U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: SPECIFICATION FOR L-890 AIRPORT LIGHTING CONTROL AND MONITORING SYSTEM (ALCMS)
Date: 09/30/04
Initiated by: AAS-100
AC No.: 150/5345-56
Change:

1. PURPOSE. This advisory circular (AC) specifies minimum requirements for an Airport Lighting Control and Monitoring System (ALCMS). The ALCMS simplifies the control and monitoring of lighted visual aids and enhances airport safety. The basic function of the system remains the same whether for a general aviation airport that supports only a few operations in a day or a large commercial airport which caters to hundreds of operations on any given day.

2. EFFECTIVE DATE. Effective six months after the issue date of the AC, only that equipment qualified in accordance with the specification herein will be listed in accordance with AC 150/5345-53, Airport Lighting Equipment Certification Program. Airports that have previously installed an Airport Lighting Control and Monitoring System (ALCMS) will not be required to install a new system after the effective date of the AC.

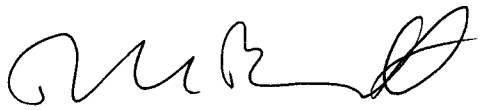
3. APPLICATION. The standards contained in this AC are recommended by the Federal Aviation Administration (FAA) in all applications involving airport development of this nature. For airport projects receiving federal funds under the airport grant assistance program, the use of the standards in this AC are mandatory.

4. BACKGROUND. Many airports are requesting to install computerized touchscreen controls for airport lighting systems. The current specification for lighting control panel described in Advisory Circular (AC) 150/5345-3, Specification for L-821, Panels for Control of Airport Lighting, does not include specifications for this technology. However, under the Federal Aviation Administration's (FAA) modification of standards provisions, computerized touchscreen control panels have been installed at some airports and have proven to meet the functional requirements for lighting control panels as specified in AC 150/5345-3 and other related AC's.

5. METRICS. To promote an orderly transition to metric units, this advisory circular includes both English and metric dimensions. The metric conversion may not be exact equivalents, and until there is an official changeover to the metric system, the English dimensions will govern.

6. COPIES OF THIS AC. The Office of Airport Safety and Standards is in the process of making ACs available to the public through the Internet. These ACs may be found through the Federal Aviation Administration (FAA) home page (www.faa.gov). To get to the AC area, on the home page: (select) Airports & Air Traffic: (select) Information for: Airport Operators: (select) Topic Index: Advisory Circulars. A printed copy of this and other ACs can be ordered from the U.S. Department of Transportation, Subsequent Business Office, Annmore East Business Center, 3341 Q 75th Avenue, Landover, Maryland, 20785.

ACs may also be ordered through the AC Checklist, which can also be accessed through the FAA home page. To access the AC Checklist from the FAA home page, select "Site Map," “FAA Organizations," "Headquarters Offices," “Financial Services (ABA),” “Advisory Circulars,” then "Advisory Circular Checklist."



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Director of Airport Safety and Standards

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FAA Specification for L-890
Airport Lighting Control and Monitoring System (ALCMS)

1. Scope and Classification

1.1 Scope

This specification covers the requirements and recommendations for an Airport Lighting Control and Monitoring System (ALCMS)

1.2 Equipment Classifications

This specification covers the Airport Lighting Control and Monitoring System with the following classifications types.

1.2.1 Type

The following types of systems are covered by this specification

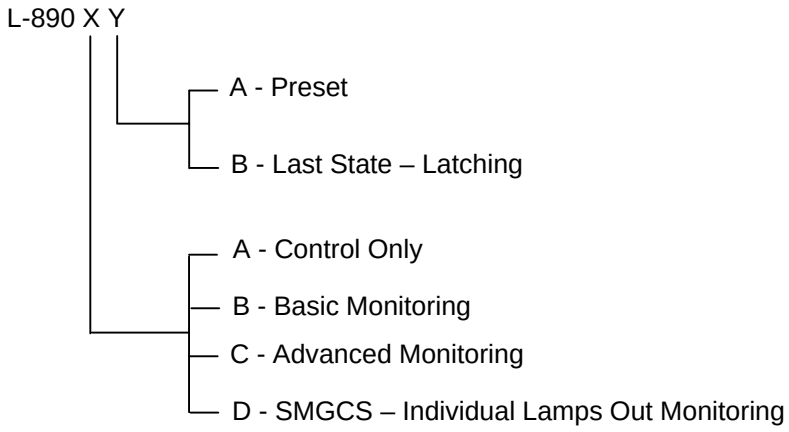


Table 1: ALCMS Classification Types

Details regarding requirements of the classification types are covered by this specification in the following sections:

Control Design Requirements	Section 5
Monitoring Requirements	Section 6
Failsafe Design Requirements	Section 7

1.3 Definition of Terms

To follow are definitions of terms and acronyms used in this specification

AC	Advisory Circular
AGL	Airport Ground Lighting
ALSF	High Intensity Approach Lights with Sequenced Flasher
ATC	Airport Traffic Control – Includes ATCT and Flight Service Station
ATCT	Airport Traffic Control Tower
CCR	Constant Current Regulator
CGC	Commercial Grade Computer
CPU	Central Processing Unit
CRT	Cathode Ray Tube
CSR	Current Sensing Relay
Designer	One who designs and specifies the requirements for the ALCMS
Electrical Vault	Installation location of Constant Current Regulators
EMI	Electro-magnetic Interference
FSS	Flight Service Station
GUI	Graphical User Interface
HMI	Human Machine Interface: a touchscreen that displays an airport graphic with touch points that control the various constant current regulators and related equipment.
IGC	Industrial Grade Computer
IRM	Insulation Resistance Monitor
LED	Light Emitting Diode
PC	Personal Computer
PLC	Programmable Logic Controller
MALSR	Medium Approach Lighting System with Runway Alignment Indicator Lights
M Ohm	Meg Ohm
PAPI	Precision Approach Path Indicator
RAID	Redundant Array of Inexpensive Disks
REIL	Runway End Identifier Light
RF	Radio Frequency
RVR	Runway Visual Range
SMGCS	Surface Movement Guidance and Control System
UPS	Uninterruptible Power Supply
VAC	Voltage Alternating Current
VASI	Visual Approach Slope Indicator
VDC	Voltage Direct Current
VP	Vault Processor – Computer or Programmable Logic Controller (PLC)

2. Reference Documents

2.1 FAA Advisory Circulars

AC 120-57	Surface Movement Guidance and Control System
AC 150-5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-3	Specification for L-821 Panels for Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-53	Airport Lighting Equipment Certification Program
AC 150/5370-10	Standards for Specifying Construction of Airports

2.2 FAA Orders

Order 6750.24	Instrument Landing System and Ancillary Electronic Component Configuration and Performance Requirements
Order 6850.2	Visual Guidance Lighting Systems
Order 7110.65	Air Traffic Control

2.3 Military Standards

MIL-STD-810F	DoD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests

2.4 National Electric Code (NEC)

NFPA 70	National Electrical Code

3. ALCMS General System Requirements

3.1 ALCMS Overview

Figure 1 illustrates the integration of the primary control and monitoring functions of the ALCMS system. The airport operator can control and monitor all elements of the system using the computer processing power to simplify and manage the systems in a way defined by the airport operator.

The arrows indicate the direction in which information flows. A solid line represents the minimum control and monitoring system interfaces one would expect in a basic system. The broken line indicates those options available that may be utilized depending on the airport configuration and requirements.

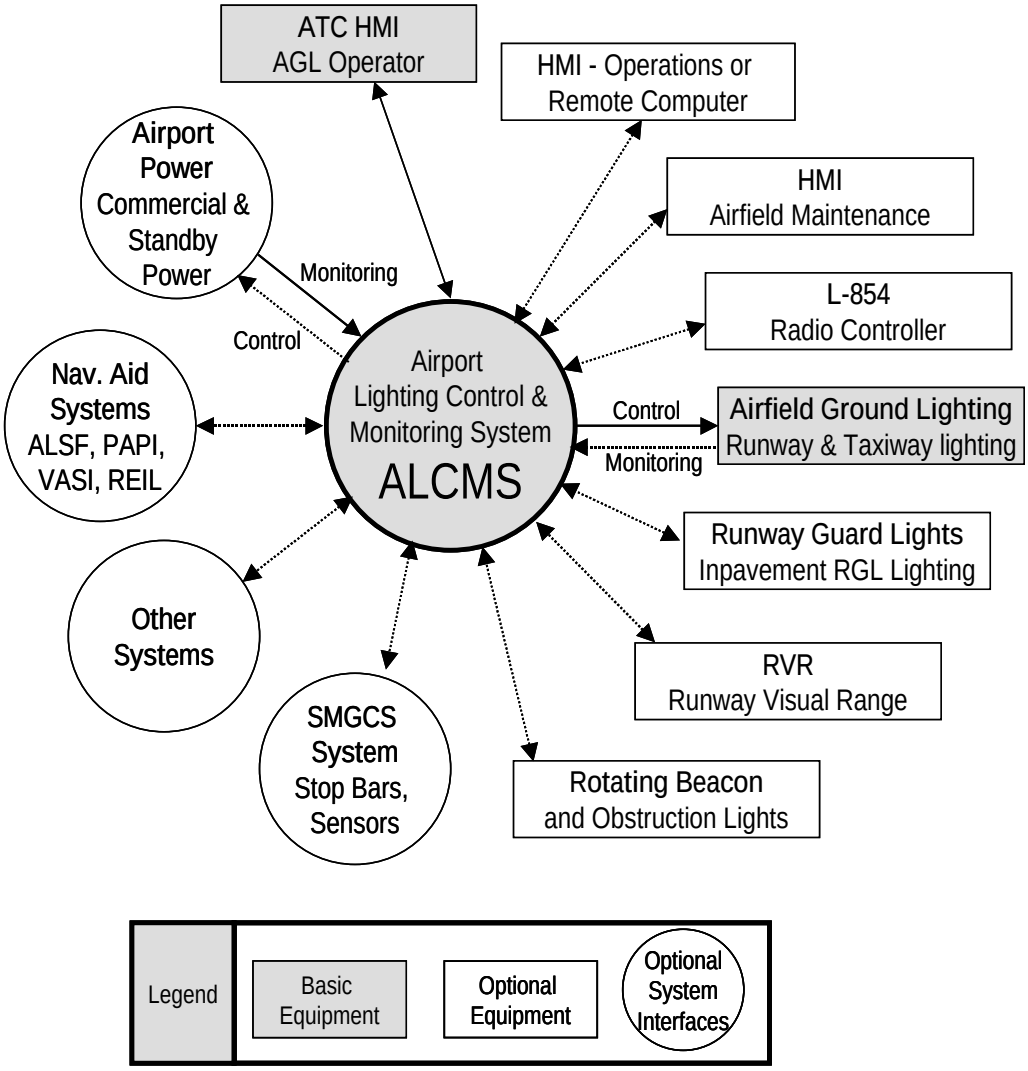


Figure 1: ALCMS Interface Overview

3.2 ALCMS Components

Each control system utilizes similar hardware components to perform certain functions that are part of the overall system. The major components of an ALCMS are illustrated in Figure 2 and discussed in detail in the section to follow.

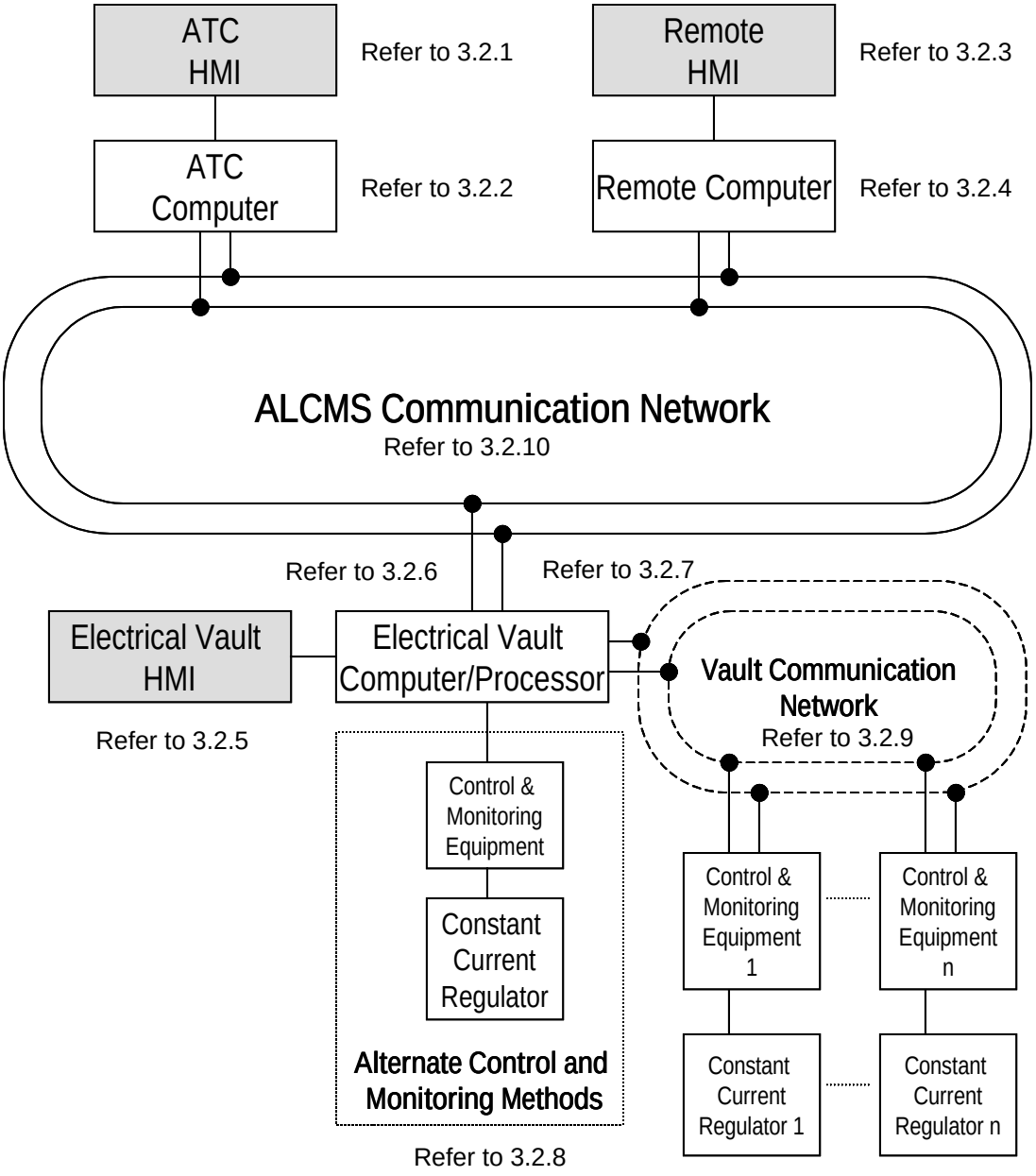


Figure 2: ALCMS Components Overview

3.2.1 ATC Human Machine Interface (HMI)

This is the hardware that interfaces between the airport lighting control operator and the control system. The HMI is a touchscreen that displays an airport graphic with touch points that control the various constant current regulators and related equipment. The number of HMI units depends on the complexity of the airport and the desire for added redundancy.

3.2.2 ATC Computer
This computer, usually located near the ATC HMI in the tower, receives the commands from the HMI and converts them to digital format for transmission over a fiber optic cable, wireless network or copper wire to a computer in the electrical vault. The computer must be an industrial type. The hardware must be suitable to run operating systems such as a Windows or UNIX platform. Two computers running simultaneously can be utilized if added redundancy is desired. Laptop computers must not be used for the ATC Computer.

3.2.3 Remote HMI
This is the hardware that allows remote operating personnel to interface with the ALCMS. This HMI is typically a service monitor, keyboard and mouse (Touchscreen is optional). This HMI displays "view only" status information of the ALCMS. The number of Remote HMI units depends on the complexity of the airport and the desire for added redundancy. A Remote HMI must be capable of providing "control" capabilities if desired by the airport.

3.2.4 Remote Computer
The airport may desire computer(s) at other locations around the airport for the purpose of monitoring the status of the airport lighting equipment (i.e. Operations). This computer will be connected to the airport network utilizing the appropriate network interface equipment and will display the information required by the airport via the Remote HMI mentioned previously.

3.2.5 Electrical Vault HMI
This is the hardware that provides an operator interface at the Electrical Vault. This HMI is typically a service monitor, keyboard and mouse (Touchscreen is optional). This HMI defaults as "view only" status information of the ALCMS. The number of Vault HMI units depends on the complexity of the airport and the desire for added redundancy. The Vault HMI must be capable of providing "control" capabilities if desired by the airport.

3.2.6 Electrical Vault Computer
This computer is the same type as the ATC computer except it is located in the electrical vault and has the necessary equipment for interfacing with the vault network. The network interfacing equipment may be integral or separate from the vault computer. Two computers running simultaneously can be utilized if added redundancy is desired. Laptop computers must not be used for the Electrical Vault Computer.

3.2.7 Vault Processor (VP)
This device interfaces directly with the ALCMS Communication Network. The VP may be a CPU, PLC or other device that provides the necessary link to the CCR, circuit selector switch, generator, insulation resistance meggering unit, power line carrier, or other system.

3.2.8 Control and Monitoring Equipment Interface
This device interfaces with the Vault Communication Network and provides the necessary relay contacts or data link to the CCR, circuit selector switch, generator, insulation resistance meggering unit, power line carrier, or other system. The interface device must have inputs and outputs to handle the control of all previously mentioned equipment. Inputs and Outputs must include analog, digital and other data ports as required for interfacing with the equipment. The interface device may also have a built in processor. It may also be used in transmitting equipment performance and circuit data to the vault network that will then be transmitted to the ATC HMI and Remote HMI. This device may be an integral component of the control and monitored element or a separate device that is interfaced to the element.

3.2.9 Vault Communication Network
The vault communication network provides communication between the electrical vault computer and any controlled or monitored equipment. The vault network transmission medium may be hardwire or fiber optic cable. This network is dedicated for the ALCMS. Refer to Appendix 1: Communications Application Notes for designing the vault communication network.

3.2.10 ALCMS Communication Network

The communication network ties all the various computers and the electrical vault computer(s) together forming the Airport Lighting Control and Monitoring System (ALCMS). The network transmission medium may be hardwire, fiber optic cable or wireless. This network is dedicated for the ALCMS. Refer to Appendix 1: Communications Application Notes for designing the ALCMS communication network.

4. Design Requirements

This section provides design requirements for the ALCMS and reviews all of the subsystems that may be incorporated as part of the control and monitoring system.

4.1 Environmental Requirements

The equipment furnished as part of the control and monitoring system must be suitable for the environment that it will be operated in. All equipment must be rated to operate in ambient temperature between 32°/+104°F (0°C/+40°C) at 0-90% relative humidity. The ALCMS components must be housed in an enclosure (minimum NEMA 12) in accordance with applicable NEC requirements for the environmental conditions. Additional climate control of the ALCMS component enclosures may be required based on site conditions. The ALCMS must cause minimal radiated or conducted electromagnetic interference to other equipment such as computers, radars, instrument landing systems, radio receivers, very high frequency omni directional radio ranges, etc., that may be located on or near an airport, or that may use the same power supply.

4.2 Electrical Requirements

All enclosures must meet the NEC requirements for volume to house components. Wiring sizes, insulation, and over-current protection devices must meet the NEC requirements. Fiber Optic cables must meet the NEC requirements. Low voltage from computer cabinets to control and monitoring devices must meet the NEC requirements for permanent wiring.

4.3 Hardware Requirements

This section provides detailed hardware design requirements for the selection and specifying of the ALCMS components as illustrated in Figure 2.

4.3.1 ATC HMI

The ATC HMI must be a touchscreen monitor. The Designer must specify the size, resolution and mounting requirements of the monitor. Monitor resolution must be capable of displaying the airport graphics. At a minimum the touchscreen monitor must have the following requirements:

a. The monitor must be liquid crystal display (LCD) or equivalent technology. CRT monitors are not acceptable.
b. Integrated touchscreen technology. Refer to Appendix 3 for application notes in specifying the touchscreen technology
c. Non-glare, non-reflective viewing surface
d. Refer to Appendix 4 for application note regarding touchscreen installation.

4.3.2 ATC Computer

The ATC Computer associated with the ATC HMI must have the following minimum requirements:

a. Capable of being installed a minimum of 500 feet (to correspond to Appendix 4.h) from the ATC HMI. Additional video/communication extension equipment may be required.
b. Industrial Grade Computer (IGC) designed for industrial applications. This computer can be a separate component or integrated with the ATC HMI.

c. All equipment must be assembled in NEMA 12 enclosures and connected as a complete system. This enclosure must be suitable for the local environment.
d. Required communication equipment capable of transmitting the control and status information between the ATC HMI and the other ALCMS computers.
e. Power for the ATC Computer must be from a circuit on the tower emergency power panel or by an independent uninterruptible power supply specified by the Designer.

4.3.3 Remote HMI
The Remote HMI must be a video monitor with keyboard and mouse (Touchscreen monitor is optional). The Designer must specify the size of the monitor based on installation limitations and recommendations from ALCMS manufacturers. Monitor resolution must be capable of handling the airport graphics.

4.3.4 Remote Computer
The ALCMS must be capable of adding additional Remote Computers to its network topology as required. The Remote Computer must have the following minimum requirements:

a. Industrial or Commercial Grade Computer.
b. Required communication equipment capable of viewing the control and status information of the ALCMS
c. At a minimum the Remote Computer must provide the operator the capabilities to display the ALCMS historical and current information (events, warnings and alarms). If system has monitoring capabilities, the computer must display airport lighting circuit monitoring status.
d. The Remote Computer must default to “view only” but have the capability to control the airport lighting system if the airport requires this feature.
e. Power for the Remote Computer must be from an uninterruptible power supply.

4.3.5 Electrical Vault HMI
a. The Electrical Vault HMI must be a video monitor with keyboard and mouse (Touchscreen monitor is optional). The Designer must specify the size of the monitor based on installation limitations and recommendations from ALCMS manufacturers. Monitor resolution must be capable of handling the airport graphics.

4.3.6 Electrical Vault Computer
The Electrical Vault Computer associated with the Vault HMI must have the following minimum requirements:

a. Industrial Grade Computer (IGC) designed for industrial applications.
b. All equipment must be assembled in NEMA 12 enclosures and connected as a complete system.
c. Required communication equipment capable of transmitting the control and status information to the ATC HMI and the other ALCMS computers.
d. Capable of control and/or monitoring of the airport circuits, generators, and other devices within the Electrical Vault
e. Interface to Vault Control and Monitoring Equipment.
f. Interface to the Failsafe system.
g. Power for the Vault Computer must be from an uninterruptible power supply.

4.3.7 Vault Processor
The Vault Processor must have the following minimum requirements:

a. All equipment must be assembled in NEMA 12 enclosures and connected as a complete system.
b. Required communication equipment capable of transmitting the control and status information to the ATC HMI and the other ALCMS computers.

c. Capable of control and/or monitoring of the airport circuits, generators, and other devices within the Electrical Vault.
d. Interface to Vault Control and Monitoring Equipment.
e. Interface to the Failsafe system.
f. Power for the Vault Computer must be from an uninterruptible power supply.

4.3.8 Control and Monitoring Equipment

The Control and Monitoring Equipment must have the following minimum requirements:

a. Power for the Control and Monitoring Equipment must be from an uninterruptible power supply.
b. For design requirements of the Control and Monitoring Equipment, refer to the following sections:
   Section 5 Control Design Requirements;

   Section 6 Monitoring Requirements;

   Section 7 Failsafe Design Requirements.

4.4 Communication requirements

The communications subsystem must be capable of communicating over hard wire, fiber optic, wireless or telephone modems to interface the ALCMS components. For added redundancy, a backup link is recommended between the ATC and vault. Where a redundant link is used, it must automatically switch over to the backup link. Once the primary link is available and determined to be operational by the ALCMS the ALCMS must automatically switch back to the primary link. Application notes for communications are provided in Appendix 1 and a worksheet for performing fiber optic budget calculations is provided in Appendix 2.

In the event of a loss of communication over one link between these subsystems, an alarm must be displayed on the ATC HMI touchscreens, Vault HMI, and other Remote Client HMIs as defined by the airport sponsor. Refer to section 7.2 for more detail on ALCMS event handling and storage.

4.5 Software Version Control

The ALCMS software includes but is not limited to the software source code, compiled programs, executable files and PLC ladder logic. All software associated with the ALCMS must be kept under appropriate version control by the ALCMS manufacturer. Software version control must meet the following minimum requirements:

a. ALCMS manufacturer must have established ISO certified (current edition) software control procedures.
b. Proper software coding techniques must be practiced including software remarks when appropriate.
c. All ALCMS software must be version controlled utilizing a software version control system.
d. Software versions must be date stamped with the ability to track software changes.
e. All ALCMS software must be stored electronically (i.e. on a network).
f. The network must be backed up with back-up copies stored off site.

4.6 Hardware Design Version Control

The ALCMS hardware design, including assembly drawings, wiring diagrams and bill of materials must be kept under appropriate version control by the ALCMS manufacturer. Hardware design version control must meet the following minimum requirements:

a. ALCMS manufacturer must have established ISO certified documentation control procedures.

b. The ALCMS hardware must be designed using a commercially available Computer Aided Design (CAD) software package.
c. All ALCMS drawings must be tracked based on date of changes.
d. All ALCMS drawings must be stored electronically (i.e. on a network).
e. The network must be backed up with back-up copies stored off site.

4.7 Human Machine Interface (HMI) Graphics Requirements

This section describes the graphical requirements for the HMI's of the ALCMS.

4.7.1 General Requirements

The ALCMS must have the following minimum HMI graphics requirements:

a. A "CONFIRM" or "ACCEPT" button to prevent unintentional actuation of circuits and to allow an operator to authenticate a control action .
b. A "REJECT" or "CANCEL" button to abort a control action.
c. The color red must be used for alarm annunciation of circuit graphics and touch buttons.
d. The color orange must be used for maintenance lockout.
e. A color legend must be able to be displayed to indicate color representation.
f. Various colors must be able to be used to indicate the change of runway and taxiway lighting brightness steps.
g. Brightness step settings must be indicated by text on the associated circuit button.

4.7.2 Touchscreen Requirements

The Touchscreen interfaces must have the following minimum HMI graphic requirements:

a. A clean screen button to prevent accidental actuation of circuits while cleaning the screen.
b. Touch buttons or touch sensitive areas must be a minimum of 5/8 inch wide by 1/2 inch high. (This is to prevent touching more than one button at a time).
c. Separation between touch buttons or touch sensitive areas must be a minimum of 1/8 inch between button/area edges. (This helps to prevent inadvertent pressing of buttons).
d. The system must provide the user with the ability to calibrate the touchscreen.

5. Control Design Requirements

This section describes design requirements for the control methodology of the ALCMS system.

5.1 General Requirements

The ALCMS must have the following minimum control requirements:

a. The ALCMS must have the capability of individually controlling each of the airport lighting circuit elements. This includes changing brightness steps and switching the circuit on or off.
b. The ALCMS must be capable of controlling circuit selector switches.
c. Each ATC HMI must be capable of independently or simultaneously controlling and displaying the entire airport lighting system. This applies when multiple ATC HMI's are designed into the ALCMS.
d. The ALCMS must allow transfer of control between the ATC HMI, Remote HMI and Vault HMI stations.
e. The ALCMS must provide the flexibility to provide exclusive control (1 HMI station in control) or cumulative control (Multiple HMI stations in control).
f. The ALCMS must have the capability to enable or disable control authorization at each HMI station. This prevents unauthorized locations from being able to control the airport lighting.

5.2 Control Interfaces

The ALCMS must have the following minimum control interfaces:

a. The ALCMS must not allow other external interfaces to automatically control the airport lighting without confirmation and intervention from an HMI. This includes automatic control changes from the Runway Visual Range (RVR), radio control, photocell, or Sunrise/Sunset tables.
b. The ALCMS must have provisions for a photocell or air-to-ground radio (pilot-controlled radio) to control the airport lighting as required by the operator. Refer to Appendix 5 for design guides on interfacing with air-to-ground radios and photocells.
c. The ALCMS must be able to provide Sunrise and Sunset notifications at the ATC HMI as requested by the Designer and airport
d. The ALCMS must be capable of controlling CCRs and other equipment with control power internally (i.e. CCI) or with control power from an external source (i.e. 120VAC circuit).
e. The ALCMS must operate with control voltages of 24VDC, 48VDC or 115 VAC with a tolerance, of +10% and -5%.
f. The ALCMS must be capable of controlling AGL to meet the time requirements in AC 150/5340-30, Design and Installation Details for Airport Visual Aids.

5.3 Control Soft Start Requirements

The ALCMS must have the following minimum soft start control requirements:

a. The ALCMS must provide “Soft Start” control functionality to allow for automatic ramping up and down of brightness level of AGL.
b. The “Soft Start” ramp up control function must switch circuits on, and then step up the brightness level in a controlled fashion.
c. The “Soft Start” ramp down control function must switch circuits down through the brightness levels and then turn the circuit off.
d. The “Soft Start” switching interval (time delay) must be adjustable.

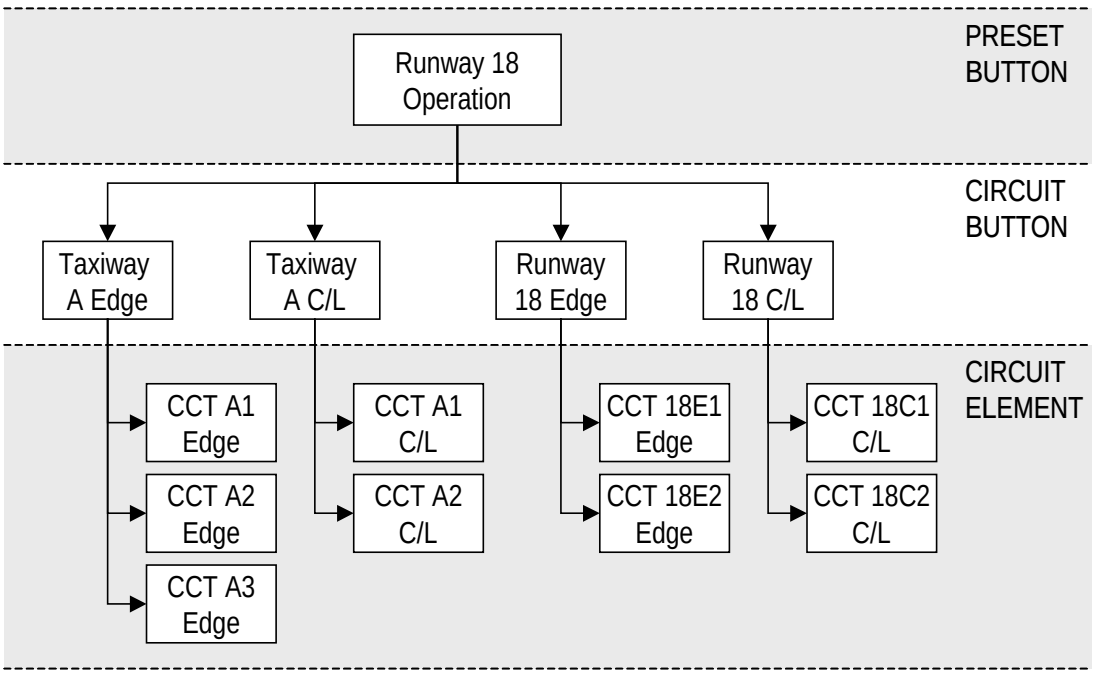


Figure 3: Control Methodology Overview

5.4 Pre-programmed Control Buttons

Refer to Figure 3: Control Methodology Overview

a. The ALCMS must have the capability to control a number of circuits using a circuit button. For example, in Figure 3, the Taxiway A Edge Button controls three Taxiway A Edge circuits (A1, A2, A3).
b. The ALCMS must be capable of executing preset commands using a preset button.
c. Preset commands must be programmable for specific predefined lighting configurations that the airport and/or air traffic control has established for various operational requirements as illustrated in Figure 3. The preset settings are established in accordance with FAA Order 7110.65, Air Traffic Control Handbook, latest revision. Refer to Appendix 6 for preset tables.
d. The ALCMS must be able to override preset lighting configurations as needed using the individual circuit button.

6. Monitoring Requirements

This section reviews the requirements for the monitoring classification types of the ALCMS and provides design recommendations for specifying the monitoring options of the ALCMS. The type of airport lighting monitoring is dependant on the desired operating conditions as well as the level of monitoring information that an airport wishes to collect. The Designer must select the monitoring classification type(s) that matches the monitoring requirements of the airport.

Design Note – A combination of all types of monitoring (Type A through D) can be designed into the system to maximize performance and meet any budget constraints. The monitoring selected must coincide with the category of operations the airport is certified for.

6.1 Type A – Control Only

This type of monitoring is the lowest level of monitoring and provides basic system level diagnostic and alarm reporting. This monitoring level does not provide monitoring or feedback for the controlled elements of the system (i.e. Constant Current Regulators). The minimum Type A monitoring design criteria is as follows:

a. Annunciation of a computer malfunction to indicate system is unable to execute lighting control commands.
b. Annunciation of communication link warnings (1 link failure) and alarm (complete loss of communication).
c. Annunciation that system is in “Failsafe” to indicate the system is unable to execute remote lighting control commands and that lighting circuits have switched to the systems failsafe state. Refer to Section 7 for more detail on failsafe.
d. Annunciation of Vault control interface equipment failure to indicate the system is unable to execute a lighting control command to a controlled element or group of elements (i.e. the constant current regulators).

Optional monitoring

e. Annunciation of loss of system commercial power indicating system is operating on emergency power.
f. Annunciation of UPS warnings and alarms to indicate possible faults with UPS equipment (i.e. loss of input power, UPS on inverter, low battery).

6.2 Type B – Basic Monitoring

This type of monitoring increases system operational awareness and provides basic monitoring for the controlled elements not provided in the Type A monitoring. This level of monitoring is typically required at airports capable of operating in VFR or Category I conditions. The minimum Type B monitoring design criteria is as follows:

a. All monitoring requirements of the Type A.
b. Feedback that a controlled element (i.e. Runway & Taxiway Lighting) is on or off. This monitoring must provide positive feedback that a controlled element turned on when it was commanded on and turned off when it was commanded off.
c. Basic monitoring must be completed via one of the following methods or an airport approved equivalent:

Method A - Current Sensing Relay (CSR) - This monitoring method can be designed using a CSR on the output of the Constant Current Regulator or other controlled element. The CSR provides a positive feedback signal when there is a pre-determined current level present on the circuit. For example, the CSR can be set to detect current levels of > 2.5A for 5-step CCRs and > 4.5A on 3-step CCRs. Lower levels of current detection may be required for beacons and other contactors.

Method B - Current Transducer Method – This monitoring method can be designed using a Current Transformer (CT) or 4-20mA Current Transducer installed on the output of the CCR or controlled element. This option provides positive feedback similar to the CSR method, but also provides an analog signal corresponding to the output current of the controlled element.

Optional monitoring
d. Annunciation of loss of system commercial power indicating system is operating on generator power.
e. Annunciation of UPS warnings and alarms to indicate possible faults with UPS equipment (i.e. loss of input power, UPS on inverter, low battery).

6.3 Type C – Advanced Monitoring

This type of monitoring expands even further the monitoring capabilities for the controlled elements not provided in the Type B monitoring. This level of monitoring is typically required at airports capable of operating in Category II and Category III conditions. The minimum Type C monitoring design criteria is as follows:

a. All monitoring requirements of the Type A and Type B.
b. CCR monitoring must meet all requirements of AC 150/5345-10 (current edition) - Specification for Constant Current Regulators and Regulator Monitors. Refer to AC 150/5345-10 for details on these monitoring requirements.
c. Monitoring of burnt out lamps.
d. Annunciation that number of lamps out has reached warning threshold (Configurable between 1 and 15 lamps).
e. Annunciation that number of lamps out has reached alarm threshold (Configurable between 1 and 15 lamps).
f. True RMS output current of the CCR (+/- 3%).
g. True RMS output voltage of the CCR (+/- 3%).

Optional monitoring
h. Annunciation of loss of system commercial power indicating system is operating on generator power.
i. Annunciation of UPS warnings and alarms to indicate possible faults with UPS equipment (i.e. loss of input power, UPS on inverter, low battery).

6.4 Type D – SMGCS Ready: Individual Lamps Out Monitoring

This type of monitoring represents the highest level of monitoring capabilities. This level of monitoring is typically required at airports capable of operating at Category III levels that have implemented a SMGCS plan. The minimum Type D monitoring design criteria is as follows:

a. All monitoring requirements of the Type A, Type B and Type C.
b. Individual Lamps Out monitoring that meets all the requirements of AC 120-57 and AC 150/5340-30.
c. Notification of exact location and fixture ID of burnt out lamp.
d. Annunciation of adjacent lights out as specified in SMGCS plan.
e. Annunciation of non-adjacent lights out exceeding maintenance criteria specified in SMGCS plan.
f. Annunciation of a functional or operational failure of an individual control and monitoring device, devices or any control components that prevent the ALCMS from receiving accurate status of the individual lamps out system.

Optional monitoring

g. Annunciation of loss of system commercial power indicating system is operating on emergency power.
h. Annunciation of UPS warnings and alarms to indicate possible faults with UPS equipment (i.e. loss of input power, UPS on inverter, low battery).
i. Annunciation of movement detected by airport sensors (i.e. microwave, inductive loops).
j. Annunciation of alarms of airport sensors.

7. Failsafe Design Requirements

Failsafe is the action taken by the ALCMS to ensure the continued safe operation of the AGL resulting from the inability to execute a command for a controllable element. Failsafe can be executed at the system or component level.

Refer to Section 4.2 for failsafe equipment electrical requirements. An ALCMS that is designed with a self-contained failsafe feature must meet the following minimum criteria:

a. Self-monitor the ALCMS control and monitoring interface equipment and verify proper operation.
b. Ensure predefined default operation of the airport lighting in the event of ALCMS failure, resulting in a failsafe condition.
c. Ensure the airport lighting remains at the failsafe state as long as the CCR has primary power.
d. It must be possible to override the failsafe state locally at the CCR or other controlled element by local personnel.
e. Permit maintenance on portions of the control system, without changing the operational status of the lighting system.
f. The failsafe feature must be adaptable to each CCR regardless of internal or external control voltage.

The Designer must select the failsafe mode that matches the requirements of the airport. Failsafe modes must be field changeable by the airport, but may be limited to the ALCMS hardware capabilities.

7.1 Failsafe Types

The ALCMS can be designed with various classification types of failsafe devices. AGL associated with Category II/III operations must have Type B Failsafe. This section reviews the classification types.

7.1.1 Type A - Preset

An ALCMS system with a Preset Failsafe classification type must meet the following minimum criteria:

a. Upon a failsafe condition, the ALCMS controlled devices must switch to a pre-defined state (ON to a pre-defined brightness level, or OFF).
b. The pre-defined setting (preset) must be configurable via hardware or software by the operator.
c. Preset failsafe must operate even in the event that there is loss of power to the failsafe device.

7.1.2 Type B - Last State

An ALCMS system with a last state failsafe classification type must meet the following minimum criteria:

a. Upon a failsafe condition, the ALCMS controlled devices must remain on at the same brightness level prior to failsafe condition.
b. The failsafe device must maintain last state (latched) condition.
c. The failsafe device must maintain last state even after complete loss of power, including battery backup.
d. Software or firmware within the ALCMS must not be used to maintain last state condition.
e. If the CCR or other controlled element was switched OFF before the failure, it must remain OFF.
f. The brightness level of the CCR or other controlled elements must be able to be controlled locally at the CCR or controlled element as requested by the operator.

7.2 Event Message Classification

This section reviews the requirements for the generation of event messages within the ALCMS. Event messages must provide a clear and concise understanding of system transactions, warnings and alarms. All Events, Warnings and Alarms are date and time stamped to the second.

Application notes on how to specify ALCMS event classification and alarm filtering is provided in Appendix 7.

Design Note – The capabilities of generating event messages is dependant upon the type of monitoring specified for the ALCMS. Certain events cannot be generated if the monitoring option is not specified. For example, an ALCMS that is designed as “Control Only” will not provide detailed CCR monitoring such as current, voltage and lamps out.

7.2.1 Events

The ALCMS system must be capable of generating and recording event transactions. An event is any operator command or change in the status of monitored equipment. The ALCMS system must be flexible as to provide the user the ability to view the events and must meet the following criteria:

a. Events must be annunciated as specified by the airport sponsor and the ATCT to any part of the HMI system.

b. Events must be logged to a database.
c. Events must be date stamped with date and time of occurrence. This allows for possible reconstruction of sequences of events within the ALCMS.
d. Events that must be recorded include but are not limited to the following:
   - Changes in airport lighting brightness steps
   - Changes in states of the computers (start-up, shut-down)
   - Changes in states of the communication links (link up, link down)
   - Changes in control authorizations (Tower control, Vault control)
   - Changes in warning and alarm states.

7.2.2 Warnings

A warning is an event indicating a fault condition or a low-level failure detected by the ALCMS that has not yet resulted in a degradation of visual aids below defined serviceability criteria. The ALCMS system must be flexible as to provide the user the ability to view the warning and must meet the following criteria:

a. The system must provide the ability to classify events as warnings.
b. Warnings must be annunciated at maintenance HMI interfaces.
c. Warnings must not be annunciated (filtered) at the ATC HMI interfaces.
d. Warnings must be logged to a database.
e. Warnings must be date stamped with date and time of occurrence. This allows for possible reconstruction of sequences of events within the ALCMS.
f. Warnings that must be recorded include but are not limited to the following:
   - Commanded brightness step does not match actual output brightness current
   - Other low-level CCR monitored items (i.e. Low VA)
   - Lamps Out equal to warning threshold
   - Changes in states of the communication links (link up, link down)
   - Loss or change in utility status.

7.2.3 Alarms

An alarm is an event indicating a fault condition, detected by the ALCMS that has resulted in a degradation of visual aids below defined serviceability criteria. The ALCMS system must be flexible as to provide the user the ability to view the alarms and must meet the following criteria:

a. The system must provide the ability to classify events as alarms.
b. Alarms must be annunciated at maintenance HMI interfaces.
c. Alarms must be annunciated at the ATC HMI interfaces.
d. Alarms must be logged to a file.
e. Alarms must be date stamped with date and time of occurrence. This allows for possible reconstruction of sequences of events within the ALCMS.
f. Alarms that must be recorded include but are not limited to the following:
   - Protective Shutdown of a CCR
   - Failure of a controlled element to respond to commanded step
   - Lamps Out equal to alarm threshold
   - Loss of communication links (all links down)
   - System in “failsafe”
   - Loss or change in utility status.

7.3 Audible Alarm

As an option, an audible indication for an alarm event must be provided in conjunction with the ATC HMI touchscreen stations. The audible alarm assembly must be designed such that the tone can be disabled (turned off) and the user can control the volume.

7.4 Event Message Handling

Event message handling determines how the ALMCS logs, displays, archives and purges the system events. The level of event handling is dependant upon the type of monitoring options specified.

Design Note – A "Control Only" ALCMS system can be designed without an event database. This means that only currently active events (warnings or alarms) are viewable. Once an event is no longer active, the event is purged.

An ALCMS with an events storage database for storing and retrieving events must meet the following minimum criteria:

a. Viewing – Events, including warnings and alarms, must be able to be viewed via a user HMI interface.
b. Subset Viewing - Subset of events, including warnings and alarms, must be able to be viewed via a subset HMI interface that allows the user to specify a date and time range to view.
c. Logging – All active and cleared events must be stored to a database designed for optimal retrieval performance.
d. Date/Time Stamp – Stored events must be stamped with the date and time of occurrence.
e. Archiving – Events must be stored for a predefined amount of time. Storage time must be defined by the airport and must be configurable from 1 day to 1 year.
f. Back-up – The ALCMS must provide a method (via HMI interface) for backing up event database to external media (floppy, CD-ROM, tape or other media).
g. Purging – The ALCMS must provide a method (automatic or manual) for erasing the events database to allow for hard disk space recovery.

7.5 Security Administration

The ALCMS must provide system-wide security administration capabilities. The system must allow a system administrator to establish user accounts and passwords for end-users and determine each user's level of system authorization.

The security feature must be able to record user's who logon to the system and record events that occur during the user's logon period. User accounts are typically set up to be simple, yet allow only those that have been trained in certain aspects of the system to gain access to these features.

7.6 Standard Reporting

The ALCMS must provide the capabilities to save (external media) or print out (paper hard-copy) ALCMS system reports.

Design Note – A "Control Only" ALCMS system can be designed without an event database and thus would not provide system reporting capabilities. This means that only current active events (warnings or alarms) are viewable and could be printed out.

At a minimum, the ALCMS must provide the ability to create the following reports:

a. Events Report – Events, including warnings and alarms, must be able to be saved to external media or printed to a printer.
b. Subset Events Report - Subset of events, including warnings and alarms, must be able to be saved to external media or printed to a printer.
c. Constant Current Regulator Report – Current status of all CCR and other controlled elements including monitoring status must be able to be saved to external media or printed to a printer.

d. Monitoring Report – Current status of all CCR and other controlled elements including monitoring status must be able to be saved to external media or printed to a printer.

7.7 System Software Recovery

The ALCMS System must provide the ability for complete recovery from system hard drive crashes or computer malfunction. The system must be provided with backup software that would allow the end-user to rebuild a computer hard drive for any of the ALCMS computers (Tower, Vault or Maintenance Center).
Design Note: Refer to Appendix 8 for application notes for designing a fault-tolerant hard drive system.

8. Special Interface Design Requirements

Refer to section 4.2 for minimum electrical requirements of interface equipment.

The Designer of the ALCMS must identify all airport equipment and other navigational aids that the ALCMS will interface with. Airport and FAA equipment may require special control and monitoring requirements. The Designer needs to research these requirements in order to specify them to the ALCMS manufacturer. If the airport wants to incorporate any FAA equipment into the ALCMS, approval must be obtained from the Regional FAA office.

The Designer must be familiar with the approach lighting system and understand the control and monitoring operation. The Designer must determine proper contact sizes, current ratings and lightning protection on all control and monitoring points.

The Designer must also note the location of the interface wiring. The ALCMS manufacturer must assume the control and monitoring interfaces are handled at the Airport Lighting Electrical Vault unless otherwise specified. The ALCMS manufacturer must assume that dry-contact closures are available for all monitoring feedback points unless specified by the Designer.

8.1 Constant Current Regulator Control

An airport's CCRs may be new or existing. During qualification testing, the ALCS manufacturer must verify that data typical of that shown in Table 4 can be configured into the ALCMS. The Designer must determine the final configuration of the CCRs and complete an index of the information as shown in Table 2: CCR Control and Monitoring Index (The index is shown with sample CCR descriptions).

						Steps Used (indicate w/ X)									
CCR #	CCR Description	Size	Current Output	Steps	CCI Int./Ext.	B1 (B10)	B2 (B30)	B3 (B100)	B4	B5	Manfctr.	Model #	Monitoring	Circuit Selector #	Circuit Selector Loop Descriptions
1	Runway Edge -RE	30kW	6.6	5	Int. 120	X	X	X	X	X	CCR Man.	Model	Lamps Out	None	
2	Runway Centerline - RC1	30kW	6.6	5	Int. 120	X	X	X	X	X	CCR Man.	Model	Lamps Out	None	
3	Runway Centerline - RC2	30kW	6.6	5	Int. 120	X	X	X	X	X	CCR Man.	Model	Lamps Out	None	
4	Distance Remaining Signs	20kW	6.6	5	Int. 120			X			CCR Man.	Model	Lamps Out	None	
5	Taxiway A & B Edge	20kW	6.6	3	Int. 120	X	X	X			CCR Man.	Model	Current Sensing Relay	1	Loop 1 - Twy A Edge Loop 2 - Twy B Edge
6	Taxiway C Edge	10kW	6.6	3	Int. 120	X	X	X			CCR Man.	Model	Current Sensing Relay	None	
7	Taxiway Signs	10kW	6.6	3	Int. 120		X				CCR Man.	Model	Current Sensing Relay	None	
8	Taxiway A Centerline	10kW	6.6	3	Int. 120	X	X	X			CCR Man.	Model	Current Sensing Relay	None	

Table 2: CCR Control and Monitoring Index

The following is a description of each column of the CCR control and monitoring index:

CCR #	Number of ID used by the airport to designate the associated CCR.
CCR Description	Description or lighting function of the CCR.
Size	kW rating of the CCR (4kW – 70kW).
Current Output	Output current from the CCR (6.6A or 20A).
Steps	Number of steps available on the CCR (1, 3 or 5 step CCR).
CCI Int./Ext.	Control voltage availability internal to the CCR (48VDC or 120VAC). Older model CCRs do not have internal CCI and require external 120VAC power source to control and must be indicated as “Ext. “
Steps Used	Indicate with an “X” what steps are used on the CCR. CCRs may have 3 or 5 steps but only 1 or some of the steps are used in the control system.
Manufacturer	Manufacturer indicated on the CCR product label.
Model #	Model number indicated on the CCR product label.
Monitoring	Monitoring requirements for the CCR. When L-829 monitoring is specified, the Designer must verify that appropriate monitoring points are available on existing equipment. Remote/Local and Primary Power monitoring points must be determined by the Designer and may require CCR manufacturer to modify the CCR to provide required monitoring points.
Circuit Selector #	The Designer must verify if CCR(s) are interfaced to circuit selector switches and indicate selector switch number.
Circuit Selector Loop Description	If circuit selector switches are interfaced to the CCR(s), the Designer must indicate the function and description of each associated loop.

8.2 Runway Visual Range (RVR)

An airport's RVR equipment may be new or existing. The Designer must determine if RVR monitoring must remain "as-is" and be handled by the airport or if the ALCMS must be required to provide RVR monitoring feedback.

RVR monitoring feedback from the ALCMS system must be able to provide simple dry-contact closures confirming circuit brightness steps as illustrated in **Figure 4**. This confirmation feedback is typically only needed for the top three brightness steps of the CCR. The contact closure must only occur when the CCR meets the desired monitoring feedback criteria. This means the contact must only close when the CCR has reached the brightness step and is providing the correct current for that brightness step.

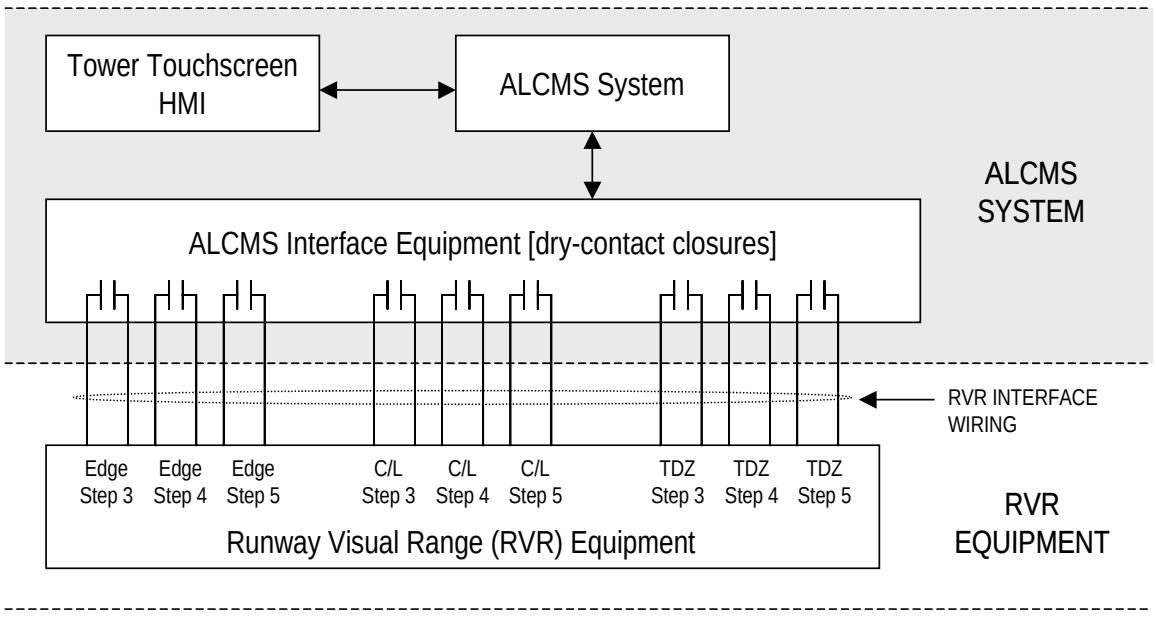


Figure 4: RVR Interface Diagram

Design Note: This example is one method of providing RVR monitoring feedback that provides simple contact closures that are used for the interface point. The Designer must verify that this type of feedback is acceptable and must interface with the RVR equipment.

The Designer must also note the location of the interface wiring. The ALCMS manufacturer must assume the control and monitoring interfaces are handled at the Airport Lighting Electrical Vault unless otherwise specified.

8.3 Approach Lighting

Control and monitoring of airport's approach lights and navigational aids is airport specific. **Figure 5** provides general guidelines for specifying an interface between an ALSF and the ALCMS.

Designer Note: If an airport is requesting integration of the approach lighting into the ALCMS system, the Designer must thoroughly research the control functionality that the airport requires. However, all interfaces with FAA owned equipment must be approved by the FAA. Typically approach lighting control and monitoring cabling is located at the ATCT. This means that control and monitoring equipment must now be designed into the ATC computer system (The ATC computer system normally does not provide any control or monitoring points).

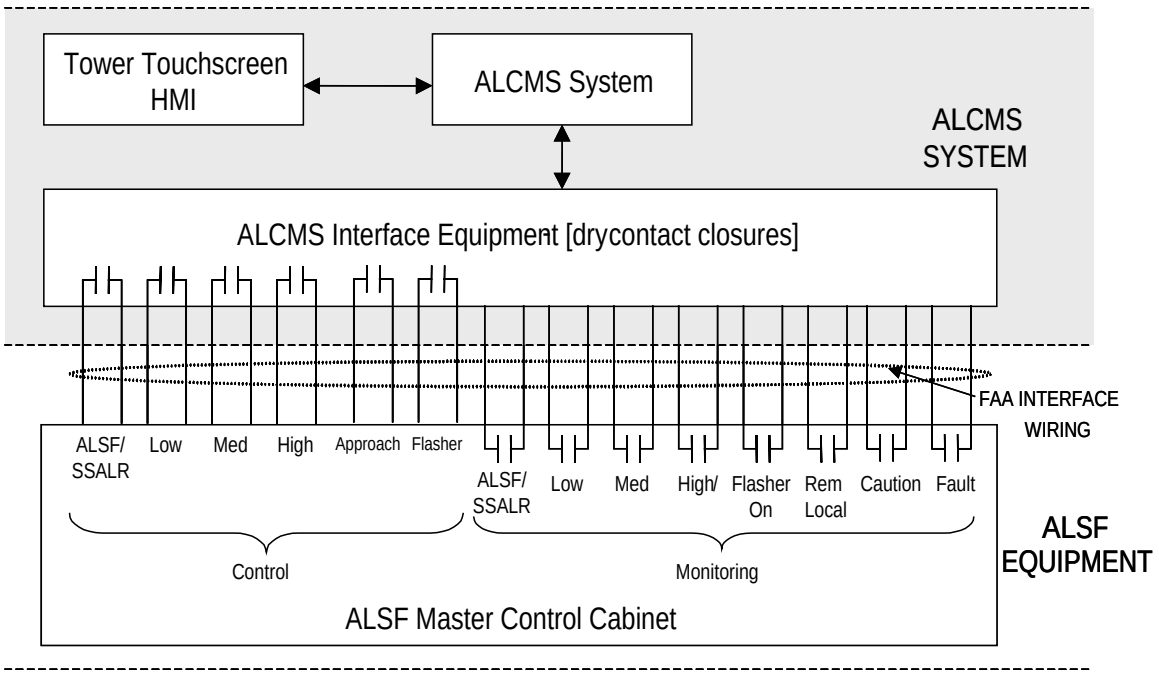


Figure 5: ALSF Interface Diagram

8.3.1 ALSF / SSALR Approach System

For steady burning lights refer to Section 5 and Section 6 for control and monitoring. The sequenced flasher lights must provide the minimum control and monitoring criteria outlined in Table 3.

Sequence Flasher Control Points	Monitoring Points
ALSF/SSALR Control	ALSF/SSALR Mode
Low Intensity	Low Intensity
Medium Intensity	Medium Intensity
High Intensity	High Intensity
Approach On/Off	Flasher On
Flashers On/Off	Local Mode
	Caution
	Fault

Table 3: ALSF / SSALR Interface Criteria

8.3.2 MALSR / MALSF Approach System

The ALCMS interface must provide the minimum control and monitoring criteria outlined in Table 4: MALSR / MALSF Interface Criteria.

Control Points	Monitoring Points
MALSR/MALSF Control	MALSR/MALSF Mode
Low Intensity	Low Intensity
Medium Intensity	Medium Intensity
High Intensity	High Intensity
Approach On/Off	Flasher On
Flashers On/Off	Local Mode
	Caution
	Fault

Table 4: MALSR / MALSF Interface Criteria

8.3.3 REIL, ODALS, PAPI, and VASI Approach System

The ALCMS interface must provide the minimum control and monitoring criteria outlined in Table 5.

Control Points	Monitoring Points
On/Off Control	Lamp Out
Low Intensity	
Medium Intensity	
High Intensity	

Table 5: REIL, ODALS, PAPI, and VASI Interface Criteria

8.4 General ON/OFF Contactor control and monitoring

Some airports will have several ON/OFF control contactors that may be used for controlling devices. Some examples of ON/OFF contactors include, but are not limited to, sequence flashers (current or voltage driven), low intensity approaches (LIA), windsocks, obstruction lights and floodlights.

The Designer must be familiar with the ON/OFF contactors and understand the control and monitoring operation. The Designer must determine proper contact sizes, current ratings and lightning protection on all control and monitoring points for the ON/OFF contactors. Refer to Figure 6 for design guidelines for interfacing an ALCMS to control and monitor ON/OFF contactors or other types of ON/OFF controlled equipment.

Designer Note: This type of design consideration applies to all types of airport equipment that does not follow the standard CCR (step 1 through step 5) control scheme. Special design research and precautions need to be taken when interfacing with any device that requires special control and/or the energizing of a contactor.

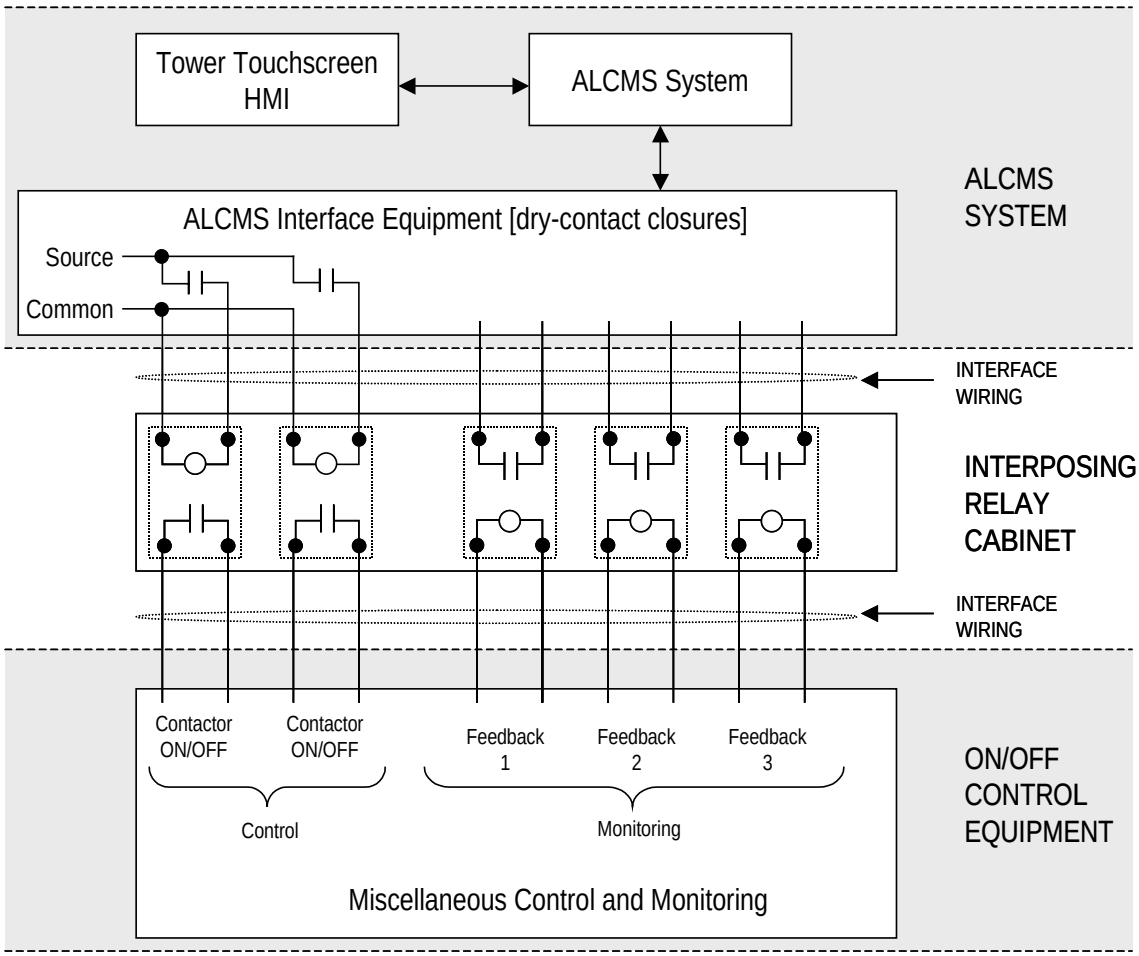


Figure 6: Contactor Interface Diagram

8.4.1 Contactor Control

Refer to Figure 6. Voltage driven equipment that require the energizing of a contactor may require a special interposing relay design to accommodate the low current switching capabilities of the ALCMS system.

8.4.2 Contactor Monitoring

Monitoring of the voltage driven equipment can be accomplished by adding a Current Sensing Relay (CSR) to the output side of the contactor. The CSR can be adjusted to provide positive feedback when a predetermined current level is detected on the contactor output. This type of on/off monitoring can be applied to any type of contactor-controlled device.

8.5 Generator and Automatic Transfer Switches (ATS)

There are many options available for control and monitoring the generator and ATS. It is up to the Designer to determine control and monitoring "pick-up" points and terminal block connections within the existing or specified equipment. Refer to Appendix 9 for application notes on generator and ATS interface wiring.

8.5.1 Generator Control

The control capabilities of the Generator are specific to each manufacturer. Refer to Table 6 for general guidelines for controlling Generators.

Option	Control Signal	Description	Comments
1	Generator Start/Stop	Maintained Contact	Closed – Generator Start Open – Generator Stop
2	Generator Start/Stop	Momentary Pulse	1st Pulse – Generator Start 2nd Pulse – Generator Stop
3	Generator Start	Momentary Pulse	Older Type Generators
	Generator Stop	Momentary Pulse	Older Type Generators
4	Generator Start	Maintained Contact	
	Generator Stop	Maintained Contact	

Table 6: Generator Control Interface Criteria

8.5.2 Generator and ATS Monitoring

The monitoring capabilities of the Generator and Automatic Transfer Switch (ATS) are specific to each manufacturer. Not all Generator and ATS equipment provide monitoring signals by default. Designer must determine availability of monitoring points and determine if optional monitoring kits are needed to provide monitoring functions. The Designer must specify the monitoring kits. Refer to Table 7 for general guidelines for specifying Generator and ATS monitoring.

Monitoring Signal	Description	Comments
Generator Alarm	Common Alarm	Alarm exists at the Generator. May require monitoring kit
Utility Available	Utility power is present	May require monitoring kit
Utility On-line	Utility power is primary source of power	May require monitoring kit
Generator Available	Generator is running and available for transfer	May require monitoring kit
Generator On-line	Generator power is primary source of power	May require monitoring kit

Table 7: Generator Monitoring Interface Criteria

8.6 Rotating Beacon

The rotating beacon control differs for every airport. The Designer must become familiar with the airport's equipment and understand the existing control and monitoring operation and design accordingly in the ALCMS. The Designer must determine proper contact sizes, current ratings and lightning protection on all control and monitoring points for the Rotating Beacon.

Refer to Appendix 10 for more information.

8.6.1 Beacon control in ATCT

If the beacon control wiring is located at the ATCT, this will require special control and monitoring equipment within the ATC computer enclosure such as additional control relays or a PLC.

8.6.2 Beacon control in Vault

If the control wiring is located at the airport lighting vault, an additional control and monitoring device needs to be specified.

8.6.3 Remote Beacon control

The beacon may be controlled via a radio, fiber optic, telephone line or a photocell. In this case, special control equipment must be specified indicating how the beacon is to be controlled by the ALCMS system. This may require the use of a dial-up modem control device, wireless radio equipment or new control wiring will have to be pulled between the beacon location and the ALCMS.

8.6.4 Beacon monitoring

If beacon monitoring is required, the Designer must specify the type of monitoring and determine all of the proper wiring, "pick-up" points and contact ratings of the monitoring points. The beacon may provide monitoring contact closures that must interface with the ALCMS system or the Designer may have to specify a current sensing relay or other device to provide on/off monitoring.

9. Manufacturer Support

9.1 Warranty

The ALCMS manufacturer must warrant against defects in workmanship, hardware and software for a minimum period of twelve (12) months.

9.2 Training

The ALCMS manufacturer must provide the following documentation and training.

9.2.1 Touchscreen Simulation

The ALCMS manufacturer must provide as part of the training package a method for running the ALCMS touchscreen HMI on a separate computer not connected to the ALCMS network. This Touchscreen simulation must run independently of the ALCMS and provide a method for training personnel outside of the ALCMS environment.

9.2.2 Training Agenda

The ALCMS manufacturer must provide a sample training course syllabus and training schedule before on-site training.

9.2.3 FAA ATC Training

The Designer must specify the amount and length of training classes required for FAA ATC training. The Designer must have previously coordinated with the FAA the number of controllers and shifts that will need to be trained. The total number of classes, lengths of classes and shifts

of classes needs to be specified. Training classes for FAA ATC personnel must be limited to a maximum of 4-6 people per class. Typical FAA ATC training classes last approximately 1-2 hours but depend on the complexity of the ALCMS system.

The Designer must coordinate with the FAA ATC Training Coordinator that they are capable of performing touchscreen training. This method of training would allow the ALCMS manufacturer to train the FAA ATC training coordinator who would then be responsible for training all of the ATC personnel prior to commissioning of the new ALCMS system. This dramatically simplifies the FAA ATC training program and is the most efficient method.

The FAA ATC training must include the following minimum criteria:

a. General system overview – Theory of Operation
b. Review touchscreen operations
c. Review AGL Operator HMI interface
d. Review preset and control sequences
e. Review Events, Alarm and Warning messages
f. Review failsafe scenarios and what to do during failsafe
g. Review how to grant and relinquish airport lighting control to the Vaults.

9.2.4 Maintenance Training

The Designer must specify the amount and length of training classes required for maintenance and other airport personnel (i.e. Operations). The Designer must have previously coordinated with the airport the number of maintenance personnel and shifts that will need to be trained. The total number of classes, lengths of classes and shifts of classes needs to be specified. Training classes for maintenance personnel must be limited to a maximum of 4-6 people per class. Typical training classes for maintenance personnel must be scheduled for two (2) days at 8 hours per day, but depend on the complexity of the ALCMS system.

The Maintenance training must include the following minimum criteria:

a. Review system block diagram – Theory of Operation
b. Review drawing package - System assemblies and wiring diagrams
c. Review touchscreen operation
d. Review Maintenance HMI interface
e. Review system maintenance
f. Provide hands-on troubleshooting
g. Review how to grant and relinquish airport lighting control to the Vaults
h. Review system power-up and power-down sequences
i. Review failsafe scenarios and what to do during failsafe
j. Review system reporting capabilities
k. Review control and monitoring capabilities.

9.3 Technical Support

The ALCMS manufacturer must provide the following minimum technical support during the warranty period:

a. Technical phone assistance
b. Technical support via telephone line must be available 7 days a week, 24 hours a day, 365 days a year
c. On-site technical field service as required.

9.4 Documentation

The Designer must specify the details of the ALCMS documentation package. The ALCMS manufacturer must demonstrate that they are capable of providing a professional documentation package that meets the criteria outlined in this section.

9.4.1 Maintenance Manuals

The ALCMS manufacturer must provide one copy, or as specified, of the operation and maintenance manuals that are hard-covered and suitable for daily operation and maintenance of the system. The manuals must include operational overview, system theory of operation and graphical user interface screen operation.

9.4.2 FAA ATC Manuals

The ALCMS manufacturer must provide one copy, or as specified, of the operation manuals for the Air Traffic Controllers (ATC) that are hard-covered and suitable for daily operation of the system. At a minimum, the manuals must include Touchscreen operation (human machine interface) and Touchscreen maintenance (i.e. calibration).

9.4.3 As-Installed Drawing Package

The ALCMS manufacturer must provide one copy, or as specified, of As-Installed drawings after system acceptance. The As-Installed drawings must reflect the final installation design of the ALCMS including System Block Diagram (1-line drawings), System External Wiring Diagrams, Assembly Drawings and Assembly Wiring Diagrams.

9.5 System Testing

The ALCMS manufacturer must provide a set of test documents detailing the level of testing to be performed. The ALCMS testing must meet the minimum criteria outlined in this section.

9.5.1 Factory Acceptance Test (FAT)

The ALCMS manufacturer must perform a FAT at the manufacturer's facility to assure that the ALCMS meets the requirements of the specification. The FAT must demonstrate operation of the software and hardware design. A report of the FAT must be provided by the manufacturer.

Design Note: As an option, the Designer may specify that the FAT be witnessed by the Designer and/or an airport representative. The Designer must specify who is responsible (Contractor or ALCS manufacturer) for covering the expenses of the FAT including travel expenses and per diems. If not specified, the ALCMS manufacturer must assume that the Contractor covers FAT expenses not including ALCMS manufacturer's labor.

9.5.2 System Acceptance Test (SAT)

The ALCMS manufacturer must perform a SAT on-site (airport) to assure that the ALCMS meets the requirements of the specification. The SAT test plan must be submitted to the Designer for review and approval of the completeness of the SAT. The SAT must be witnessed by the Designer. The SAT must demonstrate operation of the software and hardware design to the satisfaction of the Designer. A report of the SAT must be provided by the manufacturer.

9.6 Spare Parts

The Designer must specify the type of spare parts in the project specifications required for the continued operation of the ALCMS.

10. Qualification Requirements

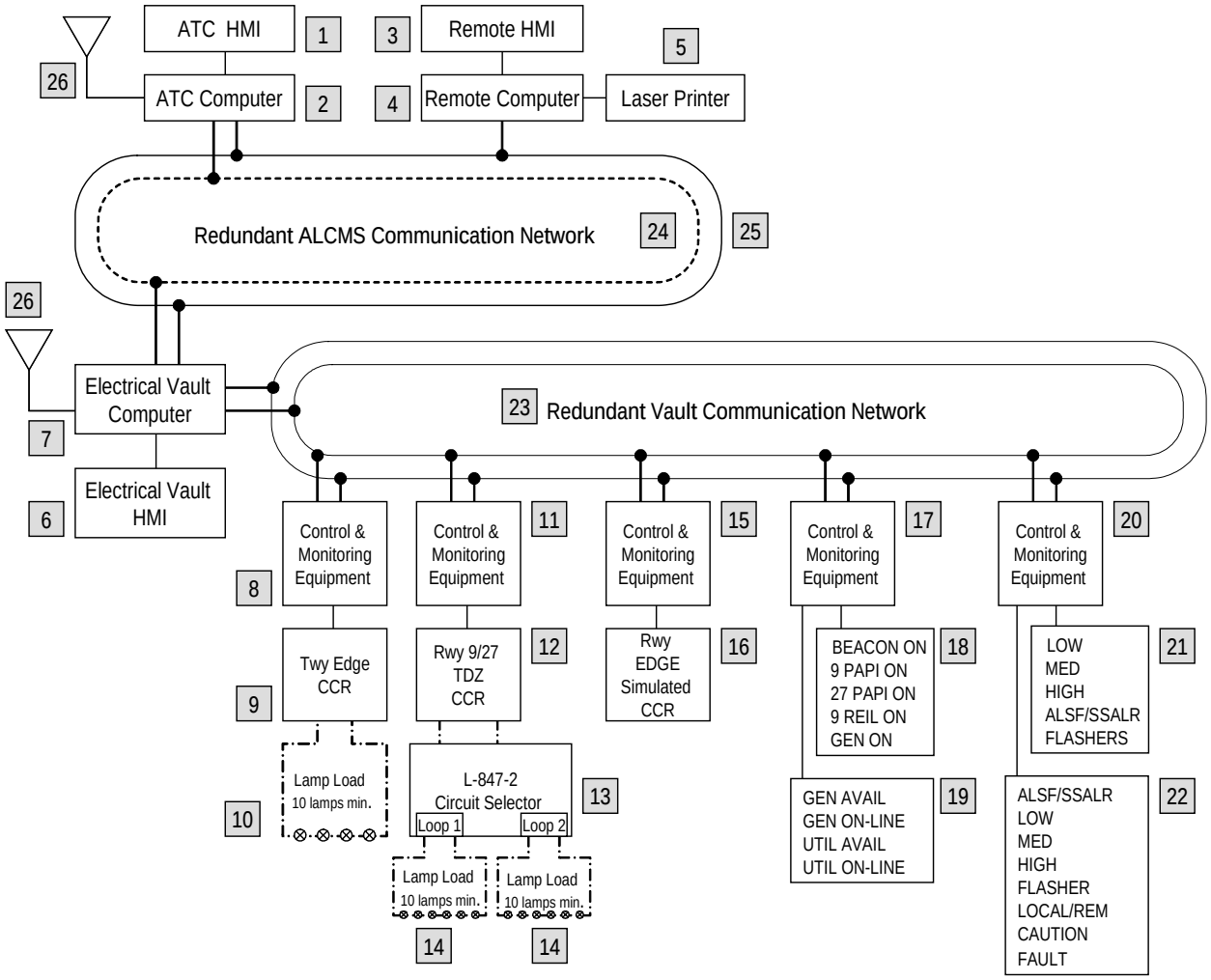
This section provides detail on the testing and qualification requirements that must be met by the ALCMS manufacturer initially and every four years in order to certify an ALCMS system. However, even though Advisory Circular 15/5345-53, Airport Lighting Equipment Certification Program, requires manufacturers to test and qualify airport lighting equipment every eight years, components associated with an ALCMS will change significantly over an eight-year term versus a four-year term, and therefore a recertification term of eight years for testing and qualification is too long. A length of four years will be used for testing and qualification of ALCMS equipment. The qualification testing is outlined to indicate what tests are necessary for each associated classification type.

10.1 Qualification Procedures

An ALCMS manufacturer must successfully complete qualification tests outlined herein to receive certification of their ALCMS and specific classification type. In addition, the procedures for qualifying equipment to be furnished under the Federal grant assistance program for airports contained in AC 150/5345-53, Airport Lighting Equipment Certification Program must also be met.

10.2 ALCMS Test System - Hardware Design Requirements

The tests are designed to demonstrate all operational requirements using an actual ALCMS test system integrated with simulated airport lighting conditions and control equipment. This includes interfacing to CCRs, circuit selector switches and actual lighting loads. All control outputs with their associated interfaces must be demonstrated. All monitoring requirements must be verified by simulating the appropriate condition. A representative of each type of hardware, communication media, software structures, and interface equipment must be included in the qualification testing.



The numbers in the shaded boxes refer to the text in the following section.

Figure 7: ALCMS Test System Hardware Design

The minimum ALCMS test system design required for ALCMS certification is illustrated in Figure 7. To follow is an outline of the components indicated in Figure 7that is required to be assembled and tested for certification:

1. ATC HMI must meet the requirements of 4.3.1 and the following:
Screen size: 15-inch minimum
Resolution: 1024x768
Input device: touchscreen only (no keyboard or mouse).

2. ATC computer must meet the requirements of 4.3.2 and the following:
Signal extension equipment tested with 500 feet extension cable. The signals must include video, audio, and touch input. An UPS must provide a minimum of ten minutes of run time for all equipment. All equipment must be assembled in NEMA 12 enclosures and connected as a complete system.

3. Remote HMI must meet the requirements of 4.3.3 and the following:
Screen size: 15-inch minimum
Resolution: 1024x768.

4. Remote computer must meet the requirements of 4.3.4.

5. Remote computer Laserjet Printer.

6. Vault HMI must meet the requirements of 4.3.5 and the following:
Screen size: 15 inch minimum
Resolution: 1024x768.

7. Vault computer must meet the requirements of 4.3.6 and meet the following requirements:
An UPS must provide a minimum of ten minutes of run time for all equipment. All equipment must be assembled in NEMA 12 enclosures and connected as a complete system.

8. Control and monitoring equipment must meet the requirements of 4.3.8 and configured to control a 3 step CCR.

9. Taxiway Edge **-** A 3 step Constant Current Regulator must be used to assure control and monitoring equipment properly controls a 3 step CCR

10. A lighting load including a minimum of ten (10) isolation transformers and ten (10) lights.

11. Control and monitoring equipment must meet the requirements of 4.3.8 and configured to control a 5 step CCR and a L-847-2 circuit selector.

12. Runway 9 & 27 TDZ - A 5-step Constant Current Regulator must be used to assure control and monitoring equipment properly controls a 5 step CCR

13. An L-847-2 circuit selector must be used to assure control and monitoring equipment properly controls a circuit selector

14. A lighting load on the output of each loop of the circuit selector including a minimum of ten (10) isolation transformers and ten (10) lights.

15. Control and monitoring equipment must meet the requirements of 4.3.8 and configured to control a 5-step CCR.

16. Simulation equipment must be provided to demonstrate control of the following 5-step CCR control points.

O.1	Rwy Edge Step 1	O.2	Rwy Edge Step 2
O.3	Rwy Edge Step 3	O.4	Rwy Edge Step 4
O.5	Rwy Edge Step 5		

17. Control and monitoring equipment must meet the requirements of 4.3.8 and configured to control five (5) On/Off elements and monitor four (4) feedback signals.

18. Simulation equipment must be provided to demonstrate control of the following five (5) Outputs.

O.6	Beacon ON	O.7	PAPI #1 ON
O.8	PAPI #2 ON	O.9	REIL ON
O.10	GEN ON.		

19. Simulation equipment must be provided to demonstrate monitoring of the following four (4) inputs feedback signals.

I.1	GEN AVAIL	I.2	GEN ON-LINE
I.3	UTIL AVAIL	I.4	UTIL ON-LINE.

20. Control and monitoring equipment must meet the requirements of 4.3.8 and configured to control an ALSF Approach System with five (5) control signals and monitor eight (8) feedback signals.

21. Simulation equipment must be provided to demonstrate control of the following five (5) On/Off signals for the ALSF Approach System.

O.11	LOW	O.12	MED
O.13	HIGH	O.14	ALSF/SSALR
O.15	FLASHERS.		

22. Simulation equipment must be provided to demonstrate monitoring of the following eight (8) feedback signals from the ALSF Approach System.

I.5	ALSF/SSALR	I.6	LOW
I.7	MED	I.8	HIGH
I.9	FLASHER	I.10	LOCAL/REMOTE
I.11	CAUTION	I.12	FAULT.

23. The Vault Communication Network must meet the requirements of 4.4 and must be configured as a multiple redundant network using hardwire communication cable. This item is not required if the Alternate Control and Monitoring method is used.

24. Link (1) of the ALCMS Communication Network must meet the requirements of 4.4 and must be configured as a fiber optic link. Simulation equipment must be provided to assure communication over 3 miles of fiber.

25. Link (2) of the ALCMS Communication Network must meet the requirements of 4.4 and must be configured as a hardwire link. Simulation equipment must be provided to assure communication over 1 miles of hardwire cable.

26. Link (3) of the ALCMS Communication Network must meet the requirements of 4.4 and must be configured as a wireless radio link. Simulation equipment must be provided to assure communication over 3 miles.

10.3 ALCMS Test System – Touchscreen GUI Design Requirements

The ALCMS manufacturer must configure an ALCMS Test System according to the touchscreen GUI design requirements of this section. All regulator presets must follow the guidelines of FAA Order 7110.65. The touchscreen design and functionality must meet all of the criteria previously outlined in this document.

10.3.1 Test System Touchscreen GUI Overview

The touchscreen GUI must be configured with three (3) pages referred to as Preset Page, Rwy/Twy Page and Utility Page. The GUI must depict the test airport graphics as shown in Figure 8.

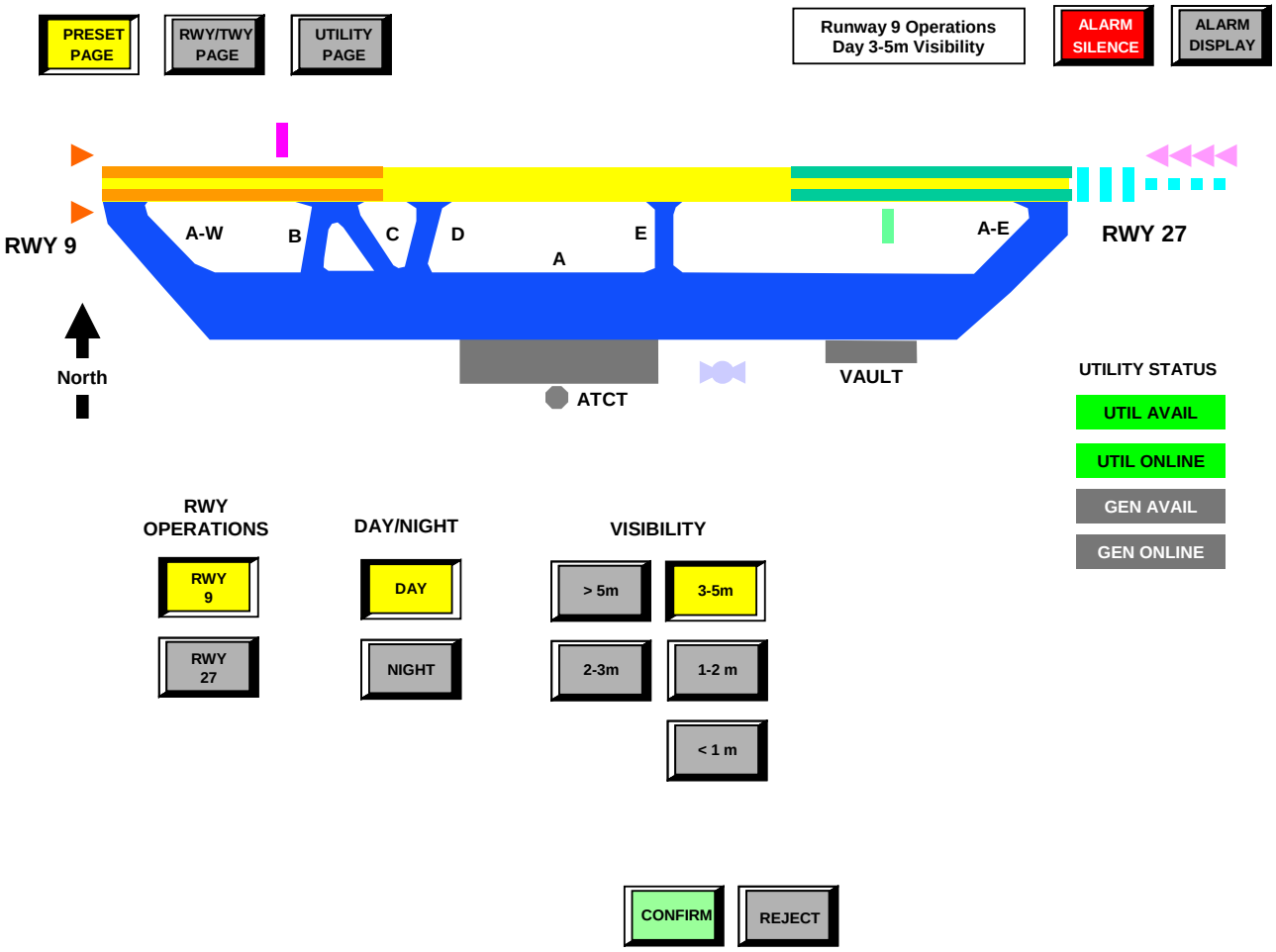


Figure 8: ALCMS Test System Touchscreen GUI: Preset Page

10.3.2 Preset Page and Airport Lighting Presets

The touchscreen's preset page must match the test system shown in Figure 8. The preset lighting configurations must be programmed in accordance with preset tables outlined to follow. There is one (1) preset table for each visibility setting.

CIRCUIT DESCRIPTIONS	Steps	OPERATIONS DAY		OPERATIONS NIGHT	
		RWY 9	RWY 27	RWY 9	RWY 27
9-27 Edge	5	0	0	1	1
9 TDZ	5	0	0	1	0
27 TDZ	5	0	0	0	1
9 REIL	1	1	0	1	0
9 PAPI	1	1	0	1	0
27 Approach Lights	3	0	0	0	1
27 Flashers	3	0	0	0	1
27 PAPI	1	0	1	0	1
Taxiway Edge	3	0	0	1	1
Beacon	1	0	0	1	1
Generator	1	0	0	0	0

Table 8: Greater than 5 miles Visibility

CIRCUIT DESCRIPTIONS	Steps	OPERATIONS DAY		OPERATIONS NIGHT	
		RWY 9	RWY 27	RWY 9	RWY 27
9-27 Edge	5	0	0	2	2
9 TDZ	5	0	0	2	0
27 TDZ	5	0	0	0	2
9 REIL	1	1	0	1	0
9 PAPI	1	1	0	1	0
27 Approach Lights	3	0	0	0	1
27 Flashers	3	0	0	0	1
27 PAPI	1	0	1	0	1
Taxiway Edge	3	0	0	1	1
Beacon	1	0	0	1	1
Generator	1	0	0	0	0

Table 9: 3 to 5 miles Visibility

CIRCUIT DESCRIPTIONS	Steps	OPERATIONS DAY		OPERATIONS NIGHT	
		RWY 9	RWY 27	RWY 9	RWY 27
9-27 Edge	5	3	3	3	3
9 TDZ	5	3	0	3	0
27 TDZ	5	0	3	0	3
9 REIL	1	1	0	1	0
9 PAPI	1	1	0	1	0
27 Approach Lights	3	0	0	0	1
27 Flashers	3	0	0	0	1
27 PAPI	1	0	1	0	1
Taxiway Edge	3	0	0	1	1
Beacon	1	0	0	1	1
Generator	1	0	0	0	0

Table 10: 2 to 3 miles Visibility

CIRCUIT DESCRIPTIONS	Steps	OPERATIONS DAY		OPERATIONS NIGHT	
		RWY 9	RWY 27	RWY 9	RWY 27
9-27 Edge	5	4	4	3	3
9 TDZ	5	4	0	3	0
27 TDZ	5	0	4	0	3
9 REIL	1	1	0	1	0
9 PAPI	1	1	0	1	0
27 Approach Lights	3	0	0	0	1
27 Flashers	3	0	0	0	1
27 PAPI	1	0	1	0	1
Taxiway Edge	3	0	0	1	1
Beacon	1	1	1	1	1
Generator	1	0	0	0	0

Table 11: 1 to 2 miles Visibility

CIRCUIT DESCRIPTIONS	Steps	OPERATIONS DAY		OPERATIONS NIGHT	
		RWY 9	RWY 27	RWY 9	RWY 27
9-27 Edge	5	5	5	4	4
9 TDZ	5	5	0	4	0
27 TDZ	5	0	5	0	4
9 REIL	1	1	0	1	0
9 PAPI	1	1	0	1	0
27 Approach Lights	3	0	3	0	2
27 Flashers	3	0	3	0	2
27 PAPI	1	0	1	0	1
Taxiway Edge	3	3	3	2	2
Beacon	1	1	1	1	1
Generator	1	0	0	0	0

Table 12: Less than 1 mile Visibility

10.3.3 Runway and Taxiway Page

The touchscreen's Rwy/Twy page must match the test system shown in Figure 9.

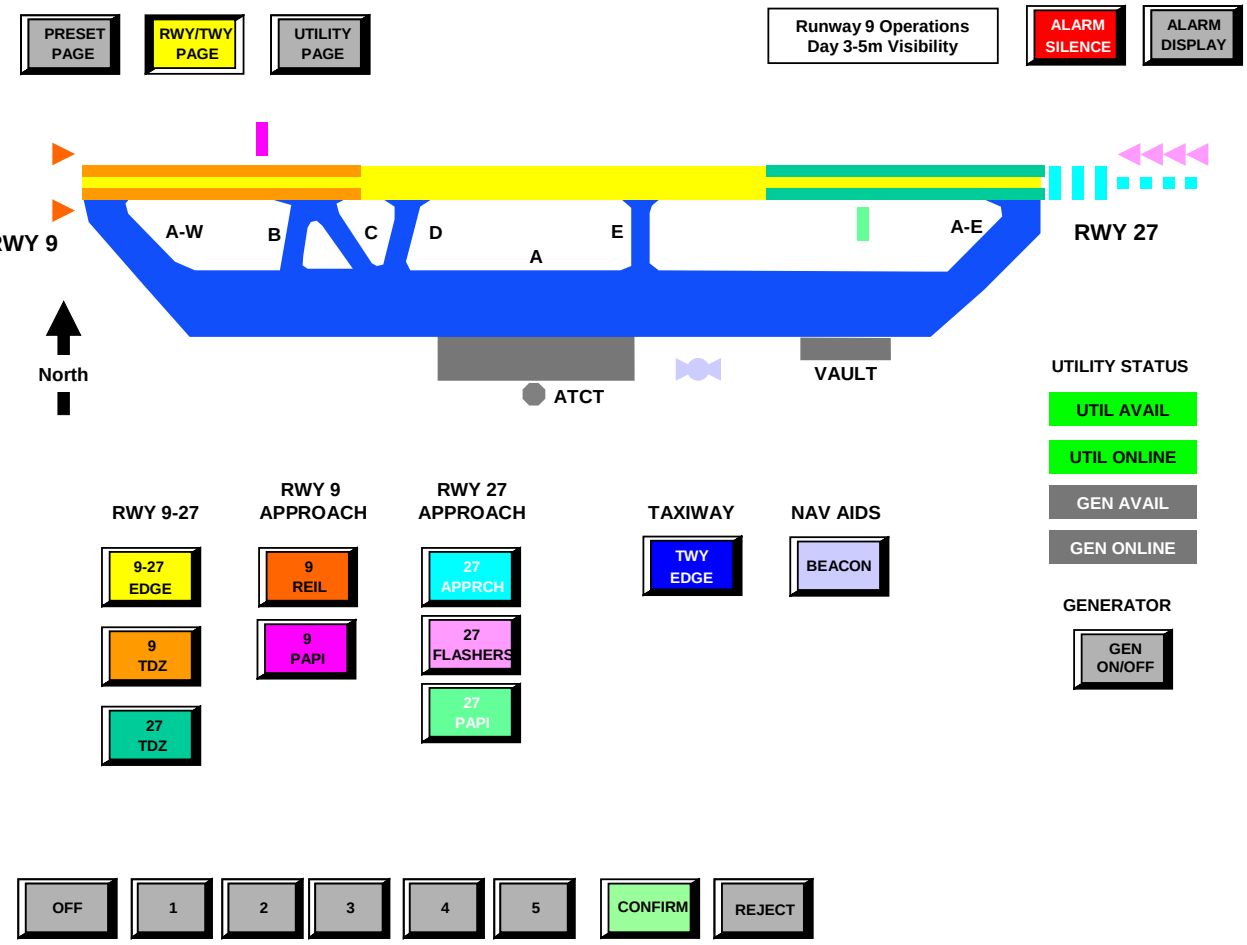


Figure 9: ALCMS Test System Touchscreen GUI: RWY/TWY Page

The control methodology for the runway, approach, taxiway and navigational aids must be configured according to the following table:

Button Description	Test System Circuit Name(s)	Test System Circuit Name(s)
9-27 EDGE	9-27 EDGE	Outputs 0.1 thru 0.5
9 TDZ	9 TDZ	RWY TDZ CCR and Loop 1
27 TDZ	27 TDZ	RWY TDZ CCR and Loop 2
9 REIL	9 REIL	Output Point O.x
9 PAPI	9 PAPI	Output Point O.x
27 APPRCH	27 APPRCH	Output Points O.x thru O.x
27 FLASHERS	27 FLASHERS	Output Points O.x thru O.x
27 PAPI	27 PAPI	Output Points O.x thru O.x
TWY EDGE	TWY EDGE	TWY EDGE CCR
BEACON	BEACON	Output Point O.x
GEN ON/OFF	GENERATOR	Output Point O.x

Table 13: Runway/Taxiway Page Control Methodology

10.3.4 Utility Page

The touchscreen's Utility page must match the test system shown in Figure 10.

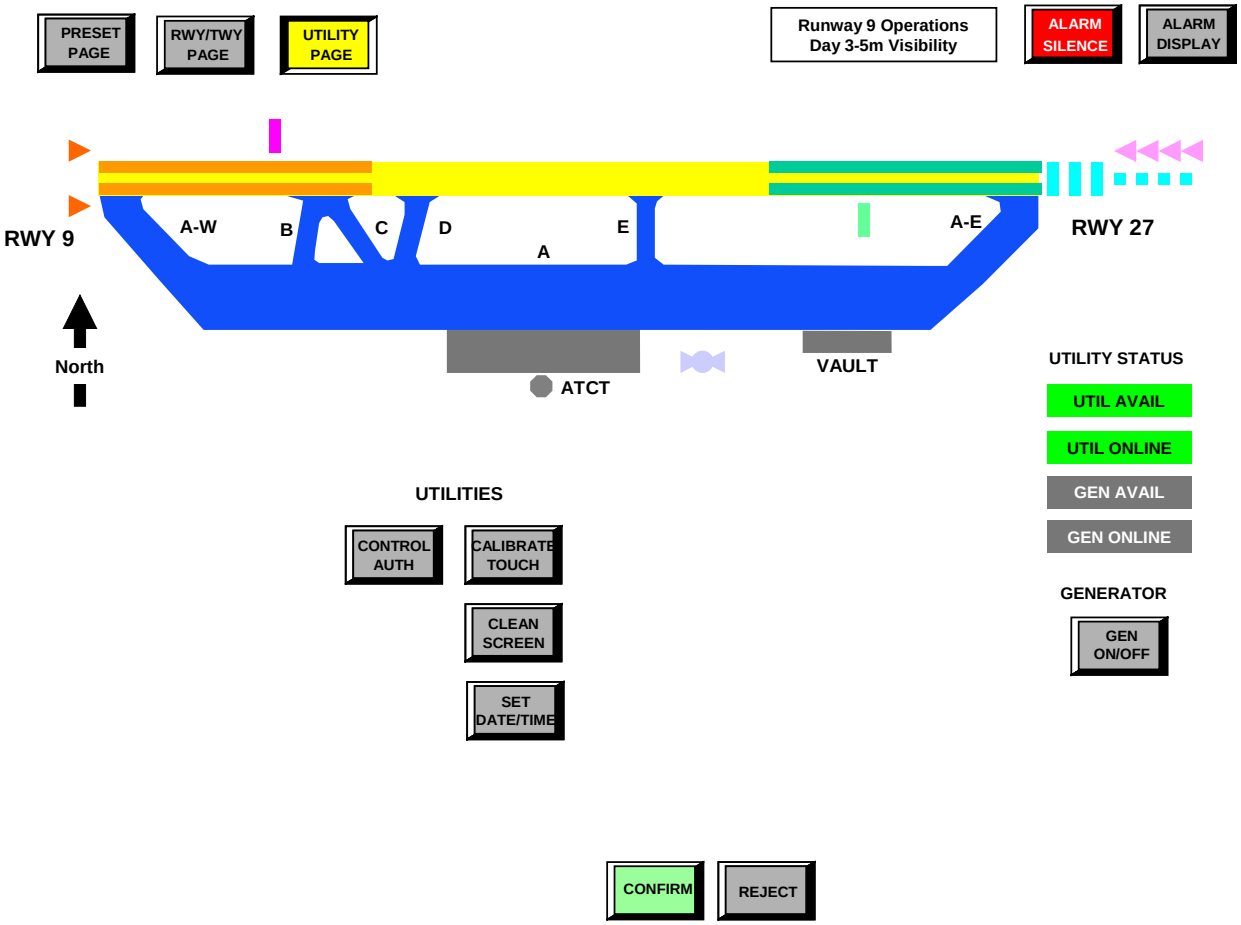


Figure 10: ALCMS Test System Touchscreen GUI: Utility Page

The button functions for the Utility page must be configured according to the following table:

Button Description	Button Function
Control Authorization	Executes program to authorize control of airport lighting at the Vault and Remote Computer locations.
Calibrate Touchscreen	Executes program to authorize calibration of the touchscreen.
Clean Screen	Executes program to allow for the cleaning of the touchscreen without affecting the airport lighting.
Set Date/Time	Executes program to allow for authorized user to set the system date and time.

Table 14: Utility Page Control Methodology

10.3.5 Common Buttons and Indicators

All the touchscreen GUI pages must have the following common buttons, indicators and operational fields:

Button, Indicator and Operational Fields	Function
Preset Settings	Display in text format the current preset settings selected.
Alarm Silence	Silences the audible alarm.
Alarm Display	Executes program to allow for the viewing of current system alarms.
UTIL AVAIL	Indicator lights green when Utility Available feedback is present.
UTIL ONLINE	Indicator lights green when Utility Power Online feedback is present.
GEN AVAIL	Indicator lights green when Generator Available feedback is present.
GEN ONLINE	Indicator lights green when Generator Power Online feedback is present.
OFF,1,2,3,4,5 Brightness Step buttons	Brightness step buttons provide brightness control.
Confirm/Reject buttons	Confirm and Reject buttons provides confirm and reject functionality.

Table 15: Common Button and Indicator Functions

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10.4 Qualification Tests

The following tests must be performed on each system submitted for qualification, to demonstrate compliance with the specification.

10.4.1 Visual Exam

A visual exam must be performed to verify compliance with the specification requirements. All system component details must be identified. All system components must be verified to be an acceptable industrial grade. The HMI must be examined to verify that it meets standard requirements on dimensions, color, visibility, and format.

10.4.2 Hardware Design Review

A review must be performed to verify that all required control and monitoring requirements of the specification are provided. Hardware design must match the ALCMS Test System (reference section 10.2). Any optional features must be completely documented.

10.4.3 Software Design Review

A review must be performed to verify that all required control and monitoring requirements of the specification are provided. Software design must match the ALCMS Touchscreen GUI Test System (reference section 10.3). Any optional features must be completely documented.

10.4.4 Software Version Control

Must meet the requirements of 4.5.

10.4.5 Hardware Design Version Control

Must meet the requirements of 4.6.

10.4.6 Documentation Review

A review of all documentation provided by the manufacturer to the end user must be performed to verify that it is in compliance with the specification. All warranty, training, and technical support material must be reviewed for adequacy and accuracy.

10.5 Operational Certification Test

The operational certification test must be completed to demonstrate that all operational requirements have been met for the ALCMS classification type being certified. Operational tests are specific to the type of ALCMS being certified. The certification test for each type of ALCMS is outlined in Table 16.

	Monitoring	**Failsafe**	**Certification Test**
L-890-	**X**	**Y**	
	A - Control Only	A - Preset	Level 1
	B - Basic Monitoring	A - Preset	Level 2
	C - Advanced Monitoring	B - Last State	Level 3
	D - SMGCS Ready	B – Last State	Level 4

Table 16: ALCMS Certification Tests

Level 4 represents the most stringent testing requirements. An ALCMS manufacturer certified under Level 4 testing must complete all tests under Level 1 through 4. An ALCMS manufacturer certified under Level 4 testing must meet all of the requirements for every classification type of ALCMS.

10.6 Level 1: ALCMS Certification Test

Level 1 certification test defines all of the test procedures that must be successfully performed for the Level 1 acceptance of an ALCMS. The tests in 10.6.1, 10.6.2, 10.6.3, 10.6.4, and 10.6.5 must be completed to ensure that the ALCMS meets all technical, operational, and performance requirements as designated by a Level 1 certification.

10.6.1 Communication Link Test

This test must be used to verify the communication links between each computer node. The test must demonstrate the redundancy capabilities as well as the warning and alarm reporting of the system

Test ID	**Action**	**ALCMS Results**	**Database Results**
1.1.1	Disconnect Link 1 at Tower	No noticeable operational change. System continues to operate on Link 2 and 3.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.2	Initiate airfield lighting preset change	No noticeable operational change. All circuits turn on according to preset and control methodology tables.	
1.1.3	Reconnect Link 1 at Tower	No noticeable operational change.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.4	Disconnect Link 2 at Tower	No noticeable operational change. System continues to operate on Link 1 and 3.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.5	Initiate airfield lighting preset change	No noticeable operational change. All circuits turn on according to preset and control methodology tables.	
1.1.6	Reconnect Link 2 at Tower	No noticeable operational change.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.

1.1.7	Disconnect Link 3 at Tower	No noticeable operational change. System continues to operate on Link 1 and 2.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.8	Initiate airfield lighting preset change	No noticeable operational change. All circuits turn on according to preset and control methodology tables.	
1.1.9	Reconnect Link 3 at Tower	No noticeable operational change.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.10	Disconnect Links 1&2 at Vault	No noticeable operational change. System continues to operate on Link 3.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.11	Initiate airfield lighting preset change	No noticeable operational change. All circuits turn on according to preset and control methodology tables.	
1.1.12	Reconnect Links 1&2 at Vault	No noticeable operational change.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.13	Disconnect Links 1,2 & 3 at Tower	System must go to failsafe condition within 1 minute according to Failsafe requirements.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.14	Reconnect Links 1,2 & 3 at Tower	System must return to normal system operation within 1 minute.	Verify event recorded in database. Event must be stamped with correct Link description and date/time of occurrence.
1.1.15	Initiate airfield lighting preset change	No noticeable operational change. All circuits turn on according to preset and control methodology tables.	

10.6.2 Tower Preset Lighting Control Test

This test must verify proper airport preset lighting control functionality. This test must be completed from the Tower GUI Preset Page and witnessed at the Vault and Remote Computer. All preset lighting settings must be programmed according to Preset Lighting Tables outlined in 10.3.2.

Test ID	Action	ALCMS Results	Database Results	Touchscreen Graphics Results
1.2.1	Select RWY 9, Day			
1.2.2	Select >5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.3	Select 3-5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.4	Select 2-3 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.5	Select 1-2 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.6	Select < 1 mile Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.7	Select Night			
1.2.8	Select >5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.9	Select 3-5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.10	Select 2-3 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.11	Select 1-2 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.12	Select < 1 mile Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI

1.2.13	Select RWY 27, Day			
1.2.14	Select >5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.15	Select 3-5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.16	Select 2-3 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.17	Select 1-2 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.18	Select < 1 mile Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.19	Select Night			
1.2.20	Select >5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.21	Select 3-5 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.22	Select 2-3 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.23	Select 1-2 miles Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.2.24	Select < 1 mile Visibility and Confirm	All circuits must match brightness levels defined by Preset Table	Verify event recorded in computer database	Correct graphics illuminates on GUI

10.6.3 Tower Remote Control Test

This test must verify proper individual airport lighting control functionality. This test must be completed from the Tower GUI Runway/Taxiway Page and witnessed at the Vault and Remote Computer. All individual control lighting settings must be programmed according to Circuit Control Methodology Table outlined in 10.3.3.

Test ID	Action	Vault Control Outputs Response	Database Results	Touchscreen Graphics Feedback
	Test 9-27 Edge			
1.3.1	Select Step 1 and Confirm	CCR ramps to Step-1	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.3.2	Select Step 2 and Confirm	CCR ramps to Step-2	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.3.3	Select Step 3 and Confirm	CCR ramps to Step-3	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.3.4	Select Step 4 and Confirm	CCR ramps to Step-4	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.3.5	Select Step 5 and Confirm	CCR ramps to Step-5	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.3.6	Select OFF and Confirm	CCR ramps to Step-OFF	Verify event recorded in computer database	Correct graphics turns OFF on GUI
1.3.7	Select Step 5 and Confirm	CCR ramps to Step-5	Verify event recorded in computer database	Correct graphics illuminates on GUI
1.3.8	Select OFF and Confirm	CCR ramps to Step-OFF	Verify event recorded in computer database	Correct graphics turns OFF on GUI
1.3.9	Repeat for 9 TDZ			
1.3.10	Repeat for 27 TDZ			
1.3.11	Repeat for 9 REIL			
1.3.12	Repeat for 9 PAPI			
1.3.13	Repeat for 27 APPRCH			
1.3.14	Repeat for 27 FLASHERS			
1.3.15	Repeat for 27 PAPI			
1.3.16	Repeat for TWY EDGE			
1.3.17	Repeat for BEACON			
1.3.18	Repeat for GENERATOR			

10.6.4 Requesting and Granting Control

This test must verify that the Vault and Remote Computer is capable of requesting and gaining control of the airport lighting system.

Test ID	Action	Results
1.4.1	Request control from the Vault GUI using ALCMS program	Verify standby message
1.4.2	At the Tower GUI, authorize control to the requesting station	Verify Tower GUI goes to “View Only Mode” and has the “Revoke” available
1.4.3	Make a preset lighting command change from the Vault GUI	Verify location has control and preset lighting command is executed
1.4.4	Select “Revoke” command	Verify Tower GUI receives control back
1.4.5	Make a preset lighting command change from the new control location	Verify location has control and preset lighting command is executed
1.4.6	Request control from the Remote GUI using ALCMS program	Verify standby message
1.4.7	At the Tower GUI authorize control to the requesting station.	Verify Tower GUI goes to “View Only Mode” and has the “Revoke” available.
1.4.8	Make a preset lighting command change from the Remote GUI	Verify location has control and preset lighting command is executed
1.4.9	Exit control from Remote GUI. This is different from Tower selecting the Revoke option.	Verify Tower GUI receives control back

10.6.5 Preset Failsafe System Test

This test must verify correct execution of the failsafe. Multiple tests must be performed to demonstrate the failsafe system.

Loss of Communication

Test ID	Action	Results
1.5.1	Initiate a group of commands at the touch screen to activate the lighting circuits to a specific step.	Verify units are on the step specified.
1.5.2	At the vault computer, disconnect the communications to the touch screen computer. This must simulate a complete loss of communications between vault computer and touch screen computer.	Verify that touch screen goes into alarm and indicates system in Failsafe. Verify that the units have switched to the preset failsafe step specified.
1.5.3	Re-connect communication links between touch screen computer and vault computer.	Verify that communications are re-established. Verify that system comes out of Failsafe, the touch screen has the control of the circuits, and circuits have changed back to the ALCMS commanded settings.

Computer Reboot

Test ID	Action	Results
1.6.1	Initiate a group of commands at the touch screen to activate the lighting circuits to a specific step.	Verify units are on the step specified.
1.6.2	Execute a shutdown at the vault computer and reboot the computer. This must simulate a vault computer failure/reboot.	Verify that touch screen goes into alarm and indicates system in Failsafe. Verify that the units have switched to the preset failsafe step specified.
1.6.3	Allow computer to recover and restart the vault programs.	Verify that communications are re-established. Verify that system comes out of Failsafe, the touch screen has the control of the circuits, and circuits have changed back to the ALCMS commanded settings.

Power Failure

Test ID	Action	Results
1.7.1	Initiate a group of commands at the touch screen to activate the lighting circuits to a specific step.	Verify units are on the step specified.
1.7.2	Execute a complete system power failure including normal and UPS power on all ALCMS components. Only the CCR must have power applied.	Verify that touch screen goes into alarm and indicates system in Failsafe. Verify that the units have switched to the preset failsafe step specified.
1.7.3	Restore power to all ALCMS components.	Verify that communications are re-established. Verify that system comes out of Failsafe, the touch screen has the control of the circuits, and circuits have changed back to the ALCMS commanded settings.

10.7 Level 2: ALCMS Certification Test

Level 2 certification test defines all of the test procedures that must be successfully performed for the Level 2 acceptance of an ALCMS. The following tests must be completed to ensure that the ALCMS meets all technical, operational, and performance requirements as designated by a Level 2 certification. Level 2 certification requires Level 1 testing to be successfully completed.

Additional required hardware:

3 – Current Sensing Relays (Basic Monitoring equipment)

Modify CCR Taxiway Edge, CCR 9-27 TDZ and Circuit Selector Loop 1 (9 TDZ) and Loop 2 (27 TDZ) to provide basic ON/OFF current monitoring capabilities

Test ID	Action	Results
2.1.1	Add Basic Monitoring to 9-27 Edge	Verify hardware
2.1.2	Cause Alarm	Verify alarm condition on Tower GUI
2.1.3		Verify alarm in database
2.1.4	Clear Alarm	Verify alarm condition on Tower GUI clears
2.1.5		Verify alarm in database clears
2.1.6	Repeat for 9 TDZ	
2.1.7	Repeat for 27 TDZ	
2.1.8	Cause Alarm on 27 Approach	

10.8 Level 3: ALCMS Certification Test

Level 3 certification test defines all of the test procedures that must be successfully performed for the Level 3 acceptance of an ALCMS. The following tests must be completed to ensure that the ALCMS meets all technical, operational, and performance requirements as designated by a Level 3 certification. Level 3 certification requires Level 1 and Level 2 testing to be successfully completed.

Additional required hardware:

3 – Advanced Monitoring equipment providing L-827 monitoring capabilities
3 – Sets of Current and Voltage monitoring equipment

Modify CCR Taxiway Edge, CCR 9-27 TDZ and Circuit Selector Loop 1 (9 TDZ) and Loop 2 (27 TDZ) to provide full L-827 monitoring capabilities.

10.8.1 Regulator Status Monitoring Test

The following tests must verify the status monitoring components of the regulators and ensure proper feedback to the ALCMS. These tests must be performed on each CCR / Circuit listed by the manufacture. A CCR / Circuit may be in any brightness step or on / off state to run this test.

Test ID	Action	Results
3.1.1	Command a circuit to ON (any step).	Verify touch screen and vault computers indicate that circuit is ON at commanded step.
3.1.2	Turn OFF the primary power for the CCR / Circuit to simulate a loss of primary power alarm.	Verify that touch screen circuit graphic goes into alarm.
3.1.3	View database.	**Verify that database shows alarm for the circuit**
3.1.4	Turn ON the primary power for the CCR / Circuit.	Verify that touch screen circuit graphic comes out of alarm.
3.1.5	View database.	Verify that database shows alarm being cleared.
3.1.6	Switch the control wire from CCR Step-2 and Step-3.	Verify that power is turned OFF prior to working on terminals and turned back ON prior to resuming test.
3.1.7	Command CCR to Step-2.	Verify that touch screen circuit graphic goes into output alarm.
3.1.8	View database.	Verify that database shows alarm for the circuit.
3.1.9	Switch the control wire back to CCR Step-2 and Step-3.	Verify that power is turned OFF prior to working on terminals and turned back ON prior to resuming test.
3.1.10	Command CCR to Step-2.	Verify that touch screen circuit graphic output alarm has cleared.
3.1.11	View database.	Verify that database shows alarm cleared for the circuit.

10.8.2 Remote / Local Test

This test must be preformed on each CCR / Circuit manufacturer lists.

Test ID	Action	Results
3.2.1	Command a circuit ON (any step).	Verify touch screen and vault computer indicate that circuit is on at commanded step.
3.2.2	Switch the CCR / Circuit remote/local switch to “local”.	Verify that the touch screen circuit graphic goes into ALARM.
3.2.3	View database.	Verify that database shows ALARM for the circuit.
3.2.4	Switch the CCR / Circuit remote/local switch to “remote”.	Verify that touch screen graphic comes out of ALARM.
3.2.5	View database.	Verify that database shows ALARM being cleared.

10.8.3 Uninterruptible Power Supply (UPS) Monitoring

This test must verify that each UPS in the ALCMS reports normal and alarm status to the system. This test must be conducted on each UPS in the ALCMS.

Test ID	Action	Results
3.3.1	View UPS monitor application and verify the system is monitoring the UPS.	Verify input and output voltages.
3.3.2	Pull communication link to the UPS.	Verify UPS alarm is logged in the database.
3.3.3	Return communication link to the UPS.	Verify UPS alarm clears.
3.3.4	Pull primary power to UPS.	Verify alarm is logged to the database.
3.3.5	Return primary power to the UPS.	Verify alarm is cleared.

10.8.4 Latching Failsafe System Test

This test must verify correct execution of the failsafe. Multiple tests must be performed to demonstrate the failsafe system.

Loss of Communication

Test ID	Action	Results
3.4.1	Initiate a group of commands at the touch screen to activate the lighting circuits to a specific step.	Verify units are on the step specified.
3.4.2	At the vault computer, disconnect the communications to the touch screen computer. This must simulate a complete loss of communications between vault computer and touch screen computer.	Verify that touch screen goes into alarm and indicates system in Failsafe. Verify that the units have maintained the previous step specified.
3.4.3	Re-connect communication links between touch screen computer and vault computer.	Verify that communications are re-established. Verify that system comes out of Failsafe and the touch screen has the control of the circuits.

Computer Reboot

Test ID	Action	Results
3.5.1	Initiate a group of commands at the touch screen to activate the lighting circuits to a specific step.	Verify units are on the step specified.
3.5.2	Execute a shutdown at the vault computer and reboot the computer. This must simulate a vault computer failure/reboot.	Verify that system goes into Latch Failsafe mode and all lighting circuits maintain their last commanded step. Verify that system goes into alarm and indicates system in Failsafe.
3.5.3	Allow computer to recover and restart the vault programs.	Verify that system comes out of Failsafe and the touch screen has the control of the circuits.

Power Failure

Test ID	Action	Results
3.6.1	Initiate a group of commands at the touch screen to activate the lighting circuits to a specific step.	Verify units are on the step specified.
3.6.2	Execute a complete system power failure including normal and UPS power on all ALCMS components. Only the CCR must have power applied.	Verify that system goes into Latch Failsafe mode and all lighting circuits maintain their last commanded step. Verify that system goes into alarm and indicates system in Failsafe.
3.6.3	Restore power to all ALCMS components.	Verify that system comes out of Failsafe and the touch screen has the control of the circuits.

10.8.5 Event Handling Test

This test must verify the ALCMS properly handles event filtering, purging, archiving and backup.

Test ID	Action	Results
3.7.1	Demonstrate Event Filtering.	Verify ALCMS events can be filtered.
3.7.2	Demonstrate Event Archiving.	Verify ALCMS events can be archived.
3.7.3	Demonstrate Event Purging.	Verify ALCMS events can be purged.

10.8.6 Event Reporting Test

This test must verify the ALCMS provides adequate event reports.

Test ID	Action	Results
3.8.1	Demonstrate Event Report Print Outs	Verify ALCMS events can be printed out

10.9 Level 4: ALCMS Certification Test

Level 4 certification test defines all of the test procedures that shall be successfully performed for the Level 4 acceptance of an ALCMS. The following tests shall be completed to ensure that the ALCMS meets all technical, operational, and performance requirements as designated by a Level 4 certification. Level 4 certification requires Level 1, Level 2, and Level 3 testing to be successfully completed.

Additional required hardware:

23 - Intelligent Lamp Switching Device
2 - Intelligent Input Detection Device
2 - Intelligent Lamp Switching Device Modems
1 – Stopbar circuit – 5 inpavement stopbar fixtures, 2 L-862S elevated red lights
1 – Taxiway Lead-in circuit – 16 inpavement taxiway centerline lights
1 – Set of microwave presence detection equipment
1 – Set of Inductive Loop presence detection equipment.

10.9.1 Hardware Test Set-up

Hardware shall be assembly with actual Constant Current Regulators, series circuit cabling, isolation transformers and airfield lighting fixtures as outlined in Figure 11.

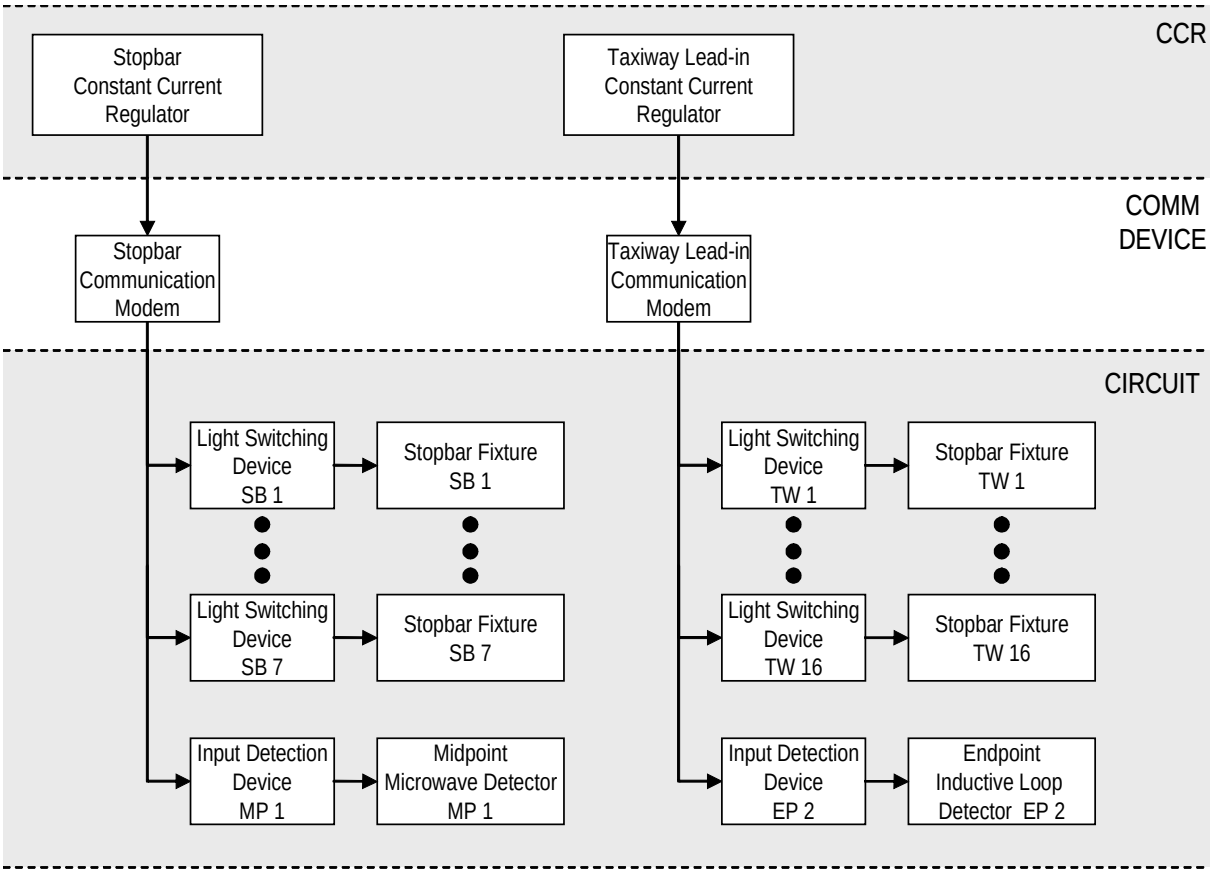

Figure 11: SMGCS Test System

10.9.2 Stopbar Page Touchscreen Design

An additional touchscreen page referred to as the "Stopbar Page" shall be designed in accordance with Figure 12. The fixture ID's SB1 thru SB7 and TW1 thru TW 16 are used for reference purposes only. This page shall be accessible from a button on the "Preset Page".

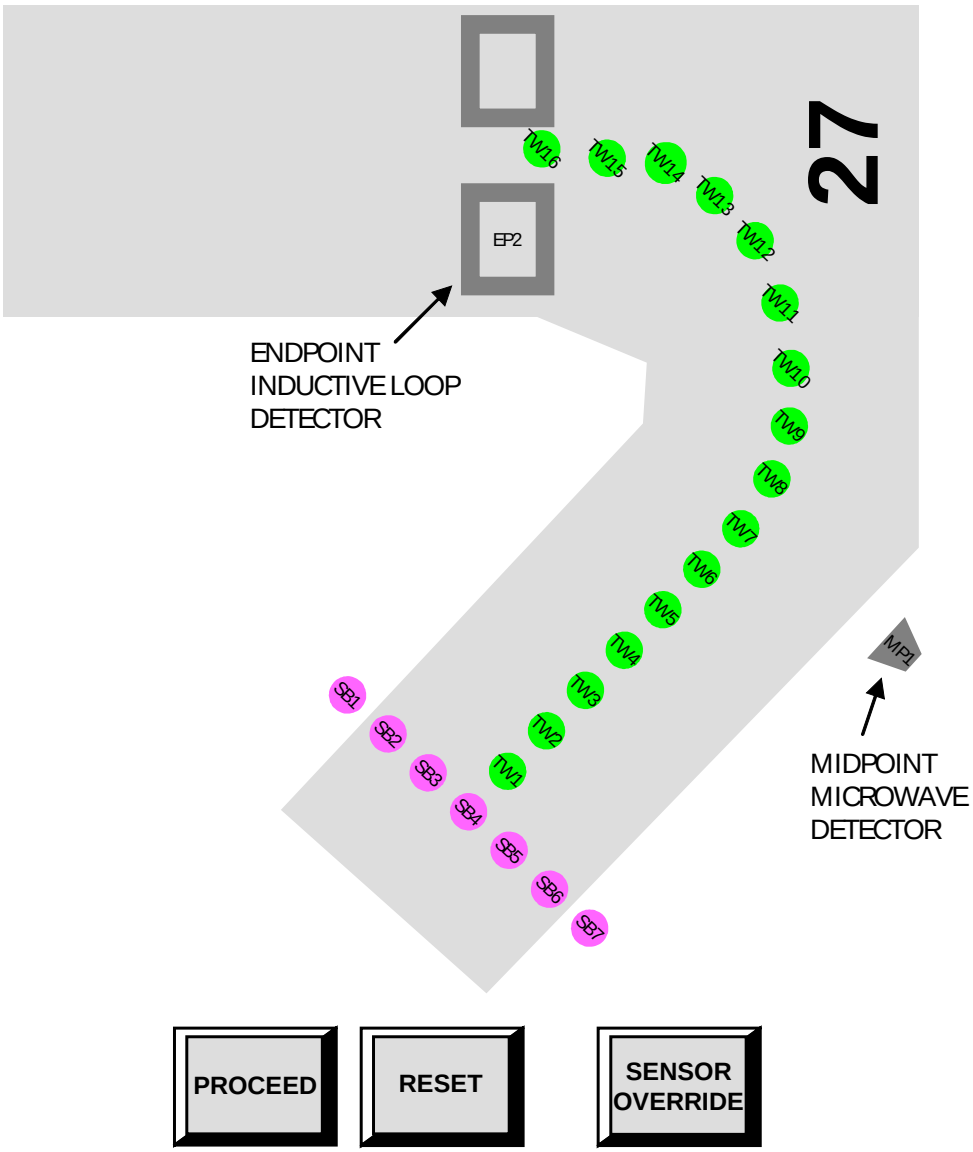

Figure 12: Stopbar Control Page

10.9.3 Initiating a Low Visibility Test

The following tests will verify the system is capable of initiating a low visibility preset and commanding the system into low visibility operations. The preset settings for less than 1200 RVR are indicated in Table 17.

CIRCUIT DESCRIPTIONS	Steps	OPERATIONS DAY		OPERATIONS NIGHT	
		RWY 9	RWY 27	RWY 9	RWY 27
9-27 Edge	5	5	5	5	5
9 TDZ	5	5	0	5	0
27 TDZ	5	0	5	0	5
9 REIL	1	1	0	1	0
9 PAPI	1	1	0	1	0
27 Approach Lights	3	0	3	0	3
27 Flashers	3	0	3	0	3
27 PAPI	1	0	1	0	1
Taxiway Edge	3	3	3	3	3
Taxiway Centerline	3	3	3	3	3
Stopbar	1	3	3	3	3
Beacon	1	1	1	1	1
Generator	1	1	1	1	1

Table 17: Less 1200 RVR Visibility

Test ID	Action	Results
4.1.1	Initial Low Visibility Preset Setting. Less than 1200 RVR.	Verify all circuits are activated according to preset table settings.
4.1.2	Observe lighting fixtures.	Verify stopbar circuit is activated ON.
4.1.3	Observe lighting fixtures.	Verify taxiway centerline lights are activated ON.
4.1.4	Switch to Stopbar Page.	Verify Stopbar Page is shown on the Touchscreen.
4.1.5	Observe the Stopbar Page.	Verify Stopbar graphics are ON (SB1 – SB7) and lead-on graphics are OFF (TW1 – TW16).

10.9.4 Stopbar Cycling and Resetting Test

The following tests will verify the system is capable of cycling a stopbar and resetting a stopbar.

Test ID	Action	Results
4.2.1	Cycle the stopbar by pressing the “Proceed” button.	
4.2.2	Observe lighting fixtures control response time.	Verify stopbar lights turn OFF and lead-on lights turn ON within allowable time outlined in AC 150/5340-30.
4.2.3	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is OFF (SB1 – SB7) and lead-on graphic feedback is ON (TW1 – TW16) within allowable time outlined in AC 150/5340-30.
4.2.4	Reset the stopbar by pressing the “Reset” button.	
4.2.5	Observe lighting fixtures control response time.	Verify stopbar lights turn ON and lead-on lights turn OFF within allowable time outlined in AC 150/5340-30.
4.2.6	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is ON (SB1 – SB7) and lead-on graphic feedback is OFF (TW1 – TW16) within allowable time outlined in AC 150/5340-30.

10.9.5 Stopbar Presence Detector Test

The following tests will verify the system is capable of interfacing with two (2) types of presence detectors. The test will verify that the Midpoint detector reset the stopbar and turn off the "black-hole" segment of lead-in lights and the Endpoint detector will turn off the remaining segment of lead-in lights.

Test ID	Action	Results
4.3.1	Cycle the stopbar by pressing the "Proceed" button.	
4.3.2	Observe lighting fixtures control response time.	Verify stopbar lights shut OFF and lead-on lights turn ON within allowable time outlined in AC 150/5340-30.
4.3.3	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is OFF (SB1 – SB7) and lead-on graphic feedback is ON (TW1 – TW16) within allowable time outlined in AC 150/5340-30.
4.3.4	Simulate aircraft detection at the Midpoint detector.	
4.3.5	Observe lighting fixtures control response time.	Verify stopbar lights turn ON and segment 1 lead-on lights (TW1 – TW8) turn OFF within allowable time outlined in AC 150/5340-30.
4.3.6	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is ON (SB1 – SB7) and lead-on lights (TW1 – TW8) graphic feedback is OFF, while lead-on lights segment 2 (TW9 – TW16) remain ON.
4.3.7	Simulate aircraft detection at the Endpoint detector.	
4.3.8	Observe lighting fixtures control response time.	Verify segment 2 lead-on lights (TW9 – TW16) turn OFF within allowable time outlined in AC 150/5340-30.
4.3.9	Observe the Stopbar Page feedback (back indication) response time.	Verify segment 2 lead-on lights (TW9 – TW16) graphic feedback turn OFF.
4.3.10	Repeat steps as needed to verify all control and feedback response times.	

10.9.6 Sensor Override Test

The following tests will verify the system is capable of performing a sensor override in which the back indication from the two (2) types of presence detectors is ignored for 2 minutes.

Test ID	Action	Results
4.4.1	Perform and sensor override by pressing the "Sensor Override" button.	
4.4.1	Begin 2 minute timer.	
4.4.2	Observe lighting fixtures control response time.	Verify stopbar lights shut OFF and lead-on lights turn ON within allowable time outlined in AC 150/5340-30.
4.4.3	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is OFF (SB1 – SB7) and lead-on graphic feedback is ON (TW1 – TW16) within allowable time outlined in AC 150/5340-30.
4.4.4	Simulate aircraft detection at the Midpoint detector.	Verify detection is ignored by the Midpoint detector.
4.4.5	Observe lighting fixtures control response time.	Verify stopbar lights remain OFF and all lead-on lights (TW1 – TW16) remain ON.
4.4.6	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is ON (SB1 – SB7) and lead-on lights (TW1 – TW16) graphic feedback is ON.
4.4.7	Simulate aircraft detection at the Endpoint detector.	Verify detection is ignored by the Endpoint detector.
4.4.8	Observe lighting fixtures control response time.	Verify stopbar lights remain OFF and all lead-on lights (TW1 – TW16) remain ON.
4.4.9	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is ON (SB1 – SB7) and lead-on lights (TW1 – TW16) graphic feedback is ON.
4.4.10	Allow 2 minute timer to expire.	
4.4.11	Observe lighting fixtures control response time.	Verify stopbar lights turn ON and all lead-on lights (TW1 – TW16) turn OFF within allowable time outlined in AC 150/5340-30.
4.4.12	Observe the Stopbar Page feedback (back	Verify stopbar graphic feedback is ON (SB1 – SB7) and lead-

	indication) response time.	on lights (TW1 – TW16) graphic feedback is OFF.
4.4.13	Repeat steps as needed to verify all control and feedback response times.	

10.9.7 Stopbar Presence Detector Failure Test

The following tests will verify the system is capable of continuing to operate in the event of detector failures. When the Midpoint sensor fails, the system should reset the stopbar and turn off the "black-hole" segment of lead-in lights after a 45 second timer expires and if the Endpoint detector fails the system shall turn off the remaining segment of lead-in lights after an additional 1 minute and 15 second timer expires.

Test ID	Action	Results
4.5.1	Cycle the stopbar by pressing the "Proceed" button.	
4.5.2	Begin 2 minute timer.	
4.5.3	Observe lighting fixtures control response time.	Verify stopbar lights shut OFF and lead-on lights turn ON within allowable time outlined in AC 150/5340-30.
4.5.4	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is OFF (SB1 – SB7) and lead-on graphic feedback is ON (TW1 – TW16) within allowable time outlined in AC 150/5340-30.
4.5.5	Wait for 45 seconds to expire. This simulates no aircraft detection at the Midpoint detector or detector failure.	
4.5.6	Observe lighting fixtures control response time.	Verify stopbar lights turn ON and segment 1 lead-on lights (TW1 – TW8) turn OFF within allowable time outlined in AC 150/5340-30.
4.5.7	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar graphic feedback is ON (SB1 – SB7) and lead-on lights (TW1 – TW8) graphic feedback is OFF, while lead-on lights segment 2 (TW9 – TW16) remain ON.
4.5.8	Wait for additional 1 minute and 15 seconds to expire. This simulates no aircraft detection at the Endpoint detector or detector failure.	
4.5.9	Observe lighting fixtures control response time.	Verify segment 2 lead-on lights (TW9 – TW16) turn OFF within allowable time outlined in AC 150/5340-30.
4.5.10	Observe the Stopbar Page feedback (back indication) response time.	Verify segment 2 lead-on lights (TW9 – TW16) graphic feedback turn OFF.
4.5.11	Repeat steps as needed to verify all control and feedback response times.	

10.9.8 Stopbar Lamps Out Warning and Alarm Test

The following tests will verify the system reports stopbar lamp out warning and alarms in accordance with maintenance criteria outlined in AC 150/5340-30.

Test ID	Action	Results
4.6.1	Remove 1 elevated stopbar light (SB1) from the transformer / circuit.	
4.6.2	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar goes into alarm within allowable time outlined in AC 150/5340-30.
4.6.3	Verify event reported to database.	Verify stopbar fixture ID SB1 shows lamp out in database.
4.6.4	Return elevated stopbar light (SB1) to the transformer / circuit.	
4.6.5	Observe the Stopbar Page feedback (back indication) response time.	Verify stopbar goes out of alarm within allowable time outlined in AC 150/5340-30.
4.6.6	Verify event reported to database.	Verify stopbar fixture ID SB1 shows lamp out cleared in database.
4.6.7	Remove 1 in-pavement stopbar light SB2 from the transformer / circuit.	Verify stopbar warning within allowable time outlined in AC 150/5340-30.
4.6.8	Verify event reported to database.	Verify stopbar fixture ID SB2 shows lamp out in database.
4.6.9	Remove adjacent in-pavement stopbar light SB3 from the transformer / circuit.	Verify stopbar goes into alarm within allowable time outlined in AC 150/5340-30.
4.6.10	Verify event reported to database.	Verify stopbar fixture ID SB3 shows lamp out in database.
4.6.11	Return 1 in-pavement stopbar light SB2 to the transformer / circuit.	Verify stopbar alarm clears and returns to warning within allowable time outlined in AC 150/5340-30.
4.6.12	Verify event reported to database.	Verify stopbar fixture ID SB2 shows lamp out cleared in database.
4.6.13	Return in-pavement stopbar light SB3 to the transformer / circuit.	Verify stopbar warning clears within allowable time outlined in AC 150/5340-30.
4.6.14	Verify event reported to database.	Verify stopbar fixture ID SB3 shows lamp out cleared in database.

10.9.9 Taxiway Lead-on Lights Lamps Out Warning and Alarm Test

The following tests will verify the system reports taxiway lead-on lights lamp out warning and alarms in accordance with maintenance criteria outlined in AC 150/5340-30.

Test ID	Action	Results
4.7.1	Remove 1 taxiway light TW8 from the transformer / circuit.	Verify taxiway warning within allowable time outlined in AC 150/5340-30.
4.7.2	Verify event reported to database.	Verify taxiway fixture ID TW8 shows lamp out in database.
4.7.3	Remove adjacent taxiway light TW9 from the transformer / circuit.	Verify taxiway lead-on segments go into alarm within allowable time outlined in AC 150/5340-30.
4.7.4	Verify event reported to database.	Verify taxiway fixture ID TW9 shows lamp out in database.
4.7.5	Return light TW 8 to the transformer / circuit.	Verify lead-on alarm clears and returns to warning within allowable time outlined in AC 150/5340-30.
4.7.6	Verify event reported to database.	Verify fixture ID TW8 shows lamp out cleared in database.
4.7.7	Return light TW 9 to the transformer / circuit.	Verify lead-on warning clears within allowable time outlined in AC 150/5340-30.
4.7.8	Verify event reported to database.	Verify fixture ID TW9 shows lamp out cleared in database.

10.9.10 Stopbar Failsafe Test

The following tests will verify the system enters into a failsafe condition in the event that the system reports a critical failure, which prevents communication to the light switching devices.

Test ID	Action	Results
4.8.1	Remove connection between the Control Device and the Lamp Switching Device	
4.8.2	Observe lighting fixtures control response time	Verify stopbar lights are ON, lead-on segment 1 (TW1-TW8) lights turn OFF and lead-on segment 2 (TW9-16) are ON
4.8.3	Observe the Stopbar Page feedback (back indication) response time	Verify stopbar graphic feedback is ON (SB1 – SB7), lead-on segment 1 graphic feedback is OFF (TW1 – TW8) and lead-on segment 2 (TW9-16) is ON
4.8.4	Verify event reported to database	Verify alarm is reported to database
4.8.5	Restore connection between the Control Device and the Lamp Switching Device	
4.8.6	Observe lighting fixtures control response time	Verify stopbar lights are ON, lead-on segment 1 (TW1-TW8) lights turn OFF and lead-on segment 2 (TW9-16) are OFF
4.8.7	Verify event reported to database	Verify alarm is cleared in the database

Appendix 1: Communications Application Notes

Vault Communication Network

With hard-wire vault communication networks, consideration must be taken during the design and installation in order to minimize susceptibility to EMI generated by other electrical equipment. As with any hard-wire system, communication and voltage cabling (120VAC or 5000VAC field cabling) must be isolated during installation by installing in a separate raceway. The ALCMS system supplier must be consulted regarding cable type, placement and installation guidelines.

ALCMS Communication Network

The Communication Network must be a dedicated communication network designed solely for the ALCMS system. Since network traffic, service and support of networks cannot always be predicted; a dedicated ALCMS communication network helps to assure the most reliable and predictable control and monitoring system.

In order to provide added redundancy it is recommended that a minimum of two (2) network communication links be designed into the ALCMS. The Designer needs to specify all communication requirements and perform required site surveys to determine cable lengths, line-of-site and communication baud rate desired. This section reviews several communication options and design guidelines when specifying them as part of an ALCMS.

Fiber Optic, Multi-mode, 10/100BASE-T

Fiber optic cable offers excellent isolation from EMI or lightning discharge. Typical system design uses two (2) fiber optic communication links.

- The fiber optic cables must be multi-mode, 850/1300nm wavelength
- Fiber cable size must be selected based on budget calculation. Refer to Appendix 2
- Each fiber communication link requires 2 fibers.
- Fiber optic cable must be terminated at a fiber optic patch panel within each subsystem before being terminated at the communication equipment.
- Fiber optic jumper cables must be provided from the fiber patch panel to the computer equipment enclosures.
- Fiber optic cable must be terminated with connectors as specified by the Designer at the fiber optic transceivers located within the vault computer cabinet.
- Fiber optic runs must be direct point-point runs with no splices if installation allows.
- Fifty percent (50%) spare fiber cables must be pulled and terminated within the fiber optic patch panel for future expansion.
- Upon completion of fiber optic installation, the airport/owner must receive a test report that must include dB loss test results.

Designer Note: The Fiber Optic system must be supplied and installed by a qualified fiber communications specialist. The Designer must specify who (Contractor or ALCMS manufacturer) is responsible for supplying the fiber optic equipment including fiber, patch panels, jumpers and all other peripherals. The ALCMS manufacturer must assume that the Contractor supplies all fiber optic equipment if not specified.

Fiber Optic, Single mode, 10/100 BASE-T

- The fiber optic cables must be single mode, 1300nm wavelength.
- Fiber cable size must be selected based on budget calculation. Refer to Appendix 2
- Each fiber communication link requires 2 fibers.
- All fiber optic cable must be terminated at a fiber optic patch panel within each subsystem before being terminated at the communication equipment.

- Fiber optic jumper cables must be provided from the fiber patch panel to the computer equipment enclosures.
- Fiber optic cable must be terminated with connectors at the fiber optic transceivers located within the vault computer cabinet.
- Fiber optic runs must be direct point-point runs with no splices if installation allows.
- Fifty percent (50%) spare fiber cables must be pulled and terminated within the fiber optic patch panel for future expansion.
- Upon completion of fiber optic installation, the airport/owner must receive a test report that must include dB loss test results.

Hard-wire Communication

- The hard wire cable must be stranded copper conductors.
- All cable must be terminated at a terminal cabinet within each subsystem before being terminated at the communication equipment.
- Cable jumpers must be provided from the terminal cabinet to the computer equipment enclosures.
- Hard wire runs must be direct point-to-point runs with no splices if installation allows.
- Fifty percent (50%) spare conductors must be pulled and terminated within the terminal cabinet for future expansion.
- Upon completion of hard wire installation, the airport/owner must receive an insulation resistance test report that confirms proper installation. The insulation resistance must be 50M Ohms minimum.
- Upon completion of hard wire installation, the airport/owner must receive a continuity test report that confirms proper installation. The continuity resistance per conductor must not exceed .7 Ohms per 1000 feet.

Designer Note: If existing cabling is part of the ALMCS design, the Designer must research the current conditions of the cable. This includes completing an insulation resistance and continuity test report and including this data in the ALCMS design specifications. The ALCMS manufacturer must assume that the Designer has confirmed the tests meet the minimum criteria as outlined above if not specified.

Wireless [Requires Direct line-of-site]
The method of wireless communication chosen must be suitable for use in the airport environment and proper RF site survey must be completed by the Designer or clearly coordinated with the ALCMS manufacturer as a requirement for the project. The basic rules of a radio site survey must be observed (See Wireless Communication Site Inspection below).

- It is recommended that the wireless network be license-free.
- If the airport / owner has not previously performed a site inspection and survey and indicated an exact frequency, the Designer may coordinate a radio site survey in order to select a wireless frequency.
- The Designer must verify wireless communication system has direct line-of-site between subsystems. No obstructions including trees, buildings, towers, etc. can be between locations of antennas.
- The wireless system must combine antenna diversity and digital signal processing to assure secure, reliable wireless communication.

Wireless Communication Site Inspection
As part of selecting the use of wireless communication, the Designer must complete an on-site inspection and survey which includes the following:

- A RF site inspection and survey must be performed by a trained and qualified RF specialist to determine wireless communication equipment requirements and verify open frequencies that can be used for wireless communication.
- The Designer in cooperation with the airport / owner must have previously determined antenna installation locations and mast sizes. All of these locations must be indicated on the Contract Documents
- The Designer must have previously verified that direct line-of-site communication is possible between all locations.
- If direct line-of-site is not possible, locations of all repeaters must be specified.
- Line-of-site distances between all locations must be specified.
- Wireless Communication Interference Test: As part of selecting the use of wireless communication, the Designer must complete an interference test that includes a frequency sweep (using a spectrum analyzer) run over a 24-hour period. The resulting usable frequency report must be included as part of the design.

Appendix 2: Fiber Optic Budget Worksheet

The Designer may complete a fiber optic budget calculation and include as part of the ALCMS design. The fiber optic calculations must assure that the selected fiber optic communication equipment, fiber cable, connector kits, patch panels and splice kits when combined as an entire fiber system must operate within the designed application.

Table 18 is an example of an Optical budget calculator worksheet that may be used by the Designer as part of the optical budget calculations.

Table 19 is an example of a completed optical budget. This is an example for one specific application and does not apply for other optical budgets.

	Optical Budget Calculator					
				Minimum Transmit Power		
				Minimum Receive Sensitivity	–	
				Available Power	=	
	Km of cable	X		dB/km	=	
	Connectors	X		dB/Con.	=	
	Splices	X		dB/splice	=	
				Link Margin	=	
	Repair Splices	X		dB/Splice	=	
				Safety Margin / Aging	–	
				Excess Power		

Table 18: Fiber Optic Budget Calculator Worksheet

	Optical Budget Calculator					
				Minimum Transmit Power		-10 dBm
				Minimum Receive Sensitivity	–	-33 dBm
				Available Power	=	23 dB
20	Km of cable	X	.5 dB	dB/km	=	10 dB
6	Connectors	X	.75 dB	dB/Con.	=	4.5 dB
4	Splices	X	.1 dB	dB/splice	=	.4 dB
				Link Margin	=	8.1 dB
5	Repair Splices	X	.1dB	dB/Splice	=	.5 dB
				Safety Margin / Aging	–	3 dB
				Excess Power		4.6 dB

Table 19: Fiber Optic Budget Worksheet Sample

Appendix 3: Touchscreen Technology Review

This section explores the design considerations when developing a HMI interface for airport use.

Touchscreens Advantages

Upgrades

A touchscreen allows software upgrades to be easily implemented if changes need to be made after the hardware has been installed. Since all controls and displays are presented visually on the monitor, it is much easier and less costly to make changes at a later point in time if, for example, a new taxiway is added. Any airport that plans to have major changes has often required that the entire panel be replaced. Implementing spare buttons in the panel, however, has usually accommodated minor changes.

Space

Physical space is often at a premium in Airport Traffic Control Towers (ATCT). For very large airport or very complex SMGCS systems, a touchscreen may potentially use less space since different "pages" can be implemented to control or monitor various aspects of the airport.

User-Friendly

Touchscreens reduce training time and operator error. The interface is dedicated to each airport and is designed with graphical buttons replacing complex push button panels. Since only valid operations are offered on the screen, even new operators can quickly and easily learn how to use complex systems.

Multi-Function

Touchscreens have the potential to serve multiple functions. Advisory Circular 150/5340-30 requires that a push button panel be used for Controllable Stop bars in Low Visibility conditions. The user is to receive a tactile feedback when a pushbutton is pressed. It is believed that this additional level of physical feedback increases safety in this critical application. A "click" is required at the bottom of the button movement to further increase the tactile feedback. If a touch screen is used for normal visibility operations, the normal visibility controls become inactive and the push button panel activates as soon as low visibility operations are started (RVR less than 1200 feet). The push button panel has a simplified graphical representation of the low visibility route with individual controls for each controllable stop bar.

A touch screen can be used to control the airport lighting and the controllable stop bars, upon activating the low visibility lights the user could select which stop bar is to be controlled. A separate touchscreen page (no split screens) pops up for only the stop bar selected. The stop bar could be specific to touchscreen size that will allow clearer viewing and allow viewing monitoring of each light (on or off). The screen would allow buttons to be highlighted with visual/audible tactile feedback. This larger screen allows buttons to be larger than the buttons on a mechanical panel. This allows the display to be easily viewed on bright days.

These same arguments apply to LAHSO lighting panels, PAPI control and some of the other devices usually owned by the airports or FAA.

Touchscreen Redundancy

It is often a design consideration to increase system reliability through the use of redundant systems. In an ALCS system, this is often accomplished by requiring dual communication links, dual hard-drives on computers, dual computers (hot swappable system), etc. Depending upon the degree of reliability desired and cost limitations, dual touchscreens are sometimes desired. Other methods of handling concerns of the touch screen going down would be to have a compatible touchscreen be available as a spare.

It is sometimes necessary to have multiple HMI touchscreens in the tower in order to minimize the amount of travel an operator in the tower has to do in order to interact with the HMI. It must be required that both touchscreens be able to operate the entire airport. This will provide a higher level of redundancy.

Choosing the Right Touchscreen Technology
All touchscreen systems include two parts: the sensory overlay, or bezel, which is attached to the face of the display, and the controller circuitry which monitors the Touchscreen sensor and determines the location of input. The controller also converts the signals from the touch sensor into usable signals for the host computer. In order to improve the speed of response during screen paging, a dedicated computer must be connected to the Touchscreen. The sole function of this computer is to optimize the performance of the Touchscreen. Specific device "drivers" installed via software in this computer provide the link to the application software.

The touch sensor can be installed as a slip-on overlay or can be completely integrated into the monitor.

The resolution for a 20" display is typically 1024 x 768. This number is directly related to the maximum number of infrared LED's that can be fit into an overlay. However, the size of a human finger limits the minimum size that a Touch Screen button can be made. Therefore, the human finger limits the resolution that can be achieved and not the technology used. In order to properly consider the effects of the human finger on the Touch Screen design, the specification must state that the button must be ½" high by 5/8" wide minimum, and that there must be 1/8" unused space around all buttons. This space is to be provided around the button in order to insure that there is no inadvertent activation. This is completely independent of screen size, resolution or number of pixels.

Infrared Technology
The infrared Touch Screen surrounds the face of the display with a frame of light emitting diodes (LED's) and diametrically opposing phototransistor detectors. The circuitry within the frame directs a sequence of pulses to the LED's, scanning the screen with an invisible lattice of infrared light beams just above the surface. The Touch Screen circuitry then detects input at the location where light beams have become obstructed by any solid object.

Advantages
- Image quality is not affected since there is 100% light transmission from the display surface. This is because there is nothing on the surface of the touchscreen display.

- Any solid (opaque) object may be used as the input device. However, current consensus is such that it is preferable to only have to use a finger as the input technique. It is not desired to encumber an Air Traffic Controller (ATC) with the extra task of picking up a separate object, such as a stylus.

Disadvantages:
- Dust, water, grease, dirt or a "post-it" note may obstruct a phototransistor receptor, preventing input, or "dead touch zones". This is not usually a problem (with the exception of the post-it) at Air Traffic Control Tower (ATCT), since the environment is fairly clean. In addition, a "Clean Screen" button may be provided which allows the Touch Screen to be occasionally manually cleaned, thereby preventing these problems.
- The beams of infrared light are slightly in front of the display (usually 1/4" at center, 1/2" at corners). Visual discrepancies may exist, especially at the edges, if the user's line of sight and their finger approaching the screen are different, if the angle is great, and the buttons are too small and close together, the ATC could select an incorrect area. This problem can be eliminated through the use of proper size buttons and sufficient spacing between buttons.
- Any object dropped on screen may cause electrical contact.

Surface Acoustical Wave (SAW) Technology
This Touchscreen uses the solid glass monitor display surface for the touch sensor. Two surface acoustic (sound) waves are transmitted across the surface of the glass sensor, one for vertical detection and one for horizontal detection. These sound waves are inaudible to the human ear. Each wave is spread across the screen by bouncing off reflector arrays along the edges of the overlay. Two receivers detect the waves, one for each axis. Since the velocity of the acoustic wave through glass is known and the size of the overlay is fixed, the arrival time of the waves of the respective receivers is known. When the ATC touches the glass surface, the water content of the user's finger absorbs some of the energy of the acoustic wave, weakening it. The Touchscreen circuitry measures the time at which the received amplitude dips to determine the X and Y coordinates of the touch location.

In addition to the X and Y coordinates, SAW technology can also provide Z axis (Depth) information. As the user presses against the screen, the more energy the finger absorbs, the greater will be the dip in signal strength. This strength is then measured in order to provide Z-axis information. There is also some question as to the ability of a human to determine the "strength" differences to activate a certain Z access input. Therefore, measuring depth information is not a requirement for airport use.

Advantages
- Provides X, Y and Z information from a single touch.

Disadvantages
- Heavy water, grease, or other energy absorbing materials (large pencil eraser) can cause unwanted input.

Resistive Technology
How it works: A resistive Touch Screen uses a display overlay consisting of two elements, a glass substrate covered by a tight fitting plastic cover sheet. Conductive coating is applied to the inner surfaces of both elements. Separating the glass substrate from the plastic cover sheet are special separator dots, evenly distributed across the active area. Light finger pressure causes internal electrical contact at the point of touch, supplying the Touch Screen circuitry with vertical and horizontal analog voltages for digitization.

Advantages
- Dust, grease, or standing water does not affect resistive Touch Screen.
- Any pointing device can be used.

Disadvantages
- Susceptible to scratches from sharp objects and abrasion from rough surfaces because the cover sheet is made of plastic.
- Any object dropped on screen may cause electrical contact.
- Decreased image brightness since the sensor overlay only allows approximately 65% light transmission.

Capacitive Technology
A Capacitive Touchscreen uses an overlay made of glass with a coating of Capacitive (charge storing) material deposited electrically over its surface and employs four oscillator circuits, each of which is connected to one of the four corners of the glass sensor. The frequency of each oscillator is determined by the capacitance between the overlay and ground. When the ATC touches the sensor, the user's body capacitance charges the capacitance seen by the four oscillators and changes their frequency. The Touchscreen circuitry measures the frequency changes to determine the X and Y coordinates of the touch.

Advantages
- Not effected by dirt or grease.
- Impervious to scratches from sharp objects or abrasion from rough surfaces.

Disadvantages
- Must use conductive pointing device. A human hand cannot be used to interact with a Capacitive Touch Screen using technology available today. A gloved finger is only effective if the glove is conductive.
- For this reason Capacitive Touch Screens are not normally used at airports.

Summary
Generally, resolution and speed are not a problem in airport applications. Taking into consideration the operational environment, Sound Acoustic Wave (SAW) touchscreens are most often the technology of choice at airports.

The monitor must be sealed to protect it from spilled liquids. Although liquids are energy absorbing and can cause a circuit connection with this technology, one would have to completely flood the screen with large quantities of liquid to cause a circuit connection.

	Infrared	**SAW**	**Resistive**
Resolution	Good	Best	Best
Optical Clarity	Best 100%	Good 95 - 100%	Fair 65 - 75%
Speed (points per second)	Fair (20-50)	Good (100)	Good (60-175)
Stylus	Solid	Energy Absorbing	Pressure
Parallax error	Fair	Good	Good
Durability (touches)	Best	Good (2 mil)	Fair (1 mil)
Resistance to:			
Dust	Poor	Best	Best
Abrasion/Scratches	Good	Best	Poor
Liquids	Poor	Good	Good

Table 20: Touchscreen Technology Comparison

Appendix 4: Touchscreen Installation Application Note

Before selecting a Touchscreen or specifying a Touchscreen size, the Designer must perform an inspection and survey of the installation location. At a minimum, the following information must be considered in a touchscreen ALCMS design. Refer to Figure 13.

a. Dimensions of available space of upper console (Reference A) must be confirmed.
b. The touchscreen (Reference B) that is specified must be selected based on available space.
c. The touchscreen must be installed at an easily viewable angle away from direct sunlight when possible.
d. Touchscreens must be installed at an angle and must never be installed completely flat.
e. Clearance in the lower console must be inspected to assure room for touchscreen interface wiring (Reference C).
f. Available shelf space (Reference D) must be confirmed or specifications for constructing a shelf must be detailed.
g. The video extension equipment (Reference E) must be positioned such that there is easy access to view and troubleshoot.
h. Clearance in the lower console must be inspected to assure room for interface wiring to the ATC computer equipment located remotely from the touchscreen (500 feet minimum). Conduit capacity must be evaluated to determine cable routing. (Reference F).
i. Available space must be confirmed for a UPS (Reference G) if required. This is required if Emergency power is not available in the lower console.
j. Consideration must be given to mounting the touchscreen on a pivot, which provides a minimum tilt of 30 degrees. Many glare issues after installation can be addressed by pivoting the touchscreen a couple of degrees.

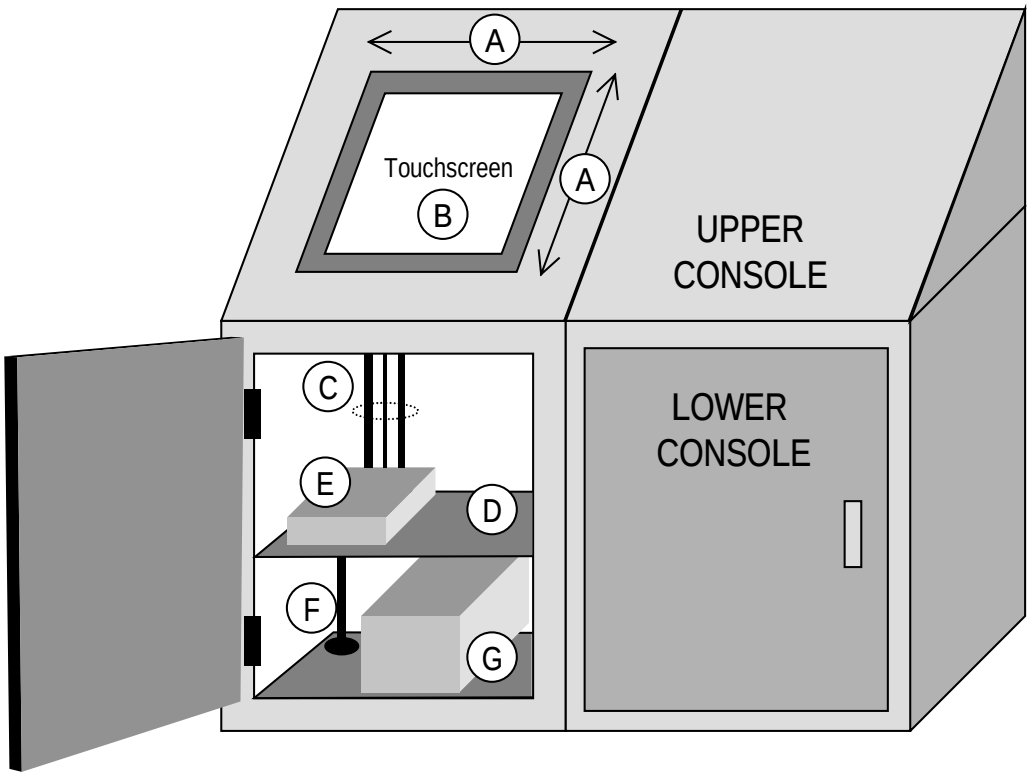

Figure 13: Touchscreen Installation

Appendix 5: Radio Control (L-854) Interface Application Notes

Airports that do not have staffed ATC Tower 24 hours a day, may utilize an air-to-ground radio control unit (See AC 150/5345-49, Specification L-854, Radio Control Equipment, for more information) or photocell to control airport lighting during hours in which the ATC Tower is not staffed. Refer to Figure 14 for an example of how this may be interfaced to an ALCMS system.

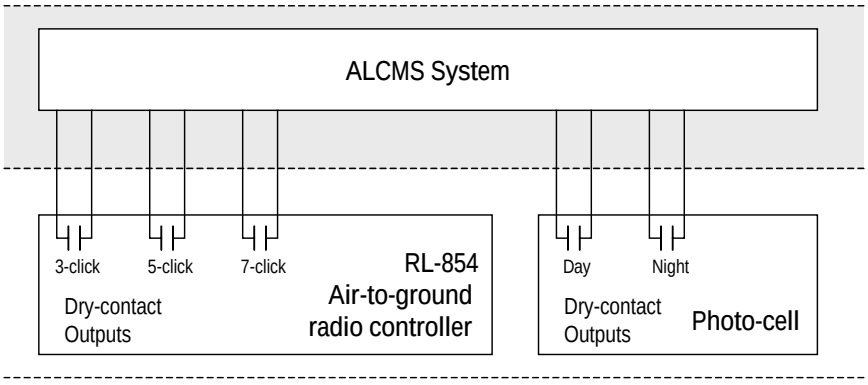

Figure 14: Radio Control and Photocell interface examples

The Designer must review with the airport the installation and operation of the radio controller unit (or photocell) to determine how it is used. The Designer must specify in detail under what conditions the radio controller (or photocell) is used and define the airport lighting preset and intensity levels required.

Designer Note: Air-to-ground radio controllers typically have three (3) control settings which are accomplished by the pilot keying (clicking) their microphone in succession. Three-click turns the lighting on to low, 5-click medium and 7-click is high. The radio controller is designed to time out after a certain time period at which point the airport lighting will return to their default night closure state.

The Designer may complete a similar table as shown below to provide information on how the radio controller and photocell work. Typically a "Radio Control" button is provided on the touchscreen that allows the ATC HMI to initiate a night closure when the tower is not staffed. This executes the "Night Closure Initialization" airport lighting intensities as seen below. The ALCMS is now awaiting inputs (3, 5 or 7-click) from the L-854 to execute changes in the lighting intensities. These lighting intensities are indicated in the table below.

Circuit Description	Night Closure Initialization	Low 3-click	Medium 5-click	High 7-click	Photocell Day	Photocell Night
Rwy 18 Edge	0	1	3	5	Not Used	Not Used
Rwy 12 Edge	0	1	3	5	Not Used	Not Used
Rwy 18 Centerline	0	1	3	5	Not Used	Not Used
Rwy 12 Centerline	0	1	3	5	Not Used	Not Used
Twy A Edge	1	1	2	3	Not Used	Not Used
Twy B Edge	1	1	2	3	Not Used	Not Used
Twy C Edge	1	1	2	3	Not Used	Not Used
Twy A Centerline	1	1	2	3	Not Used	Not Used
Beacon	ON	ON	ON	ON	Not Used	ON

Table 21: L-854 Radio Control Airport Lighting Presets

Appendix 6: Airport Lighting Preset Controls

The Designer must review all preset configurations with the airport owner representative and FAA. Any preset exceptions need to be specified if the airport operations requires special preset conditions.

Designer Note: PAPI regulators have an interim setting between dusk and dawn that does not specifically match tables established in FAA Order 7110.65.

Designer Note: Runway Guard Light circuits may be required to be on all the time at a predetermined brightness step.

Visibility	Day (Brightness step)	Night (Brightness step)
Less than 1 mile	5	4
1 to but not including 2 miles	4	3
2 to but not including 3 miles	3	3
3 to 5 miles inclusive	0	2
More than 5 miles	0	1

Table 22: Brightness Steps for 5-step Circuits

Visibility	Day (Brightness step)	Night (Brightness step)
Less than 1 mile	3	2
1 to but not including 2 miles	0	1
2 to but not including 3 miles	0	1
3 to 5 miles inclusive	0	1
More than 5 miles	0	1

Table 23: Brightness Steps for 3-step Circuits

Visibility	Day (Brightness step)	Night (Brightness step)
Less than 1 mile	**1**	1
1 to but not including 2 miles	0	1
2 to but not including 3 miles	0	1
3 to 5 miles inclusive	0	1
More than 5 miles	0	1

Table 24: Brightness Steps for 1-step Circuits

Appendix 7: Event Classification and Filtering

To prevent "information overload" for ATC, the system must have the ability to filter what event messages are annunciated at the ATC HMI touchscreen. This is referred to as "alarm filtering" and is airport specific based on their operations and monitoring requirements. The Designer in coordination with the airport must determine what messages are filtered from the ATC HMI touchscreen.

An example of how this information could be illustrated in an ALCMS specification is shown in Table 25.

Event	Description	Event Classification	Report to ATC HMI	Report to Maintenance
CCR changed brightness level	CCR step was changed from ATC HMI	Event	No	Yes
Lighting control granted to Vault	ATC HMI granted control to Vault	Event	No	Yes
CCR Over-current Shutdown	CCR shut off	Alarm	Yes	Yes
CCR Open Circuit Shutdown	CCR shut off	Alarm	Yes	Yes
CCR in Local Mode	Circuit cannot be turned on remotely	Alarm	Yes	Yes
CCR loss primary power	Circuit cannot be turned on remotely	Alarm	Yes	Yes
CCR incorrect current	Output current outside allowed tolerance	Warning	No	Yes
CCR Low VA	Output Volt-Amp outside allowed tolerance	Warning	No	Yes
Lamps Out Alarm, 5% lamps out	Lamps Out greater than warning threshold	Warning	No	Yes
Lamps Out Alarm, 10% lamps out	Lamps Out greater than alarm threshold	Alarm	Yes	Yes
Insulation Resistance Warning	Circuit cabling resistance greater than warning threshold	Warning	No	Yes
Insulation Resistance Alarm	Circuit cabling resistance greater than alarm threshold	Alarm	No	Yes
Communication Link failure	Primary or backup Communication failure	Warning	No	Yes
All Communication Link failure	Both primary and backup communication failure	Alarm	Yes	Yes
System in Failsafe	No lighting control from ATC HMI	Alarm	Yes	Yes
Loss of Utility Power at Vault	Vault must be running on Generator	Warning	Yes	Yes
Generator Alarm	Problem with Vault Generator	Alarm	Yes	Yes
Alarm Acknowledged	Alarm condition acknowledged by User	Event	No	Yes

Table 25: Event Classification Example

Appendix 8: Design Application Notes

Hard-drive Redundancy
Improved software recovery can be designed by specifying a dual hard drive fault tolerant system. This would allow quicker and easier recovery because the data is stored on two (2) separate hard drives within the computer and if one drive fails it can be removed and a new drive can be installed and automatically rebuilt by the computer system.

Computer Redundancy
The ALCMS system may incorporate redundant computers at each critical node in the system (Tower and Vault). The redundant computers must provide independent back-up of all processes at the node location. In the event of a single computer failure, the second computer must immediate assume control without any noticeable affect to the ALCMS.

RAID 1 Fault Tolerant Hard Drive System
The ALCMS system may incorporate a fault tolerant hard drive system at each critical node in the system (Tower and Vault). RAID Level 1, also referred to as “disk mirroring”, sends and retrieves identical data from two (2) hard drives within the same computer. The ALCMS system must monitor the status of both hard drives and provide an alarm message when one of the hard-drives fails. This system must continue to operate from the single drive.

Hot Swapping Hard Drives
The ALCMS system may incorporate “hot swap” drive bays that permit continuous PC operation even when replacing and rebuilding a failed hard drive. The “hot swap” design must allow the simple removal of a failed drive by sliding out a removable drive carrier while the ALCMS system continues to operate. A new hard drive / carrier is replaced into the housing assembly and the new hard drive is rebuilt automatically by the ALCMS system “in the background” while the system continues to operate.

Power Supply Redundancy
The ALCMS system may incorporate “hot swap” power supplies that permit continuous operation even in the event there is a power supply failure. The “hot swap” design must allow the simple removal of a failed power supply by sliding out a removable power supply while the ALCMS system continues to operate. A new power supply can be replaced while the system continues to operate.

User Configurability
As an option, the ALCMS system may incorporate tools to allow the user to make modifications to the system. The extent of user configurability to the ALCMS must be identified in the project specifications. Caution must be exercised by the airport if they make a modification that causes damage to the ALCMS system, which could void the warranty with the manufacturer.

Appendix 9: Generator and ATS Interface Application Notes

The Designer must review all Generator and Automatic Transfer Switch equipment to determine the available control and monitoring capabilities of the equipment. The Designer may not specify any control or monitoring point unless previously reviewing the equipment's documentation and determine where and how these control and monitoring points are connected.

At a minimum, the Designer must specify the equipment manufacturer and indicate via wiring diagrams how the control and monitoring points must be interfaced to the ALCMS equipment. In addition, the Designer may provide a summary table describing the control and monitoring requirements for the Generator and ATS equipment as illustrated in Table 26.

Control / Monitoring Signal	Description	Voltage	Termination Point
Generator Start/Stop	Control Source	120VAC	GENSET: TB1-1
Generator Start/Stop	Start/Stop Signal	120VAC	GENSET: TB1-2
Generator Alarm	Feedback Signal	48VDC	GENSET: TB2-6
Generator Alarm	Feedback Common	Ground	GENSET: TB2-8
Generator Running	Feedback Signal	48VDC	GENSET: K9-1
Generator Running	Feedback Common	Ground	GENSET: K9-2
Utility Available	Feedback Signal	48VDC	ATS: TB8-3
Utility Available	Feedback Common	Ground	ATS: TB8-2
Utility On-line	Feedback Signal	48VDC	ATS: TB8-4
Utility On-line	Feedback Common	Ground	ATS: TB8-2
Generator Available	Feedback Signal	48VDC	ATS: TB8-5
Generator Available	Feedback Common	Ground	ATS: TB8-2
Generator On-line	Feedback Signal	48VDC	ATS: TB8-6
Generator On-line	Feedback Common	Ground	ATS: TB8-2

Table 26: Generator and ATS Interface Example

Appendix 10: Beacon Control and Monitoring Application Notes

Beacon Control
The Designer must provide detailed design information that specifies how the Beacon is to be controlled and monitored.

As illustrated in the Figure below, several items need to be specified and must be researched with the ALCMS manufacturer to confirm control and monitoring options. The ALCMS manufacturer must assume the control and monitoring interfaces are handled at the Airport Lighting Electrical Vault unless otherwise specified.

The Designer must consider the control cabling (Ref A below) between the Beacon and the ALCMS. This may be existing fiber, telephone line or hardwire. The Designer needs to indicate location, size and type of contactor (Ref B below). This may be at the Beacon, at the Tower or the Vault. The Designer must specify type of control and monitoring equipment needed (Ref C below). This may be simple ON/OFF control with a Current Sensing Relay (CSR) providing positive feedback that the contactor is energized.

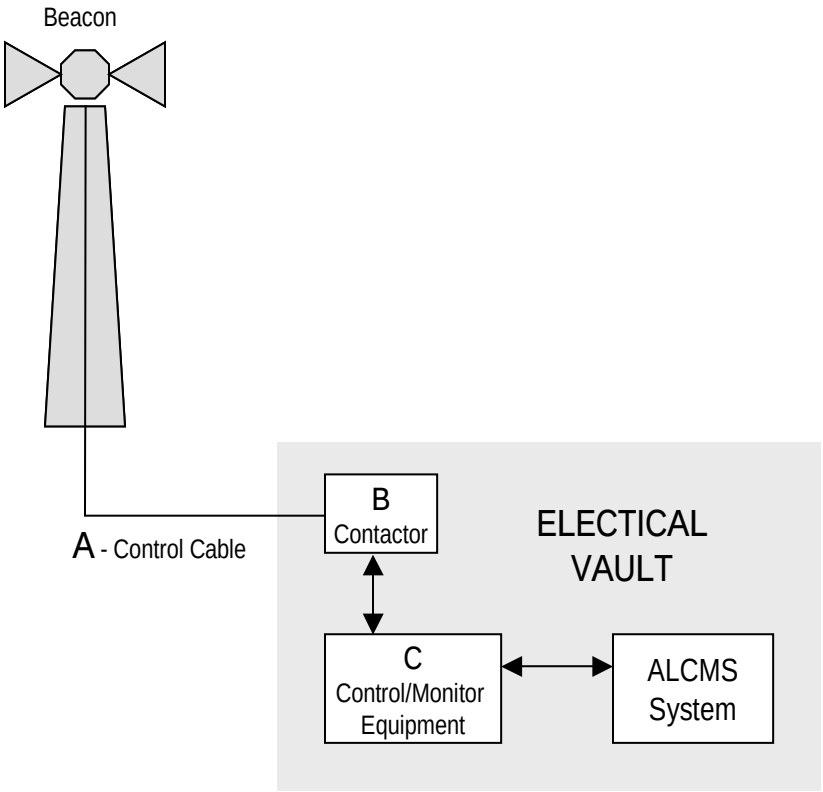

Figure 15: Beacon Installation Example