
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</table>
Appendix B

- GLOSSARY?
- FDB INCLUSIONS?
- DESIGN COMPLIANCE GUIDE?
- SAMPLE DISPENSATION REQUIREMENTS?
Appendix C – Preventative Maintenance Schedule and Procedures-

Appendix C  Preventative Maintenance Schedule and Procedures
Appendix C – Preventative Maintenance Schedule and Procedures

1. Preventative Maintenance Schedule and Procedures

1.1.1 The AGLMA is responsible for implementing the routine preventative maintenance schedule as detailed in the following table in accordance with the associated procedures detailed thereafter.

1.1.2 Check sheets or other suitable records must be used. Indicative check sheets are provided in Appendix J that may be used to record the activity and outcomes of undertaking the routine preventative maintenance that allows validation of the visual aid’s operation and physical condition, including cleanliness, alignment and configuration. These may be used as presented or modified to suit the AGLMA works’ management system.

1.1.3 The AGLMA shall monitor the condition of the AGL system and make suitable recommendations to DEEP through the local DS Regional Manager for any necessary improvements to ensure the condition of the AGL is adequately achieved and also when required to optimise maintenance.
### Appendix C – Preventative Maintenance Schedule and Procedures

<table>
<thead>
<tr>
<th>Facility</th>
<th>Interval (fortnightly)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Switchboards</td>
<td>T3</td>
</tr>
<tr>
<td>AFL Control Panels</td>
<td>T3</td>
</tr>
<tr>
<td>CCR / MIT</td>
<td>T3</td>
</tr>
<tr>
<td>Battery and Charger</td>
<td>T3</td>
</tr>
<tr>
<td>Cables</td>
<td>P</td>
</tr>
</tbody>
</table>

P = Performance Inspection  
T = Monthly Technical Inspection  
T3 = 3-monthly Technical Inspection  
T6 = 6-monthly Technical Inspection  
T12 = 12-monthly Technical Inspection
2. AGL Fortnightly Performance Inspection Report

2.1.1 A fortnightly assessment shall be made of the performance of all visual aids and ancillary equipment associated with the AGL asset.

Serviceability Requirement

2.1.2 The following serviceability criteria shall be used to validate the performance of the AGL asset:

2.1.3 A PAPI system is deemed unserviceable when

- a PAPI light unit is deemed un serviceable when more than one lamp in a 3 or more lamp light unit has failed, or any lamp in a less-than-3-lamp light unit has failed;

- whenever a red filter has deteriorated such that it does not produce the correct colour light beam, is missing, or is damaged, all the lamps associated with that filter must be extinguished until the red filter is rectified. The affected lamp/s are included as failed lamps when determining (a) above.

- a double-sided PAPI system (i.e. 8 light units) is:
  i) deemed to be unserviceable but useable when all light units in one wing bar are fully functioning, and any light units in the other wing bar have failed. The system may remain in use but a NOTAM must be issued detailing the number of light units failed, and on which side of the runway they are; and
  ii) deemed unserviceable when one or more light units in each wing bar is failed. The double-sided PAPI system must be extinguished until the system is rectified;

- a single-sided PAPI system (i.e. 4 light units) is deemed to be unserviceable when any light unit is failed. The PAPI system must be extinguished until the system is rectified.

2.1.4 At least 85% of the runway edge, threshold, end, and taxiway lights are to be serviceable with the overall pattern and layout adequately defined. No two adjacent lights may be extinguished.

2.1.5 At least one lamp must be serviceable in each quadrant of an IWI. At least one IWI must be serviceable on the aerodrome.

2.1.6 The ABN may be unserviceable; with repair undertaken as soon as practicable.

2.1.7 Obstruction lights must be serviceable with one lamp of a dual fitting operational.

2.2 Inspection Requirements

Fortnightly Performance Inspection

2.2.1 Use Inspection Checklist to record activity and outcomes

2.2.2 Undertake a night inspection:

- Confirm that appearance, uniformity, serviceability and overall AGL pattern is good with no dull or extinguished lights.

2.2.3 Undertake a day inspection:

- a) Make a visual check of all lights and fittings inspecting for mechanical damage.

- b) Replace faulty lamps (exchanging inset light assemblies to allow rebuild in workshop environment).

- c) Confirm that all fasteners required are present and secure.

- d) Confirm that all light bases and surrounding tarmac are secure.

- e) Clean the lens of each PAPI unit.

- f) Log defects due to misaligned fittings; poor focusing; dirty or cracked filters, lenses or prisms; filament aging etc. Where lenses or filters are pitted or discoloured they are to be changed. All fittings with broken glassware, situated in the runway must be replaced or blanked off; they must not be left in service.

- g) Inspect DTRMs/HCMs and MAGS for mechanical damage. Confirm the structure is secure.

- h) Inspect the IWIs for mechanical damage. Confirm the structure is secure and the wind sleeve is not ripped or torn.
Appendix C – Preventative Maintenance Schedule and Procedures

i) Test operate all circuits from the control tower console, where applicable, and observe correct operation and revertive indications. Check operation of fault flasher where appropriate by inducing a circuit fault. Check indicating lights. Confirm correct operation and correct revertive indication. Replace faulty indicator lamps as required. Repair all malfunctions found.

j) Undertake general housekeeping within the ALER; sweep the floors, maintain clear egress to all equipment, and check for any signs of rodent infestation.

2.2.4 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
Appendix C - Preventative Maintenance Schedule and Procedures-
3. PAPI Maintenance Requirement

3.1 Serviceability Requirement

3.1.1 A PAPI system is deemed unserviceable when:

a) a PAPI light unit is deemed unserviceable when more than one lamp in a 3 or more lamp light unit has failed, or any lamp in a less-than-3-lamp light unit has failed;

b) whenever a red filter has deteriorated such that it does not produce the correct colour light beam, is missing, or is damaged, all the lamps associated with that filter must be extinguished until the red filter is rectified. The affected lamp/s are included as failed lamps when determining (a) above.

c) a double-sided PAPI system (i.e. 8 light units) is:

i) deemed to be unserviceable but useable when all light units in one wing bar are fully functioning, and any light units in the other wing bar have failed. The system may remain in use but a NOTAM must be issued detailing the number of light units failed, and on which side of the runway they are; and

ii) deemed unserviceable when one or more light units in each wing bar is failed. The double-sided PAPI system must be extinguished until the system is rectified;

d) single-sided PAPI system (i.e. 4 light units) is deemed to be unserviceable when any light unit is failed. The PAPI system must be extinguished until the system is rectified.

3.2 Inspection Requirements

3.2.1 Use Inspection Checklist to record activity and outcomes

a) Complete Fortnightly Performance Inspection.

b) Check mounting feet and pillars for structural soundness and security.

c) Check covers for cracks or damage. Check for free operation of hinges. Confirm structural security.

d) Check exterior and internal paintwork. Touch up where necessary.

e) Lightly lubricate setting screws and bolts etc to prevent corrosion. Confirm there is no corrosion that would prevent adjustments.

f) Check and clean the interior. Check for insects and rodents. Confirm electrically sound.

g) Check and record alignment levels with “clinometer” tool. Compare with configuration elevation level and tolerance limits. Note: If a unit is found to be outside tolerance and cannot be re-levelled immediately it must be withdrawn from service with ATC informed for NOTAM action. Major adjustment requires a flight check.

h) Remove grass and debris likely to infringe the light beams. Hand mow as required. Confirm there is no obstruction of the light display and appearance is as designed. Clean the lens of each unit.

3.2.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
Annual Technical Inspection

3.2.3 Use Inspection Checklist to record activity and outcomes
   a) Record the date of the previous Annual Technical Inspection.
   b) Perform the normal Fortnightly Performance and Monthly Technical Inspections.
   c) Tighten fasteners. Check supports and foundations.
   d) Maintain legibility of all unit identification numbers.
   e) Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.
   f) Inspect transformer chambers and covers for cleanliness and corrosion and visually check SITs.
   g) Validate glide path and azimuth alignment by obtaining the flight inspection test results.

3.2.4 At completion of the Performance Inspection, record the activity including time and date in the
   Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required
4. Approach Lighting, Runway Lighting and Guidance Sign Requirement

Serviceability Requirement

4.1.1 At least 85% of the lights are to be serviceable and overall pattern and layout is adequately defined. No two adjacent lights may be extinguished.

4.2 Inspection Requirements

Annual Technical Inspection

4.2.1 Use Inspection Checklist to record activity and outcomes;

a) Record the date of the previous Annual Technical Inspection.

b) Perform the normal Fortnightly Performance Inspection.

Elevated Lights

c) Check, clean and polish glassware, including lenses, prisms, reflectors, refractors and filters. Confirm orientation, light colour and effective light outputs are as specified.

d) Observe condition of wiring and terminations, lamp holders, gaskets, assembly fixings, housings/fixtures. Confirm electrically sound. Confirm physical state of fittings allows serviceability.

e) Check vegetation growth and other obstacles that may infringe the lights, and remove obstruction. Confirm there is no obstruction of the light display and appearance is as designed.

f) Check general condition of all fittings, repair or repaint as necessary.

g) Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.

h) Maintain legibility of all light identification numbers.

i) Check all fasteners tighten as necessary. Confirm all fasteners comply fully with manufacturers recommended torque figures.

j) Check light base and transformer chamber. Check condition of wiring and termination for tightness.

k) Confirm that base shall meet frangibility requirement.

l) Confirm that any security chains/cables are attached and fit for use.

m) Check supports and foundations. Confirm they are secure.

n) Check levelling, azimuth and elevation, and adjust as necessary. Confirm orientation is as specified.

o) Maintain legibility of all light identification numbers

Inset Lights

p) Check all flush fittings for moisture and water ingress, cracked filters or broken glassware. Replace fittings where necessary. Confirm orientation, light colour, serviceability and effective light outputs are as specified. Clean glassware and lenses.

q) Check torque for all flush fittings in runway and taxiway. Note: Fasteners for all flush fittings, adaptor plates and blanking plates situated in a runway or taxiway must be torque tested and the torques restored to the manufacturers recommended figures, unless a tab washer protects the fastener. Where tab washers protect fasteners and a visual check indicates the tab has not been strained, this will suffice.

r) Check surrounding tarmac for signs of break up near to flush runway and taxiway fittings. Report defects.

s) Confirm security of light base and surrounding tarmac and the alignment of the seating plate is as designed.

t) Check general condition of all fittings, repair or repaint as necessary.

u) Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.

v) Maintain legibility of all light identification numbers.

4.2.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
Appendix C – Preventative Maintenance Schedule and Procedures

5. Threshold / End and High Use Area Maintenance Requirement

5.1.1 Includes Touchdown, Lead-off Taxiway Lights.

5.2 Serviceability Requirement

5.2.1 At least 85% of the lights are to be serviceable and overall pattern and layout is adequately defined. No two adjacent lights may be extinguished.

Inspection Requirements

5.3 6-Monthly Technical Inspection

5.3.1 Use Inspection Checklist to record activity and outcomes

a) Complete the Fortnightly Performance Inspection

**Elevated Lights**

b) Check, clean and polish glassware, including lenses, prisms, reflectors, refractors and filters. Confirm orientation, light colour and effective light outputs are as specified.

c) Observe condition of wiring and terminations, lamp holders, gaskets, assembly fixings, housings/fixtures. Confirm electrically sound. Confirm physical state of fittings allows serviceability.

d) Check vegetation growth and other obstacles that may infringe the lights, and remove obstruction. Confirm there is no obstruction of the light display and appearance is as designed.

**Inset Lights**

e) Check all flush fittings including centreline lights and edge lights for moisture and water ingress, cracked filters or broken glassware. Replace fittings where necessary. Confirm orientation, light colour, serviceability and effective light outputs are as specified.

f) Check torque for all flush fittings in runway and taxiway. Note: Fasteners for all flush fittings, adaptor plates and blanking plates situated in a runway or taxiway must be torque tested and the torques restored to the manufactures recommended figures, unless a tab washer protects the fastener. Where tab washers protect fasteners and a visual check indicates the tab has not been strained, this will suffice.

g) Check surrounding tarmac for signs of break up near to flush runway and taxiway fittings. Report defects.

h) Confirm security of light base and surrounding tarmac and the alignment of the seating plate is as designed.

5.3.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
5.4 Annual Technical Inspection

5.4.1 Use Inspection Checklist to record activity and outcomes
   a) Record the date of the previous Annual Technical Inspection.
   b) Perform the normal Fortnightly Performance and 6-Monthly Technical Inspections

*Elevated Lights*
   c) Check general condition of all fittings, repair or repaint as necessary.
   d) Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.
   e) Maintain legibility of all light identification numbers.
   f) Check all fasteners tighten as necessary. Confirm all fasteners comply fully with recommended torque figures.
   g) Check light base and transformer chamber. Check condition of wiring and termination for tightness. Confirm fittings are electrically sound.
   h) Confirm that base shall meet frangibility requirement.
   i) Confirm that any security chains/cables are attached and fit for use.
   j) Check supports and foundations. Confirm they are secure.
   k) Check levelling, azimuth and elevation, and adjust as necessary. Confirm orientation is as designed.

*Inset Lights*
   l) Check general condition of all fittings, repair or repaint as necessary.
   m) Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.
   n) Maintain legibility of all light identification numbers.

5.4.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
5.5 DTRM/HCM/MAGS Maintenance Requirement

Serviceability Requirement
5.5.1 No two adjacent sign’s lighting may be extinguished.

Annual Technical Inspection Requirements
5.5.2 Use Inspection Checklist to record activity and outcomes;
   a) Record the date of the previous Annual Technical Inspection.
   b) Perform the normal Fortnightly Performance Inspection.
   c) Clean face panels of signs.
   d) Check condition of lamp holders, reflectors, wiring and terminations.
   e) Perform an insulation test if the sign lighting is powered at 230V; measure circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with the AS/NZS 3000.
   f) Check attachment points and frangible couplings; confirm they are sound.
   g) Check paintwork and touch up as necessary.

5.5.3 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
5.6 C.6 Taxiway and Apron Edge Maintenance Requirement

Serviceability Requirement

5.6.1 At least 85% of the lights are to be serviceable and overall pattern and layout is adequately defined. No two adjacent lights may be extinguished.

Annual Technical Inspection Requirements

5.6.2 Use Inspection Checklist to record activity and outcomes

a) Record the date of the previous Annual Technical Inspection.

b) Perform the normal Fortnightly Performance Inspection.

c) Check, clean and polish glassware, including lenses, prisms, reflectors, refractors and filters. Confirm orientation, light colour and effective light outputs are as specified.

d) Observe condition of wiring and terminations, lamp holders, gaskets, assembly fixings, housings/fixtures. Confirm electrically sound. Confirm physical state of fittings allows serviceability.

e) Check general condition of all fittings, repair or repaint as necessary.

f) Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.

g) Maintain legibility of all light identification numbers.

h) Check all fasteners tighten as necessary. Confirm all fasteners comply fully with manufacturers recommended torque figures.

i) Check light base and transformer chamber. Check condition of wiring and termination for tightness.

j) Confirm light base and surrounding tarmac are secure.

k) Check supports and foundations. Confirm they are secure.

l) Check levelling, azimuth and elevation, and adjust as necessary. Confirm orientation is as designed.

m) Check vegetation growth and other obstacles that may infringe the lights, and remove obstruction.

n) Confirm there is no obstruction of the light display and appearance is as designed.

Inset Lights

o) Check all flush fittings for moisture and water ingress, cracked filters or broken glassware. Replace fittings where necessary. Confirm orientation, light colour, serviceability and effective light outputs are as specified. Clean glassware and lenses.

p) Check torque for all flush fittings in runway and taxiway. Note: Fasteners for all flush fittings, adaptor plates and blanking plates situated in a runway or taxiway must be torque tested and the torques restored to the manufacturers recommended figures, unless a tab washer protects the fastener. Where tab washers protect fasteners and a visual check indicates the tab has not been strained, this will suffice.

q) Check surrounding tarmac for signs of break up near to flush runway and taxiway fittings. Report defects.

r) Confirm security of light base and surrounding tarmac and the alignment of the seating plate is as designed.

s) Check general condition of all fittings, repair or repaint as necessary.

t) Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.

u) Maintain legibility of all light identification numbers.

v) At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
5.7 C.7 IWI Maintenance Requirement

Serviceability Requirement

5.7.1 At least one lamp must be serviceable in each quadrant. At least one IWI must be serviceable on the aerodrome.

Annual Technical Inspection Requirements

5.7.2 Use Inspection Checklist to record activity and outcomes
   a) Perform normal Fortnightly Performance Inspection.
   b) Check bearings for freedom of movement in azimuth and elevation. Lubricate bearings if appropriate.
   c) Check fabric and sock attachment points.
   d) Check condition of lamp holders, reflectors, wiring and terminations
   e) Perform an insulation test. If IWI is powered by a 230V supply, measure circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with the AS/NZS 3000.
   f) Check paintwork and touch up as necessary.
   g) Inspect supports and foundations. Confirm they are sound.

5.7.3 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
5.8 Aerodrome Beacon Maintenance Requirement

Serviceability Requirement

5.8.1 May be unserviceable. Repair as soon as practicable.

Annual Technical Inspection

5.8.2 Use Inspection Checklist to record activity and outcomes

a) Record the date of previous of the previous Annual Technical Inspection.
b) Complete Fortnightly Performance Inspection.
c) Check bearings for freedom of movement. Lubricate as required.
d) Check condition of lamp holders, reflectors, wiring and terminations.
e) Perform an insulation test. If powered by 230V, measure circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with AS/NZS 3000.
f) Replace service and standby lamps ensure correct lamp alignment and orientation.
g) Check condition of glassware and filters, if applicable. Confirm effective light output and light colour is as specified.
h) Check condition of wiring and termination for tightness. Confirm fittings are electrically sound.
i) Check rotating parts. Confirm freedom of movement.
j) Check, clean and lubricate the following: main bearings, motor bearings, reduction gear. Confirm free operation.
k) Check operation of clutch. Confirm correct operation.
l) Inspect and clean slip rings and brush gear. Confirm electrically sound.
m) Measure insulation of motor, transformer and wiring. Note: Both limits and plug-in electronic units should first be removed. Record IR test results.
n) Check mounting and levelling. Confirm angular coverage is as designed.
o) Check weatherproofing and gaskets. Confirm they are sound.
p) Count flash rate. Confirm compliance with commissioning figure.

5.8.3 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
5.9 Obstacle Light Maintenance Requirement

Serviceability Requirement

5.9.1 Must be serviceable. One lamp of a dual fitting must be serviceable.

6-Monthly Technical Inspection

5.9.2 Use Inspection Checklist to record activity and outcomes
   a) Perform insulation test of electrical feeders. Measure 230-volt circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with AS/NZS 3000.

5.9.3 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.

Annual Technical Inspection

5.9.4 Use Inspection Checklist to record activity and outcomes
   a) Record the date of the previous Annual Technical Inspection.
   b) Perform the normal 6-Monthly Technical Inspection.
   c) Change Lamps, Check, clean and polish glassware.
   d) Check fasteners, Check light base.
   e) Check wiring and termination.
   f) Inspect structures, posts and poles. Inspect supports and foundations.
   g) Check levelling, azimuth and elevation.
   h) Maintain identification numbers

5.9.5 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
5.10 Series Field Circuit Maintenance Requirement

5.10.1 Most AGL visual aids are supplied from CCRs (or MITs) on a circuit with the load/lamps connected in series utilising series isolating transformers.

5.10.2 Each series circuit shall be tested for continuity by ohmmeter or equivalent method.

5.10.3 Each series circuit shall be subjected to high voltage insulation resistance tests to determine isolation from mass earth.

5.10.4 Frequent checks of the circuit insulation resistance shall be undertaken. Experience has shown that a circuit’s insulation resistance will vary depending on soil conditions; circuits which pass IR tests during dry weather may fail after heavy rain. Accordingly, the trend of results is just as important as the absolute result of a single test. If a significant difference from the last recorded value is measured or a marked deterioration trend is noticed, the cause shall be identified and any problem rectified.

Serviceability Data – Series Circuit Primary Cable

5.10.5 A primary cable circuit is considered serviceable if it has an insulation resistance greater than that calculated allowing for 2 µA for each series isolating transformer in circuit and 1 µA for each 100 metres of primary cable in circuit when a test voltage of 1000V for 3000V rated cable or 3000V for 5000V rated cable is applied.

5.10.6 Minimum insulation resistance $R_c = \frac{\text{test voltage/maximum calculated leakage current}}{\Omega}$

5.10.7 For example, a taxiway circuit configured with a 4000 metre circuit length of 5000 V rated cable supplying 100 lights should have a leakage current less than 240 µA at a test voltage of 3000 V; equivalent to 12.5 MΩ.

It is noted that some installations may incorporate primary field circuits that do not achieve the minimum insulation resistance required. In this event, dispensation may be sought from DEEP for a reduced minimum insulation resistance requirement.

In seeking such dispensation, cognisance shall be taken of the following:

AS/NZS 3000 requires a minimum insulation resistance of 1 MΩ when tested at 500V (refer clause 8.3.6 AS/NZS 3000 – 2007)

Whilst an IR result should be as high as possible to minimise the hazard risk, the lower “safe” limit of insulation resistance to limit the leakage current to 40 mA may be estimated by the following approximation:

$R_{\text{min}} = \frac{\text{IPZL/IB}}{\Omega} = \frac{(S/IP)/IB}{\Omega} = \frac{(20/6.6)/.04}{\Omega} = 75.8 \text{ kΩ}$

Where S equals the CCRs nominal rated power in kVA (20 kVA used as this is the largest rated CCR used on Defence airfields), IP is the rated RMS current of the CCR and IB is the lethal body current. The minimum insulation value (Rmin) should be regarded as a safety requirement; therefore, for safety, 200 kΩ may be regarded as the minimum acceptable value for a series current circuit.
Appendix C – Preventative Maintenance Schedule and Procedures -

5.11 6-Monthly Technical Inspection - Series Circuit Primary Cable

5.11.1 Use Inspection Checklist to record activity and outcomes.
   a) De-energise all circuits and tag appropriately.
   b) Isolate/disconnect both leads from the regulator output terminals. Earth connections that have been applied for the purpose of performing maintenance may be temporarily removed if necessary to perform specific tests. The earth connections shall only be disconnected whilst those tests are being performed and shall be reconnected upon completion of the tests.
   c) Test for continuity of the primary circuit by ohmmeter or equivalent method; measuring and recording the result for each field circuit.
   d) Test the cable at the required test voltage (1000V for 3000V rated cable; 3000V for 5000V rated cable); measuring and recording the Insulation Resistance for each field circuit. The maximum acceptable leakage current for the circuit tested, in microamperes, should not exceed a value calculated as follows:
      o 2 µA for each series isolating transformer in circuit
      o 1 µA for each 100 metres of primary cable in circuit
   e) If the leakage current exceeds the value calculated as outlined above, that is, the insulation resistance falls below the serviceability value, the circuit shall be sectionalised and the tests repeated for each section to determine if the deterioration is localised or a general deterioration. Ensure that the cable end and sheath is clean and dry for a distance of 300 mm from the end of the cable when cable is sectionalised external to the ALER.
   f) If the low Insulation Resistance reading is restricted to one part of the circuit, the faulty component, section of cable or any SIT found to be the cause of low Insulation Resistance readings shall be replaced immediately.
   g) Defective components must be located and repaired (or replaced) until the entire circuit passes the test. Should all parts of the circuit be found defective, the AGLMA is to provide a report on the fault together with the recommended corrective action for Regional Manager approval.
   h) Major modifications, which include complete circuit replacement, will require the Regional Manager to obtain Design Authority approval prior to giving the Maintenance Agent approval to proceed. On approval, the Maintenance Agent will be instructed to implement the corrective works.
   i) The position of any additional cable or cable joints is to be recorded in the appendix of as constructed drawings. In addition, the relevant section of this manual is also to be updated.
   j) Record insulation resistances in a tabulated format to allow the trend to be determined for the life of the cable.

5.11.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
Appendix C – Preventative Maintenance Schedule and Procedures

5.12 Annual Technical Inspection – Series Circuit Primary Cable

5.12.1 Use Inspection Checklist to record activity and outcomes
   a) Record the date of the previous Annual Technical Inspection.
   b) Perform the normal 6-Monthly Technical Inspection

5.12.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.

Serviceability Data – Series Isolating Transformer

5.12.3 As the insulation values to earth of series isolating transformers effectively reduce when connected in parallel, resulting in moderate values of insulation resistance when combined producing a very much reduced overall insulation resistance value, high values of insulation resistance in the order of 200 MΩ for individual transformers is essential.

5.13 6-Monthly Technical Inspection – Series Isolating Transformer

5.13.1 Use Inspection Checklist to record activity and outcomes
   a) In conjunction with primary cable IR tests, cables inclusive of SITs with low insulation values should be sectionalised to find the cause, where the cause is found to be leaky transformers they should be changed before failure.

5.13.2 Once a transformer is suspected to be the cause of system low insulation, the method of test should be to immerse the transformer in a bucket of water with the exposed ends of the primary leads above the water. The secondary lead should be earthed in the water, then insulation resistance tests made between the primary leads and the water. The SIT shall be tested using an Insulation Tester (Megger) with a test voltage of either 1000 VDC or 3000 VDC depending on whether the SIT is installed in a circuit with 3000V or 5000V rated cable.

5.13.3 It is important that these tests be made immediately the transformer is taken out of the ground, experience shows that a leaking transformer exposed to the air for several hours will dry out and give an apparently healthy IR test, however, once placed in the ground the heating and cooling of use will very quickly absorb ground moisture again. It is noted that the insulation resistance of a SIT may degrade if the SIT is left in water for an extended period.

5.13.4 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.

5.14 Annual Technical Inspection – Series Isolating Transformer

5.14.1 Use Inspection Checklist to record activity and outcomes
   a) Record the date of the previous Annual Technical Inspection.
   b) Perform the normal 6-Monthly Technical Inspection

5.14.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
6. Parallel Field Circuit Maintenance Procedure

6.1 Parallel Field Circuit Maintenance Procedure

6.1.1 Some AGL visual aids are supplied on a constant voltage circuit with the load/lamps connected in parallel; eg IWI and SFAL.

6.1.2 Each parallel circuit shall be tested for continuity by ohmmeter or equivalent method.

6.1.3 Each parallel circuit shall be subjected to high voltage insulation resistance tests to determine isolation from mass earth.

6.1.4 Frequent checks of the circuit insulation resistance shall be undertaken. Experience has shown that a circuit’s insulation resistance will vary depending on soil conditions; circuits which pass IR tests during dry weather may fail after heavy rain. Accordingly, the trend of results is just as important as the absolute result of a single test. If a significant difference from the last recorded value is measured or a marked deterioration trend is noticed, the cause shall be identified and any problem rectified.

Serviceability Data - Parallel Circuit Primary Cable

6.1.5 AS/NZS 3000 requires a minimum insulation resistance of 1 MΩ when tested at 500V.

6.2 6-Monthly Technical Inspection – Parallel Circuit Primary Cable

6.2.1 Use Inspection Checklist to record activity and outcomes

a) De-energise all circuits and tag appropriately.

b) Isolate/disconnect leads from the supply equipment output terminals.

Earth connections that have been applied for the purpose of performing maintenance may be temporarily removed if necessary to perform specific tests. The earth connections shall only be disconnected whilst those tests are being performed and shall be reconnected upon completion of the tests.

c) Test for continuity of the primary circuit by ohmmeter or equivalent method; measuring and recording the result for each field circuit.

d) Measure parallel circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester; measuring and recording the Insulation Resistance for each field circuit.

e) If the insulation resistance of a circuit drops below the serviceable value, the circuit should be renewed.

6.2.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.

6.3 Annual Technical Inspection – Parallel Circuit Primary Cable

6.3.1 Use Inspection Checklist to record activity and outcomes

a) Record the date of the previous Annual Technical Inspection.

b) Perform the normal 6-Monthly Technical Inspection

6.3.2 At completion of the Performance Inspection, record the activity including time and date in the Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.
7. ALER Maintenance Requirement

Serviceability Requirement
7.1.1 During the Annual Technical Generator Inspection; restoration of the AGL supplied on the LEG after mains failure within a period of less than 15 seconds needs to be validated.

ALER Annual Technical Inspection
7.1.2 Use Inspection Checklist to record activity and outcomes

7.1.3 General Condition
   a) Undertake general housekeeping.
   b) Sweep the floors; maintain clear egress to all equipment.
   c) Check for any signs of rodent infestation.
   d) The ALER is not to be used as a storage facility for non-AGL equipment.

7.1.4 LV Switchboards and Control Panels
   a) Check operation of local and remote controls.
   b) Check the operating voltages between phases and between phases to neutral are normal.
   c) Check all indicating lights are working correctly.
   d) Check switchboard and control panel interlocks.
   e) Check switchboard and control panel operation and clean.
   f) Clean and lubricate all relays and contactors.
   g) Calibrate all instruments.
   h) Check all wiring and terminations.
   i) Measure and record insulation resistance of the installation; validate compliance with AS/NZS 3000 (1 MΩ).

7.1.5 Constant Current Regulators
   a) Check operation of local and remote controls.
   b) Check and adjust current output for each circuit and intensity recording field-measured results.
   c) Check the tap position on transformers. Check and adjust outputs to comply with value recorded in configuration details.

7.1.6 Lighting Control System
   a) Test (operate) all aeronautical ground lighting circuits. Observe correct operation and revertive indication.
   b) Check all indications are operating correctly. Replace faulty lamps and indicators as applicable.

7.1.7 Battery And Charger Supply
   a) Record from the inbuilt meters, (where fitted): Input voltage; input current; battery voltage.
   b) Check and record charger rate.
   c) Check electrolyte level and specific gravity of wet cells. Top up with distilled water if necessary.
   d) Check battery vent plugs, terminals and connections

7.1.8 Local Emergency Generator
   a) Validate restoration of the AGL supplied on the LEG after mains failure within a period of less than 15 seconds.
## AGL Maintenance Diary

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Task / Ref Number.</th>
<th>Equipment</th>
<th>Description of work performed / notification</th>
<th>Signature</th>
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## Appendix E  AGL Maintenance Permit to Work

### 1 ISSUE

<table>
<thead>
<tr>
<th>Issued to:</th>
<th>At location:</th>
<th>Serial No.</th>
<th>Authorised by:</th>
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**Note:** Permit is invalid without a serial number

### 2

1. **Description of equipment to be worked on**

2. **Points of Isolation**

3. **Point of application of circuit earth**

4. **Caution and hazard sign location(s)**

5. **Other precautions to prevent access to or contact with live equipment**

6. **Location of nearest live conductors**

7. **Control circuits are / are not alive at ___________ Volts a.c. / d.c**

**Warning:** All other parts of the AGL system are hazardous

### 3 Work to be carried out, if testing - state the earths to be removed and whether to be replaced on completion

### DECLARATION

I hereby declare that the equipment described is safe for the work/test detailed and will remain so until you have signed Part 4 of this permission/sanction. You are instructed to take charge of the work/test as described.

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<th>Time</th>
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### NOTE 1

The supervisor of the work/test shall

- a) Acknowledge receipt of the permit/sanction by signing Part 3 of the copy held in the AGL maintenance log
- b) Retain the permit/sanction whilst the work/test is proceeding
- c) Retain the permit/sanction when the work/test is completed after signing Part 4 of the copy held in the AGL maintenance log (permits/sanctions)

### NOTE 2

The authorised maintenance person shall not energise the equipment until Part 5 of the copy in the AGL maintenance log (permit/sanctions) has been completed.
### 3 RECEIPT

I have read and I fully understand this permit-to-work/sanction-to-test. I am fully conversant with the work/test to be done. I accept responsibility for carrying out the work/test on the equipment described.

No attempt by me or by any person under my control will be made to work on, or test, any other part of the AGL system.

<table>
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<th>Time</th>
<th>Date</th>
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### 4 FINAL CLEARANCE CERTIFICATE

My part of the work/test is now finished and I declare that all persons under my charge have been withdrawn and warned that it is no longer safe to work on the equipment specified in this permit-to-work/sanction-to-test and all tools and test equipment are clear.

<table>
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<th>Time</th>
<th>Date</th>
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<td>(person in charge of work/test)</td>
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</tbody>
</table>

### 5 CANCELLATION (strike out and initial all statements which are not correct)

I have inspected the work and consider it satisfactorily completed

I am satisfied that all temporary earth connections have been removed

I am satisfied that all other permits/sanctions relating to the equipment are cancelled

I have removed all earth circuits

I have carried out or witnessed insulation tests

I am satisfied that phasing is correct

I have amended circuit labels as necessary

I consider that the equipment is safe for reconnection to the AGL system

<table>
<thead>
<tr>
<th>Time</th>
<th>Date</th>
<th>Signed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(person in charge of work/test)</td>
</tr>
</tbody>
</table>

### 6 SUSPENSION (when applicable)

(a) I confirm that all work by me is suspended and that all persons under my charge have been withdrawn and warned that it is no longer safe to work on the equipment specified in this permit-to-work/sanction-to-test.

<table>
<thead>
<tr>
<th>Time</th>
<th>Date</th>
<th>Signed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(person in charge of work/test)</td>
</tr>
</tbody>
</table>

(b) I acknowledge receipt of this permit-to-work/sanction-to-test for the purposes of carrying out testing during which time I will remove the circuit earth(s) when permitted to do so by the AGLMM.

<table>
<thead>
<tr>
<th>Time</th>
<th>Date</th>
<th>Signed</th>
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<tbody>
<tr>
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<td>(person in charge of work/test)</td>
</tr>
</tbody>
</table>

(c) I confirm that all testing is complete, that circuit earth(s) and protection devices have been re-instated to the AGLMM instructions.

<table>
<thead>
<tr>
<th>Time</th>
<th>Date</th>
<th>Signed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(person in charge of work/test)</td>
</tr>
</tbody>
</table>

(d) I acknowledge that all testing is complete, that circuit earth(s) have been re-instated and accept the return of this permit-to-work/sanction-to-test in its original form.

<table>
<thead>
<tr>
<th>Time</th>
<th>Date</th>
<th>Signed</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(person in charge of work/test)</td>
</tr>
</tbody>
</table>
# Appendix F  AGL Ground Check Certificate

I hereby declare that the AGL equipment at _____________________ is fit for purpose and safe for operation as of the date(s) indicated. All relevant performance and technical inspections have been undertaken and resultant check sheets are attached.

Any specific unserviceabilities, faults or corrective actions occurring during the reporting period are detailed on Page 2 of this certificate.

<table>
<thead>
<tr>
<th>Description</th>
<th>Valid To:</th>
<th>Signed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The power supply, including primary source, secondary source, switchover time, and electrical circuitry, are in accordance with the relevant standards.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
<tr>
<td>Light fixtures are in accordance with the relevant standards and fit for the purpose.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
<tr>
<td>Light fixtures are installed correctly; with correct alignment, beam angles and levelling.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
<tr>
<td>Colour of light is correct.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
<tr>
<td>The installation does not pose a hazard to aircraft; equipment and mountings are frangible; footings and foundations do not extend above surrounding ground level.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
<tr>
<td>Overall condition of the installation; cleanliness of optical surfaces; removal of construction materials and potential “foreign object damage” materials; reinstatement and consolidation of surfaces is acceptable.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
<tr>
<td>Control of lighting systems confirmed as working correctly. Remote control and monitoring, including fault indication, provided to Control Tower, has been fully exercised and confirmed, including any interlocks present. Current settings have been measured and recorded with suitable instruments.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
<tr>
<td>Light-sensitive switches incorporated into control systems have been checked to ensure correct operation, free from the effect of any artificial lights in the vicinity.</td>
<td>/       /</td>
<td>(AGLMM)</td>
</tr>
</tbody>
</table>
## Unserviceabilities

<table>
<thead>
<tr>
<th>List and describe unserviceabilities:</th>
</tr>
</thead>
</table>

## Faults

<table>
<thead>
<tr>
<th>List and describe fault(s):</th>
</tr>
</thead>
</table>

## Corrective actions

<table>
<thead>
<tr>
<th>Describe corrective actions for unserviceabilities and faults:</th>
</tr>
</thead>
</table>

## Spares usage

<table>
<thead>
<tr>
<th>List excessive spares usage and outstanding back orders:</th>
</tr>
</thead>
</table>

Signed: _______________________________ (AGLMM)                   Date: _______/_______/_______
Appendix G – AGL Spares Procurement Proforma

## Appendix G  Spares Procurement Proforma

<table>
<thead>
<tr>
<th>FORM ID:</th>
<th>Sequence No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spare Part Description</strong></td>
<td><strong>Used in: / Fault Report Reference</strong></td>
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</tbody>
</table>
Appendix H  Notification of Faults/Obsolete Spares

Faults shall be reported on a form applicable to the Base (for example RAAF “Report Form 605”).

A typical fault report flow diagram is shown. The Maintenance Agent shall develop, in conjunction with the other stakeholders, a notification procedure that will ensure that all faults and defects are captured, monitored, reported and closed and that the spares inventory is kept up to date.

Obsolete Spares
When obsolete spares are identified, the Maintenance Agent shall notify DEEP. The process to identify suitable replacement parts shall require liaison with the original equipment manufacturer as required.

Once a suitable replacement has been identified, DEEP will initiate the process to update the Required Spares List and any other documentation referring to the part.
1. Preventative Maintenance Guide

1.1.1 In undertaking routine preventative maintenance it is recognised that the initial assessment of photometric performance and condition will be undertaken in the field. However, were it is necessary to break down or open a fitting to undertake maintenance (particularly inset fittings) it may be prudent to exchange the unit in the field with an equivalent spare assembly and return to the workshop to undertake the maintenance regime required associated with replacing lamps, lens and gaskets; cleaning glassware; etc. This will limit the time required in the field and restore the AGL asset to full operation in the least amount of time. Accordingly, a sufficient number of assembled “exchange units” should be available to facilitate the routine preventative maintenance regime.

1.2 Inspection of Light Fittings

1.2.1 Degraded operation of luminaires is generally due to:
   a) Time expired or damaged lamp(s)
   b) Dirty or damaged glassware
   c) Mechanical or optical misalignment
   d) Water ingress

1.2.2 Compliance requirements require luminaires to be monitored for light output and visual consistency. A night inspection of a system will generally identify luminaires operating below their expected output.

1.3 Time Expired or Damaged Lamp(s)

1.3.1 The light output from a lamp will degrade with time in service. The human eye is usually quite good at picking relative “differences” within a group of lights, however measurement of actual light output of a luminaire can only be done with specialised test equipment. Equipment used to test entire runway systems will usually identify luminaires that are operating below their rated level or at a level significantly different from other luminaires in the same group.

1.3.2 Luminaires that exhibit degraded output shall be checked as follows:
   a) Confirm that the correct lamp type is being used for the particular luminaire
   b) Check the lamp’s general condition. Is there abnormal discolouration or loose pins?
   c) Check the lamp base fitted correctly and the wiring is attached securely.

1.3.3 If any doubt exists as to the type or condition of the lamp, it should be replaced.

1.4 Dirty or Damaged Glassware

1.4.1 Reduction of light output due to dirt or damaged glassware can be significant. Check for:
   a) Cleanliness. If the glassware is dirty then refer to “cleaning of elevated glassware” or “cleaning of inset lenses” for cleaning procedure.
   b) Damage. If the glass, filter or lens is cracked, chipped or abraded then consider replacement.
   c) However, if damage is minor, then simple actions such as reorientation may restore compliant operation.

1.5 Abraded Glassware

1.5.1 Damaged or abraded glassware can result in a major reduction of the luminaire’s light output. The usual cause of abrasion is sandblasting by either aircraft prop/jet wash or from strong prevailing winds.
   a) To minimise damage to glassware, ensure the runway and surrounding areas are swept and are as free as possible from dirt, small stones and other debris.
   b) If more than 30% of the area of a glass fitting is abraded (frosted), it shall be replaced.
Appendix I – Preventative Maintenance Guide

c) Observe the glassware damage carefully before disassembling a fitting. The direction and amount of damage may provide a clue as to the abrasive source.

1.5.2 For example, if abrasion damage to an elevated light that is close to a threshold is found on the side facing towards the threshold, then it is unlikely to be caused by aircraft movements, more likely from a prevailing wind. Check other lights nearby for similar conditions.

1.5.3 With elevated lights, if the damage is minor, consider refitting the degraded area of the glassware at a different angle to maximize the light output “up and down” the runway.

1.6 Mechanical or Optical Misalignment

1.6.1 Check for the following causes of misalignment.
   a) Impact damage
   b) Movement of the luminaire due to a shift in pavement level (asphalt movement, subsidence)
   c) A shift in the levelling mechanism of the luminaire. Refer to “levelling and alignment of elevated fittings” for corrective action.
   d) Movement of the lensing system within the luminaire. Check manufacturer’s manual for corrective action.

1.7 Water Ingress

1.7.1 Water ingress shall be treated to prevent reoccurrence of the problem.
   a) Use compressed air (max 30psi) to clear away any dirt/dust/debris that may have lodged around the unit.
   b) Gently remove glassware or top (if inset). Check for damage/chipping/cracking that may defeat sealing.
   c) Observe where water is pooling, then remove water (compressed air or vacuum) and dry.
   d) Check for corrosion or electrolytic damage to the base and electrical wiring/connectors/lamp base(s).
   e) If corrosion is minor, treat affected area with a corrosion inhibitor suitable for the type of metal used.
   f) Ensure drain holes (if fitted) are clear.
   g) Repair or replace any electrical wires, connectors or lamp bases that are damaged.
   h) Replace all gaskets and seals with correct replacement items. Follow manufacturer’s recommendation for lubricants.
   i) Refit lamp(s). Use new lamp(s) if necessary.
   j) Refit glassware. Use new glass or prism if necessary. Check for secure fitment. Torque screws to correct tension.

1.7.2 Record any defects found.
1.8 **Levelling and Alignment of Elevated Fittings**

1.8.1 Undertake the following:

a) Use compressed air (max 30psi) to clear away any dirt/dust/debris that may have lodged around the unit.

b) Remove and clean glassware as per “cleaning of elevated glassware”.

c) Check that the base is secured tightly to the pavement and the pavement footing is sound.

d) Check that any swivel/rotation mechanism moves freely and that the levelling/set screws are free.

e) Place the levelling tool (usually a 360° bubble level) onto the base.

f) Adjust the levelling mechanism and setscrews until the bubble lies within the centre ring.

g) Lock the swivel/tilt mechanism and check that the bubble remains centred.

h) Replace the glassware.

i) Check the luminaire at night to confirm alignment.

1.8.2 Record any defects found.

1.9 **Levelling and Alignment of Inset Lights**

1.9.1 Inset light fixtures are aligned and levelled during installation. If a fixture becomes misaligned it may have to be removed, the core hole cleaned and the fixture re-seated using the installation alignment jig and then fixed in place.

1.9.2 The following procedure is used to check the levelling of an inset light:

a) Use compressed air (max 30psi) to clear away any dirt/dust/debris that may have lodged around the unit.

b) Remove light top and clean glass as per "cleaning of inset lenses".

c) Check that the light base is secured tightly to the pavement and the pavement footing is sound.

d) Check rubber seals/o-rings for integrity and fitting. Follow manufacturer’s recommendation for lubricants.

e) Replace top and check for secure fitment. Torque screws to correct tension.

f) Place the levelling tool (usually a 360° bubble level) onto the top of the fixture.

g) Check and note the bubble position.

h) Check the luminaire at night to confirm alignment.

1.9.3 Record any defects found.

1.10 **Cleaning of Elevated Glassware**

1.10.1 Undertake the following:

a) Use compressed air (max 30psi) to clear away any dirt/dust/debris that may have lodged around the base and top.

b) Release the catch(s) or screw(s) that secures the glass to the elevated base.

c) Gently lift the glass (and filter if used) away from the base.

d) Remove any additional dirt/dust/debris found in the base cavity (compressed air or vacuum)

e) Wipe out the cavity and ensure it is dry. Ensure drain holes (if fitted) are clear.

f) Clean the glassware inside and out. Use alcohol or other cleaning agents that do not require rinsing.
Appendix I – Preventative Maintenance Guide

1.10.2 Record any defects found.

1.11 Cleaning of Inset Lenses

1.11.1 Undertake the following;
   a) Use compressed air (max 30psi) to clear away any dirt/dust/debris that may have lodged around the unit.
   b) Undo holding screws to release the top and gently lift away from the base.
   c) Remove any additional dirt/dust/debris found in the base cavity (compressed air or vacuum)
   d) Wipe out the cavity and ensure it is dry.

1.11.2 First use a non-scratch implement (e.g. plastic spatula) to remove excess build up of rubber or dirt then clean the glass window inside and out. Use alcohol or other cleaning agents that do not require rinsing. Use compressed air to dry. Remove any streaks with soft cloth.
   a) Remove and check lamp(s) for cleanliness and correct rating. Refit. (Use new lamp if necessary)
   b) Check rubber seals/o-rings for integrity and fitting. Follow manufacturer’s recommendation for lubricants.
   c) Replace top and check for secure fitment. Torque screws to correct tension.

1.11.3 Record any defects found.
1.12 **Routine Testing of Primary Cable Insulation Resistance**

1.12.1 Whenever possible during scheduled maintenance, these tests should be performed when the ground is thoroughly wet, as circuits that pass insulation resistance tests during dry weather may fail after a heavy rain.

1.12.2 A 10 to 20 percent annual decrease in insulation resistance value (in mega-ohms) is normal. An annual decline of over 50 percent, from one annual reading to the next, indicates the existence of a problem.

1.13 **Calculation of Leakage Currents**


1.13.2 When calculating the amount of leakage current, add together the allowances for number of SITs and cable lengths as given below.

<table>
<thead>
<tr>
<th>Allowance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 2µA for each series transformer</td>
<td></td>
</tr>
<tr>
<td>b) 1µA for each 100m of cable</td>
<td></td>
</tr>
</tbody>
</table>

1.13.3 If the Megger displays only resistance, use the formula $I_{LEAKAGE} = \frac{V_{APPLIED}}{R_{MEASURED}}$ to calculate the actual leakage current.

For example if the tester is set to an output of 3000V and the meter indicates an insulation resistance of 20MΩ, then

\[
I_{LEAKAGE} = \frac{3000V}{20 \times 10^6 \Omega} = 0.00015 \text{ Amps} \quad (==> 150\mu\text{A})
\]

1.13.5 This measured value should then be compared to the value allowed for the actual circuit configuration and length.

1.14 **IR Test Procedure**

1.14.1 **Caution:** Ensure the AGL system is switched off and made safe and cannot be activated remotely by ATC or PALC.

1.14.2 **Note:** The test procedure for field circuits requires the use of an Insulation Tester (Megger) with an output capability of up to 5000VDC to allow the routine testing of 5000V rated cable at 3000V and 3000V rated cable at 1000V. Note that new circuits or cable segments are initially tested at their rated voltage but the test voltage for previously energised cable is reduced to the levels noted.

a) Disconnect both circuit leads from the field distribution terminals. Support both leads so there are air gaps between bare conductors and ground. Make sure the cable sheath is clean and dry for a distance of at least 300 mm from the end of the cable. Also make sure exposed insulation at the end of the cable is clean and dry.

b) Connect the two leads from the tester - one to one leg of the field circuit, the other to ground.

c) Apply the test voltage for at least 1 minute. Minimum insulation resistance readings should be the level calculated using the test voltage and maximum leakage current (refer above).

d) Move the tester lead to the other leg of the field circuit and apply test voltage again for 1 minute.

e) Record the IR readings for each leg of the field circuit.

1.14.3 If the IR reading for a circuit is less than expected then troubleshooting may be necessary.
1.15 SIT Testing (Water Immersion Test)

1.15.1 This procedure is used when a SIT is suspect or when benchmark testing a field circuit. Test requires the use of an Insulation Tester (Megger) with a test voltage of either 1000VDC or 3000VDC depending on whether the SIT is installed in a circuit with 5000V or 3000V rated cable.

1.15.2 It is important that these tests be made immediately the transformer is taken out of the ground, experience shows that a leaking transformer exposed to the air for several hours will dry out and give an apparently healthy IR test, however, once placed in the ground the heating and cooling of use will very quickly absorb ground moisture again. It is noted that the insulation resistance of a SIT may degrade if the SIT is left in water for an extended period.

a) Immerse the SIT under test in a bucket of salt water (saline) so that it is completely covered with the ends of its leads in free air. The saline can be made up by adding 10 grams of table salt (sodium chloride) to one litre of tap water.

b) Twist the two wire ends of the primary winding together so that they are electrically shorted.

c) Twist the two wire ends of the secondary winding together so that they are electrically shorted.

d) Choose one of the shorted windings and connect the shorted joint to ground.

e) Connect one lead of the tester to the free, shorted, joint and the other test lead to ground.

f) Apply the test voltage for at least 1 minute. Insulation resistance readings should be at least 200 MΩ.

g) Remove the ground from the (first) shorted joint and connect to the other winding.

h) Reconnect the tester between the free joint and ground.

i) Apply the test voltage for at least 1 minute. Insulation resistance readings should be at least 200 MΩ.

1.16 Testing Oil Contained in CCR or MIT

1.16.1 Some types of older CCR and MIT have oil-filled transformers in their output stage. The oil is the key to the length of life of a liquid-filled transformer as it provides electrical insulation and conducts heat away from the windings.

1.16.2 As little as 10 parts per million of water in the oil will reduce the dielectric strength below a satisfactory value. Breathing of a transformer through a defective seal may bring in enough moisture to cause a problem. Exposure to air or excessive temperatures may cause formation of sludge. If enough sludge and water accumulate in the oil, the entire oil supply may require filtering to gain acceptable dielectric strength. If too much water gets in the transformer, it may require drying out.

1.16.3 The oil should be sampled and tested as per AS 1767.2.1-1999: Insulating liquids - Test Methods - Determination of the breakdown voltage at power frequency.

1.16.4 Do not use or add any type of oil that has not been approved by the manufacturer of the transformer. If the oil level changes appreciably from the normal range for the operating temperature, the cause should be identified and necessary repairs made.

1.16.5 Caution: Some older types of oil filled transformers may use oil that contains Polychlorinated Biphenyls (PCB), a hazardous substance. Only a competent person should check the oil for PCB content. If found to contain PCB, then the oil shall be removed as per EPA guidelines and replaced with approved, non-PCB based oil.

Typical Test Procedure

1.16.6 Note: As this testing is of an infrequent and unusual nature and specialised test equipment is required, it is recommended that the Maintenance Agent outsource this testing.

1.16.7 To test the oil in a large transformer, separate samples are taken from both the top and bottom of the transformer. These are poured into the oil test unit separately so that the oil covers two electrodes separated by a small gap.
1.16.8 Next, a high voltage is applied across the electrodes, gradually increasing up to 22 KV. If the oil can withstand a voltage of 22 KV, it is in good condition. Sparking across the electrodes indicates that the oil should be changed or filtered.
Appendix J – Inspection Check Sheets

Appendix J  Inspection Check Sheets

This appendix schedules indicative worksheets that may be used to undertake and record the required preventative maintenance.

Check sheets are provided for:

- Fortnightly AGL Performance Inspection Check Sheet
- PAPI Technical Inspection Check Sheet
- Approach Lighting, Runway Lighting Technical Inspection Check Sheet
- Threshold/End and High Use Area Technical Inspection Check Sheet
- DTRM/HCM/MAGS Technical Inspection Check Sheet
- Taxiway and Apron Edge Technical Inspection Check Sheet
- IWI Technical Inspection Check Sheet
- Aerodrome Beacon Technical Inspection Check Sheet
- Obstacle Light Technical Inspection Check Sheet
- Field Circuit Technical Inspection Check Sheet
- ALER Technical Inspection Check Sheet
### Fortnightly AGL Performance Inspection Check Sheet

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FORTNIGHTLY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.1.1(a)</td>
<td>Undertake a night inspection. Confirm that appearance, uniformity, serviceability and overall AGL pattern is good with no dull or extinguished lights.</td>
<td></td>
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<tr>
<td>App C.1.1 (b)</td>
<td>Make a visual check of all lights and fittings inspecting for mechanical damage.</td>
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<tr>
<td>App C.1.1 (c)</td>
<td>Replace faulty lamps (exchanging inset light assemblies to allow rebuild in workshop environment).</td>
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<tr>
<td>App C.1.1 (d)</td>
<td>Confirm that all fasteners required are present and secure.</td>
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</tr>
<tr>
<td>App C.1.1 (e)</td>
<td>Confirm that all light bases and surrounding tarmac are secure.</td>
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<tr>
<td>App C.1.1 (f)</td>
<td>Clean the lens of each PAPI unit.</td>
<td></td>
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<tr>
<td>App C.1.1 (g)</td>
<td>Log defects due to misaligned fittings; poor focusing; dirty or cracked filters, lenses or prisms; filament aging etc. Where lenses or filters are pitted or discoloured they are to be changed. All fittings with broken glassware, situated in the runway must be replaced or blanked off; they may not be left in service.</td>
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<tr>
<td>App C.1.1 (h)</td>
<td>Inspect DTRMs/HCMs and MAGS for mechanical damage. Confirm the structure is secure.</td>
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<tr>
<td>App C.1.1 (i)</td>
<td>Inspect the IWIs for mechanical damage. Confirm the structure is secure and the wind sleeve is not ripped or torn.</td>
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</tr>
<tr>
<td>App C.1.1 (j)</td>
<td>Test operate all circuits from the control tower console, where applicable, and observe correct operation and revertive indications. Check operation of fault flasher where appropriate by inducing a circuit fault. Check indicating lights. Confirm correct operation and correct revertive indication. Replace faulty indicator lamps as required. Repair all malfunctions found.</td>
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</tbody>
</table>
## Appendix J – Inspection Check Sheets

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.1.1 (k)</td>
<td>Undertake general housekeeping within the ALER; sweep the floors, maintain clear egress to all equipment, and check for any signs of rodent infestation.</td>
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<tr>
<td></td>
<td>Fortnightly certification of specific system elements:</td>
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<tr>
<td></td>
<td>☐ ABN</td>
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<tr>
<td></td>
<td>☐ Approach Lighting</td>
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<td></td>
<td>☐ Visual Approach Slope Indicator</td>
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<td>☐ Runway Lighting</td>
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<td></td>
<td>☐ Illuminated Wind Indicators</td>
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<td>☐ DTRM/HCMs</td>
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<td>☐ Taxiway Lighting</td>
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<td>☐ Apron Lighting</td>
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<td>☐ ALER</td>
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Inspecting Officer (Print): ___________________________  sign  ___________________________  Date  /  /  /
## PAPI Technical Inspection Check Sheet

**FORM ID:**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
<th>Initial</th>
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<tbody>
<tr>
<td><strong>MONTHLY</strong></td>
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<td></td>
</tr>
<tr>
<td>App C.2.1 (a)</td>
<td>Complete Fortnightly Performance Inspection</td>
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<td></td>
</tr>
<tr>
<td>App C.2.1 (b)</td>
<td>Check mounting feet and pillars for structural soundness and security</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.1 (c)</td>
<td>Check covers for cracks or damage. Check for free operation of hinges. Confirm structural security</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.1 (d)</td>
<td>Check exterior and internal paintwork. Touch up where necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.1 (e)</td>
<td>Lightly lubricate setting screws and bolts etc to prevent corrosion. Confirm there is no corrosion that would prevent adjustments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.1 (f)</td>
<td>Check and clean the interior. Check for insects and rodents. Confirm electrically sound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.1 (g)</td>
<td>Check and record alignment levels with &quot;clinometer&quot; tool. Compare with configuration elevation level and tolerance limits.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.1 (h)</td>
<td>Remove grass and debris likely to infringe the light beams. Hand mow as required. Confirm there is no obstruction of the light display and appearance is as designed. Clean the lens of each unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ANNUAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.2 (a)</td>
<td>Record the date of the previous Annual Technical Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.2 (b)</td>
<td>Perform the normal Fortnightly Performance and Monthly Technical Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.2 (c)</td>
<td>Tighten fasteners. Check supports and foundations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.2 (d)</td>
<td>Maintain legibility of all unit identification numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.2 (e)</td>
<td>Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix J – Inspection Check Sheets

<table>
<thead>
<tr>
<th>Reference</th>
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<th>Results / Remarks</th>
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</tr>
</thead>
<tbody>
<tr>
<td>App C.2.2 (f)</td>
<td>Inspect transformer chambers and covers for cleanliness and corrosion and visually check SITS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.2.2 (g)</td>
<td>Validate glide path and azimuth alignment by obtaining the flight inspection test results undertaken by 44WG.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inspecting Officer (Print): ___________________________ (sign) ___________________________ Date / /
## Approach Lighting, Runway Lighting Technical Inspection Check Sheet

**FORM ID:**

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<tr>
<th>Reference</th>
<th>Task</th>
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<td><strong>ANNUAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (a)</td>
<td>Record the date of the previous Annual Technical Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (b)</td>
<td>Perform the normal Fortnightly Technical Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>ANNUAL - ELEVATED LIGHTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (c)</td>
<td>Check, clean and polish glassware, including lenses, prisms, reflectors, refractors and filters. Confirm orientation, light colour and effective light output are as specified.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (d)</td>
<td>Observe condition of wiring and terminations, lamp holders, gaskets, assembly fixings, housings/fixtures. Confirm electrically sound. Confirm physical state of fittings allows serviceability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (e)</td>
<td>Check vegetation growth and other obstacles that may infringe the lights, and remove obstruction. Confirm there is no obstruction of the light display and appearance is as designed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (f)</td>
<td>Check general condition of all fittings, repair or repaint as necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (g)</td>
<td>Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (h)</td>
<td>Maintain legibility of all light identification numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (i)</td>
<td>Check all fasteners tighten as necessary. Confirm all fasteners comply fully with manufacturers recommended torque figures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (j)</td>
<td>Check light base and transformer chamber. Check condition of wiring and termination for tightness. Confirm fittings are electrically sound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (k)</td>
<td>Confirm that base shall meet frangibility requirement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (l)</td>
<td>Confirm that any security chains/cables are attached and fit for use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (m)</td>
<td>Check supports and foundations. Confirm they are secure</td>
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</table>
### Appendix J – Inspection Check Sheets

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<tbody>
<tr>
<td>App C.3.1 (n)</td>
<td>Check levelling, azimuth and elevation, and adjust as necessary. Confirm orientation is as specified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (o)</td>
<td>Maintain legibility of all light identification numbers</td>
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#### ANNUAL - INSET LIGHTS

<table>
<thead>
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<tbody>
<tr>
<td>App C.3.1 (p)</td>
<td>Check all flush fittings for moisture and water ingress, cracked filters or broken glassware. Replace fittings where necessary. Confirm orientation, light colour, serviceability and effective light output are as specified. Clean glassware and lenses.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (q)</td>
<td>Check torque for all flush fittings in runway and taxiway. Note: Fasteners for all flush fittings, adaptor plates and blanking plates situated in a runway or taxiway must be torque tested and the torques restored to the manufacturers recommended figures, unless a tab washer protects the fastener. Where tab washers protect fasteners and a visual check indicates the tab has not been strained, this will suffice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (r)</td>
<td>Check surrounding tarmac for signs of break up near to flush runway and taxiway fittings. Report defects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (s)</td>
<td>Confirm security of light base and surrounding tarmac and the alignment of the seating plate is as designed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (t)</td>
<td>Check general condition of all fittings, repair or repaint as necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (u)</td>
<td>Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.3.1 (v)</td>
<td>Maintain legibility of all light identification numbers</td>
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</table>

Inspecting Officer (Print): ___________________________ (sign) ___________________________ Date / /
<table>
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<tr>
<td>SIX-MONTHLY</td>
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<tr>
<td>App C.4.1 (a)</td>
<td>Complete the Fortnightly Technical Inspection</td>
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<tr>
<td>ELEVATED LIGHTS</td>
<td></td>
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</tr>
<tr>
<td>App C.4.1 (b)</td>
<td>Check, clean and polish glassware, including lenses, prisms, reflectors, refractors and filters. Confirm orientation, light colour and effective light output are as specified.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.1 (c)</td>
<td>Observe condition of wiring and terminations, lamp holders, gaskets, assembly fixings, housings/fixtures. Confirm electrically sound. Confirm physical state of fittings allows serviceability.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.1 (d)</td>
<td>Check vegetation growth and other obstacles that may infringe the lights, and remove obstruction. Confirm there is no obstruction of the light display and appearance is as designed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSET LIGHTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.1 (e)</td>
<td>Check all flush fittings including centreline lights and edge lights for moisture and water ingress, cracked filters or broken glassware. Replace fittings where necessary. Confirm orientation, light colour, serviceability and effective light output are as specified.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.1 (f)</td>
<td>Check torque for all flush fittings in runway and taxiway. Note: Fasteners for all flush fittings, adaptor plates and blanking plates situated in a runway or taxiway must be torque tested and the torques restored to the manufacturers recommended figures, unless a tab washer protects the fastener. Where tab washers protect fasteners and a visual check indicates the tab has not been strained, this will suffice.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.1 (g)</td>
<td>Check surrounding tarmac for signs of break up near to flush runway and taxiway fittings. Report defects.</td>
<td></td>
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**Appendix J – Inspection Check Sheets**

**Threshold/End and High Use Area Technical Inspection Check Sheet**
## Appendix J – Inspection Check Sheets

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</tr>
</thead>
<tbody>
<tr>
<td>App C.4.1 (h)</td>
<td>Confirm security of light base and surrounding tarmac and the alignment of the seating plate is as designed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ANNUAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (a)</td>
<td>Record the date of the previous Annual Technical Inspection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (b)</td>
<td>Perform the normal Fortnightly Performance and 6-Monthly Technical Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ELEVATED LIGHTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (c)</td>
<td>Check general condition of all fittings, repair or repaint as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (d)</td>
<td>Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (e)</td>
<td>Maintain legibility of all light identification numbers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (f)</td>
<td>Check all fasteners tighten as necessary. Confirm all fasteners comply fully with recommended torque figures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (g)</td>
<td>Check light base and transformer chamber. Check condition of wiring and termination for tightness. Confirm fittings are electrically sound.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (h)</td>
<td>Confirm that base shall meet frangibility requirement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (i)</td>
<td>Confirm that any security chains/cables are attached and fit for use.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (j)</td>
<td>Check supports and foundations. Confirm they are secure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (k)</td>
<td>Check levelling, azimuth and elevation, and adjust as necessary. Confirm orientation is as designed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>INSET LIGHTS</strong></td>
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### Appendix J – Inspection Check Sheets

<table>
<thead>
<tr>
<th>Reference</th>
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<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.4.2 (l)</td>
<td>Check general condition of all fittings, repair or repaint as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (m)</td>
<td>Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.4.2 (n)</td>
<td>Maintain legibility of all light identification numbers.</td>
<td></td>
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</tbody>
</table>

Inspecting Officer (Print): ________________________________ (sign) ________________________________ Date / /
## DTRM/HCM/MAGS Technical Inspection Check Sheet

**FORM ID:**

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<tr>
<td>App C.5.1 (a)</td>
<td>Record the date of the previous Annual Technical Inspection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.5.1 (b)</td>
<td>Perform the normal Fortnightly Performance Inspection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.5.1 (c)</td>
<td>Clean face panels of signs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.5.1 (d)</td>
<td>Check condition of lamp holders, reflectors, wiring and terminations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.5.1 (e)</td>
<td>Perform an insulation test if the sign lighting is powered at 230V; measure circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with the AS/NZS 3000.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.5.1 (f)</td>
<td>Check attachment points and frangible couplings; confirm they are sound.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.5.1 (g)</td>
<td>Check paintwork and touch up as necessary.</td>
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</table>

Inspecting Officer (Print): ______________________________ (sign) ______________________________ Date / /
# Appendix J – Inspection Check Sheets

## Taxiway and Apron Edge Technical Inspection Check Sheet

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## ANNUAL

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<tbody>
<tr>
<td>App C.6.1 (a)</td>
<td>Record the date of the previous Annual Technical Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (b)</td>
<td>Complete the normal Fortnightly Technical Inspection</td>
<td></td>
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</table>

## ELEVATED LIGHTS

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
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</tr>
</thead>
<tbody>
<tr>
<td>App C.6.1 (c)</td>
<td>Check, clean and polish glassware, including lenses, prisms, reflectors, refractors and filters. Confirm orientation, light colour and effective light output are as specified.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (d)</td>
<td>Observe condition of wiring and terminations, lamp holders, gaskets, assembly fixings, housings/fixtures. Confirm electrically sound. Confirm physical state of fittings allows serviceability.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (e)</td>
<td>Check general condition of all fittings, repair or repaint as necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (f)</td>
<td>Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (g)</td>
<td>Maintain legibility of all light identification numbers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (h)</td>
<td>Check all fasteners tighten as necessary. Confirm all fasteners comply fully with recommended torque figures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (i)</td>
<td>Check light base and transformer chamber. Check condition of wiring and terminations for tightness.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (j)</td>
<td>Confirm light base and surrounding tarmac are secure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (k)</td>
<td>Check supports and foundations. Confirm they are secure</td>
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</table>
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<tbody>
<tr>
<td>App C.6.1 (l)</td>
<td>Check levelling, azimuth and elevation, and adjust as necessary. Confirm orientation is as designed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (m)</td>
<td>Check vegetation growth and other obstacles that may infringe the lights, and remove obstruction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (n)</td>
<td>Confirm there is no obstruction of the light display and appearance is as designed.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### INSET LIGHTS

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>App C.6.1 (o)</td>
<td>Check all flush fittings for moisture and water ingress, cracked filters or broken glassware. Replace fittings where necessary. Confirm orientation, light colour, serviceability and effective light output are as specified. Clean glassware and lenses.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (p)</td>
<td>Check torque for all flush fittings in runway and taxiway. Note: Fasteners for all flush fittings, adaptor plates and blanking plates situated in a runway or taxiway must be torque tested and the torques restored to the manufacturers recommended figures, unless a tab washer protects the fastener. Where tab washers protect fasteners and a visual check indicates the tab has not been strained, this will suffice.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (q)</td>
<td>Check surrounding tarmac for signs of break up near to flush runway and taxiway fittings. Report defects.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (r)</td>
<td>Confirm security of light base and surrounding tarmac and the alignment of the seating plate is as designed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (s)</td>
<td>Check general condition of all fittings, repair or repaint as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (t)</td>
<td>Evaluate lamp condition (filament shape, excessive discolouration) and replace as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.6.1 (u)</td>
<td>Maintain legibility of all light identification numbers.</td>
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<tr>
<td>App C.6.1 (v)</td>
<td>At the completion of the Performance Inspection, record the activity including time and date in Maintenance Diary and file the signed checklist in a suitable manner that allows retrieval as required.</td>
<td></td>
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</tr>
</tbody>
</table>

Inspecting Officer (Print): ___________________________ (sign) ___________________________ Date / /
## IWI Technical Inspection Check Sheet

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<td><strong>ANNUAL</strong></td>
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<tr>
<td>App C.7.1 (a)</td>
<td>Perform normal Fortnightly Performance Inspection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.7.1 (b)</td>
<td>Check bearings for freedom of movement in azimuth and elevation. Lubricate bearings if appropriate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.7.1 (c)</td>
<td>Check fabric and sock attachment points.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.7.1 (d)</td>
<td>Check condition of lamp holders, reflectors, wiring and terminations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.7.1 (e)</td>
<td>Perform an insulation test. If IWI is powered by a 230V supply, measure circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with the AS/NZS 3000.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.7.1 (f)</td>
<td>Check paintwork and touch up as necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.7.1 (g)</td>
<td>Inspect supports and foundations. Confirm they are sound.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inspecting Officer (Print): ___________________________ (sign) ___________________________ Date / /
### Aerodrome Beacon Technical Inspection Check Sheet

**FORM ID:**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANNUAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (a)</td>
<td>Record the date of previous of the previous Annual Technical Inspection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (b)</td>
<td>Complete Fortnightly Performance Inspection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (c)</td>
<td>Check bearings for freedom of movement. Lubricate as required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (d)</td>
<td>Check condition of lamp holders, reflectors, wiring and terminations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (e)</td>
<td>Perform an insulation test. If powered by 230V, measure circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with AS/NZS 3000.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (f)</td>
<td>Replace service and standby lamps. Ensure correct lamp alignment and orientation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (g)</td>
<td>Check condition of glassware and filters, if applicable. Confirm effective light output and light colour is as specified.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (h)</td>
<td>Check condition of wiring and termination for tightness. Confirm fittings are electrically sound.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (j)</td>
<td>Check, clean and lubricate the following: main bearings; motor bearings; reduction gear. Confirm free operation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (l)</td>
<td>Inspect and clean slip rings and brush gear. Confirm electrically sound.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix J – Inspection Check Sheets

**FORM ID:**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.8.1 (m)</td>
<td>Measure insulation of motor, transformer and wiring. Note: Both limits and plug-in electronic units should first be removed. Record IR test results.</td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (n)</td>
<td>Check mounting and levelling. Confirm angular coverage is as designed.</td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (o)</td>
<td>Check weatherproofing and gaskets. Confirm they are sound.</td>
<td></td>
</tr>
<tr>
<td>App C.8.1 (p)</td>
<td>Count flash rate. Confirm compliance with commissioning figure.</td>
<td></td>
</tr>
</tbody>
</table>

Inspecting Officer (Print): ________________________________ (sign) ____________________________ Date / / /
### Obstacle Light Technical Inspection Check Sheet

**FORM ID:**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

#### SIX-MONTHLY

- **App C.9.1 (a):** Perform insulation test of electrical feeders. Measure 230-volt circuits between phase and earth, phase and neutral and neutral and earth with a 500-volt insulation tester. Circuits must comply with AS/NZS 3000.

#### ANNUAL

- **App C.9.2 (a):** Record the date of the previous Annual Technical Inspection.
- **App C.9.2 (b):** Perform the normal 6-Monthly Technical Inspection
- **App C.9.2 (c):** Change Lamps, Check, clean and polish glassware
- **App C.9.2 (d):** Check fasteners, Check light base
- **App C.9.2 (e):** Check wiring and termination
- **App C.9.2 (f):** Inspect structures, posts and poles. Inspect supports and foundations
- **App C.9.2 (g):** Check levelling, azimuth and elevation.
- **App C.9.2 (h):** Maintain identification numbers

**Inspecting Officer (Print):** ________________________________  
**(sign)..................................................................................**  
**Date: / /**
### Field Circuit Technical Inspection Check Sheet

**FORM ID:**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Date of Last Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.10.1(a) and App C.11.1 (a)</td>
<td>De-energise all circuits and tag appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.10.1(b) and App C.11.1 (b)</td>
<td>Isolate/disconnect both leads from the regulator output terminals</td>
<td>Earth connections that have been applied for the purpose of performing maintenance may be temporarily removed if necessary to perform specific tests. The earth connections shall only be disconnected whilst those tests are being performed and shall be reconnected upon completion of the tests.</td>
<td></td>
</tr>
<tr>
<td>App C.10.1(c) and App C.11.1 (c)</td>
<td>Test for continuity of the primary circuit by ohmmeter or equivalent method; measuring and recording the result for each field circuit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| App C.10.1(d) and App C.11.1 (d) | Test the cable at the required test voltage (1000V for 3000V rated cable; 3000V for 5000V rated cable); measuring and recording the Insulation Resistance for each field circuit. The maximum acceptable leakage current for the circuit tested, in microamperes, should not exceed a value calculated as follows:  
  - 2 \( \mu \)A for each series isolating transformer in circuit  
  - 1 \( \mu \)A for each 100 metres of primary cable in circuit |                  |         |
| App C.10.1(e) | If the leakage current exceeds the value calculated as outlined above, that is, the insulation resistance falls below the serviceability value, the circuit shall be sectionalised and the tests repeated for each section to determine if the deterioration is localised or a general deterioration. Ensure that the cable end and sheath is clean and dry for a distance of 300 mm from the end of the cable when cable is sectionalised external to the ALER. |                  |         |
## Appendix J – Inspection Check Sheets

### FORM ID:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.10.1(f) and App C.11.1 (e)</td>
<td>If the low Insulation Resistance reading is restricted to one part of the circuit, the faulty component, section of cable or any SIT found to be the cause of low Insulation Resistance readings shall be replaced immediately.</td>
<td></td>
</tr>
<tr>
<td>App C.10.3 (a)</td>
<td>Investigate and replace SITs with low values of IR</td>
<td></td>
</tr>
<tr>
<td>App C.10.1</td>
<td>Record insulation resistances in a tabulated format</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Circuit Continuity</th>
<th>Insulation Resistance - Calculated</th>
<th>Insulation Resistance - Measured</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Approach Lighting Circuit</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Visual Approach Slope Indicator Circuit</td>
<td></td>
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<tr>
<td>Runway Circuit</td>
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<tr>
<td>Illuminated Wind Indicator Circuit</td>
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<tr>
<td>DTRM/HCM Circuit</td>
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<tr>
<td>Taxiway Circuit</td>
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<tr>
<td>Apron Circuit</td>
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<tr>
<td>MAGS Circuit</td>
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Inspecting Officer (Print): ______________________________ (sign) __________________________ Date / / /
## ALER Technical Inspection Check Sheet

<table>
<thead>
<tr>
<th>Reference</th>
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<th>Results / Remarks</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANNUAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GENERAL CONDITION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.1 (a)</td>
<td>Undertake general housekeeping.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.1 (b)</td>
<td>Sweep the floors; maintain clear egress to all equipment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.1 (c)</td>
<td>Check for any signs of rodent infestation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.1 (d)</td>
<td>The ALER is not to be used as a storage facility for non-AGL equipment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LV SWITCHBOARDS AND CONTROL PANELS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (a)</td>
<td>Check operation of local and remote controls.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (b)</td>
<td>Check the operating voltages between phases, and between phases to neutral are normal.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (c)</td>
<td>Check all indicating lights are working correctly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (d)</td>
<td>Check switchboard and control panel interlocks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (e)</td>
<td>Check switchboard and control panel operation and clean.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (f)</td>
<td>Clean and lubricate all relays and contactors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (g)</td>
<td>Calibrate all instruments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td>Task</td>
<td>Results / Remarks</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>App C.12.2 (h)</td>
<td>Check all wiring and terminations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>App C.12.2 (i)</td>
<td>Measure and record insulation resistance of the installation; validate compliance with AS/NZS 3000 (1 MΩ).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CONSTANT CURRENT REGULATORS

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.12.3 (a)</td>
<td>Check operation of local and remote controls.</td>
<td></td>
</tr>
<tr>
<td>App C.12.3 (b)</td>
<td>Check and adjust current output for each circuit and intensity recording field measured results.</td>
<td></td>
</tr>
<tr>
<td>App C.12.3 (c)</td>
<td>Check the tap position on transformers. Check and adjust outputs to comply with value recorded in configuration details.</td>
<td></td>
</tr>
</tbody>
</table>

### LIGHTING CONTROL SYSTEM

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.12.4 (a)</td>
<td>Test (operate) all aeronautical ground lighting circuits. Observe correct operation and revertive indication.</td>
<td></td>
</tr>
<tr>
<td>App C.12.4 (b)</td>
<td>Check all indications are operating correctly. Replace faulty lamps and indicators as applicable.</td>
<td></td>
</tr>
</tbody>
</table>

### BATTERY AND CHARGER SUPPLY

<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.12.5 (a)</td>
<td>Record from the inbuilt meters, (where fitted): Input voltage; input current; battery voltage</td>
<td></td>
</tr>
<tr>
<td>App C.12.5 (b)</td>
<td>Check and record charger rate.</td>
<td></td>
</tr>
<tr>
<td>App C.12.5 (c)</td>
<td>Check electrolyte level and specific gravity of wet cells. Top up with distilled water if necessary.</td>
<td></td>
</tr>
<tr>
<td>App C.12.5 (d)</td>
<td>Check battery vent plugs, terminals and connections</td>
<td></td>
</tr>
</tbody>
</table>

### LOCAL EMERGENCY GENERATOR
<table>
<thead>
<tr>
<th>Reference</th>
<th>Task</th>
<th>Results / Remarks</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>App C.12.6 (a)</td>
<td>Validate restoration of the AGL supplied on the LEG after mains failure within a period of less than 15 seconds.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inspecting Officer (Print): ____________________________ (sign) ____________________________

Date / /