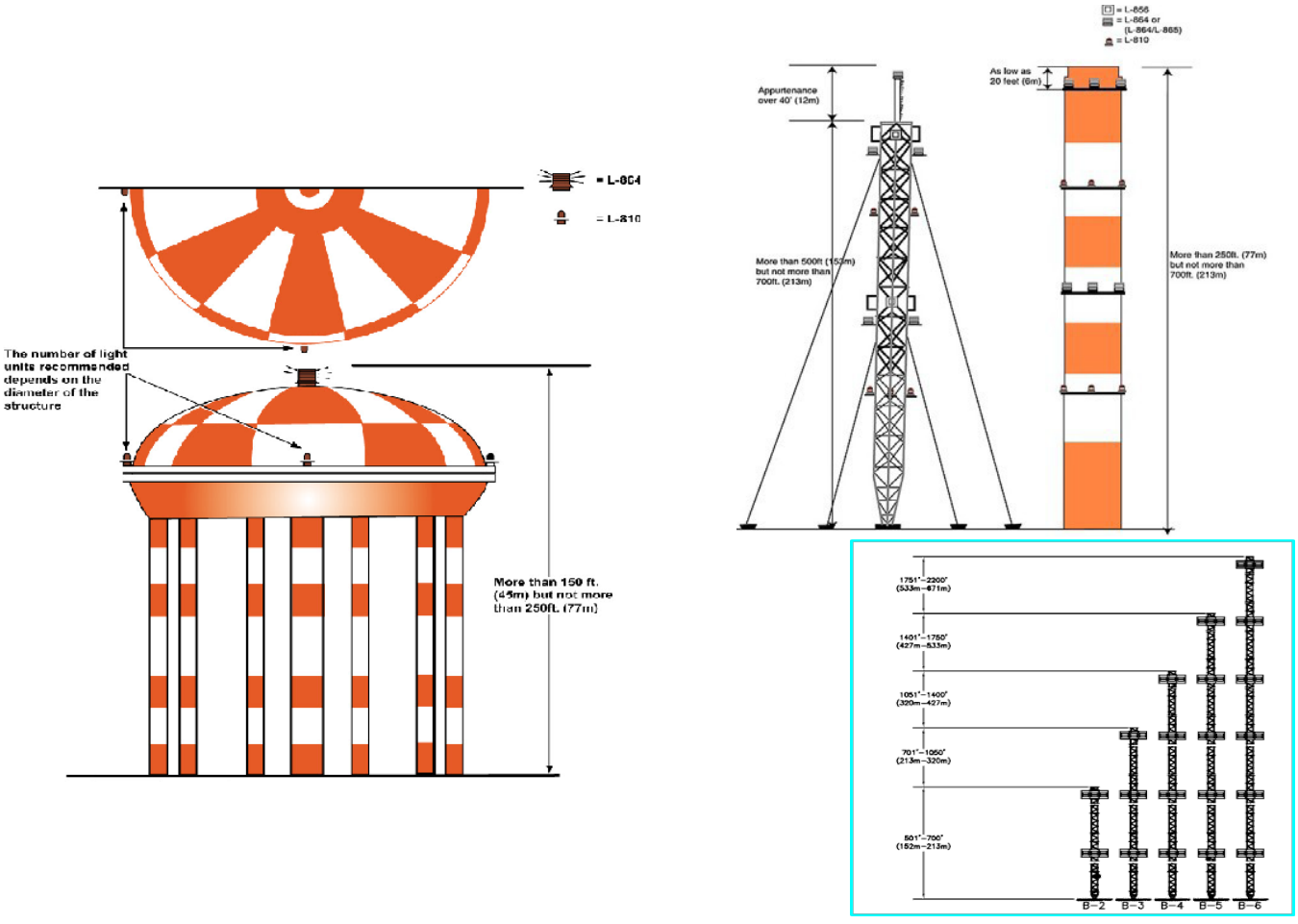
U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular



Obstruction Marking and Lighting

Date: 10/29/2024

Initiated By: AJV-P13

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Obstruction Marking and Lighting

Date: 11/16/2020
AC No. 70/7460-1M
Initiated By: AJV-P13

Purpose.

This Advisory Circular (AC) describes the Federal Aviation Administration's standards for marking and lighting structures to promote aviation safety.

Cancellation.

AC 70/7460-1L, change 2, Obstruction Marking and Lighting, dated August 2018 is cancelled by this version.

Effective Date.

This AC is effective November 16, 2020.

Related Documents.

Title 14 of the Code of Federal Regulations Part 77 describes the standards used relative to objects in the navigable airspace and specifies the requirements for notice to the Administrator of certain proposed construction or alteration.
Federal Communications Commission (FCC) specifications are contained in Part 17 of the FCC Rules and Regulations.

Principal Changes.

This circular contains numerous editorial changes. Major changes are listed below.

a. Page 2, Addition of Note. The FAA has changed specifications for light emitting diode (LED)-based red obstruction lights to make them visible to pilots using certain night vision goggle systems. Effective with the implementation of this change in FAA AC 150/5345-43, Specification for Obstruction Lighting Equipment, manufacturers will be required to meet the new specification for certified red LED-based obstruction lights.
b. Page 6, Removed paragraph 2.8, Obstruction Height Definition. Structures lower than 499 feet AGL can be considered obstructions. As written, the paragraph caused confusion and was deleted.
c. Informational paragraphs are added regarding the change to manufacturing standards for LED-based red obstruction lights compatibility with night vision goggle systems and maintaining conspicuity to avoid misinterpretation when replacing lights.
d. Reorganized information in Chapter 11, Marking and Lighting of Catenary and Catenary Support Structures and chapter 13, Marking and Lighting Wind Turbines.
e. Reorganized chapters by subject matter and figures in Pages A-1 to A-29, as well as minor grammatical changes.

f. Added Chapter 14, Marking and Lighting Temporary Structures and associated figures in the Appendix, Figures A-31 through A-33.
g. Added Figure 22, Catenary Markers - Line Spacing (Adjacent Lines Within 200 feet (60.96 m) or Less.
h. Added Figure 30, Wind Turbine Lighting During Construction.

Federal Aviation Administration Manager,
Policy Assurance Attention: AJV-P13
600 Independence Avenue, S.W. Washington, DC 20591

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Karen Chiodini, Director (A) Policy, AJV-P

Mission Support Services Federal Aviation Administration

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Obstruction Marking and Lighting | **Date:** 10/23/23 | **AC No:** 70/7460-1M, Change 1
Initiated By: AJV-P13

Purpose.

This Advisory Circular (AC) describes the Federal Aviation Administration's standards for marking and lighting structures to promote aviation safety. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way, and the document is intended only to provide information to the public regarding existing requirements under the law or agency policies.

Audience.

This Advisory Circular applies to structure Sponsors, and serves as a reference tool for the Mission Support Services, Obstruction Evaluation Group and Office of Airports.

Effective Date.

This AC is effective October 29, 2024.

Related Documents.

a. Title 14 of the Code of Federal Regulations Part 77 describes the standards used relative to objects in the navigable airspace and specifies the requirements for notice to the Administrator of certain proposed construction or alteration.
b. Federal Communications Commission (FCC) specifications are contained in Parts 17 and 47 of the FCC Rules and Regulations.
c. Sponsors are required to contact the United States Coast Guard (USCG) for prior approval for the lighting of bridges according to 33 CFR 118.

Principal Changes.

This change is to update or correct information and modify standards to include new methods of marking structures and remove the use of steady-burning lights on tower structures. The change also clarifies information regarding modifications and deviations; updates verbiage to reflect the non-regulatory nature of the advisory circular and Meteorological Evaluation Tower name; as well as numerous editorial and formatting updates. Information regarding the major changes is listed below.

a. Page 1, Chapter 1, Paragraph 1.5. The information regarding modifications and deviations is updated to clearly define the meaning of each, as well as how they are requested by Sponsors and analyzed by the FAA.
b. Page 10, Chapter 2, Paragraph 2.7. The name of Meteorological Evaluation Towers is changed to meteorological towers. There is no abbreviation for the title of Meteorological Tower(s), so the use of "MET" for these structures is removed.

c. Page 53, Chapter 15, Paragraph 15.2.2 item 2. and throughout the document. The FAA has approved the use of alternative methods of marking structures, vinyl wrapping and powder coating, in addition to painting. This change adds information regarding the marking standards for the use of these methods. Additionally, due to these new marking methods for structures, paint is no longer the sole source and the term “marking” has replaced “painting” as appropriate throughout the AC.
d. Flashing side lights have replaced steady burning lights to avoid avian confusion and provide a level of protection to reduce deaths. Existing structures lit with steady burning lighting is acceptable at this time. However, as these lights necessitate replacement, they should be upgraded to flashing lights. All new construction requires the installation of flashing lights.
e. In paragraphs 7.6, 7.7. and 9.5 corrected the alphanumeric lighting type to reflect medium-intensity lighting.
f. The informational paragraph in Appendix B has been updated to clearly reflect the information as the application of data from Table-B and Figure B-1 to calculate pilot visibility of structures.
g. Addition of Advisory Circular Feedback page (last page).
h. Throughout the document, verbiage has been updated to reflect the non-regulatory nature of an advisory circular. Examples include changing the use of the word “must” to “should” and “requirements” to “recommendations” or “standards” as appropriate.
i. Editorial/format changes throughout the document were made where necessary, including Appendix A.

Application

The FAA recommends the guidelines and standards in this AC for determining the proper way to light and mark obstructions affecting navigable airspace. This AC does not constitute a regulation and, in general, is not mandatory. However, a sponsor proposing any type of construction or alteration of a structure that may affect the National Airspace System (NAS) is required under the provisions of Title 14 Code of Federal Regulations to notify the FAA by completing the Notice of Proposed Construction or Alteration form (FAA Form 7460-1).

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback Form on the last page of this document.

Federal Aviation Administration
600 Independence Avenue, S.W., Attention: AJV-P13
Washington, DC 20597-5580

MICHAEL R BECKLES
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Michael Beckles
Director, Policy, AJV-P
Mission Support Services | Air Traffic Organization
Federal Aviation Administration

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CHAPTER 1. ADMINISTRATIVE AND GENERAL PROCEDURES

1.1 Reporting Requirements.

A Sponsor proposing any type of construction or alteration of a structure that may affect the National Airspace System (NAS) as required under the provisions of Code of Federal Regulations (CFR), Title 14, Aeronautics and Space, Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace (14 CFR, Part 77), must notify the Federal Aviation Administration (FAA) by completing the FAA Form 7460-1, Notice of Proposed Construction or Alteration.

This form should be filed electronically at https://oeaaa.faa.gov. The website includes the FAA Notice Criteria Tool for Sponsors use to determine if the structure exceeds criteria threshold and requires a notice to be filed.

1.2 Preconstruction Notice.

The notice must be submitted:

1. At least 45 days prior to the date of proposed construction or alteration is to begin.
2. On or before the date an application for a construction permit is filed with the Federal Communications Commission (FCC). The FCC advises its applicants to file with the FAA well in advance of the 45-day period to expedite FCC processing.

1.3 FAA Acknowledgement.

The FAA will acknowledge, electronically, each FAA Form 7460-1 notice received.

1.4 Supplemental Notice Requirement.

1.4.1 If required, the FAA will include a statement requiring the filing of FAA Form 7460-2, Notice of Actual Construction or Alteration, on the determination. All FAA Forms 7460-2 should be filed electronically at https://oeaaa.faa.gov.

1.4.2 FAA Form 7460-2, Part 1, must be submitted to the FAA at least ten days prior to starting the actual construction or alteration of a structure. The FAA Form 7460-2, Part 2, completed within five days after the structure has reached its greatest height.

1.4.3 In addition, notification of dismantlement or abandonment of construction must be submitted to the FAA using the supplemental notice FAA Form 7460-2.

Note: Notification as required in the determination is critical to aviation safety.

1.5 Modifications and Deviations.

Requests for modification or deviation from the standards outlined in this Advisory Circular (AC) should be submitted to the FAA Obstruction Evaluation Group (OEG) by submitting FAA Form 7460-1, Notice of Proposed Construction or Alteration, to

determine the potential effect on aviation safety. The Sponsor is responsible for adhering to approved marking and/or lighting limitations, and recommendations given, and should notify the FAA and FCC (for those structures regulated by the FCC) prior to making any changes, such as removal of marking and/or lighting.

1.5.1 Modifications.

A Sponsor may request a modification from the marking and lighting recommendations contained in a determination to the OEG to use alternative methods or configurations from the AC standards. Requests received for any changes after a determination has been issued will require a new aeronautical study and may result in a modified determination, including updated marking and/or lighting recommendations. If the FAA issues a modification from the marking or lighting requirements prior to the implementation of the changes, the Sponsor may also be required to notify the FCC. Some examples of modifications are as follows:

1. Marking and/or lighting only a portion of an object. The object may be located with respect to other objects or terrain that only a portion of it needs to be marked and/or lighted.
2. No marking and/or lighting. The object may be located with respect to other objects or terrain, removed from the general flow of air traffic, or may be so conspicuous by its shape, size, or color that marking or lighting would serve no useful purpose.
3. Voluntary marking and/or lighting. The object may be located with respect to other objects or terrain that the Sponsor feels increased conspicuity would better serve aviation safety. Sponsors who desire to voluntarily mark and/or light their structure should do so in accordance with this AC.
4. Marking or lighting an object in accordance with the standards for an object of greater height or size. The object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure aviation safety.

The FAA strongly recommends that Sponsors become familiar with the different types of lighting systems and specifically request the type of lighting system desired when submitting FAA Form 7460-1. Information regarding types of lighting systems is provided in Chapters 5 - 10, and specifications regarding lighting equipment classifications in Appendix A, Table A-1, in this AC. While the FAA will make an effort to accommodate the structure Sponsor’s request, Sponsors should also request information from system manufacturers to determine which system best meets their needs based on purpose, installation, and maintenance costs.

1.5.2 `Deviations.

The assigned Obstruction Evaluation Specialist will forward the request to the FAA Airport Safety Research and Development Section to conduct analysis and testing of the proposed deviation(s) for approval of use or to initiate testing in cooperation with the FAA. Proposed requests to deviate from current marking and lighting standards for research and development to introduce new technology or improve current standards. The FAA will perform a safety assessment for use in the NAS and may request status

reports and/or additional information as needed. If at any time the FAA determines the study has created an unsafe condition, the deviation request may be terminated. Research and development testing is independent of the aeronautical study process and generally requires a more lengthy analysis period for evaluation by the FAA for aviation safety. When testing is complete and the FAA concludes its review, the Sponsor will be notified of the determination. Examples of deviations that may be considered include, but are not limited to alternative painting schemes, colors/types of lights, basic signals and intensity of lights, night/day lighting combinations, and flash rate.

1.6 Additional Notification.

Proper authorization and annotations of obstruction marking and lighting may require the Sponsor to provide notice to the FCC prior to making any change to the submitted information which the FAA based its determination. This includes modification, deviation, or optional upgrade to white lighting on structure, which may be subject to inspection and enforcement of marking and lighting requirements by the FCC. FCC forms and bulletins can be obtained from the FCC's National Call Center at 1-888-CALL-FCC (1-888-225-5322) or online at: Forms | Federal Communications Commission (fcc.gov) and Antenna Structure Registration (ASR) - Forms | Federal Communications Commission (fcc.gov). Additionally, upon completion of the actual change complete the Supplemental Notice (FAA Form 7460-2) at the https://oeaaa.faa.gov website.

CHAPTER 2. GENERAL

2.1 Structures to be Marked and Lighted

Any temporary or permanent structure, including all appurtenances, that exceeds any obstruction standard contained in 14 CFR Part 77 or an overall height of 200 feet (60.96 m) above ground level (AGL) should be marked and/or lighted. However, an FAA aeronautical study may reveal that the absence of marking and/or lighting will not impair aviation safety. Conversely, the object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure aviation safety. Recommendations for marking and/or lighting structures can vary, depending on terrain features, weather patterns, geographic location, number of structures, and overall design layout. The FAA may also recommend marking and/or lighting a structure that does not exceed 200 feet (60.96 m) AGL or 14 CFR Part 77 standards because of its particular location. The marking and lighting configurations are illustrated in Appendix A.

2.2 Guyed Structures

Properly maintained marking and lighting are important for increased conspicuity because the guys of a structure are difficult to see until the aircraft is dangerously close. Section 91.119 of 14 CFR requires pilots, when operating over other than congested areas, to remain at least 500 feet (152.40 m) from man-made structures. Therefore, the tower must be cleared by 2,000 feet (609.60 m) horizontally to avoid all guy wires. The guys of a 2,000-foot (609.60 m) skeletal tower are anchored between 1,600 feet (487.68 m) and 2,000 feet (609.60 m) from the base of the structure. This places a portion of the guys 1,500 feet (457.20 m) from the tower at a height of between 125 feet (38.10 m) and 500 feet (152.40 m) AGL.

2.3 Marking and Lighting Equipment

Considerable effort and research were expended to determine the minimum marking and lighting systems and quality of materials that will produce an acceptable level of aviation safety. The FAA will recommend only those marking and lighting systems that meet established technical standards and commercial outside lighting should not be used in lieu of FAA recommended marking and/or lighting. While additional lights may be desirable to identify an obstruction to air navigation, and may on occasion be recommended, the FAA will recommend minimum standards in the interest of safety, economy, and related concerns. Therefore, to provide an adequate level of safety, obstruction lighting systems should be installed, operated, and maintained in accordance with the recommended standards herein. Chapter 15 contains descriptions of FAA-approved obstruction marking and lighting equipment and information referred to in this AC.

2.4 Light Failure Notification

Sponsors should consider that conspicuity is achieved only when all recommended lights are working. Partial equipment outages decrease the margin of safety. Any flashing light outage should be REPORTED IMMEDIATELY AND corrected as soon as possible. Failure of steady-burning side or intermediate lights should be corrected as soon as possible, but notification is not required.

Manufacturers are required to meet FAA specifications for certified red LED-based obstruction lights to make them visible to pilots using certain night vision goggle systems. FAA AC 150/5345-43, Specification for Obstruction Lighting Equipment, specification ensures the light is visible to pilots operating with night vision goggles, to avoid the risk of a pilot misinterpreting the tower height if a legacy intermediate-level light is replaced with one that meets the specification unless the top light meets the new specification as well. Therefore, if a legacy specification intermediate-level LED-based light is replaced with a light that meets the specifications, then the top-level light(s) on the obstruction should also be updated to ensure the entire obstruction is visible during the use of night vision goggles.

2.4.1 Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light, flashing obstruction light regardless of its position, wind turbine lighting fixture, or wind turbine synchronization should be reported immediately by calling Outage Reporting and Notice to Air Missions (NOTAM) at 877-487-6867, or in Alaska 800-478-3576, so a NOTAM can be issued. For structures that are regulated by the FCC, the FCC advises that noncompliance with notification procedures could subject the Sponsor to penalties or monetary forfeitures. Voluntarily installed lights (not recommended in an FAA determination) do not require a NOTAM.

2.4.2 The following information should be specified for outage reporting:

1. Name of persons or organizations reporting the light failures, including any title, address, and telephone number.
2. The type of structure.
3. Location of structure (including latitude and longitude, prominent structures, landmarks, etc.).
4. Height of structure AGL/above mean sea level (AMSL) if known.
5. Return to service date.
6. FCC Antenna Structure Registration Number (for structures that are regulated by the FCC).

Note: When the primary lamp in a double obstruction light fails and the secondary lamp comes on, no report is required.

2.5 Notification of Restoration

As soon as normal operation is restored, notify Outage Reporting and NOTAM Offices (see Paragraph 2.4.1).

Note: For structures regulated by the FCC, the FCC advises that noncompliance with notification procedures could subject the Sponsor to penalties or monetary forfeitures.

2.6 Federal Communications Commission (FCC) Requirement

The use of a high intensity flashing white lighting system on structures located in residential neighborhoods (as defined by applicable zoning laws) trigger requirements for FCC licenses and an environmental assessment.

2.7 Voluntary Marking of Meteorological Towers Less Than 200 Feet (60.96 m) AGL

The FAA recommends marking of meteorological towers less than 200 feet (60.96 m) AGL in accordance with marking guidance contained in this AC. Historically, this guidance has not been applied; however the FAA recognizes the need to address safety impacts to low-level agricultural flight operations and believes that marking meteorological towers less than 200 feet (60.96 m) AGL in remote and rural areas enhances the conspicuity of these structures.

2.7.1 Marking.

The meteorological tower should be marked in accordance with the standards and criteria contained in Chapters 3 and 15, with alternating bands of aviation orange and white. In addition, all markings should be replaced when faded or otherwise deteriorated below approved SAE AMSSTD595A standards (see Chapter 15).

2.7.2 High-visibility sleeves.

It is recommended that several high-visibility sleeves be installed on the meteorological tower outer guy wires (see Figure A-2). One high-visibility sleeve should be installed on each guy wire, as close to the anchor point as possible, but at a height well above the crop or vegetation canopy. A second sleeve should be installed on the same outer guy wires midway between the location of the lower sleeve and the upper attachment point of the guy wire to the meteorological tower.

2.7.3 Spherical markers.

It is also recommended that high-visibility aviation orange spherical marker (or cable) balls are attached to the guy wires. Spherical markers should be installed and displayed in accordance with Chapters 3 and 11. The FAA, however, recognizes various weather conditions and manufacturing placement standards may affect the placement and use of high-visibility sleeves and/or spherical markers. Thus, some flexibility is allowed when determining sleeve length and marker placement on the meteorological tower.

CHAPTER 3. MARKING GUIDELINES

3.1 Purpose

This chapter provides recommended guidelines to make certain structures conspicuous to pilots during daylight hours. One way to achieve this conspicuity is to paint and/or mark these structures. Recommendations on marking structures can vary, depending on terrain features, weather patterns, geographic location, and the number of structures.

3.2 Marking Colors

Alternate sections of aviation orange and white marking should be used as the contrast in colors provides maximum visibility of an obstruction. Specific marking standards are contained in Chapter 15.

3.3 Marking Standards

To be effective, the marking used should meet specific color requirements when freshly applied to a structure. Because all outdoor markings deteriorate with time, and it is not practical to give a maintenance schedule for all climates, surfaces should have markings reapplied when the color changes noticeably or its effectiveness is reduced by scaling, oxidation, chipping, or layers of contamination. The subsequent standards should be followed.

3.3.1 Materials and Application

The FAA recommends that quality markings (paint, powder coat, vinyl wrap, etc.) and materials be selected to maximize years of service. The marking should be appropriate for the surfaces to be marked, including any previous applications, and suitable for the environmental conditions. Surface preparation and marking application should follow the manufacturer's recommendations.

Note: In-Service Aviation Orange Color Tolerance Charts are available from private suppliers for determining when repainting is appropriate. The color should be sampled on the upper half of the structure where paint weathering is greater.

3.3.2 Surfaces not Requiring Marking

Ladders, decks, and walkways of steel towers and similar structures do not need to be marked if a smooth surface presents a potential hazard to maintenance personnel. Marking may also be omitted from precision or critical surfaces if the marking would have an adverse effect on the transmission or radiation characteristics of a signal. However, the structure's overall marking effect should not be reduced.

3.3.3 Skeletal Structures

Complete all marking/painting prior to or immediately upon completion of construction. This applies to catenary support structures, radio and television towers, and similar skeletal structures. To be effective, marking should be applied to all inner and outer surfaces of the framework.

3.4 Marking Patterns

Various types of marking patterns are used to distinguish structures. The pattern is determined by the size and shape of the structure. The following patterns are recommended:

3.4.1 Solid Pattern

Obstacles should be marked aviation orange if the structure's horizontal and vertical dimensions do not exceed 10.5 feet (3.20 m).

3.4.2 Checkerboard Pattern

Alternating rectangles of aviation orange and white are normally displayed on the following structures:

1. Water, gas, and grain storage tanks (see Figures A-3, A-4, and A-5).
2. Buildings, as required.
3. Large structures exceeding 10.5 feet (3.20 m) across, having a horizontal dimension that is equal to or greater than the vertical dimension.

3.4.3 Size of Patterns

The sides of the checkerboard pattern should measure not less than five feet (1.52 m) or more than 20 feet (6.10 m) and should be as nearly square as possible. However, if it is impractical because of the size or shape of a structure, the sides of the patterns may be less than five feet (1.52 m). The pattern should be arranged so that each outer corner of the structure will be painted aviation orange.

3.4.4 Alternate Bands

Alternate bands of aviation orange and white are normally displayed on the following structures:

1. Communication towers and catenary support structures.
2. Poles.
3. Smokestacks.
4. Skeletal framework of storage tanks and similar structures.
5. Structures that appear narrow from a side view that are 10.5 feet (3.20 m) or less across, and the horizontal dimension is less than the vertical dimension.
6. Coaxial cable, conduits, and other cables attached to the face of a tower.
7. Wind turbines in snow prone areas may also use off-white (see Chapter 13) for greater conspicuity.

3.4.5 Color Band Characteristics

Bands for structures of any height (see Figure A-6) should be:

1. Equal in width, provided each band is not less than 1 1/2 feet (0.46 m) or more than 100 feet (30.48 m) wide.

2. Perpendicular to the vertical axis with the bands at the top and bottom marked orange.
3. An odd number of bands on the structure.
4. Equal and in proportion to the structure's AGL height.
5. Approximately one-seventh the height, if the structure is equal to or less than 700 feet (213.36 m) AGL. For each additional 200 feet (60.96 m) or fraction thereof, add one additional orange and one additional white band. Table 3-1 shows the required band widths based on the height of the structure.

Table 3-1: Structure Height to Bandwidth Ratio

If a structure is:		**Then Band Width:**
Greater Than	**Equal to or Less Than**	**Band Width**
10.5 feet (3.20 m)	700 feet (213.36 m)	1/7 of
700 feet (213.36 m)	900 feet (274.32 m)	1/9 of
900 feet (274.32 m)	1,100 feet (335.28 m)	1/11 of
1,100 feet (335.28 m)	1,300 feet (396.24 m)	1/13 of

3.4.6 Structures With a Cover or Roof

If the structure has a cover or roof, the highest orange band should be continued to cover the entire top of the structure (see Figures A-3 and A-4).

3.4.7 Skeletal Structures Atop Buildings

If a flagpole, skeletal structure, or similar object is erected on top of a building, the combined height of the object and building will determine whether marking is recommended. However, only the height of the object filed with the FAA determines the width of the color bands.

3.4.8 Partial Marking

If marking is recommended for only a portion of a structure because the lower portion of the structure is shielded by other objects or terrain, the width of the bands on the exposed portion should still be determined by the overall height of the structure. Paragraph 3.4.5.5 provides details on calculating the width of the paint bands. A minimum of three bands should be displayed on the exposed portion of the structure. If the exposed portion of the structure is not large enough to have at least three bands, the

width of the bands may be reduced equally so that three equally sized bands can be fit. This will ensure that the marking pattern provides sufficient contrast for a pilot to locate the structure.

3.4.9 Teardrop Pattern

Spherical water storage tanks with a single, circular standpipe support may be marked in a teardrop-striped pattern. The tank should show alternate stripes of aviation orange and white. The stripes should extend from the top center of the tank to its supporting standpipe. The width of the stripes should be equal, and the width of each stripe at the greatest girth of the tank should not be less than five feet (1.52 m) nor more than 15 feet (4.57 m) (see Figure A-5).

3.4.10 Community Names

If it is desirable to display the name of the community on the side of a tank or other structure, the stripe pattern may be broken to serve this purpose. This open area should have a maximum height of three feet (0.91 m) (see Figure A-5).

3.4.11 Exceptions

Structural designs not conducive to standard markings may be marked as follows:

1. If it is not practical to mark the roof of a structure in a checkerboard pattern, it may be marked solid orange.
2. If a spherical structure is not suitable for an exact checkerboard pattern, the shape of the rectangles may be modified to fit the shape of the surface.
3. Storage tanks not suitable for a checkerboard pattern may have alternating bands of aviation orange and white or a limited checkerboard pattern applied to the upper one-third of the structure.
4. The skeletal framework of certain water, gas, and grain storage tanks may be excluded from the checkerboard pattern.
5. Solid spherical water tank stands do not require marking.

3.5 Unlighted Markers

Unlighted markers are used to identify structures and to make them more conspicuous when it is impractical to mark them. Unlighted markers may also be used with aviation orange and white markings when additional conspicuity is necessary for aviation safety. Unlighted markers should be displayed in conspicuous positions on or adjacent to the structures to retain the general definition of the structure. They should be recognizable in clear, daytime visibility from a distance of at least 4,000 feet (1,219.20 m) and in all directions from which aircraft are likely to approach. Unlighted markers should be distinctively shaped, i.e., spherical or cylindrical, so that they are not mistaken for items that are used to convey other information. They should be replaced when faded or otherwise deteriorated.

3.5.1 Spherical Markers

Spherical markers are primarily used to identify overhead wires and catenary transmission lines that are less than 69 kilovolts (kV). Markers may be of another shape, i.e., cylindrical, provided the projected area of such markers is not less than that presented by a spherical marker.

3.5.2 Size and Color

The diameter of the markers used on extensive catenary wires (catenary wires that cross canyons, lakes, rivers, etc.) should not be less than 36 inches (91.44 centimeters (cm)). Smaller 20-inch (50.80-cm) spheres are permitted on less extensive catenary wires or on power lines below 50 feet (15.24 m) AGL and within 1,500 feet (457.20 m) of an airport runway end. Each marker should be a solid color, specifically aviation orange, white, or yellow.

3.5.3 Installation

3.5.3.1 Spacing. Unlighted markers should be spaced equally along the wire at approximately 200-foot (60.96 m) intervals, or fraction thereof. There should be less space between markers in critical areas near runway ends (i.e., 30 feet to 50 feet (9.14 m to 15.24 m)). They should be displayed on the highest wire or by another means at the same height as the highest wire. Where there is more than one wire at the highest point, the markers may be installed alternately along each wire if the distance between adjacent markers meets the spacing standard of 200 feet (60.96 m) or less. This method distributes the weight and wind-loading factors (see Figures A-21 and A-24).

3.5.3.2 Pattern. An alternating color scheme provides the most conspicuity against all backgrounds. Unlighted markers should be installed by alternating solid-colored markers of aviation orange, white, and yellow. Normally, an orange marker is placed at each end of a line and the spacing is adjusted (not to exceed 200 feet (60.96 m)) to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange.

3.5.3.3 Wire Sag. Wire Sag, or droop, will occur due to temperature, wire weight, wind, etc. Twenty-five feet (7.62 m) is the maximum allowable distance between the highest wire installed with marker balls and the highest wire without marker balls and should not violate the sag standards of the transmission line design.

3.5.3.4 Adjacent Lines. Catenary crossings with multiple transmission lines require appropriate markers when the adjacent catenary structure’s outside lines are greater than 200 feet (60.96 m) away from the center of the primary structure. If the outside lines of the adjacent catenary structure are within 200 feet (60.96 m) or less from the center of the primary structure, markers are not required on the adjacent lines.

3.6 Flag Markers

Flags are used to mark certain structures or objects when it is technically impractical to use spherical markers or quality markings (paint, powder coat, vinyl wrap, etc.). Flag markers should be mounted at the highest point of the structure to ensure visibility. Some common examples of structures that may utilize this type of markers include, temporary construction equipment and vehicles, oil and drilling rigs, cranes, and derricks.

3.6.1 Minimum Size
Each side of the flag marker should be at least two feet (0.61 m) in length.

3.6.2 Color Patterns
Flags should be colored as follows:

1. Solid. Aviation orange.
2. Orange and White. Arrange two triangular sections, one aviation orange, and the other white to form a rectangle.
3. Checkerboard. Flags three feet (0.91 m) or larger should be a checkerboard pattern of aviation orange and white squares, each one foot (0.30 m) plus or minus 10 percent.
4. Shape. Flags should be rectangular in shape and have stiffeners to keep them from drooping in calm wind.

3.6.3 Display. Flag markers should be displayed around, on top, or along the highest edge of the obstruction. When flags are used to mark extensive or closely grouped obstructions, they should be displayed approximately 50 feet (15.24 m) apart. The flag stakes should be strong enough to support the flags and be higher than the surrounding ground, structures, and/or objects of natural growth.

3.7 Omission or Alternatives to Marking

The alternatives listed below require FAA review and concurrence prior to making changes. See subsequent chapters for specific guidance.

3.7.1 High Intensity Flashing White Lighting Systems are more effective than aviation orange and white marking and therefore can be recommended instead of paint marking. This is particularly true under certain ambient light conditions involving the position of the sun relative to the direction of flight. High-intensity lighting systems should not be used on structures 700 feet (213.36 m) AGL or less, however, when operated during daytime, twilight, or 24 hours a day, other methods of marking and lighting may be omitted.

3.7.2 Medium Intensity Flashing White Lighting Systems are operated during daytime and twilight on structures 700 feet (213.36 m) AGL or less, but generally not on structures less than 200 feet (60.96 m) AGL. When used, other methods of marking may be omitted.

Note: Note: Sponsors may need to coordinate alternative markings with the FCC for certain structures prior to making any changes.

3.8 Unusual Complexities

The FAA may also recommend appropriate marking in an area in which grouped obstructions present a common obstruction to air navigation.

CHAPTER 4. LIGHTING GUIDELINES

4.1 Purpose

This chapter describes the various obstruction lighting systems used to identify structures that have been determined to require added conspicuity. The lighting standards in this Advisory Circular (AC) are the minimum necessary for aviation safety. Recommendations for lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

4.2 Standards

The standards outlined in this A/C are based on using light units that meet specified intensities, beam patterns, color, and flash rates as stated in AC 150/5345-43, Specification for Obstruction Lighting Equipment. The AC may be obtained from: https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1035508.

4.3 Lighting Systems

All flashing lights on a structure should flash simultaneously except for catenary support structures, which have a distinct flashing sequence between the levels of lights (see paragraph 11.4.2). Obstruction lighting may be displayed on structures as follows (refer to subsequent chapters for details):

1. Aviation Red Obstruction Lights.

   Use flashing lights and/or steady-burning lights during nighttime. Tower structures are typically marked with flashing red lights. Buildings and smaller obstructions located near airports should be marked with steady-burning red lights.

2. Medium Intensity Flashing White Obstruction Lights.

   Medium intensity flashing white obstruction lights may be used during daytime and twilight with automatic reduced intensity selected for nighttime operation. When this system is used on structures 700 feet (213.36 m) AGL or less, other methods of marking and lighting the structure may be omitted. Aviation orange and white marking is always required for daytime marking on structures exceeding 700 feet (213.36 m) AGL. This system is not normally recommended on structures 200 feet (60.96 m) AGL or less.

3. High Intensity Flashing White Obstruction Lights.

   High intensity flashing white obstruction lights may be used during daytime, with automatically selected reduced intensities for twilight and nighttime operations. When this system is used, other methods of marking and lighting the structure may be omitted. This system should not be used on structures 700 feet (213.36 m) AGL or less unless an FAA aeronautical study shows otherwise.

4. Dual Lighting.

   This system consists of red lights for nighttime and high- or medium-intensity flashing white obstruction lights for daytime and twilight. When a dual lighting system incorporates medium-intensity flashing white lights on structures 700 feet (213.36 m) AGL or less or high-intensity flashing white lights on structures greater than 700 feet (213.36 m) AGL, other methods of marking the structure may be omitted.

5. Lighted Spherical Markers.

   Lighted markers are available for increased night conspicuity of high-voltage (69 kV or greater) transmission line catenary wires and should be manufacturer-certified as, visible and recognizable from a minimum distance of 4,000 feet (1,219.20 m) under nighttime conditions and under minimum VFR conditions and have a minimum intensity of at least 32.5 candelas. Markers should be distinctively shaped, i.e., spherical or cylindrical, so that they are not mistaken for items used to convey other information.

6. Aircraft Detection Lighting System.

   Lights are controlled by sensor-based systems designed to detect aircraft approaching a single obstacle or group of obstacles and automatically activate the appropriate obstruction lights until the aircraft has departed the area and the lights are no longer needed. This technology reduces the impact of nighttime lighting on nearby communities and migratory birds, as well as extends the life expectancy of obstruction lights.

7. Obstruction Lights During Construction.

   As the height of the structure exceeds each level at which permanent obstruction lights would be recommended, two or more lights of the type specified in the determination should be installed at that level. Temporary high- or medium-intensity flashing white lights, if recommended in the determination, should be operated 24 hours a day until all permanent lights are in operation. In either case, two or more lights should be installed on the uppermost part of the structure any time it exceeds the height of the temporary construction equipment. They may be turned off for periods when they could interfere with construction personnel. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. The lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level when approaching from any direction.

8. Obstruction Lights in Urban Areas.

   When a structure is located in an urban area where there are numerous other white lights (e.g., streetlights), red obstruction lights with appropriate marking or a medium-intensity dual system is recommended. White lighting is not normally recommended on structures less than 200 feet (60.96 m) or within 3 NM (5.56 km) of an airport.

4.4 Inspection, Repair, and Maintenance

To ensure the proper candela output for fixtures with incandescent lamps, the voltage provided to the lamp filament should not vary more than plus or minus three percent of the lamp's rated voltage. The input voltage should be measured at the closest disconnecting means to the lamp fixture with the lamp operating during the hours of normal operation (for strobes, the input voltage of the power supplies should be within 10 percent of rated voltage).

Lamps should be replaced after being in operation for approximately 75 percent of their rated life or immediately upon failure.

Flashtubes in a light unit should be replaced immediately upon failure, when the peak effective intensity falls below specification limits, when the fixture begins skipping flashes, or at the manufacturer's recommended intervals.

Due to the effects of harsh environments, light fixture lenses should be visually inspected every 24 months or when the light fixture fails for ultraviolet (UV) damage, cracks, crazing, dirt buildup, etc., to ensure the certified light output has not deteriorated (see Chapter 2, paragraph 2.4 for reporting requirements in case of failure). Lenses that have cracks, UV damage, crazing, or excessive dirt buildup should be cleaned or replaced.

4.5 Nonstandard Lights

Moored balloons, chimneys, church steeples, teardrop water tanks, and similar obstructions may be floodlighted by fixed search light projectors installed at three or more equidistant points around the base of each obstruction. The searchlight projectors should provide an average illumination of at least 15 foot-candles (161.46 lux) over the top one-third of the obstruction.

4.6 Placement Factors

The height above ground level (AGL) of the structure determines the number of light levels. The light levels may be adjusted slightly, but not to exceed 10 feet (3.05 m) when necessary to accommodate guy wires and personnel who replace or repair light fixtures. Except for catenary wire support structures (see Chapter 11), the following factors should be considered when determining the placement of obstruction lights on a structure:

1. Red Obstruction Lighting Systems.

   The structure's overall height, including all appurtenances, such as rods, antennas, and obstruction lights, determines the number of light levels.

2. Medium Intensity Flashing White Obstruction Lighting Systems.

   The structure's overall height, including all appurtenances such as rods, antennas, and obstruction lights, determines the number of light levels.

3. High Intensity Flashing White Obstruction Lighting Systems.

   The main structure's overall height, excluding all appurtenances, such as rods, antennas, and obstruction lights, determines the number of light levels.

4. Dual Obstruction Lighting Systems.

   The structure's overall height, including all appurtenances, such as rods, antennas, and obstruction lights, is used to determine the number of light levels for a medium-intensity white obstruction light/red obstruction dual lighting system. The structure's overall height, excluding all appurtenances, is used to determine the number of light levels for a high-intensity white obstruction light/red obstruction dual lighting system.

5. Aircraft Lighting Detection System.

   The system should be designed with sufficient sensors and mounted with a clear view to provide complete detection coverage for aircraft that enter a three-dimensional volume of airspace, or coverage area, around an obstruction(s). The system should activate the obstruction lighting system in sufficient time to allow the lights to illuminate and synchronize to flash simultaneously prior to an aircraft penetrating the defined volume and remain on for a specified time expected for the aircraft to depart the coverage area.

6. Lighted Spherical Markers.

   The lighting unit should emit a steady-burning red light and be mounted on the highest energized line, visible to a pilot approaching from any direction. If the lighted markers are installed on a line other than the highest catenary wire, then unlighted markers should be used in addition to the lighted markers and should be installed on the highest energized line. The maximum distance between the line energizing the lighted markers and the highest catenary above the lighted marker should be no more than 25 feet (7.62 m) and should not violate the sag standards of the transmission line design.

7. Adjacent Structures.

   The elevation of the tops of adjacent buildings in congested areas may be used as the equivalent of ground level to determine the correct number of light levels required.

8. Shielded Lights.

   If an adjacent structure or object blocks the visibility of an obstruction light, the light's horizontal placement should be adjusted, or additional lights should be mounted on that object to retain or contribute to the definition of the obstruction.

9. Nesting of Lights.

   Care should be taken to ensure that obstruction lights do not become blocked or "nested" as new antennas, hardware, or appurtenances are added to the top of a structure. If new equipment is added that blocks the obstruction light's visibility, the light fixtures should be relocated and/or raised so that it is not blocked by the new equipment. For example, when new larger cellular antenna panels are fitted to

older towers, the obstruction light should be raised so that it is not blocked by the larger antenna panels. The widest structure, appurtenance, lightning rod, or antenna that can be placed in front of an obstruction light (excluding the L-810 light) without significantly blocking the obstruction light's visibility should be no wider than 7/8 of an inch. Due to their smaller size, L-810 lights should not be blocked by any structure.

4.7 Monitoring Obstruction Lights

Obstruction lighting systems should be closely monitored by visual or automatic means. It is extremely important to visually inspect obstruction lighting in all operating intensities at least once every 24 hours on systems without automatic monitoring. In the event a structure is not readily accessible for visual observation, a properly maintained automatic monitor should be used. This monitor should be designed to register the malfunction of any light on the obstruction regardless of its position or color. When using remote monitoring devices, the system's communication and operational status should be confirmed at least once every 24 hours. The monitor (aural or visual) should be located in an area generally occupied by the responsible personnel. In some cases, this may require a remote monitor in an attended location. For each structure, a log should be maintained in which the lighting system's daily operations status is recorded. Light fixture lenses should be replaced if serious cracks, hazing, dirt buildup, etc., has occurred.

4.8 Ice Shields

Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulation from damaging the light units. The light should be mounted in a manner to ensure an unobstructed view of at least one light by a pilot approaching from any direction.

4.9 Light Shields

In general, light shields are not permitted because of the adverse effects they have on the obstruction light fixture's photometrics. In addition, these shields can promote undesired snow accumulation, bird nesting, and wind loading.

4.10 Distractions

When obstruction lights are in proximity to a navigable waterway, they may distract vessel operators. To avoid interference with marine navigation, coordinate with the Office of Navigation Systems, United States (U.S.) Coast Guard before installing the lighting system.

The contact information for the U.S. Coast Guard is:

Commandant (CG-BRG-1)
U.S. Coast Guard
2703 Martin Luther King Jr. Avenue, Southeast STOP 7418
Washington, DC 20593-0001
Telephone: 202-815-2101

CHAPTER 5. RED OBSTRUCTION LIGHT SYSTEM

5.1 Purpose

Red steady burning (L-810) and flashing (L-810 F or L-864) Obstruction Light Systems are used to increase conspicuity during nighttime, however additional marking and/or lighting during daytime and twilight is required. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

5.2 Standards

The red obstruction light system is composed of flashing omnidirectional lights (L-864) and/or steady-burning or flashing (L-810/L-810 (F)) lights. When one or more levels are comprised of flashing lights, the lights should flash simultaneously. To determine the number of light levels needed, refer to Figure A-6.

5.2.1 Single Obstruction Light

A single red obstruction light may be used when more than one obstruction light is required either vertically or horizontally, or when maintenance is needed, and can be installed within a reasonable time.

5.2.1.1 Top level

A single steady-burning light may be used to identify low structures, such as airport instrument landing system buildings, as well as long horizontal structures, such as perimeter fences and building roof outlines.

5.2.1.2 Intermediate level

Single flashing or steady-burning lights (as appropriate for size and type of structure) may be used on skeletal and solid structures when more than one level of lights is installed and there are two or more single lights per level.

5.2.2 Double Obstruction Light

A double steady-burning light should be installed when used as a top light, at each end of a row of single obstruction lights, and in areas or locations where the failure of a single unit could cause an obstruction to be totally unlighted.

5.2.2.1 Top level

Structures 150 feet (45.72 m) AGL or less should have one or more double steady-burning lights installed at the highest point and operating simultaneously.

5.2.2.2 Intermediate level

Double flashing or steady-burning lights (as appropriate for size and type of structure) should be installed at intermediate levels when a malfunction

of a single light could create an unsafe condition and in remote areas where immediate maintenance cannot be performed. Both units may operate simultaneously, or a transfer relay may be used to switch to a spare unit should the active system fail.

5.2.2.3 Lowest level

The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by the FAA, the lowest level of lights may be eliminated.

5.3 Control Device

Red obstruction lights should be operated by an acceptable control device (e.g., photocell, timer, etc.) adjusted so the lights will be turned on when the northern sky illuminance reaching a vertical surface falls below a level of 60 foot-candles (645.83 lux) but before reaching a level of 35 foot-candles (376.73 lux). The sensing device should, if practical, face the northern sky in the Northern Hemisphere (see AC 150/5345-43, Specification for Obstruction Lighting Equipment). The control device should turn the lights off when the northern sky illuminance rises to a level of not more than 60 foot-candles (645.83 lux). The lights may also remain on continuously.

5.4 Alternate Method of Displaying Obstruction Lights

In certain cases, instead of installing lights on the obstruction, the FAA may recommend the placement of a light(s) on an adjacent pole of equal height.

5.5 Poles, Towers, and Similar Skeletal Structures

The following standards apply to radio and television towers, supporting structures for overhead transmission lines, and similar structures.

5.5.1 Top-Mounted Obstruction Lights

5.5.1.1 Structures 150 feet (45.72 m) AGL or less.

Two or more steady-burning red (L-810) lights should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

5.5.1.2 Structures exceeding 150 feet (45.72 m) AGL.

At least one red flashing (L-864) light should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

5.5.1.3 Appurtenances 40 feet (12.19 m) or less.

If a rod, antenna, or other appurtenance 40 feet (12.19 m) or less in height is incapable of supporting a red flashing light, then it may be placed at the base of the appurtenance. If the mounting location does not allow an

unobstructed view of the light by a pilot approaching in any direction, then additional lights should be added.

5.5.1.4 Appurtenances exceeding 40 feet (12.19 m).

If a rod, antenna, or other appurtenance exceeding 40 feet (12.19 m) in height is incapable of supporting a red flashing light, a supporting mast with one or more lights should be installed adjacent to the appurtenance. Adjacent installations should not exceed the appurtenance's height and be within 40 feet (12.19 m) of the tip to allow the pilot an unobstructed view of at least one light. If the rod, antenna, or other appurtenance is 7/8 inch wide or more, at least two lights should be installed on the supporting mast to provide the necessary unobstructed view.

5.5.2 Mounting Intermediate Levels.

The number of light levels is determined by the height of the structure, including all appurtenances, as shown in, Figure A-6. The number of lights on each level is determined by the shape and height of the structure. These lights should be mounted to ensure an unobstructed view of at least one light by a pilot approaching in any direction.

5.5.2.1 Steady-burning lights (L-810)

1. Structures 150 feet (45.72 m) AGL or less.

   Two or more steady-burning lights should be installed diagonally or on diametrically opposite positions.

2. Structures exceeding 150 feet (45.72 m) AGL.

   These structures do not require steady-burning lights.

5.5.2.2 Flashing lights (L-810 F)

For structures exceeding 150 feet (45.72 m) but not more than 350 feet (106.68 m), two or more flashing lights should be mounted outside at diagonally opposite positions at intermediate levels. These lights should be configured to flash simultaneously with the L-864 flashing light on the top of the structure at a rate of 30 flashes per minute (fpm) (± 3 fpm).

5.5.2.3 Flashing lights (L-864)

1. Structures 350 feet (106.68 m) AGL or less.

   These structures do not require flashing (L-864) lights at intermediate levels.

2. Structures exceeding 350 feet (106.68 m) AGL.

   At intermediate levels, two (L-864) lights should be mounted outside at diagonally opposite positions.

5.6 Chimneys, Flare Stacks, and Similar Solid Structures (except Hyperbolic Cooling Towers)

5.6.1 Number of Light Units

The number of units recommended depends on the diameter of the structure at the top. The number of lights recommended below is the minimum (see Figure A-10).

5.6.1.1 Structures 20 feet (6.10 m) or less in diameter.

Three light units per level.

5.6.1.2 Structures exceeding 20 feet (6.10 m) but not more than 100 feet (31 m) in diameter.

Four light units per level.

5.6.2 Top-Mounted Obstruction Lights

5.6.2.1 Structures 150 feet (45.72 m) AGL or less.

L-810 lights should be installed horizontally at regular intervals at or near the top.

5.6.2.2 Structures exceeding 150 feet (45.72 m) AGL.

At least three L-864 lights should be installed.

5.6.2.3 Chimneys, Cooling Towers, and Flare Stacks.

Lights may be displayed as low as 20 feet (6.10 m) below the top (Figure A-7) to avoid the obscuring effect of deposits and heat generally emitted by this type of structure. It is important that these lights are readily accessible for cleaning and lamp replacement. It is understood that with flare stacks, as well as any other structures associated with the petrol-chemical industry, normal lighting requirements may not be necessary. This could be due to the location of the flare stack/structure within a large, well-lighted, petrol-chemical plant, or the fact that the flare, or working lights surrounding the flare stack/structure, is as conspicuous as obstruction lights.

5.6.3 Mounting Intermediate Levels

The number of light levels is determined by the height of the structure including all appurtenances. Structures between 150 feet and 350 feet (45.72 m and 106.68 m) AGL should have a second level of steady-burning red-light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights. Structures exceeding 350 feet (106.68 m) AGL should have a second level of flashing light units. For cooling towers 600 feet (182.88 m) AGL or less, intermediate light levels are not necessary.

5.6.3.1 Steady-burning (L-810) lights.

The recommended number of light levels is shown in Figure A-6. At least three lights should be installed on each level.

5.6.3.2 Flashing (L-864) lights.

The recommended number of light levels is shown in Figure A-6.

5.6.3.3 Structures 350 feet (106.68 m) AGL or less.

These structures do not need intermediate levels of flashing lights.

5.6.3.4 Structures exceeding 350 feet (106.68 m) AGL.

At least three flashing (L-864) lights should be installed on each level in a manner allowing an unobstructed view of at least one light.

5.7 Prominent Buildings, Bridges, and Similar Extensive Obstructions

When objects within a group of obstructions are approximately the same overall height above the surface and are located a maximum of 150 feet (45.72 m) apart, the group of obstructions may be considered an extensive obstruction. Light units should be installed on the same horizontal plane at the highest portion, or edge, of the prominent obstructions. Light units should be placed to ensure the light is visible to a pilot approaching from any direction. If the structure is a bridge (see Figure A-8) and is over navigable water, the Sponsor must obtain prior approval of the lighting installation from the Commander of the District Office of the U.S. Coast Guard to avoid interference with marine navigation. Steady-burning lights should be displayed to indicate the extent of the obstruction as follows:

1. Structures 150 feet (45.72 m) or less in any horizontal direction.

   If the structure/bridge/ extensive obstruction is 150 feet (45.72 m) or less horizontally, at least one steady-burning light (L-810) should be displayed on the highest point at each end of the obstruction's major axis. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

2. Structures exceeding 150 feet (45.72 m) in at least one horizontal direction.

   If the structure/bridge/extensive obstruction exceeds 150 feet (45.72 m) horizontally, at least one steady-burning light should be displayed for each 150 feet (45.72 m), or fraction thereof, of the overall length of the major axis. At least one of these lights should be displayed on the highest point at each end of the obstruction. Additional lights should be displayed at approximately equal intervals, not to exceed 150 feet (45.72 m) on the highest points along the edge between the end lights. If an obstruction is located near a landing area and two or more edges are the same height, the edge nearest the landing area should be lighted.

3. Structures exceeding 150 feet (45.72 m) AGL

   Steady-burning red obstruction lights should be installed on the highest point at each end. At intermediate levels, steady-burning red lights should be displayed for each 150 feet (45.72 m), or fraction thereof. The vertical position of these lights should be equidistant between the top lights and the ground level, as the shape and type of obstruction will permit. A steady-burning red light should be displayed at each outside corner on each level with the remaining lights evenly spaced between the corner lights.

4. Exceptions

   Flashing red lights (L-864) may be used instead of steady-burning lights if early or special warning is necessary. These lights should be displayed on the highest points of an extensive obstruction at intervals not exceeding 3,000 feet (914.40 m). At least three lights should be displayed on one side of the extensive obstruction to indicate a line of lights.

5. Ice Shields

   Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulation from damaging the light units. The light should be mounted in a manner to ensure an unobstructed view of at least one light by a pilot approaching from any direction.

5.8 Group of Obstructions

With the exception of wind turbines, when individual structures within a group of obstructions differ in height and are spaced no more than 150 feet (45.72 m) apart, the prominent structures within the group should be lighted in accordance with the standards for individual obstructions based on its corresponding height. Shorter structures within the group of obstructions do not need to be lighted based on its corresponding height. When structures are shorter than the prominent structure and are located on the outside of the group of obstructions, those structures should be lighted in accordance with the standards for individual obstructions based on its corresponding height. In addition to lighting the shorter structures on the outside of the group, at least one flashing light should be installed either at the top of the tallest, most prominent center structure, or on a dedicated tower that is located near the center of the group and is the same height as the most prominent structure. Light units should be placed on the structures to ensure that the lights are visible to a pilot approaching from any direction. If one or more of the structures within the group are a solid mass (non-skeletal), additional lighting may be necessary to make sure that the light is not being blocked by the more prominent structure(s). For the purpose of marking and lighting these structures, a group of obstructions is considered to be three or more structures.

CHAPTER 6.
MEDIUM INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

6.1 Purpose

Medium intensity flashing white (L-865) obstruction lights may provide conspicuity both day and night. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

Using a 24-hour, medium intensity, flashing white light system in urban/populated areas is not normally recommended due to their tendency to blend with the background lighting in these areas at night. This makes it extremely difficult for some types of aviation operations, i.e., medical-evacuation (medevac) and police helicopters to see these structures. In addition, to avoid pilot distractions during low-level flight this system is not recommended on structures within 3 NM (5.56 km) of an airport.

6.2 Standards

The medium intensity flashing white light system is normally composed of flashing omnidirectional lights. Medium intensity flashing white obstruction lights may be used during daytime and twilight with automatically selected, reduced intensity for nighttime operation. When this system is used on structures 700 feet (213.36 m) AGL or less, other methods of marking and lighting the structure may be omitted, however, structures exceeding 700 feet (213.36 m) AGL always require aviation orange and white marking for daytime. The number of light levels needed is shown in Figure A-9. This system is not normally recommended on structures 200 feet (60.96 m) AGL or less and use in urban and rural areas often results in complaints.

6.3 Control Device.

The light intensity is controlled by a device (photocell) that changes the light's intensity when the ambient light changes. The illuminance sensing device should, if practical, face the northern sky in the Northern Hemisphere and the system should automatically change intensity steps when the illuminance reaching a north-facing vertical surface is as follows:

1. Twilight-to-Night.

   This should not occur before the illumination drops below 5 foot-candles (53.82 lux) but should occur before it drops below 2 foot-candles (21.53 lux).

2. Night-to-Day.

   The intensity changes listed in subparagraph 6.3.1 above should be reversed when changing from the night-to-day mode.

6.4 Radio and Television Towers and Similar Skeletal Structures.

6.4.1 Mounting Lights.

The number of levels recommended depends on the height of the structure, including antennas and similar appurtenances.

6.4.1.1 Top levels.

One or more lights should be installed at the highest point to provide 360-degree coverage, ensuring an unobstructed view by a pilot approaching from any direction.

6.4.1.2 Appurtenances 40 feet (12.19 m) or less.

If a rod, antenna, or other appurtenance 40 feet (12.19 m) or less in height is incapable of supporting the medium intensity flashing white light, then it may be placed at the base of the appurtenance. If the mounting location does not allow an unobstructed view of the medium intensity flashing white light by a pilot approaching from any direction, then additional lights should be added.

6.4.1.3 Appurtenances exceeding 40 feet (12.19 m).

If a rod, antenna, or other appurtenance exceeds 40 feet (12.19 m) above the tip of the main structure, a medium intensity flashing white light should be placed within 40 feet (12.19 m) from the top of the appurtenance. If the appurtenance (such as a whip antenna) is incapable of supporting the light, one or more lights should be mounted on a pole adjacent to the appurtenance. Adjacent installations should not exceed the height of the appurtenance and be within 40 feet (12.19 m) of the tip to allow the pilot an unobstructed view of at least one light. If the rod, antenna, or other appurtenance is 7/8 of an inch wide or more, at least two lights should be installed on the supporting mast to provide the necessary unobstructed view.

6.4.2 Mounting Intermediate Levels.

At intermediate levels, two or more lights (L-865) should be mounted outside at diagonally or diametrically opposite positions of intermediate levels. The lowest light level should not be less than 200 feet (60.96 m) AGL.

6.4.3 Lowest Levels.

The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by the FAA, the lowest level of lights may be eliminated.

6.4.4 Structures 700 feet (213.36 m) AGL or less.

When medium-intensity flashing white lights are used during nighttime and twilight only, marking is required for daytime. When operated 24 hours a day, other methods of marking and lighting are not required.

6.4.5 Structures exceeding 700 feet (213.36 m) AGL.

Medium intensity lights should be used during nighttime, twilight, and may be used 24 hours a day. Additionally, marking is always required for daytime. The number of light levels needed is the same as high intensity lights as shown in Figures A-13 and A-14.

6.4.6 Ice Shields.

Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulation from damaging the light units. The light should be mounted in a manner to ensure an unobstructed view of at least one light by a pilot approaching from any direction.

6.5 Chimneys, Flare Stacks, and Similar Solid Structures.

The recommended number of top-level light units depends on the diameter of the structure at the highest point of a structure. The lights should be installed at the highest point, however, top level chimney lights may be installed as low as 20 feet (6.10 m) below the top to minimize deposit build-up due to emissions (see Figure A-10). The number of lights per level below is the minimum recommended.

1. Structures 20 feet (6.10 m) or less in diameter. Three light units per level.
2. Structures exceeding 20 feet (6.10 m) but not more than 100 feet (31 m) in diameter. Four light units per level.

6.6 Prominent Buildings and Similar Extensive Obstructions.

With the exception of wind turbines, when objects within a group of obstructions are approximately the same overall height above the surface and are located a maximum of 150 feet (45.72 m) apart, the group of obstructions may be considered an extensive obstruction. Light units should be installed on the same horizontal plane at the highest portion, or edge, of the prominent obstructions. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. Lights should be displayed to indicate the extent of the obstruction as follows:

6.6.1 Structures 150 feet (45.72 m) or less in any horizontal direction.

If the structure/extensive obstruction is 150 feet (45.72 m) or less horizontally, at least one light should be displayed on the highest point at each end of the obstruction’s major axis. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

6.6.2 Structures exceeding 150 feet (45.72 m) in at least one horizontal direction.

If the structure/extensive obstruction exceeds 150 feet (45.72 m) horizontally, at least one light should be displayed for each 150 feet (45.72 m), or fraction thereof, of the overall length of the major axis. At least one of these lights should be displayed on the highest point at each end of the obstruction. Additional lights should be displayed at approximately equal intervals not to exceed 150 feet (45.72 m) on the highest points along the edge between the end lights. If an obstruction is located near a landing area and two or more edges are the same height, the edge nearest the landing area should be lighted.

6.6.3 Structures exceeding 150 feet (45.72 m) AGL.

Lights should be installed on the highest point at each end. At intermediate levels, lights should be displayed for each 150 feet (45.72 m), or fraction thereof. The vertical position of these lights should be equidistant between the top lights and the ground level as the shape and type of obstruction will permit. One such light should be displayed at each outside corner on each level with the remaining lights evenly spaced between the corner lights.

6.7 Group of Obstructions.

With the exception of wind turbines, when individual structures within a group of obstructions differ in height and are spaced no more than 150 feet (45.72 m) apart, the prominent structures within the group should be lighted in accordance with the standards for individual obstructions based on its corresponding height. Shorter structures within the group of obstructions do not need to be lighted. When structures are shorter than the prominent structure and located on the outside of the group of obstructions, those structures should be lighted in accordance with the standards for individual obstructions based on its corresponding height. In addition to lighting the shorter structures on the outside of the group, at least one flashing light should be installed either at the top of the tallest, most prominent center structure, or on a dedicated tower that is located near the center of the group and is the same height as the most prominent structure. Light units should be placed on the structures to ensure that the lights are visible to a pilot approaching from any direction. If one or more of the structures within the group are a solid mass (non-skeletal), additional lighting may be necessary to make sure that the light is not being blocked by the more prominent structure(s). For the purpose of marking and lighting these structures, a group of obstructions is considered to be three or more structures.

6.8 Special Cases.

When lighting systems are installed on structures located near highways, waterways, airport approach areas, etc., caution should be exercised to ensure that the lights do not distract or otherwise cause a hazard to motorists, vessel operators, or pilots on an approach to an airport. In these cases, shielding may be necessary and should not derogate the lighting system’s intended purpose.

CHAPTER 7. HIGH INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

7.1 Purpose.

High-intensity (L-856) flashing white obstruction lights provide the highest degree of conspicuity both day and night. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

Use extreme caution when using high intensity flashing white lights. Using a 24-hour, high intensity flashing white light system within 3 NM (5.56 km) of an airfield or in urban/populated areas is not normally recommended due to their tendency to merge with background lighting in these areas at night. This makes it extremely difficult for some types of aviation operations (i.e., medevac) and police helicopters to see these structures. Additionally, this type of system in urban and rural areas often results in complaints.

7.2 Standards.

High intensity flashing white obstruction lights should be used during daytime with automatically selected, reduced intensities for twilight and nighttime operations. When high-intensity white obstruction lights are operated 24 hours a day, other methods of marking and lighting may be omitted. This system should not be on structures 700 feet (213.36 m) AGL or less unless an FAA aeronautical study shows otherwise. The number of light levels needed is shown in Figures A-13 and A-14.

7.3 Control Device.

Light intensity is controlled by a device (photocell) that changes the light's intensity when the ambient light changes. The illuminance sensing device should, if practical, face the northern sky in the Northern Hemisphere and the system should automatically change intensity steps when the illuminance reaching a north-facing vertical surface is as follows:

1. Day-to-twilight.

   This should not occur before the illumination drops to 60 foot-candles (645.83 lux) but should occur before it drops below 35 foot-candles (376.74 lux).

2. Twilight-to-night.

   This should not occur before the illumination drops below 5 foot-candles (53.82 lux) but should occur before it drops below 2 foot-candles (21.53 lux).

3. Night-to-day. The intensity changes listed in subparagraphs 7.3.1 and 7.3.2 above should be reversed when changing from the night-to-day mode.

7.4 Units per Level.

One or more light units are needed to obtain the desired horizontal coverage. The number of light units recommended per level (except for the supporting structures of catenary wires and buildings) depends upon the average outside diameter of the specific structure and the horizontal beam width of the light fixture. Light units should be installed to ensure an unobstructed view of the system by a pilot approaching from any direction. The number of lights recommended below is the minimum.

1. Structures 20 feet (6.10 m) or less in diameter. Three light units per level.
2. Structures exceeding 20 feet (6.10 m) but not more than 100 feet (30.48 m) in diameter. Four light units per level.
3. Structures exceeding 100 feet (30.48 m) in diameter. Six light units per level.
4. Structures exceeding 200 feet (60.96 m) in diameter. Eight light units per level.

7.5 Installation Guidance.

On most obstruction high-intensity light fixtures, the effective peak intensity of the light beam can be adjusted from zero-to-eight degrees above the horizon. Standard installation should place the top light at zero degrees to the horizontal and all other light units installed in accordance with **Table 7-1**.

Table 7-1 Light Unit Elevation Above the Horizontal

Height of Light Unit Above Terrain	Degrees of Elevation Above
Exceeding 500 feet AGL	0°
Above 400 feet to 500 feet AGL	1°
Above 300 feet to 400 feet AGL	2°
300 feet AGL or less	3°

7.5.1 Vertical Aiming.

When terrain, nearby residential areas, or other situations dictate, the light beam may be further elevated above the horizontal. The main beam of light at the lowest level should not strike the ground closer than 3 SM (4.83 kilometers (k)) from the structure. If additional adjustments are necessary, the lights may be individually adjusted upward, in

one-degree increments, starting at the bottom. Excessive elevation may reduce conspicuity by raising the beam above a collision course flight path.

7.5.2 Relocation or Omission of Light Units.

Light units should not be installed in such a manner that the light pattern/output is disrupted by the structure.

7.5.2.1 Lowest Level.

The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by the FAA, the lowest level of lights may be eliminated.

7.5.2.2 Two Adjacent Structures.

When two structures are within 500 feet (152.40 m) of each other and the light units are installed at the same levels, the sides of the structures facing each other do not need be lighted (see Figures A-11 and A-12). However, all lights on both structures must flash simultaneously, except for adjacent catenary support structures (see paragraph 11.4). Vertical placement of the lights should be adjusted to either or both structures' intermediate levels to place the lights on the same horizontal plane. If one structure is higher than the other, a complete level of lights should be installed on the higher structure that extends above the top of the lower structure. If the structures are of such heights that the levels of lights cannot be placed in identical horizontal planes, then the light units should be placed so that the center of the horizontal beam patterns do not face toward the adjacent structure. For example, structures situated north and south of each other should have the light units on both structures installed on a northwest/southeast and northeast/southwest orientation.

7.5.2.3 Three or More Adjacent Structures.

The treatment of a cluster of structures as an individual or a complex of structures will be determined by the FAA, taking into consideration the location, heights, and spacing of other structures.

7.6 Radio and Television Towers and Similar Skeletal Structures.

7.6.1 Mounting Lights.

The number of levels recommended depends on the height of the structure, excluding antennas and similar appurtenances. At least three lights should be installed on each level and mounted to ensure that the effective intensity of the full horizontal beam coverage is not impaired by the structural members.

7.6.2 Top Level.

One level of lights should be installed at the highest point of the structure. If the highest point is a rod or antenna incapable of supporting a lighting system, then the top level of lights should be installed at the highest portion of the main skeletal structure. If guy wires come together at the top, it may be necessary to install this level of lights as low as 10 feet (3.05 m) below the top. If the appurtenance (rod, antenna, etc.) exceeds 40 feet (12.19 m) above the main structure, a medium-intensity, flashing white light (L-865) should be mounted on the highest point (see Figure A-7). If the appurtenance (such as a whip antenna) is incapable of supporting a medium-intensity light, one or more lights should be installed on a pole adjacent to the appurtenance. The pole should not exceed the height of the appurtenance and no lower than 40 feet (12.19 m) from the top, allowing a pilot an unobstructed view of at least one light in any direction. If the pole, rod, antenna, or other appurtenance is 7/8 of an inch wide or more, at least two lights should be installed on the supporting mast to provide the necessary unobstructed view.

7.6.3 Ice Shields.

Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulation from damaging the light units. The light should be mounted in a manner to ensure an unobstructed view of at least one light by a pilot approaching from any direction.

7.7 Antenna or Similar Appurtenance Light.

When a structure lighted by a high-intensity, flashing white light system is topped with an antenna or similar appurtenance exceeding 40 feet (12.19 m) in height, a medium-intensity flashing white light (L-865) should be placed within 40 feet (12.19 m) from the tip of the appurtenance. This light should operate 24 hours a day and flash simultaneously with the rest of the lighting system. The location of the appurtenance light is shown in, Figure A-14. Structures with an appurtenance 40 feet (12.19 m) or less in height should be lit in accordance with Figure A-13.

7.8 Chimneys, Flare Stacks, and Similar Solid Structures.

The number of light levels depends on the height of the structure, excluding appurtenances. Three or more lights should be installed on each level to ensure an unobstructed view by the pilot. Normally, the top-level lights are on the highest point of a structure, however, top level chimney lights may be installed as low as 20 feet (6.10 m) below the top to minimize deposit buildup due to emissions.

7.9 Prominent Buildings and Similar Extensive Obstructions.

When objects within a group of obstructions are approximately the same overall height above the surface and are located a maximum of 150 feet (45.72 m) apart, the group of obstructions may be considered an extensive obstruction. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. These lights may require shielding, such as louvers, to ensure minimum adverse impact on local

communities. Light units should be installed on the same horizontal plane at the highest portion or edge of the prominent obstructions and displayed to indicate the extent of the obstruction as follows:

7.9.1 Obstructions 200 feet (60.96 m) or less in either horizontal dimension.

Three or more light units should be installed at the highest portion of the structure to ensure that at least one light is visible to a pilot approaching from any direction. Light units may be mounted on a single pedestal at or near the center of the obstruction. If the light units are placed more than 10 feet (3.05 m) from the center point of the structure, use a minimum of four light units.

7.9.2 Obstruction exceeds 200 feet (60.96 m) in one horizontal dimension but is 200 feet (60.96 m) or less in the other.

Two light units should be placed on each of the shorter sides. These light units may be installed either adjacent to each other at the midpoint of the obstruction's edge or at (near) each corner, with the light unit aimed to provide 180 degrees of coverage at each edge. One or more light units should be installed along the overall length of the major axis at approximate equal intervals, not to exceed a distance of 100 feet (30.48 m) from the corners or from each other.

7.9.3 Obstruction exceeds 200 feet (60.96 m) in both horizontal dimensions.

The light units should be equally spaced along the overall perimeter of the obstruction at intervals of 100 feet (30.48 m), or fraction thereof.

7.10 Hyperbolic Cooling Towers.

High intensity light units should be installed to ensure an unobstructed view of at least two lights by a pilot approaching from any direction.

7.10.1 Number of light units.

The number of units recommended depends on the diameter of the structure at the top, as shown in Figure A-15. The minimum number of light units recommended is indicated below.

1. Structures exceeding 100 feet (30.48 m) but not more than 200 feet (60.96 m) diameter. Six light units per level.
2. Structures exceeding 200 feet (60.96 m) in diameter. Eight light units per level.

7.11 Special Cases.

When lighting systems are installed on structures located near highways, waterways, airport approach areas, etc., caution should be exercised to ensure that the lights do not distract or otherwise cause a hazard to motorists, vessel operators, or pilots on an approach to an airport. In these cases, shielding or adjusting the aim of the vertical or horizontal light may be necessary. This adjustment should not derogate the lighting

system’s intended purpose. Such adjustments may require an additional review, as described in paragraph 7.5.

CHAPTER 8. DUAL LIGHTING WITH RED/MEDIUM INTENSITY FLASHING WHITE LIGHT SYSTEMS

8.1 Purpose.

This dual lighting system includes red lights (L-864) for nighttime and medium-intensity flashing white lights (L-865) for daytime and twilight use. This lighting system may be used in lieu of operating a medium intensity flashing white lighting system at night. There may be some populated areas where nighttime use of medium-intensity light systems may cause significant environmental concerns. Using the dual lighting system should reduce/mitigate those concerns and complaints. Recommendations for lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

8.2 Installation.

The light units should be installed as specified in Chapters 4, 5, and 6 of this advisory circular. The number of light levels needed is dependent on the height of the obstruction, as shown in Figure, A-16.

8.3 Operation.

Light systems should be operated as specified in Chapters 4, 5, and 6. These systems should not be operated simultaneously; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of the uppermost red light should activate the white obstruction light system and operate in its specified “night” step intensity.

8.4 Control Device.

The light system is controlled by a device (photocell) that changes the intensity of the lights when the ambient light changes. The illuminance sensing device should, if practical, face the northern sky in the Northern Hemisphere and the system should automatically change intensity steps when the illuminance reaching a north-facing vertical surface is as follows:

1. Twilight-to-Night.

   This should not occur before the illumination drops below 5 foot-candles (53.82 lux) but should occur before it drops below 2 foot-candles (21.53 lux).

2. Night-to-Day.

   The intensity changes listed in subparagraph 8.4.1 above should be reversed when changing from the night-to-day mode.

8.5 Antenna or Similar Appurtenance Light.

8.5.1 When a structure equipped with a dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12.19 m) in height, a medium-intensity flashing white (L-865) and a flashing red light (L-864) should be placed within 40 feet (12.19 m) from the tip of the appurtenance. The white light should operate during daytime and twilight and the red light during nighttime. These lights should flash simultaneously with the rest of the lighting system.

8.5.2 When a structure equipped with a dual lighting system is topped with an antenna or similar appurtenance less than 40 feet (12.19 m) in height and exceeds 7/8 of an inch, a minimum of two medium-intensity flashing white (L-865) and flashing red lights (L-864) should be placed immediately below, within 40 feet (12.19 m) from the tip of the appurtenance (see Figure A-17). The white light should operate during daytime and twilight and the red light between the hours of sunset and sunrise. These lights should flash simultaneously with the rest of the lighting system.

8.6 Mounting Lights

The number of levels recommended depends on the height of the structure, including antennas and similar appurtenances.

8.6.1 Top levels.

One or more lights should be installed at the highest point to provide 360-degree coverage, ensuring an unobstructed view by a pilot approaching from any direction.

8.6.2 Appurtenances 40 feet (12.19 m) or less.

When a structure equipped with a dual lighting system is topped with an antenna or similar appurtenance less than 40 feet (12.19 m) in height and exceeds 7/8 of an inch, a minimum of two medium-intensity flashing white (L-865) and flashing red lights (L-864) should be placed immediately below, within 40 feet (12.19 m) from the tip of the appurtenance (see Figure A-17). The white lights should operate during daytime and twilight and the red light between the hours of sunset and sunrise. These lights should flash simultaneously with the rest of the lighting system. If a rod, antenna, or other appurtenance 40 feet (12.19 m) or less in height is incapable of supporting the dual lighting system, then it may be placed at the base of the appurtenance. If the mounting location does not allow an unobstructed view by a pilot approaching from any direction, then additional lights should be added.

8.6.3 When a structure equipped with a dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12.19 m) in height, a medium-intensity flashing white (L-865) and a flashing red light (L-864) should be placed within 40 feet (12.19 m) from the tip of the appurtenance. The white light should operate during daytime and twilight and the red light during nighttime. These lights should flash simultaneously with the rest of the lighting system. If the appurtenance (such as a whip antenna) is incapable of supporting the light, one or more lights should be mounted on a pole adjacent to the appurtenance. Adjacent installations should not exceed the height of the

appurtenance and be within 40 feet (12.19 m) of the tip to allow the pilot an unobstructed view of at least one light. If the rod, antenna, or other appurtenance is 7/8 of an inch wide or more, at least two lights should be installed on the supporting mast to provide the necessary unobstructed view.

8.6.4 Mounting Intermediate Levels.

At intermediate levels, two or more lights (L-864/L-865) should be mounted outside at diagonally or diametrically opposite positions of intermediate levels. The lowest light level should not be less than 200 feet (60.96 m) AGL.

8.6.5 Lowest Levels.

The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by the FAA, the lowest level of lights may be eliminated.

8.7 Omission of Marking

When medium intensity white obstruction lights are operated on structures 700 feet (213.36 m) AGL or less during daytime and twilight, other methods of marking may be omitted.

CHAPTER 9. DUAL LIGHTING WITH RED/HIGH-INTENSITY FLASHING WHITE LIGHT SYSTEMS

9.1 Purpose

This dual lighting system includes red lights (L-864) for nighttime and high intensity flashing white lights (L-856) for daytime and twilight use. This lighting system may be used in lieu of operating a flashing high intensity white lighting system at night. There may be some populated areas where nighttime use of high-intensity lights may cause significant environmental concerns and complaints. Using the dual lighting system should reduce/mitigate those concerns. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

9.2 Installation

The light units should be installed as specified in Chapters 4, 5, and 7 of this advisory circular. The number of light levels needed is dependent on the height of the structure as shown in Figures A-18 and A-19.

9.3 Operation

Lighting systems should be operated as specified in Chapters 4, 5, and 7. These systems should not be operated simultaneously; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of the uppermost red light should activate the white obstruction lighting system and operate in its specified "night" step intensity.

9.4 Control Device

The light intensity is controlled by a device (photocell) that changes the light intensity when the ambient light changes. The illuminance sensing device should, if practical, face the northern sky in the Northern Hemisphere and the system should automatically change intensity steps when the illuminance reaching a north-facing vertical surface is as follows:

1. Day-to-Twilight.

   This should not occur before the illumination drops to 60 foot-candles (645.83 lux) but should occur before it drops below 35 foot-candles (376.74 lux).

2. Twilight-to-Night.

   This should not occur before the illumination drops below 5 foot-candles (53.82 lux) but should occur before it drops below 2 foot-candles (21.53 lux).

3. Night-to-Day.

   The intensity changes listed in subparagraph 9.4.1 and 9.4.2 above should be reversed when changing from the night to day mode.

9.5 Antenna or Similar Appurtenance Light

When a structure using this dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12.19 m) in height, a medium-intensity flashing white light (L- 865) and a red flashing light (L-864) should be placed within 40 feet (12.19 m) from the tip of the appurtenance (see Figure A-18). The white light should operate during daytime and twilight and the red light during nighttime. Structures with an appurtenance 40 feet (12.19 m) or less in height should be lit in accordance with see Figure A-19.

9.6 Omission of Marking

When high-intensity white obstruction lights are operated during daytime and twilight, other methods of marking may be omitted.

CHAPTER 10. AIRCRAFT DETECTION LIGHTING SYSTEMS

10.1 Purpose

Aircraft Detection Lighting Systems (ADLS) are sensor-based systems designed to detect aircraft as they approach an obstruction or group of obstructions; they automatically activate the appropriate obstruction lights until they are no longer needed by the aircraft. This technology reduces the impact of nighttime lighting on nearby communities and migratory birds and extends the life expectancy of the obstruction lights.

10.2 General Standards

10.2.1 The system should be designed with sufficient sensors to provide complete detection coverage for aircraft that enter a three-dimensional volume of airspace or coverage area around the obstruction(s) (Figure A-20), as follows:

1. Horizontal detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the perimeter of the volume, which is a minimum of 3 NM (5.56 km) away from the obstruction or the perimeter of a group of obstructions. In some situations, such as when the 3 NM (5.56 km) perimeter is not achievable, lighting uncontrolled by the ADLS may be required.
2. Vertical detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the volume, which extends from 200 feet above the ground up to 1,000 feet (304.80 m) above the highest part of the obstruction or group of obstructions, for all areas within the 3 NM (5.56 km) perimeter defined in subparagraph 10.2.1.1 above.
3. In some circumstances, it may not be possible to meet the volume area defined above because the terrain may mask the detection signal from acquiring an aircraft target within the 3 NM (5.56 km) perimeter. In these cases, the sponsor should identify these areas in their application to the FAA for further evaluation.
4. In some situations, lighting not controlled by the ADLS may be required when the 3 NM (5.56 km) perimeter is not achievable to ensure pilots have sufficient warning before approaching the obstructions.

10.2.2 The ADLS should activate the obstruction lighting system in sufficient time to allow the lights to illuminate and synchronize to flash simultaneously prior to an aircraft penetrating the volume defined above. The lights should remain on for a specific time period, as follows:

For ADLSs capable of continuously monitoring aircraft while they are within the 3 NM/1,000-foot (5.56 km/304.80 m) volume, the obstruction lights should stay on until the aircraft exits the volume. In the event detection of the aircraft is lost while being continuously monitored within the 3 NM/1,000-foot (5.56 km/304.80 m) volume, the ADLS should initiate a 30-minute timer to keep the obstruction lights on until the timer

expires. This should provide the untracked aircraft sufficient time to exit the area and give the ADLS time to reset.

1. For ADLSs without the capability of monitoring aircraft targets in the 3 NM/1,000-foot (5.56 km/304.80 m) volume, the obstruction lights should stay on for a preset amount of time, calculated as follows:
2. A single obstacle: seven minutes.
3. A group of multiple obstacles: (the widest dimension of the group in nautical miles + 6) x 90 seconds, equals the number of seconds the light(s) should remain on.

10.2.3 Approval of an ADLS will be on a case-by-case basis and may be modified, adjusted, or denied based on proximity of the obstruction or group of obstructions to airports, low-altitude flight routes, military training areas, or other areas of frequent flight activity. It may be appropriate to keep certain obstructions closest to these known activity areas illuminated continuously during the nighttime hours, while the remainder of the group's obstruction lighting is controlled by the ADLS.

10.2.4 Project sponsors requesting the use of ADLS should indicate the location of the proposed sensors, range of each sensor, and a visual indication showing how each sensor's detection arc provides the full horizontal and vertical coverage, as required under paragraph 10.2.1 on their application maps or diagrams. In the event that detection coverage is not 100 percent due to terrain masking, project sponsors should provide multiple maps or diagrams that indicate coverage at the affected altitudes. A sample diagram is shown in Figure A-20.

10.2.5 Types of ADLS component or system failure events.

1. In the event of an ADLS component or system failure, the ADLS should automatically turn on all the obstruction lighting and operate in accordance with this AC as if it was not controlled by an ADLS. The obstruction lighting should remain in this state until the ADLS and its components are fully restored.
2. In the event that an ADLS component failure occurs and an individual obstruction light cannot be controlled by the ADLS, but the rest of the ADLS is functional, that particular obstruction light should automatically turn on and operate in accordance with this AC as if it was not controlled by an ADLS, and the remaining obstruction lights can continue to be controlled by the ADLS. The obstruction lighting should remain in this state until the ADLS and its components are restored.
3. Complete light failure should be addressed in accordance with Chapter 2, paragraph 2.4.

10.2.6 The ADLS's communication and operational status should be checked at least once every 24 hours to ensure both systems are operational.

10.2.7 The ADLS should be able to detect an aircraft with a cross-sectional area of one square meter or more within the volume, as required in subparagraphs 10.2.1.1. and 10.2.1.2.

10.2.8 Each ADLS installation should maintain a log of activity data for a period of no less than the previous 15 days. This data should include, but not be limited to, the date, time, duration of all system activations/deactivations, track of aircraft activity, maintenance issues, system errors, communication and operational issues, lighting outages/issues, etc.

10.2.9 Operational frequencies.

10.2.9.1 Unlicensed devices (including FCC Part 15) cannot be used for this type of system.

10.2.9.2 Any frequency used for the operation of ADLS must be individually licensed through the FCC

CHAPTER 11. MARKING AND LIGHTING OF CATENARY AND CATENARY SUPPORT STRUCTURES

11.1 Purpose

This chapter provides guidelines for marking and lighting catenary and catenary support structures. For the purpose of marking and lighting, catenary is defined as suspended wires (or lines) kept at a defined mechanical tension by supporting structures. These wires may be either energized or non-energized and are used for transmission, distribution, or other purposes, as defined. The recommended marking and lighting of both the structures and wires provides day and night conspicuity and assists pilots in identifying and avoiding catenary wires and associated support structures. Catenary lines that are suspended across open areas such as rivers, canyons, and lakes create a unique hazard to pilots. The term "violation area" is used to describe these open areas within the catenary span that an aircraft would most likely encounter the wires.

11.2 Lighted Spherical Markers

11.2.1 Lighted markers are available for increased night conspicuity of high-voltage (69 kV or greater) transmission line catenary wires. These markers should be used on transmission line catenary wires near airports, heliports, across rivers, canyons, lakes, etc. The lighted markers should be manufacturer-certified as recognizable from a minimum distance of 4,000 feet (1,219.20 m) under nighttime conditions, minimum Visual Flight Rules (VFR) conditions, or having a minimum intensity of at least 32.5 candelas. The lighting unit should emit a steady-burning, red light.

11.2.2 Lighted markers should be installed on the highest energized line. If the lighted markers are installed on a line other than the highest catenary, then unlighted markers specified in paragraph 11.3.2, should be used in addition to the lighted markers. The maximum distance between the line energizing the lighted markers and the highest catenary above the lighted marker should be no more than 25 feet (7.62 m) and must not violate the sag requirements of the transmission line design (see Figures A-21 through A-24).

Lighted markers should be distinctively shaped, (i.e., spherical or cylindrical) so they are not mistaken for items that are used to convey other information. They should be visible in all directions from which aircraft are likely to approach. The area in the immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's lights (see Figure A-21). When a catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide full coverage from which aircraft are likely to approach.

11.3 Catenary Marking Standards

Catenary wires should be marked with lighted or unlighted marker balls to make the wires more visible to pilots approaching the hazard from any direction. High-voltage (69 kilovolts (kV) or greater) transmission lines are typically mounted on large catenary

support structures and should be fitted with lighted markers to provide sufficient conspicuity in both day and nighttime conditions. Transmission lines that are less than 69 kV are typically mounted on smaller catenary support structures and should be fitted with unlighted markers that provide daytime conspicuity.

11.3.1 Lighted Catenary Markers.

Lighted markers provide increased nighttime conspicuity of high-voltage (69 kV or greater) transmission line catenary wires. However, since lighted markers require a minimum line load to operate, it should be noted that the lights may not be operational under certain transmission system conditions, such as power outages or line maintenance. Whenever possible, these lighted markers should be used on transmission line catenary wires near airports, heliports, across rivers, canyons, lakes, areas of known risk to aviation, etc.

The lighted markers should be manufacturer-certified as, visible and recognizable from a minimum distance of 4,000 feet (1,219.20 m) under nighttime conditions and under minimum VFR conditions, and have a minimum intensity of at least 32.5 candelas. Markers should be distinctively shaped, i.e., spherical or cylindrical, so that they are not mistaken for items used to convey other information. The lighting unit should emit a steady-burning red light and be mounted on the highest energized line, visible to a pilot approaching from any direction. If the lighted markers are installed on a line other than the highest catenary wire, then unlighted markers should be used in addition to the lighted markers (see Figure A-24).

11.3.1.1 Size and Color.

The diameter of the markers (lighted and unlighted) used on extensive catenary wires that cross canyons, lakes, rivers, etc., should not be less than 36 inches (91.44 centimeters (cm)). The 20-inch (50.80 cm) markers, or smaller 12-inch (30.48 cm) markers, are permitted on less extensive catenary wires or on power lines below 50 feet (15.24 m) above the ground and within 1,500 feet (457.20 m) of an airport runway end. Each lighted marker should be a solid color, specifically aviation orange, white, or yellow. Transmission lines that are configured in a “double-bundled” arrangement would typically require the larger 36-inch (91.44 cm) markers, however the next smaller size marker may be used to prevent the marker from rubbing against the parallel transmission line.

Note: For the purposes of this advisory circular, the term “extensive” is used to describe catenary wire crossings that extend across an open area that an aircraft could be reasonably expected to fly at or below the altitude that the catenary wires are suspended. “Less extensive” is used to describe catenary wire crossings that extend across an open area that an aircraft could reasonably be expected to fly at or above the same altitude.

11.3.1.2 Installation.

11.3.1.2.1 Spacing. Lighted markers should be spaced equally along the wire at intervals of approximately 200 feet (60.96 m), or a fraction thereof.

Intervals between markers should be less in critical areas near runway ends, i.e., 30 feet to 50 feet (9.14 m to 15.24 m). If the lighted markers are installed on a line other than the highest catenary wire, then unlighted markers specified in paragraph 11.3.2, should be used in addition to the lighted markers. The lighted markers may be installed alternately along each wire if the distance between adjacent markers meets the 200-foot (60.96m) spacing standard. This method allows the weight and wind loading factors to be distributed.

11.3.1.2.2 Pattern. An alternating color scheme provides the most conspicuity against all backgrounds. Lighted and unlighted markers should be installed by alternating solid-colored markers of aviation orange, white, and yellow. Normally, an orange marker is placed at each end of a line and the spacing is adjusted (not to exceed 200 feet (60.96 m)) to accommodate the rest of the markers (see Figure A-24). When less than four markers are used, they should all be aviation orange.

11.3.1.2.3 Wire Sag. Wire sag or droop will occur due to temperature, wire weight, wind, etc. The maximum sag distance between the line energizing the lighted markers and the highest catenary wire above the lighted markers should be no more than 25 feet (7.62 m), and it should not violate the sag requirements of the transmission line design.

11.3.1.2.4 Adjacent Lines. Catenary crossings with multiple transmission lines require appropriate markers when the adjacent catenary structure's outside lines are greater than 200 feet (60.96 m) away from the center of the primary structure (see Figure A-23). If the outside lines of the adjacent catenary structure are within 200 feet (60.96 m) or less from the center of the primary structure, markers are not required on the adjacent lines (see Figure A-22). If the catenary crossing is within close proximity to an airport, specifically within 1,500 feet (458 m) of an airport runway end, then all catenary lines should be marked, regardless of their proximity to each other.

11.3.2 Unlighted Catenary Markers.

Unlighted markers provide increased daytime conspicuity of non-high-voltage (less than 69 kV) transmission line catenary wires (see Figure A-21). These unlighted markers should be used on transmission line catenary wires near airports, heliports, across rivers, canyons, lakes, areas of known risk to aviation, etc. where lighted markers are not possible.

The unlighted markers should be manufacturer certified as recognizable from a minimum distance of 4,000 feet (1,219.20 m) under daytime, VFR conditions. Markers should be distinctively shaped, i.e., spherical or cylindrical, so that they are not mistaken for items used to convey other information. Unlighted markers should be mounted on the highest catenary line, visible to a pilot approaching from any direction.

11.3.2.1 Size and Color.

The diameter of the unlighted markers used on extensive catenary wires that cross canyons, lakes, rivers, etc., should not be less than 36 inches (91.44 cm). The 20-inch (50.80-cm) markers, or smaller 12-inch (30.48-cm) markers are permitted on less extensive catenary wires or on power lines below 50 feet (15.24 m) above the ground and within 1,500 feet (457.20 m) of an airport runway end. Each unlighted marker should be a solid color, specifically aviation orange, white, or yellow. For transmission lines that are configured in a "double-bundled" arrangement and would typically require the larger 36-inch markers, the next smaller size marker may be used to prevent the marker from rubbing against the parallel transmission line.

Note: For the purposes of this advisory circular, the term "extensive" is used to describe catenary wire crossings that extend across an open area that an aircraft could be reasonably expected to fly at or below the altitude that the catenary wires are suspended. "Less extensive" is used to describe catenary wire crossings that extend across an open area that an aircraft could be reasonable expected to fly at or above the same altitude.

11.3.2.2 Installation.

11.3.2.2.1 Spacing.

Unlighted markers should be spaced equally along the wire at intervals of approximately 200 feet (60.96 m), or a fraction thereof. Intervals between markers should be less in critical areas near runway ends, i.e., 30 feet to 50 feet (9.14 m to 15.24 m). The unlighted markers may be installed alternately along each wire if the distance between adjacent markers meets the 200-foot (60.96 m) spacing standard. This method allows the weight and wind loading factors to be distributed (see Figures A-21 and A-22).

11.3.2.2.2 Pattern.

An alternating color scheme provides the most conspicuity against all backgrounds. Unlighted markers should be installed by alternating solid-colored markers of aviation orange, white, and yellow. Normally, an orange marker is placed at each end of a line and the spacing is adjusted (not to exceed 200 feet (60.96 m)) to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange.

11.3.2.2.3 Wire Sag.

Wire sag or droop will occur due to temperature, wire weight, wind, etc. The maximum sag distance between the line holding the unlighted markers and the next lowest catenary wire should be no more than 25 feet (7.62 m), and it should not violate the sag requirements of the transmission line design.

11.3.2.2.4 Adjacent Lines.

Catenary crossings with multiple transmission lines require appropriate markers when the adjacent catenary structure's outside lines are greater than 200 feet (60.96 m) away from the center of the primary catenary structure (see Figure A-25). If the outside lines of the adjacent catenary structure are within 200 feet (60.96 m) or less from the center of the primary catenary structure, markers are not required on the adjacent line.

11.4 Catenary Lighting Standards

When using medium intensity flashing white (L-866), high intensity flashing white (L-857), dual medium-intensity (L-866/L-885), or dual high-intensity (L-857/L-885) lighting systems operated 24 hours a day, other marking of the support structure is not necessary.

11.4.1 Levels.

A system of three levels of sequentially flashing light units should be installed on each supporting structure or adjacent terrain. One level should be installed at the top of the structure, one at the height of the lowest point in the catenary wire, and one level approximately midway between the other two light levels. In general, the middle level should be at least 50 feet (15.24 m) from the other two levels. The middle light unit may be omitted when the distance between the top and the bottom light levels is less than 100 feet (30.48 m).

11.4.1.1 Top Levels.

One or more lights should be installed at the top of the structure to provide 360-degree coverage, ensuring an unobstructed view. If the installation presents a potential danger to maintenance personnel or inhibits lightning protection, the top level of lights may be mounted as low as 20 feet (6.10 m) below the highest point of the structure.

11.4.1.2 Horizontal Coverage.

The light units at the middle and bottom levels should be installed to provide a minimum of 180-degree coverage, centered perpendicularly to the flyway. When a catenary crossing is situated near a bend in a river, canyon, etc., or is not perpendicular to the flyway, the horizontal beam should be directed to provide the most effective light coverage to warn pilots approaching from either direction of the catenary wires.

11.4.1.3 Variation.

The vertical and horizontal arrangements of the lights may be subject to the structural limits of the towers and/or adjacent terrain. A tolerance of 20 percent from uniform spacing of the bottom and middle light is allowed. If the base of the supporting structure(s) is higher than the lowest point in the catenary, such as a canyon crossing, one or more lights should be installed on the adjacent terrain at the level of the lowest point in the span. These

lights should be installed on the structure or terrain at the height of the lowest point in the catenary (see Figure A-25).

11.4.2 Flash Sequence and Duration.

The flash sequence for catenary wire support structures should be middle, top, and bottom with all lights on the same level flashing simultaneously. This pattern of flashes is designed to present a unique signal that pilots should interpret as a warning that catenary wires are in the vicinity of the lights. The time intervals for the sequence and duration of the flash pattern are outlined in FAA AC 150/5345-43, Specification for Obstruction Lighting Equipment. If Light-Emitting Diode (LED) obstruction light fixtures are used to light catenary wires, a slower flash rate of 40 fpm is allowed to enable each light fixture to make a well-defined flash so that the middle-top-bottom flash pattern will be easily recognized. Field experience has shown that LED fixtures flashing at 60 fpm, as specified in AC 150/5345-43, do not have enough time to turn off in between flash cycles, and appear as if they are steady-burning. Slowing the flash rate to 40 fpm promotes a cleaner, crisper presentation for the pilot to recognize. In the event there are only two levels of lights, the lights should simply alternate at the same flash rate/duration as if there were three lights.

11.4.3 Synchronization.

Although not required, it is preferred that the corresponding light levels on associated supporting towers of a catenary crossing flash simultaneously.

11.4.4 Structures 700 feet (213.36 m) AGL or less.

When medium intensity white lights (L-866) are operated 24 hours a day or when a dual red/medium-intensity light system (L-866 daytime and twilight/L-885 nighttime) is used, marking can be omitted. When using a medium intensity white light (L-866) or a flashing red light (L-885) during twilight or nighttime only, marking should be used for daytime marking.

11.4.5 Structures exceeding 700 feet (213.36 m) AGL.

When high-intensity white lights (L-857) are operated 24 hours a day or when a dual red/high-intensity system (L-857 daytime and twilight/L-885 nighttime) is used, marking can be omitted. This system should not be used on structures 700 feet (213.36 m) or less unless an FAA aeronautical study determines otherwise. When a flashing red obstruction light (L-885), a medium intensity (L-866) flashing white lighting system, or a high intensity white lighting system (L-857) is used for nighttime and twilight only, marking should be used for daytime.

11.5 Control Device

The light intensity is controlled by a device (photocell) that changes the intensity when the ambient light changes. The illuminance sensing device should, if practical, face the northern sky in the Northern Hemisphere and the lighting system should automatically change intensity steps when the northern sky illuminance reaching a north-facing vertical surface is as follows:

1. Day-to-Twilight (L-857 System).

   This should not occur before the illumination drops to 60 foot-candles (645.83 lux) but should occur before it drops below 35 foot-candles (376.74 lux).

2. Twilight-to-Night (L-857 System).

   This should not occur before the illumination drops below 5 foot-candles (53.82 lux) but should occur before it drops below 2 foot-candles (21.53 lux).

3. Night-to-Day.

   The intensity changes listed in subparagraph 11.4.1 and 11.4.2 above should be reversed when changing from the night-to-day mode.

4. Day-to-Night (L-866 or L-885/L-866).

   This should not occur before the illumination drops below 5 foot-candles (563.82 lux) but should occur before it drops below 2 foot-candles (21.53 lux).

5. Night-to-Day.

   The intensity changes listed in subparagraph 11.5.4 above should be reversed when changing from the night-to-day mode.

6. Red Obstruction (L-885).

   The red lights should not turn on until the illumination drops below 60 foot-candles (645.83 lux) but should occur before reaching a level of 35 foot-candles (367.74 lux). Lights should not turn off before the illumination rises above 35 foot-candles (367.76 lux) but should occur before reaching 60 foot-candles (645.83 lux).

11.6 Area Surrounding Catenary Wire Support Structures

The area in the immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's lights.

11.7 Three or More Catenary Wire Support Structures

Where a catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide full 360-degree coverage across rivers, canyons, lakes, areas of known risk to aviation, etc.

CHAPTER 12. MARKING AND LIGHTING MOORED BALLOONS AND KITES

12.1 Purpose

The purpose of marking and lighting moored balloons, kites, and their cables or mooring lines is to indicate the presence and general definition of these objects to pilots when approaching from any direction.

12.2 Standards

These marking and lighting standards pertain to all moored balloons and kites that require marking and lighting under 14 CFR, Part 101.

12.3 Marking

Flag markers must be used on mooring lines to warn pilots of their presence during daylight hours.

12.3.1 Display. Markers must be displayed at no more than 50-foot (15.24 m) intervals and must be visible for at least 1 SM (1.61 km).

12.3.2 Shape. Markers should be rectangular in shape and not less than 2 feet (0.61 m) in length. Stiffeners should be used in the borders to expose a large area and to prevent drooping in calm wind or wrapping around the cable.

12.3.3 Color Patterns. One of the following color patterns should be used:

1. Solid Color. Aviation orange.
2. Orange and White. Two triangular sections, one of aviation orange and the other white, combined to form a rectangle.

12.4 Purpose

Flashing obstruction lights must be used on moored balloons or kites and their mooring lines to warn pilots of their presence during the hours between sunset and sunrise and during periods of reduced visibility. These lights may be operated 24 hours a day.

12.4.1 Systems.

Flashing red (L-864) or medium intensity white lights (L-865) may be used to light moored balloons or kites. High-intensity lights (L-856) are not recommended.

12.4.2 Display.

Simultaneously flashing lights should be displayed on the top, nose, and tail sections, as well as the tether cable approximately 15 feet (4.57 m) below the craft to define the extremes of size and shape. Additional lights should be equally spaced along the cable's overall length for each 350 feet (106.68 m), or fraction thereof.

12.4.3 Exceptions.

When the requirements of this paragraph cannot be met, floodlights may be used.

12.5 Operational Characteristics

The light intensity is controlled by a device (photocell) that changes the intensity when the ambient light changes. The system should automatically turn the lights on and change intensities as ambient light conditions change. The reverse order should apply in changing from nighttime-to-daytime operation.

CHAPTER 13. MARKING AND LIGHTING WIND TURBINES

13.1 Purpose

This chapter provides guidelines for the marking and lighting applicable to single wind turbines and wind turbine farms. For the purpose of this AC, wind turbine farms are defined as a wind turbine development that contains more than three turbines. The recommended marking and lighting of these structures is intended to provide day and night conspicuity and to assist pilots in identifying and avoiding these obstacles.

13.2 General Standards

The development of wind turbine farms is a very dynamic process, which changes based on the terrain. Each wind turbine farm is unique; therefore, it is important that a lighting plan is developed that provides sufficient safety for air traffic. When developing lighting plans for wind turbine farms, it is best to use an aerial-view map or diagram of the turbine farm to plan the location of the required lighting. This way, a certain degree of strategy planning can be applied, which in many instances results in a minimal number of lights. Proximity to airports and VFR routes, extreme terrain where heights may vary widely, and local flight activity should be considered when developing a lighting plan. The following guidelines are recommended for wind turbines.

13.3 Wind Turbine Configurations

Prior to marking and lighting the wind turbine farm, the configuration and the terrain of the wind turbine farm should be determined. The following is a description of the most common configurations (see Figure A-26):

1. Linear.

   Wind turbine farms in a direct, consecutive configuration, often located along a ridgeline, the face of a mountain, or along borders of a mesa or field. The line may be ragged in shape or be periodically broken and may vary in size from just a few turbines to many turbines forming a line that is several miles long.

2. Cluster.

   Wind turbine farms arranged in circular configuration. A cluster is typically characterized by having a pronounced perimeter, with various turbines placed inside the circle at various, erratic distances throughout the center of the circle.

3. Grid.

   Wind turbine farms arranged in a geographical shape, such as a square or a rectangle, in which the turbines are placed a consistent distance from each other in rows, giving the appearance that they are part of a square pattern.

13.4 Marking Standards

13.4.1 Wind turbines should be marked white or light grey, as these colors have been shown to be the most effective method for providing daytime conspicuity (see Figure A-26). Wind turbine manufacturers typically use a European color-matching system that is referred to as the RAL Color Standard. The RAL system uses a four-digit code to identify a specific color of marking, for example, an RAL 9xxx code would represent a color in the white/black range. The preferred white marking color is pure white, RAL 9010, or an equivalent, however most wind turbines currently produced are marked light grey, RAL 7035, which is the darkest acceptable off-white marking allowed. Any shade of white between these two RAL specifications is strongly recommended (see Table 13-1).

Table 13-1. Wind Turbine Marking Standard Colors

Color	RAL Number
Pure White (preferred color)	9010
Light Grey (Darkest acceptable)	7035

13.4.2 In geographic areas that experience lengthy periods of snow cover (i.e., Alaska), and where it is deemed necessary, the mast of the turbine may be marked with alternating bands of aviation orange and white to provide additional contrast against the snow. The nacelle and blades of the turbine should remain solid white or light grey (see Figure A-27).

13.4.3 Blades or blade tips should not be marked with or manufactured in colors to camouflage wind turbines with the surrounding terrain.

13.4.4 For turbines that are constructed with lattice-type masts, the mast structure should be marked with alternating bands in aviation orange and white, in accordance with Chapter 3. The turbine’s nacelle and blades should remain solid white or light grey.

13.5 Lighting Standards

13.5.1 Studies have shown that red lights provide the most conspicuity to pilots, therefore during nighttime hours and periods of reduced visibilities, wind turbine obstruction lighting should consist of FAA L-864 aviation red flashing, strobe, or pulsed obstruction lights. Any array of flashing, strobe, or pulsed obstruction lighting should be synchronized to flash simultaneously (within ±1/20 second (0.05 second) of each

other). Light fixtures should be placed as high as possible on the turbine nacelle so they are visible by a pilot approaching from any direction (see Figure A-29). Should any lighting fixture or the lighting system synchronization fail, a lighting outage report should be prepared in accordance with Chapter 2, paragraph 2.4.

13.5.2 Daytime lighting of wind turbines is not required. See paragraph 13.4 for daytime marking requirements.

13.5.3 In most cases, not all wind turbine units within a wind turbine farm need to be lighted. Obstruction lights should be placed along the perimeter of the wind turbine farm so that there are no unlit separations or gaps more than 1/2 SM (0.80 km) (see Figure A-26). Wind turbines within a grid or cluster should not have an unlighted separation or gap of more than 1 SM (1.61 km) across the interior of a grid or cluster of turbines.

13.5.4 Linear Turbine Configurations.

Lights should be placed on the turbine positioned at each end of a line or string of turbines. Lights should also be placed along the line of turbines so that there is no more than a 1/2 SM (804.67 m) gap between the lighted turbines. In the event the gap between lights on the last segment of turbines is significantly short, it may be appropriate to move the lights on the turbine string back toward the starting point to present a well- balanced string of lights. High concentrations of lights should be avoided.

13.5.5 Cluster Turbine Configurations.

A turbine should be selected as a starting point along the outer perimeter of the cluster. The turbine should be lighted, and a light should be placed on the next turbine along the perimeter of the cluster (clockwise or counterclockwise) so that no more than a 1/2 SM (804.67 m) gap exists. This pattern should be continued around the perimeter of the cluster until the starting point is reached. In the event that the gap between the lights on the last segment of turbines is significantly short, it may be appropriate to move the lights along the perimeter of the cluster back toward the starting point to present a well-balanced perimeter of lights. If the distance across the cluster is greater than 1 SM (1.61 km), additional lights should be placed on other turbines throughout the center of the cluster so that there are no unlighted gaps across the cluster. For example, if the distance across a wind turbine farm is 1.8 SM (2.90 km), a light should be placed on a turbine at approximately every 0.9 SM (1.45 km).

13.5.6 Grid Turbine Configurations.

Turbines on the corners of the farm should be lit, and then use the same concept for selecting which turbines should be lit as outlined in paragraph 13.5.3.

13.5.7 Special Considerations.

Occasionally, some wind turbines may be located apart from the main group of turbines. If one or two wind turbines protrude from the general limits of the turbine farm, these turbines should be lighted in addition to those identified in the main group. Additional lighting may be necessary on wind turbines located on the interior of a

cluster or grid configuration whose height is 100 feet (30.48 m) or higher than the other wind turbines located within the farm.

13.6 Wind Turbines Above 499 Feet (152.10 m)

13.6.1 For wind turbines with a rotor tip height, while at top dead center, greater than 499 feet (152.10 m) AGL, but less than 699 feet (213.06 m) AGL, the turbines should be lighted in accordance with paragraph 13.5. In addition to these requirements, the top of the turbine's nacelle should be equipped with a second L-864 flashing red light (see Figure A-28 and A-29).

13.6.2 The two obstruction lights should be arranged horizontally, positioned on opposite sides of the nacelle, visible to a pilot approaching from any direction, and flash simultaneously. Using this lighting configuration ensures the conspicuity of turbines in this size category.

13.6.3 In the event one of the two obstruction lights fails, no light failure notification is required; however, the light should be restored to service as soon as possible.

13.6.4 All turbines within this size category should be illuminated, regardless of their location within a wind turbine farm, and should be configured to flash simultaneously with the other turbines in the same farm. This requirement ensures the pilots operating at low altitudes above 500 feet AGL have sufficient warning that a wind turbine obstruction may be within their flight path.

13.7 Wind Turbines at or Above 699 Feet (213.36 m)

13.7.1 For wind turbines with a rotor tip height, while at top dead center, at or above 699 feet (213.06 m) AGL, additional lighting is required. All wind turbines of this size, regardless of number or configuration should be lighted.

13.7.2 In addition to the lighting identified in paragraphs 13.5 and 13.6, an additional level of lights is required at a point midway between the top of the nacelle and ground level. The location of the additional lights may be adjusted as necessary to allow mounting at a seam within the turbine's mast.

13.7.3 The additional level of lights should consist of a minimum of three L-810 F flashing red lights configured to flash in unison with the two L-864 red flashing lights located at the top of the nacelle at a rate of 30 fpm (± 3 fpm). The L-810 F lights should be spaced at equal distances around the mast to ensure a pilot approaching from any direction has an unobstructed view of at least two of the lights (see Figure A-28 and A-29).

13.7.4 For wind turbine structures with a mast diameter greater than 20 feet (6.10 m), four L-810 red lights should be used.

13.7.5 All turbines within this size category should be illuminated, regardless of their location within a turbine farm, and should be configured to flash simultaneously with the other turbines in the same farm. This requirement ensures the pilots operating at low altitudes above 500 feet AGL have sufficient warning that a wind turbine obstruction may be within their flight path.

13.8 Lighting of Wind Turbines During Construction Phase

To ensure proper conspicuity of turbines at night during construction, all turbines should be lighted with temporary lighting once they reach a height of 200 feet (60.96 m) or greater until the permanent lighting configuration is turned on. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. As the structure's height continues to increase, the temporary lighting should be relocated to the structure's uppermost height (see Figure A-30). An L-810 steady-burning red light should be used to light the structure during the construction phase, if the permanent L-864 flashing-red lights are not in place. The temporary lighting may be turned off for short periods if they interfere with construction personnel. If power is not available, turbines should be lighted with a self-contained, solar-powered, LED, steady-burning red light that meets the photometric requirements of an FAA L-810 lighting system. The lights should be positioned to ensure a pilot has an unobstructed view of at least one light at each level. Using a NOTAM to justify not lighting the turbines until the entire project is completed is prohibited.

13.9 Lighting and Marking of Airborne Wind Turbines

The FAA is currently conducting research to develop special lighting and marking standards for Airborne Wind Turbines. Sponsors should consult with their respective FAA OE Specialists for updated information.

13.10 Lighting and Marking of Offshore Wind Turbines

FAA lighting and marking recommendations for Offshore Wind Turbines applies to structures in United States territorial seas, which extends from the coastline to 12 NM (22.22 km) offshore. The Bureau of Ocean Energy Management (BOEM), which maintains jurisdiction of land leases beyond the 12 NM (22.22 km), is considering the need to require marking and lighting standards for offshore wind turbines.

CHAPTER 14. MARKING AND LIGHTING TEMPORARY STRUCTURES

14.1 Purpose

This chapter provides general guidelines for marking and lighting temporary structures, such as construction equipment, cranes, derricks, oil and drilling rigs, etc. The purpose of marking and lighting these obstructions is to indicate the presence and general outline of the structure to assist pilots when approaching from any direction to identify and avoid these obstacles. These guidelines are not to be considered all-inclusive, each obstacle must be evaluated individually, and the determination will provide lighting recommendations that are specific to the structure.

14.2 General Standards

Due to the temporary nature, potential mobility, and ability to instantaneously extend to full height, accommodations must be made to mitigate the effects of these structures on the airspace for safe operations. Temporary structures are unique based on the structure type, size, and use, and the aeronautical study evaluates the potential effect on airspace. Proximity to airports, navigational aids (NAVAIDS), air routes, and local flight activity, as well as the duration of the project are considered during the evaluation process.

Marking and/or lighting of these structures is intended to provide day and night conspicuity and to assist pilots in identifying and avoiding these obstacles. In some cases, the Sponsor will also be required to initiate a NOTAM to provide additional mitigation procedures for the safe operation of the temporary obstacle due to the proximity of these aviation elements.

14.3 Marking Standards

Marking is used to increase conspicuity of structures for daytime conditions. Flags are used to mark certain structures or objects when it is technically impractical to use quality markings (paint, powder coat, vinyl wrap, etc.). When using markings, various types of marking colors and patterns are used to mark structures and the pattern should ensure the paint contrasts with the surrounding environment.

14.3.1 Flag Markers.

Flag markers should be mounted at the highest point of the structure to ensure visibility. Some common examples of structures that may utilize this type of markers include, temporary construction equipment and vehicles, oil and drilling rigs, cranes, and derricks. Refer to Section 3.6 for full details.

14.3.1.1 Minimum Size.

Each side of the flag marker should be at least two feet (0.61 m) in length.

14.3.1.2 Color Patterns.

Flags should be colored as follows:

1. Solid colored flags should be aviation orange.
2. When using two colors, arrange two triangular sections, one aviation orange and the other white to form a rectangle.
3. Flags three feet (0.91 m) or larger should be a checkerboard pattern of aviation orange and white squares, each one foot (0.30 m) plus or minus 10 percent.

14.3.1.3 Display.

Flag markers should be displayed around, on top, or along the highest edge of the obstruction. The flag staff should be strong enough to support the flag and be higher than the surrounding ground, structures, and/or objects of natural growth.

14.3.2 Marking.

14.3.2.1 Ideally cranes should be marked aviation orange or alternating aviation orange and white, however with flags and/or lights, contrasting bright colors that do not merge into the surrounding environment are acceptable. Colors that camouflage with the surrounding environment (i.e., sky blue, forest green, etc.) should be avoided.

14.3.2.2 Refer to paragraph 3.3, Marking Standards, for details.

14.3.3 Alternative to Marking.

14.3.3.1 Along with, or as an alternative to marking, medium intensity white lighting can be used to make the obstacle more conspicuous during daytime conditions for structures over 200 feet AGL.

14.3.3.2 High intensity lighting is not recommended on temporary structures.

14.4 Lighting Standards

Lighting is used to increase conspicuity of structures for day or nighttime conditions and should be visible to a pilot approaching in any direction. When a temporary structure cannot be removed from site or lowered below the no-effect height, the addition of lighting should be used to alert pilots of their presence. Generally, red lights are recommended during the hours between sunset and sunrise and periods of reduced visibility, using marking for the remainder of the time with occasional exceptions. Lights should be mounted at the highest point of the structure, and in cases of more extensive structures additional lights may be necessary at intermediate levels and furthest horizontal points (i.e., horizontal boom ends, etc.) to clarify the outline of the structure (see Figures A-31 through A-33).

14.4.1 Structures 150 feet (45.72 m) AGL or less.

Two or more steady-burning or flashing red (L-810/L-810 F) lights should be installed on the highest part of the structure in a manner to ensure an unobstructed view of one or more lights by a pilot.

14.4.2 Structures exceeding 150 feet (45.72 m) AGL and not more than 350 feet (106.68 m) AGL.

At least one red flashing (L-864) light should be installed on the highest part of the structure and intermediate levels of one or more flashing red lights (L-810 F) should be mounted in a manner to ensure an unobstructed view of one or more lights by a pilot.

14.4.2.1 Mounting Intermediate Level Lights.

The number of light levels required is determined by the height of the structure, including all appurtenances, as shown in, Figure A-6. The number of lights on each level is determined by the shape and width of the structure. At least two or more of these lights (L-810 F) should be mounted diagonally or on diametrically opposite positions to ensure an unobstructed view of at least one light at each level by a pilot approaching in any direction. These lights should be configured to flash simultaneously with the L-864 flashing light on the top of the structure at a rate of 30 flashes per minute (fpm) (± 3 fpm). Steady burning lights (L-810) and red flashing lights (L-864) are not used as intermediate level lights on these types of structures.

14.4.3 Structures exceeding 350 feet (106.68 m) AGL.

At least one red flashing (L-864) light should be installed on the highest part of the structure in a manner to ensure an unobstructed view of one or more lights by a pilot. In addition, intermediate levels of lights of flashing red (L-864) should be used.

14.4.3.1 Intermediate Levels Lights.

The number of light levels required is determined by the height of the structure, including all appurtenances, as shown in, Figure A-6. The number of lights on each level is determined by the shape and width of the structure. At least two or more of these lights (L-864) should be mounted diagonally or on diametrically opposite positions to ensure an unobstructed view of at least one light at each level by a pilot approaching in any direction. These lights should be configured to flash simultaneously with the L-864 flashing light on the top of the structure at a rate of 30 flashes per minute (fpm) (± 3 fpm). Steady burning lights are not used on these types of structures.

14.4.4 Construction Cranes or Rigs (Oil and Drilling).

When a crane or rig cannot be removed from site or lowered below the no-effect height, the addition of lighting should be used to alert pilots of their presence during the hours between sunset and sunrise and periods of reduced visibility. Lights should be mounted at the highest point, and in cases of more extensive structures additional lights may be

necessary at intermediate levels and furthest horizontal (i.e., horizontal boom ends, etc.) points to clarify the outline of the structure (see Figure A-32).

14.4.4.1 Systems.

Steady burning and flashing red lights (L-864/L-810) may be used to light cranes and rigs. High-intensity lights (L-856) are not recommended.

14.4.4.2 Display.

The flashing light (L-864) should be displayed on the highest point, and the steady light (L-810) at the ends of boom, and other various locations along the top of the structure to best define the outline. Additionally, in certain cases, intermediate level lighting or sidelights (L-810) may be required. For construction cranes with angular booms, the lights should be mounted on a pivot axis so the fixture remains level when the boom tilts to ensure the lights remain level and is not obscured by the structure.

14.4.4.3 Exceptions.

14.4.4.3.1 Architectural lighting or floodlights may be used in addition to, but not in place of, standard lighting provided they do not cause an adverse effect on the obstruction light fixture's photometrics and do not result in an obscured view of one of more obstruction lights by a pilot.

14.4.4.3.2 In some cases, the boom or rig may be lowered below the no-effect height or removed from site, and nighttime lighting is not required.

14.4.5 Container Cranes.

14.4.5.1 These structures are generally used in brightly lit areas; however, lighting should be used to alert pilots of the current configuration and presence of the obstruction during the hours between sunset and sunrise and periods of reduced visibility. Extensive structures require additional lights at intermediate levels and furthest horizontal points, (i.e., horizontal boom ends, etc.), as well as horizontal mid-points as necessary, to clarify the outline of the structure for pilots approaching from any direction.

14.4.5.2 Systems.

Medium intensity white lights (L-865) may be used and high-intensity lights (L-856) are not recommended.

14.4.5.3 Display.

The lights should be displayed on the highest point, ends of boom, and other various ways to best define the size and shape of the structure. Lights should be mounted at the highest point at all times during usage. For large container cranes with angular booms, the lights should be mounted on a pivot axis, so the fixture remains level when the boom tilts

to ensure the lights remain level and is not obscured by the structure (see Figure A-33).

14.4.5.4 Exceptions.

Architectural lighting or floodlights may be used in addition to, but not in place of, standard lighting provided they do not cause an adverse effect on the obstruction light fixture's photometrics and do not result in an obscured view of one of more obstruction lights by a pilot.

14.5 Operational Characteristics

When using flashing lights, the lights should flash simultaneously.

CHAPTER 15. MARKING AND LIGHTING EQUIPMENT AND INFORMATION

15.1 Purpose

This chapter lists documents relating to obstruction marking and lighting systems and where they may be obtained.

15.2 Marking Standard

15.2.1 Marking and aviation colors/gloss, referred to in this Advisory Circular, with the exception of wind turbines, should conform to Aerospace Material Specification Standard, SAE AMSSTD595A, Colors Used in Government Procurement, previously known as FED-STD-595 (cancelled February 14, 2017). Wind turbines should meet the standards in Chapter 13, paragraph 13.4, of this advisory circular.

15.2.2 Approved colors should be formulated without using lead, zinc chromate, or other heavy metals to match international aviation orange, white, and yellow, as listed in Table 15-1. All coatings must be manufactured and labeled in accordance with U.S. Environmental Protection Agency regulations, including the National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

Table 15-1: Aerospace Material Specification Standard, SAE AMSSTD595A

Color	Number
Orange	EA 12197
White	EA 17875
Yellow	EA 13538

15.2.3 Paint.

15.2.3.1 Exterior Acrylic Waterborne Paint.

Coatings must be ready-mixed, 100 percent acrylic, exterior latex formulated for application directly to galvanized surfaces. Ferrous iron and steel or non-galvanized surfaces must be primed with a manufacturer-recommended primer compatible with the finish coat.

15.2.3.2 Exterior Solvent-Borne Alkyd-Based Paint.

Coatings must be ready-mixed, alkyd-based, exterior enamel for application directly to non-galvanized surfaces, such as ferrous iron and steel. Galvanized surfaces must be primed with a manufacturer-

recommended primer compatible with the finish coat.

15.2.3.3 Powder Coating and Vinyl Wrapping.

Materials must meet color and gloss in accordance with SAE AMSSTD595A, Colors Used in Government Procurement. Materials must meet peel strength requirements in accordance with ASTM D3359-17, Standard Test Method for Rating Adhesion by Tape Testing. Materials must meet Corrosion resistance requirements in accordance with ASTM G85-16, *Standard Practice for Modified Salt Spray (Fog).*

15.2.3.4 Testing.

Materials should withstand weather conditions in accordance with ASTM G154-16, Standard Practice for Operating Fluorescent (UV) Lamp Apparatus for expire of nonmetallic Materials.

15.3 Availability of Specifications and Advisory Circulars

Federal and military specifications describing the technical characteristics of various paints and their application techniques are available through the ASSIST Database at https://assist.dla.mil/online/start/. ASSIST is a robust, comprehensive website used by standardization management activities to develop, coordinate, distribute, and manage defense and federal specifications and standards, military handbooks, commercial item descriptions, data item descriptions, and related technical documents prepared in accordance with the policies and procedures of the Defense Standardization Program (DSP).

15.3.1 For Federal Product Description line items only (for download, refer to ASSIST), use the following Uniform Resource Locator (URL): https://www.gsa.gov/buying-selling/purchasing-programs/requisition-programs/gsa-global-supply/supply-standards/index-of-federal-specifications-standards-and-commercial-item-descriptions.

15.3.2 Copies of FAA Advisory Circulars may be obtained online at: https://www.faa.gov/regulations_policies/advisory_circulars/

15.4 Lights and Associated Equipment Standards

The lighting equipment referred to in this AC should conform to the latest edition of one of the following specifications, as applicable:

15.4.1 Obstruction Lighting Equipment.

15.4.1.1 AC 150/5345-43, FAA Specification for Obstruction Lighting Equipment.

15.4.1.2 Military Specifications MIL-L-6273, Light, Navigational, Beacon, Obstacle, or Code, Type G-1.

15.4.1.3 Military Specifications MIL-L-7830, Light Assembly, Marker, Aircraft Obstruction.

15.4.2 Certified Equipment.

15.4.2.1 AC 150/5345-53, Airport Lighting Certification Program, lists the manufacturers that have demonstrated compliance with the specification requirements of AC 150/5345-43, FAA Specification for Obstruction Lighting Equipment.

15.4.2.2 Other manufacturers' equipment may be used provided the equipment meets the specification requirements of AC 150/5345-43, FAA Specification for Obstruction Lighting Equipment.

15.4.3 Airport Lighting Installation and Maintenance.

AC 150/5340-30, Design and Installation Details for Airport Visual Aids.

15.4.4 Vehicles and Structures.

15.4.4.1 AC 150/5210-5, *Painting, Marking, and Lighting of Vehicles Used on an Airport*, contains provisions for marking vehicles principally used on airports.

15.4.4.2 FAA Standard FAA-STD-003, *Paint Systems for Structures.* Obstruction marking for FAA facilities must conform to FAA Drawing Number D-5480
(page 39 of 42).

15.5 Availability of Military Specifications

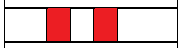
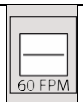
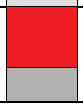
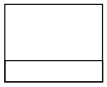
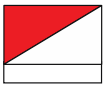
The military standards and specifications listed above may be obtained from:

DAP/DODSSP
Building 4, Section D
700 Robbins Avenue
Philadelphia, PA 19111-5904
Telephone: (215) 737-8000
FAX: (215) 737-7155

URL: https://quicksearch.dla.mil/ (ASSIST Database)

APPENDIX A. SPECIFICATIONS FOR OBSTRUCTION LIGHTING EQUIPMENT CLASSIFICATION

Table A-1: FAA-Approved Obstruction Lighting Fixtures

Type	Symbol	Description
L-810 L-810 F		Steady-Burning or Flashing (30 FPM) - RED Single Obstruction Light
L-810 L-810 F		Steady-Burning or Flashing (30 FPM) – RED Double Obstruction Light
L-856		High-Intensity Flashing – WHITE Obstruction Light (40 FPM), LED (60 FPM)
L-857		High-Intensity Flashing – WHITE Catenary Light (60 FPM), incandescent 40 FPM
L-864		Medium-Intensity Flashing – RED Obstruction Light (20-40 FPM) (30 FPM when used with L-810 F)
L-865		Medium-Intensity Flashing – WHITE Obstruction Light (40-FPM)
L-866		Medium-Intensity Flashing - WHITE Catenary Light (60-FPM)
L-864/L-865		Medium-Intensity Flashing Dual – RED / WHITE Obstruction Light (20-40 FPM) Obstruction Light (40 FPM)
L-885		Flashing Obstruction Light - RED Obstruction Light (60 FPM)

FPM = Flashes Per Minute

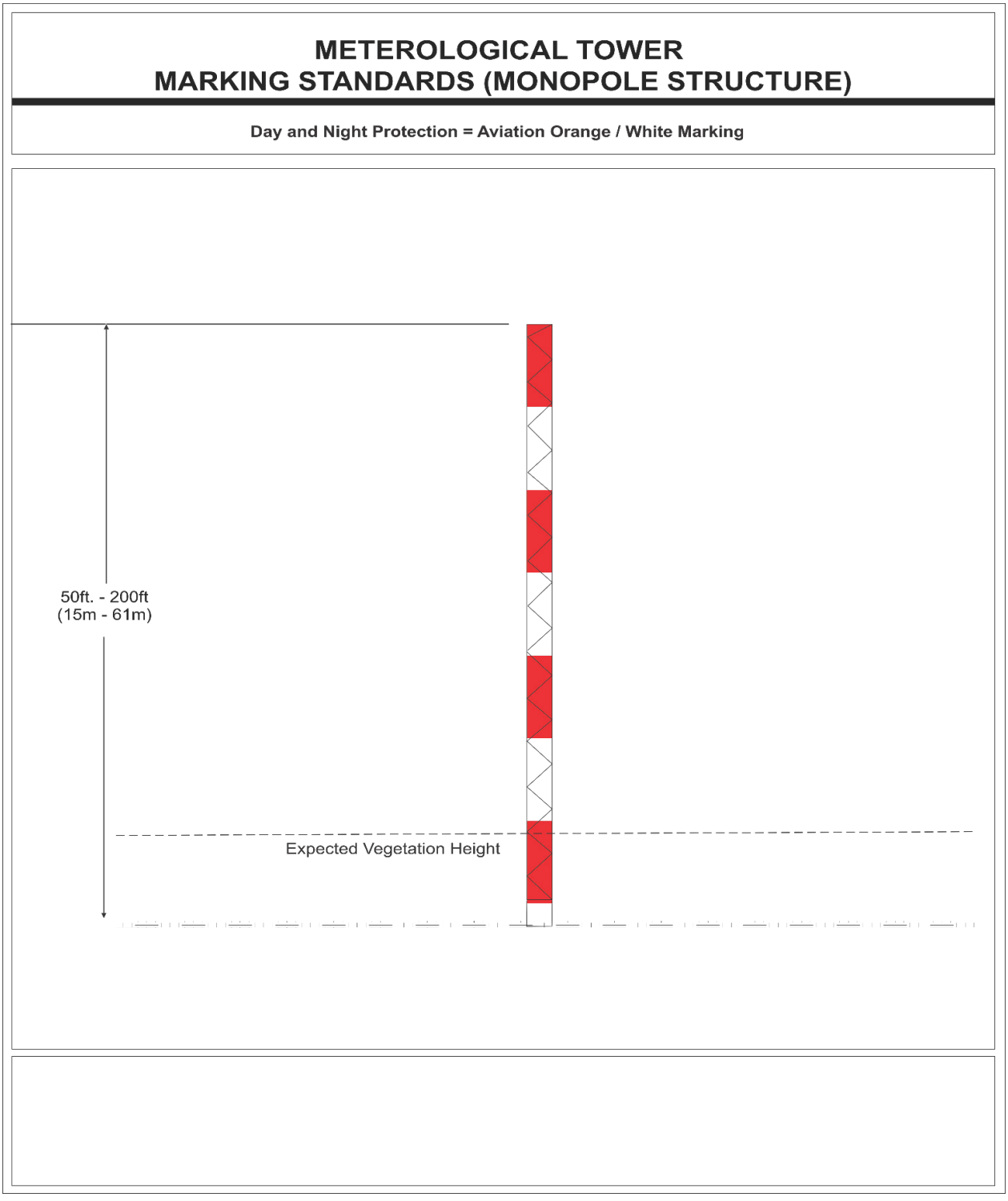


Figure A-1. Meteorological Tower Marking Standards (Monopole Structure)

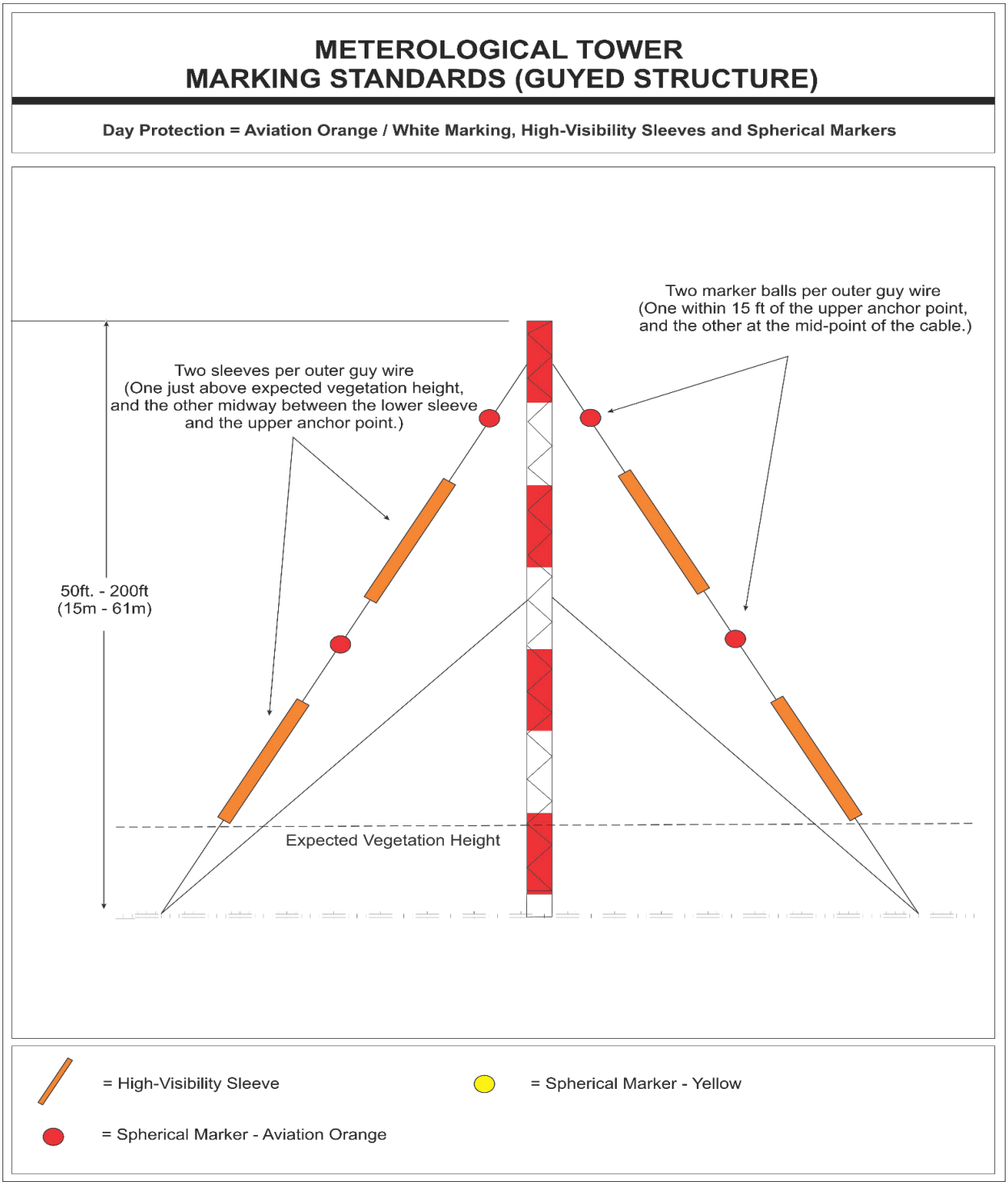


Figure A-2. Meteorological Tower Marking Standards (Guyed Structure)

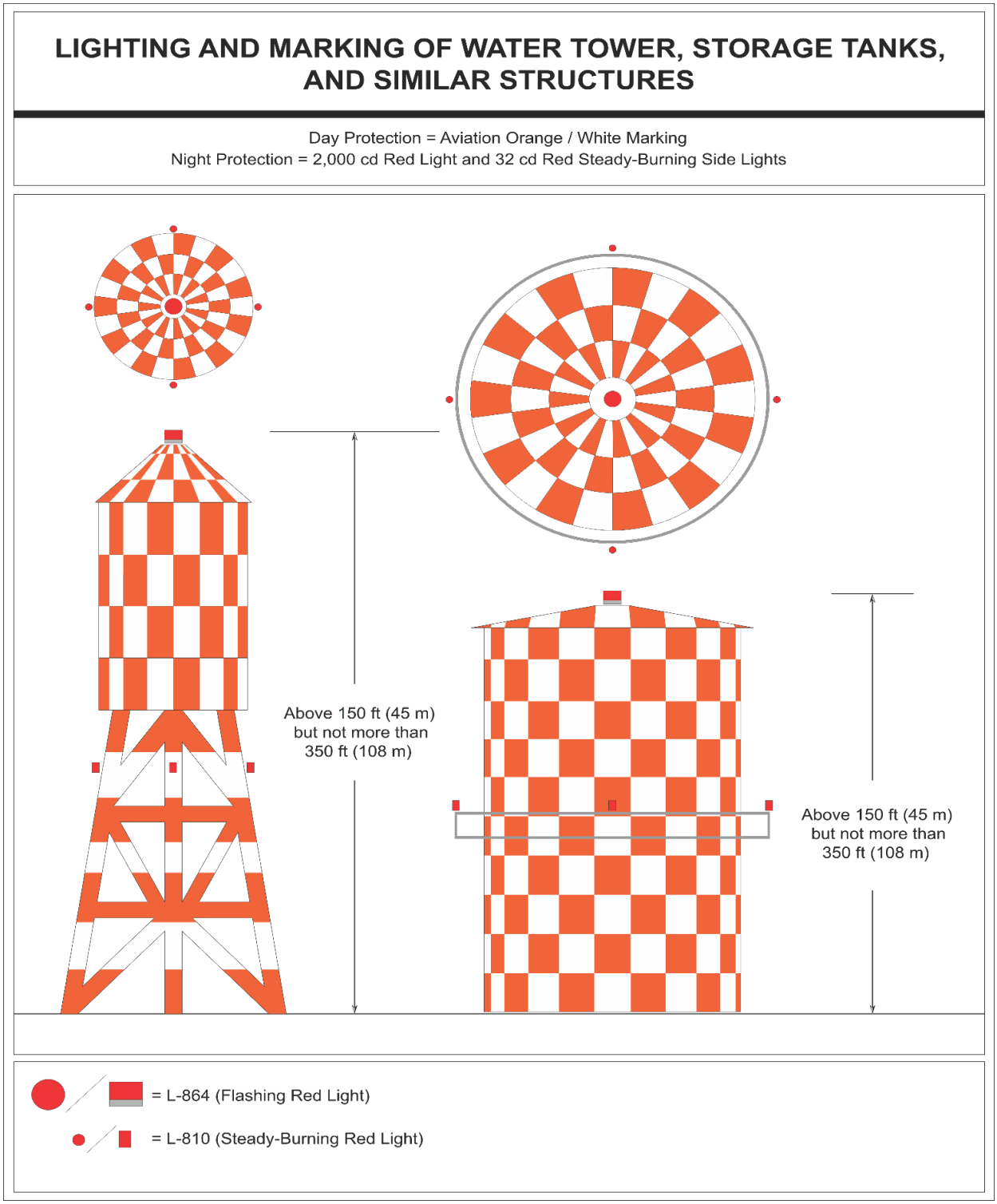


Figure A-3. Marking and Lighting of Water Towers, Storage Tanks, and Similar Structures

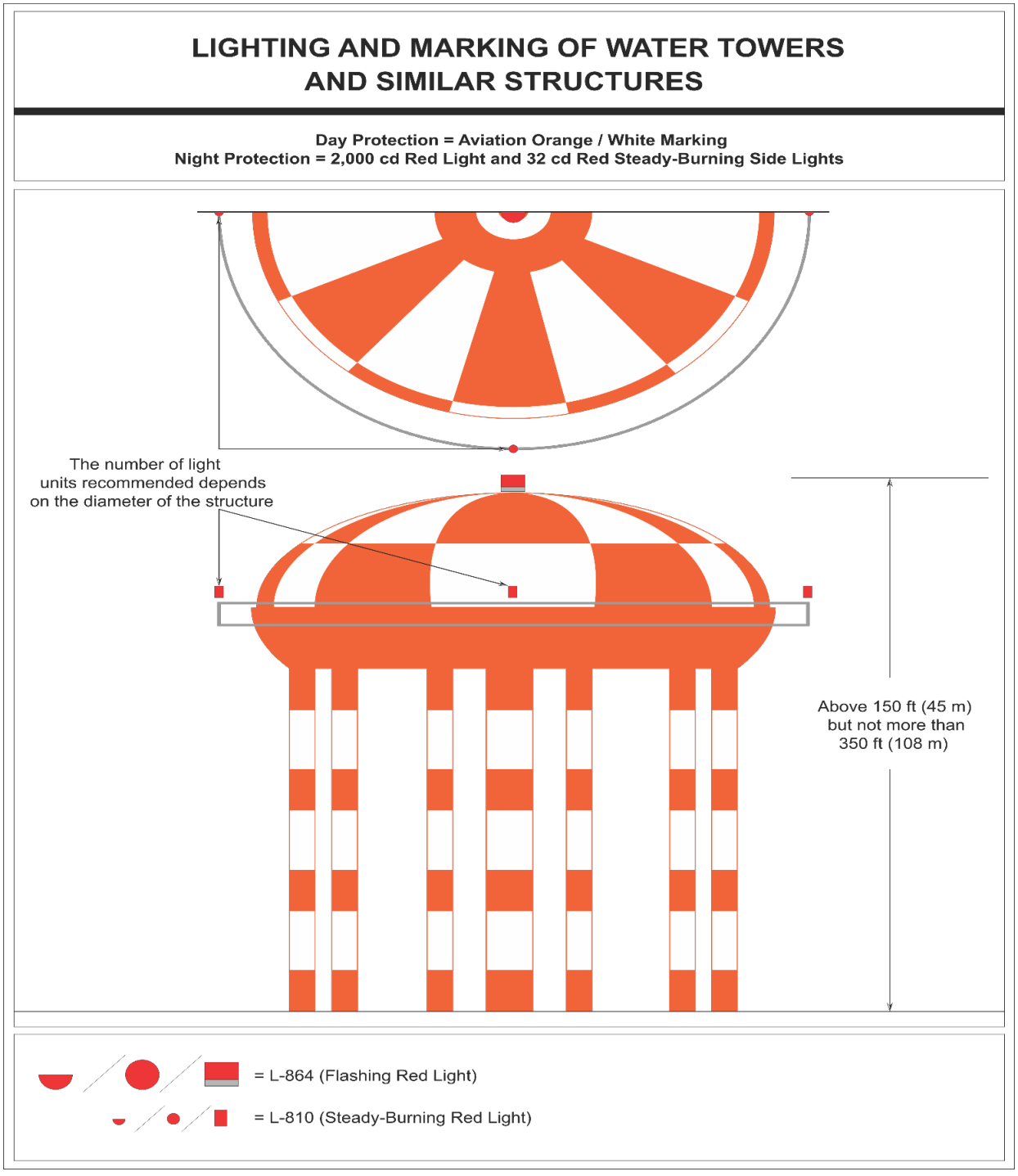


Figure A-4. Marking and Lighting of Water Towers and Similar Structures

Figure A-5. Marking a Single Pedestal Water Tower Using the Teardrop Pattern

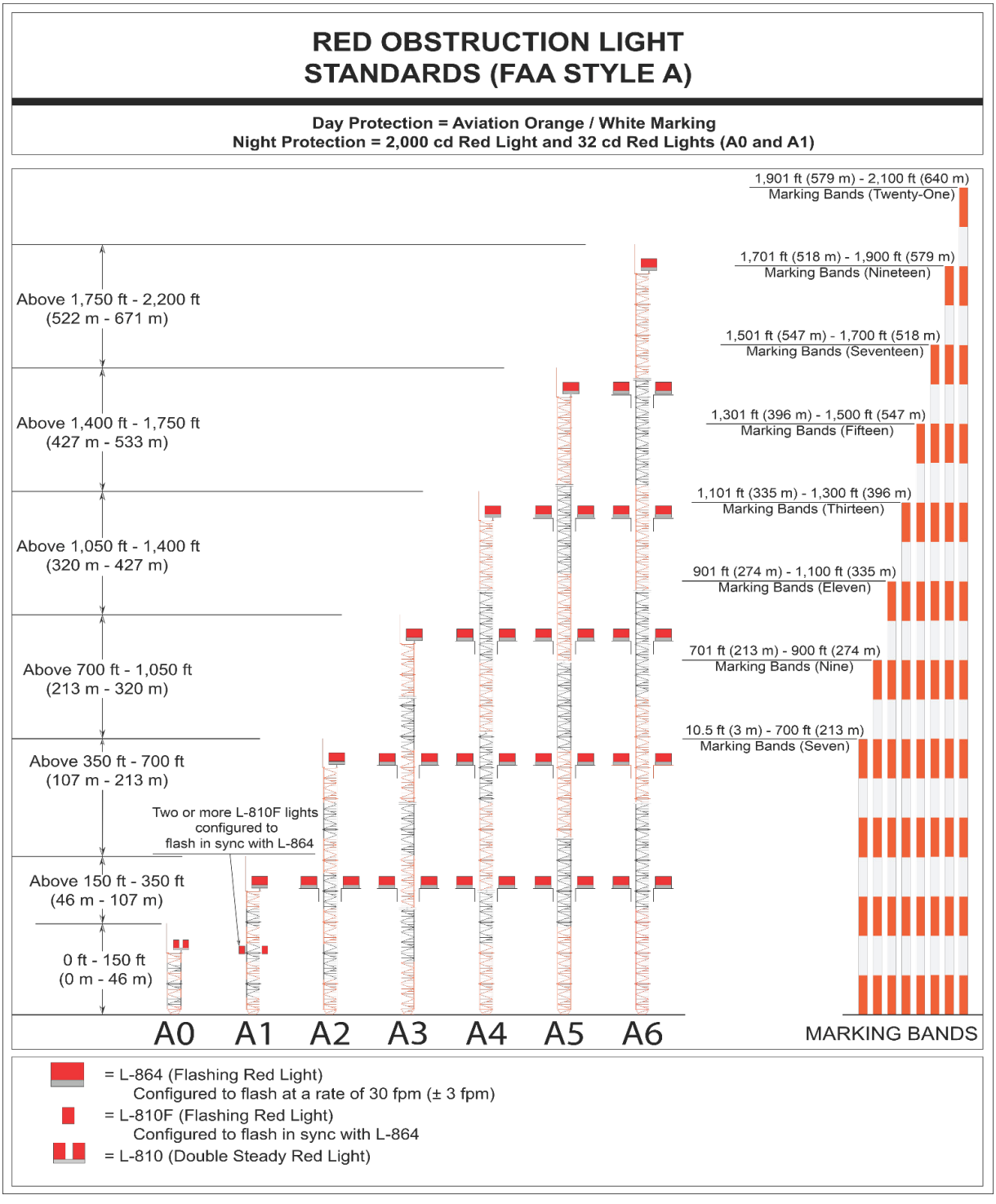

RED OBSTRUCTION LIGHT
STANDARDS (FAA STYLE A)
Day Protection = Aviation Orange / White Marking
Night Protection = 2,000 cd Red Light and 32 cd Red Lights (A0 and A1)
Above 1,750 ft - 2,200 ft
(522 m - 671 m)
Above 1,400 ft - 1,750 ft
(427 m - 533 m)
Above 1,050 ft - 1,400 ft
(320 m - 427 m)
Above 700 ft - 1,050 ft
(213 m - 320 m)
Above 350 ft - 700 ft
(107 m - 213 m)
Above 150 ft - 350 ft
(46 m - 107 m)
0 ft - 150 ft
(0 m - 46 m)
Two or more L-810F lights
configured to
flash in sync with L-864
A0
A1
A2
A3
A4
A5
A6
1,901 ft (579 m) - 2,100 ft (640 m)
Marking Bands (Twenty-One)
1,701 ft (518 m) - 1,900 ft (579 m)
Marking Bands (Nineteen)
1,501 ft (547 m) - 1,700 ft (518 m)
Marking Bands (Seventeen)
1,301 ft (396 m) - 1,500 ft (547 m)
Marking Bands (Fifteen)
1,101 ft (335 m) - 1,300 ft (396 m)
Marking Bands (Thirteen)
901 ft (274 m) - 1,100 ft (335 m)
Marking Bands (Eleven)
701 ft (213 m) - 900 ft (274 m)
Marking Bands (Nine)
10.5 ft (3 m) - 700 ft (213 m)
Marking Bands (Seven)
MARKING BANDS
= L-864 (Flashing Red Light)
Configured to flash at a rate of 30 fpm (± 3 fpm)
= L-810F (Flashing Red Light)
Configured to flash in sync with L-864
= L-810 (Double Steady Red Light)

Figure A-6. Red Obstruction Light Standards (FAA Style A)

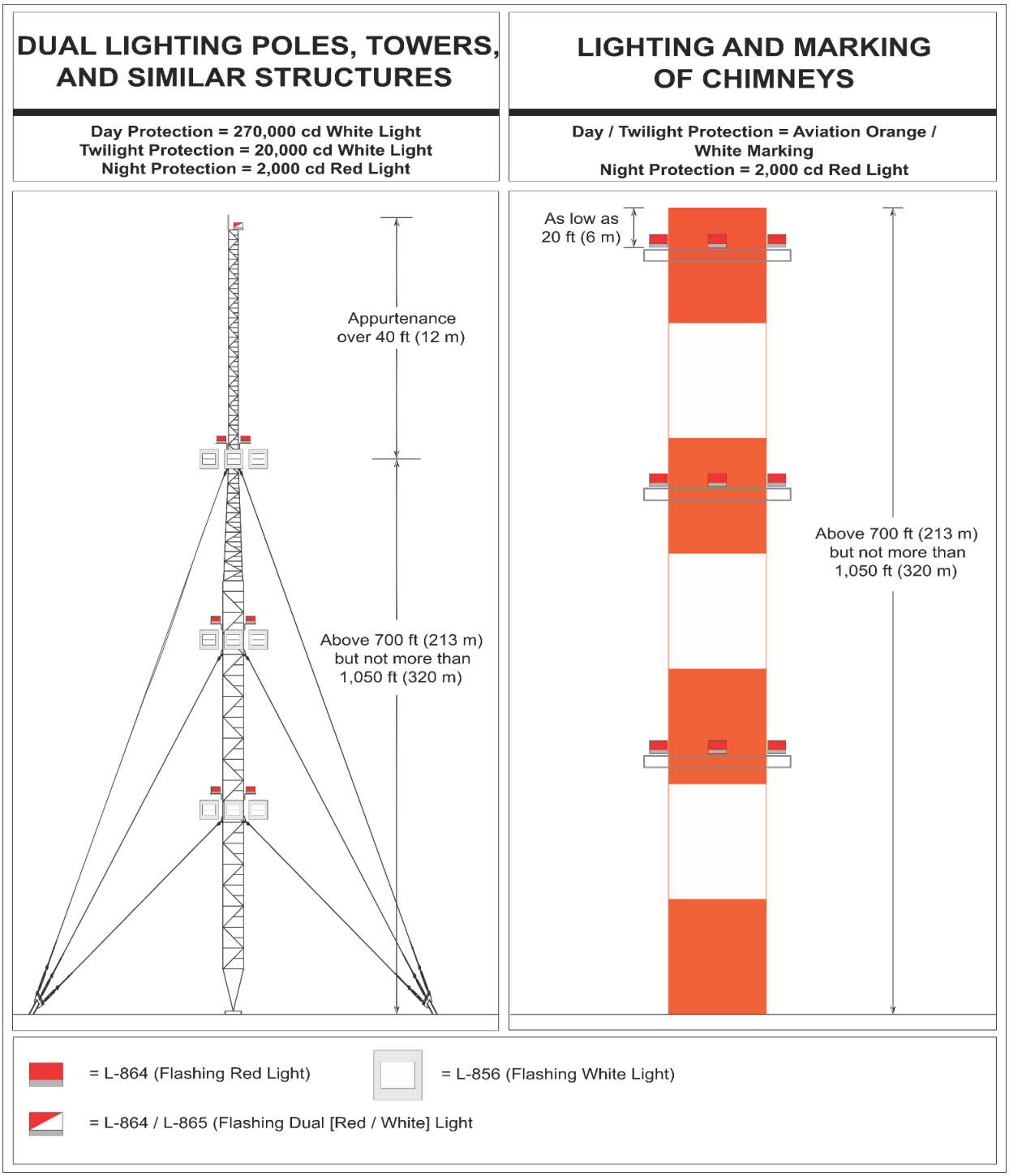


Figure A-7. Dual Lighting of Poles, Towers, and Similar Structures/Lighting and Painting of Chimneys

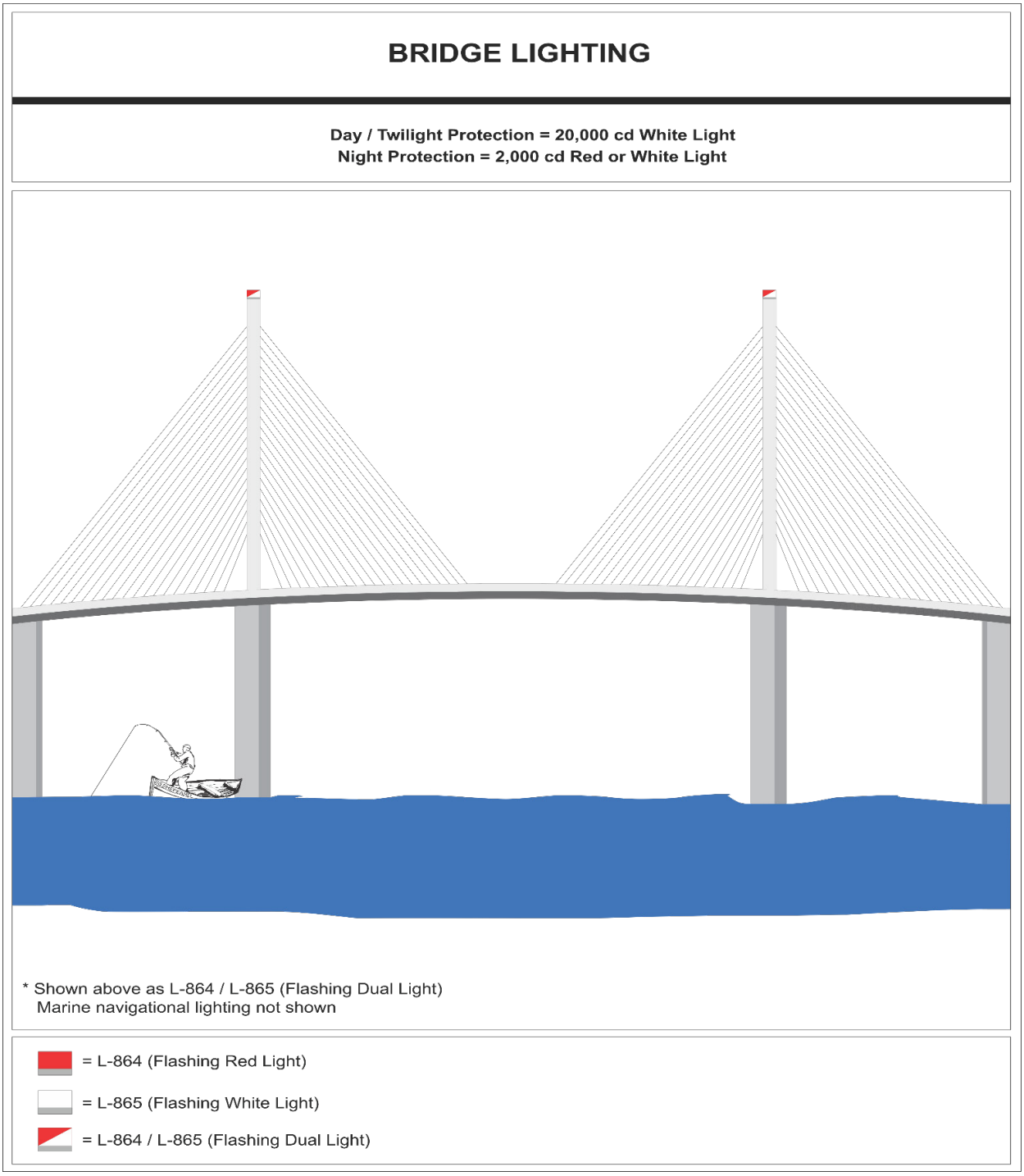


Figure A-8. Bridge Lighting

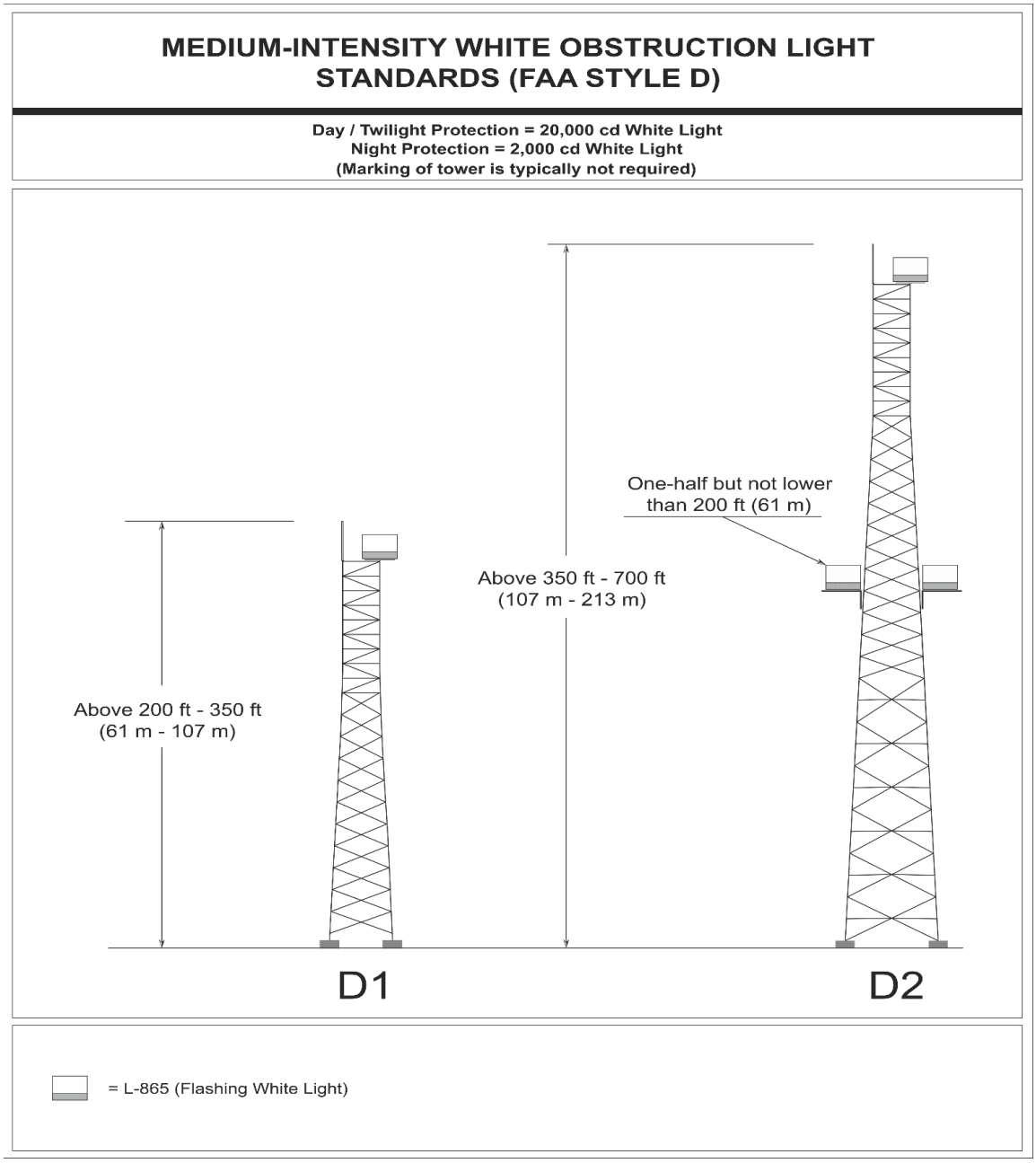


Figure A-9. Medium-Intensity White Obstruction Light Standards (FAA Style D)

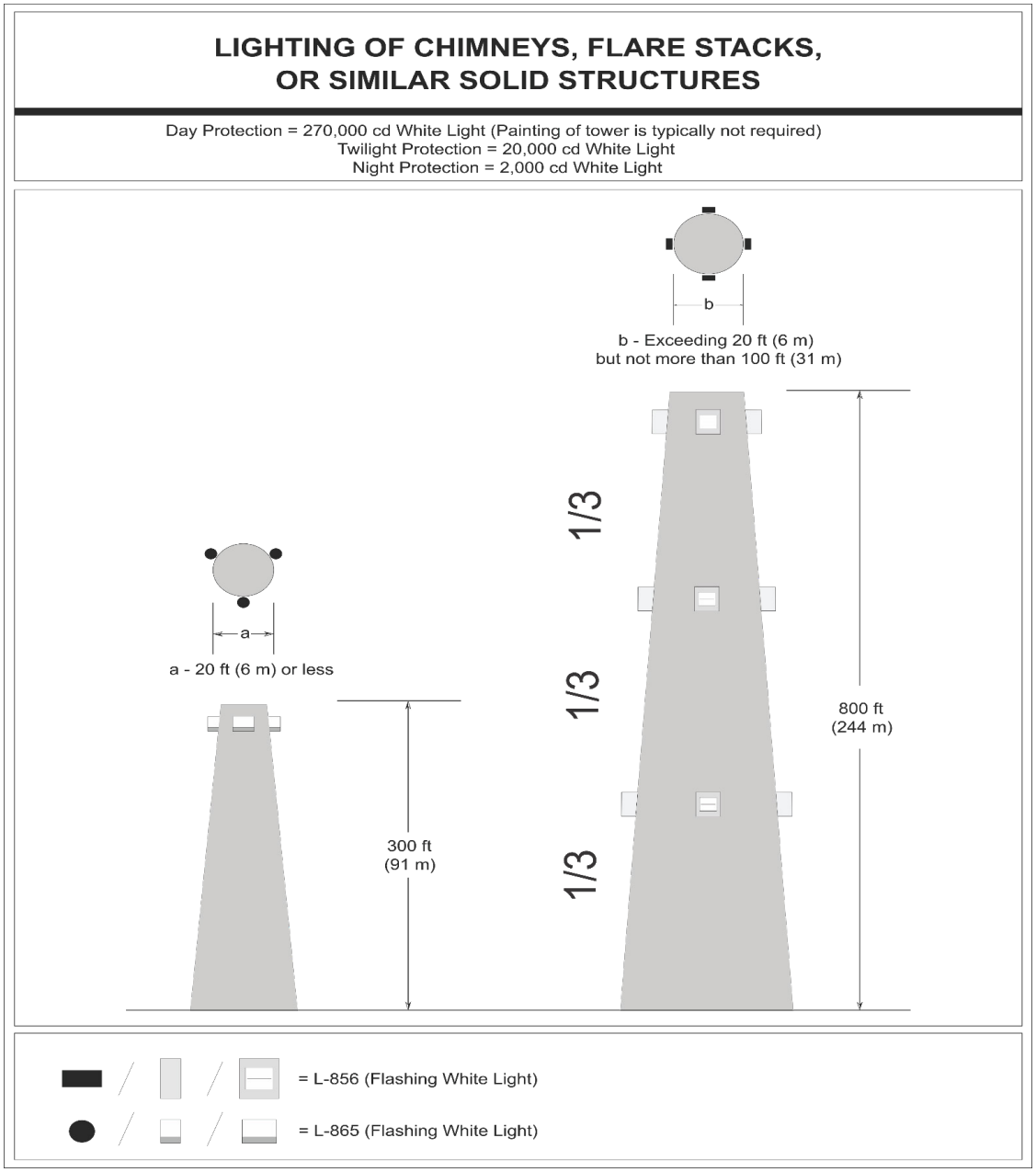


Figure A-10. Lighting of Chimneys, Flare Stacks, or Similar Solid Structures

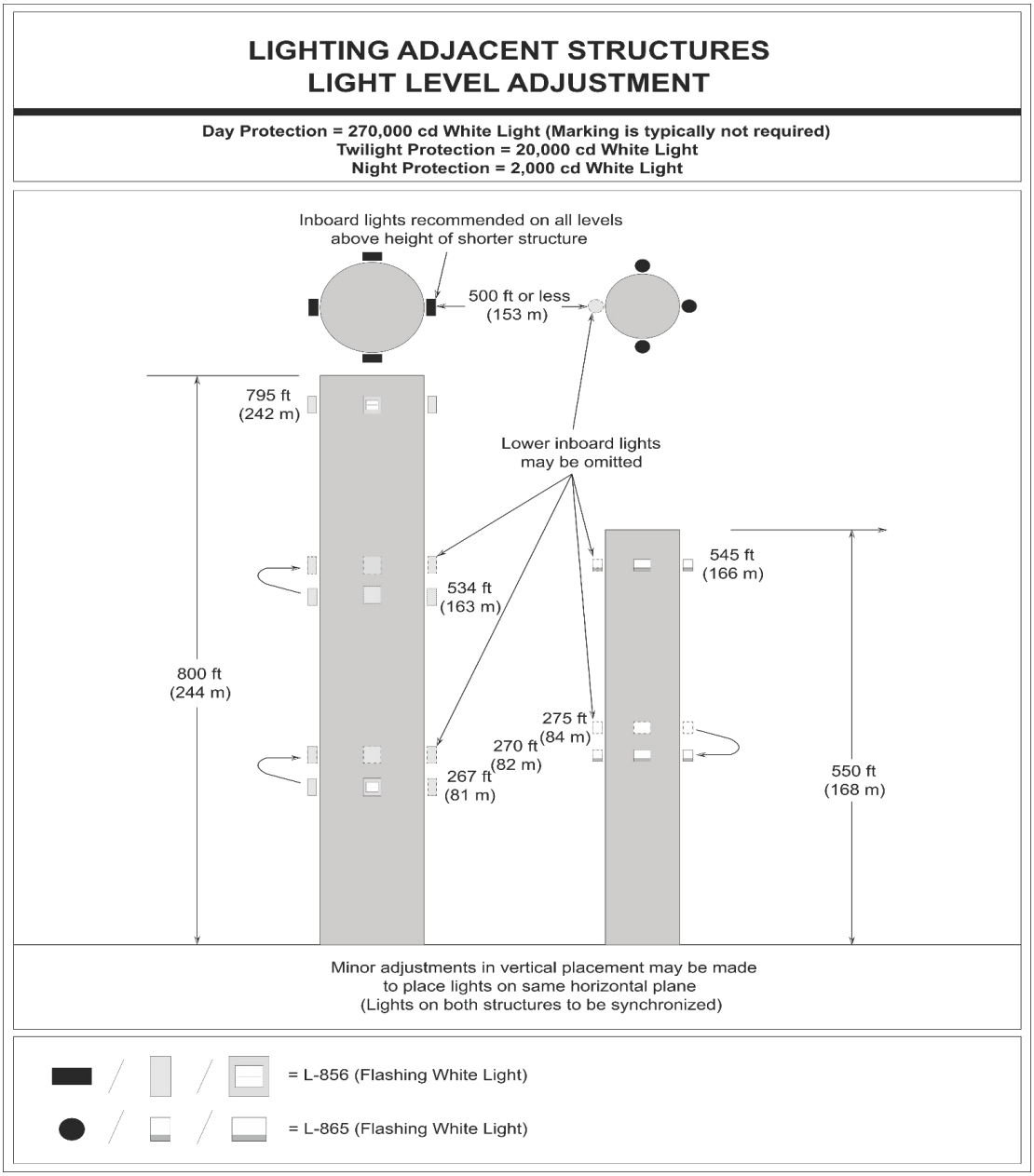


Figure A-11. Lighting Adjacent Structures—Light Level Adjustment

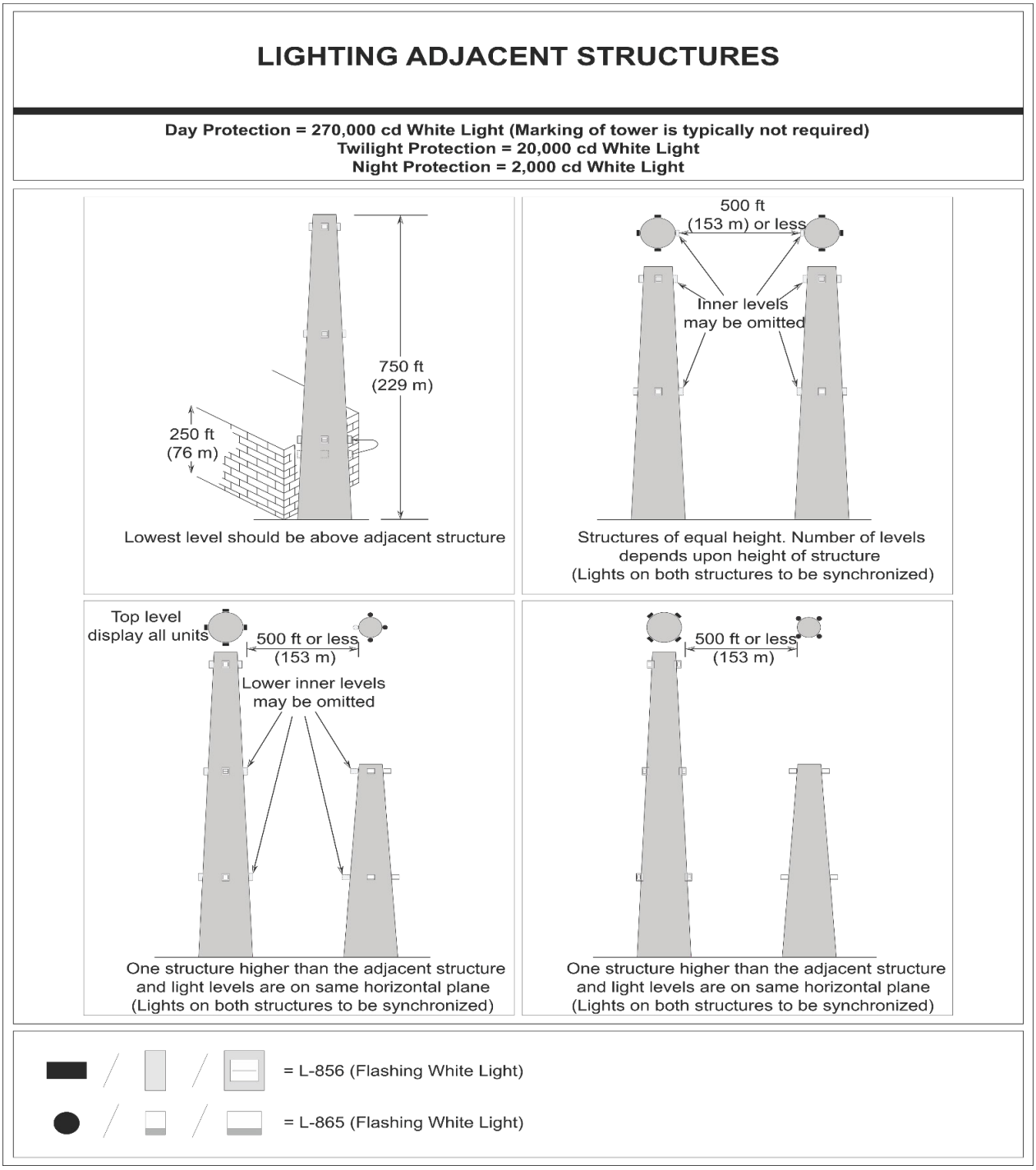


Figure A-12. Lighting Adjacent Structures

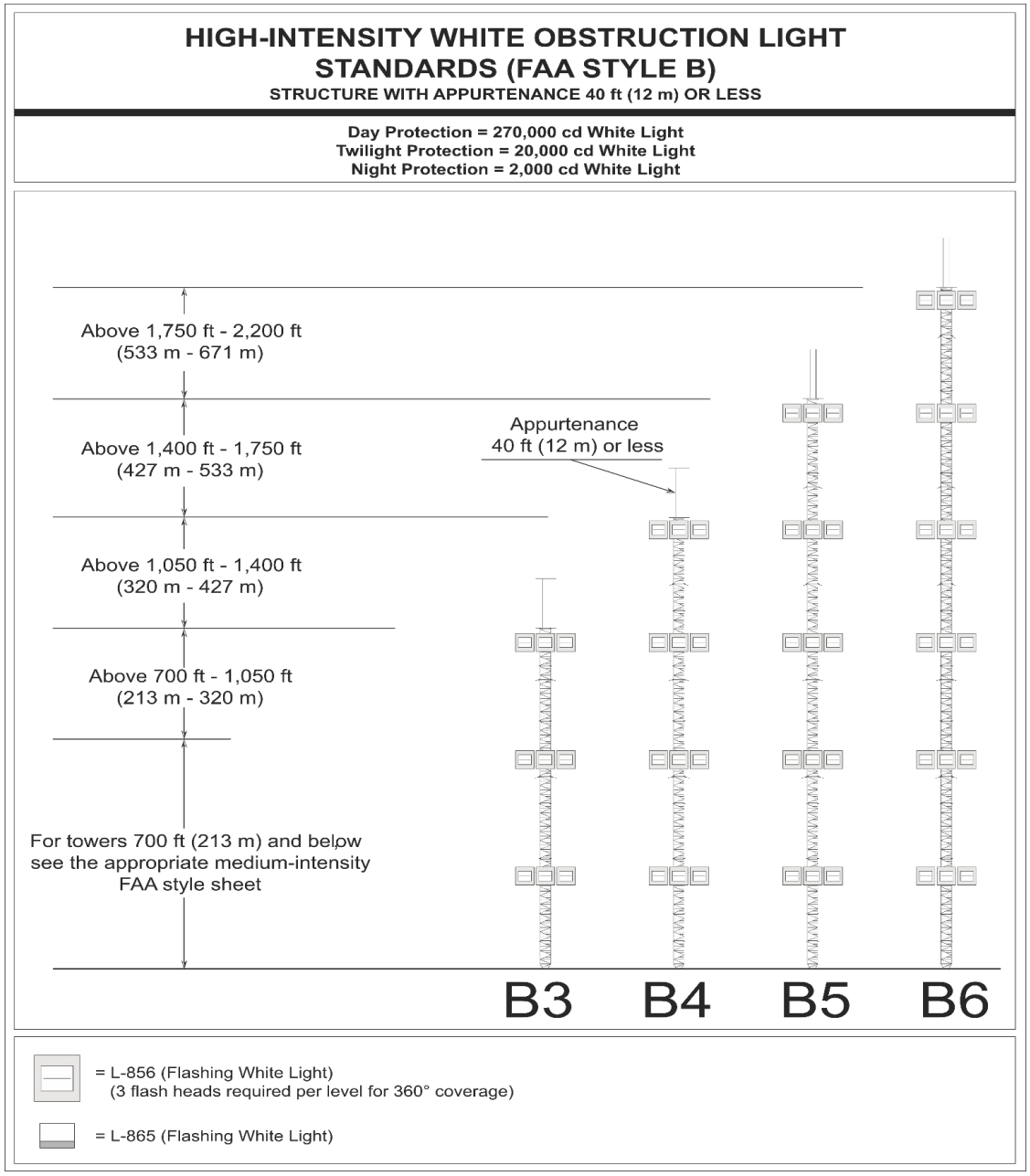


Figure A-13. High-Intensity White Obstruction Light Standards (FAA Style B)—With Appurtenance 40 Feet or Less

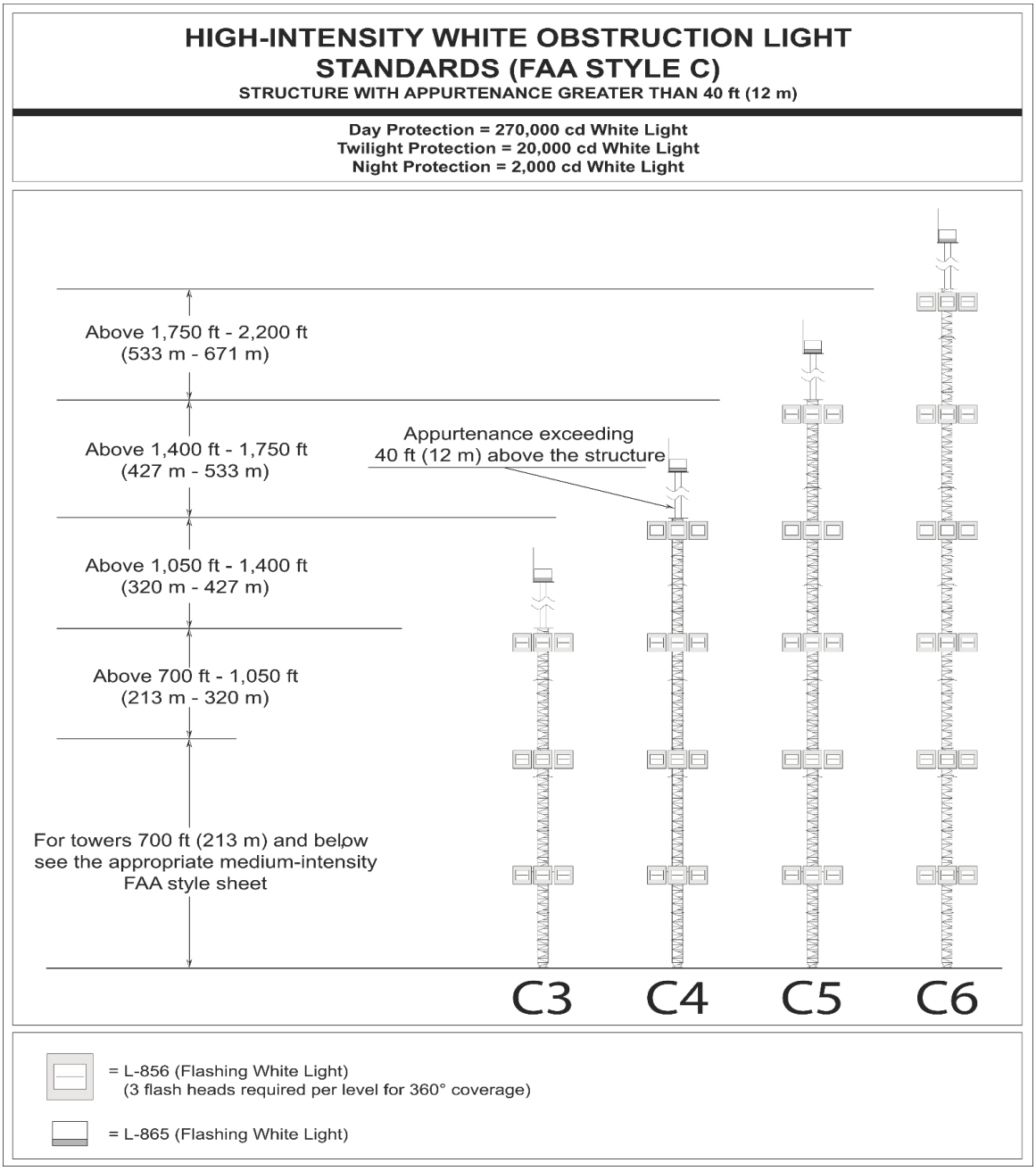


Figure A-14. High-Intensity White Obstruction Light Standards (FAA Style C)—With Appurtenance Over 40 Feet High

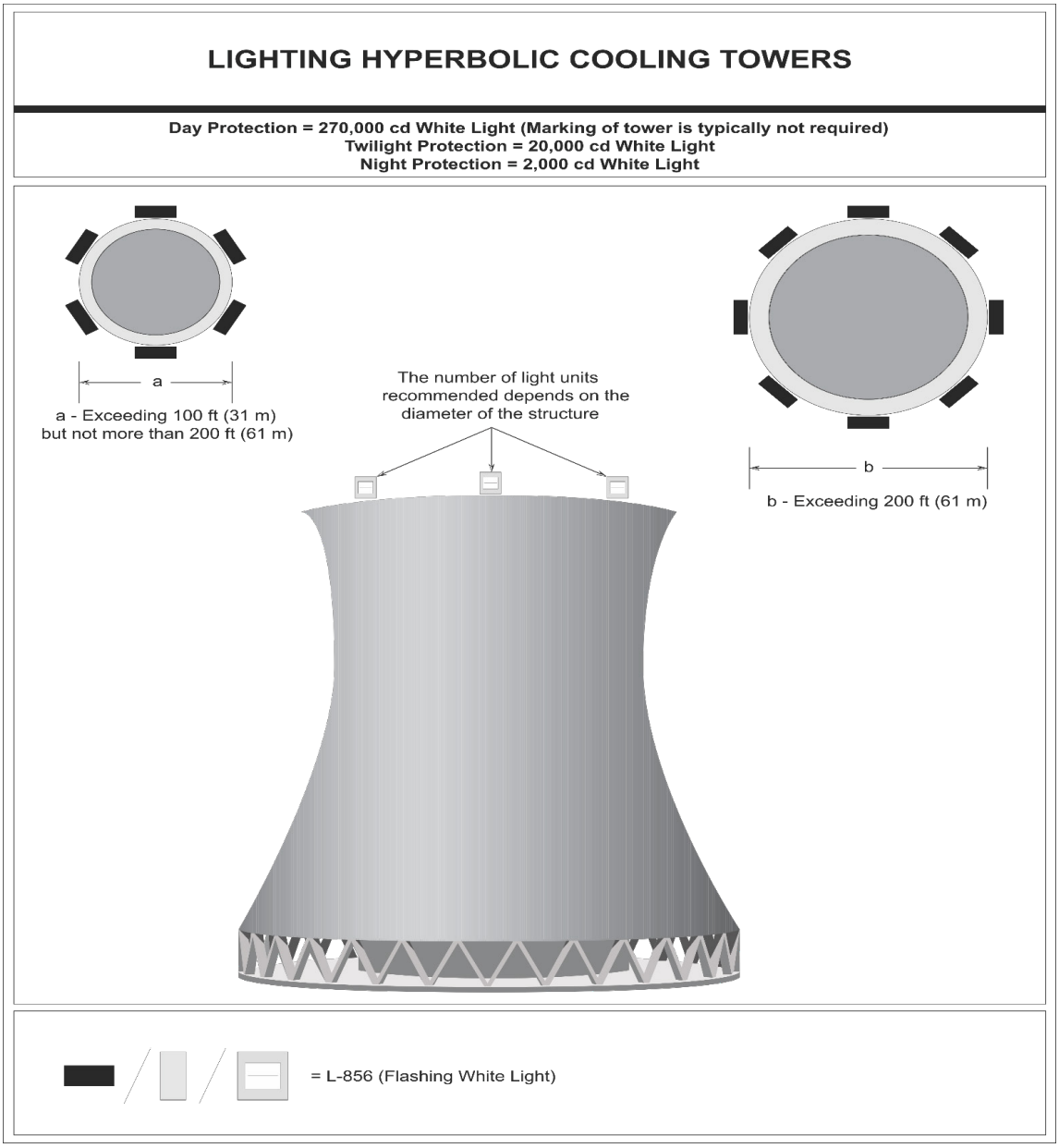


Figure A-15. Lighting Hyperbolic Cooling Tower

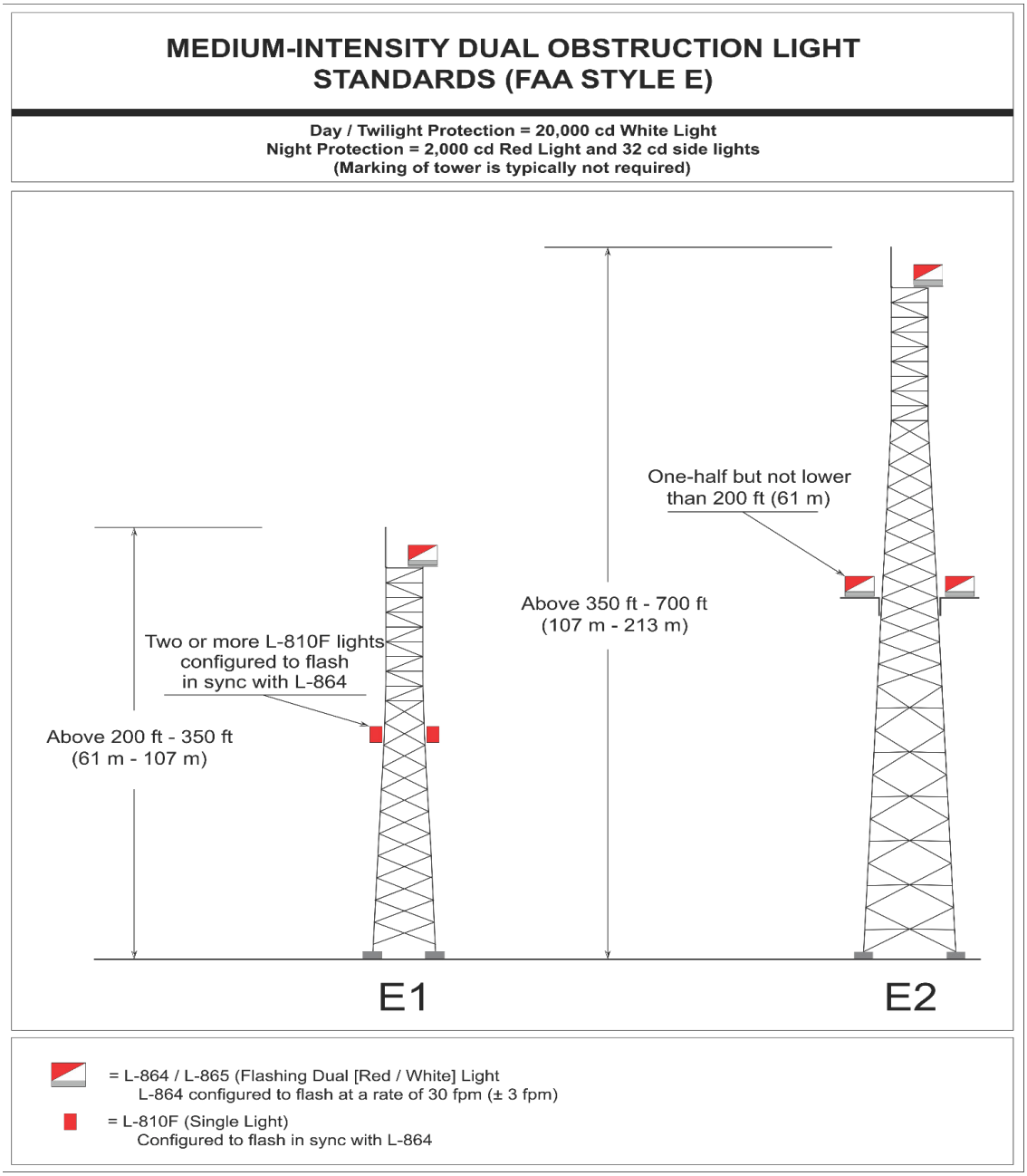


Figure A-16. Medium-Intensity Dual Obstruction Light Standards (FAA Style E)

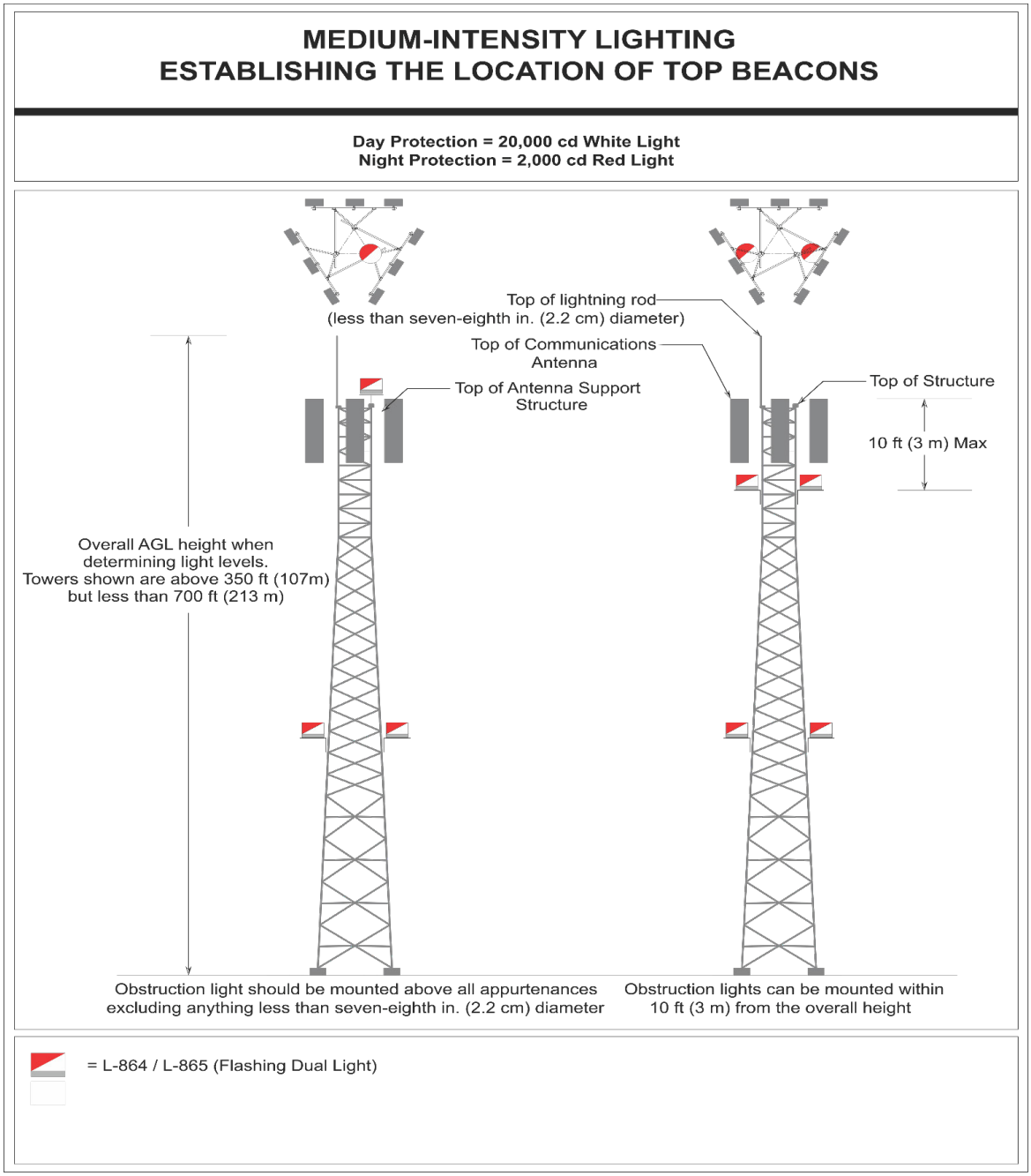


Figure A-17. Medium-Intensity Lighting—Establishing the Location of Top Beacons

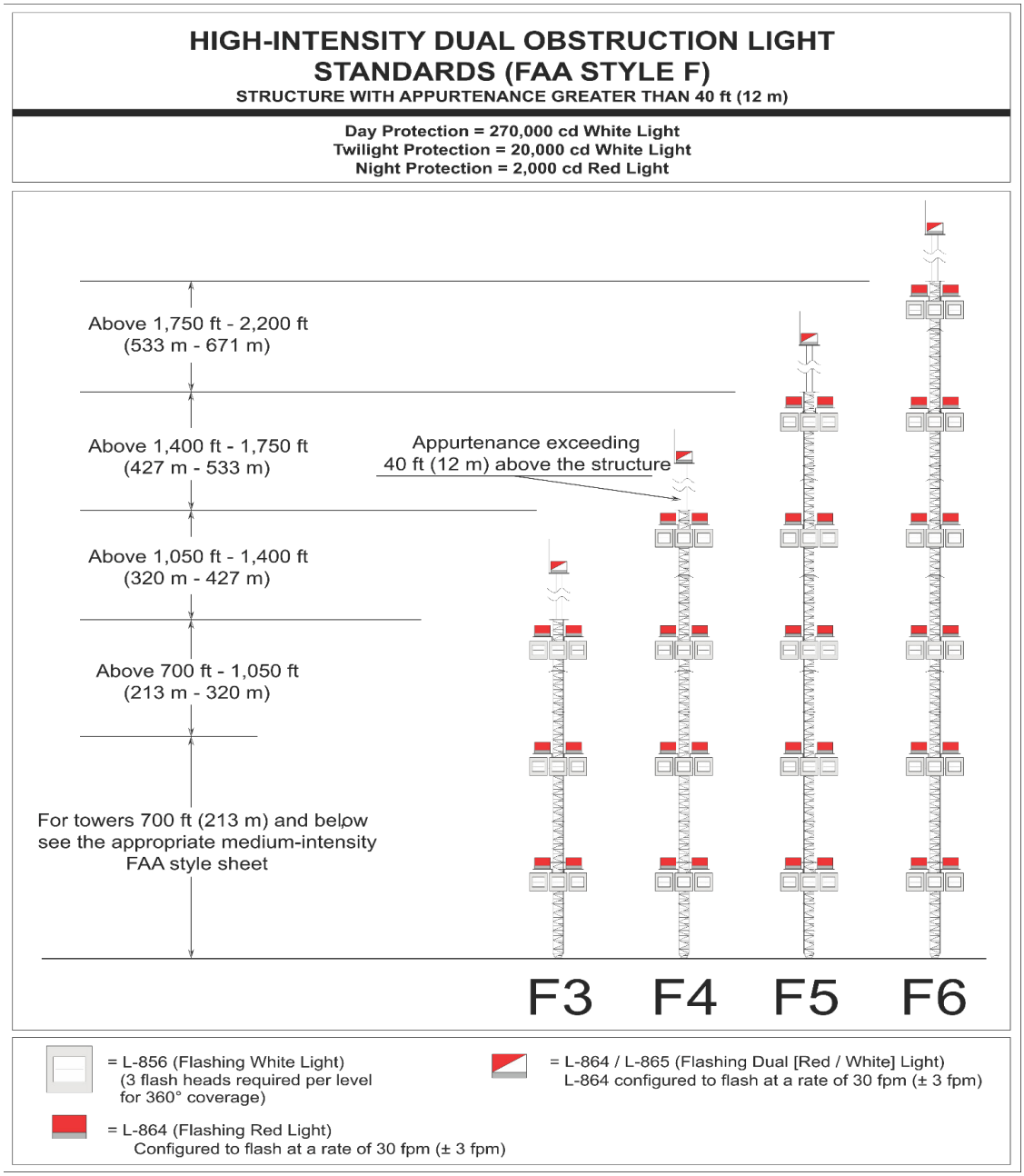


Figure A-18. High-Intensity Dual Obstruction Light Standards (FAA Style F)—With Appurtenance Over 40 Feet High

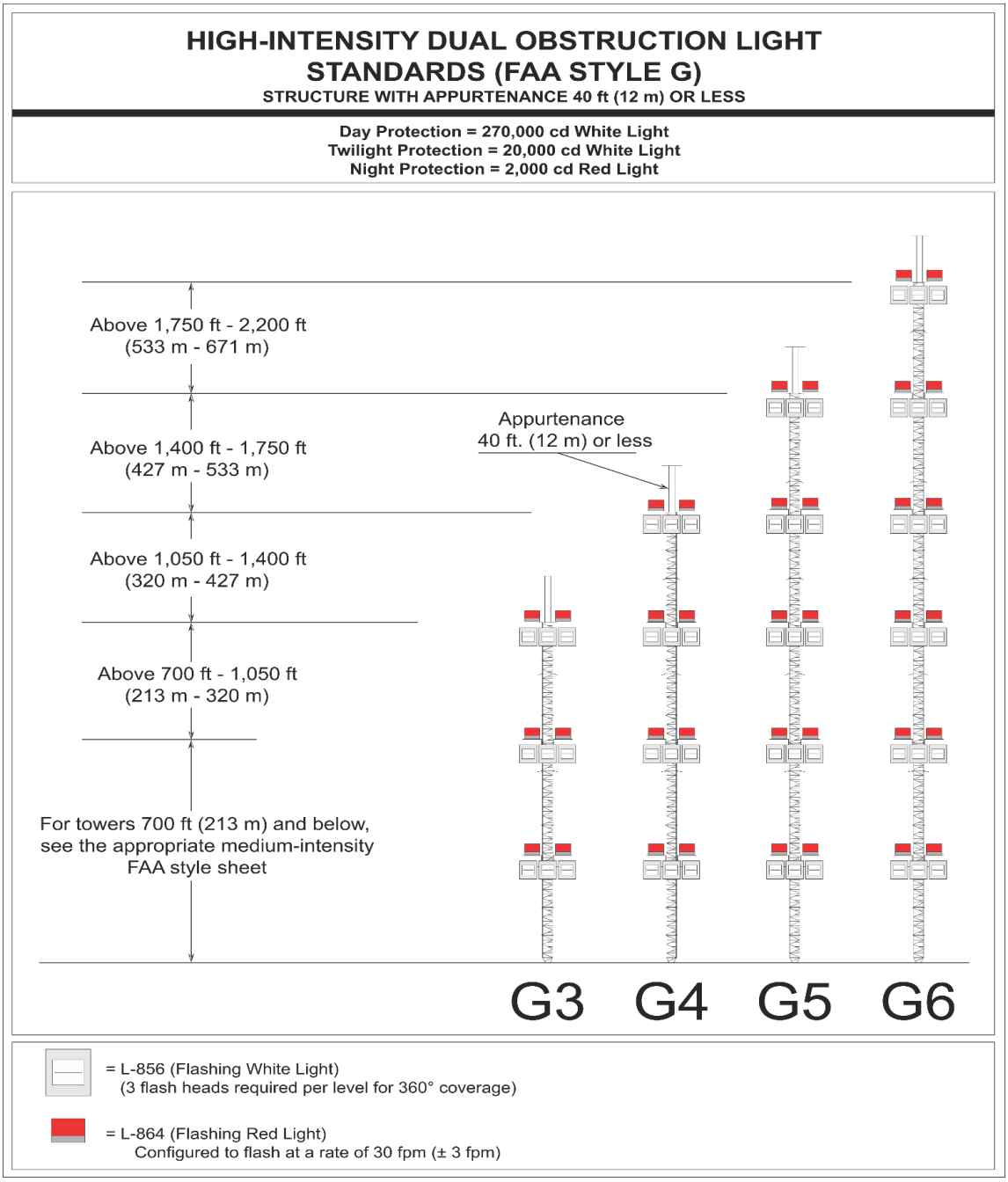


Figure A-19. High-Intensity Dual Obstruction Light Standards (FAA Style G)—With Appurtenance 40 Feet or Less

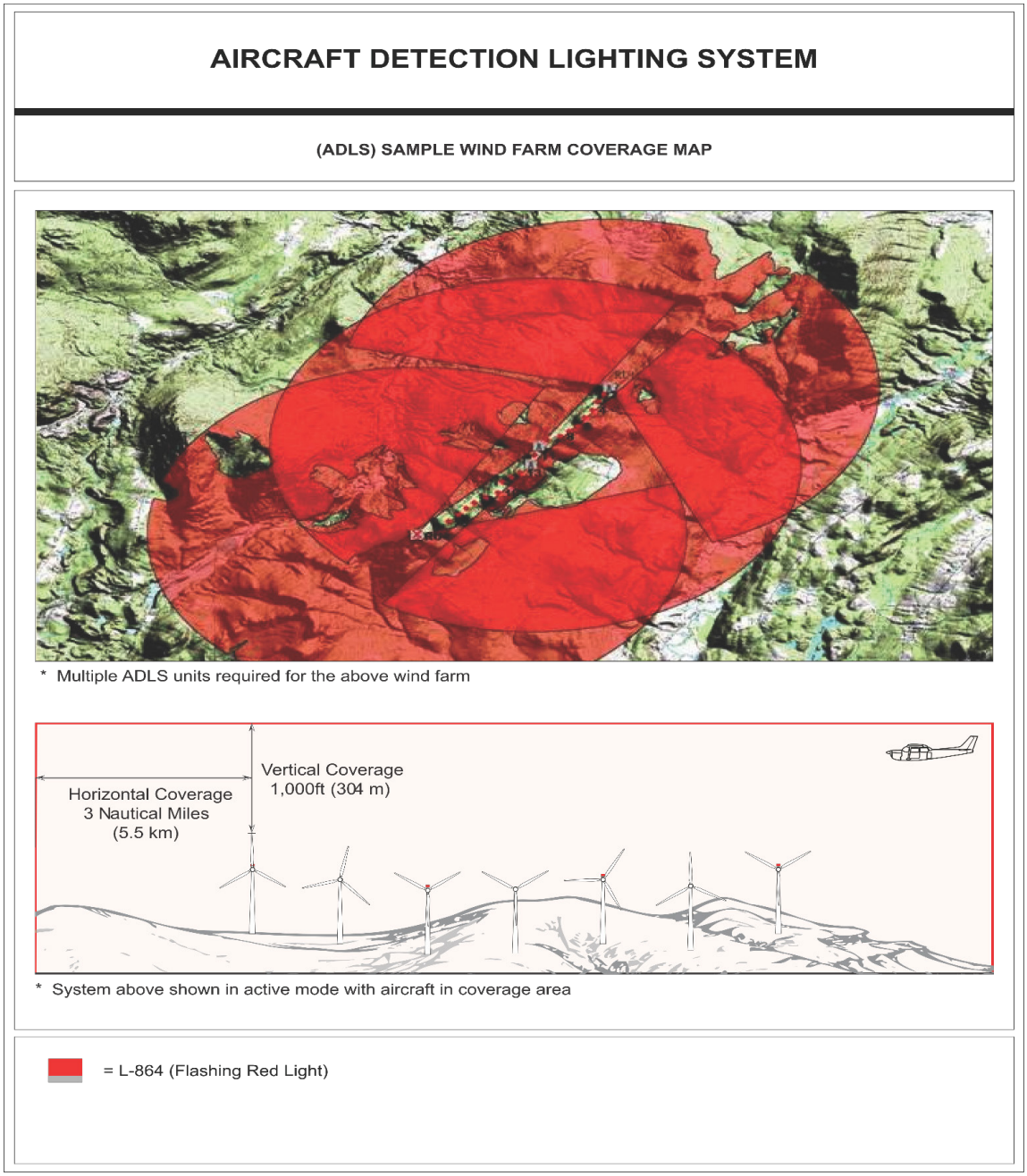


Figure A-20. Aircraft Detection Lighting System (sample coverage map)

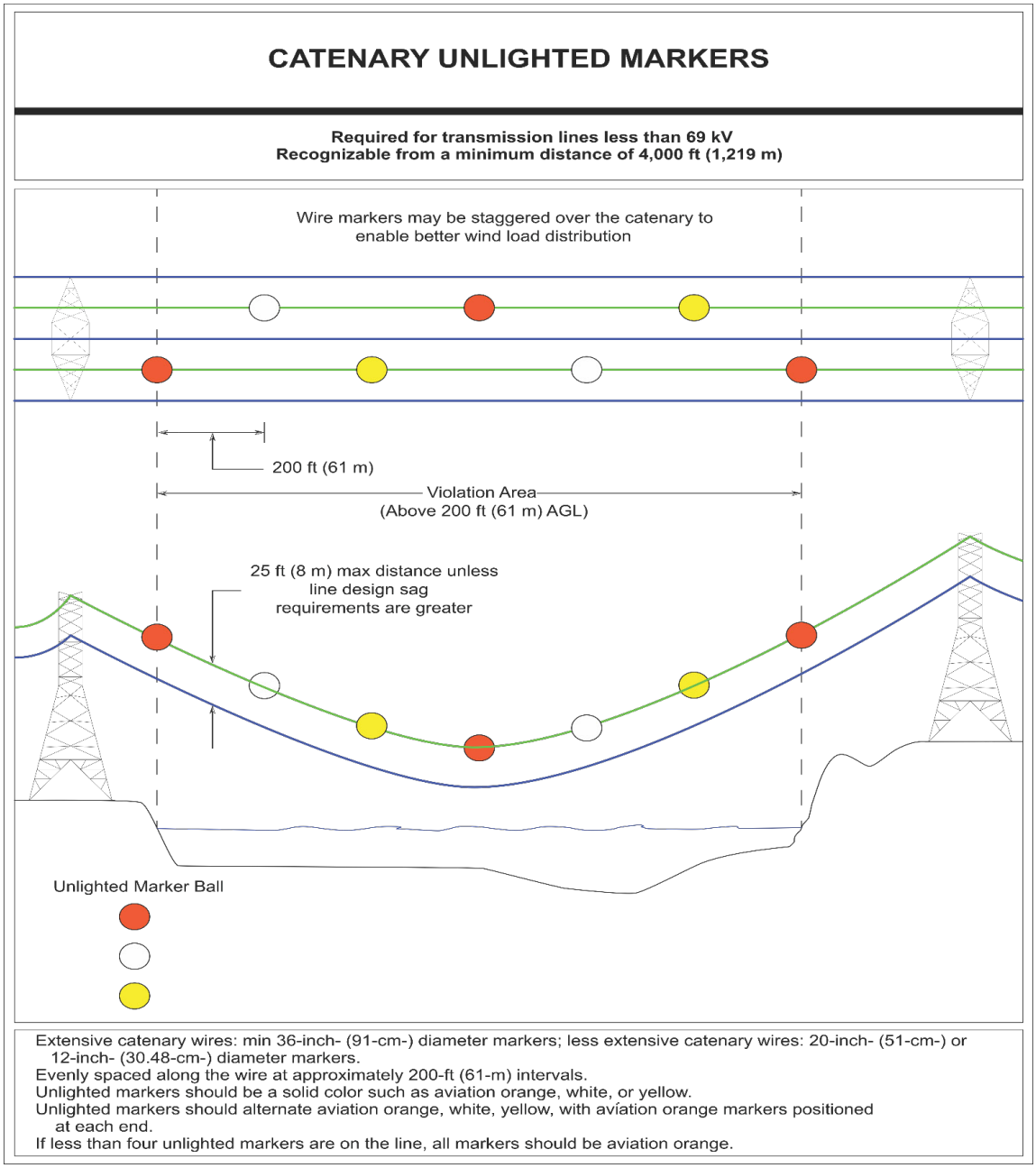


Figure A-21. Catenary Unlighted Markers (less than 69 kV)

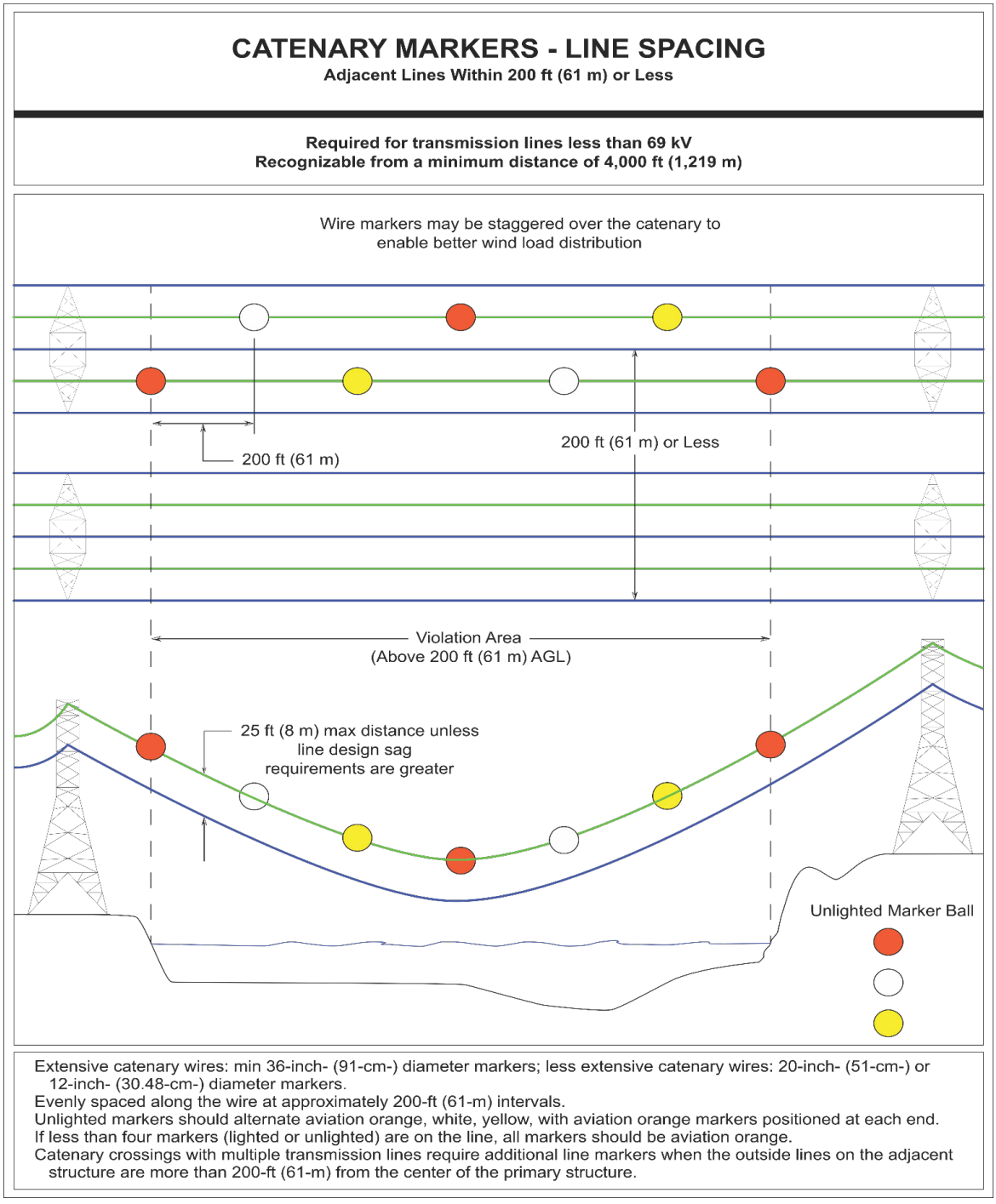


Figure A-22. Catenary Markers – Line Spacing (Adjacent Lines Within 200 Feet (60.96 m) or Less)

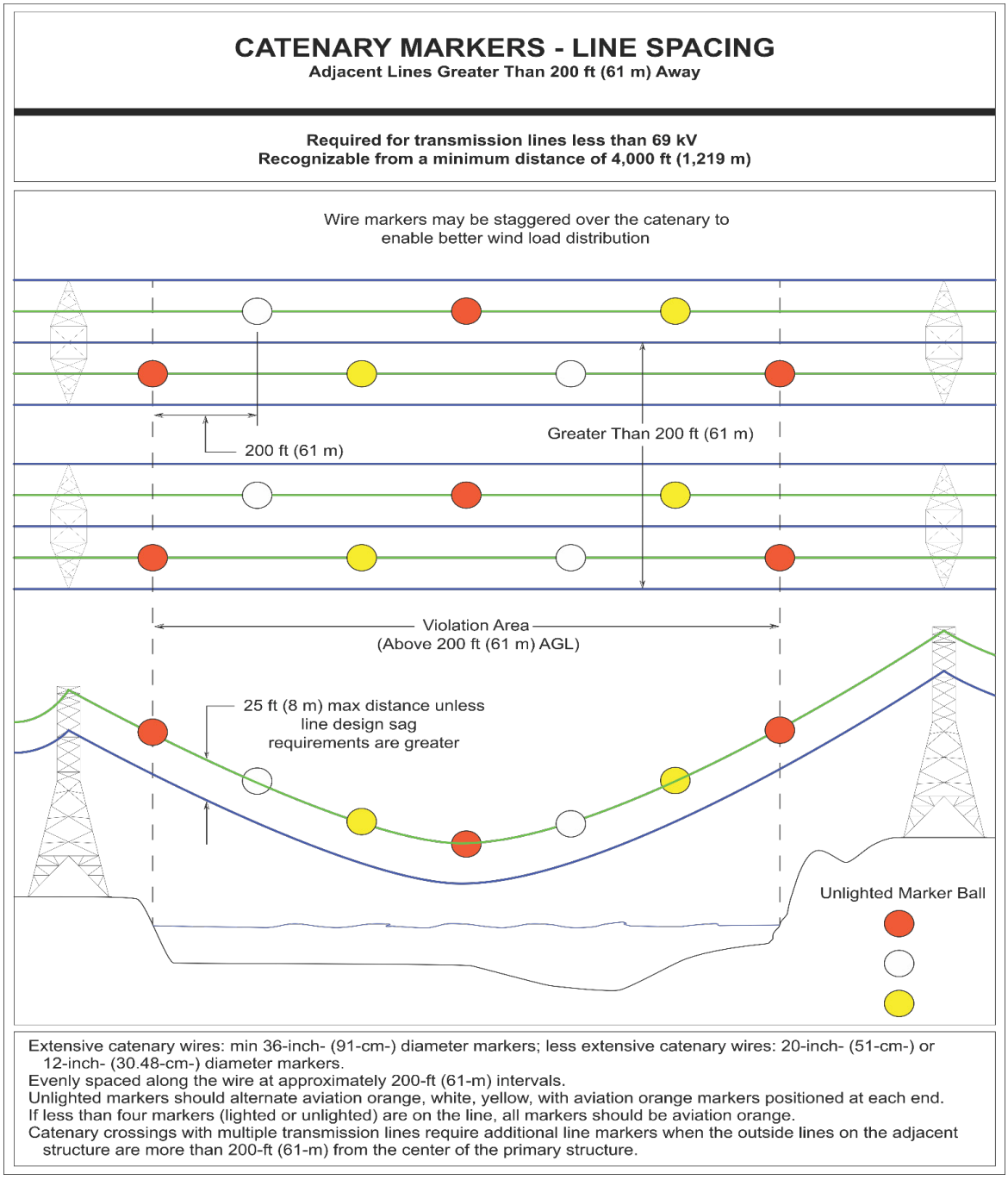


Figure A-23. Catenary Markers - Line Spacing (Adjacent Lines Greater Than 200 Feet (60.96 m) Away)

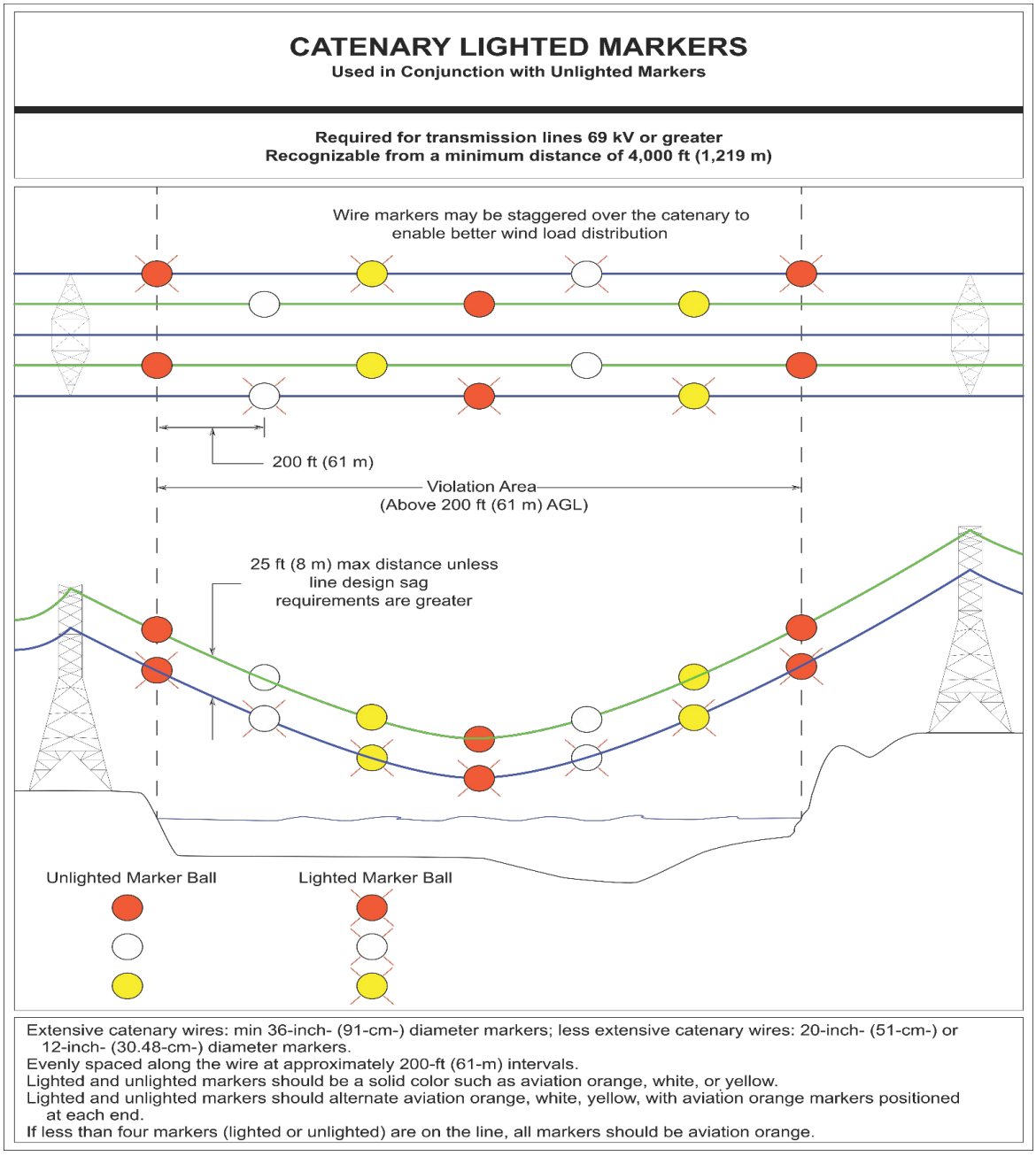


Figure A-24. Catenary Lighted Markers – Used in Conjunction with Unlighted Markers (69 kV or greater)

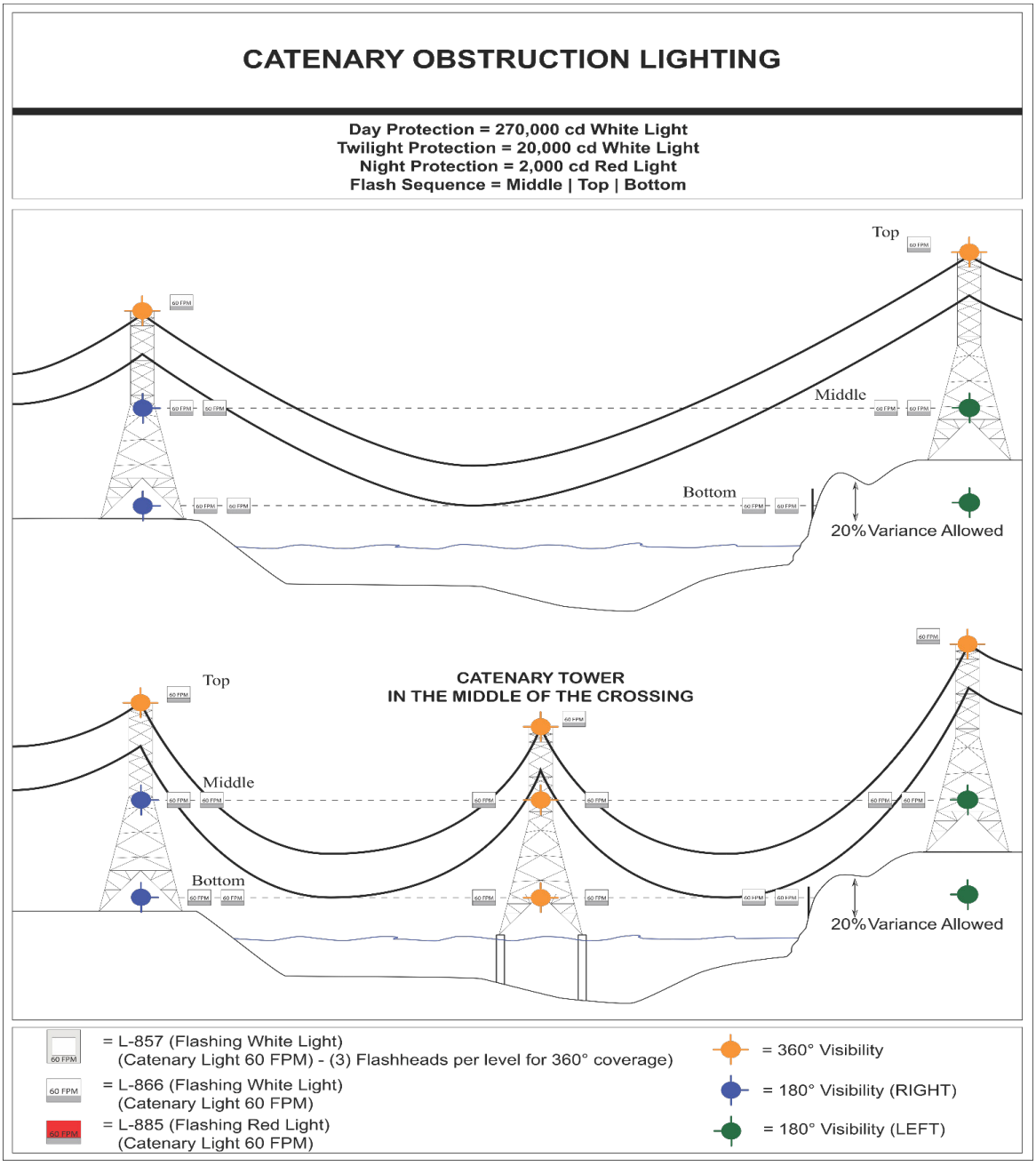


Figure A-25. Catenary Obstruction Lighting

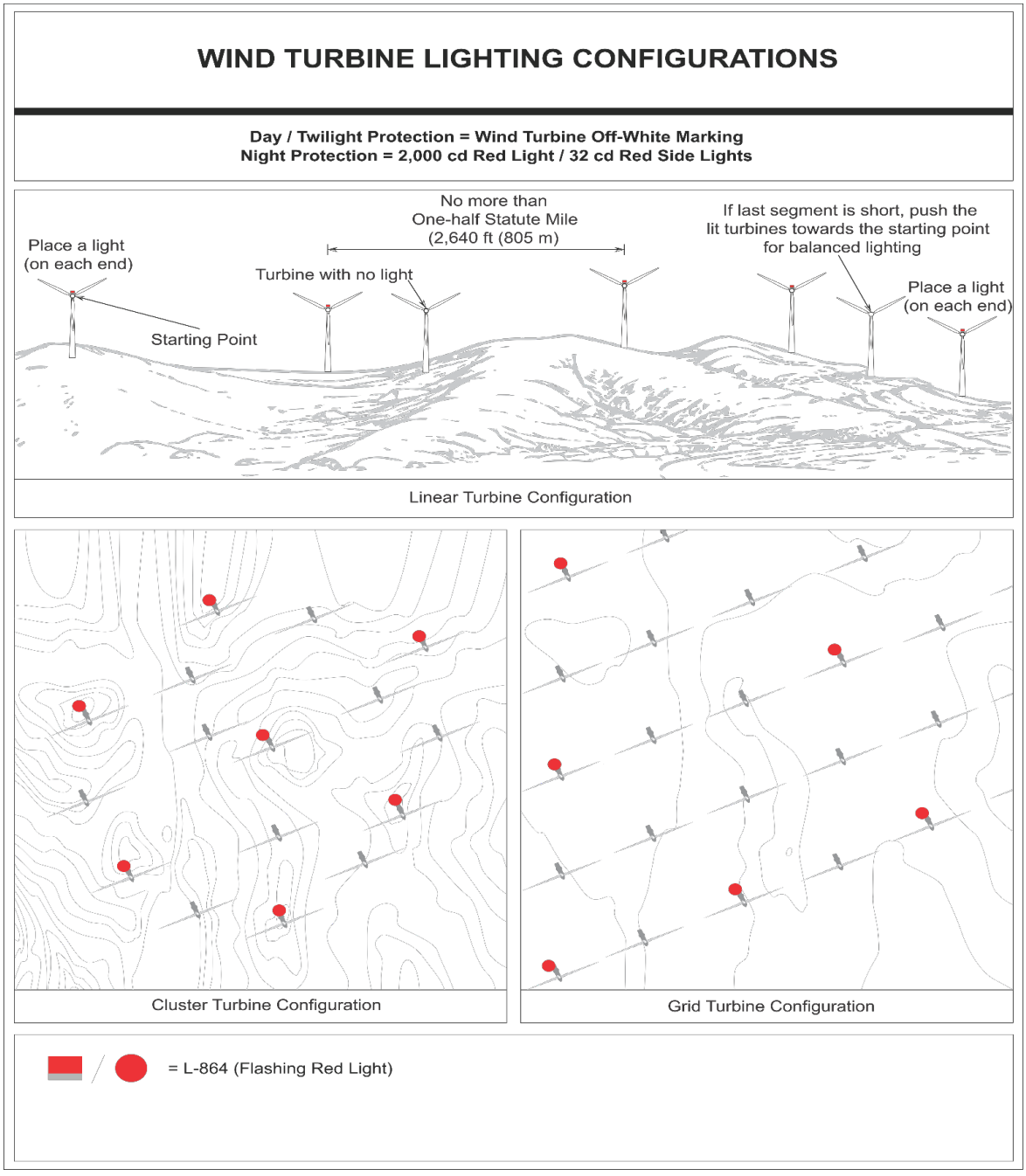


Figure A-26. Wind Turbine Lighting Configurations

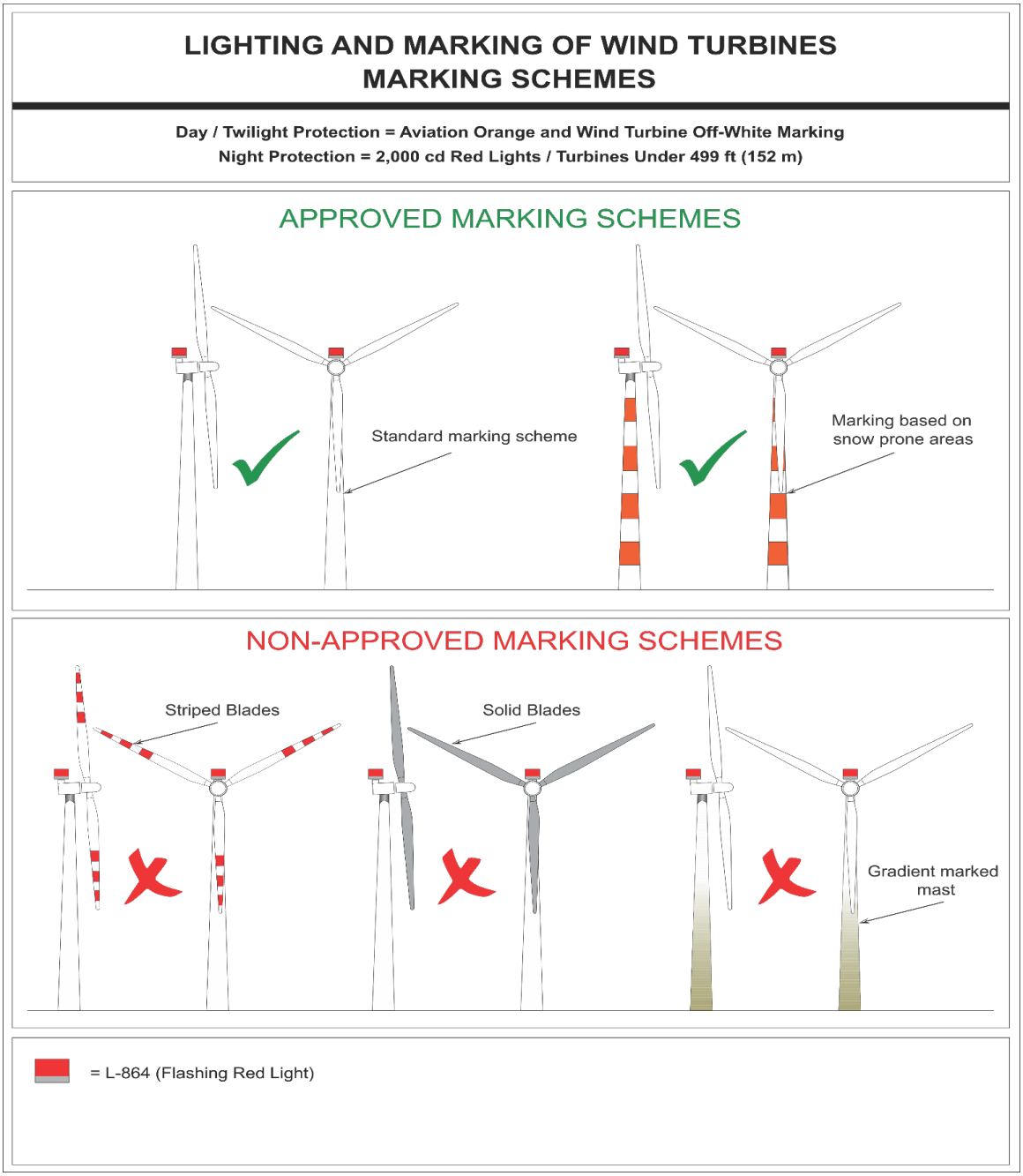


Figure A-27. Lighting and Marking of Wind Turbines – Paint Schemes

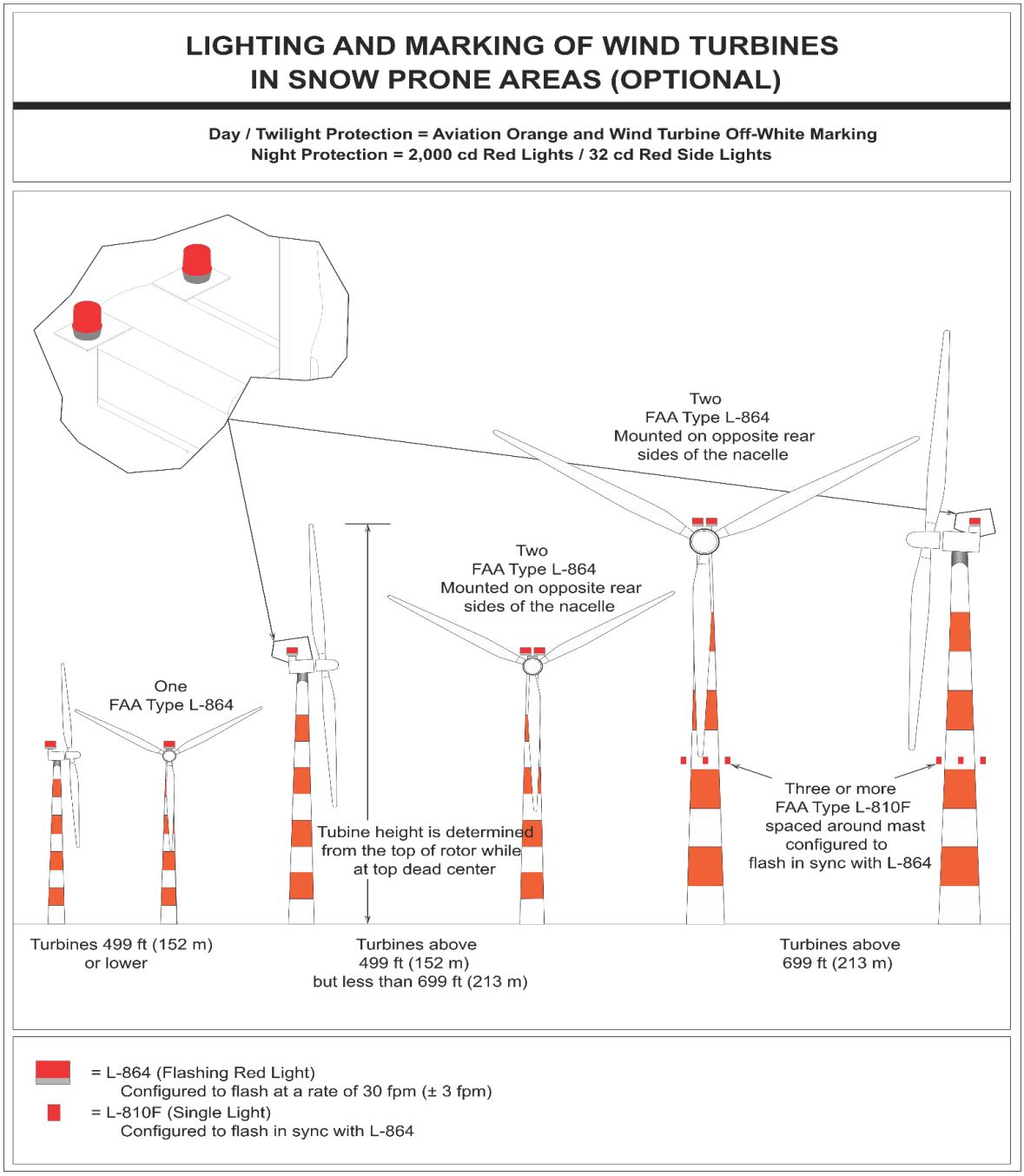


Figure A-28. Wind Turbine Lighting and Marking in Snow Prone Areas (Optional)

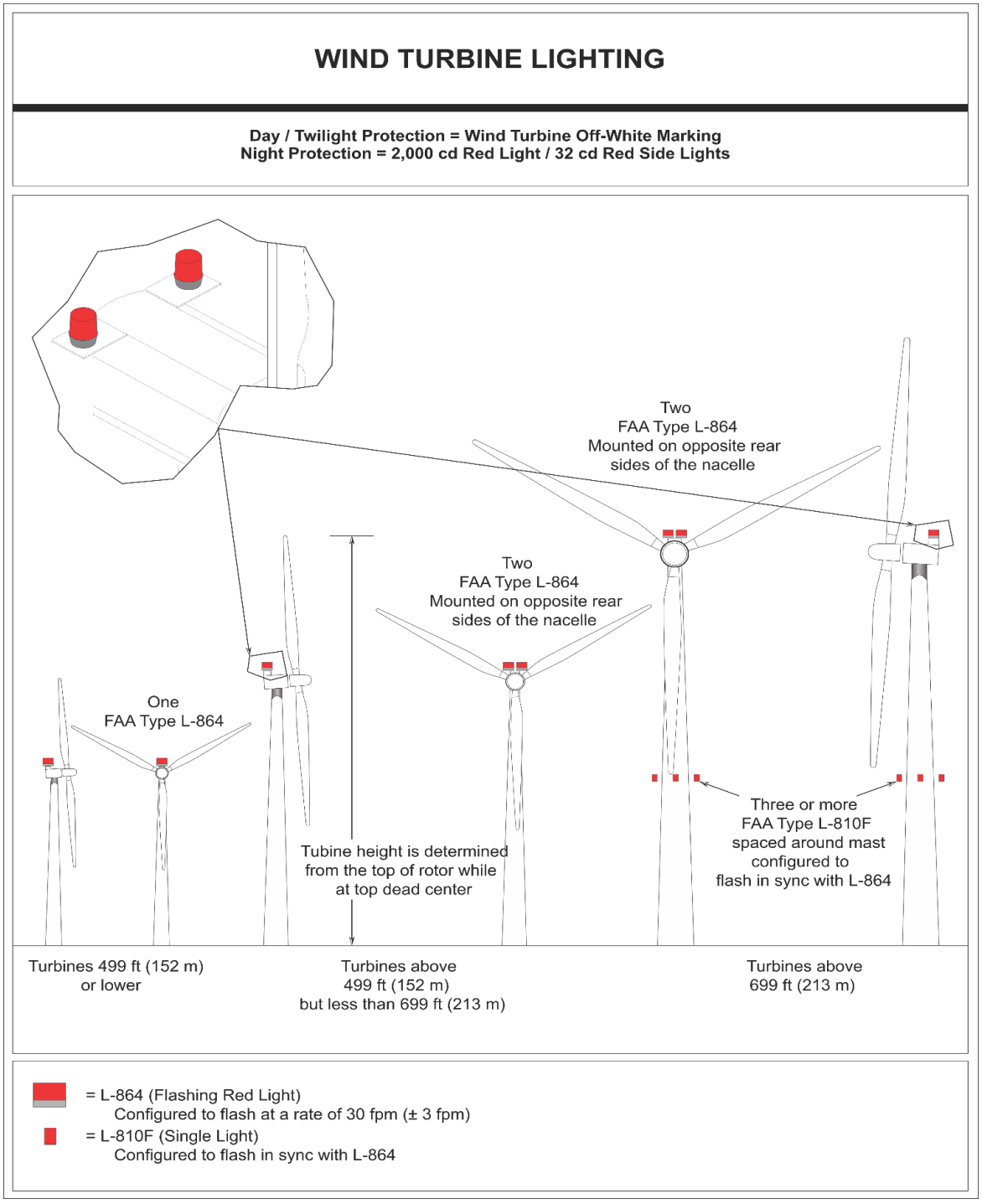


Figure A-29. Wind Turbine Lighting

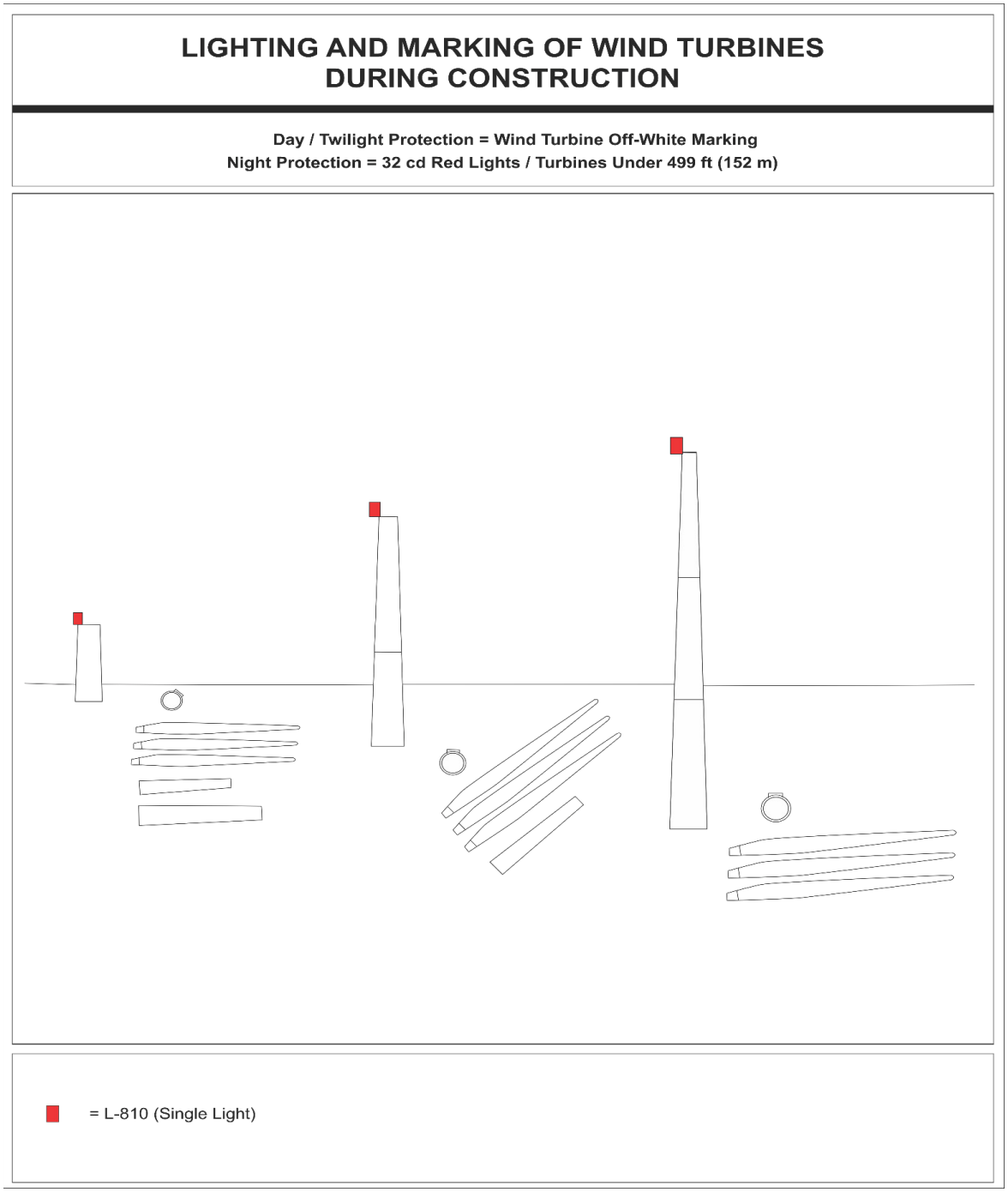


Figure A-30. Marking and Lighting of Turbines During Construction

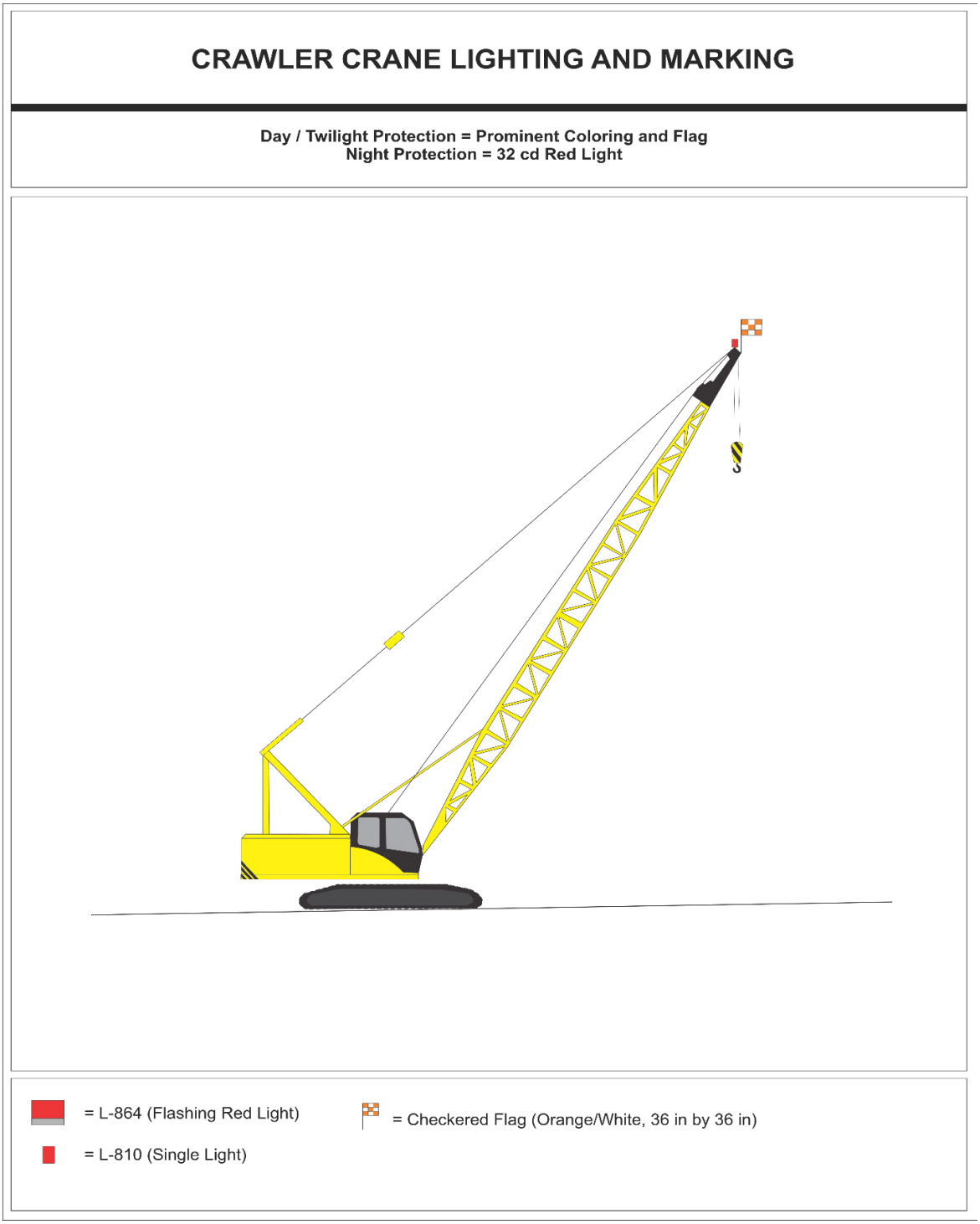


Figure A-31. Crawler Crane Marking and Lighting

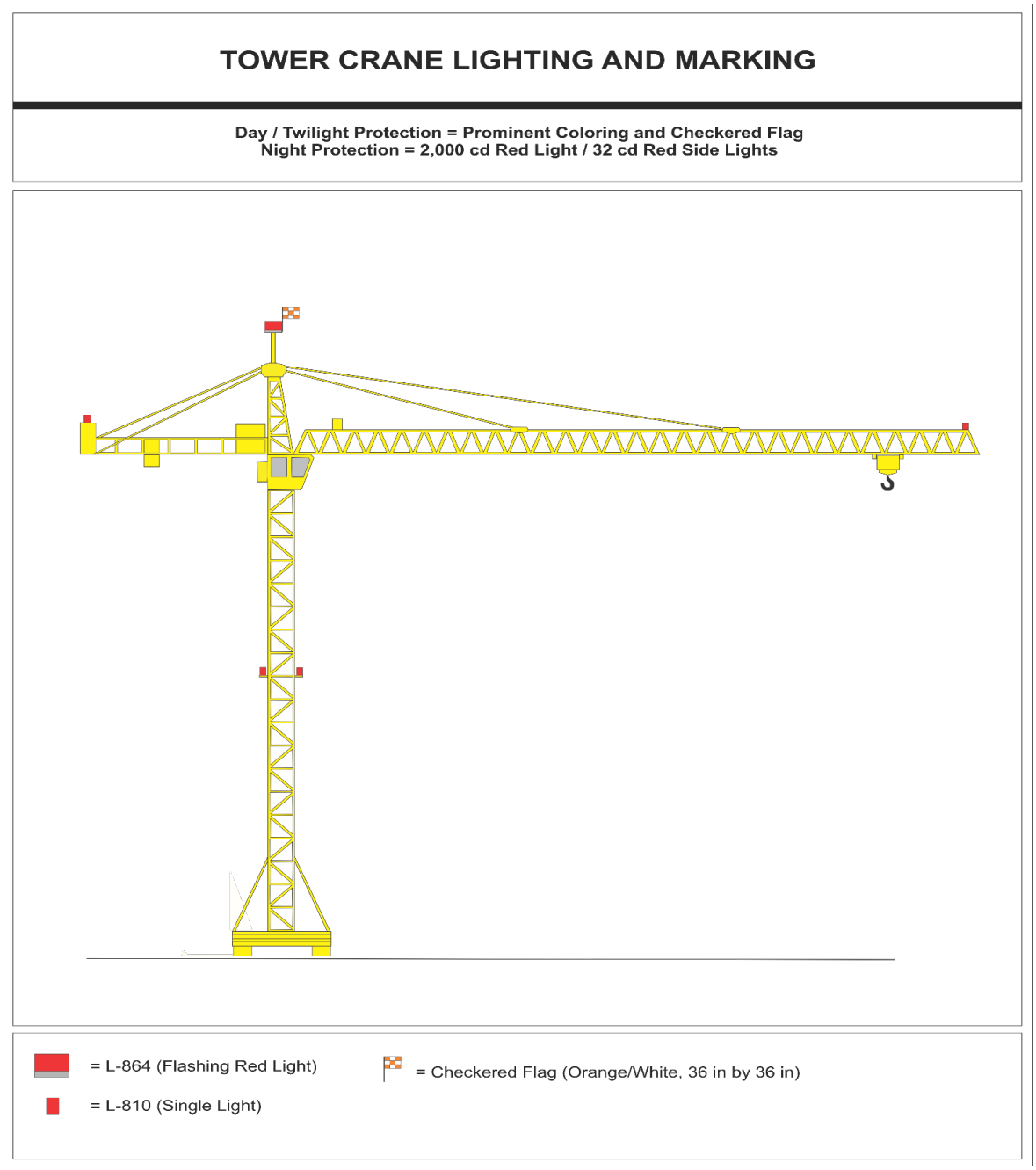


Figure A-32. Tower Crane Marking and Lighting

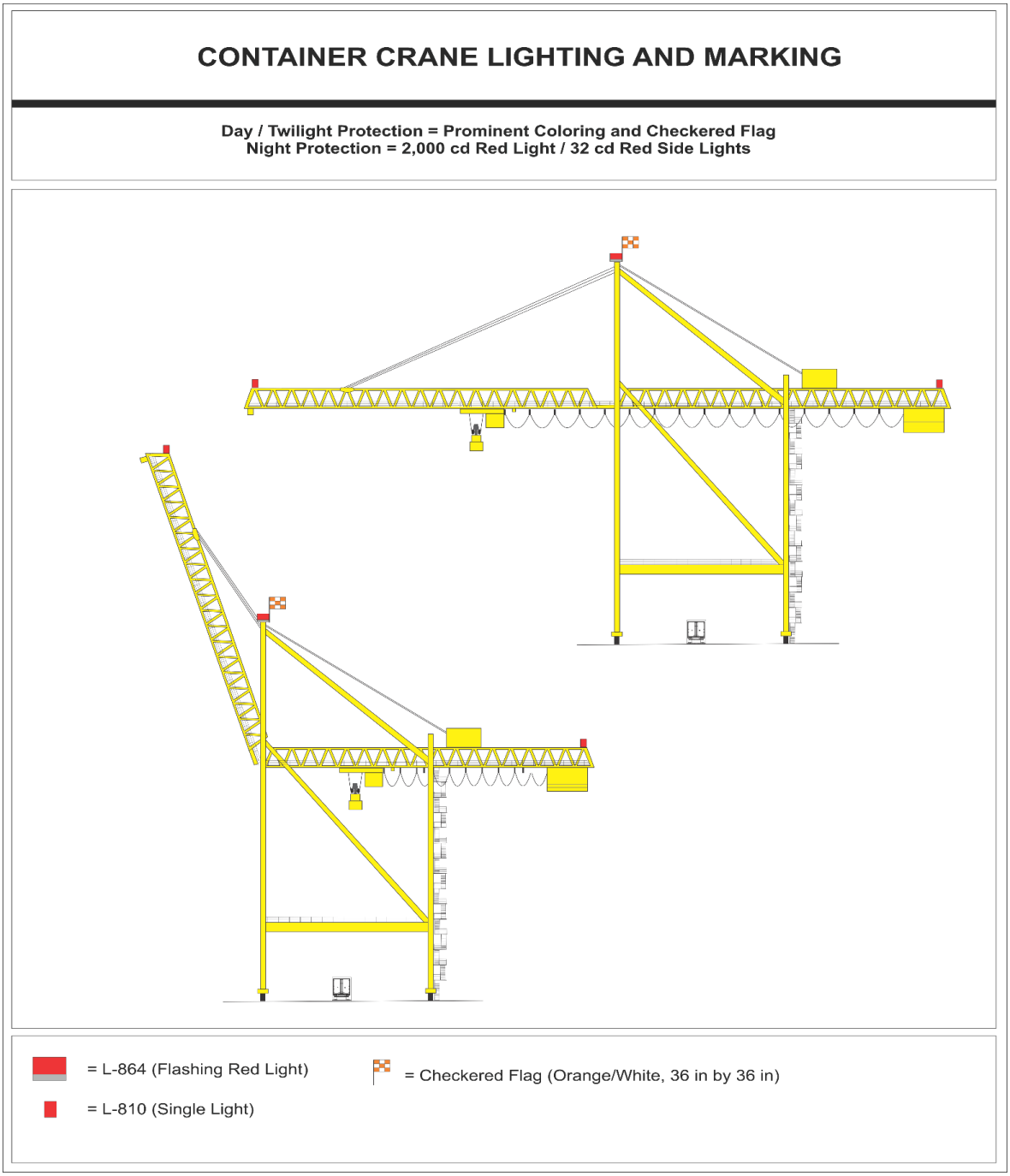


Figure A-33. Container Crane Marking and Lighting

APPENDIX B. MISCELLANEOUS

B.1 Rationale for Obstruction Light Intensities.

Sections 91.117, 91.119 and 91.155 of 14 CFR Part 91, *General Operating and Flight Rules*, prescribe aircraft speed restrictions, minimum safe altitudes, and basic visual flight rules (VFR) weather minimums for governing the operation of aircraft, including helicopters, within the United States.

B.2 Distance Versus Intensities.

Table B-1 indicates at what distance the various candela intensities are visible under one and three statute mile meteorological visibilities:

Table B-1. Distance and Intensity

Time Period	Meteorological Visibility Statute Miles	Distance Statute Miles	Intensity Candelas
Night	3 (4.83 km)	2.9 (4.67 km)	1,500 (±25%)
		3.1 (4.99 km)	2,000 (±25%)
		1.4 (2.25 km)	32
Day	1 (1.61 km)	1.5 (2.41 km)	200,000
		1.4 (2.25 km)	100,000
		1.0 (1.61 km)	20,000 (±25%)
Day	3 (4.83 km)	3.0 (4.83 km)	200,000
		2.7 (4.35 km)	100,000
		1.8 (2.90 km)	20,000 (±25%)
Twilight	1 (1.61 km)	1.0 (1.61 km) to 1.5 (2.41 km)	20,000 (±25%)
Twilight	3 (4.83 km)	1.8 (2.90 km) to 4.2 (6.76 km)	20,000 (±25%)

Note: Distance calculated for north sky illuminance

Figure B-1 illustrates the acquisition distance that an aircraft flying at a design speed of 165 knots (189.88 miles per hour (mph)/305.58 kilometers per hour (kph)) would need to allow for sufficient avoidance distance. The 2,000-foot avoidance distance comes from the guy wires of a 2,000-foot structure. The guy wires at a 45-degree angle would be at a distance of 1,500 feet from the structure at a 500-foot elevation. Since the aircraft is to be 500 feet clear of obstacles (the guy wire), the distance of avoidance from the structure is 1,500 + 500 = 2,000 feet (see Figure B-1 below).

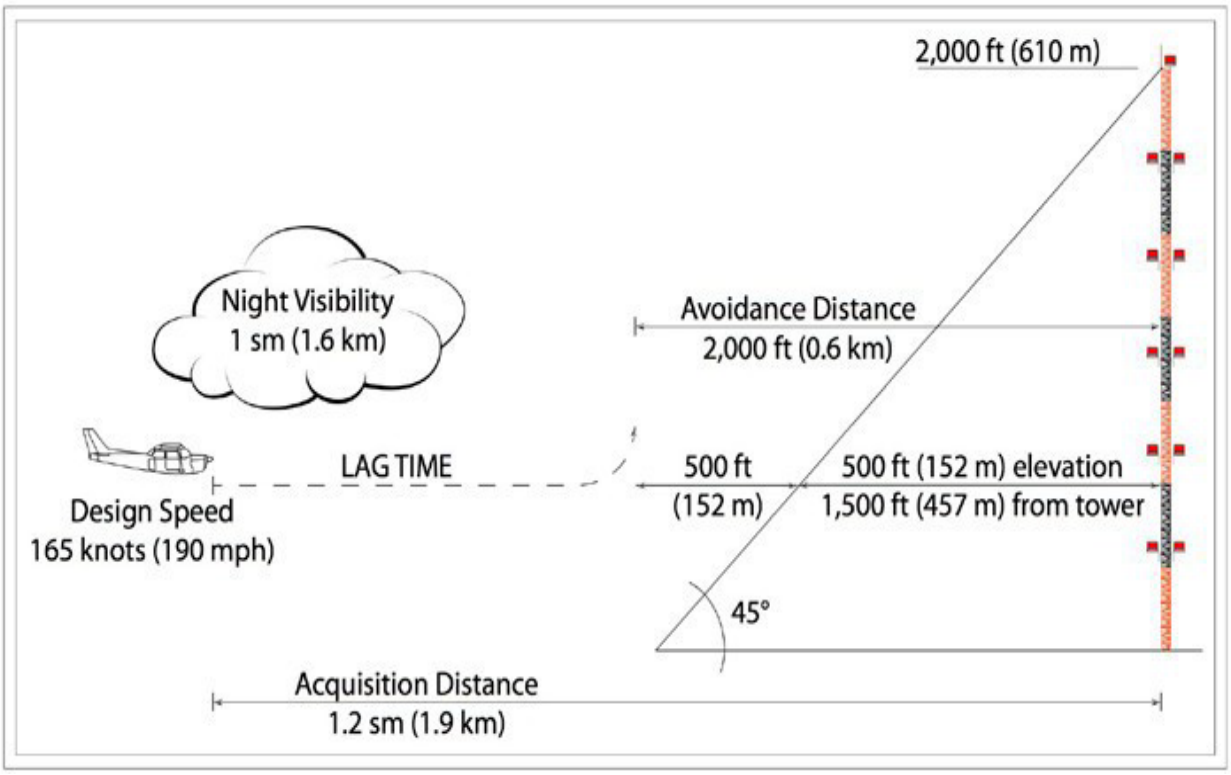


Figure B-1. Acquisition Distance Calculation

B.3 Application.

Aircraft pilots travelling at 165 knots (189.88 miles per hour (mph)/305.58 kilometers per hour (kph)) or less should be able to see obstruction lights in sufficient time to avoid the structure by at least 2,000 feet (609.60 m) horizontally under all conditions of operation, provided the pilot is operating in accordance with 14 CFR Part 91. Pilots operating aircraft between 165 knots (189.88 mph/305.58 kph) and 250 knots (287.70 mph/463.00 kph) should also be able to see the obstruction lights at the same distance unless the visibility deteriorates to 1 SM (1.61 km) at night. reducing the visible light (the ability to see the light) to 1.2 SM (1.93 km) using 2,000 candela. When the visibility at night deteriorates to 1SM, the pilot's ability to see the lights of a structure using 2,000 candela is reduced to 1.2 SM. To provide an acquisition distance of 1.5 SM

a higher intensity obstruction light of 20,000 candela is required. When night visibility is 3 SM or greater, 20,000 candela could generate a residential annoyance factor resulting in complaints.

B.4 Definitions.

B-4.1 Flight Visibility.

The average forward horizontal distance, from the cockpit of an aircraft in flight, at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.

Reference: *Airman's Information Manual Pilot/Controller Glossary*.

B-4.2 Meteorological Visibility.

A term that denotes the greatest distance, expressed in statute miles, that selected objects (visibility markers) or lights of moderate intensity (25 candelas) can be seen and identified under specified conditions of observation.

APPENDIX C. ACRONYMS

Abbreviation	Meaning
AC	Advisory Circular
ADLS	Aircraft Detection Lighting System
AGL	Above Ground Level
AMSL	Above Mean Sean Level
cd	Candela
CFR	Code of Federal Regulations
CM	Centimeter
F	Flashing Lights
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FPM	Flashes Per Minute
IFR	Instrument Flight Rules
IR	IFR Military Training Route
KHZ	Kilohertz
KM	Kilometers
KPH	Kilometer Per Hour
KV	Kilovolts
LED	Light Emitting Diode
LUX	Lumen Per Square Meter
M	Meter
MHZ	Megahertz
MPH	Miles Per Hour
NAS	National Airspace System
NAVAIDS	Navigational Aids
NM	Nautical Mile
NOTAM	Notice to Air Missions
NVG	Night Vision Goggles
OEG	Obstruction Evaluation Group

APPENDIX C. ACRONYMS

Abbreviation	Meaning
SM	Statute Mile
URL	Uniform Resource Locator
UV	Ultraviolet
US	United States
VFR	Visual Flight Rules

APPENDIX D. ADVISORY CIRCULAR FEEDBACK FORM

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☐ An error (procedural or typographical) has been noted in paragraph_____on page.

☐ Recommend paragraph_____on page_____be changed as follows:

☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

☐ Other comments:

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Submitted by:_____Date: _____