AIRPORT LIGHTING
Session Highlights

In May 2002, the Airport Technical Assistance Program, also known as AirTAP, sponsored three airport-lighting training sessions at different locations in Minnesota. These sessions were designed to offer practical-yet-specialized training and information outreach for personnel operating, maintaining, and administering Minnesota s public-use airports. This particular series provided information on airport lighting and navigational aid equipment selection, funding, maintenance, and operation.

John Schroeder, airport lighting engineer for Mn/DOT Aeronautics, facilitated the sharing of ideas and best practices among session participants, including airport managers, maintenance staff, consultants, and elected officials. Schroeder began his career as an electronics technician at Control Data Corporation and worked for Unisys in computer engineering and development until joining Mn/DOT Aeronautics in 1989.

This highlights package summarizes much of the information shared during these training sessions. If you were unable to attend, we hope this will provide you with useful new information on airport lighting issues. For those who attended the seminar, use these highlights as a reference for the information presented during the sessions.

AirTAP is a statewide assistance program for aviation personnel that offers practical instruction by knowledgeable and experienced trainers, as well as a range of information resources. AirTAP s efforts include providing training programs, technical assistance, access to experts, and printed materials.

AirTAP was developed through the joint efforts of the Minnesota Department of Transportation (Mn/DOT), the Minnesota Council of Airports (MCOA), and the Center for Transportation Studies at the University of Minnesota.

To receive more information about the program or copies of the AirTAP materials mentioned in these highlights, please contact:

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STATE AND FEDERAL REGULATIONS GOVERNING LIGHTING AND NAVIGATIONAL AIDS

A complete list of federal regulations for airfield lighting is located in Federal Aviation Administration advisory circulars, available online at **www.faa.gov** or by mail at the following address:

Federal Aviation Administration, Airports
800 Independence Ave. S.W.
Washington, D.C. 20591

To qualify for federal funding, airfield lighting must comply with the regulations outlined in the advisory circulars, and the airport owners must fulfill the terms of their current Mn/DOT airport maintenance and operations agreement.

Minnesota s state airport lighting regulations are outlined in Minnesota Rule 8800.1600, located at **www.revisor.leg.state.mn.us**. This rule provides lighting requirements based on a runway s length as well as wind indicator and other lighting requirements. To receive state financial assistance, municipalities must fulfill their current Mn/DOT maintenance and operations agreement.

FUNDING OPPORTUNITIES FOR INSTALLATION AND MAINTENANCE

A variety of federal and state funding options are available for installing and maintaining airport lighting systems. With federal funding, the federal and local shares of the project costs are split 90/10. To be approved for federal funding, an airport must be classified in the national plan of integrated airport systems (NPIAS), the lighting equipment must be new, not refurbished, and the airport layout plan (ALP) must be current.

State funding also may be used to fund lighting systems installations. The state and local shares of the project costs are split 60/40. To qualify for state funding, an airport must be licensed as a publicly owned and used airport, the project must be on a capital improvement plan, and there must be a consultant or qualified electrical contractor working on the project. State funding is not limited to NPIAS airports.

The temporary airport lighting system (TALS) program is a state-funded program that requires a city to send a letter of request to Mn/DOT for grant funding on lighting projects under $ 25,000. This program is primarily for entry-level airports or for refurbishing an original TALS. While a lighted windsock is included in the TALS program, a rotating beacon is not.

TALS program requirements:

- The airport must be licensed as a publicly owned and used airport
- The state will purchase all low-intensity runway light (LIRL) equipment directly and will also supply the as-built plans.
- The local share of the project is the cost for a qualified electrical contractor to trench wiring and install fixtures, etc., at the airport.

State funding for electrical maintenance is also available.

HOW TO SELECT LIGHTING EQUIPMENT

Lighting Systems

Airport lighting is an important safety feature necessary at every airport to facilitate night flying. Generally speaking, the type of aircraft using the airport determines the type of lighting necessary. One type of required system is an *edge-light* system used to outline usable operating areas of airports during periods of darkness or low visibility. There are several edge-light systems available. The particular type of system necessary depends on the flight rules used at the airport:

- Low-intensity runway light (LIRL) systems are used for runways with visual flight rules and no immediately planned approach procedures.
- Medium-intensity runway light (MIRL) or medium-intensity threshold lighting (MITHL) systems are for runways with visual or instrument flight rules and circling or straight-in (non-precision) approaches.
- High-intensity runway light (HIRL) or high-intensity threshold lighting (HITHL) systems are for runways with precision-instrument flight-rule approaches using runway visual-range rules.

For taxiways, the following lighting systems are available:

- Low-intensity taxiway light (LITL) systems, which are used at airports where LIRLs are used.
- Medium-intensity taxiway light (MITL) systems, which are used at airports where MIRLs or HIRLs are used.

Once the actual lighting system is selected, the type of *edge-light mount* must be selected. There are two basic types of light mounts:

- Stake-mount lights This type has a lower installation cost but makes it difficult to access failed wiring or transformers, which are located underground. This presents major problems in the winter when the ground is frozen.
- Base-mount lights This type has a higher initial cost but facilitates easy repair in all seasons and has an in-duct, rigid wiring system that protects the wire insulation from rodents or aggregate abrasion.

Threshold lights, another type of lighting system, are used as follows:

- Visual-approach runways six threshold lights per runway end fitted with split red/green lenses
- Non-precision- or precision-approach runways eight threshold lights per runway end fitted with split red/green lenses
- Displaced threshold six obscure/green split lights plus two white/green split lights at the threshold and eight solid red lenses at the displaced threshold
- Between the real threshold and the displaced threshold split white/red or amber/red edge lights

Rotating Beacons

The *rotating beacon* is another required light source. For federally funded projects, the beacon is generally 36 inches in diameter. Small airports usually use the 8-inch type. The

belt-drive, stationary lamp design, along with a caged tower or pole, provides a low-maintenance option. With small beacons, a 40-foot wood pole is typically used.

Power Sources
Selecting the proper power source for an airport lighting system is also an important decision. Most Minnesota airports use a *series-circuit* power system. This system is primarily used on long taxiways and runways and makes it easy to add on to the runway. The other option is a *parallel 120 VAC* system, used primarily for TALS, LIRLs, and MIRLs. This system is limited to 4,000-foot runways and has a 5 percent voltage-drop criterion. Extending a runway is more difficult with a parallel power source in place. Runway-end identifier light systems (REILS), visual-approach slope indicators (VASI), precision-approach path indicators (PAPI), beacons, and windsocks can also be powered with a parallel 120/240 VAC system.

Windcones
The *windcone* (sometimes referred to as a windsock) is also a required navigational aid. A standard windcone is 36 inches by 12 feet and is lit by two internal 90-watt flood lamps or quartz halogen-type lamps of improved vibration resistance. A windcone is typically mounted 21 feet high on a tilt down or tuxedo bend pole. An obstruction light is no longer required since windcones are no longer located in the object-free zone. The State of Minnesota provides free windcones to airports approximately once every quarter, the time frame in which a windcone begins to fade.

Visual-Approach Slope Indicators and Precision-Approach Path Indicators
VASIs are another airport navigational aid. Though VASIs cost about $ 0.25 an hour to operate, which is 25 to 50 percent less than PAPIs, they are not recommended for precision approaches. VASIs are powered by a 240 VAC or 6.6-amp series circuit. It is recommended they be turned on via pilot-controlled radio. Currently, the FAA does not fund VASI systems.

FAA funding is available for PAPIs. If a PAPI is used on an instrument-landing system runway, it must be flight-checked by the FAA. PAPI systems are powered by a 240 VAC parallel or separate 6.6-amp series circuit, and it is recommended that they be turned on by a pilot-controlled radio.

Pilot-controlled lighting systems, such as VASIs and PAPIs, are an important feature for many airports. These systems save on power costs since VASI and PAPI systems are powered on only when needed. A standard L 854 pilot-controller design is recommended.

Guidance signs are powered on a parallel or series circuit. Some models contain internal electronics to improve electrical efficiency and provide constant brightness. FAA approval is needed for these signs. Distance-remaining signs are placed on runways longer than 3,500 feet.

LIGHTING INSTALLATION PROCEDURES

Equipment specifications and wiring installation standards and guidelines are located in the FAA advisory circulars, available online at **www.faa.gov** or by mail at the following address:

Federal Aviation Administration, Airports
800 Independence Ave. S.W.
Washington, D.C. 20591

Advisory circulars 150/5340, 5345, and 5370 include all aspects of airport lighting, from taxiway-guidance signs to plug and receptacle specifications. Specifications and guidelines for lighting are also found in the following publications, also available online at **www.faa.gov** or by mail:

- FAA order 6850.2A: *Facilities and Equipment Visual Aids Installation Standards*
- FAA GL 600-1: *Typical Installation Drawings for Lighting Equipment*
- The project consultant s project plans and specifications

FAA GL 600-1 provides recommended layouts for equipment locations, details for footings, details for wire installation, and alignment standards. The consultant s project plans and specifications provide guidance for installing underground cables, installing the airport underground electrical duct, construction methods, and installing airport lighting systems.

Lighting Installation Procedure Summary for Complete Runway/Taxiway Surfaces:

1. Survey station locations of all edge lights, REIL S, VASIs, or PAPIs, guidance signs, windcones, beacons, duct banks, and markers.
2. Auger holes for all base or junction cans.
3. Trench or plow series-circuit wires.
4. Tamp hole bottoms and install pea rock.
5. Install sonotubes around cans and pour concrete surrounds, pads, and all footings.
6. Complete trenching to cans.
7. Install wiring to cans.
8. Install can covers and light fixtures.
9. Install and align VASI, PAPI, REIL S, and signs.
10. Install windcone and beacon structures.
11. Install regulators, panelboards, L 854 relay controller, contactors, and S-1 cutouts in vault.
12. Test system.
13. Provide spare sets of instructions and maintenance documents.
14. Conduct pre-final and final inspections.

Important Safety Note: *Keep safety first when installing lighting equipment. Install ground wires for personal safety and counterpoise wires separately for lightning protection.*

ROUTINE MAINTENANCE TECHNIQUES

The following list includes some typical routine maintenance issues associated with airport lighting:

- L amp replacement
- Frangible coupling replacement
- L ens, lamp, and filter cleaning
- R odent entry causes insulation damages
- Cabinet rust periodically oil the hinges
- Windsock replacement
- Grass cutting and snow removal
- VASI and PAPI alignment

***Important Safety Note**: Safety is a key concern when replacing lamps or fixing light structures. Always disable the power before changing a lamp and wear clean gloves when replacing lamps to prevent skin oils from damaging the lamps.*

Other High Maintenance Issues

Frangible couplings also present high maintenance airport lighting issues. To help smooth the replacement process, it is best to apply anti-seize grease to the coupling threads before replacing the couplings. Some experts recommend using aluminum or metal couplings when possible and avoiding fiberglass couplings.

VASI systems consist of two VASI boxes located approximately 600 feet apart from each other along the runway. Each box is offset approximately 90 feet from the edge of the runway to the pilot s left. If the VASI is aligned properly, a pilot will see red lights over red lights if below the glide path, red lights over white lights if on the correct glide path, and white lights over white lights if above the glide path.

A *Walker Bar* is the trade name for the calibration tool used to properly realign a VASI system. To use a Walker Bar, follow these steps:

1. Check the calibration of the alignment tool.
2. Check the frangible couplings.
3. Set the upwind VASI at 3 degrees.
4. Set the downwind VASI at 2.5 degrees.
5. L evel the cabinet horizontally from the front and back.
6. Align the tilt switch to level.
7. Verify that the tilt circuit works.
8. Verify the day/night mode.

Four-box PAPI systems and two-box PAPI systems are available. These systems are located approximately 380 feet from the end of the runway, with the boxes spaced approximately 20 feet apart. L ike the VASIs, PAPIs are located to the pilot s left. With a four-box PAPI system, a pilot will see all four white lights if above the glide path, three white and one red if slightly above the glide path, two white followed by two red if right

on the glide path, one white and three red if slightly below the glide path, and all four red lights if below the glide path. With a two-box PAPI system, there is no indication for being slightly above the glide path or slightly below the glide path.

Advanced Lighting Maintenance Issues:

- Lightning damage to electronic assemblies
- Series-circuit isolation transformer failures
- Electrical cable connector failures
- Guidance sign or regulator current adjustment
- Series circuit and unit troubleshooting
- REIL, PAPI, VASI, and power control troubleshooting

***Important Safety Note**: Unless maintenance workers are qualified for more advanced maintenance issues, call an electrician. Open-circuit voltages in an electrical loop are fatal.*

Every airport must have a foolproof safety routine and should include procedures for shutting down regulator(s) circuit breakers, keeping plug cutout units in the truck with maintenance workers, locking electrical vaults, and always working under the assumption that all circuits are energized. FAA Advisory Circular 150/5340-26 is an excellent reference for airport visual aid maintenance information.

NEWLY APPLIED TECHNOLOGY

New, advanced technologies are currently being developed to improve airport lighting. However, much of this new technology is still in the testing and FAA approval stages or is still too expensive to implement. Following are some examples of emerging aviation lighting technologies:

Rugged insulated-gate bipolar transistors (IGBT) technology has been incorporated into the latest generation of series-circuit regulators. These regulators operate more efficiently and produce near sine wave output current, making them more compatible to the equipment they are powering.

Light-emitting diode (LED) technology has advanced to the point of being more efficient than the incandescent lamps in current use. A 14-watt blue elevated taxiway fixture produces the same light output as a 45-watt incandescent fixture. Lifetime is projected to be about 100 times greater (100,000 hours). Red obstruction lights and blue taxiway lights have been certified by the FAA and are available from several manufacturers. White and red/green edge lights and multi-colored, flush-mount, in-pavement lights have also been developed and are in the certification stages. Manufacturers include Dialight, Thern, and Crouse Hinds.

One new product now on the market is a *remote lamp-monitoring system*. This system detects low frequency signals over regulators or 120 VAC circuits and can monitor more than 100 lamps per receiver. The system can monitor runway lights, VASI lights, PAPI lights, a windcone, beacon, and medium-intensity approach lighting system with runway-alignment indicator lights (MALSR). (Pilots use the MALSR during instrument landing approaches to align the aircraft with the centerline of the runway.) The system also can keep a data log for future reference, and can be monitored via modem hookup.

The remote lamp-monitoring system works as follows:

- Each lamp has a transmitter that is on a different frequency.
- The receiver board has a current loop detector.
- The PC or embedded processor then looks for presence of the known quality of transmitters, thus reporting the location of burnt-out lamps.

Mn/DOT has provided $ 12,000 to install and evaluate such a system at the Aitkin, Minnesota, airport.

Comteq, Inc., from Crosby, Minnesota, is developing the monitoring system, known as computerized airfield-light monitoring (CALM). These systems are being installed in Oklahoma City, Oklahoma; San Jose, California; Spokane, Washington; and several locations in New Jersey.