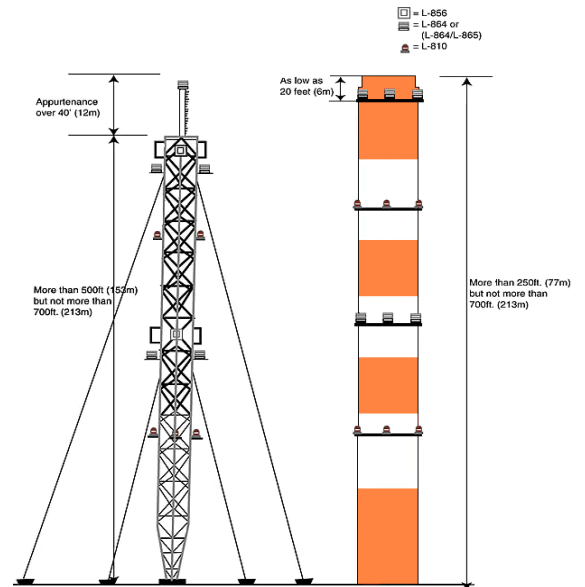
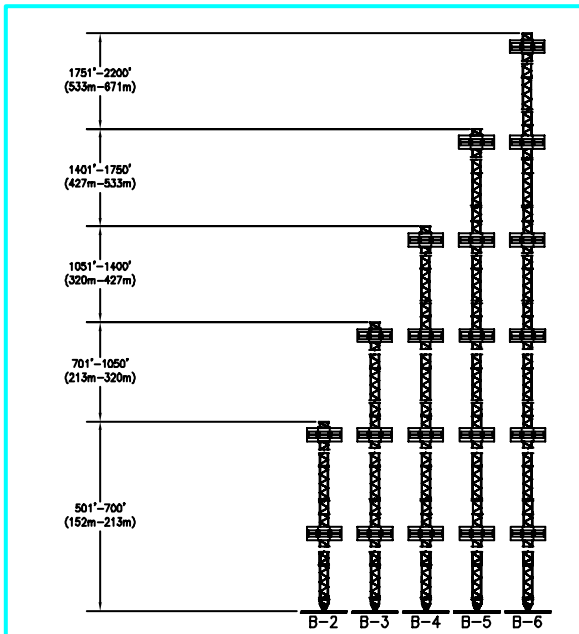
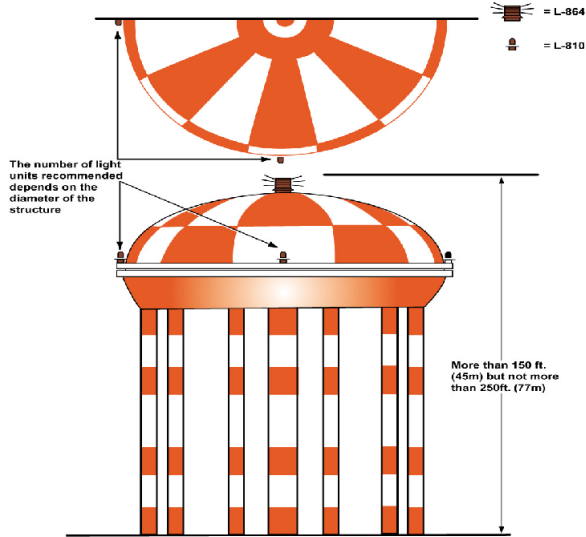




## Obstruction Marking and Lighting



## CHAPTER 4. LIGHTING GUIDELINE

### 40. PURPOSE

This chapter describes the various obstruction lighting systems used to identify structures that an aeronautical study has determined will require added conspicuity. The lighting standards in this circular are the minimum necessary for aviation safety. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 41. STANDARDS

The standards outlined in this AC are based on the use of light units that meet specified intensities, beam patterns, color, and flash rates as specified in AC 150/5345-43.

These standards may be obtained from:

Department of Transportation  
TASC  
Subsequent Distribution Office, SVC-121.23  
Ardmore East Business Center  
3341 Q 75th Avenue  
Landover, MD 20785

### 42. LIGHTING SYSTEMS

Obstruction lighting may be displayed on structures as follows:

**a. Aviation Red Obstruction Lights.** Use flashing beacons and/or steady burning lights during nighttime.

**b. Medium Intensity Flashing White Obstruction 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 500 feet (153m) AGL or less in height, other methods of marking and lighting the structure may be omitted. Aviation orange and white paint is always required for daytime marking on structures exceeding 500 feet (153m) AGL. This system is not normally recommended on structures 200 feet (61m) AGL or less.

**c. High Intensity Flashing White Obstruction Lights.** Use high intensity flashing white obstruction lights 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 recommended on structures 500 feet (153m) AGL or less, unless an FAA aeronautical study shows otherwise.

*Note-*

*All flashing lights on a structure should flash simultaneously except for catenary support structures, which have a distinct sequence flashing between levels.*

**d. Dual Lighting.** This system consists of red lights for nighttime and high or medium intensity flashing white lights for daytime and twilight. When a dual lighting system incorporates medium flashing intensity lights on structures 500 feet (153m) or less, or high intensity flashing white lights on structures of any height, other methods of marking the structure may be omitted.

**e. 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, as 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 would 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.

**f. Obstruction Lights in Urban Areas.** When a structure is located in an urban area where there are numerous other white lights (e.g., streetlights, etc.) red obstruction lights with painting or a medium intensity dual system is recommended. Medium intensity lighting is not normally recommended on structures less than 200 feet (61m).

**g. Temporary Construction Equipment Lighting.** Since there is such a variance in construction cranes, derricks, oil and other drilling rigs, each case should be considered individually. Lights should be installed according to the standards given in Chapters 5, 6, 7, or 8, as they would apply to permanent structures.

### 43. CATENARY LIGHTING

Lighted markers are available for increased night conspicuity of high-voltage (69KV 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 (1219m) under nighttime conditions, minimum visual flight rules (VFR) conditions or having a minimum intensity of at least 32.5 candela. The lighting unit should emit a steady burning red light. They should be used on the highest energized line. If the lighted markers are installed on a line other than the highest catenary, then markers specified in paragraph 34 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 20 feet (6m).) Markers should be distinctively shaped, i.e., spherical, 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. 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 a full coverage.

### 44. 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 3 percent of the rated voltage of the lamp. The input voltage should be measured at the lamp socket 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 operated for not more than 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 or when the fixture begins skipping flashes, or at the manufacturer's recommended intervals. Due to the effects of harsh environments, beacon lenses should be visually inspected for ultraviolet damage, cracks, crazing, dirt

build up, etc., to insure that the certified light output has not deteriorated. (See paragraph 23, for reporting requirements in case of failure.)

### 45. NONSTANDARD LIGHTS

Moored balloons, chimneys, church steeples, 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 over the top one-third of the obstruction.

### 46. PLACEMENT FACTORS

The height of the structure AGL determines the number of light levels. The light levels may be adjusted slightly, but not to exceed 10 feet (3m), when necessary to accommodate guy wires and personnel who replace or repair light fixtures. Except for catenary support structures, the following factors should be considered when determining the placement of obstruction lights on a structure.

**a. Red Obstruction Lighting Systems.** The overall height of the structure including all appurtenances such as rods, antennas, obstruction lights, etc., determines the number of light levels.

**b. Medium Intensity Flashing White Obstruction Lighting Systems.** The overall height of the structure including all appurtenances such as rods, antennas, obstruction lights, etc., determines the number of light levels.

**c. High Intensity Flashing White Obstruction Lighting Systems.** The overall height of the main structure including all appurtenances such as rods, antennas, obstruction lights, etc., determines the number of light levels.

**d. Dual Obstruction Lighting Systems.** The overall height of the structure including all appurtenances such as rods, antennas, obstruction lights, etc., is used to determine the number of light levels for a medium intensity white obstruction light/red obstruction dual lighting system. The overall height of the structure including all appurtenances is used to determine the number of light levels for a high intensity white obstruction light/red obstruction dual lighting system.

**e. 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 proper number of light levels required.

**f. *Shielded Lights.*** If an adjacent object shields any light, horizontal placement of the lights should be adjusted or additional lights should be mounted on that object to retain or contribute to the definition of the obstruction.

#### **47. 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 communication status and operational status of the system should be confirmed at least once every 24 hours. The monitor (aural or visual) should be located in an area generally occupied by 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 daily operations status of the lighting system is recorded. Beacon

lenses should be replaced if serious cracks, crazing, dirt build up, etc., has occurred.

#### **48. 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 accumulations from damaging the light units.

#### **49. DISTRACTION**

**a.** Where obstruction lights may distract operators of vessels in the proximity of a navigable waterway, the sponsor must coordinate with the Commandant, U.S. Coast Guard, to avoid interference with marine navigation.

**b.** The address for marine information and coordination is:

Chief, Aids to Navigation Division (OPN) U.S. Coast Guard Headquarters 2100 2nd Street, SW., Rm. 3610 Washington, DC 20593-0001 <i>Telephone: (202) 267-0980</i>
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## CHAPTER 5. RED OBSTRUCTION LIGHT SYSTEM

### 50. PURPOSE

Red Obstruction lights are used to increase conspicuity during nighttime. Daytime and twilight marking is required. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 51. STANDARDS

The red obstruction lighting system is composed of flashing omnidirectional beacons (L-864) and/or steady burning (L-810) lights. When one or more levels is comprised of flashing beacon lighting, the lights should flash simultaneously.

**a. *Single Obstruction Light.*** A single (L-810) light may be used when more than one obstruction light is required either vertically or horizontally or where maintenance can be accomplished within a reasonable time.

**1. *Top Level.*** A single light may be used to identify low structures such as airport ILS buildings and long horizontal structures such as perimeter fences and building roof outlines.

**2. *Intermediate Level.*** Single lights 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.

**b. *Double Obstruction Light.*** A double (L-810) 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.

**1. *Top Level. Structures 150 feet (46m) AGL or less*** should have one or more double lights installed at the highest point and operating simultaneously.

**2. *Intermediate Level.*** Double lights should be installed at intermediate levels when a malfunction of a single light could create an unsafe condition and in remote areas where maintenance cannot be performed within a reasonable time. Both units may operate simultaneously, or a transfer relay may be used to switch to a spare unit should the active system fail.

**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 an FAA aeronautical study, the lowest level of lights may be eliminated.

### 52. CONTROL DEVICE

Red obstruction lights should be operated by a satisfactory control device (e.g., photo cell, 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 (645.8 lux) but before reaching a level of 35 foot-candles (367.7 lux). The control device should turn the lights off when the northern sky illuminance rises to a level of not more than 60 foot-candles (645.8 lux). The lights may also remain on continuously. The sensing device should, if practical, face the northern sky in the Northern Hemisphere. (See AC 150/5345-43.)

### 53. POLES, TOWERS, AND SIMILAR SKELETAL STRUCTURES

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

#### **a. *Top Mounted Obstruction Light.***

**1. *Structures 150 Feet (46m) AGL or Less.*** Two or more steady burning (L-810) lights should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

**2. *Structures Exceeding 150 Feet (46m) AGL.*** At least one red flashing (L-864) beacon should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

**3. *Appurtenances 40 Feet (12m) or Less.*** If a rod, antenna, or other appurtenance 40 feet (12m) or less in height is incapable of supporting a red flashing beacon, then it may be placed at the base of the appurtenance. If the mounting location does not allow unobstructed viewing of the beacon by a pilot, then additional beacons should be added.

**4. *Appurtenances Exceeding 40 Feet (12m).*** If a rod, antenna, or other appurtenance exceeding 40 feet (12m) in height is incapable of supporting a red flashing beacon, a supporting mast with one or more beacons should be installed adjacent to the appurtenance. Adjacent installations should not exceed the height of the appurtenance and be within 40 feet (12m) of the tip to allow the pilot an unobstructed view of at least one beacon.

**b. *Mounting Intermediate Levels.*** The number of light levels is determined by the height of the structure, including all appurtenances, and is detailed in Appendix 1. The number of lights on each level is

determined by the shape and height of the structure. These lights should be mounted so as to ensure an unobstructed view of at least one light by a pilot.

#### 1. *Steady Burning Lights (L-810).*

##### (a) *Structures 350 Feet (107m) AGL or Less.*

Two or more steady burning (L-810) lights should be installed on diagonally or diametrically opposite positions.

(b) *Structures Exceeding 350 Feet (107m) AGL.* Install steady burning (L-810) lights on each outside corner of each level.

#### 2. *Flashing Beacons (L-864).*

##### (a) *Structures 350 Feet (107m) AGL or Less.*

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

(b) *Structure Exceeding 350 Feet (107m) AGL.* At intermediate levels, two beacons (L-864) should be mounted outside at diagonally opposite positions of intermediate levels.

### 54. CHIMNEYS, FLARE STACKS, AND SIMILAR SOLID STRUCTURES

#### a. *Number of Light Units.*

1. The number of units recommended depends on the diameter of the structure at the top. The number of lights recommended below are the minimum.

2. When the structure diameter is:

(a) *20 Feet (6m) or Less.* Three light units per level.

(b) *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m).* Four light units per level.

(c) *Exceeding 100 Feet (31m) But Not More Than 200 Feet (61m).* Six light units per level.

(d) *Exceeding 200 Feet (61m).* Eight light units per level.

#### b. *Top Mounted Obstruction Lights.*

1. *Structures 150 Feet (46m) AGL or Less.* L-810 lights should be installed horizontally at regular intervals at or near the top.

2. *Structures Exceeding 150 Feet (46m) AGL.* At least three L-864 beacons should be installed.

3. *Chimneys, Cooling Towers, and Flare Stacks.* Lights may be displayed as low as 20 feet (6m) below the top to avoid the obscuring effect of deposits and heat generally emitted by this type of structure. It is important that these lights be 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.

c. *Mounting Intermediate Levels.* The number of light levels is determined by the height of the structure including all appurtenances. For cooling towers 600 feet (183m) or less, intermediate light levels are not necessary. Structures exceeding 600 feet (183m) AGL should have a second level of light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights.

1. *Steady Burning (L-810) Lights.* The recommended number of light levels may be obtained from Appendix 1. At least three lights should be installed on each level.

2. *Flashing (L-864) Beacons.* The recommended number of beacon levels may be obtained from Appendix 1. At least three lights should be installed on each level.

(a) *Structures 350 Feet (107m) AGL or Less.* These structures do not need intermediate levels of flashing beacons.

(b) *Structures Exceeding 350 Feet (107m) AGL.* At least three flashing (L-864) beacons should be installed on each level in a manner to allow an unobstructed view of at least one beacon.

### 55. WIND TURBINE STRUCTURES

Wind turbine structures should be lighted by mounting two flashing red beacons (L-864) on top of the generator housing. Both beacons should flash simultaneously. Lighting fixtures are to be mounted at a horizontal separation to ensure an unobstructed view of at least one fixture by a pilot approaching from any direction.

### 56. GROUP OF OBSTRUCTIONS

When individual objects, except wind turbines, within a group of obstructions are not the same height and are spaced a maximum of 150 feet (46m) apart, the prominent objects within the group should be lighted in accordance with the standards for individual obstructions of a corresponding height. If the outer structure is shorter than the prominent, the outer structure should be lighted in accordance with the standards for individual obstructions of a

corresponding height. Light units should be placed to ensure that the light is visible to a pilot approaching from **any** direction. In addition, at least one flashing beacon should be installed at the top of a prominent center obstruction or on a special tower located near the center of the group.

#### **57. ALTERNATE METHOD OF DISPLAYING OBSTRUCTION LIGHTS**

When recommended in an FAA aeronautical study, lights may be placed on poles equal to the height of the obstruction and installed on or adjacent to the structure instead of installing lights on the obstruction.

#### **58. 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 (46m) apart, the group of obstructions may be considered an extensive obstruction. Install light units on the same horizontal plane at the highest portion or edge of prominent obstructions. Light units should be placed to ensure that the light is visible to a pilot approaching from **any** direction. If the structure is a bridge and is over navigable water, the sponsor must obtain prior approval of the lighting installation from the Commander of the District Office of the United States Coast Guard to avoid interference with marine navigation. Steady burning lights should be displayed to indicate the extent of the obstruction as follows:

**a. Structures 150 Feet (46m) or Less in Any Horizontal Direction.** If the structure/bridge/extensive obstruction is 150 feet (46m) or less horizontally, at least one steady burning light (L-810) should be displayed on the highest point at each end of the major axis of the obstruction. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

**b. Structures Exceeding 150 Feet (46m) in at Least One Horizontal Direction.** If the structure/bridge/extensive obstruction exceeds 150 feet (46m) horizontally, display at least one steady burning light for each 150 feet (46m), 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 (46m) 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.

**c. Structures Exceeding 150 Feet (46m) 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 (46m) 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.

**d. Exceptions.** Flashing red beacons (L-864) may be used instead of steady burning obstruction lights if early or special warning is necessary. These beacons should be displayed on the highest points of an extensive obstruction at intervals not exceeding 3,000 feet (915m). At least three beacons should be displayed on one side of the extensive obstruction to indicate a line of lights.

**e. 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 accumulations 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.

## CHAPTER 6. MEDIUM INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

### 60. 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 in the case of wind turbines, number of structures and overall layout of design.

### 61. 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 500 feet (153m) AGL or less in height, other methods of marking and lighting the structure may be omitted. Aviation orange and white paint is always required for daytime marking on structures exceeding 500 feet (153m) AGL. This system is not normally recommended on structures 200 feet (61m) AGL or less.

The use of a 24-hour medium intensity flashing white light system 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., med-evac, and police helicopters to see these structures. The use of this type of system in urban and rural areas often results in complaints. In addition, this system is not recommended on structures within 3 nautical miles of an airport.

### 62. RADIO AND TELEVISION TOWERS AND SIMILAR SKELETAL STRUCTURES

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

**1. Top Levels.** One or more lights should be installed at the highest point to provide 360-degree coverage ensuring an unobstructed view.

**2. Appurtenances 40 feet (12m) or less.** If a rod, antenna, or other appurtenance 40 feet (12m) 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 unobstructed viewing of the medium intensity flashing white light by a pilot, then additional lights should be added.

**3. Appurtenances Exceeding 40 feet (12m).** If a rod, antenna, or other appurtenance exceeds 40 feet (12m) above the tip of the main structure, a medium intensity flashing white light should be placed within 40 feet (12m) 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 (12m) of the tip to allow the pilot an unobstructed view of at least one light.

**b. Intermediate Levels.** At intermediate levels, two beacons (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 (61m) AGL.

**c. 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 an FAA aeronautical study, the lowest level of lights may be eliminated.

**d. Structures 500 Feet (153m) AGL or Less.** When 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.

**e. Structures Exceeding 500 Feet (153m) AGL.** The lights should be used during nighttime and twilight and may be used 24 hours a day. Marking is always required for daytime.

**f. 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 accumulations 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.

### 63. CONTROL DEVICE

The light intensity is controlled by a device that changes the intensity when the ambient light changes. The system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

**a. Twilight-to-Night.** This should not occur before the illumination drops below five foot-candles (53.8

lux) but should occur before it drops below two foot-candles (21.5 lux).

**b. Night-to-Day.** The intensity changes listed in subparagraph 63a above should be reversed when changing from the night to day mode.

#### **64. CHIMNEYS, FLARE STACKS, AND SIMILAR SOLID STRUCTURES**

**a. Number of Light Units.** The number of units recommended depends on the diameter of the structure at the top. Normally, the top level is on the highest point of a structure. However, the top level of chimney lights may be installed as low as 20 feet (6m) below the top to minimize deposit build-up due to emissions. The number of lights recommended are the minimum. When the structure diameter is:

1. *20 Feet (6m) or Less.* Three light units per level.
2. *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m).* Four light units per level.
3. *Exceeding 100 Feet (31m) But Not More Than 200 Feet (61m).* Six light units per level.
4. *Exceeding 200 Feet (61m).* Eight light units per level.

#### **65. WIND TURBINE STRUCTURES**

Wind turbine structures should be lighted by mounting two flashing white beacons (L-865) on top of the generator housing. Both beacons should flash simultaneously. Lighting fixtures are to be mounted at a horizontal separation to ensure an unobstructed view of at least one fixture by a pilot approaching from any direction. Intermediate light levels and other marking may be omitted on these structures.

#### **66. GROUP OF OBSTRUCTIONS**

When individual objects within a group of obstructions are not the same height and are spaced a maximum of 150 feet (46m) apart, the prominent objects within the group should be lighted in accordance with the standards for individual obstructions of a corresponding height. If the outer structure is shorter than the prominent, the outer structure should be lighted in accordance with the standards for individual obstructions of a corresponding height. Light units should be placed to ensure that the light is visible to a pilot approaching from **any** direction. In addition, at least one medium intensity flashing white light should be installed at the top of a prominent center obstruction or on a special tower located near the center of the group.

#### **67. SPECIAL CASES**

Where 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. This shielding should not derogate the intended purpose of the lighting system.

#### **68. 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 (46m) apart, the group of obstructions may be considered an extensive obstruction. Install light units on the same horizontal plane at the highest portion or edge of 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:

**a. Structures 150 Feet (46m) or Less in Any Horizontal Direction.** If the structure/extensive obstruction is 150 feet (46m) or less horizontally, at least one light should be displayed on the highest point at each end of the major axis of the obstruction. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

**b. Structures Exceeding 150 Feet (46m) in at Least One Horizontal Direction.** If the structure/extensive obstruction exceeds 150 feet (46m) horizontally, display at least one light for each 150 feet (46m) 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 (46m) 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.

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**c. *Structures Exceeding 150 Feet (46m) AGL.*** Lights should be installed on the highest point at each end. At intermediate levels, lights should be displayed for each 150 feet (46m), 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.

## CHAPTER 7. HIGH INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

### 70. PURPOSE

Lighting with high intensity (L-856) flashing white obstruction lights provides the highest degree of conspicuity both day and night. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 71. STANDARDS

Use high intensity flashing white obstruction lights during daytime with automatically selected reduced intensities for twilight and nighttime operations. When high intensity white lights are operated 24 hours a day, other methods of marking and lighting may be omitted. This system should not be recommended on structures 500 feet (153m) AGL or less unless an FAA aeronautical study shows otherwise.

### 72. CONTROL DEVICE

Light intensity is controlled by a device that changes the intensity when the ambient light changes. The use of a 24-hour high intensity flashing white light system 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., med-evac, and police helicopters to see these structures. The use of this type of system in urban and rural areas often results in complaints.

The system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

**a. Day-to-Twilight.** This should not occur before the illumination drops to 60 foot-candles (645.8 lux), but should occur before it drops below 35 foot-candles (376.7 lux). The illuminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.

**b. Twilight-to-Night.** This should not occur before the illumination drops below five foot-candles (53.8 lux), but should occur before it drops below two foot-candles (21.5 lux).

**c. Night-to-Day.** The intensity changes listed in subparagraph 72 a and b above should be reversed when changing from the night to day mode.

### 73. UNITS PER LEVEL

One or more light units is 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. The light units should be installed in a manner to ensure an unobstructed view of the system by a pilot approaching from any direction. The number of lights recommended are the minimum. When the structure diameter is:

- a. *20 Feet (6m) or Less.* Three light units per level.
- b. *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m).* Four light units per level.
- c. *Exceeding 100 Feet (31m).* Six light units per level.

### 74. INSTALLATION GUIDANCE

Manufacturing specifications provide for the effective peak intensity of the light beam to be adjustable from zero to 8 degrees above the horizon. Normal installation should place the top light at zero degrees to the horizontal and all other light units installed in accordance with Table 2:

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

TBL 2

**a. Vertical Aiming.** Where 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 statute miles (5km) from the structure. If additional adjustments are necessary, the lights may be individually adjusted upward, in 1-degree increments, starting at the bottom. Excessive elevation may reduce its conspicuity by raising the beam above a collision course flight path.

**b. Special Cases.** Where 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 an adjustment to the vertical or horizontal light aiming may be necessary. This adjustment should not derogate the intended purpose of the lighting system. Such adjustments may require review action as described in Chapter 1, paragraph 5.

**c. 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.

**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 an FAA aeronautical study, the lowest level of lights may be eliminated.

**2. Two Adjacent Structures.** Where two structures are situated within 500 feet (153m) of each other and the light units are installed at the same levels, the sides of the structures facing each other need not be lighted. However, all lights on both structures must flash simultaneously, except for adjacent catenary support structures. Adjust vertical placement of the lights to either or both structures' intermediate levels to place the lights on the same horizontal plane. Where one structure is higher than the other, complete level(s) of lights should be installed on that part of 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 such 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.

**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 as the result of an aeronautical study, taking into consideration the location, heights, and spacing with other structures.

#### **75. ANTENNA OR SIMILAR APPURTENANCE LIGHT**

When a structure lighted by a high intensity flashing light system is topped with an antenna or similar appurtenance exceeding 40 feet (12m) in height, a medium intensity flashing white light (L-865) should be placed within 40 feet (12m) from the tip of the

appurtenance. This light should operate 24 hours a day and flash simultaneously with the rest of the lighting system.

#### **76. 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 in such a manner to ensure an unobstructed view by the pilot. Normally, the top level is on the highest point of a structure. However, the top level of chimney lights may be installed as low as 20 feet (6m) below the top to minimize deposit build-up due to emissions.

#### **77. RADIO AND TELEVISION TOWERS AND SIMILAR SKELETAL STRUCTURES**

**a. 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.

**b. 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. When guy wires come together at the top, it may be necessary to install this level of lights as low as 10 feet (3m) below the top. If the rod or antenna exceeds 40 feet (12m) above the main structure, a medium intensity flashing white light (L-865) should be mounted on the highest point. 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. Adjacent installation should not exceed the height of the appurtenance and be within 40 feet (12m) of the top to allow an unobstructed view of at least one light.

**c. 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 accumulations from damaging the light units.

#### **78. HYPERBOLIC COOLING TOWERS**

Light units should be installed in a manner to ensure an unobstructed view of at least two lights by a pilot approaching from **any** direction.

**a. Number of Light Units.** The number of units recommended depends on the diameter of the structure

at the top. The number of lights recommended in the following table are the minimum. When the structure diameter is:

1. *20 Feet (6m) or Less.* Three light units per level.

2. *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m).* Four light units per level.

3. *Exceeding 100 Feet (31m) But Not More Than 200 Feet (61m).* Six light units per level.

4. *Exceeding 200 Feet (61m).* Eight light units per level.

**b. Structures Exceeding 600 Feet (183m) AGL.** Structures exceeding 600 feet (183m) AGL should have a second level of light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights.

#### **79. 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 not more than 150 feet (46m) apart, the group of obstructions may be considered an extensive obstruction. Install light units on the same horizontal plane at the highest portion or edge of prominent obstructions. 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. Extreme caution in the use of high intensity flashing white lights should be exercised.

**a. If the Obstruction is 200 feet (61m) or Less in Either Horizontal Dimension,** install three or more light units at the highest portion of the structure in a manner to ensure that at least one light is visible to a pilot approaching from **any** direction. Units may be mounted on a single pedestal at or near the center of the obstruction. If light units are placed more than 10 feet (3m) from the center point of the structure, use a minimum of four units.

**b. If the Obstruction Exceeds 200 Feet (61m) in One Horizontal Dimension,** but is 200 feet (61m) or less in the other, two light units should be placed on each of the shorter sides. These light units may either be installed adjacent to each other at the midpoint of the edge of the obstruction 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. These lights should be installed at approximately equal intervals not to exceed a distance of 100 feet (31m) from the corners or from each other.

**c. If the Obstruction Exceeds 200 Feet (61m) in Both Horizontal Dimensions,** light units should be equally spaced along the overall perimeter of the obstruction at intervals of 100 feet (31m) or fraction thereof.

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

### 80. 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 the use of medium intensity at night may cause significant environmental concerns. The use of the dual lighting system should reduce/mitigate those concerns. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 81. INSTALLATION

The light units should be installed as specified in the appropriate portions of Chapters 4, 5, and 6. The number of light levels needed may be obtained from Appendix 1.

### 82. OPERATION

Lighting systems should be operated as specified in Chapter 3. Both systems should not be operated at the same time; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of one of two lamps in the uppermost red beacon (L-864 incandescent unit) or outage of any uppermost red light shall cause the white obstruction light system to operate in its specified "night" step intensity.

### 83. CONTROL DEVICE

The light system is controlled by a device that changes the system when the ambient light changes. The system should automatically change steps when

the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

a. *Twilight-to-Night.* This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).

b. *Night-to-Day.* The intensity changes listed in subparagraph 83 a above should be reversed when changing from the night to day mode.

### 84. ANTENNA OR SIMILAR APPURTENANCE LIGHT

When a structure utilizing this dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12m) in height, a medium intensity flashing white (L-865) and a red flashing beacon (L-864) should be placed within 40 feet (12m) 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.

### 85. WIND TURBINE STRUCTURES

Wind turbine structures should be lighted by mounting two flashing dual beacons (L-864/L-865) on top of the generator housing. Both beacons should flash simultaneously. Lighting fixtures are to be mounted at a horizontal separation to ensure an unobstructed view of at least one fixture by a pilot approaching from any direction. Intermediate light levels and other marking may be omitted on these structures.

### 86. OMISSION OF MARKING

When medium intensity white lights are operated on structures 500 feet (153m) AGL or less during daytime and twilight, other methods of marking may be omitted.

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

### 90. 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 white lighting system at night. There may be some populated areas where the use of high intensity lights at night may cause significant environmental concerns and complaints. The use of the dual lighting system should reduce/mitigate those concerns. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 91. INSTALLATION

The light units should be installed as specified in the appropriate portions of Chapters 4, 5, and 7. The number of light levels needed may be obtained from Appendix 1.

### 92. OPERATION

Lighting systems should be operated as specified in Chapters 4, 5, and 7. Both systems should not be operated at the same time; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of one of two lamps in the uppermost red beacon (L-864 incandescent unit) or outage of any uppermost red light shall cause the white obstruction light system to operate in its specified "night" step intensity.

### 93. CONTROL DEVICE

The light intensity is controlled by a device that changes the intensity when the ambient light changes.

The system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

**a. Day-to-Twilight.** This should not occur before the illumination drops to 60 foot-candles (645.8 lux) but should occur before it drops below 35 foot-candles (376.7 lux). The illuminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.

**b. Twilight-to-Night.** This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).

**c. Night-to-Day.** The intensity changes listed in subparagraph 93 a and b above should be reversed when changing from the night to day mode.

### 94. ANTENNA OR SIMILAR APPURTENANCE LIGHT

When a structure utilizing this dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12m) in height, a medium intensity flashing white light (L-865) and a red flashing beacon (L-864) should be placed within 40 feet (12m) from the tip of the appurtenance. The white light should operate during daytime and twilight and the red light during nighttime.

### 95. OMISSION OF MARKING

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

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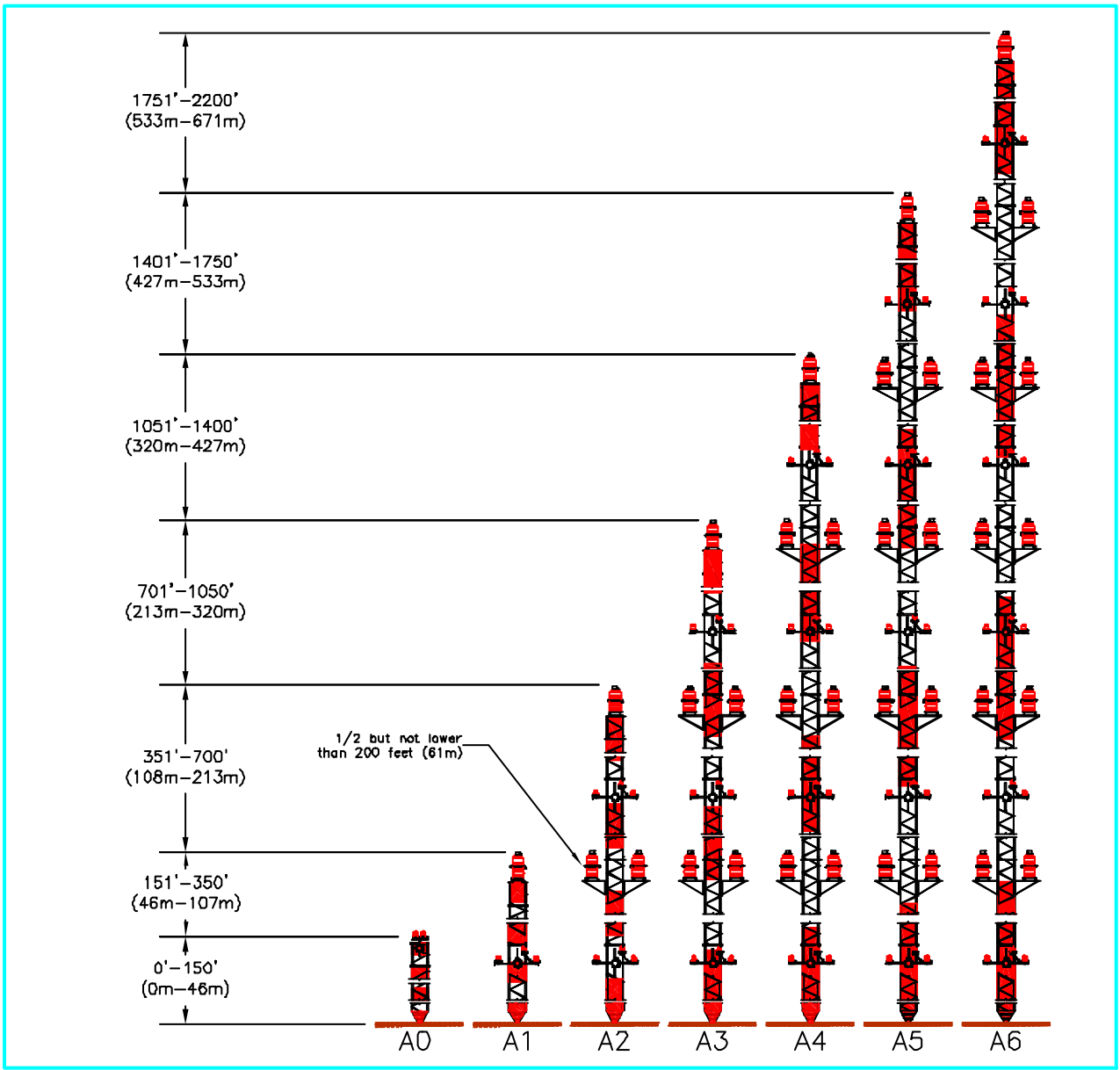
**APPENDIX 1: Specifications for Obstruction Lighting Equipment Classification**
**APPENDIX**

Type	Description
L-810	Steady-burning Red Obstruction Light
L-856	High Intensity Flashing White Obstruction Light (40 FPM)
L-857	High Intensity Flashing White Obstruction Light (60 FPM)
L-864	Flashing Red Obstruction Light (20-40 FPM)
L-865	Medium Intensity Flashing White Obstruction Light (40-FPM)
L-866	Medium Intensity Flashing White Obstruction Light (60-FPM)
L-864/L-865	Dual: Flashing Red Obstruction Light (20-40 FPM) and Medium Intensity Flashing White Obstruction Light (40 FPM)
L-885	Red Catenary 60 FPM
FPM = Flashes Per Minute	

*TBL 4*

# RED OBSTRUCTION LIGHTING STANDARDS (FAA Style A)

Day Protection = Aviation Orange/White Paint  
Night Protection = 2,000cd Red Beacon and sidelights



- L-864 Flashing Beacon

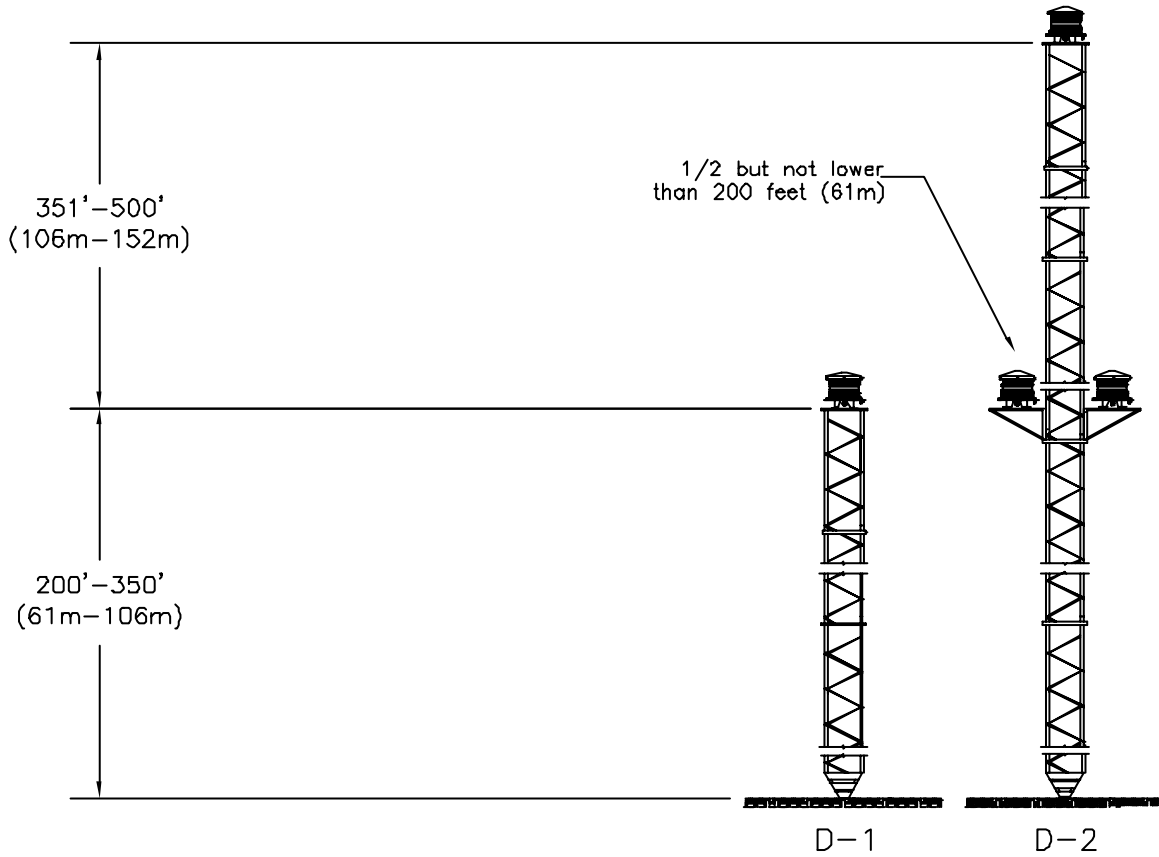


- L-810 Obstruction Light

FIG 13

# MEDIUM INTENSITY WHITE OBSTRUCTION LIGHTING STANDARDS (FAA Style D)

Day/Twilight Protection = 20,000cd White Strobe  
Night Protection = 2,000cd White Strobe  
Painting of tower is typically not required.

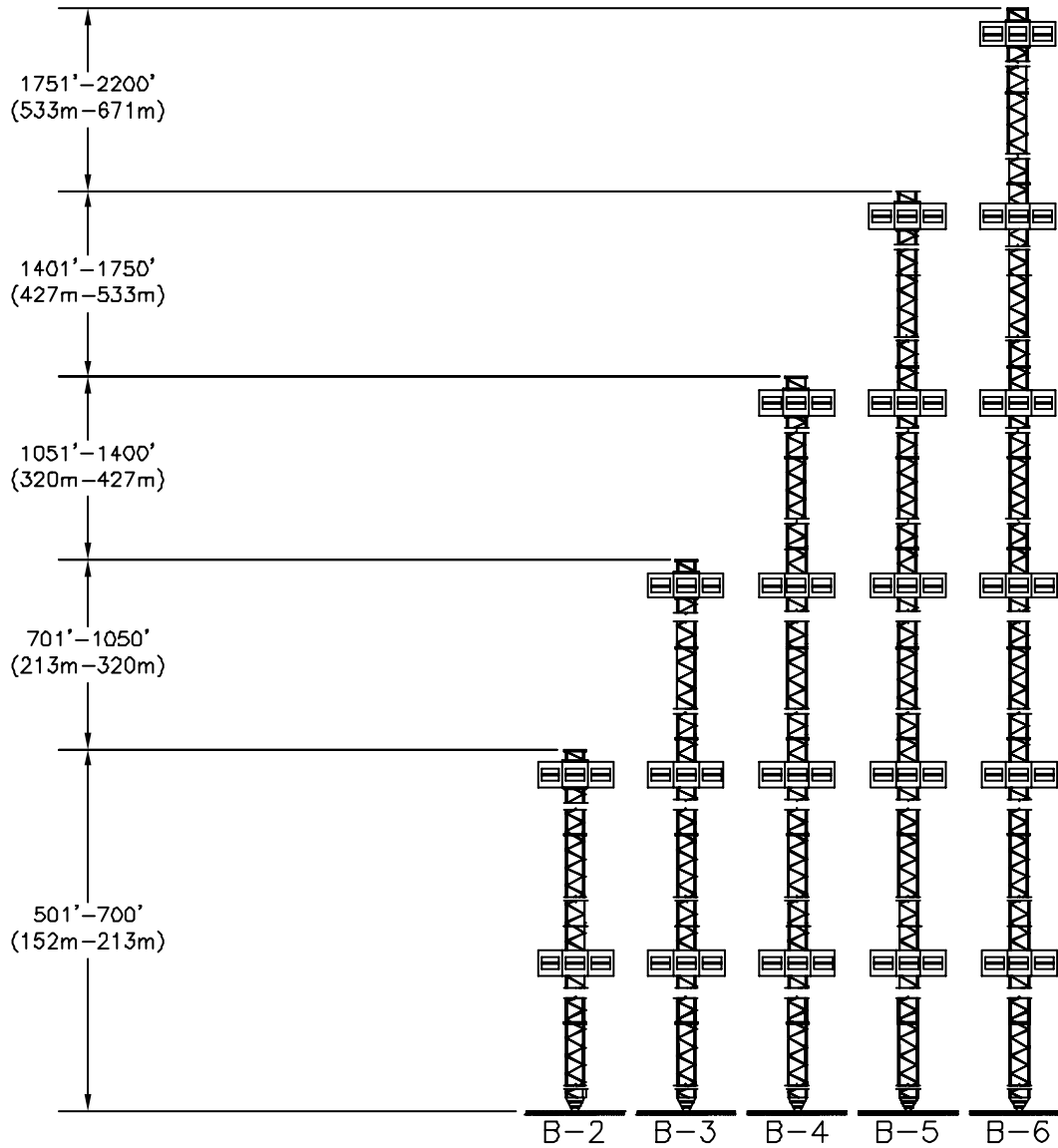


- L-865 Flashing White Strobe

FIG 14

# HIGH INTENSITY OBSTRUCTION LIGHTING STANDARDS (FAA Style B)

Day Protection = 200,000cd White Strobe  
 Twilight Protection = 20,000cd White Strobe  
 Night Protection = 2,000cd White Strobe

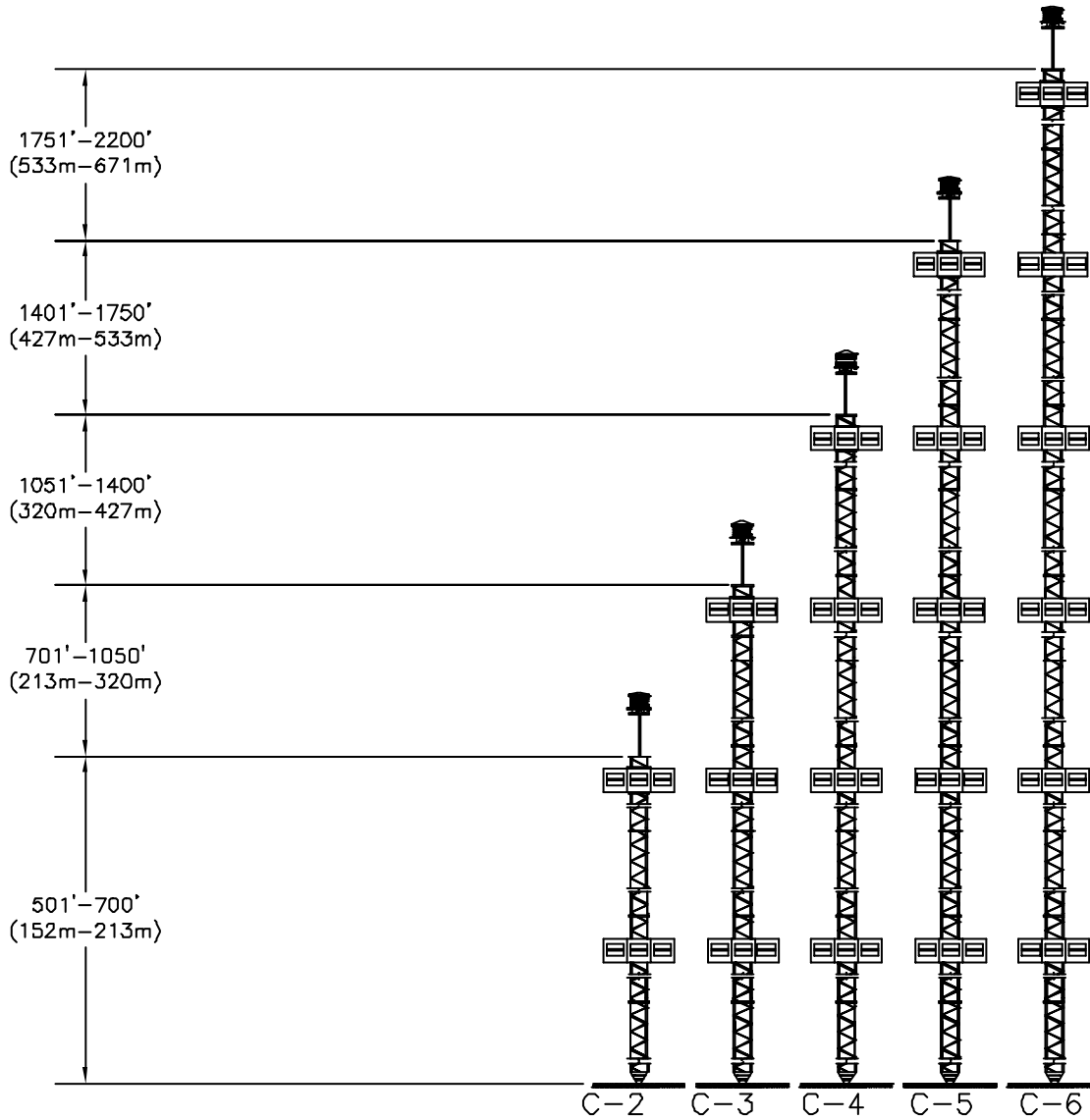


- L-856 High Intensity Strobe  
 (3 Flashheads required per level for 360° coverage)

FIG 15

# HIGH INTENSITY OBSTRUCTION LIGHTING STANDARDS (FAA Style C)

Day Protection = 200,000cd White Strobe  
 Twilight Protection = 20,000cd White Strobe  
 Night Protection = 2,000cd White Strobe





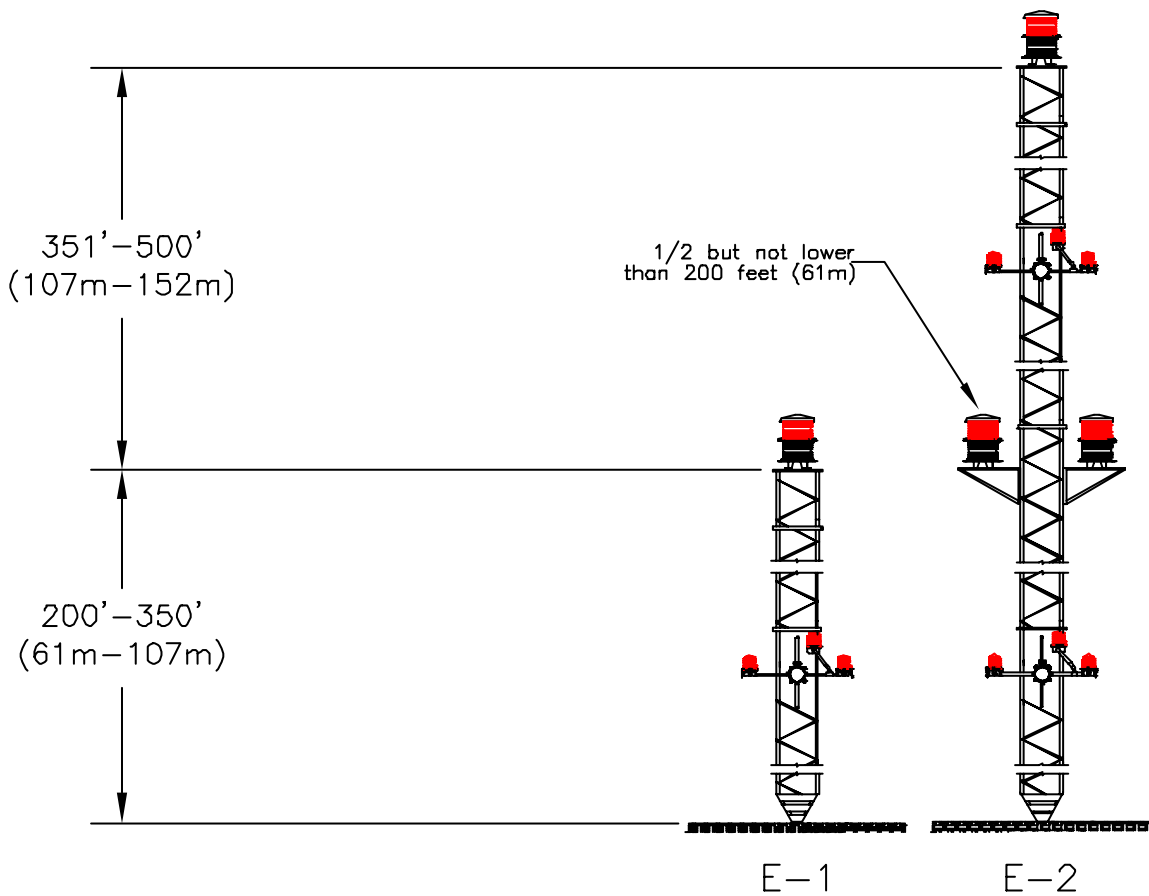
-  - L-856 High Intensity Strobe  
(3 Flashheads required per level for 360° coverage)
-  - L-865 Medium Intensity Strobe  
required for appertanances of 40 feet or greater.

FIG 16

# MEDIUM INTENSITY DUAL OBSTRUCTION LIGHTING STANDARDS (FAA Style E)

Day/Twilight Protection = 20,000cd White Strobe  
 Night Protection = 2,000cd Red Strobe and sidelights  
 Painting of tower is typically not required.





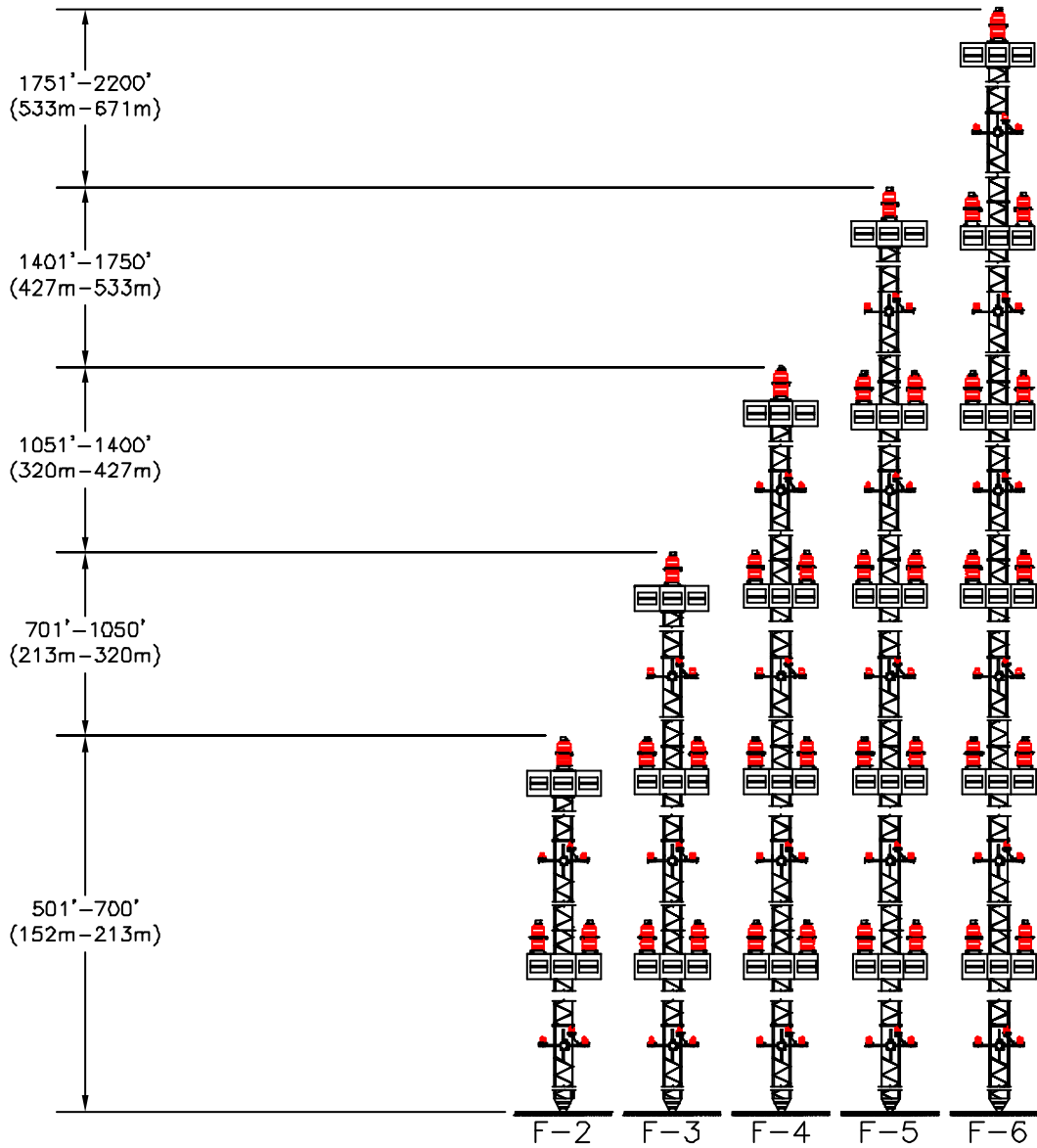
-  - L-864/L-865 Flashing Dual (White/Red) Strobe
-  - L-810 Obstruction Light

FIG 17

# DUAL HIGH INTENSITY OBSTRUCTION LIGHTING STANDARDS (FAA Style F)

Day Protection = 200,000cd White Strobe  
 Twilight Protection = 20,000cd White Strobe  
 Night Protection = 2,000cd Red Beacon and sidelights






-  - L-B64 Flashing Beacon
-  - L-B10 Obstruction Light
-  - L-B56 High Intensity Strobe  
(3 Flashheads required per level for 360° coverage)

FIG 18

## APPENDIX 2. Miscellaneous

### 1. RATIONALE FOR OBSTRUCTION LIGHT INTENSITIES.

Sections 91.117, 91.119 and 91.155 of the FAR 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.

### 2. DISTANCE VERSUS INTENSITIES.

TBL 5 depicts the distance the various intensities can be seen under 1 and 3 statute miles meteorological visibilities:

Distance/Intensity Table

Time Period	Meteorological Visibility Statute Miles	Distance Statute Miles	Intensity Candelas
Night		2.9 (4.7km)	1,500 (+/- 25%)
	3 (4.8km)	3.1 (4.9km)	2,000 (+/- 25%)
		1.4 (2.2km)	32
Day		1.5 (2.4km)	200,000
	1 (1.6km)	1.4 (2.2km)	100,000
		1.0 (1.6km)	20,000 (+/- 25%)
Day		3.0 (4.8km)	200,000
	3 (4.8km)	2.7 (4.3km)	100,000
		1.8 (2.9km)	20,000 (+/- 25%)
Twilight	1 (1.6km)	1.0 (1.6km) to 1.5 (2.4km)	20,000 (+/- 25%)?
Twilight	3 (4.8km)	1.8 (2.9km) to 4.2 (6.7km)	20,000 (+/- 25%)?

Note-

1. DISTANCE CALCULATED FOR NORTH SKY ILLUMINANCE.

TBL 5

### 3. CONCLUSION.

Pilots of aircraft travelling at 165 knots (190 mph/306kph) or less should be able to see obstruction lights in sufficient time to avoid the structure by at least 2,000 feet (610m) horizontally under all conditions of operation, provided the pilot is operating in accordance with FAR Part 91. Pilots operating between 165 knots (190 mph/303 km/h) and 250 knots (288 mph/463 kph) should be able to see the obstruction lights unless the weather deteriorates to 3 statute miles (4.8 kilometers) visibility at night, during which time period 2,000 candelas would be required to see the lights at 1.2 statute miles (1.9km). A higher intensity, with 3 statute miles (4.8 kilometers) visibility at night, could generate a residential annoyance factor. In addition, aircraft in these speed ranges can normally be expected to operate under instrument flight rules (IFR) at night when the visibility is 1 statute mile (1.6 kilometers).

### 4. DEFINITIONS.

a. 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. 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.

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**5. LIGHTING SYSTEM CONFIGURATION.**

- a. *Configuration A.* Red lighting system.
- b. *Configuration B.* High Intensity White Obstruction Lights (including appurtenance lighting).
- c. *Configuration C.* Dual Lighting System - High Intensity White & Red (including appurtenance lighting).

d. *Configuration D.* Medium Intensity White Lights (including appurtenance lighting).

e. *Configuration E.* Dual Lighting Systems - Medium Intensity White & Red (including appurtenance lighting).

*Example-*

*“CONFIGURATION B 3” DENOTES A HIGH INTENSITY LIGHTING SYSTEM WITH THREE LEVELS OF LIGHT.*