Guidance for Identifying and Mitigating Approach Lighting System Hazards

DETAILS

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GUIDANCE FOR IDENTIFYING AND MITIGATING APPROACH LIGHTING SYSTEM HAZARDS

This digest presents the results of ACRP Project 04-03, "Guidebook for Approach Light System Hazard Assessment and Mitigation." The digest was prepared by Ronald B. Gibbons, Christopher Edwards, and Antonio Trani of Virginia Tech, Blacksburg, VA. The contractor's final report is available as *ACRP Web-Only Document 4* at http://trb.org/news/blurb_detail.asp?id=9830.

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INTRODUCTION

This digest has been developed to assist with defining response procedures to mitigate or reduce the hazards associated with aircraft and approach lighting system incidents. These incidents can occur as a result of an overrun or undershoot. The digest is intended to be used by airport operations, emergency response, and Federal Aviation Administration (FAA) personnel. The suggestions and any further hazard reduction procedures identified while reviewing this digest should be part of a larger response plan and can be integrated into existing airport emergency response procedures. The reason or cause of the incident is not addressed in this digest.

As part of this research, airport operators, associated emergency response, and FAA personnel were interviewed at 18 airports that included primary, reliever, and general aviation airports. The purpose of the interviews was to (1) gain an understanding of potential hazards presented to passengers, crew, and emergency response personnel by an aircraft incident involving the approach lighting system and (2) collect information on procedures, especially best practices, taken to reduce or mitigate these hazards.

Interviews conducted indicated that the hazards associated with approach lighting systems are, for a variety of reasons, not always appreciated, but are readily apparent when identified. It should be noted that personnel interviewed at several facilities had considered approach lighting system hazards in their emergency response plans.

Airport lighting systems are installed at more than 900 airports throughout the United States. The approach lighting systems for a large percentage of the airports are owned by the FAA. Access to this federal property is generally restricted to FAA personnel and FAA maintenance contractors. In addition, some approach lights are located outside of airport property where emergency response services are provided by off-site emergency response personnel. As a result of these and other site-specific details at each airport, the specific procedures to mitigate or reduce the hazards may vary widely and will need to be tailored to each airport facility. Nevertheless, it appears that for many airports, these hazards can be mitigated or reduced and addressed by awareness measures without large expenditures.

The digest also contains a checklist of suggested efforts to reduce the identified

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hazards. However, the checklist and suggestions are intended as a guide and can in no way be considered for addressing all the unique situations that exist. The purpose of the digest is to encourage reviewing potential hazards and mitigation techniques.

While this digest was prepared specifically to address the hazards associated with approach lighting systems, the procedures suggested also may be useful in mitigating hazards with other airport lighting systems, such as runway end identifier lights, visual approach slope indicator lights, runway edge lights, runway centerline, and taxiway lights.

HOW TO USE THIS DIGEST

Airport operations, emergency response, and FAA personnel (as needed) are encouraged to identify potential hazards that may occur at the airport facility. This digest was designed to aid readers in identifying hazards and establishing reduction techniques. Using the checklist provided may require a variety of actions, including the following:

- Meetings;
- Collecting information on the approach lighting system (block diagrams, photographs, etc.);
- Memorandums of agreement with associated organizations;
- Short classroom-type cross training and familiarization sessions on the approach lighting systems, the associated hazards, and the electrical test equipment to confirm that electrical systems are not energized;
- Walk-throughs of how to de-energize the approach lighting systems;
- Changes in emergency response practices, procedures, and drills;
- A plan to be executed and reviewed yearly to keep new personnel up to date with plan changes or other events. The progress of the plan can be tracked with the checklist.

USE OF OUTSIDE EXPERTS

It is suggested that outside experts not be directly involved in completing the checklist until after it has been reviewed and implemented by airport, aircraft rescue fire fighting (ARFF), mutual aid, and FAA personnel directly involved with the airport. Attempting to accomplish the checklist tasks with in-house staff will make it clear whether outside experts are required and allow outside expert efforts, if needed, to be better focused on specific limitations identified by in-house airport, ARFF, mutual aid, or FAA personnel. If outside experts are indeed desired, the following criteria are recommended for selecting specific expert personnel:

- A narrowly worded statement of work may be required in order to focus and identify specific issues and the scope of work needed.
- Multiple experts should be invited to submit proposals accomplishing the work.
- Bidding by the outside experts should follow organizational procurement requirements that apply to the scope of work and amount of funding required.
- References should be checked on the quality of work performed on comparable tasks. Work products prepared by the outside experts for similar tasks should be reviewed for quality and scope of effort.

Hazards Associated with an Approach Lighting System during an Aircraft Accident

The research project reviewed previous incidents and conducted a series of interviews with a variety of airport facilities' and airport/FAA personnel to identify what hazards may occur if an aircraft collided with an approach lighting system. Insights from the review and research process identified that approach lighting system hazards were apparent, but few interviewees appreciated the potential extent of these hazards. A variety of hazards were identified, including electrical shock injury, electrical ignition sources, debris hazards, and terrain limitations. Specifically, common hazards and issues identified by the interviewees included:

- Electrocution or electrical injury due to contact with electrified/energized components of the approach lighting system. These hazards apply to the evacuation of passengers, crew, and emergency response personnel.
- Potential electrical ignition sources from an aircraft leaking fuel.
- Lack of redundant systems for shutdown and control of the electrical system. If the control lines from the tower are damaged, there may be no method for shutting down the approach lighting system.

- Debris from approach lighting system components can cause injury (such as tripping or cuts) to passengers and crew that are evacuating and/or response personnel at the scene. Debris can also result in further damage to response equipment.
- Limited access to the incident scene caused by the location of the incident requires further considerations regarding response techniques and, potentially, airport design. Ensuring redundant access to each approach lighting system can mitigate hazards associated with poor access to an aircraft accident site.
- Lack of knowledge about the status and the integrity of the approach lighting system.
- Lack of knowledge regarding the location of all components of the approach lighting system.

Given these potentially serious situations, a questionnaire was created to assist airport operators, ARFF crews, planners, and FAA personnel with finding potential hazards that may occur if an approach lighting system incident occurred.

The questionnaire should be a starting point to help individuals identify where hazards and therefore risks may exist and how to appropriately plan to reduce the risk associated with these hazards.

Approach lighting system at Logan International Airport, Boston, MA.

HAZARD IDENTIFICATION QUESTIONNAIRE

The purpose of this questionnaire is to provide a quick reference guide to identify hazards that may be applicable to your airport location and response operations. The following list is not all-inclusive and should encourage individuals to identify further hazards specific to their airport location. This questionnaire is a good starting point to identify hazards and it is recommended that all questions be completed that apply to your airport location. When complete, the mitigation checklist should be reviewed for suggestions that can assist with approach lighting system risk reduction. Additional ideas that go beyond the suggested mitigation recommendations may become apparent when reviewing this digest and it is suggested that these techniques be incorporated into emergency response and future planning. The questionnaire begins with identifying the types and locations of the approach lighting systems at your airport:

1. What type of approach lighting system do you have on each runway?
    a. Runway_____ ALS:_____
    b. Runway_____ ALS:_____
    c. Runway_____ ALS:_____
    d. Runway_____ ALS:_____
    e. Runway_____ ALS:_____
2. The next critical set of questions applies to airport operations, response, planning, and FAA personnel so that adequate planning, preparation, and response measures are in place if an incident occurs with the approach lighting system(s):
    a. How would you shut down the approach lighting system if an incident occurs? (How would you shut down the approach lighting system for each runway end?)
    b. Are there procedures or specific steps that must be followed to shut down the approach lighting system? What are the procedures or steps for each runway end?
    c. Who has access to the approach lighting system control room/panel?
3. Do response personnel know how to de-energize the approach lighting system?
    a. Do emergency response personnel have any indication when the approach lighting system is turned off (for each approach lighting system on each runway end)?
    b. Does your approach lighting system have a back-up generator?
        i. Which runway ends/approach lighting systems have generators?

    If so:
        ii. How do you know if the back-up generator is running?
            1. Which approach lighting system is it providing power to?
        iii. How would you turn off or shut down the generator in the event of an incident?
            1. Are there multiple generators that may need to be de-energized in the event of an incident?
        iv. What are the procedures for shutting the generator(s) down in an emergency situation?
4. What type of support structures are in place for the approach lighting system?
    a. Are there solid structures that may further damage an aircraft or injure response personnel during an incident? How can injury be minimized?
    b. How would debris from approach lighting system structures impact response efforts for both rescue vehicles and response personnel?

5. During a potential incident, an aircraft can dig up or expose approach lighting system wiring:
    a. Do you have any equipment either on the vehicle or carried by response personnel that can detect energized electrical wiring or electrical fields?
    b. Are there special procedures in place on how to use the equipment?
    c. Who can use or who is properly trained to use the energized wiring detection equipment?
    d. How do you avoid or reduce the risk of electrical shock if there is wiring energized?
6. Additional injury or debris can result from the components of the approach lighting system such as the support structures, casing, and the lighting itself. The following questions ask about potential injury that may result:
    a. Are there any procedures in place to minimize injury from the lights/light bulbs/glass of the approach lighting system for both evacuating passengers and response personnel?
    b. How do you minimize potential injury to passengers, crew, and response personnel from other approach lighting debris, such as support structures, light bars, and secondary wiring?
7. Approach lighting systems can be placed in a variety of environments from solely land-based systems to systems that extend into a river, lake, harbor, or bay. The following questions review environmental features that may be unique to your airport location:
    a. Do you have land-based runways and approach lighting system areas?
        i. Do you have any specific environmental features that may limit response access (e.g., hills, slopes, ground condition, buildings, and non-airport roadways)?
        ii. How is access limited by these environmental features?
        iii. How do these environmental features interact with potential debris from the approach lighting system? Are there cable supports or large supporting structures because of the environment?
        iv. Are there alternate access points and are these adequately covered in the emergency plan?
    b. Do you have approach lighting systems that extend into waterways?
        i. What procedures are in place if an incident occurs with an approach lighting system that extends into water (e.g., pier structures, rivers, harbors, bays)?
        ii. How is access limited by these features?
        iii. How do response personnel deal with additional hazards such as pier structures and wiring for approach lighting systems that extend into waterways?
        iv. Are emergency response procedures in place to shut down approach lighting systems in these areas?
8. If an incident occurs with the approach lighting system, access to these areas is critical for response personnel. The following questions review potential access issues that may occur when responding to an approach lighting system incident:
    a. Are there accessibility issues if an incident occurs in the approach lighting system area?
    b. Are there alternate and other planned accessibility routes for all types of response equipment within the approach lighting system area?
    c. Can you think of any other accessibility issues that may occur if there was an incident involving the approach lighting system?

9. Bad weather conditions often dictate the use of an approach lighting system. Given these low-visibility conditions that can occur during daytime and especially nighttime operations, it is recommended that emergency planning take into account both accessibility issues and visibility issues during an approach lighting system incident:
    a. Are there accessibility issues if an incident occurs in the approach lighting system area and how are these influenced based on the following weather conditions for daytime and nighttime operations?
        i. Rain
        ii. Fog
        iii. Snow
        iv. Icing conditions
10. Depending on the resources and the size of your facility, there may be additional support procedures from Air Traffic Control tower operations. However, airport locations also work with no or limited tower operational times. Given these various operating conditions, some of the next set of questions can be overlooked depending on your specific facility requirements:
    a. What procedures are in place for deactivating an approach lighting system if there is no air traffic control tower at your facility?
        i. Have these procedures been reviewed by the mutual response groups?
    b. Are there any specific procedures in place when incidents occur during normal tower operation times?
        i. If so, what are they?
        ii. Have they been recently reviewed or updated?
        iii. Can they be improved upon?
        iv. Are the response personnel notified if the tower shuts down the approach lighting system in the event of an incident?
    c. If you have limited air traffic control tower times:
        i. What are the procedures if an incident occurs during “non-towered” times?
        ii. How are response personnel notified that the approach lighting system has been deactivated during an emergency and during non-towered times?
        iii. Who is on-call during non-towered times and do they have access to and knowledge regarding how to de-energize the approach lighting system?
    d. The air traffic control tower may not be able to fully de-energize the approach lighting system. Are there redundant methods in place to shut down the system?

HAZARD MITIGATION AND REDUCTION TECHNIQUES

The majority of hazards that occur during an approach lighting system incident involving an aircraft can be mitigated through awareness, planning, and procedural measures. In addition, some of the hazards identified during the research may require the use of on-site equipment in an effort to verify the status of the approach lighting system. The focus and intent of this section is to provide suggestions for mitigating hazards identified during the hazard questionnaire.

1. Hazard Identification

- It is suggested that a small group of airport operations, emergency response (on-site aircraft rescue fire fighting [ARFF] or off-site mutual aid emergency response personnel), and FAA personnel (as appropriate to the size/classification of the airport) be convened to examine the hazard questionnaire and to agree on the hazards specific to the particular airport.
- It is suggested that a yearly review of potential approach lighting system hazards also be conducted to update and discuss emergency response planning and procedures.
- In some cases, approach lighting system light poles and structures are located outside of the airport boundary, and emergency response personnel, other than those dedicated to the airport, respond to aircraft accidents in these areas. In such cases, the emergency response personnel who deal with emergencies outside the airport boundary should be included in this review.
- It is suggested that a calendar reminder to re-examine preparations for aircraft accidents with the approach lighting system be established so that changes to other policies that may impact approach lighting system mitigation efforts can be identified. This may be included in—or accomplished concurrently with—periodic reviews of emergency preparedness.
- It is suggested that a copy of this digest be provided to each member of the meeting group.

2. Emergency Response Planning and Training

- Familiarize or cross-train personnel on how the approach lighting system functions so that they are knowledgeable on system operations and shutting down the system during a potential incident involving the approach lighting system.
- Conduct walk-through training as necessary to confirm that personnel who might be involved in responding to an aircraft accident related to the approach lighting system know how to de-energize the system (including any emergency power sources to the system) and know how to confirm that the approach lighting system equipment is de-energized at the scene. Include walk-though training on communications between emergency response personnel responsible for accident response outside the airport boundary with those responsible for de-energizing the system. Also, include walk-throughs of areas to the approach lights to confirm that access routes and any desired alternate routes are acceptable.
- Specifically train and cross-train as appropriate each of those who might respond to an aircraft accident involving the approach lighting system: (1) to de-energize the system before entering an accident scene where the aircraft has collided with the system, and (2) to operate the electrical test equipment to confirm the safety of the approach lighting system.
- Incorporate the findings from the hazard questionnaire review into emergency response procedures, drills, and walk-throughs as appropriate. Drills should include responders de-energizing the approach lighting system and checking that the system is de-energized. Include emergency response organizations that are responsible for handling accidents involving the approach lighting system outside airport property in these drills.

3. System Awareness, Training, and Planning

- During the hazard review, it is suggested that individuals from the FAA and airport operations that have on-site electricians review

with the remaining airport operations and response staff how the system operates and the current methods for shutting down the system.
- It is suggested that an in-house reference guide that is simple, inexpensive, and appropriate to the size/classification be prepared for the airport in order to orient personnel on the approach lighting system. This guide might include:
  - Simple block diagrams of circuitry for the approach lighting system.
  - Photographs of approach lighting system buildings and components including light poles and supports, backup power supplies, and cutoff switches or circuit breakers for primary and backup power.
  - Photographs of breakaway electrical connections and approach lighting system fixtures.
  - Photographs of frangible approach lighting system fixtures.
  - Security features for the approach lighting system such as fence locks, building locks, and locking features on cutoff switches and/or breakers.
- Compile a list of names, phone numbers (home, mobile, pager), and work schedules for all those who might be involved in responding to an aircraft incident with the approach lighting system. This list can be included in the reference guide above and also placed in a convenient location for emergency purposes. Be sure to include:
  - Individuals who have access to approach lighting system cutoff switches and/or breakers (e.g., control towers) or keys to facilities containing cutoff switches and/or breakers.
  - Individuals most likely to be involved and their backups.
- It is recommended that very large airports confirm that the approach lighting system can be de-energized for one runway while leaving it energized for other runways so that airport operations may continue while responding to an incident.
- Establish means for personnel who might be involved in responding to an aircraft accident with an approach lighting system to have access to the areas required to de-energize the system, which may involve:
  - Passing a set of keys for the approach lighting system's power facilities between people on various shifts or locating the key in a key box that can be quickly accessed by all necessary personnel (e.g., ARFF or mutual aid response personnel).
  - Memorandums of agreement with different organizations (e.g., airport operations and the FAA) authorizing access to the approach lighting system to de-energize it during an accident and specifying how the keys to the FAA facility will be maintained securely by those holding the keys.
  - Memorandums of agreement from the FAA guaranteeing that it will shut down the approach lighting system in an emergency before the response personnel arrive at the incident site.

4. Tower Operations Planning

- It is recommended that the response planning group identify pre-existing procedures that may be in place for shutting down the approach lighting system from active air traffic control towers.
- In some instances, the air traffic control tower personnel may not have the ability to fully de-energize the approach lighting system. It is recommended that redundant shutoff procedures be put in place and that emergency response personnel confirm that the approach lighting system has been completely de-energized before proceeding into the system's field.
- It is recommended that procedures for non-towered operations be constructed for emergency and response personnel such that facilities with limited tower operations or non-towered facilities have a way of deactivating the approach lighting system. Planning includes:
  - Identifying tower operation times and procedures for approach lighting system emergencies.
  - Identifying approach lighting system shutdown procedures and responsible personnel during non-towered operational times.

- Allowing emergency personnel access to approach lighting system power vaults so that response personnel can shut down the system.
- Agreements between FAA-owned approach lighting system areas and response personnel during non-towered operational times, which may include memorandums of agreement between airport operations and the FAA.

5. On-site Emergency Approach Lighting System Procedures

- It is recommended that the approach lighting system be de-energized as soon as possible and before emergency response personnel enter the accident scene. Isolation of both backup and primary power supplies is required. This is recommended because frangible electrical connectors have been known to malfunction and/or the system could be breeched on the energized side of the frangible connection.
- It may be desirable to physically lock the power supply switches/breakers open with padlocks, which are not to be removed until the emergency response is complete and electricians have confirmed that the system is safe.
- It is recommended that very large airports confirm that the approach lighting system can be de-energized for one runway while leaving it energized for other runways so that airport operations may continue while responding to an incident.

6. On-site Accessibility, Debris, and Weather Planning

- It is recommended that emergency personnel be aware that the approach lighting system may be an additional source of debris at the accident scene.
- Access for emergency vehicles and response personnel to reach areas where approach lights are located may already be included in existing emergency procedures. If the review group is unsure about this access, the group may wish to examine the means of access to areas surrounding the approach lighting system in the event that an aircraft may strike it. Additional issues of land-based structures on hillsides or in limited access areas should be discussed. Also, appropriate response techniques for approach lighting system areas that extend into waterways and use pier structures should be included in emergency scenario planning. Prior to any potential incidents, the Emergency Response Plan should determine if adequate access exists or if alternate means of access should be provided.
- Additional access concerns should be addressed for all weather conditions and all types of response vehicles. Specific fog, rain, or snow conditions may limit access to the incident if it occurs within the approach lighting system area. These access points and limitations should be identified by airport operations, ARFF, and mutual aid response personnel (and, where needed, FAA operations personnel) to ensure that response plans take approach lighting systems into account. This identification should occur early in the process so that access points are known if an incident were to occur.

7. On-site Approach Lighting System Status Check

- It is recommended that first responders confirm that the approach lighting system is de-energized when they arrive at the scene.
- It is recommended that airport facilities, where possible, purchase cable detection equipment that may be used by first responders and other response personnel to confirm that the approach lighting system is de-energized. Potential system checks include the following:
  - It is suggested that a common "power cable" checkpoint be established for all runways that contain approach lighting systems. These pre-located checkpoints will be areas where the approach lighting system cabling is known to enter the approach lighting system area. At these locations, the ARFF and/or mutual aid response groups can verify if the approach lighting system has been de-energized by using a cable detection unit. These units are commercially available and can read if power cables are supplying electricity or not. Simple verification by one member of the response group can confirm that the approach lighting system has

been de-energized and response teams can proceed accordingly.

8. On-site Communications

- Establish a reliable means of communication (such as two-way radio, mobile phone, or both) between any emergency response personnel responsible for incidents involving the approach lighting system outside the airport boundary with those airport personnel responsible for de-energizing the approach lights.

Hazard Mitigation/Reduction Matrix

The matrix in Table 1 identifies common hazards encountered during the research interview process with 18 airport facilities. These hazards are then matched to the appropriate mitigation techniques previously described.

Table 1 Hazard mitigation reduction matrix

		Hazard Reduction/ Mitigation Technique							
#	Hazard	1	2	3	4	5	6	7	8
1	Approach Lighting System Electrical Components can be ignition source for fuel and vapor					✓			
2	Runway environment large non-frangible towers may damage aircraft during incident						✓		
3	Approach Lighting Components can damage aircraft						✓		
4	Approach Lighting Components can injure aircraft occupants						✓		
5	Approach Lighting Components' debris can limit access to critical response areas						✓		✓
6	Approach Lighting Components' debris in the response area can cause injury to response personnel						✓		✓
7	Approach Lighting Components' debris in the response area can cause injury to walking wounded						✓		✓
8	Approach Lighting System Electrical Components (e.g., compromised wiring) can cause injury to aircraft occupants (electrocution)					✓	✓	✓	✓
9	Approach Lighting System Electrical Components (e.g., compromised wiring) can cause injury to response teams						✓	✓	✓
10	Availability of Response Equipment and Personnel: Responders cannot disable approach lighting system if required	✓	✓	✓		✓		✓	✓
11	Tower Operations Procedures: Incident occurs outside of tower operational time				✓				
12	Tower Operations Procedures: There are no redundant methods for controlling the approach lighting system				✓				
13	Weather Conditions: Difficulty identifying debris in low visibility						✓		✓
14	Weather Conditions: Lengthened response time in low visibility						✓		✓
15	Weather Conditions: Limited information about system status in low visibility conditions						✓	✓	✓
16	Weather Conditions: Possible injury in wet conditions						✓		✓
17	Availability of Response Equipment and Personnel: Response Team does not carry equipment to test electrical components.	✓	✓					✓	✓
18	Availability of Response Equipment and Personnel: Response Team has no familiarity with the approach lighting system	✓	✓	✓		✓		✓	✓
19	Tower Operations Procedures: There is no standard operating procedure to shut the approach lighting system down in case of incident				✓	✓		✓	✓

HAZARD MITIGATION CHECKLIST

The checklist contained in Table 2 incorporates the mitigation suggestions and has been constructed to be used in combination with the hazard questionnaire.

Please note that the list of suggested hazard reduction techniques is intended as a guide but cannot address all situations that exist at the more than 900 airports that have approach lighting systems. Additional hazard reduction techniques may become apparent as the questionnaire and the checklist are used.

Table 2 Checklist of suggested procedures to mitigate approach lighting system hazards

	Item	Date Complete	Initials
1.	a) Convene a small group of airport operations, emergency response (e.g., on-site aircraft rescue fire fighting (ARFF) or off-site mutual aid emergency response personnel) and FAA personnel to examine the approach lighting systems and agree on the hazards specific to the airport. b) Conduct a yearly review of potential approach lighting system hazards to update and discuss emergency response planning and procedures for these hazards. Notes:		
2.	a) Develop a cooperative plan with the approach lighting system hazard risk response group for mitigating the hazards. • Include de-energizing the approach lighting system as soon as possible and before emergency response personnel enter the accident scene. • Include how to isolate both backup and primary power supplies. • Identify how to physically lock the power supply switches/breakers open with padlocks which are not to be removed until the emergency response is complete and electricians have confirmed the system safe. • When required, identify how approach lighting systems at large airports can be individually de-energized without affecting other runways. • First responders should confirm that the approach lighting system is de-energized when they arrive at the scene. b) Train emergency personnel that the approach lighting system may be an additional source of debris at the accident scene. c) Discuss access for emergency vehicles and personnel and include issues in the emergency response plan. • Identify response personnel and vehicle limitations based on all weather conditions. Notes:		
3.	a) Prepare in-house common reference guide to orient personnel on the approach lighting system. This guide might include: • Simple block diagrams of circuitry for the approach lighting system. • Photographs of approach lighting system buildings and components, including light poles and supports, backup power supplies, cutoff switches or circuit breakers for primary and backup power.		

	Item	Date Complete	Initials
	• Photographs of breakaway electrical connections and approach lighting system fixtures. • Photographs of frangible approach lighting system fixtures. • Security features for the approach lighting system, such as fence locks, building locks, and locking features on cutoff switches and/or breakers. Notes:		
4.	a) List names, phone numbers (home, mobile, pager) and work schedules for all those who might be involved in responding to an aircraft incident with the approach lighting system. _____ _____ _____ _____ _____ _____ _____ b) List individuals who have access to the approach lighting system's cutoff switches and/or breakers (e.g., control towers) or keys to facilities containing cutoff switches and/or breakers: _____ _____ _____ _____ _____ _____ _____ c) List individuals most likely to be involved and their backups: _____ _____ _____ _____ _____ _____ _____		
5.	a) Identify who requires access to the approach lighting system power vault in emergency situations. b) Create a memorandum of agreement between different organizations (e.g., airport operations and the FAA) authorizing access to the approach lighting system to de-energize it during an accident and specifying how the keys to the FAA facility will be maintained securely by those holding the keys. c) Identify where access keys are located for the approach lighting system's power facilities (and how these keys are passed between people on various shifts) or locate a key in a key box, which can be quickly accessed by all necessary personnel.		

	Item	Date Complete	Initials
	d) If the above memorandum cannot be obtained, confirm if the FAA can guarantee in emergency situations involving the approach lighting system that the FAA will shut down the approach lighting system in an emergency before the response personnel arrive at the incident site.		
6.	a) Purchase or acquire cable detection equipment that may be used to confirm that the approach lighting system is de-energized. • Electricians and emergency response personnel may well be able to assist with selecting the appropriate test equipment. b) Establish a common "power cable" checkpoint for all runways that contain approach lighting systems. These pre-located checkpoints will be areas where the approach lighting system cabling is known to enter the system's area. c) During an emergency response involving the approach lighting system, ARFF/Mutual aid response will meet at the designated power cable checkpoint. Response personnel can then confirm that the system has been de-energized.		
7.	a) Familiarize and/or cross-train personnel on how the approach lighting system functions.		
8.	a) Train and cross-train as appropriate all personnel who might respond to an aircraft accident involving the approach lighting system: (1) to de-energize the system before entering an accident scene where the aircraft has collided with the system and (2) to operate the electrical test equipment to confirm that the approach lighting system equipment is de-energized.		
9.	a) Establish communication protocols between any emergency response personnel when responding outside the airport boundary with those airport personnel responsible for de-energizing the approach lights.		
10.	a) Conduct walk-through training as necessary to confirm that response personnel know how to de-energize the approach lighting system. b) Train and conduct walk-through exercises to confirm that emergency response personnel can access power vaults and verify/confirm that the approach lighting system is de-energized. c) Walk through and conduct mock exercises that involve emergency response personnel responsible for accident response outside the airport boundary with those responsible for de-energizing the system. d) Walk through access issues using mock approach lighting system scenarios to confirm that access routes to the approach lights and any desired alternate routes are acceptable.		
11.	a) Live emergency drills should include responders de-energizing the approach lighting system and checking that the system is de-energized. Include emergency response organizations that are responsible for handling accidents involving the approach lighting system outside airport property in these drills.		

Item	Date Complete	Initials
12. a) A calendar reminder to re-examine preparations for aircraft accidents with the approach lighting system (including this checklist) should be established yearly. b) This may be included in or accomplished concurrently with periodic reviews of emergency preparedness.		

CONCLUSION AND RECOMMENDATIONS

The research showed that undershoot situations that involve collisions with the approach lighting system were more frequent than overrun collisions with the approach lighting system. However, the reports associated with these types of events lack specific details regarding the interaction of the approach lighting system with the aircraft incident. The reports often only state that the approach lighting system was struck, but there is no evidence if the system played a major role in the outcome of the situation or if it hindered or caused further safety concerns. The reporting process should allow for specific information to be entered regarding the approach lighting system with respect to details about damage, whether the system shut down or tripped breakers, whether the system functioned as operationally intended after the incident or if other complications were identified. These additional details can help determine how the system interacted with the incident aircraft and if the approach lighting system posed additional risks after the incident.

Implementation of SMS efforts into this Guidance were considered premature such that further SMS reviews and discussions need to occur before implementing the rating system into the approach lighting safety area. Once the SMS has been adopted as an FAA standard, the research team suggests that the approach lighting system guidebook be updated to reflect the established SMS methods. Currently, the SMS has not been adequately refined for use in this project.

The risk matrix appears to be adequately defined in FAA AC 150/5200-37; however, benchmarking is required to adequately rate both likelihood and severity of these risks. Further refinement of the document is required before airport operators can adequately apply these risk ratings to approach lighting system safety issues.

Future Research

Additional research is required in order to identify the technology needed to de-energize the approach lighting system when a valid incident occurs. During the interview process the research team asked about technological solutions, and respondents voiced concern about how a system would identify a valid incident situation. Further research is required to investigate what a valid incident situation consists of and also what technology would need to be incorporated on current systems to allow for a system to de-energize. Multiple testing techniques will be required to ensure that systems do not deactivate unintentionally. The adoption of technological shutoff mechanisms may be considered in the future; however, extensive research regarding how the system detects an incident and what elements are shut down needs further exploration.

Finally, future research is required to identify appropriate warning mechanisms for response personnel during incidents involving approach lighting systems. A thorough human factors review of warning types (e.g., visual, auditory, etc.) should be considered in order to warn response personnel when an approach lighting system has been deactivated. Preliminary assessment of warning types suggests a two-point approach that incorporates both visual and auditory warning mechanisms. These warning efforts can be incorporated into future research regarding automated de-energization of systems that may be employed in the future.

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