TRAINING PROGRAM FOR AIRPORT LIGHTING MAINTENANCE PERSONNEL

About This Training Program

This training program was developed at the request of the airport lighting maintenance electricians and others involved in the design and construction of airport lighting systems, who have long been requesting a formal standardized training program which will train them in the essentials of their trade. This program is intended to provide a basic training for all airport lighting electricians and maintenance and supervisory personnel. It is also intended to form the basis for a standardized level of training and provide a path for continued training and achievement recognition. A result of this training will be increased safety for those who work at the airport and improved reliability for the airport lighting visual aids systems that are so important to aircraft safety during landing, takeoff and taxiing operations.

The training program detailed in the following outline is comprehensive and cannot be taught in its entirety without spending a number of days. A three or four day course will cover the fundamentals of airport lighting and the elements presented in this outline.

A manual will be furnished to the class participants covering in detail the program subjects along with a CD ROM containing reference materials such as FAA Advisory Circulars and Military and International Regulations as deemed appropriate. Each session will have adequate discussion time so that local airport issues, as well as specific problems and solutions, may be covered.

Each class participant will be presented a certificate signifying successful completion of the course.

THE INSTRUCTORS

David Rainey

David Rainey is Vice President of Airfield Systems Development for Navaid Lighting Associates, Inc. offering services in the areas of training and consulting for airports and the military; inspection and photometric testing services for new installations; and design assistance and plans review for design firms.

Mr. Rainey is a licensed master electrician and has over 30 years experience in airfield lighting design, maintenance and installation. Prior to his joining Navaid Lighting Associates, Inc., he served as Senior Airfield Electrician with the Memphis-Shelby County Airport Authority in Memphis, Tennessee. While employed for the Authority, he was responsible for overseeing operation and maintenance of all airfield lighting and control systems. In addition, he held responsible oversight of airfield lighting designs.

David is a member of the Executive Board of the Illuminating Engineering Society Aviation Lighting Committee and former Chairman of the Maintenance Subcommittee where he initiated the "Users Group" which was designed to address the needs and concerns of airfield lighting maintenance personnel.

He was appointed to the International Electrotechnical Commission (IEC) Technical Committee 97 to serve as an airfield lighting expert to represent the United States in development of requirements and standards for Aeronautical Ground Lighting (AGL) and associated systems.

He has assisted in providing upgrades to FAA Airports Division AAS-100 for AC 150/5345-42 "Specification For Airport Light Bases, Transformer Housings, Junction Boxes, And Accessories" and is the author of the latest update to AC 150/5340-26A "Maintenance of Airport Visual Aid Facilities".

THE INSTRUCTORS

Seward Ford

Seward Ford has been associated with the airport lighting industry for over 40 years. During this time, his activities have included the following:

He was worked for Crouse-Hinds Airport Lighting Products holding positions during his tenure of Manager of Engineering and Marketing Manager.

In 1994, Mr. Ford established Visual Aids Services for the purpose of providing various support and consulting services to the visual aids industry.

Seward's current activity includes providing services to Optimus Engineering of Washington, D.C. Optimus is supporting the efforts of the FAA Surface Technology Assessment Team, AND-520. The team is assessing potential technical solutions for improving visual cues to the pilot for both the Part 139 and non-Part 139 airports in all weather conditions.

Mr. Ford has provided upgrades to FAA Airports Division, AAS-100 for AC 150/5345-42 Specification For Airport Light Bases, Transformer Housings, Junction Boxes, And Accessories and AC 150/5340-26A Maintenance of Airport Visual Aid Facilities

Mr. Ford has the following current affiliations:

- Member of Illuminating Engineering Society of North America since April 1978.
- Currently Technical Advisor for the United States National Committee of IEC pertaining to TC-97 Electrical Installations for Lighting and Beaconing of Aerodromes. Promoted initial US involvement in this international effort.
- Member of the FAA working group that authored the Advisory Circular 150/5345-56, "Specifications for L-890 Airport Lighting control and Monitoring Systems" for the FAA covering airport lighting control systems.

CHAPTER ONE: AIRPORT LIGHTING OVERVIEW

Airport lighting technology has changed a great deal over the last years and it is fascinating to review the history and evolution of airport lighting from the early days when the entire air field was illuminated to today when signal lighting is used to give the pilot proper guidance.
How we got to where we are will be covered briefly in the classroom but more extensively in the training manual. This chapter also covers basic airport layout and requirements for visual aids.

1. Guidance material pertaining to airport lighting is covered with the intent to make the student familiar with some of the common aspects of airport lighting as defined by various standards setting groups and to familiarize the student with the various documents.

2. Airport lighting requirements for precision approach: Particular lighting systems are required to meet certain Runway Visual Range Requirements. The class will review what the various categories of landing operations are and the lighting requirement for each.

4. The regulatory requirements for proper maintenance of airport lighting equipment: The government has, in defining our air carrier airports, mandated that the lighting systems be properly maintained. The class will be briefly introduced to this mandate and the performance levels that are required to maintain safe operations for different levels of visibility.

CHAPTER TWO: AIRPORT LIGHTING SERIES CIRCUIT

The Series circuit is the chosen method of delivering electrical energy to the airport lighting fixtures. This chapter contains the basic fundamentals of the series circuit and its application to airport lighting as well as practical measurement and troubleshooting information.

1. Electrical fundamentals of the series circuit: The characteristics of a basic series circuit are examined regarding electrical theory and the application of Ohm's Law.

2. Airport lighting application: The advantages of using the series circuit in airport lighting as well as basic components of the system and theory of operation are covered in detail. A typical airport lighting series circuit layout is shown. Standard FAA output brightness steps and actual behavior of voltage and current in a typical airport lighting series circuit is examined.

3. Preventive maintenance: The class will provide considerable guidance on monitoring lighting circuit performance. Included is detailed information on insulation resistance measurement of underground cable systems and the interpretation of resistance readings.

4. Troubleshooting constant current series circuits: Detailed instructions, drawings and charts outline troubleshooting methods from the initial fault investigation through testing and repair.

CHAPTER THREE: CONSTANT CURRENT REGULATORS

The airport lighting Constant Current Regulator (CCR) is the power source for all series circuit lighting applications. A basic understanding of how it works and the electrical characteristics associated with it must be understood by the airport maintenance personnel in order to provide proper maintenance. The various types of regulators available and the characteristics of each will be explored.

1. FAA types, classes and styles of regulators are covered in this chapter.

2. Constant current regulator output and allowable minimum / maximum deviation is explained.

3. The major components of constant current regulators are covered and their operation is explained in detail.

4. Each general design of constant current regulator is examined along with typical schematic diagrams and operational theory.
    - Moving (floating) coil
    - Resonant network
    - Saturable reactor
    - Ferroresonant
    - Series (Thyristor)

5. Constant current regulator remote control and proper wiring connections are shown.

6. Constant current regulator preventive maintenance as well as troubleshooting and testing are covered.

7. Circuit selector switches and their usage are discussed.

CHAPTER FOUR: SERIES CIRCUIT TRANSFORMERS

The electrical characteristics of series circuit transformers are presented in this chapter. These seemingly non-traditional transformers are examined in light of their airport lighting applications.

1. Basic theory of operation.

2. Benefits to the operation of the series circuit.

3. Standard transformer sizes and outputs.

4. Connector kits and proper installation including use of specialized tools.

CHAPTER FIVE: LIGHT SOURCES

Knowledge of the various light sources used in airport lighting is necessary for the proper design and maintenance of airport lighting systems.

1. Characteristics of lamps.
2. Types of light sources used in airport lighting are covered.
3. Tungsten-halogen and the halogen cycle.
4. Lamp life versus lamp voltage.
5. Light Emitting Diodes (LEDs) and their impact on the industry are examined.

CHAPTER SIX: AIRPORT RUNWAY AND TAXIWAY FIXTURES

The number of different types of airport lighting fixtures, both elevated and in-pavement has grown considerably over the last years. As the need for operation at lower and lower visibilities has increased so has the number of fixtures, many of which are designed for low visibility operations.

1. Elevated runway and taxiway lights, their types and usage.
2. In-pavement runway and taxiway lights, their types and usage.
3. Photometric requirements for elevated and in-pavement lights.
4. Light bases and proper installation.
5. Elevated and in-pavement light maintenance.
6. Proper targeting of lighting maintenance by using mobile photometric testing.
7. Maintenance of lighting bases.

CHAPTER SEVEN: SIGNS

In recent years, airports all over the world have been re-signed in accordance with newer regulations to improve the situational awareness for a pilot. This chapter includes an overview of the various types of signs now available with their intended use along with their characteristics.

1. Sign types, sizes, styles, FAA class and other criteria are covered.

2. Airport sign applications such as mandatory signs, information signs and location signs are discussed.

3. Electrical characteristics and loading.

4. Proper sign maintenance.

CHAPTER EIGHT: MISCELLANEOUS VISUAL AIDS

The airport rotating beacon has long been a symbol of airport lighting. From its first use as an airways beacon to provide night time guidance for pilots, to today's modern airport beacons, the basic design of these visual aids has not changed significantly. Likewise, wind cones or wind socks have existed since the dawn of aviation and remain and extremely useful informational tool for pilots.

1. Standard FAA beacon types and signal format.

2. Rotating beacon maintenance.

3. Lighted wind cones types and styles.

4. Wind cone preventive maintenance.

CHAPTER NINE: APPROACH LIGHTING AND VISUAL APPROACH PATH INDICATORS

Approach Light Systems (ALS) provide the basic means to transition from instrument flight to visual flight for landing. Operational requirements dictate the sophistication and configuration of the ALS for a given runway.

Included also in this section are the most common types of visual approach path indicator light systems used at civilian airports and military airfields. The purpose of these devices is to provide a pilot with a visual indicator of his aircraft's position on the glide path to the runway touchdown point while providing adequate clearance of any obstacles in the approach. These devices may be used with or without the presence of electronic glide slope equipment.

1. REIL - Runway End Identifier Lights.

2. ODALS - Omindirectional Approach Lighting System.

3. Maintenance of REILs and ODALS.

4. MALS – Medium Intensity Approach Light System
   MALSF – Medium Intensity Approach Light System with Sequenced Flashers
   MALSR – Medium Intensity Approach Light System with Runway Alignment Lights

5. Configuration and typical layout of MALS/MALSF/MALSR Systems

6. Preventive maintenance and maintenance tolerances.

7. ALSF I – High Intensity Approach Light System with Sequenced Flashers (CAT I)
   ALSF II – High Intensity Approach Light System with Sequenced Flashers (CAT II)
   SSALR – Simplified Short Approach Light System with Runway Alignment Lights (CAT I)

8. Configuration and typical layout of ALSF I/ALSF II/SSALR Systems.

9. Preventive maintenance and maintenance tolerances.

10. VASI – Visual Approach Slope Indicator

11. Configuration and typical layout of VASI

12. PAPI – Precision Approach Path Indicator

13. Configuration and typical layout of PAPI.

14. Preventive maintenance procedures for PAPI.

15. PLASI – Pulse Light Approach Slope Indicator.

16. PLASI signal projection.

17. PLASI operation and maintenance.

CHAPTER TEN: CONTROL SYSTEMS

The controlling and monitoring of airfield lighting systems has evolved greatly over the past few years. From just throwing a toggle switch in the tower and looking to see if the lights come on, to today's sophisticated computer controlled and monitored systems.

1. Constant current regulator (CCR) control.

2. Control panels, switches to touch screens.

3. Relay panels versus Programmable Logic Controllers (PLCs) and distributed control via computer interface.

4. Monitoring of overall control system and individual lights or other components.

5. Controlling individual lights for low visibility operations, SMGCS (Surface Movement Guidance Control System), stop bar lights and lead-on, lead-off lights.

6. Automatic insulation resistance testing and monitoring (Meggering®) of airfield lighting cable systems as part of the control system.

CHAPTER ELEVEN: SAFETY

There are a number of documents and standards pertaining to safety and its importance to an airport lighting electrician. This chapter reviews major procedures that must be adhered to in order to have a safe working environment. Key design elements that can enhance the overall safety of the airport system are also reviewed.

1. Common causes of accidents and basic safety procedures and guidelines.

2. Safety practices and personal safety precautions.

3. Lock-out, Tag-out procedures and use of "Danger tags"

4. Confined spaces.

5. Lightning

6. Toxic agents

7. Types and proper usage of fire extinguishers.

8. Electrical hazards particular to series lighting circuits.

9. Hazards of induced voltages.

10. Hazards of re-lamping energized fixtures.

CHAPTER TWELVE: TEST EQUIPMENT AND MEASUREMENTS

Proper maintenance of airport lighting equipment requires the use of the proper tools in diagnosing problems. This chapter deals with the use of the proper tools and test equipment and the importance of accuracy when taking measurements and performing calibrations of airfield lighting circuits. Various types of test equipment will be displayed and their usage explained.

Types of test equipment covered:

1. VOM: Volt-Ohm-Milliammeter

2. DMM: Digital Multimeter and clamp-on amp probe accessory

3. Insulation resistance tester (MegOhmMeter or Megger®)

4. Underground cable / fault locator

5. Tone test set

6. Infrared temperature measurement scope

7. Time domain reflectometer

8. Mobile photometric measurement system

CHAPTER THIRTEEN: STANDBY POWER SYSTEMS

This chapter discusses standby power systems and their various types and sizes. Information is given on the proper sizing of the power system and the proper maintenance.

1. Types of standby / emergency power systems – UPS (uninterruptible power supply) and diesel driven emergency generators.

2. Ratings of generators

3. Automatic transfer switches

4. Maintenance:

a) Review Preventative Maintenance Procedures
b) Diagnosing Common Failures

CHAPTER FOURTEEN: MAINTENANCE MANAGEMENT

In order for maintenance to be timely and cost effective, it must be properly managed. All the assets available to the maintenance manager must be utilized properly when they are required. Being able to bring one's resources to bear on a problem in a way that is sufficient to correct the problem in a timely manner is not an easy task. This chapter deals with effective maintenance management.

1. Maintenance philosophy

2. Record keeping and maintenance schedule

3. Preventive maintenance program

4. Preventive maintenance inspection program

5. Reference library and equipment manuals

6. Spare part provisioning