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July 31, 2012

Via Federal Express Overnight Delivery

Mayor Phillips & Members of the City Council
San Rafael City Council
1400 Fifth Avenue
P.O. Box 151560
San Rafael, CA 94915-1560

Re: San Rafael Airport Recreational Facility

Dear Mayor Phillips and Members of the City Council:

This firm represents the Marin Audubon Society, the Marin Conservation League, and the Gallinas Creek Defense Council on matters relating to the San Rafael Airport Recreational Facility ("Project"). Marin Audubon and Marin Conservation League have a long history of protecting the natural resources of Marin County, and are particularly concerned about the Project's impacts on wetlands, endangered species, and Gallinas Creek. The Gallinas Creek Defense Council is a coalition of citizens and organizations concerned with the well being of the Gallinas Creek watershed.

The Project represents a substantial intensification of use of the Airport site to the detriment of the sensitive biological resources on the project site, in Gallinas Creek, and to the ultimate users of the facility. The Project will attract, at a minimum, hundreds of people and vehicles to this site every day even though it is located in a wetland overlay zone, is diked baylands, and is adjacent to an operational airport. Both the San Rafael General Plan and state guidelines for airports set forth a number of policies designed to protect this site from the type of development proposed here. As detailed in this letter and the numerous previous comments by Marin Audubon, Marin Conservation League, and the Gallinas Creek Defense Council, the Project is not consistent with the City's General Plan or Zoning Ordinance and it is flatly inconsistent with state policies designed to prevent the location of group recreational facilities in close vicinity to airports. The City's review so far, however, has focused on explaining away the inconsistencies rather than modifying the Project to address them.

Moreover, the City has failed to adequately evaluate the environmental impacts associated with the Project as required by the California Environmental Quality Act. Among other deficiencies in the environmental review, the environmental impact report ("EIR") fails to seriously address the Project's impact on endangered species, particularly, the California Clapper Rail, it does not analyze the full range of noise impacts associated with the Project, it continues to downplay safety impacts, and it minimizes impacts associated with the emission of greenhouse gases.

In view of the Project's clear inconsistencies with City policies and the failure to adequately evaluate its significant impacts, the City cannot approve the Project. Rather, the Project must be revised to comply with the clear limits of the City's general plan and zoning. Even without such modifications of the Project, the City must prepare and recirculate a new EIR that fully discloses, analyzes, and mitigates the Project's significant impacts as required by CEQA.

I. The Project is Inconsistent with Land Use Policies Designed to Protect Public Safety and the Environment.

A. The Project is Not Consistent With the California Airport Land Use Planning Handbook.

Among its most significant flaws, the Project presents serious safety hazards that have not been adequately addressed either in the environmental review for the Project or the Project design. In particular, the location of this project in safety zones adjacent to the runway at the San Rafael airport is inconsistent with the provisions of the 2011 California Airport Land Use Planning Handbook which specifically provides that group recreational facilities in such zones should be prohibited. In its May 16, 2012 letter to the City, Mead & Hunt concede the project is "fundamentally considered a group recreational use." (May 16, 2012 Letter from Maranda Thompson to Kraig Tamborini, at p. 5.) Although the letter goes to great lengths to explain why the facility should nonetheless be excused from the safety provisions of the Handbook, it cannot explain away this fundamental inconsistency. That the San Rafael Airport is a private facility does not decrease the safety issues involved here. Indeed, the EIR itself indicates that because it is impossible to predict accidents, "the accepted practice of measuring airport land use risks is to use the basic safety zones" provided in the Handbook. EIR at p. 10-11. Moreover, the City's general plan also requires the City to ensure the safety of the Project. General Plan Goal 28; Policy S-1 and S-1a.

Moreover, from a CEQA perspective, the inconsistency with an express safety standard in the Airport Land Use Handbook is a significant environmental impact that must be disclosed and mitigated. That the Handbook does not apply as a regulatory tool to private airports is not relevant from a legal perspective under CEQA. *Protect The Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1107. The argument that a project's impact will not be significant solely because the project would not violate any applicable standards has been soundly rejected by the courts. See, e.g., *Communities for a Better Env't v. California Res. Agency* (2002) 103 Cal.App.4th 98, 111-12 (invalidating a CEQA guideline that presumed projects did not have significant effects if they complied with local standards.) Here, even though the Project is not subject to the Airport Handbook as a regulatory matter, it still violates the Handbook's safety standards.

The various measures suggested by Mead & Hunt to address the Project's inconsistency with the safety provisions of the Handbook do not reduce the risk of an accident that could cause injury or death to many people. These measures also fail to demonstrate how they would even reduce or eliminate the damage that such an accident would cause. For example, measures designed to limit capacity at events are completely unenforceable. Similarly, the Mead Hunt letter recommends limiting windows in the building design, yet the Project itself includes a viewing area so spectators can watch outdoor sports through windows from inside the second floor of the building. Even if the measures were enforceable or internally consistent, measures such as limiting the number of people at events, reducing windows, increasing the use of exit signs, or prohibiting fixed seating does nothing to eliminate the risk of an accident. Given that the risk of accident has not been reduced, it is unclear how the City can conclude that there are no significant safety risks simply because it may impose some measures that might theoretically reduce the number of people injured or killed in the case of an accident.

B. The Project is an Obstruction to Aviation under Federal Aviation Administration Regulations.

In addition to its inconsistency with the airport safety zones, the Project will also penetrate the airspace around the Airport. The EIR acknowledges that this obstruction would be a significant safety impact. However, the EIR ignores mobile obstructions resulting from the Project, including vehicle obstructions and soccer balls. For example, the EIR assumes that vehicles accessing the facility will be passenger vehicles that do not exceed 10 feet and the only intrusions are associated with the first row of parking for the Project. However, as pointed out in the March 9 Department of Transportation letter, a mobile object is, and a future object would be an obstruction to air navigation if it is of greater height than any of the FAR Part 77.17 surfaces. Exhibits A to this letter shows how mobile objects such as soccer balls, school buses and service vehicles will intrude into the air space around the airport. Therefore, the Planning

Commission's recommendation to simply move the first row of parking will not address these significant impacts. Similarly, reducing the height of the building will not eliminate these mobile obstructions. Finally, the applicant's claim that airspace obstructions will be eliminated by grading and site design are not supported by the current site plans.

II. The Project is not Consistent With the City General Plan and Land Use Regulations.

A. The Project Is Not Consistent with the Wetland Overlay Zone or the Declaration of Restrictions on Development of the Airport Property.

The Project is not only inconsistent with the Airport Land Use Handbook, it also conflicts with a number of City land use policies and regulations. Most significant, the Project is not consistent with the Wetland Overlay zone that applies to the Airport property or General Plan policies designed to protect wetlands. The Wetland Overlay zone includes specific limits on the types of uses that are permitted "in or near" wetlands. With respect to recreational activities, the City Code provides "Recreation/scientific activities in or near wetlands should be low intensity uses, such as bird watching, fishing, nature photography and study, wildlife observation and scientific research and education." San Rafael Zoning Ordinance §14.13.030. Given its location in a wetland overlay zone, there can be no doubt that the Project is located near a wetland. And, in fact, the uses and facilities authorized by the Project can come as close as 50 feet to a wetland that is habitat for endangered species. The sports facility here is not a low intensity use under any reasonable definition of the word. Therefore, it cannot be located in a wetland overlay zone.

City staff attempts to avoid this clear inconsistency with the restrictions of the wetland overlay zone by claiming that recreational uses can include structures and facilities. March 27, 2012 Planning Staff Report, p. 14. This argument, however, ignores the fact that the wetland overlay zone itself adds an additional limit to the type of recreational facilities permitted near wetlands – a restriction that limits these uses to low intensity ones.

For similar reasons, the Project is not consistent with the limits set forth in the declaration of restrictions recorded on the property. The fact that the County has indicated it will not challenge the Project does not mean that it is consistent with these restrictions. There are many reasons why a public agency might not challenge another public agency's review of a project, including use of public resources, reluctance to sue a fellow public agency, or concern over setting a precedent. Nothing in the County's letter regarding the Project indicates a belief that the Project is actually consistent with the declaration of restrictions.

Finally, the Project is also inconsistent with a number of policies in the San Rafael General Plan designed to protect diked baylands and sensitive species. For example, the property is identified as "diked marshland" in the City General Plan and "diked wetlands" in maps prepared by the San Francisco Estuary Institute which identify the status of various baylands in the San Francisco Bay Area. See Exhibit B to this letter. The responses to comments also provide further evidence that the site is diked baylands. Specifically Master response 12 (at C&R 27) reads in part:

> The levee system surrounding the property crosses between private (airport) and public (state lands/county) ownership and responsibility. The 12,000-linear-foot perimeter levee system that surrounds the Project site, bordering the North and South Forks of Gallinas Creek, were constructed by previous land owners by placing fill on the flat marshy areas of the property in the 1940's to reclaim lands for agricultural purposes.

The City, however, has failed to comply with Policy CON-5, which requires the protection of "seasonal wetlands and associated upland habitat contained within undeveloped diked baylands."

B. The Project Contradicts A Number of General Plan Policies Designed to Protect Biological Resources and Endangered Species.

The Project will also adversely impact the California Clapper Rail in violation of general plan policies CON-14 and Conservation Element Goal 1 and must be consistent with the Endangered Species Act. Among its other deficiencies, the Project will substantially increase noise and light in habitat for these endangered species, it will substantially increase human use of the site, and will increase litter in and around Gallinas Creek. Yet, the Project does not include adequate measures, such as limits on construction and setbacks, to protect these endangered species. Contrary to the representations in the responses to comments, there is no evidence to support the conclusion that the California Clapper Rail has become habituated to human presence. See July 22, 2012 memorandum from Jules Evens, Exhibit C to this letter. And, in fact, given the size of the Project site, the City should comply with General Plan policy CON-4, which allows for greater than a 50 foot setback from wetlands where the property is greater than 2 acres. Given the Project's location immediately adjacent to the Clapper Rail's tidal marsh habitat and the fact that this upland habitat can provide high tide refuge for the Clapper Rail as well as cover from avian predators, it is critical to increase the buffers here.

Moreover, even if it were possible to conclude that Clapper Rail in the vicinity of the Project were habituated to human presence based on existing levels of use, that does not mean that the construction and operation of an active sports facility drawing hundreds of visitors per day would not adversely impact the Clapper Rail. In addition to noise, light, and habitat impacts, the Project, with its generation of food waste on a daily basis, is highly likely to increase rat and raccoon populations – known predators of the California Clapper Rail. The EIR, however, does not discuss these impacts. Therefore, the conclusion that Project is consistent with General Plan policies designed to protect biological resources in general and endangered species particularly (Policies CON 1, CON 4, and CON 14) is not supported by the evidence.

C. The Project Is Not Consistent with General Plan Safety Policies.

The City has also failed to ensure that the Project is consistent with General Plan policies designed to prevent flood hazards. Specifically, the General Plan recognizes that levee maintenance is critical to avoiding flood hazards, especially in eastern San Rafael. Therefore, General Plan Policy S-20 requires the upgrading and maintenance of levees whenever a site is developed. The City has acknowledged the obligation to maintain the levees around the Project site to ensure consistency with this General Plan policy. April 10, 2012 letter from Kraig Tamborini to Eric Steger, Marin County Dept. of Public Works. Many of the levees that surround the Airport, however, are located on public lands, and the City has now admitted that the County has no obligation to maintain these levees. The City's solution – to simply require the applicant to maintain the levees even where they are located on public lands – does not ensure that the applicant has the authority or financial or technical ability to maintain the levees as required by the General Plan. This failure is particularly important here because the levees were never intended or engineered to protect buildings, life and personal property.

III. The City Has Not Adequately Evaluated or Mitigated the Environmental Impacts of the Project, as Required by CEQA.

The City has also failed to properly disclose, analyze and mitigate significant environmental impacts associated with the Project. Marin Audubon, Marin Conservation League, and the Gallinas Creek Defense Council have commented extensively on the EIR and FEIR. The following comments represent just a selection of some of the most serious issues that have not been adequately addressed by the environmental review.

A. The City has Not Adequately Addressed or Mitigated Impacts to Biological Resources.

As detailed above, there is no evidence to support the EIR's conclusion that because California Clapper Rail currently inhabits the project area, it has become habituated to human use and will not suffer any adverse impacts from the intensification of use that the Project will cause. Nor has the EIR adequately supported its conclusions that the Project will not result in significant impacts to the California Clapper Rail. In addition, the final EIR's responses to comments on impacts to the California Clapper Rail are speculative and unsupported by any evidence and do not meet the standards established by the case law. *The Flanders Foundation v. City of Carmel-by-the-Sea* (2012) 202 Cal. App. 4th 603.

The proposed mitigation measures also remain inadequate. Specifically, although the conditions of approval would prohibit pile driving during the nesting season, they still allow substantial construction to occur during that sensitive time period. As previously commented by Jules Evens, the proposed buffers are not nearly adequate to address construction noise and disturbance. *See also* Exh. C (Evens letter).

Moreover, the EIR never addresses the tension between maintaining the levees to protect against flooding and the impact that such maintenance will have on endangered marsh species such as the Clapper Rail. As discussed in the attached memorandum from Peter Baye, the construction of the Project and the resulting requirement that the levees be maintained in their current location will cause significant impacts to habitat for endangered marsh species as sea level rise puts additional pressure on habitat. The Project creates the need to maintain the levees in their current location to protect against flood damage, and the EIR includes measures (albeit insufficient measures as discussed above) to address this impact. However, these measures create their own potentially significant impacts that have not been addressed, as required by CEQA. *Stevens v. City of Glendale* (1981) 125 Cal. App. 3d 986; CEQA Guidelines §15126.4 (a)(1)(D). See Exhibit D to this Letter.

B. The Project Will Have Significant Cumulative Impacts to Biological Resources.

The Project is just one of many uses in the immediate vicinity that will impact the Clapper Rail. As recognized in the EIR, there are adjacent ballfields, a golf course, and batting cage in nearby McGinness Park. Rather than evaluate the cumulative impacts of this Project in connection with these other existing uses, as required by Public Resources Code section 21083 and CEQA Guidelines section 15130, the EIR simply assumes that the Clapper Rail has become accustomed to these uses. As detailed in the letter of Jules Evens, there is no evidence to support this conclusion. Moreover, under CEQA the EIR should not use existing use as a means of minimizing the impacts of the Project, but should instead evaluate whether the Project, when combined with other past, present, and reasonably foreseeable projects will have a significant impact on the environment.

Similarly, the EIR must evaluate the cumulative impact that this Project, combined with sea level rise, would cause in terms of lost habitat for salt marsh species. Because the Project requires the maintenance of levees in a fixed position, it will exacerbate the loss of habitat that will occur with sea level rise. Yet, the EIR does not evaluate this impact. See Exhibit D (Baye Comments).

C. The Project Will Result in Significant Greenhouse Gas Emissions That Have Not been Adequately Disclosed or Mitigated.

The Project will also result in emissions of greenhouse gases that far exceed the numerical standards of significance set by the Bay Area Air Quality Management District for determining the significance of a project's impact on climate change.[1] Here, it is unclear how compliance with the City's CCAP will reduce the impacts of the project below a level of significance. First, even with the application of the City's green building standards and LEED certification, the Project's emissions will far exceed the 1100 metric ton per year standard of significance established by BAAQMD, or the 900 metric tons per year standard suggested by the California Air Pollution Control Officers Association. This is because the vast majority of the Project's GHG emissions are associated with the considerable vehicle traffic it will generate. Yet, no serious effort has been made to reduce emissions from this vehicle traffic and, in fact, by its nature the Project is designed to attract hundreds of visitors by car every day. There is no way in which this Project could be consistent with the overall GHG reduction goals of the City's CCAP, even if the building itself is built to the minimum LEED standards because LEED certification will do nothing to reduce vehicle trips which are the primary source of GHGs associate with the Project. See CEQA Guidelines §15183.5 (b)(2).

[1] Although a trial court recently found that the adoption of the Thresholds is a project requiring environmental review under CEQA, it did not invalidate the Thresholds on their merits. The 1,100 metric ton/year threshold established by the District is comparable to other suggested thresholds for evaluating GHG emissions. See Exhibit E (CAPCOA Guidance.)

D. The City Has Not Adequately Addressed Safety Impacts Associated With the Project.

As detailed above, the project will have safety impacts associated with locating a group recreational facility in the runway safety zones at the Airport. This inconsistency with the Airport Land Use Handbook will cause a significant environmental impact that has not be adequately disclosed or mitigated by the City. The Project also poses potentially significant safety impacts associated with the inadequate levee system and the currently inadequate requirements to maintain the levee system.

The City has also failed to adequately address safety impacts associated with leaded aviation fuel used by planes that take off and land at the airport. Research indicates that lead levels in air near airports where planes use leaded aviation gas are significantly higher than background levels. Thus, a recent study by the National Institute for Environmental Health Science concluded that "the combustion of leaded avgas by small airplane engines may pose a health risk to children who live or attend school near airports. The lead in air surrounding airports can be inhaled directly, or the lead may be ingested by children after it settles into soil or dust (U.S. EPA 2010)." See "*A Geospatial Analysis of the Effects of Aviation Gasoline on Childhood Blood Lead Levels*," Exhibit F to this letter. The City's response to comments on this issue is not supported by any evidence, but merely the speculation of the EIR preparer regarding potential impacts. Comment and Response, p. 534. For example, the response to comments claims that the exposure to lead from aviation gas would be "minute," but makes no attempt to quantify this amount. Moreover, the EIR fails to address the fact that long-term historic use of the airport would lead to the deposition of lead from aviation gas. Yet, there has been no soil evaluation done for the Project, even though the literature indicates that lead from aviation gas is deposited to soil, where it later becomes a source of lead to people in the vicinity of the airport. *Id.*

E. The City Has Not Analyzed Significant Impacts Associated with Project Modifications and Proposals to Address Air Safety Hazards.

Moreover, the addition of obstruction lights to reduce hazards will create its own environmental impacts. See MM HAZ-2 in Resolution 12-08 on page 20 of 28 in Mitigation Monitoring and Reporting Program of Resolution 12-08. The type of obstruction lights have not been specified anywhere in the EIR or otherwise, and the impacts of these obstruction lights have not been considered. They have potential impacts on wildlife and aesthetics. There are no obstruction lights at the airport currently. If it were not for this project, there would be no obstruction lights. Although staff has suggested the use of AV23 low intensity solar obstruction light, this light does not meet the specifications for obstruction lights approved for use at airports by the (US) Federal Aviation Administration. See Exhibits G, H (FAA requirements for obstruction lights.)

Finally, the proposal to address safety issues related to air space intrusion through a project redesign should not occur outside of the public and environmental review process. Before the City approves the Project, it should require new site plans that are available for public review to ensure both that the Project does not intrude into the airspace and that the site redesign does not itself cause any new environmental impacts. Without complete plans and an analysis of their impacts, the EIR does not analyze the project as proposed and therefore the project description is not accurate, as required by CEQA. Furthermore, as it currently stands, the requirement for redesign after Project approval is an impermissible deferral of environmental review and mitigation. *Sundstrom v. County of Mendocino* (1988) 202 Cal.App.3d 296.

F. The Project Will Result in Significant Noise Impacts.

Finally, the City has failed to adequately evaluate or mitigate noise impacts from the Project. As indicated in our previous comments on the EIR, the noise analysis fails to provide an accurate picture of the impact that this Project will have on the surrounding community. In particular, the noise analysis relies on average noise measurements, even though the type of noise generated by the Project consists of many peak sounds (such as crowd cheering, shouts, and whistles) that are particularly disturbing to humans. The noise analysis also fails to evaluate noise impacts at the nearest homes (located 750 feet from the Project) and instead evaluates these impacts at 1000 feet – a distance that is 33% farther away. Finally, the EIR admits that no analysis of night-time noise impacts was conducted even though the evidence indicates that the Project will exceed even the minimal average standards for night-time noise. Monitoring noise levels at a total of 5 games over the next year is hardly adequate to ensure that night-time use of the fields does not exceed City noise standards on a regular basis.

IV. The City's Findings Are Not Supported by Substantial Evidence.

In view of the deficiencies in the City's review identified above, the City cannot support its findings with substantial evidence as required by CEQA and the case law. With respect to Resolution 12-08,

- The findings regarding impacts to listed anadromous fish species, the California Clapper Rail, and Impacts of Nocturnal lighting are contradicted by the evidence submitted by Avocet Research and that discussed above.

- Findings regarding air hazard impacts do not demonstrate that the Project is consistent with the Airport Land Use Handbook nor do they show that the City has adequately reduced any safety impacts below a level of significance.

- The City cannot find that noise impacts have been adequately analyzed or mitigated since it has not evaluated night noise impacts at all and the monitoring it conducted does not address noise impacts at the closest residence.

- The City cannot find that the Project will not have significant impacts related to the emission of GHGs because, even if it were to comply with the City's Climate Action Plan, the Project's GHG emissions still far exceed recommended thresholds of significance.

- The City's finding that there are not unavoidable significant impacts is not supported by the evidence which demonstrates that the Project will have significant impacts on wildlife, public safety, noise, climate change, and wetlands.

- Inasmuch as the Project will have significant impacts that have not been adequately avoided or mitigated, the City's findings regarding project alternatives are inadequate and must be revisited.

In addition, the findings in Resolutions 12-09 and 12-10 are legally inadequate. Among other deficiencies, findings regarding consistency with the Wetland Overlay zone are legally inadequate because the Project conflicts with provisions designed to limit recreation to low intensity uses. Findings regarding General Plan consistency are contradicted by evidence that the Project will adversely affect sensitive wildlife species and diked baylands (Resolution 12-09, Finding 1 (j). Findings regarding noise impacts cannot be made because the City did not conduct adequate noise analyses as required by the Noise Element. (Resolution 12-09, Finding 1(i)).

Finally, the finding that the Project is "substantially in compliance" with the City's Sustainability Element and Climate Action Plan is inconsistent with the central purpose of the Plan to reduce the City's total greenhouse gas emissions and carbon footprint. A defining feature of the Project is its substantial vehicle traffic. Consequently, the Project is fundamentally inconsistent with the City's Sustainability Element and Climate Action Plan.

Conclusion:

The Project as proposed is simply too intense and inappropriate for the location. Not only is the Project inconsistent with the many City and State policies designed to protect environmental resources and future users of the Project, the EIR fails to adequately address and mitigate these significant environmental effects. At a minimum, the environmental impact report must be revised and recirculated to address the many significant environmental impacts described above and in previous comments to the City. Moreover, because of its many inconsistencies with the City's General Plan and its significant environmental impacts, the City may not approve the Project. Accordingly, the Marin Audubon Society, Marin Conservation League, and Gallinas Creek Defense Counsel request that the City deny the Project.

Very truly yours,

SHUTE, MIHALY & WEINBERGER LLP

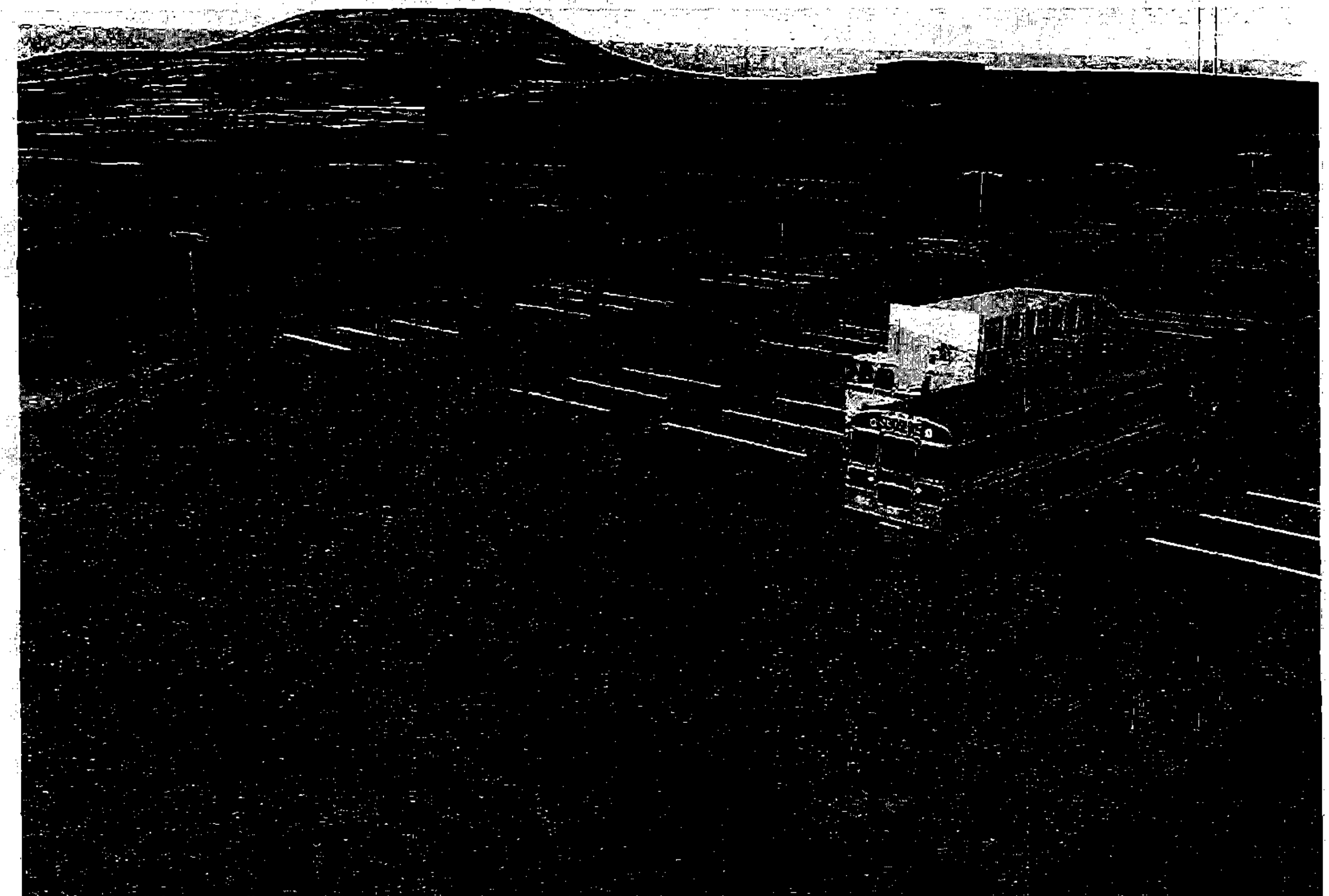
Ellison Folk

Cc: Marin Audubon Society
Marin Conservation League
Gallinas Creek Defense Counsel

408198.3

EXHIBIT A

Team Bus and Service Vehicles penetrate the FAR 77 Transitional Surface



Soccer ball kicked 35 feet in air penetrates the FAR 77 Transitional Surface by 10+ feet

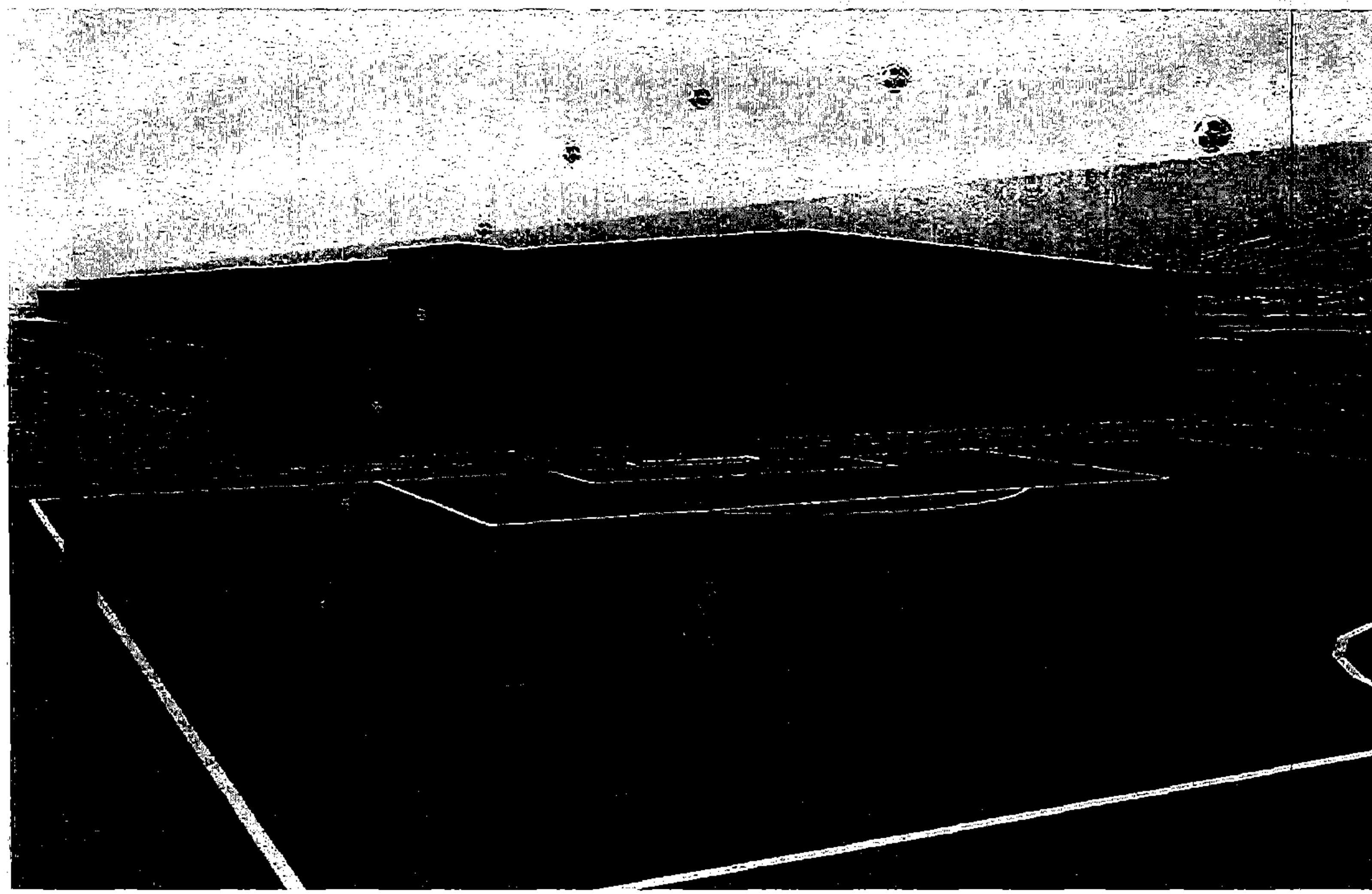
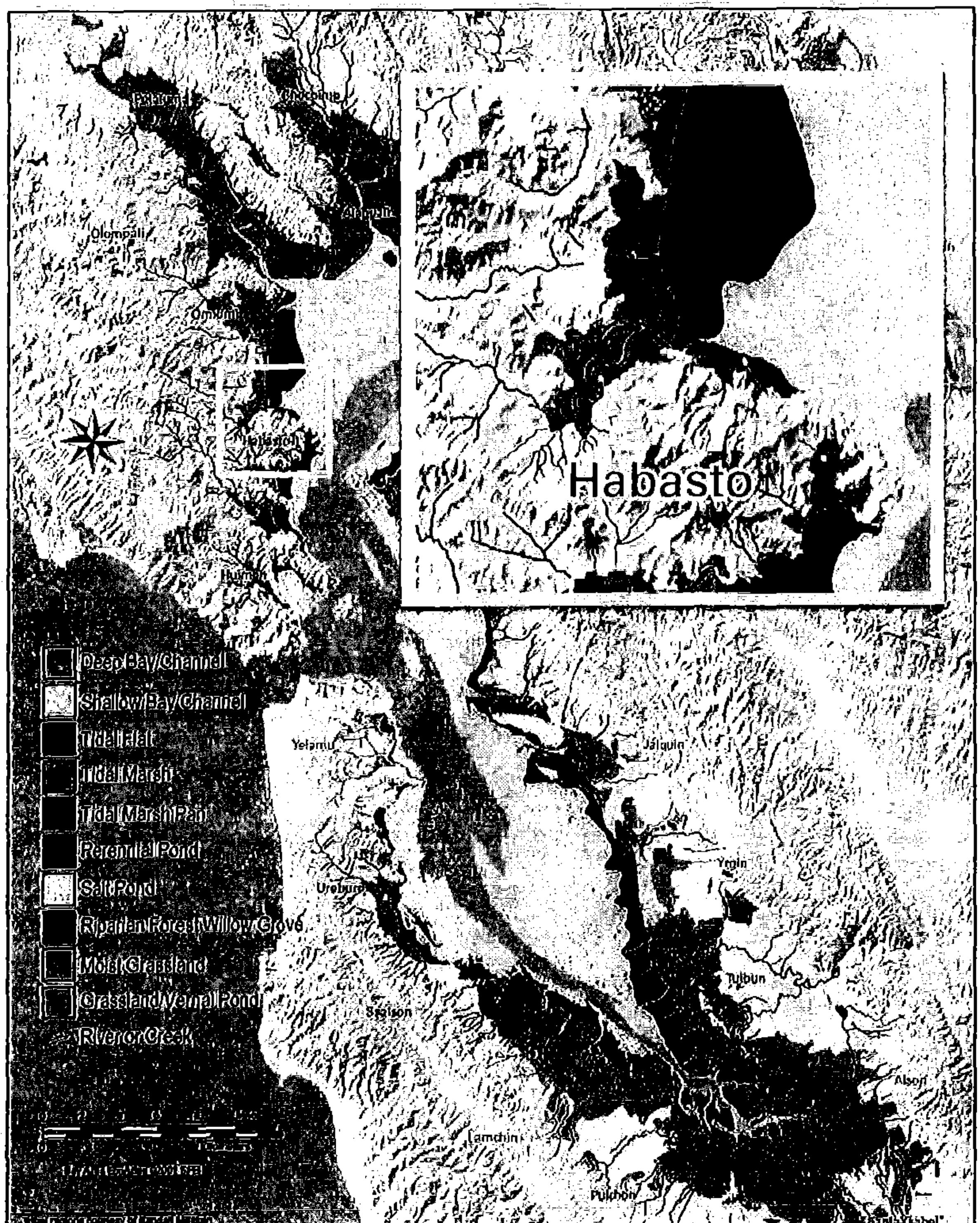


EXHIBIT B

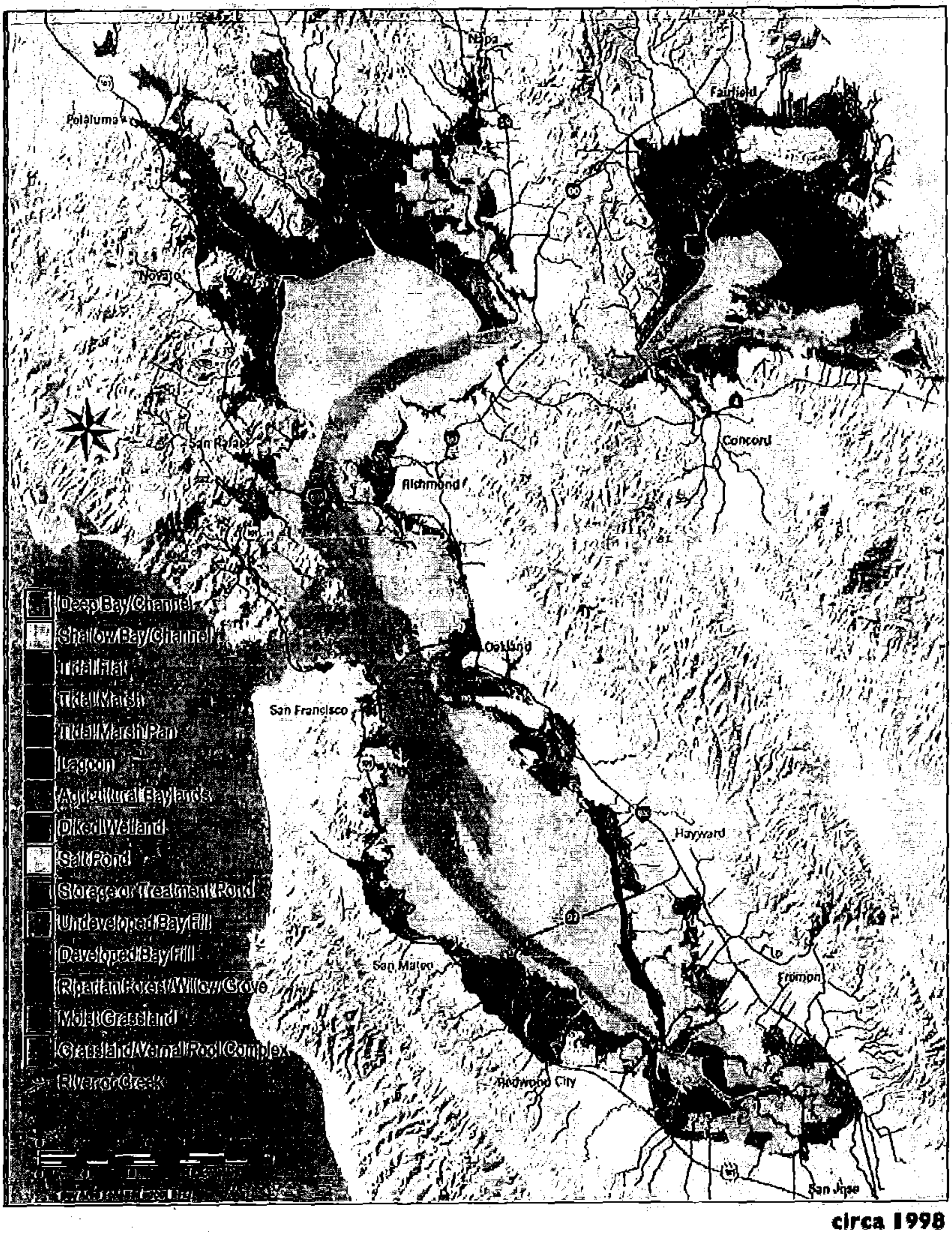
San Francisco Estuary Institute
7770 Pardee Lane, 2nd Fl
Oakland, CA 94621
(510) 746-7334
www.sfei.org
research • monitoring • GIS • data management

Historical Baylands



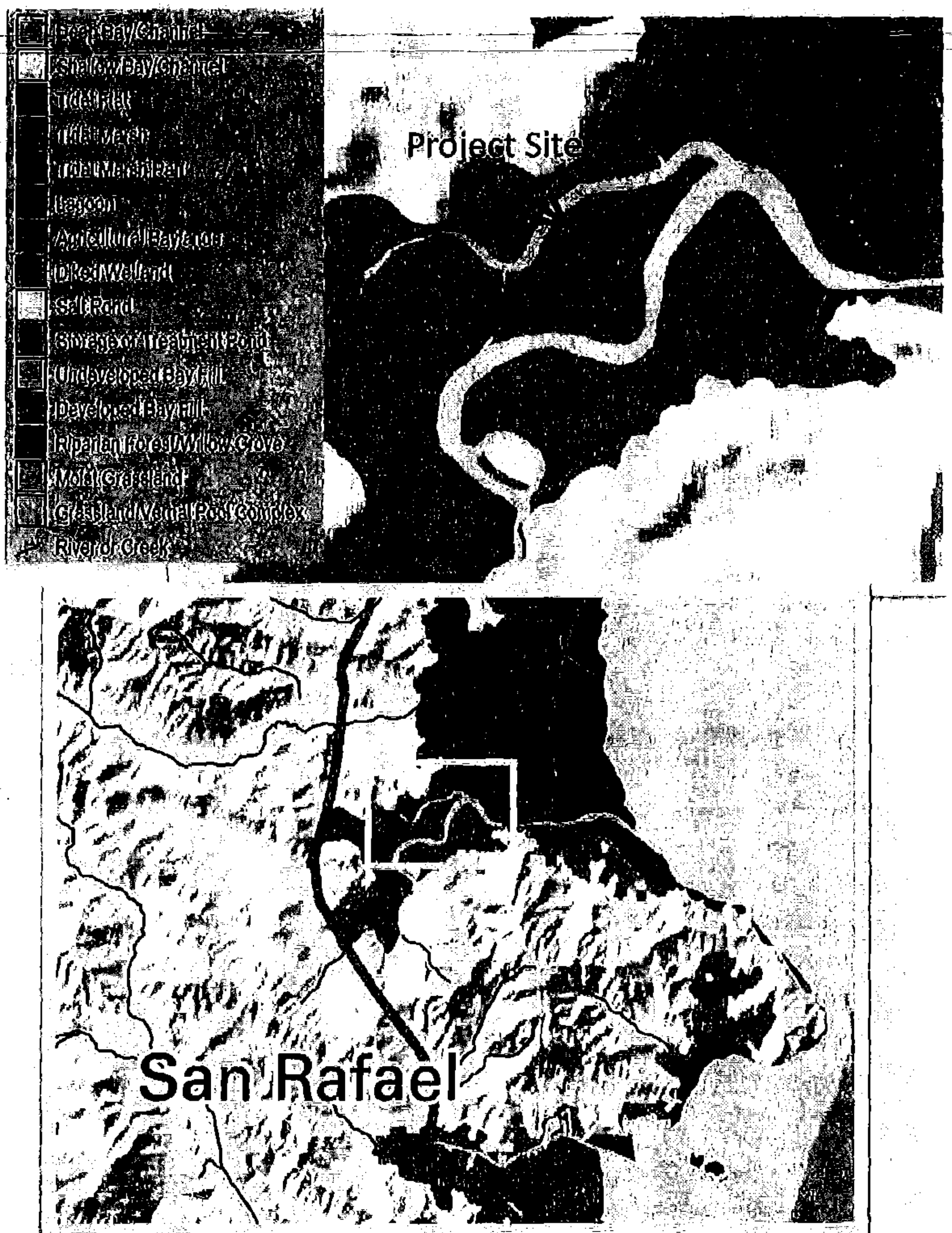
circa 1800

Modern Baylands



circa 1998

Modern Baylands



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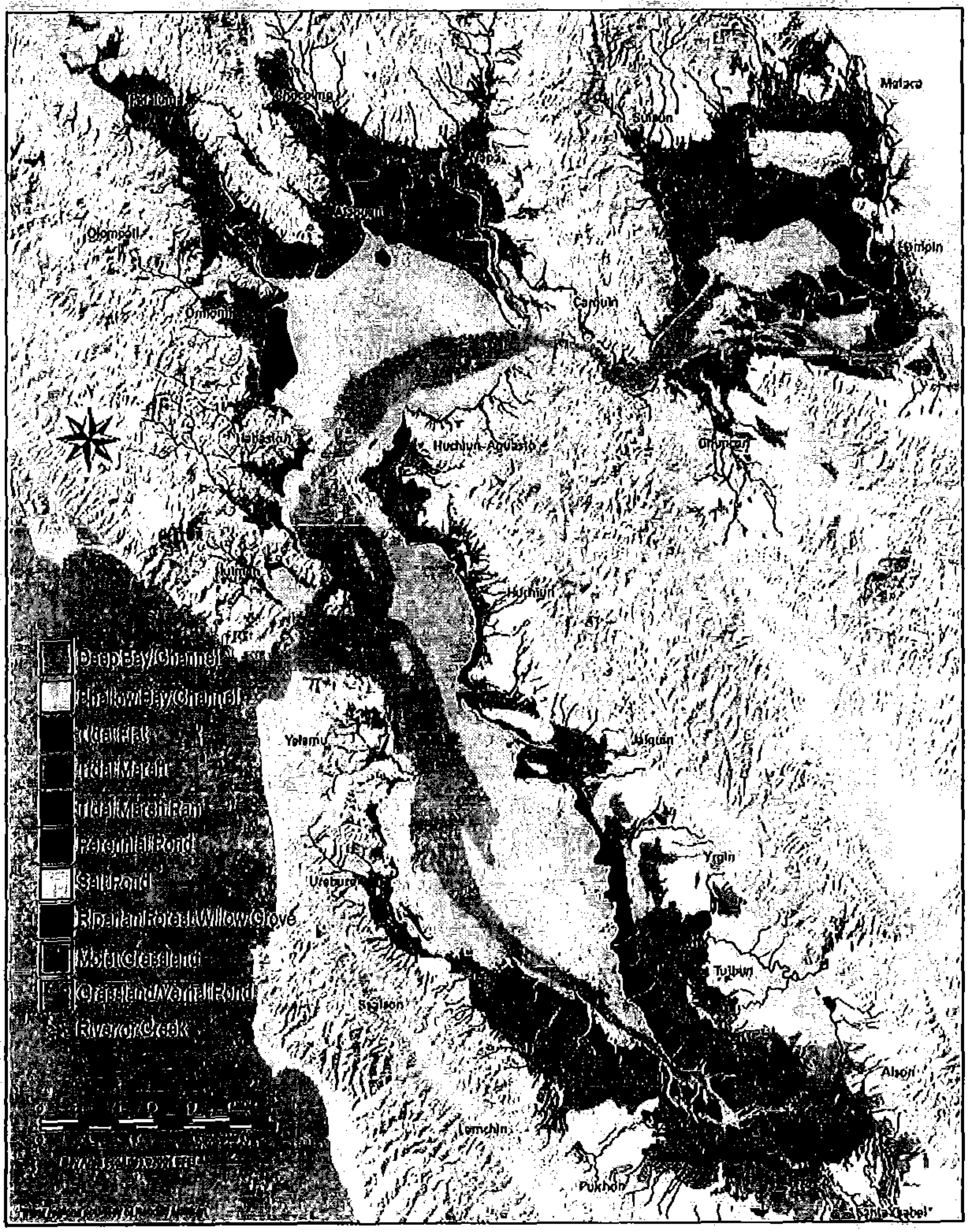
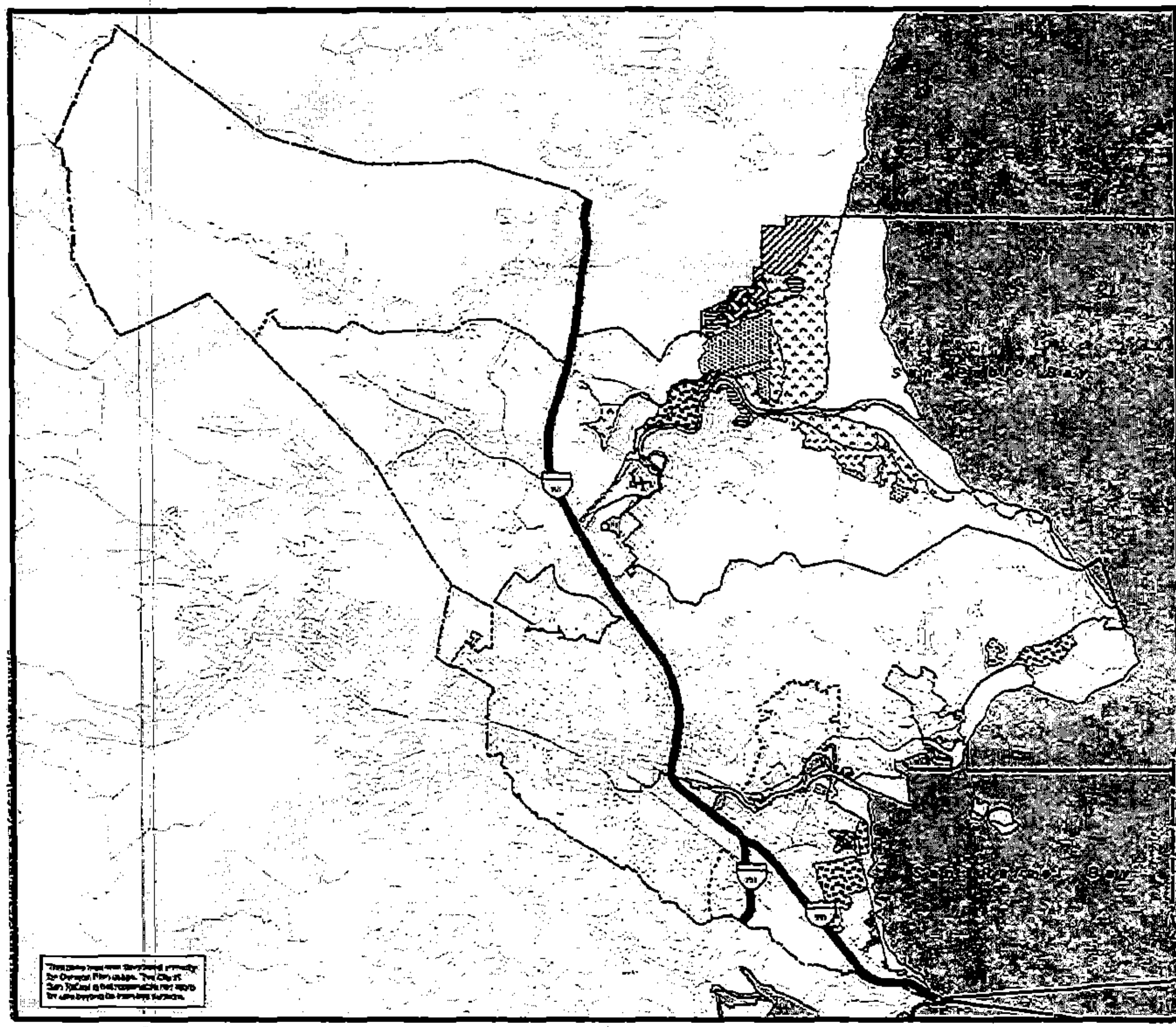
Historical Baylands



circa 1800

Exhibit 36



Baylands

- Bay Flat
- Channel Flat
- Diked Marsh
- Farmed Bayland
- Managed Marsh
- Muted Tidal Marsh
- Old High Tidal Marsh
- Ruderal Bayland
- Storage or Treatment Basin
- Young High Tidal Marsh
- Bay Waters

NOTE: This Exhibit shows information about baylands available from the San Francisco Estuary Institute. For detailed site environmental information, see Exhibit 34 'Major Biotic Habitats'.

Source: San Francisco Estuary Institute, 1999

0 500 1000 1500 Meters

0 1 Miles

Maps from San Francisco Estuary Institute

http://www.sfei.org/content/ecoatlas_habitats

EXHIBIT C

Avocet Research Associates
P.O. Box 839, Point Reyes, CA 94956. Tele: 415/663-8032; <avocetra@gmail.com>

Memorandum

Date: July 22, 2012

To: San Rafael Planning Commission

From: Jules Evens, Principal

Re: **Subject: 397-400 Smith Ranch Road (San Rafael Airport Recreational Facility)**

Please consider this memorandum a response to the Final Environmental Impact Report (FEIR) with reference to that report as well as the Report to the Planning Commission dated January 24, 2012. I am particularly concerned about assumptions and assertions made in those documents regarding sensitivity of the federal- and state-endangered California Clapper Rail to human disturbance and claims of habituation.

I also commented on the Draft EIR and have conducted numerous surveys of the California Clapper Rail in Gallinas Creek as well as other tidelands of the greater San Francisco Estuary for three decades. I also consulted with the U.S. Fish and Wildlife Service on the "Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California" and contributed to the species account of California Clapper Rail in that plan.[1] Selected excerpts from The Plan relevant to the Gallinas Creek Clapper Rails are provided in Appendix A. Particularly relevant are the sections on *Human Disturbance* and *Habitat Degradation*. Additionally, I was the co-author of the California Clapper Rail species narrative in the San Francisco Bay Area Wetlands Ecosystem Goals Project (Albertson and Evens 2000). My comments are limited mostly to the statements by Monk and Associates that make assertions of "habituation" by Clapper Rails and that either misinterpret or misrepresent the citations they rely on to support their contentions.

Responses to assertions made in FEIR and the PC report:

Assertion #1: "Wildlife, and birds in particular, are able to habituate to human beings and associated disturbances, especially when the stimuli is predictable (routine or repeated sounds) and when the disturbances that are "nonthreatening" (*i.e.* not directed toward the bird), as illustrated by Knight and Temple 1995, Knight and Cole 1995, and Riffell et. al. 1996." (PC, p.12-13)

[1] http://ecos.fws.gov/docs/recovery_plan/TMRP/Chapter II Species Accounts.pdf

Response: These are very broad generalities based on sweeping assumptions referencing studies that do not support the conclusions stated by Monk and Associates. Responses of wildlife to human disturbance are complex and influenced by a range of factors (Bejder *et al.* 2009). The studies cited by Monk and Associates relate to common landbirds in forested habitats of the Inner Mountain West, not to a rare and endangered species in tidal marshlands. (Those cited studies are discussed, below.) A better informed and more tenable discussion of habituation as it relates to the California Clapper Rail is given by the Huffman-Broadway Group (San Rafael) in the Bair Island (San Mateo Co.) EIR-EIS[2]:

> "Clapper rails vary in their sensitivity to human disturbance, both individually and between marshes. Certain types of disturbances have occurred within or adjacent to some marsh areas for a long time and certain clapper rails appear to have habituated or become tolerant of these disturbances, while others appear to habituate over time or are unable to habituate to these disturbances at all. For example, certain clapper rails in Palo Alto Baylands Nature Preserve appear to be somewhat tolerant of the relatively common pedestrian traffic on the public boardwalk that dissects the marsh. Clapper rail nests have been documented within 10 feet of trails in Elsie Romer and Cogswell marshes in Alameda County, and within 65 feet of a busy street near White Slough (Solano County). In contrast, Albertson (1995) documented a clapper rail abandoning its territory in Laumeister Marsh in south San Francisco Bay, shortly after a repair crew worked on a nearby transmission tower. The bird did not establish a stable territory within the duration of the breeding season, but eventually moved closer to its original home range several months after the disturbance. As a result of this territorial abandonment, the opportunity for successful reproduction during the breeding season was eliminated (J. Takekawa, pers. comm.). Clapper rails in Laumeister Marsh have little contact with people, and are apparently quite sensitive to human-related disturbance. On numerous occasions at the Corte Madera Ecological Preserve, rails have been observed seeking refuge from unrestrained dogs entering tidal marshes from adjacent levees with public access (J. Garcia, pers. comm. 1994). These disturbances have occurred despite the presence of signs notifying users that they are entering sensitive wildlife species areas and that pets must be under restraint while in the preserve area. Similarly, along the Redwood Shores Peninsula in San Mateo County, fences and signs installed to prevent access into areas with endangered species habitat have been repeatedly vandalized and people continue to enter the prohibited areas beyond the fences and signs (Popper and Bennett 2005). Evens and Page (1983) documented 4 rail breeding territories along the Greenbrae boardwalk in the Corte Madera Ecological Preserve. In 1993, no rail breeding territories were discovered along the boardwalk even though rail habitat conditions remained unchanged (J. Garcia, pers. comm.). This territorial abandonment is attributed to an increase in domestic and feral dogs and cats along the boardwalk resulting from new

[2] http://www.wrmp.org/docs/minutes/Bair_Island_EIR-EIS_AppB ver 4.pdf

> residents moving into nearby residential areas since 1983 (J. Garcia, pers. comm.). According to Harvey (1980) and Foerster et al. (1990), predators, especially rats, accounted for nest losses of 24 to 29 percent in certain South Bay marshes. Clapper rail reactions to disturbance may vary with season, however both breeding and non- breeding seasons are critical times. Disturbance during the nonbreeding season may primarily affect survival of adult and subadult rails. Adult clapper rail mortality is greatest during the winter (Albertson 1995; Eddleman 1989), and primarily due to predation (Albertson 1995). Human-related disturbance of clapper rails in the winter, particularly during high tide and storm events, may increase the birds' vulnerability to predators. The presence of people and their pets in the high marsh plain or near upland areas during winter high tides may prevent rails from leaving the lower marsh plain (Evens and Page 1983). Rails that remain in the marsh plain during inundation are vulnerable to predation due to minimal vegetative cover available (Evens and Page 1986). A population viability analysis under development for clapper rails identifies changes in adult survivorship as causing the greatest change in the population growth rate (M. Johnson, pers. comm). Another model also indicates that adult survivorship of clapper rails is the primary demographic variable for maintaining a stable population or causing the population to either increase or decline (Foin *et al.* 1997). These models indicate that survival of adult birds has the strongest effect on the perpetuation or extinction of the overall population.

This more balanced and cautionary approach provided by Huffman-Broadway touches on (but does not elaborate on) the underlying problem with the assertion that a given species or a given population will "habituate" to ongoing disturbance. To determine that fact, one would have to compare reproductive success and other demographic variables of a clapper rail population in a disturbed marsh with that of an undisturbed or relatively pristine marsh. Such studies are simply not available because this is an <u>federally endangered species</u>; research is limited by the USFWS Office of Endanger Species to avoid negatively impacting those few individuals that still survive and there are few, if any, pristine sites left.

The claim by Monk and Associates that habituation is a foregone conclusion for the California Clapper Rail is unsupported by any studies or the references they cite (see below), and provides a shallow and misleading interpretation of the concept:

> Habituation is often used incorrectly to refer to any form of moderation in wildlife response to human disturbance, rather than to describe a progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial. This misinterpretation, when coupled with the widely held assumption that habituation has a positive or neutral outcome for animals, can lead to inappropriate decisions about the threats human interactions pose to wildlife. (Bejder *et al.* 2009)

Regarding the references used to support Monk and Associates assertions about habituation: A peer-reviewed source (Cline *et al.* 20007) interpreted the Knight and

Temple reference cited by Monk and Associates: "A number of biological and environmental variables also contribute to individual response to disturbance. These variables are complex because wildlife responds differently to disturbance between species, between individuals of the same species, and between different periods of time for a single individual (HaySmith and Hunt 1995; Knight and Temple 1995). These confounding variables make studying disturbances difficult at best."

Likewise the other two references cited by Monk and Associates do not support their assertion about habituation.

The Riffel *et al.* study was conducted in mixed conifer forests in Wyoming and states in the abstract that "common species showed significant declines in richness and abundance over the 5 years." That study looked at common forest birds not rare, furtive and endangered tidal marsh species. (The Clapper Rail does not occur in the Intermountain West.) Indeed, another peer-reviewed study suggests a different interpretation of Riffel *et al.* 1996, as follows, from Tanner and Gange (2004): "Activities including hill walking (Riffell *et al.*, 1996), power boating (Bell, 2000), wildlife-photography and skiing (Burger, 2000) have all been shown to disturb wildlife and habitats."

Likewise, the Knight and Cole (1995) paper—a generalized study of various wildlife species in Colorado—is interpreted quite differently in a government literature review of wildlife disturbance impacts. Cline *et al.* 2007 state: "The mere presence of visitors may harm wildlife by displacing them from essential habitats or disrupting the raising of young (Knight and Cole, 1995). Therefore, the question is not so much does the activity cause impact, but rather, how much and what level of impact is acceptable. Disturbance includes both direct and indirect effects toward wildlife"

Again, Becker *et al.* (2012) draw quite a difference conclusion from Knight and Cole: "Human disturbance stimuli can distract animals from pursuing fitness-enhancing activities (e.g., feeding, mating), alter normal behavior, and cause animals to avoid suitable habitat or to reduce the size of their ranges (Boyle and Samson 1985, <u>Knight and Cole 1995</u>, Cole and Anthony 1997, Shively et al. 2005, Borkowski et al. 2006). [Emphasis added]

In summary, there is no evidence that California Clapper Rails habituate to human disturbance and it is reckless to assert otherwise, especially when determining land-use practices that may have adverse impacts on a federally-endangered species.

Assertion #2: Monk and Associates state without qualification: "The fact that Clapper rails have persisted in this area over at least several years of study, and have been repeatedly detected during the nesting season, demonstrates that the Clapper rail must be successfully reproducing."

Response: Note the emphatic use of "demonstrates" and "must." Although their conclusion may seem "logical" it is at odds with basic precepts of conservation biology and no such conclusion is certain or warranted . The presence of Clapper Rails in the area does not "demonstrate" successful reproduction. As the Draft Recovery Plan (q.v.) states explicitly: "Although clapper rails may occur in areas with high levels of human-related disturbance, the effects of the disturbance on the rails is unknown and potentially significant . . . Because most clapper rail marshes are subjected to a variety of uses, the cumulative detrimental effects may be appreciable. Numerous routine human activities have the potential to adversely affect individual rails and overall *population* viability . . ." (p. 114). [Emphasis added]

In fact, very little is known about the reproductive success of the local population. It is a basic precept of conservation biology that presence or abundance of a given species is not a reliable indicator of breeding success (Vickery *et al.* 1992) or habitat quality (VanHorne 1983). We do know that the Gallinas Creek marshlands are contiguous with perhaps the largest extant population of clapper rails left in San Pablo Bay marshes—those associated with the broad bayshore marshlands that extend from the mouth of Gallinas Creek north to Hamilton Field (Evens and Collins 1992, Collins *et al.* 1994, Albertson and Evens 2000, Avocet 2004). This is the most extensive and least disturbed parcel of tidal marsh habitat left in the North Bay, hence the presence of an apparently viable population. When the bayshore population has a successful nesting year, it likely serves as a source for those birds that disperse up Gallinas Creek. However, we have no idea how successful those dispersants are reproductively and there are no data on survivorship of the population.

The subject of metapopulation dynamics is too complex and nuanced a subject for this memorandum, but suffice it to say that some habitats are "sources" and other are "sinks" (Pulliam 1996, Battin 2004, Akcakaya *et al.* 2006, Gilroy and Sutherland 2007). Just because a species occurs in a given habitat does not mean that that habitat is viable or optimal The contention that because clapper rails are present they are "thriving" is far too facile an assumption to make when considering a federally endangered species. Rather, the responsible course of action for governmental agencies and consulting biologists is a conservative approach taking precautionary measures. It is reckless to make assumptions based on limited information and to select references that appear to support those assumptions while ignoring counterbalancing information, as is done in the FEIR and the PC report.

Concluding remarks

The presence of rails in the linear tidelands bordering Gallinas Creek does not support the assumption that the population is "thriving" or even viable. Again, as stated in the from the U.S. Fish and Wildlife Service's "Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California:"

> Although clapper rails may occur in areas with high levels of human-related disturbance, the effects of the disturbance on the rails is unknown and potentially significant . . . Because most clapper rail marshes are subjected to a variety of uses, the cumulative detrimental effects may be appreciable. Numerous routine human activities have the potential to adversely affect individual rails and overall *population* viability . . .

Even if it were possible to conclude that Clapper Rails in the vicinity of the Project were habituated to human presence based on existing levels of use, that does not mean that the construction and operation of an active sports facility drawing over a thousand visitors per day would not adversely impact the Clapper Rail. There is no evidence to support the FEIR's conclusion that the Clapper Rail will simply adapt to the additional noise impacts, lighting, and intrusions into Gallinas Creek caused by the Project. With its daily generation of food waste, the Project is highly likely to increase populations of scavengers, especially rats – known predators of the California Clapper Rail. The FEIR does not evaluate impacts of the Project caused by increased predation from rats and other predators that will be subsidized by the Project.

Additionally noise mitigations during the construction phase of the project are inadequate. Specifically, the FEIR proposes no piling driving during the nesting season, but allows other construction during that time with a 250-foot buffer. The USFWS requires a minimum 250-foot buffer from occupied habitat during the period January 15-September 1.

> "Size of buffer areas or transitional habitat (area between the marsh and uplands) is important because outside influences from the upland area may

have devastating effects in the marsh. The larger the buffer, the less severe or direct the impacts will be."[3]

In summary, the EIR's conclusion that the Project will not have a significant impact on California Clapper Rail is based on the assumption that the population of Clapper Rail in the vicinity of Gallinas Creek has become habituated to human presence. This conclusion is not supported by the research.

Thank you for your consideration of this matter.

Jules Evens

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U.S. Fish and Wildlife Endangered Species Permit: TE 786728-3
California Department of Fish and Game Collecting Permit # 801092-04
Federal Bird Marking and Salvage Permit: # 09316-AN

[3] http://www.fws.gov/desfbay/Archives/Clapper/carail.htm

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APPENDIX A. Selected excerpts from the U.S. Fish and Wildlife Service's "Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California"

"California clapper rails were recognized as endangered by the Federal government and added to the List of Endangered Species on October 13, 1970 (U.S. Fish and Wildlife Service 1970). California clapper rails were added to the State endangered species list on June 27, 1971 (California Department of Fish and Game 2005). It has a recovery priority number of 3C, based on a high degree of threat, a high potential of recovery, and its taxonomic standing as a subspecies. The additional "C" ranking indicates some degree of conflict between the conservation needs of the species and economic development (U.S. Fish and Wildlife Service 1983) The first recovery plan for the species was published November 16, 1984 (U.S. Fish and Wildlife Service 1984). Factors currently impacting rail numbers baywide include predation, contaminants, and habitat loss/alteration/degradation."

Regarding local distribution: "*San Pablo Bay*. Small *populations* of clapper rails are patchy and discontinuously distributed throughout San Pablo Bay in small isolated *tidal marsh* habitat fragments (Collins *et al.* 1994). In 2004 there were between 84 and a few hundred pairs (not individuals) in the San Pablo Bay region (Avocet Research Associates 2004). Highest numbers of clapper rails in San Pablo Bay currently occur in South Gallinas and Hamilton Army Airfield marshes, and at the mouth of Gallinas Creek (Herzog *et al.* 2006)." [Emphasis added-JE].

Productivity. Reproductive success of the California clapper rail is much reduced below the natural potential (Schwarzbach *et al.* 2006).

Survivorship. The only estimates of annual adult California clapper rail survivorship were relatively low, ranging from 0.49 to 0.52 (Albertson 1995). These are similar to survival estimates reported for the Yuma subspecies (Eddleman 1989). Increased predation occurs during extreme winter high *tides*, probably due to increased movement of rails at this time when little cover is available (Albertson and Evens 2000). Adult survivorship has been suggested as the key *demographic* variable associated with survival of clapper rail *populations* (Foin *et al.* 1997).

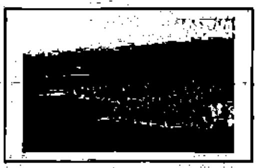
Habitat: Rail foraging and refugial habitat encompasses the lower, middle, and high *marsh* zones, as well as the adjacent transitional zone. Lower and middle *marsh* zones provide foraging habitat at low *tide*. Small *tidal* channels (*i.e.*, first- and second-order) with dense vegetation covering the banks are particularly important habitat features (Keldsen 1997, Garcia 1995). These provide important foraging habitat and hidden routes for travel in close proximity to nesting habitat. Higher *marsh* areas (high *marsh* and transitional zones) with dense vegetation are used for nesting and high-*tide refugia* (DeGroot 1927, Harvey 1988, Foerster *et al.* 1990, Evens and Collins 1992, Collins *et al.* 1994) . . . Physical habitat characteristics critical to clapper rails include *marsh* size, location relative to other marshes, presence of buffers or transitional zones between marshes and upland areas, *marsh* elevation, and *hydrology* (Collins *et al.* 1994, Albertson

1995). [Emphasis added-JE]

Under *"Reasons for Decline and Threats to Survival"* (pgs 109-110)
Habitat Degradation. Other than outright habitat loss due to *marsh* reclamation, significant historic degradation to clapper rail habitat quality in remaining *tidal* marshes is caused by numerous human-caused physical and biological changes in the San Francisco Bay Estuary *tidal* marshes, including:
(1) Construction and maintenance of *dikes* in *tidal* wetlands—many adverse effects stem from these actions, including
a. *marsh* fragmentation and reduction to small isolated marshes b. reduction in quality, distribution, and abundance of critical sub-habitats, such as high *tide refugia*
(2) Replacement of *tidal refugia* along landward *marsh* edges with unbuffered urban edges

Human Disturbance: Data on reproductive success of nests near heavily trafficked areas are lacking. Clapper rails nesting next to regularly disturbed areas are likely to be subject to higher rates of predation due to easy access provided by trails, *dikes*, and roads. Disturbance of incubating or brooding adults may translate into reduced hatch or fledge success of young through increased nest predation if the adult vacates the nest, or through temperature stress (heat or cold) due to lack of thermoregulation by the adult. Reduced reproductive success results in reduced recruitment to an already unstable endangered *population*. In addition, continued disturbance may stress the adults and reduce survival through disruption of normal activities, such as reduced foraging or resting time or increased susceptibility to predators. Reduced survival of adult clapper rails may also impact the long-term viability of the *population*, which has been identified as the most critical life stage in *population* models (M. Johnson unpubl. data; Foin *et al.* 1997).

EXHIBIT D



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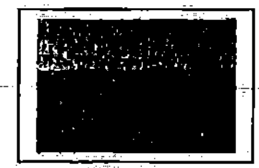

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MEMORANDUM

To: Ellison Folk, Shute-Mihaley & Weinberger LLP folk@smwlaw.com

Date: July 30, 2012

SUBJECT: San Rafael Airport Recreational Facility FEIR (SCH 200612125) biological resources

1. I have reviewed the City of San Rafael's San Rafael Airport Recreational Facility FEIR and DEIR's sections on project description and biological resources, at your request. Following preliminary review of potentially significant impacts and mitigation measures, I focused my review on an apparent gap (significant omission) in the EIR's assessment of long term cumulative impacts of the project on foreseeable future critical high tide refuge habitat for the California clapper rail, salt marsh harvest mouse (federal and state listed endangered species) and California black rail, as well as California black rails (state-listed endangered) inhabiting the fringing salt marsh neighboring the Project site.

The FEIR apparently fails to integrate revised sea level rise assessment (hydrological analysis; HYD-2) with significant habitat and endangered species impacts, in relation to levee maintenance, mowing for "safety" requirements, and the feasibility of the (static) 130-250 ft buffer zone mitigation (MM Bio 2b-c). Your comment letter on the DEIR as well as the comments of Jules Evens, the Marin County Open Space District, Marin Conservation League, and others all identified the failure of the EIR to adequately address impacts to the endangered salt marsh habitat and the species that rely on it, and the failure to analyze the project's impacts in relation to sea level rise. My comments here will focus on the failure of the EIR to address the impact of the Project, combined with sea level rise, on tidal salt marsh habitat and endangered species that rely on it, including the California Clapper Rail and the salt marsh harvest mouse.

2. The DEIR and FEIR coverage of endangered salt marsh species habitat issues, however, appears to be limited to short-term or near-term impacts based only on current sea level and habitat configurations, as though "existing conditions" precluded analysis of foreseeable cumulative impacts between the project, its mitigation measures, and sea level rise over decades. Rising sea level will change the distribution, quality, and abundance of salt marsh and high tide refuge habitat in relation to the flood control infrastructure and its

maintenance on which the project would depend. The EIR did not evaluate conflicts (impacts) between the project's new flood control requirements (HYD-2) and the inevitable vertical and horizontal displacement of high tide refuge habitat of endangered species driven by sea level rise. To the extent that the proposed project permanently relies on perpetual maintenance (or upgrading) of the existing levee for flood control of new development (to prevent levee breaching and flooding of newly developed recreational facilities), and proposes to maintain mowing in the undeveloped "buffer zone" in perpetuity landward of the existing levee, the project as proposed would cause or contribute significantly to "coastal squeeze" of existing salt marsh and high tide transition zone habitat as sea level rises 12-18 inches by 2050. (The FEIR concedes that 2050 is not a speculative long-term planning horizon for this project's re-assessment of sea level rise and flood vulnerability; see response 45-21).

3. Even if portions of the existing narrow fringing salt marsh are able to keep pace with sea level rise by accreting vertically (sediment deposition), the horizontal extent of salt marsh between the levee and the channel would narrow as tidal prism increases with sea level rise, and the extent of the critically important high tide refuge habitat (dense, tall, vegetation cover for rails and salt marsh harvest mouse during flooding of extreme high tides) would decrease if the levee is maintained in a fixed position. Maintaining ecological viability of existing salt marsh habitat, and feasible buffer zones proposed in mitigation measures (MM Bio2b-c) in the long term would require levee set-back (landward realignment, widening the outboard slope below the height of extreme high storm tide flood elevations).

The FEIR does not assess the feasibility of this biological mitigation in relation to foreseeable sea level rise. The existing extent and quality of suitable salt marsh and critical flood refuge habitat for endangered wildlife species (discussed in detail by Jules Evens, letter 40) and buffer zone functions could be maintained during sea level rise, but only with set-back of the levee (landward displacement or modification of the levee cross-section, or both). In existing conditions of undeveloped diked baylands or open space, there is less physical constraint on adapting flood control levees to sea level rise that is compatible or beneficial to long-term survival of endangered resident tidal marsh wildlife. Project-induced flood control requirements or mitigation measures (such as spatially fixed, permanent buffer zone deed restrictions that may conflict with levee realignment) may preclude or significantly impair feasibility of levee set-back for integrated coastal habitat and flood control realignment. The DEIR and FEIR are silent on this significant conflict in resource management caused by the project and static mitigation buffer zones in a regime of accelerated foreseeable sea level rise by 2050.

4. In conclusion, the FEIR apparently has not applied the revised assessment of sea level rise (response to comment 45-21; Master Response to Comments HYD-4) to the assessment of long-term project impacts on the position, quality, stability, and extent of the critical high tide refuge habitat that currently (temporarily) occurs between the landward edge of the regularly flooded intertidal salt marsh, and the outboard slope of the perimeter levee. The FEIR (citing the biological consultant, Monk & Associates) recognized that resident

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CaG

California clapper rails must "occasionally" seek refuge of the uplands immediately adjacent to the channel (i.e., levee transition zone), but the DEIR and FEIR failed to consider the significant impacts of forcing this critical habitat zone to occupy a fixed position on a levee and buffer zone maintained for flood control and vegetation mowing as sea level rises. In my professional opinion, the proposed mitigation measures to protect clapper rails would be infeasible in the long term unless the project and its mitigation were redesigned to accommodate sea level rise with integrated flood control and wildlife habitat. As proposed, the recreational facility development proposed would significantly increase conflicts with this necessary adaptation of tidal marsh and flood control structures (levees) to sea level rise.

STATEMENT OF QUALIFICATIONS

Peter Baye is a coastal ecologist and botanist with 32 years professional experience in conservation and management of coastal vegetation, focusing on dunes, barrier beaches, tidal marshes, and lagoons. He received his Ph.D. from the University of Western Ontario, Department of Plant Sciences, Canada, in 1990. Peter performed environmental analysis for NEPA, Clean Water Act, and Endangered Species Act compliance at the U.S. Army Corps of Engineers, San Francisco District, and prepared endangered species recovery plans and Section 7 consultations for the U.S. Fish and Wildlife Service, Sacramento. He currently works as an independent consulting coastal ecologist in the central California coast region, developing coastal habitat restoration projects, vegetation management plans, and endangered species recovery projects. His work in the San Francisco Estuary includes:

- lead author and coordinator of USFWS administrative draft recovery plan for tidal marsh ecosystems of Central and Northern California (with appendices), now in public draft;
- author and co-author of two bayland plant community chapters in the San Francisco Bay Ecosystem Habitat Goals Project Species and Community Profiles volume, co-chair of Plant Team of the Goals Project, USFWS and U.S. Army Corps of Engineers representative for the Goals Project, and participant in the current (2012) Goals Project update for climate change/sea level rise;
- co-author or sole author of multiple tidal marsh restoration and management plans including habitat for endangered species, including Sears Point Wetland Restoration Project, Bahia Wetland Restoration Project, Pier 94 San Francisco wetland shoreline enhancement, Petaluma Marsh Enhancement Project.

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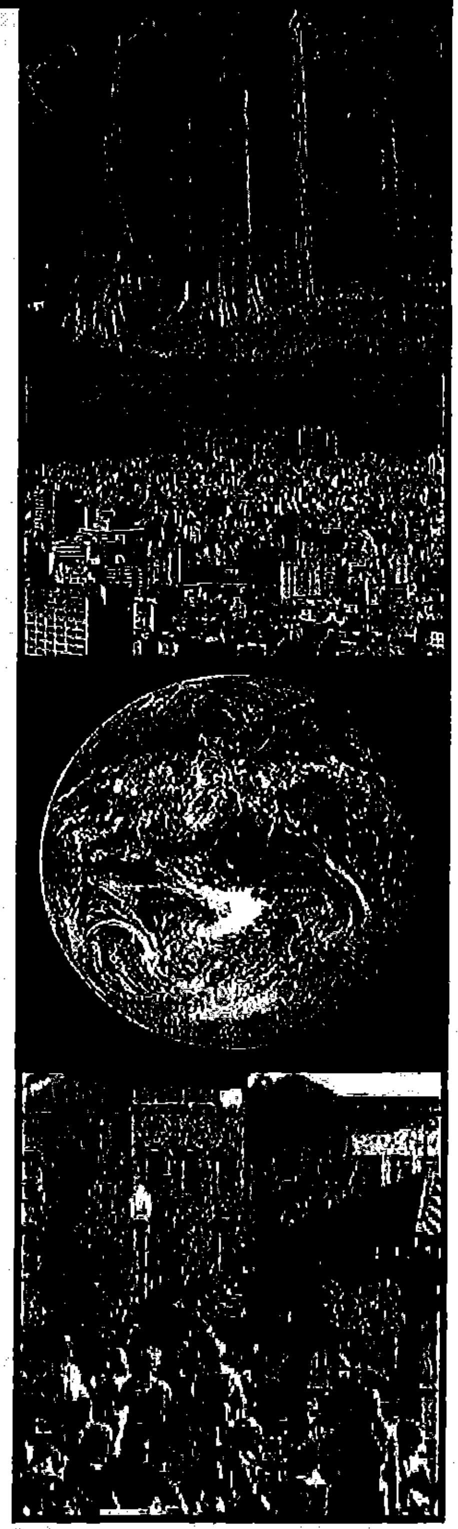
EXHIBIT E

CAPCOA

CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION



CEQA & Climate Change

Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act

January 2008

threshold low enough to capture a substantial fraction of future residential and non-residential development that will be constructed to accommodate future statewide population and job growth, while setting the emission threshold high enough to exclude small development projects that will contribute a relatively small fraction of the cumulative statewide GHG emissions.

The quantitative threshold was created by using the following steps:

- Reviewing data from four diverse cities (Los Angeles in southern California and Pleasanton, Dublin, and Livermore in northern California) on pending applications for development.
- Determining the unit (dwelling unit or square feet) threshold that would capture approximately 90 percent of the residential units or office space in the pending application lists.
- Based on the data from the four cities, the thresholds selected were 50 residential units and 30,000 square feet of commercial space.
- The GHG emissions associated with 50 single-family residential units and 30,000 square feet of office were estimated and were found to be 900 metric tons and 800 metric tons, respectively. Given the variance on individual projects, a single threshold of 900 metric tons was selected for residential and office projects.
- A 900 metric ton threshold was also selected for non-office commercial projects and industrial projects to provide equivalency for different projects in other economic sectors.
- If this threshold is preferred, it is suggested that a more robust data set be examined to increase the representativeness of the selected thresholds. At a minimum, a diverse set of at least 20 cities and/or counties from throughout the state should be examined in order to support the market capture goals of this threshold. Further, an investigation of market capture may need to be conducted for different commercial project types and for industrial projects in order to examine whether multiple quantitative emissions thresholds or different thresholds should be developed.

The 900-ton threshold corresponds to 50 residential units, which corresponds to the 84th percentile of projects in the City of Los Angeles, the 79th percentile in the City of Pleasanton, the 50th percentile in the City of Livermore and the 4th percentile in the City of Dublin. This is suggestive that the GHG reduction burden will fall on larger projects that will be a relatively small portion of overall projects within more developed central cities (Los Angeles) and suburban areas of slow growth (Pleasanton) but would be the higher portion of projects within moderately (Livermore) or more rapidly developing areas (Dublin). These conclusions are suggestive but not conclusive due to the small sample size. The proposed threshold would exclude the smallest proposed developments from potentially burdensome requirements to quantify and mitigate GHG emissions under CEQA. While this would exclude perhaps 10 percent of new residential development, the capture of 90 percent of new residential development would establish a strong basis for demonstrating that cumulative reductions are being achieved across the state. It can certainly serve as an interim measure and could be revised if subsequent regulatory action by CARB shows that a different level or different approach altogether is called for.

The 900-ton threshold would correspond to office projects of approximately 35,000 square feet, retail projects of approximately 11,000 square feet, or supermarket space of approximately 6,300 square feet. 35,000 square feet would correspond to the 46th percentile of commercial projects in the City of Los Angeles, the 54th percentile in the City of Livermore, and the 35th percentile in the City of Dublin. However, the commercial data was not separated into office, retail, supermarket or other types, and thus the amount of capture for different commercial project types is not known. The proposed threshold would exclude smaller offices, small retail (like auto-parts stores), and small supermarkets (like convenience stores) from potentially burdensome requirements to quantify and mitigate GHG emissions under CEQA but would include many medium-scale retail and supermarket projects.

The industrial sector is less amenable to a unit-based approach given the diversity of projects within this sector. One option would be to adopt a quantitative GHG emissions threshold (900 tons) for industrial projects equivalent to that for the residential/commercial thresholds described above. Industrial emissions can result from both stationary and mobile sources. CARB estimates that their suggested reporting threshold for stationary sources of 25,000 metric tons accounts for more than 90 percent of the industrial sector GHG emissions (see Threshold 2.3 for 25,000 metric ton discussion). If the CARB rationale holds, then a 900 metric ton threshold would likely capture at least 90 percent (and likely more) of new industrial and manufacturing sources. If this approach is advanced, we suggest further examination of industrial project data to determine market capture.

This threshold would require the vast majority of new development emission sources to quantify their GHG emissions, apportion the forecast emissions to relevant source categories, and develop GHG mitigation measures to reduce their emissions.

Threshold 2.3: CARB Reporting Threshold

CARB has recently proposed to require mandatory reporting from cement plants, oil refineries, hydrogen plants, electric generating facilities and electric retail providers, cogeneration facilities, and stationary combustion sources emitting ≥ 25,000 MT CO_2e/yr. AB 32 requires CARB to adopt a regulation to require the mandatory reporting and verification of emissions. CARB issued a preliminary draft version of its proposed reporting requirements in August 2007 and estimates that it would capture 94 percent of the GHG emissions associated with stationary sources.

This threshold would use 25,000 metric tons per year of GHG as the CEQA significance level. CARB proposed to use the 25,000 metric tons/year value as a reporting threshold, not as a CEQA significance threshold that would be used to define mitigation requirements. CARB is proposing the reporting threshold to begin to compile a statewide emission inventory, applicable only for a limited category of sources (large industrial facilities using fossil fuel combustion).

A 25,000 metric ton significance threshold would correspond to the GHG emissions of approximately 1,400 residential units, 1 million square feet of office space, 300,000 square feet of retail, and 175,000 square feet of supermarket space. This threshold would capture far less than half of new residential or commercial development.

As noted above, CARB estimates the industrial-based criteria would account for greater than 90 percent of GHG emissions emanating from stationary sources. However, industrial and manufacturing projects can also include substantial GHG emissions from mobile sources that are associated with the transportation of materials and delivery of products. When all transportation-related emissions are included, it is unknown what portion of new industrial or manufacturing projects a 25,000-ton threshold would actually capture.

An alternative would be to use a potential threshold of 10,000 metric tons considered by the Market Advisory Committee for inclusion in a Greenhouse Gas Cap and Trade System in California. A 10,000 metric ton significance threshold would correspond to the GHG emissions of approximately 550 residential units, 400,000 square feet of office space, 120,000 square feet of retail, and 70,000 square feet of supermarket space. This threshold would capture roughly half of new residential or commercial development.

Threshold 2.4: Regulated Emissions Inventory Capture

Most California air districts have developed CEQA significance thresholds for NOx and ROG emissions to try to reduce emissions of ozone precursors from proposed sources that are not subject to NSR pre-construction air quality permitting. The historical management of ozone nonattainment issues in urbanized air districts is somewhat analogous to today's concerns with greenhouse gas emissions in that regional ozone concentrations are a cumulative air quality problem caused by relatively small amounts of NOx and ROG emissions from thousands of individual sources, none of which emits enough by themselves to cause elevated ozone concentrations. Those same conditions apply to global climate change where the environmental problem is caused by emissions from a countless number of individual sources, none of which is large enough by itself to cause the problem. Because establishment of NOx/ROG emissions CEQA significance thresholds has been a well-tested mechanism to ensure that individual projects address cumulative impacts and to force individual projects to reduce emissions under CEQA, this threshold presumes the analogy of NOx/ROG emission thresholds could be used to develop similar GHG thresholds.

EXHIBIT F

Open Access

Research Article

A Geospatial Analysis of the Effects of Aviation Gasoline on Childhood Blood Lead Levels

- Article

Jump to

- Abstract
- Methods
- Results
- Discussion
- Conclusions
- References

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Abstract Top

Background: Aviation gasoline, commonly referred to as avgas, is a leaded fuel used in small aircraft. Recent concern about the effects of lead emissions from planes has motivated the U.S. Environmental Protection to consider regulating leaded avgas.

Objective: In this study we investigated the relationship between lead from avgas and blood lead levels in children living in six counties in North Carolina.

Methods: We used geographic information systems to approximate areas surrounding airports in which lead from avgas may be present in elevated concentrations in air and may also be deposited to soil. We then used regression analysis to examine the relationship between residential proximity to airports and North Carolina blood lead surveillance data in children 9 months to 7 years of age while controlling for factors including age of housing, socioeconomic characteristics, and seasonality.

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Results: Our results suggest that children living within 500 m of an airport at which planes use leaded avgas have higher blood lead levels than other children. This apparent effect of avgas on blood lead levels was evident also among children living within 1,000 m of airports. The estimated effect on blood lead levels exhibited a monotonically decreasing dose–response pattern, with the largest impact on children living within 500 m.

Conclusions: We estimated a significant association between potential exposure to lead emissions from avgas and blood lead levels in children. Although the estimated increase was not especially large, the results of this study are nonetheless directly relevant to the policy debate surrounding the regulation of leaded avgas.

Keywords: avgas, aviation gasoline, blood lead, childhood, geospatial, lead poisoning.

Citation: Miranda ML, Anthopolos R, Hastings D 2011. A Geospatial Analysis of the Effects of Aviation Gasoline on Childhood Blood Lead Levels. Environ Health Perspect 119:1513-1516. http://dx.doi.org/10.1289/ehp.1003231

Received: 19 November 2010; **Accepted:** 13 July 2011; **Online:** 13 July 2011

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We gratefully acknowledge aviation gas data provided by M. Hoyer from the U.S. Environmental Protection Agency (EPA) Office of Transportation and Air Quality and childhood lead exposure data provided by E. Norman and T. Ward from the N.C. Department of Environment and Natural Resources. We also acknowledge the geocoding work undertaken by the geographic information systems staff of the Children's Environmental Health Initiative.

This work was funded in part by a grant from the U.S. EPA (RD-83329301) and the N.C. Department of Environment and Natural Resources (1 H64 EH000151).

The authors declare they have no actual or potential competing financial interests.

Lead poisoning in children living in the United States has declined dramatically over the last several decades as a result of banning leaded gasoline, lead-based paint, and lead solder in plumbing. Nevertheless, children in the United States continue to be exposed to lead. The 2007–2008 National Health and Nutrition Examination Survey survey found blood lead levels at or above the Centers for Disease Control and Prevention (CDC) blood lead action level of 10 μg/dL in about 1.1% of 1- to 5-year-olds, or about 270,000 children (National Center for Health Statistics 2010). Even more worrisome is a large body of recent research that demonstrates negative health effects, including learning disabilities and behavioral disorders, associated with lead exposure levels well below the CDC action level (Canfield et al. 2003; Chiodo et al. 2004; Lanphear et al. 2000; Schnaas et al. 2006). A study by Miranda et al. (2007, 2009, 2010) suggests that early childhood blood lead levels as low as 2 μg/dL can have significant impacts on academic performance as measured by end-of-grade test scores. In response to this body of research, the CDC has stated that there is no safe level for blood lead in children (CDC 2005).

One source of lead exposure that is often overlooked is aviation fuel. Lead emitted from aircraft using leaded aviation gasoline (avgas) is currently the largest source of lead in air in the United States, constituting about 50% of lead emissions in the 2005 National Emissions Inventory [U.S. Environmental Protection Agency (EPA) 2010]. Although leaded gasoline for automobiles was phased out of use in the United States by 1995, lead is still permitted in avgas. Lead is added to avgas to achieve the high octane required for the engines of piston-driven airplanes. The most commonly used fuel for piston-driven aircraft in the United States is known as Avgas 100LL. Although the "LL" stands for low lead, 100LL gasoline contains up to 0.56 g/L lead (Royal Dutch Shell 2010). Another grade of avgas, Avgas 100, contains higher amounts of lead and is still in widespread use. Newer varieties of avgas without lead, including 82 UL and 94 UL, have been introduced recently. These unleaded fuels are not used as commonly as the two leaded grades, however, because their octane ratings are too low for many small aircraft engines.

Previous research indicates that lead levels in air near airports where planes use avgas are significantly higher than background levels. A study at the Santa Monica airport in California found that the highest lead levels occur close to airport runways and decrease exponentially with distance from an airport, dropping to background levels at about 1 km (U.S. EPA 2010). Another study at Toronto-Buttonville (Canada) airport found that the average air lead level near the airport was 4.2 times higher than the background air lead level in Toronto over a 24-hr period (Environment Canada 2000), and a study at Chicago (IL) O'Hare airport found that air lead levels were significantly higher downwind from the airport than upwind (Illinois Environmental Protection Agency 2002).

Thus, the combustion of leaded avgas by small airplane engines may pose a health risk to children who live or attend school near airports. The lead in air surrounding airports can be inhaled directly, or the lead may be ingested by children after it settles into soil or dust (U.S. EPA 2010). The U.S. EPA estimates that people living within 1 km of airports are at risk of being exposed to lead from avgas (Hitchings 2010). The U.S. EPA further notes that about 16 million people live within 1 km of an airport with planes using avgas, and 3 million children attend school within 1 km of these airports (U.S. EPA 2010).

Because of the risk of lead poisoning from avgas, environmental groups have pressured the U.S. EPA to take action to reduce lead emissions from aviation fuel. One environmental group, Friends of the Earth, has petitioned the U.S. EPA to find endangerment from and regulate lead in avgas. The U.S. EPA has responded with an Advanced Notice for Proposed Rulemaking on aviation fuel and solicited comments and further research about the effects of lead in avgas away (U.S. EPA 2010). The U.S. EPA has refrained from establishing a date by which aircraft would be required to use unleaded fuel [AOPA (Aircraft Owners and Pilots Association) ePublishing staff 2010].

Here we seek to contribute to research regarding the risk of lead in avgas by determining whether living near airports where avgas is used has a discernible impact on blood lead levels in children. Previous studies have examined whether lead from avgas is present in air and soil near airports. Our work seeks to link avgas exposure to childhood blood lead levels. To elucidate the effects of avgas on blood lead levels, we compared blood lead levels in children living near airports in six counties in North Carolina with those in children living farther away from airports but residing in the same counties. We used a multiple regression model to control for other variables that have previously been found to affect blood lead levels (CDC 1991, 1997; Sargent et al. 1995) in an effort to isolate the impact of avgas. The results of this study are directly relevant to the policy debate surrounding the regulation of leaded avgas.

Methods Top

We obtained a database of airports in North Carolina from the U.S. EPA Office of Transportation and Air Quality (2008). The database contained estimates for the annual lead emissions from each airport, along with the spatial location of each facility. We used ArcGIS 9.3 (ESRI, Redlands, WA) to plot the locations of these airports against a county boundary map of North Carolina. We selected six counties in North Carolina (Carteret, Cumberland, Guilford, Mecklenburg, Union, and Wake) (Figure 1). Counties were selected based on whether they contained multiple airports with significant air traffic, where significant numbers of children had been screened for lead exposure, and where the county tax assessor data would allow us to control for age of housing as an important confounder when assessing avgas as a source of lead exposure (Table 1). Because we wanted to control for risk from deteriorating lead-based paint, we selected counties where the county tax assessor data contained a well-populated field for age of housing. We obtained North Carolina blood lead surveillance data for all children in the study counties between the ages of 9 months and 7 years who had been tested for lead between 1995 and 2003 from the Children's Environmental Health Branch within the North Carolina Department of Environment and Natural Resources (North Carolina Childhood Lead Poisoning Prevention Program 2004). Because we were unable to ascertain where the children attended school, we were not able to control for the location of their school relative to the airports. Most of the children screened for lead are not yet old enough to be attending school. All aspects of this study were conducted in accordance with a human subjects research protocol approved by the institutional review board (IRB) of Duke University.

Figure 1.

Study counties.

Table 1.

Number of airports, estimate of lead emissions from aircrafts, and number of blood lead screens among children 9 months to 7 years of age in study counties, North Carolina (1995–2003).

After selecting our six study counties, we used geographic information systems (GIS) to delineate fixed distance areas around each airport where aircraft use avgas. We also used GIS to connect the point locations of the airports given by address to tax parcel layers for each county via shared geography. The tax parcel layers contain a polygon shape representing the property boundary of each airport. We then created buffers around each of the airport polygons to represent the area in which airplane emissions could affect air lead levels. Because previous research has indicated that lead concentrations increase exponentially with proximity to airports (Piazza 1999), we created buffers that extended 500 m, 1,000 m, 1,500 m, and 2,000 m from the polygon edges of the airport tax parcels. Figure 2 depicts this approach using the example of Wake County. Airports are indicated by the darkest shade of pink, with the different distance buffers represented by increasingly lighter shades of pink. The residential addresses of the children who were screened for blood lead is then overlaid, as shown by the green points. In accordance with our IRB protocol, the green dots do not represent the actual locations where children were screened for lead. For publicly displayed maps like Figure 2, we randomly move the actual location of the child within a fixed radial buffer, a technique known as jittering. The analysis itself, however, is done on the true locations of the children. The 500-m, 1,000-m, 1,500-m, and 2,000-m buffers only approximate the area that could be affected by lead emissions from airports, as wind directions can alter the dispersal pattern of lead particles. Nevertheless, with varied wind directions and planes that take off in multiple directions, our buffers offer a reasonable approximation of the area over which lead from avgas might disperse.

Figure 2.

Airports buffered at distances of 500 m, 1,000 m, 1,500 m, and 2,000 m in Wake County, North Carolina, plotted along with a jittered representation of the residential addresses of the children screened for blood lead.

North Carolina maintains a mandatory statewide registry of blood lead surveillance data. We obtained North Carolina blood lead surveillance data for 1995–2003 (North Carolina Childhood Lead Poisoning Prevention Program 2004), because these years bracket the 2000 census data. In previous work designed to develop childhood lead exposure risk models (Kim et al. 2008; Miranda et al. 2002), we had already geocoded the residential addresses of children screened for lead. Our geocoding success rates ranged from 37 to 89% across the six study counties. Details on how the blood lead surveillance data were processed are described by Miranda et al. (2002) and Kim et al. (2008).

We then joined the buffered airport polygons in our six study counties with the geocoded addresses of children who have been screened for blood lead. This enabled us to generate a table containing blood lead screening results and four dummy variables representing whether each child lived within 500 m, 1,000 m, 1,500 m, or 2,000 m of an airport.

We supplemented the blood lead screening and airport location data with data from county tax assessor databases on age of housing (to control for lead exposure risks from deteriorating lead-based paint), resolved at the individual tax parcel level. In addition, we used U.S. Census 2000 data on household median income (measured in tens of thousands) and proportion receiving public assistance, which were obtained at the census block group level (U.S. Census Bureau 2002), as well as proportion non-Hispanic black and proportion Hispanic, which were obtained at the census block level (U.S. Census Bureau 2001). Because previous work has shown the season of blood lead screening to be a significant predictor of blood lead levels (i.e., warm months are correlated with higher lead exposure from lead-based paint) (Johnson et al. 1996; Kim et al. 2008; Miranda et al. 2007; Yiin et al. 2000), we created individual level dummy variables representing the season in which each child was screened for lead. Because the blood lead screening data are right-skewed, we used the natural logarithm of blood lead level in our analyses. We used the spatial data architecture described above to regress logged blood lead levels on the proximity to airport variable, controlling for age of housing, season in which the child was screened, and the census demographic variables. We used multivariable regression analysis clustered at the census block group level with inverse population weights at the tax parcel level to ensure that parcels with multiple blood lead screens did not overly influence the analysis. We implemented crude and adjusted regression models for each of the four proximity to airport variables. We used a categorical distance to airport variable with 0–500 m, 501–1,000 m, 1,001–1,500 m, and 1,501–2,000 m, with a reference group of > 2,000 m. In addition, we performed a sensitivity analysis on our findings. First, we investigated whether the use of inverse population weights accounted for possible correlation among observations from the same tax parcel by running multilevel random intercept models designating the parcel as the grouping variable. Second, we considered the possibility of temporal confounding by including the lead screen year as a factor in each model with the reference year as 1995. Results regarding the importance of distance to airports were robust across these alternative specifications. We examined the results of these regressions to determine whether living near an airport using avgas had significant effects on blood lead levels. Statistical significance was set at $\alpha = 0.05$

Results Top

Blood lead screening data were available for 125,197 children in the study counties (Table 1), including 13,478 children living within 2,000 m of an airport polygon in the six study counties (Table 2).

Table 2.

Individual and group-level characteristics of children 9 months to 7 years of age who were screened for blood lead 1995–2003 (n = 125,197).

Our statistical results are shown in Table 3. In unadjusted models, logged blood lead levels were significantly and positively associated with residential proximity to an airport, with the size of the association being larger for children living closer to airports. Although controlling for individual- and group-level confounders attenuated the association between logged blood lead levels and residential proximity to an airport, evidence of a deleterious relationship remained. In the adjusted models, control variables behaved as expected: Relative to being screened in the winter season, children tested in the spring, summer, or fall had increased blood lead levels, on average. Residence in poor and minority neighborhoods was also associated with elevated lead levels. In contrast, recently constructed housing units were associated with decreased mean lead levels. The above associations were consistent between the within-distance and categorical distance regression models.

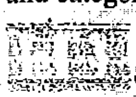

Table 3.

Change in logged blood lead level associated with a child's residential proximity to airport using multiple linear regression (n = 125,197).

In the within-distance buffer specification for the adjusted models, blood lead levels were significantly associated with residing within 500 m [coefficient = 0.043; 95% confidence interval (CI), 0.006–0.080]; 1,000 m (coefficient = 0.037; 95% CI, 0.010–0.065), and 1,500 m (coefficient = 0.021; 95% CI, 0.0008–0.041) of an airport. Blood lead levels were not associated with living at greater distances. Importantly, the magnitude of the coefficient on the distance to airport variables was largest for those children living within 500 m and decreased in a dose–response fashion out to 1,500 m. On the basis of distance to airport coefficients, children living within 500 m, 1,000 m, or 1,500 m of an airport had average blood lead levels that were 4.4, 3.8, or 2.1% higher, respectively, than other children.

In the categorical distance specification, compared with the reference category (> 2,000 m from an airport), children living within 500 m of an airport had blood lead levels that were, on average, 4.4% higher (coefficient = 0.043; 95% CI, 0.006–0.080) (Table 3). In addition, the coefficient for the 501–1000 m category was marginally significant (coefficient = 0.034; 95% CI, –0.003 to 0.072). Neither the 1,001–1,500 m nor the 1,501–2,000 m category was significant at the 5% level, with coefficient estimates near the null value. These results taken collectively suggest that children living within 500 m and within 1,000 m are driving the results in the models that entered the within-distance threshold variables separately.

Discussion Top

Based on the geospatial and statistical analysis presented above, lead from avgas may have a small (2.1–4.4%) but significant impact on blood lead levels in children who live in proximity to airports where avgas is used. The magnitude of the estimated effect of living near airports was largest for those children living within 500 m and decreased in a monotonic fashion out to 1,500 m. Because our model takes into account only whether a child is living anywhere in a fixed distance (500 m, 1,000 m, or 1,500 m) radius of an airport, children who live very close to or downwind from a runway could be affected more significantly than the average value that we estimate for all children living within the buffer.

Our finding that living beyond 1,000 m of an airport using avgas does not have a significant relationship with blood lead levels is reasonably consistent with previous research suggesting that lead drops to background levels beyond 1,000 m from an airport (Piazza 1999).

Our study has several important limitations. It does not take into account wind patterns that could increase the extent of the area containing lead particles from avgas in certain directions and decrease it in others. Furthermore, our model considers only whether children live anywhere within a particular distance from an airport and does not consider the fact that some points within this area could have higher air lead concentrations than others. Our modeling of the relationship between avgas and blood lead could be improved by incorporating wind direction information, by obtaining information about where piston-engine aircraft typically take off or land at each airport, and by controlling for air traffic volume. In addition, the variability in our geocoding success rates may introduce spatial bias. To partially address this, we re-ran the analysis without Union County, which had the lowest geocoding rate (37% compared with 58% for the remaining counties combined). The distance from airport results were robust to this change in the data set. We also note that if one includes a rural county like Union County, geocoding rates are inevitably poor. We felt it important to include a rural county, so we reported results with Union County data. Nonetheless, the analysis presented here would be strengthened with better geocoding rates. Finally, extending the study to additional counties throughout the United States could increase sample size and determine whether the trends that we observed in North Carolina are replicated elsewhere in the country. The methods we describe here for constructing buffer zones around airports could easily be replicated in other areas nationally (or internationally).

Conclusions Top

Our analysis indicates that living within 1,000 m of an airport where avgas is used may have a significant effect on blood lead levels in children. Our results further suggest that the impacts of avgas are highest among those children living closest to the airport. This study adds to the literature examining whether leaded avgas poses risks to children's health and speaks directly to the ongoing policy debate regarding the regulation of leaded avgas.

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EXHIBIT G

U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: SPECIFICATION FOR OBSTRUCTION LIGHTING EQUIPMENT
Date: 09/12/06
Initiated by: AAS-100
AC No.: 150/5345-43F
Change:

1. **PURPOSE.** This advisory circular (AC) contains the Federal Aviation Administration (FAA) specification for obstruction lighting equipment.

2. **EFFECTIVE DATE.** Effective 6 months after the date of this circular, only that equipment qualified per this specification will be listed in AC 150/5345-53, Airport Lighting Equipment Certification Program.

3. **CANCELLATION.** AC 150/5345-43E, *Specification for Obstruction Lighting Equipment,* dated October 19, 1995, is canceled.

4. **APPLICATION.** The specifications contained in this AC are recommended by the FAA in all applications involving development of this nature. For airport projects receiving Federal funds under the airport grant assistance program, the use of these standards is mandatory.

5. **DEFINITIONS.**

a. Beam Spread. The angle between the two directions in a plane for which the intensity is equal to 50 percent of the minimum specified peak beam effective intensity.

b. Vertical Aiming Angle. The angle between the horizontal and a straight line intersecting the beam at its maximum intensity.

c. Steady-Burning (fixed) Light. A light having constant luminous intensity when observed from a fixed point.

d. Effective Intensity. The effective intensity of a flashing light is equal to the intensity of a steady-burning (fixed) light of the same color that produces the same visual range under identical conditions of observation.

6. **PRINCIPAL CHANGES.**

a. Added a requirement for the use of ultraviolet and ozone resistant materials with xenon flashtubes.

b. Added a requirement for solar radiation resistant plastic parts and applicable testing.

c. Added a requirement for surge protection and testing for equipment with solid-state devices.

d. Added requirements from FAA Engineering Brief #67 as necessary to provide requirements for obstruction lighting using alternative light sources (ALDs).

e. Added optional radiated emissions requirements with no testing required.

7. **METRIC UNITS.** To promote an orderly transition to metric units, this AC includes both English and metric dimensions. The metric conversions may not be exact equivalents, and until there is an official changeover to the metric system, the English dimensions will govern.

8. **COMMENTS OR SUGGESTIONS** for improvements to this AC should be sent to:

Manager, Airport Engineering Division
Federal Aviation Administration
ATTN: AAS-100
800 Independence Avenue, S.W.
Washington, DC 20591

9. **COPIES OF THIS AC.** The Office of Airport Safety and Standards makes this AC available online at www.faa.gov.

DAVID L. BENNETT
Director of Airport Safety and Standards

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CHAPTER 1. SCOPE AND CLASSIFICATION.

1.1 Scope.

This specification sets forth the Federal Aviation Administration (FAA) requirements for obstruction lighting equipment used to increase conspicuity of structures to permit early obstruction recognition by pilots.

1.2 Equipment Classification.

Type	Description
L-810	Steady-burning red obstruction light
L-856	High intensity flashing white obstruction light, 40 Flashes Per Minute (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-885	Flashing red obstruction light, 60 FPM

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CHAPTER 2. REFERENCED DOCUMENTS.

2.1 General.

The following is a listing of documents referenced in this AC.

2.2 FAA Advisory Circulars (ACs).

AC 70/7460-1	*Obstruction Marking and Lighting*
AC 150/5345-53	*Airport Lighting Equipment Certification Program*

2.3 FAA Engineering Briefs.

Engineering Brief #67	*Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures*

2.4 Military Standards and Specifications.

MIL-STD-810F	*Environmental Engineering Considerations and Laboratory Tests*
MIL-C-7989	*Cover, Light-Transmitting, for Aeronautical Lights, General Specification for*

2.5 Code of Federal Regulations (CFR).

Title 47	*Telecommunications*
Part 15	*Radio Frequency Devices*

2.6 Institute of Electrical and Electronics Engineers (IEEE) Publications.

IEEE C62.41-1991	*IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits*
IEEE C62.45	*IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits*

2.7 International Standardization Organization (ISO) Publications.

ISO-10012	*Measurement Management Systems – Requirements for Measurement Processes and Measuring Equipment*

2.8 International Civil Aviation Organization (ICAO).

Annex 14	*Volume 1, Aerodrome Design and Operations*

2.9 Illuminating Engineering Society (IES).

IES Handbook	*Reference and Application Volume, 8th Edition, 1993, Flashing Light Signals, pp. 96-97*

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Copies of FAA ACs may be obtained from:

U.S. Department of Transportation
Subsequent Distribution
Office Ardmore East Business Center
3341 Q 75th Ave.
Landover, MD 20785

Tel: (301) 322-4961
FAX: (301) 386-5394
Website: www.faa.gov

Copies of military standards and specifications may be obtained from:

DAPS/DODSSP
Building 4, Section D
700 Robbins Avenue
Philadelphia, PA 19111-5094

Tel: (215) 697-2179
FAX: (215) 697-1460
Website: dodssp.daps.dla.mil

Copies of IEEE standards may be obtained from:

IEEE Customer Service Center
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331

Tel: (800) 678-4333
FAX: (732) 981-0060 *(Worldwide)*
FAX: (732) 981-9667
E-mail: storehelp@ieee.org
Website: shop.ieee.org/ieeestore

Copies of the ISO document are available online from:

Website: www.iso.ch

Copies of ICAO documents may be obtained from:

ICAO, Document Sales Unit
999 University Street
Montreal, Quebec, Canada H3C 5H7

Telephone: +1 (514) 954-8022
FAX: +1(514) 954-6769

E-mail: sales@incao.int
Website: www.icao.int

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Copies of IES of North America (IESNA) documents may be obtained from:

Website: www.techstreet.com
or
Website: www.iesna.org/shop/

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CHAPTER 3. EQUIPMENT REQUIREMENTS.

3.1 General.

This section addresses environmental, design, and photometric requirements for obstruction light equipment. Criteria for selecting the proper obstruction lighting equipment, installation tolerances, and administrative information are in AC 70/7460-1, *Obstruction Marking and Lighting.*

3.2 Environmental Requirements.

Obstruction lighting equipment must be designed for continuous operation under the following conditions:

a. Temperature. Storage/shipping: -67 degrees Fahrenheit (F) (-55 degrees Celsius (C)) to 130 degrees F (55 degrees C). Operating: -40 degrees F (-40 degrees C) to 130 degrees F (55 degrees C).

b. Humidity. 95 percent relative humidity.

c. Wind. Wind speeds up to 150 miles per hour (mph) (240 kilometeres per hour (kmph)).

d. Wind-blown Rain. Exposure to wind-blown rain from any direction.

e. Salt Fog. Exposure to salt-laden atmosphere.

f. Sunshine. Exposure to solar radiation.

3.3 Design Requirements.

3.3.1 Light Unit.

The light unit must be lightweight and designed for easy servicing and lamp (or flashtube) replacement. Materials used within the light unit must be selected for compatibility with their environment. All plastic lens parts (including gaskets), that are exposed to ultraviolet radiation or ozone gas must not change color, crack, check, disintegrate, or be otherwise degraded (photometry must remain compliant) and meet the equipment warranty requirements of AC 150/5345-53, Appendix 2. Each light unit must be an independent unit and must flash at the specified intensity or at its highest intensity when control signals are absent.

3.3.2 Light Covers.

Light-transmitting covers for light units must be per the requirements in MIL-C-7989. In addition, if plastic covers are used, they must be resistant to checking, crazing, or color changes caused by ultraviolet radiation or ozone gas exposure.

3.3.3 Light Colors.

The aviation red must be per ICAO Annex 14, Volume 1, Appendix 1, *Colours for Aeronautical Ground Lights,* at operating temperature within the following chromaticity boundaries:

purple boundary $y = 0.980 - x$

yellow boundary $y = 0.335$
$x + y + z = 1$

Xenon flashtube emission or a color temperature range from 4,000 to 8,000 degrees Kelvin is acceptable for white obstruction lights. See Engineering Brief #67 for additional information about lamp chromaticity requirements.

3.3.3.1 Light Color During Daytime.

Means must be provided on all L-810 obstruction lights to indicate the specified non-powered color during daytime viewing. See Engineering Brief #67 for additional information.

3.3.4 Aiming (for L-856 and L-857).

Light units must have a method for adjustment of the vertical aiming angle between 0 and +8 degrees. A spirit level or other device must be provided as part of each light unit for setting the vertical aiming angle of the light beam with an accuracy of one degree.

3.3.5 Control Unit.

3.3.5.1 Flashing White Obstruction Lighting Systems.

The control unit must set the system's flash rate, intensity and sequence and must be capable of controlling light units up to a distance of 2,500 feet (ft) (762 meters (m)). If the control unit or control wiring fails, the light units must continue to flash per Table 4 flash rate. Failure of an intensity step change circuit must cause all light units to remain operating at their proper intensity or alternatively to operate at the high intensity step.

3.3.5.1.1 Monitoring.

Each light unit must be monitored for FLASH/FAIL status. FAIL status is defined as either of the following conditions: unit misses four or more consecutive flashes; unit flashes at wrong intensity step during day operation. Monitoring must be fail safe (i.e., active signals for FLASH and absence of signals for FAIL). There must be a provision to permit connection to a remote alarm device, (supplied by others or as an option), to indicate the system and individual light unit FLASH/FAIL status.

NOTE: *See Engineering Brief #67 for additional information regarding the failure requirements for multiple alternative lighting devices (ALDs).*

3.3.5.1.2 Placement.

The control and monitor functions may be consolidated in a light unit or in a single enclosure for remote mounting or they may be distributed into several light units.

3.3.5.1.2.1 Remote Mounting.

In addition to the above, if placed in a remote mounted enclosure, the control unit must display the status of each light unit. An intensity control override switch must also be mounted in the enclosure to manually control light intensity during maintenance or in the event of a photoelectric control malfunction.

3.3.5.2 Flashing Red Obstruction Lights.

~~The control unit must set the system flash rate and flash sequence. Failure of the flashing circuit must~~ cause the light units to energize and operate as steady burning lights. An override switch must be mounted on the control unit to manually control the lights during maintenance or in the event of a lack of a photoelectric control signal. To insure proper operation, all flashing red obstruction lights, inclusive of any associated system steady burning red lights, must be certified with a control unit whether internal or external to the lighting unit.

3.3.5.2.1 Dual Lighting Systems.

The control unit may be a separate unit or incorporated as part of either the white or red obstruction light control unit. The control unit must set the operating mode for each light unit in the system. Outage of one of two lamps, or any failure in the device that causes a reduction in intensity of the horizontal beam or results in an outage in the uppermost red beacon (L-864 unit) or outage of any uppermost red strobe, must cause the white obstruction light system to operate in its specified "night" step intensity. At no time should both red and white systems be on simultaneously. An override switch must be mounted on the control unit to manually control the operating mode of the system during maintenance or in the event of a lack of a photoelectric control signal.

3.3.5.2.2 Monitoring.

Each separate L-864 light unit and each tier of L-810 light units must be monitored for FLASH/FAIL status. FAIL is defined as outage of any lamp in an L-864 light unit, outage of any one lamp in a tier of L-810 light units, or failure of a flasher (steady on and/or total) for an L-864 light unit. Monitor signals must be fail safe (i.e., active signals for FLASH and absence of signals for FAIL). There must be a provision to permit connection to a remote alarm device, (supplied by others or as an option) to indicate FLASH/FAIL status.

NOTE: *See Engineering Brief #67 for additional information regarding the failure requirements for multiple alternative lighting devices (ALDs).*

3.3.6 Input Voltage.

The obstruction lighting equipment must be designed to operate from the specified input voltage ±10 percent. Incandescent lamps must be operated to within ±3 percent of the rated lamp voltage to provide proper light output.

3.3.7 Performance Criteria.

Manufacturers are required to publish performance criteria for all light generating devices (see Engineering Brief #67).

3.3.8 Transient Protection.

Equipment with solid state devices must be designed to withstand and/or include separate surge protection devices that are tested against defined waveforms per IEEE C62.41-1991, Table 4, Location Category C1, for single phase modes (line to ground, line to neutral, line and neutral to ground).

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3.3.9 Radiated Emissions.

NOTE: *Optional only. No equipment qualification is required.*

a. Obstruction lighting that uses electronic circuitry to power the light source must be classified as an incidental radiator (47 CFR §15.13). This applies to equipment that does not intentionally generate any radio frequency energy, but may create such energy as an incidental part of its intended operations.

b. Obstruction light systems must employ sound engineering practices to minimize the risk of harmful interference.

3.3.10 Warning Labels.

All enclosures that contain voltages exceeding 150 volts direct current (VDC) or alternating current (AC) root mean square (rms) must have high voltage warning label(s) placed at a conspicuous location(s). Also, a visual indicator must be included within the enclosure to indicate that greater than 150 VDC is present on the high voltage capacitors.

3.3.11 Interlock Switches.

Interlock switches must be incorporated in each power supply and optionally in each flashhead so that opening either unit must (1) interrupt incoming power and (2) discharge all high voltage capacitors within the enclosure to 50 volts or less within 30 seconds.

3.3.12 Nameplate.

A nameplate, with the following information, must be permanently attached to each unit:

a. Name of unit (light unit, control unit, etc.).

b. FAA type (e.g., L-856, L-864, etc.).

c. Manufacturer's catalog number.

d. Manufacturer's name and address.

e. Rated separation distance in feet is ____ to _____ between power supply and optical head using American Wire Gage (AWG) ____ conductors. (Item e is required if a unique power supply and its associated optical head are separate components of the lighting system as in the case of some discharge lights.)

In addition to the above, the power supply must include nominal input voltage, number of phases, frequency, and peak VA rating.

3.3.13 Optional Arctic Kit

Light systems may be offered with an optional arctic kit to enable operation in temperatures below -40 degrees F (-40 degrees C).

3.3.14 Component Ratings.

3.3.14.1 Discharge Type Lighting Equipment.

The flashtube or flashtubes must have a minimum rated life of two years without maintenance or loss of light output below the minimum specified candela.

3.3.14.2 Component Separation Rating.

If the light unit's power supply and optical head are separate components, the manufacturer must rate each light unit for maximum and minimum separation at a given AWG wire size. The manufacturer must include this rating on the nameplate per section 3.3.12. The rating certifies that the unit meets all requirements within the rated distances. The manufacturer must maintain records of test results which support the stated separation rating until the next system re-qualification.

3.3.14.3 Incandescent Light Equipment.

Lamps must have a minimum rated life of 2,000 hours at rated voltage.

3.3.14.4 Alternative Light Source Equipment.

Light sources other than incandescent or xenon (light emitting diodes, cold cathode) must have a minimum rated life of two years without maintenance or loss of light output below the minimum specified intensity (see Engineering Brief #67).

3.3.14.5 Light Equipment Components.

All components used in obstruction lighting equipment, except lamps, must be designed to meet performance requirements for a minimum of one year without maintenance.

3.3.15 Leakage Current.

All obstruction lighting equipment classified in paragraph 1.2 must be designed to withstand application of 1,000 volts AC or 1,414 volts DC between the input power leads and equipment chassis for 10 seconds during which the leakage current must not exceed 10 microamperes at ambient room temperature and humidity.

3.4 Performance Requirements.

3.4.1 Photometric.

3.4.1.1 General.

The effective intensity for flashing lights must be calculated per the following formula by the method described for *Flashing Light Signals* in the IES Handbook, 1993 Reference and Application Volume 8th Edition, Pages 96 and 97:

$$I_e = \left(\int_{t_1}^{t_2} I dt \right) / \left(0.2 + \left(t_2 - t_1 \right) \right)$$

Where:

I_e	=	Effective intensity (Candela)
I	=	Instantaneous intensity (Candela)
$t1$, $t2$	=	Times in seconds of the beginning and end of that part of the flash when the value of I exceeds I_e. This choice of the times maximizes the value of I_e.

For discharge type flashing lights, the equipment must provide the specified light output at the specified temperature extremes as the input voltage simultaneously varies by ±10 percent from nominal. The light intensity and beam distribution requirements for obstruction lighting equipment are specified below. All intensities listed are effective intensities (except steady-burning red obstruction lights) measured at the flash rate specified in Table 4. All incandescent lights will be tested as steady burning lights. Additional requirements for ALDs are in Engineering Brief #67.

The effective intensity for multiple pulse flashes as used in strobe lights during nighttime operation must be calculated by:

$$I_e = \left(\frac{\int_{t_1}^{t_A} I dt}{0.2 + t_A - t_1} \right) + \left(\frac{\int_{t_B}^{t_C} I dt}{0.2 + t_C - t_B} \right) + \left(\frac{\int_{t_D}^{t_E} I dt}{0.2 + t_E - t_D} \right) + \ldots + \left(\frac{\int_{t_X}^{t_Z} I dt}{0.2 + t_Z - t_X} \right)$$

The frequency of the pulses must not be less than 50 Hz and the interval t_A- t_1 must not vary by more than ±5% from the nominal value from pulse to pulse over the simultaneous extremes of temperature and input voltage.

3.4.1.2 L-810 Light Unit.

The center of the vertical beam spread must be between +4 and +20 degrees. With a minimum vertical beam spread of 10 degrees and at all radials throughout 360 degrees, there must be a minimum intensity of 32.5 candela. Mechanical interface for installation must be 3/4 or 1 inch National Pipe Thread (NPT) side and/or bottom.

3.4.1.3 L-856 Light Unit.

The beam spread and effective intensity must be per Table 1.

Table 1. L-856 Intensity Requirements.

Step	Beam Spread		Peak Intensity (candela) (2)
	Horizontal (1) (degrees)	Vertical (degrees)	
Day	90 or 120	3 - 7	270,000 ±25%
Twilight	90 or 120	3 - 7	20,000 ±25%
Night	90 or 120	3 - 7	2,000 ±25%

NOTES:

(1) Multiple light units may be used to achieve a horizontal coverage of 360 degrees.

(2) When the light unit is installed per the manufacturer's instructions, the intensity at zero degrees elevation angle (horizontal) must be at least as great as the minimum specified beam peak intensity. For stray light, the intensity at 10 degrees below horizontal, at any radial, must not be greater than 3% of the peak intensity at the same radial.

3.4.1.4 L-857 Light Unit.

Photometric requirements are defined in Table 2.

Table 2. L-857 Intensity Requirements.

Step	Beam Spread		Peak Intensity (candela)(2)
	Horizontal (degrees) (1)	Vertical (degrees)	
Day	90 or 120	3 - 7	140,000 ±25%
Twilight	90 or 120	3 - 7	20,000 ±25%
Night	90 or 120	3 - 7	2,000 ±25%

NOTES:

(1) Multiple light units may be used to achieve a horizontal coverage of 360 degrees.

(2) When the light unit is installed per the manufacturer's instructions, the intensity at zero degrees elevation angle (horizontal) must be at least as great as the minimum specified beam peak intensity. For stray light, the intensity at 10 degrees below horizontal, at any radial, must not be greater than 3% of the peak intensity at the same radial.

3.4.1.5 L-864 Light Unit.

At all radials throughout the omnidirectional 360 degrees, there must be a peak effective intensity of 2,000 ±25 percent candela. There must also be a minimum effective intensity of 750 candela throughout a minimum vertical beam spread of 3 degrees.

3.4.1.5.1 Beam Adjustment.

When the light unit is installed per the manufacturer's instructions, the intensity at zero degrees elevation angle (horizontal) must be at least as great as the minimum specified beam peak intensity.

3.4.1.6 L-865 Light Unit.

Photometric requirements are defined in Table 3.

Table 3. L-865 Intensity Requirements.

Step	Beam Spread		Peak Intensity (candela)[2]
	Horizontal (degrees)[1]	Vertical (degrees)	
Day/Twilight	360	3 minimum	20,000 ±25%
Night	360	3 minimum	2,000 ±25%

NOTES:

(1) *Multiple light units may be used to achieve a horizontal coverage of 360 degrees.*
(2) *When the light unit is installed per the manufacturer's instructions, the intensity at zero degrees elevation angle (horizontal) must be at least as great as the minimum specified beam peak intensity. For stray light, the intensity at 10 degrees below horizontal, at any radial, must not be greater than 3% of the peak intensity at the same radial.*

3.4.1.7 L-866 Light Unit.

The requirements are the same as the L-865 light unit, except the flash rate must be 60 flashes per minute (FPM).

3.4.1.8 L-885 Light Unit.

The requirements are the same as the L-864 light unit, except the flash rate must be 60 FPM.

3.4.2 Flash Rate and Duration.

Flash characteristics are defined in Table 4.

Table 4. Flash Characteristics for Obstruction Lights

Type	Intensity Step	Flash Rate (1)	Flash Duration (2)
L-856	Day & Twilight	40 FPM	Less than 100 milliseconds (ms)
L-856	Night	40 FPM	Between 100 and 250 ms inclusive
L-857	Day & Twilight	60 FPM	Less than 100 ms
L-857	Night	60 FPM	Between 100 and 250 ms inclusive
L-864	Single	20-40 FPM	1/2 to 2/3 of flash period if incandescent lighting (3), and between 100 and 2000 ms inclusive if other lighting sources.
L-865	Day & Twilight	40 FPM	Less than 100 ms
L-865	Night	40 FPM	Between 100 and 1000 ms inclusive
L-866	Day & Twilight	60 FPM	Less than 100 ms
L-866	Night	60-FPM	Between 100 and 250 ms inclusive
L-885	Single	60 FPM	1/2 to 2/3 of flash period if incandescent lighting (3), and between 100 and 670 ms inclusive if other lighting sources.

NOTES:

(1) *Flash rates have a tolerance of ±5 percent.*

(2) *When the effective flash duration is achieved by a group of short flashes, the short flashes must be emitted at a rate of not less than 50 Hz.*

(3) *The light intensity during the "off" period must be less than 10 percent of the peak effective intensity. The "off" period must be at least 1/3 of the flash period.*

3.4.3 System Flashing Requirements.

3.4.3.1 Simultaneous Flashing Systems.

All obstruction lights in systems composed of either L-864 light units or L-856 and/or L-865 light units must flash within 1/60 of a second of each other.

3.4.3.2 Sequenced Flashing Systems.

a. Catenary support structure systems composed of L-857, L-866, or L-885 light units must have a sequenced flashing characteristic.

b. This system consists of three lighting levels on or near each supporting structure. One light level is near the top, one at the bottom or lowest point of the catenary, and one midway between the top and bottom.

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c. The flash sequence must be middle, top, and bottom.

d. The interval between top and bottom flashes must be about twice the interval between middle and top flashes.

e. The interval between the end of one sequence and the beginning of the next must be about 10 times the interval between middle and top flashes.

f. The time for the completion of one cycle must be one second (±5 percent).

3.4.4 Intensity Step Changing.

3.4.4.1 White Obstruction Lights.

The light unit intensity must be controlled by a photocell facing the northern (polar) sky. White obstruction lights must automatically change intensity steps when the ambient light changes as follows:

a. From day intensity to twilight intensity when the illumination decreases below 60 foot-candles (645.8 lux) but before it reaches 35 foot-candles (376.7 lux).

b. From twilight intensity to night intensity when the illumination decreases below 5 foot-candles (53.8 lux) but before it reaches 2 foot-candles (21.5 lux).

c. From night intensity to twilight intensity when the illumination increases above 2 foot-candles (21.5 lux) but before it reaches 5 foot-candles (53.8 lux).

d. From twilight intensity to day intensity when the illumination increases above 35 foot-candles (376.7 lux) but before it reaches 60 foot-candles (645.8 lux).

3.4.4.2 Red Obstruction Lights.

If automatic control is utilized, the light unit must turn on when the ambient light decreases to not less than 35 foot-candles (367.7 lux) and turn off when the ambient light increases to not more than 60 foot-candles (645.8 lux). Single L-810 light units are controlled in a manner compatible with the particular installation.

3.4.4.3 Dual Obstruction Lighting System.

White obstruction lights must turn off and red obstruction lights must turn on when the ambient light changes from twilight to night per paragraph 3.4.4.1b. Red obstruction lights must turn off and white obstruction lights must turn on when the ambient light changes from night to twilight per paragraph 3.4.4.1c.

3.5 Instruction Manual.

An instruction manual containing the following information must be furnished with all obstruction lighting equipment:

a. Complete system schematic and wiring diagrams showing all components cross-indexed to the parts list.

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b. Complete parts list of field replaceable parts with applicable rating and characteristics of each part, and with the component manufacturer's part number as appropriate.

c. Installation instructions, including leveling and aiming of light units.

d. Maintenance instructions, including lamp or flashtube replacement, theory of operation, troubleshooting charts and, as appropriate, conspicuous warnings about alignment and replacement of lamps and light units with other than manufacturer recommended items. Explanation of testing requirements regarding light units with specific lamps must be provided in the text. A discussion must be included about mixing light units as replacements with other manufacturers' units with emphasis on assuring that system design of obstruction lighting is not degraded.

e. Operating instructions.

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CHAPTER 4. EQUIPMENT QUALIFICATION REQUIREMENTS.

4.1 Qualification Procedures.

Procedures for qualifying equipment to be furnished under the Federal grant assistance program for airports are contained in AC 150/5345-53, *Airport Lighting Equipment Certification Program.*

4.2 Qualification Tests.

Qualification tests must be conducted on the light unit in the following order:

a. Initial photometric test, per paragraph 4.2.1

b. Environmental tests, per paragraphs 4.2.2, 4.2.3, 4.2.4, 4.2.5, 4.2.6, 4.2.7, and 4.2.8 (in any order)

c. 1000 hours of continuous operation, per paragraph 4.2.10

d. System Operational Test, per paragraph 4.2.10

e. Leakage Current Test, per paragraph 4.2.11

f. Sampling Photometric Test, per paragraph 4.2.1

g. Visual examination, per paragraph 4.2.12

h. Transient Protection Test, per paragraph 4.2.9. The equipment may be damaged by this test. It should only be performed when testing per paragraphs a though c above is complete.

Sample photometric and system operational tests must be conducted after completion of all environmental tests. The same unit(s) must be used throughout the tests. The following tests are required to demonstrate compliance with this specification. The tests may be run on the control unit, power supply, and a single light unit, with a simulated load replacing the other light units. Equipment tested must be as a complete system.

4.2.1 Photometric Test.

a. A full photometric test as described in this section must be performed before all environmental tests.

NOTE: *To verify proper color correction, photometric testing conducted on alternative light source fixtures must be done with a detector having an up to date calibration including spectral response data (see Engineering Brief #67).*

b. A sampling photometric retest must be conducted after the unit has been operated continuously for 1000 hours with normal (12 hour) day/night cycling. This sampling must consist of measuring the vertical beam pattern for compliance with photometric requirements at a minimum of two of the previously tested horizontal radials.

c. Light units must be energized by the system power supply and control unit, and must be tested for compliance with photometric requirements.

d. For alternative light source equipment high temperature testing, see Engineering Brief #67.

e. Incandescent lamps must be tested at ±3 percent of their nominal voltage.

f. Red light intensity may be measured in white light and then calculated if the glassware manufacturer certifies the chromaticity and transmissivity values of the red filter material for the particular source.

g. If more than one lamp type is to be used, the qualification testing must be completed for each lamp type.

h. For a discharge type flashing system, if the power supply and optical head are separate components, the manufacturer must demonstrate that the required photometrics are produced with the units separated by maximum and minimum recommended distances and connected by cable recommended by the manufacturer.

i. Photometric test results must be in the forms of:

(1) Vertical beam pattern: Distribution curve (vertical angle versus candela) with minimum one degree spacing of test points over range of specified angles.

(2) Horizontal beam pattern: Polar plot (horizontal angle versus candela) with minimum 30 degree spacing of test points.

4.2.2 High Temperature Test.

a. The high temperature test must be conducted per MIL-STD-810F, Method 501.4, Procedure II. The equipment must be subjected to a constant temperature of +130 degrees F (+55 degrees C) for 4 hours after equipment temperature stabilization and be operated throughout the test.

NOTE: *For steady state temperature testing, consider thermal stabilization to be achieved when the temperatures of critical internal operating components are relatively constant. (Because of test item duty cycling or the operating characteristics, a constant temperature may never be achieved.)*

b. During the test, the manufacturer must demonstrate that the equipment maintains the specified flash rate and (for discharge type flashing light) the proper amount of energy is being delivered to the flashtube as the input voltage is varied by ±10 percent from nominal.

c. A visual examination must be conducted after the equipment is removed from the chamber. Failure of the equipment to operate as specified is cause for rejection.

4.2.3 Low Temperature Test.

a. The low temperature test must be conducted per MIL-STD-810F, Method 502.4, Procedure II. The equipment must be placed in a chamber that maintains a temperature of -67 degrees F (-55 degrees C) for shipping/storage requirements and -40 degrees F (-40 degrees C) for equipment operational requirements.

b. Equipment operation must be demonstrated at the beginning of the test.

c. The equipment storage and shipping low temperature requirement is -67 degrees F (-55 degrees C). The equipment must be stabilized and cold soaked at the storage/shipping temperature for one hour. The test chamber must then be ramped to the -40 degree F (-4 degrees C) equipment operating temperature at no more than 6 degrees F (3 degrees C) per minute to prevent thermal shock to the equipment.

d. The equipment, with input power off, must then be exposed to a 24-hour soaking period at -40 degrees F (-40 degrees C) after which the equipment must be turned on for one hour, and must operate normally. For discharge type flashing lights, the unit must achieve specified flash rate and intensity within 1 minute after being energized. During the one hour of operation, the manufacturer must demonstrate that the equipment maintains the specified flash rate and, for discharge type flashing lights, the proper amount of energy is being delivered to the flashtube as the input voltage is varied by ±10 percent from nominal.

e. At the conclusion of the test, a visual inspection must be conducted. Failure of the equipment to operate as specified is cause for rejection.

4.2.4 Rain Test.

The wind-blown rain test must be conducted per MIL-STD-810F, Method 506.4, Procedure I, paragraph 4.4.2. The rain must be at a rate of 5.2 inches per hour (132 mm/hour) with an exposure time of 30 minutes per side. The equipment must be operated throughout the test. Failure of the equipment to operate as specified is cause for rejection.

4.2.5 Wind Test.

Evidence must be provided, either by testing or by calculation of mechanical force, to demonstrate that installed light units meet the wind requirement in paragraph 3.2c.

4.2.6 Humidity Test.

The test must be per MIL-STD-810F, Method 507.4, Procedure, paragraph 4.5.2. The equipment must be subjected to two complete cycles per Table 507.4-1, except the maximum chamber temperature must be +130 degrees F (+55 degrees C). Failure of the equipment to operate as specified is cause for rejection.

4.2.7 Salt Fog Test.

The salt fog test must be conducted per MIL-STD-810F, Method 509.4, Procedure, paragraph 4.5.2. Failure of the equipment to operate as specified is cause for rejection. If corrosion is present, the third party certification body must determine if it has impacted equipment structural integrity or functionality.

4.2.8 Sunshine Test.

NOTE: *The manufacturer may submit a certificate of compliance (for consideration by the third party certification body) from the material(s) manufacturer attesting to UV resistance (per MIL-STD-810F) in lieu of the testing requirements below.*

The equipment must be in its normal operational configuration for this test.

a. A sunshine test must be conducted per MIL-STD-810, Method 505.4, paragraph 4.4.3, Procedure II for all obstruction lighting equipment with nonmetallic exterior parts or plastic/thermoplastic light covers.

b. The equipment must be subjected to a minimum of 56 cycles.

c. Perform an operational test of the equipment after 56 cycles.

d. Any evidence of deterioration of plastic parts: chalking, bleaching, cracking, hazing, or color changes (yellowing) to the thermoplastic lenses of the test unit must be causes for rejection.

e. For plastic/thermoplastic optical lenses or covers, the photometric performance must be measured after this test.

4.2.9 Transient Protection Test.

NOTE: *The equipment may be damaged by this test. Perform this test only when tests in paragraphs 4.2.1 through 4.2.8 are completed.*

a. Subject the obstruction lighting equipment to 2 pulses at 15 second intervals to a combination wave 1.2 microseconds (μs)/50μs and 8μs/20μs (6,000 volts, 3,000 amps) test pulse per the descriptions in IEEE C62.41, Table 4, Location Category C1.

b. See IEEE C62.41-1991 Section 9.3 for test condition and test generator information.

c. See IEEE C62.41-1991 Section 9.4 for a detailed combination pulse generation and parameters discussion.

d. See also IEEE C62.45, *IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 volts (V) and Less) AC Power Circuits* for guidance about equipment test methods.

e. The equipment under test must operate normally at the conclusion of the test.

4.2.10 System Operational Test.

a. A system operational test must be performed after the unit has been operated continuously without failure for 1000 hours with normal (12 hour) day/night cycling.

b. System components must be connected with the necessary wiring to electrically simulate an actual installation in which the top and bottom light units on a structure are separated by 2,000 feet (609.6 m) for a system composed of L-856 and/or L-865 and 500 feet (152.4 m) for system composed of L-857 or L-866, and the controller separated an additional 2,500 feet (762.0 m). Simulated interconnecting cables with equivalent impedance may be used in lieu of full cable lengths.

c. The system must be energized and operated to demonstrate compliance with all specification operating requirements such as flash rate, flash sequence, photoelectric switching of intensity steps, operation of interlocked devices, and satisfactory operation under input voltage variations.

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d. If the power supply and optical head are separate components, it must be demonstrated that with the maximum and minimum nameplate rated separation between components, proper energy is delivered to the light unit to produce the specified photometrics.

e. It must be demonstrated that L-810 and L-864 lights produce the specified photometric requirement when energized over conductors (actual or simulated) representing the maximum and minimum nameplate rated cable length at the minimum input voltage.

4.2.11 Leakage Current Test.

Light units must be tested for compliance to the leakage current requirement in paragraph 3.3.15. Leakage current must be measured between the primary power connection points to the equipment chassis. The primary power connection points may be connected together during this test, but all other internal wiring must be connected as in normal operation. Devices for surge and lightning protection connected directly to input power wiring may be disconnected during this test.

4.2.12 Visual Examination.

The obstruction lighting equipment must be examined for compliance with the requirements on materials, finish, and quality of workmanship.

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CHAPTER 5. PRODUCTION TEST REQUIREMENTS.

5.1 System Production Tests.

A visual examination must be performed for all components in a system to verify proper materials and assembly. Each component of the system must be energized and tested to verify specified operation and conformance to photometric requirements.

5.2 Incandescent Light Unit Production Tests.

All light units must be visually examined for proper materials and assembly. The manufacturer must demonstrate that the on-going production photometric test results show the manufacturing process meets the photometric requirements per paragraphs 3.4.1.2, 3.4.1.5, or 3.4.1.8 and per section 5.6.

5.3 Alternative Lighting Devices (ALD).

All light units must be visually examined for proper materials and assembly. The manufacturer must demonstrate that the ongoing production photometric test results show the manufacturing process meets the photometric requirements per paragraphs 3.4.1.2 through 3.4.1.8 and per section 5.6.

5.4 Discharge Light Unit Production Test.

All light units must be visually examined for proper materials and assembly. The units must be energized and tested to verify proper operation and conformance to photometric requirements as specified in Tables 5 and 6.

5.5 Production Operational Test.

All light units must be tested to verify specified operation per the following minimum standards.

a. Each unit must be operated a minimum of 24 hours at highest intensity and a minimum of 12 hours at lowest intensity.

b. During highest intensity operation, each unit must be monitored for FLASH/FAIL as defined in 3.3.5.1.1. Minimum acceptable quality is zero FAILs in 24 hours of high intensity operation.

c. After a minimum 36 hours elapsed time of operation each light unit must be tested to verify proper operation of the following:

(1) All intensity step changes per paragraph 3.4.4.1

(2) Proper operation of monitoring per paragraph 3.3.5.1.1

(3) Proper interlock switch operation and discharge time to 50 volts (bank potential) per paragraph 3.3.11.

(4) Simultaneous flashing and intensity changing for multi-light systems per paragraphs 3.4.3.1 and 3.3.5.1, respectively

(5) Leakage current test per paragraph 3.3.15.

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5.6 Production Photometric Test.

Photometric testing must be performed per Table 5 or Table 6 using either conventional sampling per column 2 or statistical process control (SPC) per column 3. If SPC is used for a characteristic, it must show statistical capability with Cpk ≥ 1.0 and $\sigma \geq 3.0$.

Table 5. L-856/L-857 Production Photometric Requirements.

CHARACTERISTIC TESTED [1]	TEST POINTS	
	CONVENTIONAL	SPC
a) Beam peak (Day Intensity)	3 radials each unit: 1 at center of Horizontal beam +2 radials ±45 degrees or ±60 degrees from center	1 radial each unit, random orientation
b) Beam peak (Twilight Intensity)	Same radials as (a)	Same radials as (a)
c) Beam peak (Night Intensity)	Same radials as (a)	Same radials as (a)
d) Intensity at -10 degrees (Night)	Same radials as (a)	Same radials as (a)

NOTES:

(1) Characteristic must meet all specifications per paragraph 3.4.1.3 or 3.4.1.4.

Table 6. L-865/866/864[1] /885[1] Production Photometric Requirements.

CHARACTERISTIC TESTED [2,3]	TEST POINTS	
	CONVENTIONAL	SPC
a) Beam peak (Day Intensity)	4 radials each unit: equally spaced, random orientation	1 radial each unit, random orientation
b) Beam peak (Night Intensity)	Same radials as (a)	Same radials as (a)
c) Intensity at -10 degrees	Same radials as (a)	Same radials as (a)

NOTES:

(1) Discharge type and alternative light source light only.
(2) Characteristic must meet all specifications per paragraph 3.4.1.5 or 3.4.1.6.
(3) Day, night, and -10 degrees where applicable.

5.7 Production Test Records.

Records showing actual test results of all tests required by paragraph 5.5 must be maintained for a period of three years by the manufacturer. These records must be traceable to the units tested and in the case of discharge light units traceable by serial number.

5.8 Production Test Equipment.

All measuring and test equipment used in the production of obstruction lighting equipment classified under paragraph 1.2 must have its accuracy and precision maintained by a calibration program with traceability to ISO-10012 *Measurement Management Systems – Requirements for Measurement Processes and Measuring Equipment* or current industry accreditation criteria. The manufacturer must show that all production photometric testing equipment correlates to the certifying laboratory's equipment to within ±5 percent. Photometric testing must be performed in a properly designed photometric range using a calibrated photometer. For discharge type flashing lights, all photometric measurements must be based on a minimum five flash average.

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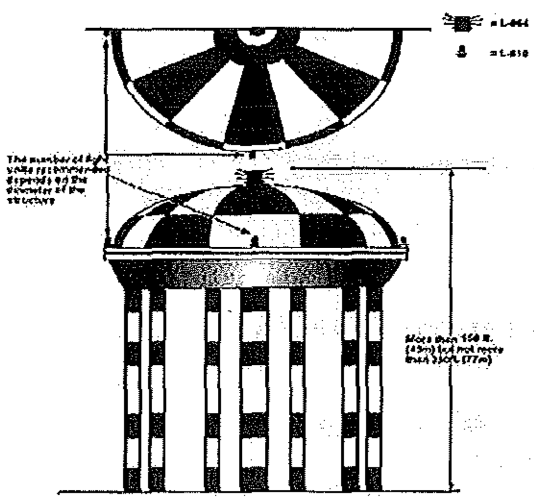
EXHIBIT H

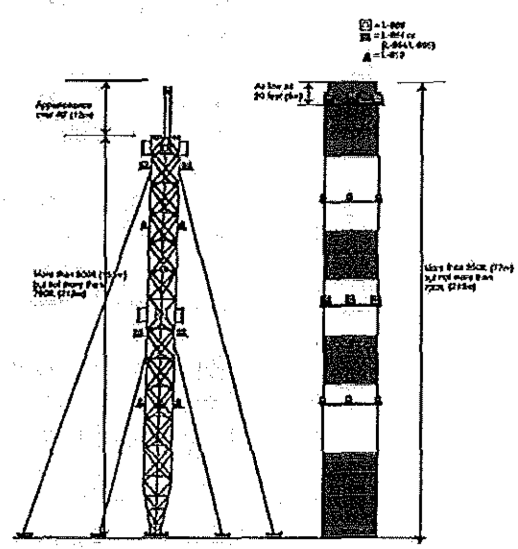
U.S. Department
of Transportation
Federal Aviation
Administration

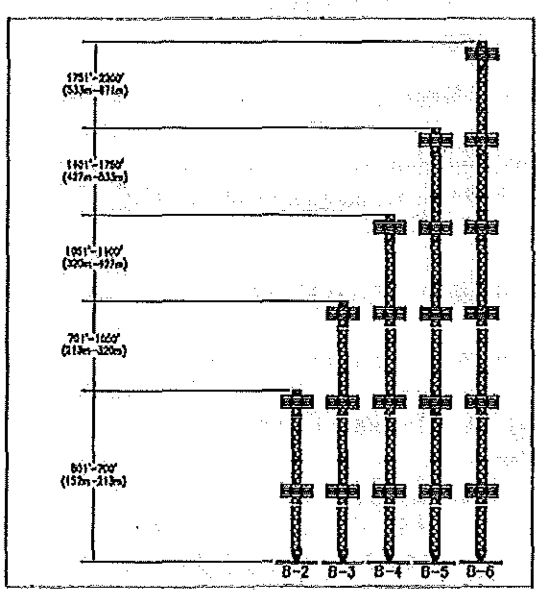
ADVISORY CIRCULAR

AC 70/7460-1K

Obstruction Marking and Lighting







Effective: 2/1/07

Initiated by: System Operations Services

Subject: CHANGE 2 TO OBSTRUCTION MARKING AND LIGHTING | **Date:** 2/1/07 | **Initiated by:** AJR-33 | **AC No.:** 70/7460-1K | **Change:** 2

1. PURPOSE. This change amends the Federal Aviation Administration's standards for marking and lighting structures to promote aviation safety. The change number and date of the change material are located at the top of the page.

2. EFFECTIVE DATE. This change is effective February 1, 2007.

3. EXPLANATION OF CHANGES.

   a. Table of Contents. Change pages i through iii.

   b. Page 1. Paragraph 1. **Reporting Requirements.** Incorporated the word "Title" in reference to the 14 Code of Federal Regulations (14 CFR part 77). FAA Regional Air Traffic Division office to read Obstruction Evaluation service (OES). FAA website to read http://oeaaa.faa.gov.

   c. Page 1. Paragraph 4. **Supplemental Notice Requirement** (subpart b). FAA Regional Air Traffic Division office to read OES.

   d. Page 1. Paragraph 5. **Modifications and Deviations** (subpart a). FAA Regional Air Traffic Division office to read OES.

   e. Page 1. Paragraph 5. **Modifications and Deviations** (subpart c). FAA Regional office to read OES.

   f. Page 2. Paragraph 5. **Modifications and Deviations** (subpart d). Removed period to create one sentence.

   g. Page 2. Paragraph 7. **Metric Units.** And to read however.

   h. Page 3. Paragraph 23. **Light Failure Notification** (subpart b). Nearest to read appropriate. FAA's website to read web. Website www.faa.gov/ats/ata/ata400 to read http://www.afss.com.

   i. Page 4. Paragraph 24. **Notification of Restoration.** Removed AFSS.

   j. Page 5. Paragraph 32. **Paint Standards.** Removed a comma after "Since".

   k. Page 5. Paragraph 33. **Paint Patterns** (subpart d. **Alternate Bands**). Removed number 6. Number 7 to read number 6.

   l. Page 9. Paragraph 41. **Standards.** TASC to read OTS. SVC-121.23 to read M-30.

m. Page 14. Paragraph 55. **Wind Turbine Structures.** Removed. The paragraph numbers that follow have been changed accordingly.

n. Page 18. Paragraph 65. **Wind Turbine Structures.** Removed. The paragraph numbers that follow have been changed accordingly.

o. Page 20. Paragraph 77. **Radio and Television Towers and Similar Skeletal Structures.** Excluding to read including.

p. Page 23. Paragraph 85. **Wind Turbine Structures.** Removed. The paragraph number that follows has been changed accordingly.

q. Page 33-34. Chapter 13. **Marking and Lighting Wind Turbine Farms.** Added.

r. Page A1-3. Appendix 1. Verbiage removed under first structure.

Nancy B Kalinowski

Nancy B. Kalinowski
Director, System Operations Airspace and Aeronautical Information Management

PAGE CONTROL CHART

AC 70/7460-1K CHG 2

Remove Pages	Dated	Insert Pages	Dated
i through iii	8/1/00	i through iii	1/1/07
1-5	8/1/00	1-5	1/1/07
9	3/1/00	9	1/1/07
14	3/1/00	14	1/1/07
18-34	3/1/00	18-34	1/1/07
A1-3	8/1/00	A1-3	1/1/07

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CHAPTER 1. ADMINISTRATIVE AND GENERAL PROCEDURES

1. REPORTING REQUIREMENTS

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 (14 CFR part 77) to notify the FAA by completing the Notice of Proposed Construction or Alteration form (FAA Form 7460-1). The form should be sent to the Obstruction Evaluation service (OES). Copies of FAA Form 7460-1 may be obtained from OES, Airports District Office or FAA Website at http://oeaaa.faa.gov.

2. PRECONSTRUCTION NOTICE

The notice must be submitted:

a. At least 30 days prior to the date of proposed construction or alteration is to begin.

b. 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 30-day period in order to expedite FCC processing.)

3. FAA ACKNOWLEDGEMENT

The FAA will acknowledge, in writing, receipt of each FAA Form 7460-1 notice received.

4. SUPPLEMENTAL NOTICE REQUIREMENT

a. If required, the FAA will include a FAA Form 7460-2, Notice of Actual Construction or Alteration, with a determination.

b. FAA Form 7460-2 Part 1 is to be completed and sent to the FAA at least 48 hours prior to starting the actual construction or alteration of a structure. Additionally, Part 2 shall be submitted no later than 5 days after the structure has reached its greatest height. The form should be sent to the OES.

c. In addition, supplemental notice shall be submitted upon abandonment of construction.

d. Letters are acceptable in cases where the construction/alteration is temporary or a proposal is abandoned. This notification process is designed to permit the FAA the necessary time to change affected procedures and/or minimum flight altitudes, and to otherwise alert airmen of the structure's presence.

Note-
NOTIFICATION AS REQUIRED IN THE DETERMINATION IS CRITICAL TO AVIATION SAFETY.

5. MODIFICATIONS AND DEVIATIONS

a. Requests for modification or deviation from the standards outlined in this AC must be submitted to the OES. The sponsor is responsible for adhering to approved marking and/or lighting limitations, and/or recommendations given, and should notify the FAA and FCC (for those structures regulated by the FCC) prior to removal of marking and/or lighting. A request received after a determination is issued may require a new study and could result in a new determination.

b. ***Modifications.*** Modifications will be based on whether or not they impact aviation safety. Examples of modifications that may be considered:

1. ***Marking and/or Lighting Only a Portion of an Object.*** The object may be so located with respect to other objects or terrain that only a portion of it needs to be marked or lighted.

2. ***No Marking and/or Lighting.*** The object may be so 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 so 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 request the proper marking and/or lighting from the FAA to ensure no aviation safety issues are impacted.

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 the safety to air navigation.

c. ***Deviations.*** The OES conducts an aeronautical study of the proposed deviation(s) and forwards its recommendation to FAA headquarters in Washington, DC, for final approval. Examples of deviations that may be considered:

1. Colors of objects.
2. Dimensions of color bands or rectangles.
3. Colors/types of lights.
4. Basic signals and intensity of lighting.

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5. Night/day lighting combinations.

6. Flash rate.

d. The FAA strongly recommends that owners become familiar with the different types of lighting systems and to specifically request the type of lighting system desired when submitting FAA Form 7460-1. (This request should be noted in "item 2.D" of the FAA form.) Information on these systems can be found in Chapter 12, Table 4 of this AC. While the FAA will make every effort to accommodate the structure sponsor's request, sponsors should also request information from system manufacturers in order to determine which system best meets their needs based on purpose, installation, and maintenance costs.

6. ADDITIONAL NOTIFICATION

Sponsors are reminded that any change to the submitted information on which the FAA has based its determination, including modification, deviation or optional upgrade to white lighting on structures which are regulated by the FCC, must also be filed with the FCC prior to making the change for proper authorization and annotations of obstruction marking and lighting. These structures will 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). Upon completion of the actual change, notify the Aeronautical Charting office at:

NOAA/NOS
Aeronautical Charting Division
Station 5601, N/ACC113
1305 East-West Highway
Silver Spring, MD 20910-3233

7. METRIC UNITS

To promote an orderly transition to metric units, sponsors should include both English and metric (SI units) dimensions. The metric conversions may not be exact equivalents, however, until there is an official changeover to the metric system, the English dimensions will govern.

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CHAPTER 2. GENERAL

20. STRUCTURES TO BE MARKED AND LIGHTED

Any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 feet (61m) above ground level (AGL) or exceeds any obstruction standard contained in 14 CFR part 77, should normally 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 safety to air navigation. Normally outside commercial lighting is not considered sufficient reason to omit recommended marking and/or lighting. Recommendations on marking and/or 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. The FAA may also recommend marking and/or lighting a structure that does not exceed 200 (61m) feet AGL or 14 CFR part 77 standards because of its particular location.

21. GUYED STRUCTURES

The guys of a 2,000-foot (610m) skeletal tower are anchored from 1,600 feet (488m) to 2,000 feet (610m) from the base of the structure. This places a portion of the guys 1,500 feet (458m) from the tower at a height of between 125 feet (38m) to 500 feet (153m) AGL. 14 CFR part 91, section 119, requires pilots, when operating over other than congested areas, to remain at least 500 feet (153m) from man-made structures. Therefore, the tower must be cleared by 2,000 feet (610m) horizontally to avoid all guy wires. Properly maintained marking and lighting are important for increased conspicuity since the guys of a structure are difficult to see until aircraft are dangerously close.

22. MARKING AND LIGHTING EQUIPMENT

Considerable effort and research have been expended in determining the minimum marking and lighting systems or quality of materials that will produce an acceptable level of safety to air navigation. The FAA will recommend the use of only those marking and lighting systems that meet established technical standards. 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.

23. LIGHT FAILURE NOTIFICATION

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

b. Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to the appropriate flight service station (FSS) so a Notice to Airmen (NOTAM) can be issued. Toll-free numbers for FSS are listed in most telephone books or on the web at http://www.afss.com. This report should contain the following information:

1. Name of persons or organizations reporting light failures including any title, address, and telephone number.

2. The type of structure.

3. Location of structure (including latitude and longitude, if known, prominent structures, landmarks, etc.).

4. Height of structure above ground level (AGL)/above mean sea level (AMSL), if known.

5. A return to service date.

6. FCC Antenna Registration Number (for structures that are regulated by the FCC).

Note-

1. When the primary lamp in a double obstruction light fails, and the secondary lamp comes on, no report is required. However, when one of the lamps in an incandescent L-864 flashing red beacon fails, it should be reported.

2. After 15 days, the NOTAM is automatically deleted from the system. The sponsor is responsible for calling the nearest FSS to extend the outage date or to report a return to service date.

24. NOTIFICATION OF RESTORATION

As soon as normal operation is restored, notify the same FSS that received the notification of failure. The FCC advises that noncompliance with notification procedures could subject its sponsor to penalties or monetary forfeitures.

25. FCC REQUIREMENT

FCC licensees are required to file an environmental assessment with the Commission when seeking authorization for the use of the high intensity flashing white lighting system on structures located in residential neighborhoods, as defined by the applicable zoning law.

CHAPTER 3. MARKING GUIDLINES

30. PURPOSE

This chapter provides recommended guidelines to make certain structures conspicuous to pilots during daylight hours. One way of achieving this conspicuity is by painting and/or marking these structures. Recommendations on marking 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.

31. PAINT COLORS

Alternate sections of aviation orange and white paint should be used as they provide maximum visibility of an obstruction by contrast in colors.

32. PAINT STANDARDS

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

a. ***Materials and Application.*** Quality paint and materials should be selected to provide extra years of service. The paint should be compatible with the surfaces to be painted, including any previous coatings, and suitable for the environmental conditions. Surface preparation and paint application should be in accordance with manufacturer's recommendations.

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

b. ***Surfaces Not Requiring Paint.*** Ladders, decks, and walkways of steel towers and similar structures need not be painted if a smooth surface presents a potential hazard to maintenance personnel. Paint may also be omitted from precision or critical surfaces if it would have an adverse effect on the transmission or radiation characteristics of a signal. However, the overall marking effect of the structure should not be reduced.

c. ***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, paint should be applied to all inner and outer surfaces of the framework.

33. PAINT PATTERNS

Paint patterns of various types are used to mark structures. The pattern to be used is determined by the size and shape of the structure. The following patterns are recommended.

a. ***Solid Pattern.*** Obstacles should be colored aviation orange if the structure has both horizontal and vertical dimensions not exceeding 10.5 feet (3.2m).

b. ***Checkerboard Pattern.*** Alternating rectangles of aviation orange and white are normally displayed on the following structures:

1. Water, gas, and grain storage tanks.

2. Buildings, as required.

3. Large structures exceeding 10.5 feet (3.2m) across having a horizontal dimension that is equal to or greater than the vertical dimension.

c. ***Size of Patterns.*** Sides of the checkerboard pattern should measure not less than 5 feet (1.5m) or more than 20 feet (6m) and should be as nearly square as possible. However, if it is impractical because of the size or shape of a structure, the patterns may have sides less than 5 feet (1.5m). When possible, corner surfaces should be colored orange.

d. ***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 which appear narrow from a side view, that are 10.5 feet (3.2m) or more 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.

e. ***Color Band Characteristics.*** Bands for structures of any height should be:

1. Equal in width, provided each band is not less than $1^1/_2$ feet (0.5m) or more than 100 feet (31m) wide.

2. Perpendicular to the vertical axis with the bands at the top and bottom ends colored orange.

3. An odd number of bands on the structure.

4. Approximately one-seventh the height if the structure is 700 feet (214m) AGL or less. For each additional 200 feet (61m) or fraction thereof, add one (1) additional orange and one (1) additional white band.

5. Equal and in proportion to the structure's height AGL.

Structure Height to Bandwidth Ratio

Example: If a Structure is:		
Greater Than	**But Not More Than**	**Band Width**
10.5 feet (3.2m)	700 feet (214m)	$^1/_7$ of height
701 feet (214m)	900 feet (275m)	$^1/_9$ of height
901 feet (275m)	1,100 feet (336m)	$^1/_{11}$ of height
1,100 feet (336m)	1,300 feet (397m)	$^1/_{13}$ of height

TBL 1

f. ***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.

g. ***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 under study determines the width of the color bands.

h. ***Partial Marking.*** If marking is recommended for only a portion of a structure because of shielding by other objects or terrain, the width of the bands should be determined by the overall height of the structure. A minimum of three bands should be displayed on the upper portion of the structure.

i. ***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 5 feet (1.5m) nor more than 15 feet (4.6m).

j. ***Community Names.*** If it is desirable to paint the name of the community on the side of a tank, the stripe pattern may be broken to serve this purpose. This open area should have a maximum height of 3 feet (0.9m).

k. ***Exceptions.*** Structural designs not conducive to standard markings may be marked as follows:

1. If it is not practical to color the roof of a structure in a checkerboard pattern, it may be colored 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 be colored by 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.

34. MARKERS

Markers are used to highlight structures when it is impractical to make them conspicuous by painting. Markers may also be used in addition to aviation orange and white paint when additional conspicuity is necessary for aviation safety. They should be displayed in conspicuous positions on or adjacent to the structures so as to retain the general definition of the structure. They should be recognizable in clear air from a distance of at least 4,000 feet (1219m) and in all directions from which aircraft are likely to approach. 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 replaced when faded or otherwise deteriorated.

a. ***Spherical Markers.*** Spherical markers are used to identify overhead wires. Markers may be of another shape, i.e., cylindrical, provided the projected area of such markers will not be less than that presented by a spherical marker.

1. ***Size and Color.***

The diameter of the markers used on extensive catenary wires across canyons, lakes, rivers, etc., should be not less than 36 inches (91cm). Smaller 20-inch (51cm) spheres are permitted on less extensive power lines or on power lines below 50 feet (15m) above the ground and within 1,500 feet (458m) of an airport runway end. Each marker should be a solid color such as aviation orange, white, or yellow.

2. ***Installations.***

(a) ***Spacing.*** Markers should be spaced equally along the wire at intervals of approximately 200 feet (61m) or a fraction thereof. Intervals between markers should be less in critical areas near runway ends (i.e., 30 to 50 feet (10m to 15m)). 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. This method allows the weight and wind loading factors to be distributed.

(b) ***Pattern.*** An alternating color scheme provides the most conspicuity against all backgrounds. Mark overhead wires by alternating solid colored markers of aviation orange, white, and yellow. Normally, an orange sphere is placed at each end of a line and the spacing is adjusted (not to exceed 200 feet (61m)) to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange.

b. ***Flag Markers.*** Flags are used to mark certain structures or objects when it is technically impractical to use spherical markers or painting. Some examples are temporary construction equipment, cranes, derricks, oil and other drilling rigs. Catenaries should use spherical markers.

1. ***Minimum Size.*** Each side of the flag marker should be at least 2 feet (0.6m) in length.

2. ***Color Patterns.*** Flags should be colored as follows:

(a) ***Solid.*** Aviation orange.

(b) ***Orange and White.*** Arrange two triangular sections, one aviation orange and the other white to form a rectangle.

(c) ***Checkerboard.*** Flags 3 feet (0.9m) or larger should be a checkerboard pattern of aviation orange and white squares, each 1 foot (0.3m) plus or minus 10 percent.

3. ***Shape.*** Flags should be rectangular in shape and have stiffeners to keep them from drooping in calm wind.

4. ***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 (15m) apart. The flag stakes should be of such strength and height that they will support the flags above all surrounding ground, structures, and/or objects of natural growth.

35. UNUSUAL COMPLEXITIES

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

36. OMISSION OR ALTERNATIVES TO MARKING

There are two alternatives to marking. Either alternative requires FAA review and concurrence.

a. ***High Intensity Flashing White Lighting Systems.*** The high intensity lighting systems are more effective than aviation orange and white paint and therefore can be recommended instead of marking. This is particularly true under certain ambient light conditions involving the position of the sun relative to the direction of flight. When high intensity lighting systems are operated during daytime and twilight, other methods of marking may be omitted. When operated 24 hours a day, other methods of marking and lighting may be omitted.

b. ***Medium Intensity Flashing White Lighting Systems.*** When medium intensity lighting systems are operated during daytime and twilight on structures 500 feet (153m) AGL or less, other methods of marking may be omitted. When operated 24 hours a day on structures 500 feet (153m) AGL or less, other methods of marking and lighting may be omitted.

Note-
SPONSORS MUST ENSURE THAT ALTERNATIVES TO MARKING ARE COORDINATED WITH THE FCC FOR STRUCTURES UNDER ITS JURISDICTION PRIOR TO MAKING THE CHANGE.

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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 OTS Subsequent Distribution Office, M-30 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.

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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
Telephone: (202) 267-0980

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 structutes 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

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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. 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.

56. 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.

57. 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 in 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. 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.

66. 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.

67. 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.

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 structutes 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:

Light Unit Elevation Above the Horizontal

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

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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,

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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, including 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

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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.

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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 structutes 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. 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.

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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 structutes 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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CHAPTER 10. MARKING AND LIGHTING OF CATENARY AND CATENARY SUPPORT STRUCTURES

100. PURPOSE

This chapter provides guidelines for marking and lighting catenary and catenary support structures. The recommended marking and lighting of these structures is intended to provide day and night conspicuity and to assist pilots in identifying and avoiding catenary wires and associated support structures.

101. CATENARY MARKING STANDARDS

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 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.

a. ***Size and Color.*** The diameter of the markers used on extensive catenary wires across canyons, lakes, rivers, etc., should be not less than 36 inches (91cm). Smaller 20-inch (51cm) markers are permitted on less extensive power lines or on power lines below 50 feet (15m) above the ground and within 1,500 feet (458m) of an airport runway end. Each marker should be a solid color such as aviation orange, white, or yellow.

b. ***Installation.***

1. ***Spacing.*** Lighted markers should be spaced equally along the wire at intervals of approximately 200 feet (61m) or a fraction thereof. Intervals between markers should be less in critical areas near runway ends, i.e., 30 to 50 feet (10m to 15m). If the 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 markers can be no more than 20 feet (6m). The lighted markers may be installed alternately along each wire if the distance between adjacent markers meets the spacing standard. This method allows the weight and wind loading factors to be distributed.

2. ***Pattern.*** An alternating color scheme provides the most conspicuity against all backgrounds. Mark overhead wires 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 (61m)) to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange.

102. 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-857/885) lighting systems, operated 24 hours a day, other marking of the support structure is not necessary.

a. ***Levels.*** A system of three levels of sequentially flashing light units should be installed on each supporting structure or adjacent terrain. Install one level at the top of the structure, one at the height of the lowest point in the catenary and one level approximately midway between the other two light levels. The middle level should normally be at least 50 feet (15m) from the other two levels. The middle light unit may be deleted when the distance between the top and the bottom light levels is less than 100 feet (30m).

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 when necessary for lightning protection, the top level of lights may be mounted as low as 20 feet (6m) below the highest point of the structure.

2. ***Horizontal Coverage.*** The light units at the middle level and bottom level should be installed so as to provide a minimum of 180-degree coverage centered perpendicular to the flyway. Where 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.

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.

b. ***Flash Sequence.*** The flash sequence should be middle, top, and bottom with all lights on the same level flashing simultaneously. The time delay between flashes of levels is designed to present a unique system display. The time delay between the start of each level of flash duration is outlined in FAA AC 150/5345-43, Specification for Obstruction Lighting Equipment.

c. ***Synchronization.*** Although desirable, the corresponding light levels on associated supporting towers of a catenary crossing need not flash simultaneously.

d. ***Structures 500 feet (153m) AGL or Less.*** When medium intensity white lights (L-866) are operated 24 hours a day, or when a dual red/medium intensity system (L-866 daytime & twilight/L-885 nighttime) is used, marking can be omitted. When using a medium intensity while light (L-866) or a flashing red light (L-885) during twilight or nighttime only, painting should be used for daytime marking.

e. *Structures Exceeding 500 Feet (153m) 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 recommended on structures 500 feet (153m) or less unless an FAA aeronautical study shows 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, painting should be used for daytime marking.

103. CONTROL DEVICE

The light intensity is controlled by a device (photocell) that changes the intensity when the ambient light changes. The lighting 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 (L-857 System).*** 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 illuminant-sensing device should, if practical, face the northern sky in the Northern Hemisphere.

b. ***Twilight-to-Night (L-857 System).*** 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 103 a. and b. above should be reversed when changing from the night to day mode.

d. ***Day-to-Night (L-866 or L-885/L-866).*** This should not occur before the illumination drops below 5 foot-candles (563.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).

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

f. ***Red Obstruction (L-885).*** The red lights should not turn on until the illumination drops below 60 foot-candles (645.8 lux) but should occur before reaching a level of 35 foot-candles (367.7 lux). Lights should not turn off before the illuminance rises above 35 foot-candles (367.7 lux), but should occur before reaching 60 foot-candles (645.8 lux).

104. AREA SURROUNDING CATENARY 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.

105. THREE OR MORE CATENARY 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 a full 360-degree coverage.

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CHAPTER 11. MARKING AND LIGHTING MOORED BALLOONS AND KITES

110. 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 converging from any normal angle of approach.

111. STANDARDS

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

112. MARKING

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

a. *Display.* Markers should be displayed at no more than 50-foot (15m) intervals and should be visible for at least 1 statute mile.

b. *Shape.* Markers should be rectangular in shape and not less than 2 feet (0.6m) on a side. Stiffeners should be used in the borders so as to expose a large area, prevent drooping in calm wind, or wrapping around the cable.

c. *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.

113. PURPOSE

Flashing obstruction lights should 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.

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

b. *Display.* Flashing lights should be displayed on the top, nose section, tail section, and on the tether cable approximately 15 feet (4.6m) below the craft so as to define the extremes of size and shape. Additional lights should be equally spaced along the cable's overall length for each 350 feet (107m) or fraction thereof.

c. *Exceptions.* When the requirements of this paragraph cannot be met, floodlighting may be used.

114. OPERATIONAL CHARACTERISTICS

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

CHAPTER 12. MARKING AND LIGHTING EQUIPMENT AND INFORMATION

120. PURPOSE

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

121. PAINT STANDARD

Paint and aviation colors/gloss, referred to in this publication should conform to Federal Standard FED-STD-595. Approved colors shall be formulated without the use of Lead, Zinc Chromate or other heavy metals to match International Orange, White and Yellow. All coatings shall be manufactured and labeled to meet Federal Environmental Protection Act Volatile Organic Compound(s) guidelines, including the National Volatile Organic Compound Emission Standards for architectural coatings.

a. Exterior Acrylic Waterborne Paint. Coating should be a ready mixed, 100% acrylic, exterior latex formulated for application directly to galvanized surfaces. Ferrous iron and steel or non-galvanized surfaces shall be primed with a manufacturer recommended primer compatible with the finish coat.

b. Exterior Solventborne Alkyd Based Paint. Coating should be ready mixed, alkyd-based, exterior enamel for application directly to non-galvanized surfaces such as ferrous iron and steel. Galvanized surfaces shall be primed with a manufacturer primer compatible with the finish coat.

Paint Standards Color Table

COLOR	NUMBER
Orange	12197
White	17875
Yellow	13538

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Note-

1. Federal specification TI-P-59, aviation surface paint, ready mixed international orange.

2. Federal specification TI-102, aviation surface paint, oil titanium zinc.

3. Federal specification TI-102, aviation surface paint, oil, exterior, ready mixed, white and light tints.

122. AVAILABILITY OF SPECIFICATIONS

Federal specifications describing the technical characteristics of various paints and their application techniques may be obtained from:

GSA- Specification Branch 470 L'Enfant Plaza Suite 8214 Washington, DC 20407 Telephone: (202) 619-8925

123. LIGHTS AND ASSOCIATED EQUIPMENT

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

a. ***Obstruction Lighting Equipment.***

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

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

3. Military Specifications MIL-L-7830, Light Assembly, Markers, Aircraft Obstruction.

b. ***Certified Equipment.***

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.

2. Other manufacturers' equipment may be used provided that equipment meets the specification requirements of AC 150/5345-43.

c. ***Airport Lighting Installation and Maintenance.***

1. AC 150/5340-21, Airport Miscellaneous Lighting Visual Aids, provides guidance for the installation, maintenance, testing, and inspection of obstruction lighting for airport visual aids such as airport beacons, wind cones, etc.

2. AC 150/5340-26, Maintenance of Airport Visual Aid Facilities, provides guidance on the maintenance of airport visual aid facilities.

d. ***Vehicles.***

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

2. FAA Facilities. Obstruction marking for FAA facilities shall conform to FAA Drawing Number D-5480, referenced in FAA Standard FAA-STD-003, Paint Systems for Structures.

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124. AVAILABILITY

The standards and specifications listed above may be obtained free of charge from the below-indicated office:

a. ***Military Specifications:***

Standardization Document Order Desk 700 Robbins Avenue Building #4, Section D Philadelphia, PA 19111-5094

b. ***FAA Specifications:***

Manager, ASD-110 Department of Transportation Document Control Center Martin Marietta/Air Traffic Systems 475 School St., SW. Washington, DC 20024 Telephone: (202) 646-2047 FAA Contractors Only

c. ***FAA Advisory Circulars:***

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CHAPTER 13. MARKING AND LIGHTING WIND TURBINE FARMS

130. PURPOSE

This chapter provides guidelines for the marking and lighting of wind turbine farms. For the purposes of this advisory circular, wind turbine farms are defined as a wind turbine development that contains more than three (3) turbines of heights over 200 feet above ground level. 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.

131. GENERAL STANDARDS

The development of wind turbine farms is a very dynamic process, which constantly changes based on the differing terrain they are built on. Each wind turbine farm is unique; therefore it is important to work closely with the sponsor to determine a lighting scheme that provides for the safety of air traffic. The following are guidelines that are recommended for wind turbine farms. Consider the proximity to airports and VFR routes, extreme terrain where heights may widely vary, and local flight activity when making the recommendation.

a. Not all wind turbine units within an installation or farm need to be lighted. Definition of the periphery of the installation is essential; however, lighting of interior wind turbines is of lesser importance unless they are taller than the peripheral units.

b. Obstruction lights within a group of wind turbines should have unlighted separations or gaps of no more than ½ statute mile if the integrity of the group appearance is to be maintained. This is especially critical if the arrangement of objects is essentially linear.

c. Any array of flashing or pulsed obstruction lighting should be synchronized or flash simultaneously.

d. Nighttime wind turbine obstruction lighting should consist of the preferred FAA L-864 aviation red-colored flashing lights.

e. White strobe fixtures (FAA L-865) may be used in lieu of the preferred L-864 red flashing lights, but must be used alone without any red lights, and must be positioned in the same manner as the red flashing lights.

f. The white paint most often found on wind turbine units is the most effective daytime early warning device. Other colors, such as light gray or blue, appear to be significantly less effective in providing daytime warning. Daytime lighting of wind turbine farms is not required, as long as the turbine structures are painted in a bright white color or light off-white color most often found on wind turbines.

132. WIND TURBINE CONFIGURATIONS –

Prior to recommending marking and lighting, determine the configuration and the terrain of the wind turbine farm. The following is a description of the most common configurations.

a. Linear – wind turbine farms in a line-like arrangement, often located along a ridge line, the face of a mountain or along borders of a mesa or field. The line may be ragged in shape or be periodically broke, and may vary in size from just a few turbines up to 20 miles long.

b. Cluster – turbine farms where the turbines are placed in circles like groups on top of a mesa, or within a large field. 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.

c. Grid – turbine farms arranged in a geographical shape such as a square or a rectangle, where each turbine is set a consistent distance from each other in rows, giving the appearance that they are part of a square like pattern.

133. MARKING STANDARDS

The bright white or light off-white paint most often found on wind turbines has been shown to be most effective, and if used, no lights are required during the daytime. However, if darker paint is used, wind turbine marking should be supplemented with daytime lighting, as required.

134. LIGHTING STANDARDS

a. Flashing red (L864), or white (L-865) lights may be used to light wind turbines. Studies have shown that red lights are most effective, and should be the first consideration for lighting recommendations of wind turbines.

b. Obstruction lights should have unlighted separations or gaps of no more than ½ mile. Lights should flash simultaneously. Should the synchronization of the lighting system fail, a lighting outage report should be made in accordance with paragraph 23 of this advisory circular. Light fixtures should be placed as high as possible on the turbine nacelle, so as to be visible from 360 degrees.

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c. Linear Turbine Configuration. Place a light on each turbine positioned at each end of the line or string of turbines. Lights should be no more than ½ statute mile, or 2640 feet from the last lit turbine. In the event the last segment is significantly short, push the lit turbines back towards the starting point to present a well balanced string of lights. High concentrations of lights should be avoided.

d. Cluster Turbine Configuration. Select a starting point among the outer perimeter of the cluster. This turbine should be lit, and a light should be placed on the next turbine so that no more than a ½ statute mile gap exists. Continue this pattern around the perimeter. If the distance across the cluster is greater than 1 mile, and/or the terrain varies by more than 100 feet, place one or more lit turbines at locations throughout the center of the cluster.

e. Grid Turbine Configuration. Select each of the defined corners of the layout to be lit, and then utilize the same concept of the cluster configuration as outlined in paragraph d.

f. Special Considerations. On occasion, one or two turbines may be located apart from the main grouping of turbines. If one or two turbines protrude from the general limits of the turbine farm, these turbines should be lit.

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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

PAINTING AND/OR DUAL LIGHTING OF CHIMNEYS, POLES, TOWERS, AND SIMILAR STRUCTURES

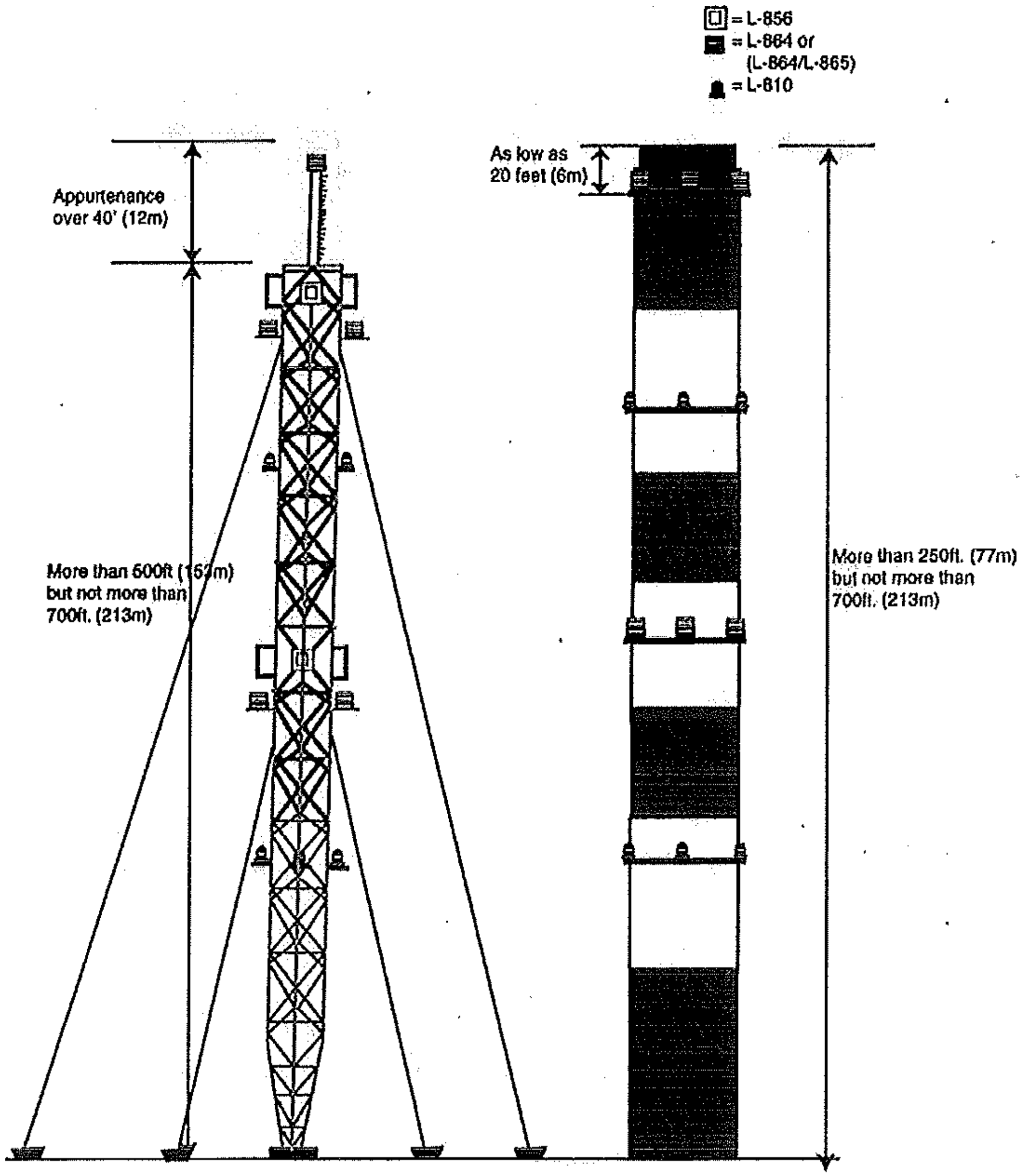

FIG 1

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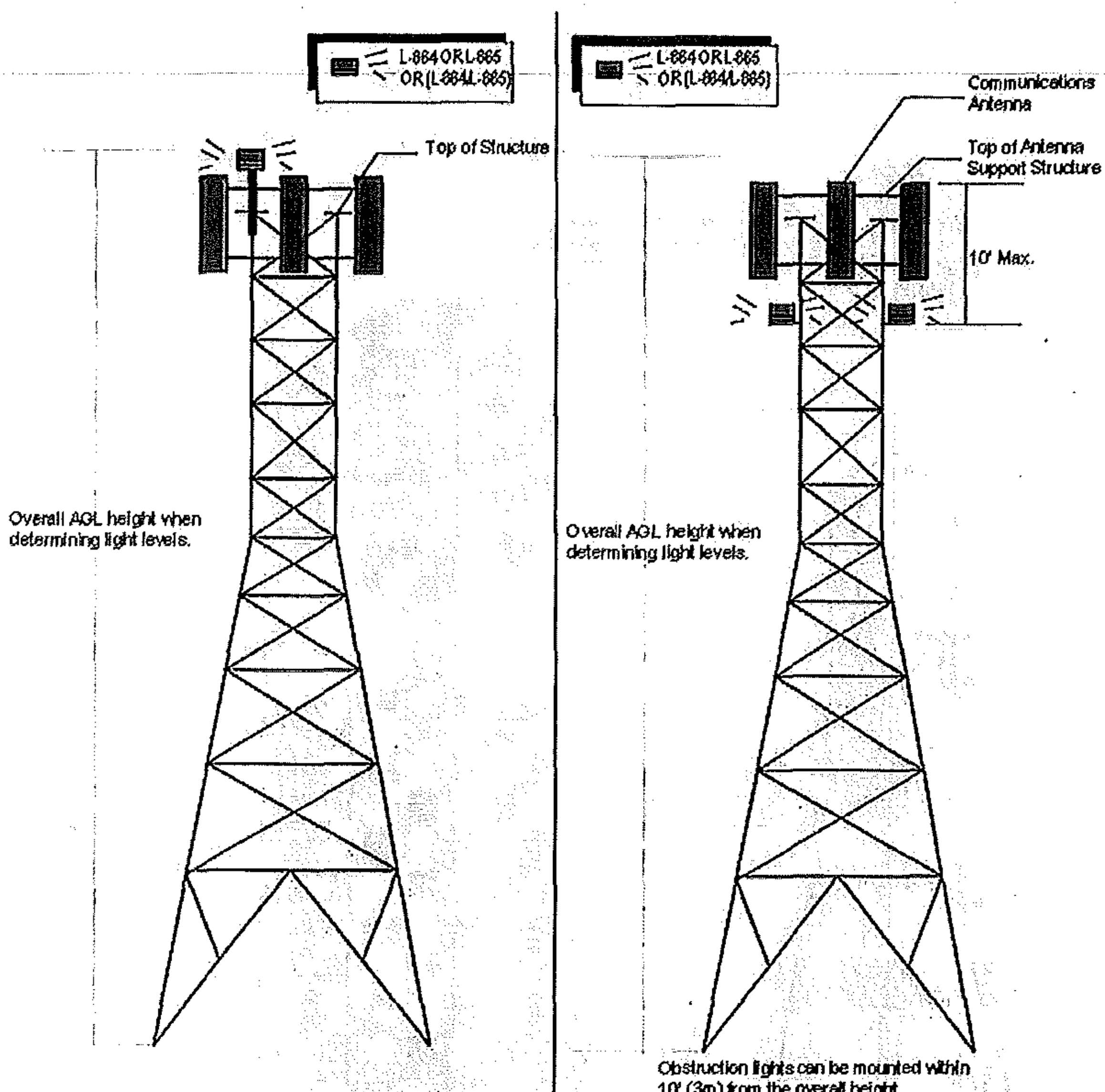

Intermediate lighting not shown. Overall AGL height if more than 200' (61m), but not more than 500' (153m).

FIG 2

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PAINTING AND LIGHTING OF WATER TOWERS, STORAGE TANKS, AND SIMILAR STRUCTURES

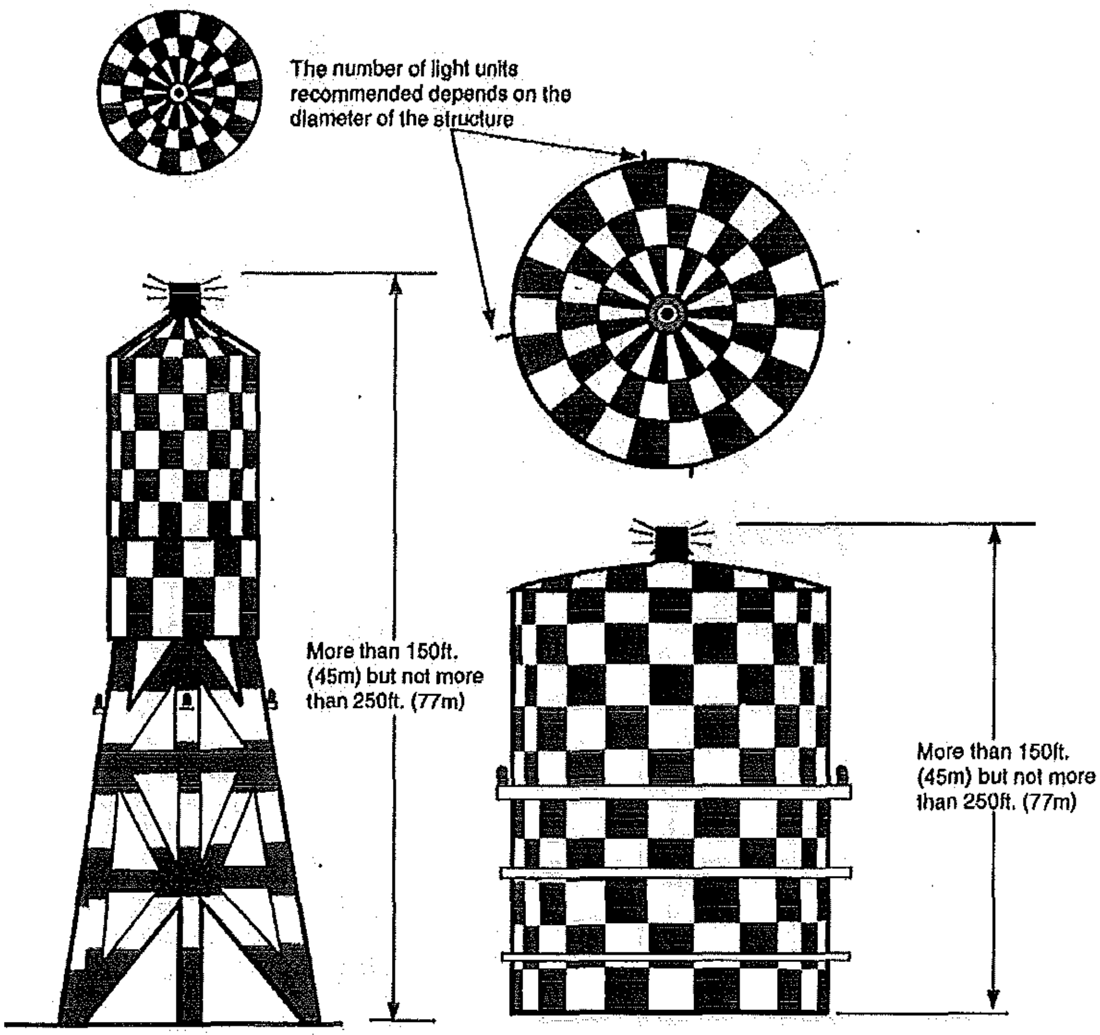

FIG 3

202

PAINTING AND LIGHTING OF WATER TOWERS ANDE SIMILAR STRUCTURES

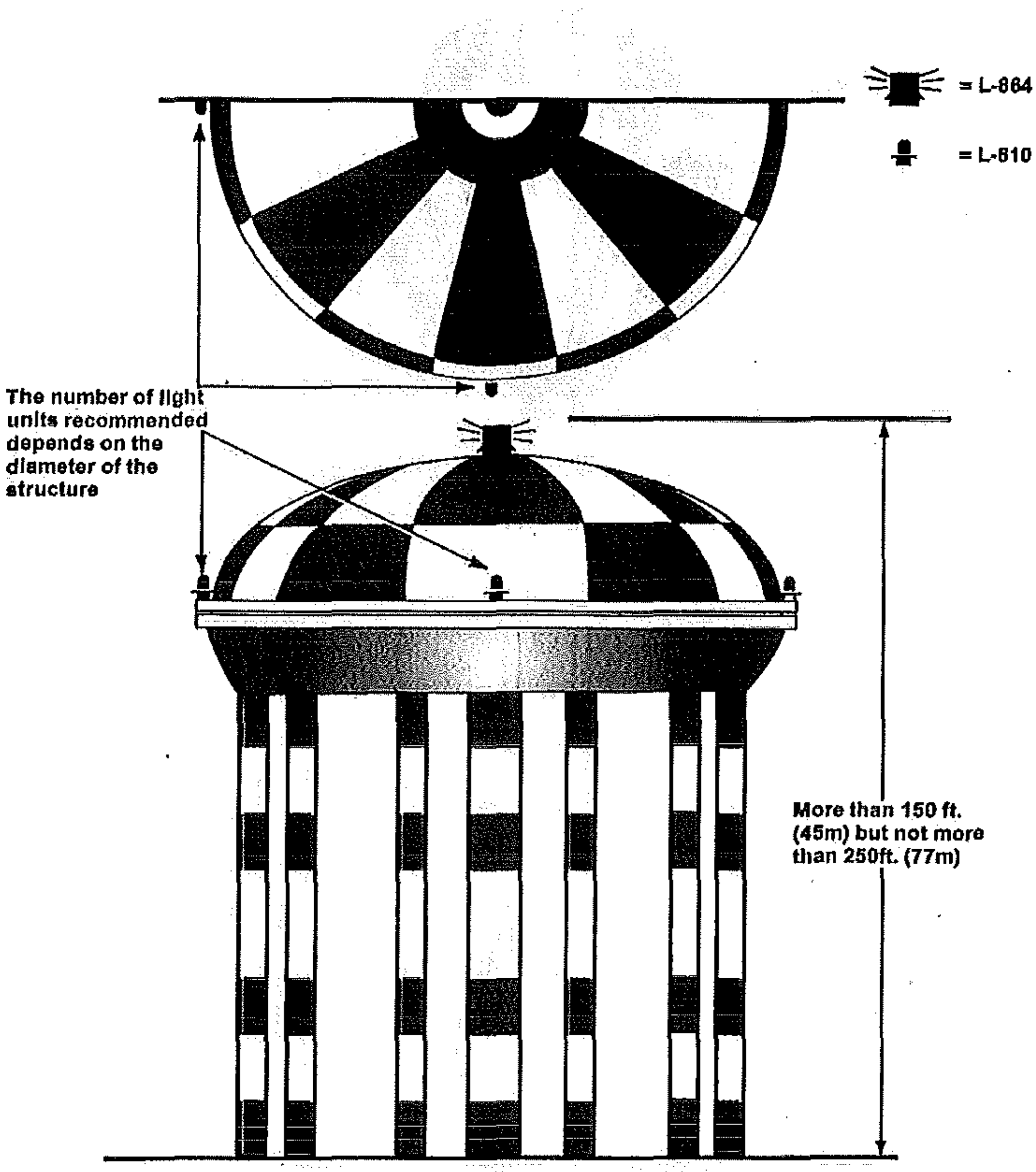

FIG 4

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PAINTING OF SINGLE PEDESTAL WATER TOWER BY TEARDROP PATTERN

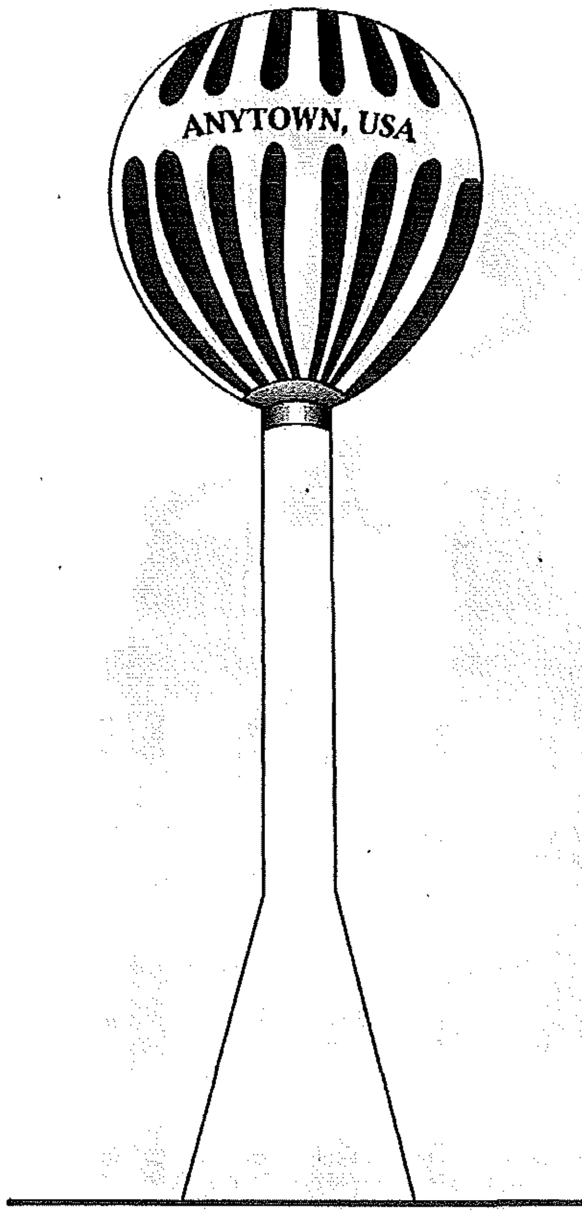

FIG 5

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LIGHTING ADJACENT STRUCTURES

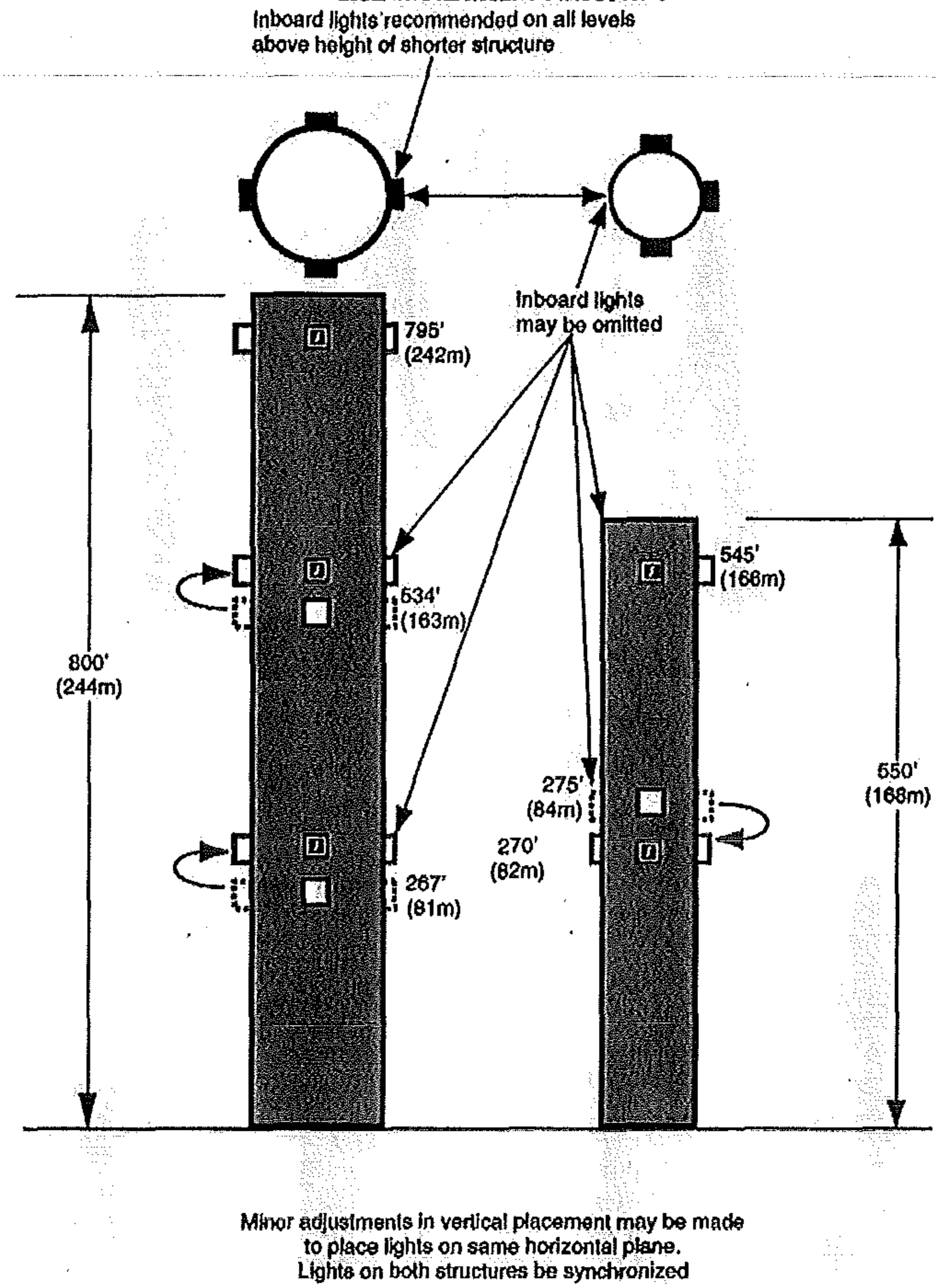

FIG 6

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Lighting Adjacent Structure

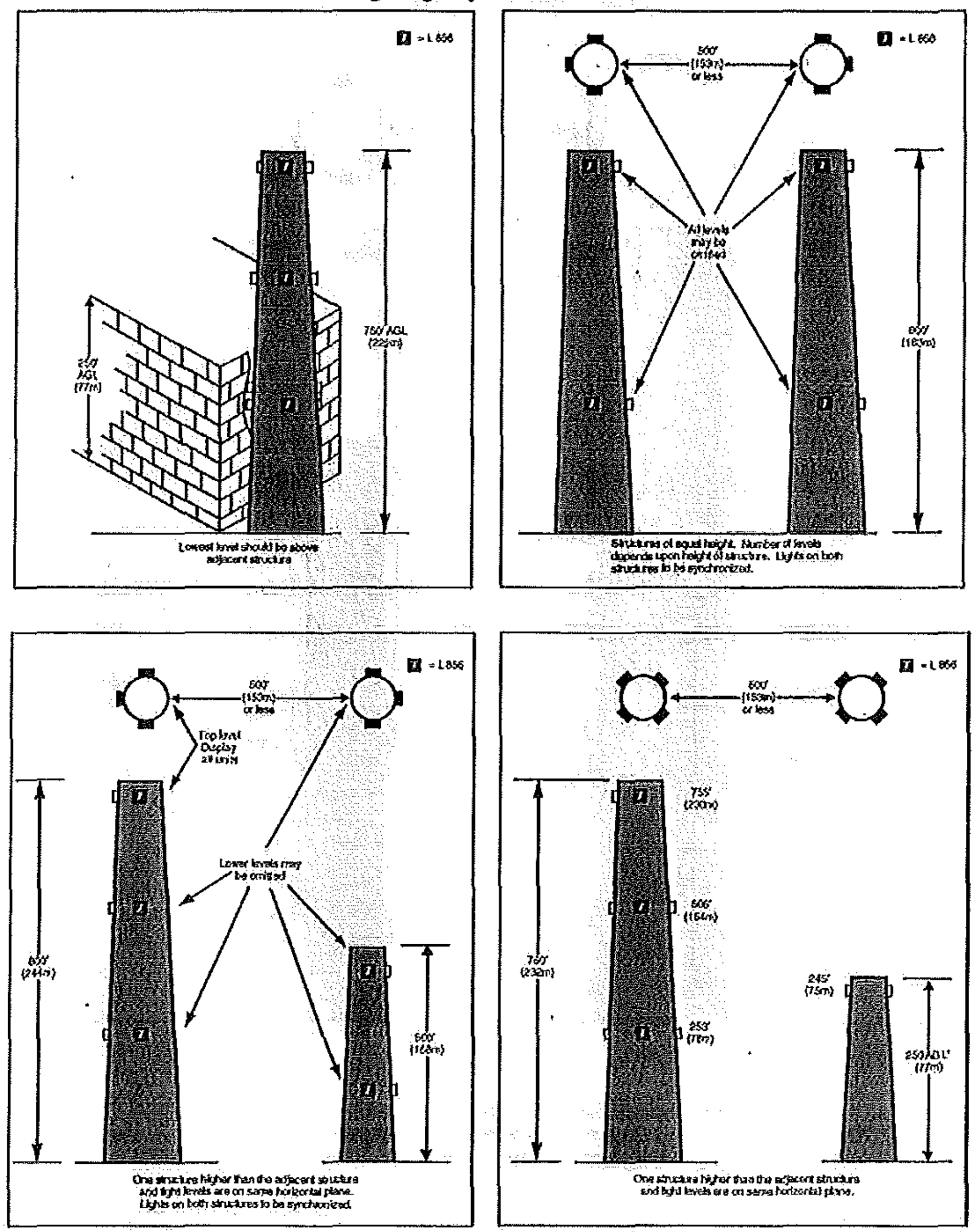

FIG 7

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Lighting Adjacent Structure

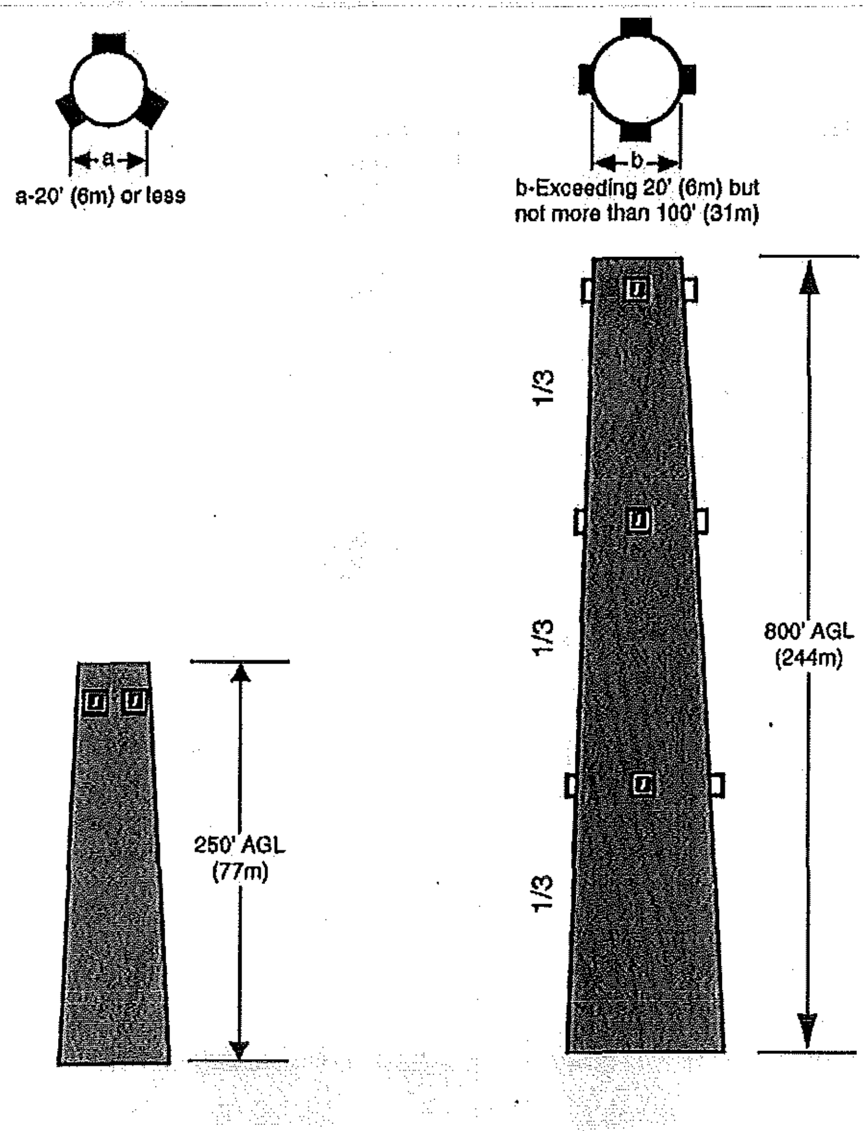

FIG 8

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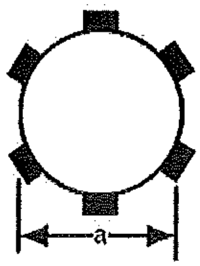
HYPERBOLIC COOLING TOWER



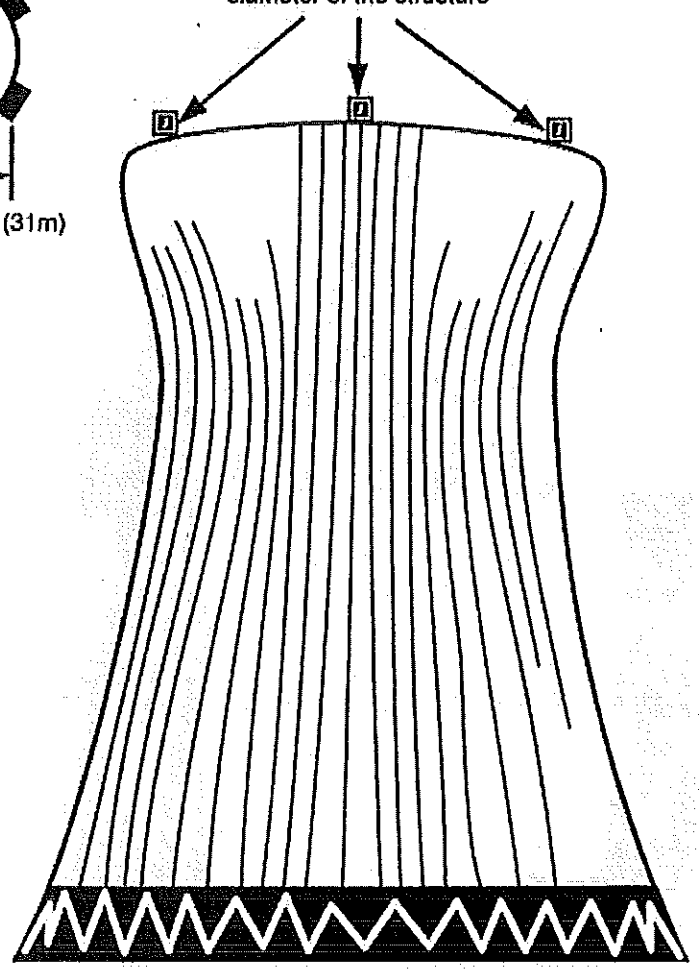


FIG 9

BRIDGE LIGHTING

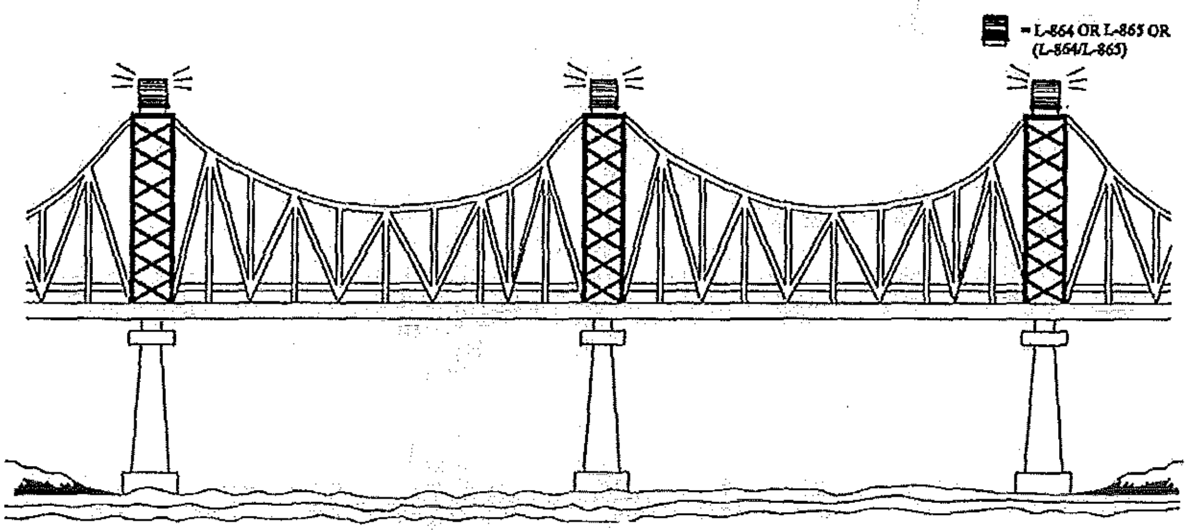


FIG 10

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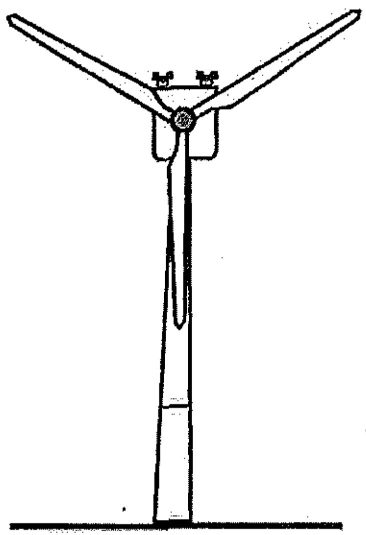
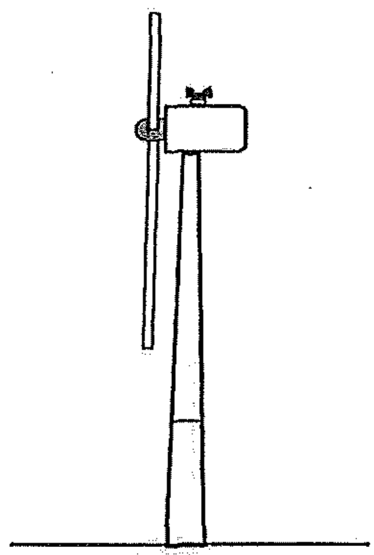
TYPICAL LIGHTING OF A STAND ALONE WIND TURBINE



Front View



Side View

FIG 11

WIND TURBINE GENERATOR

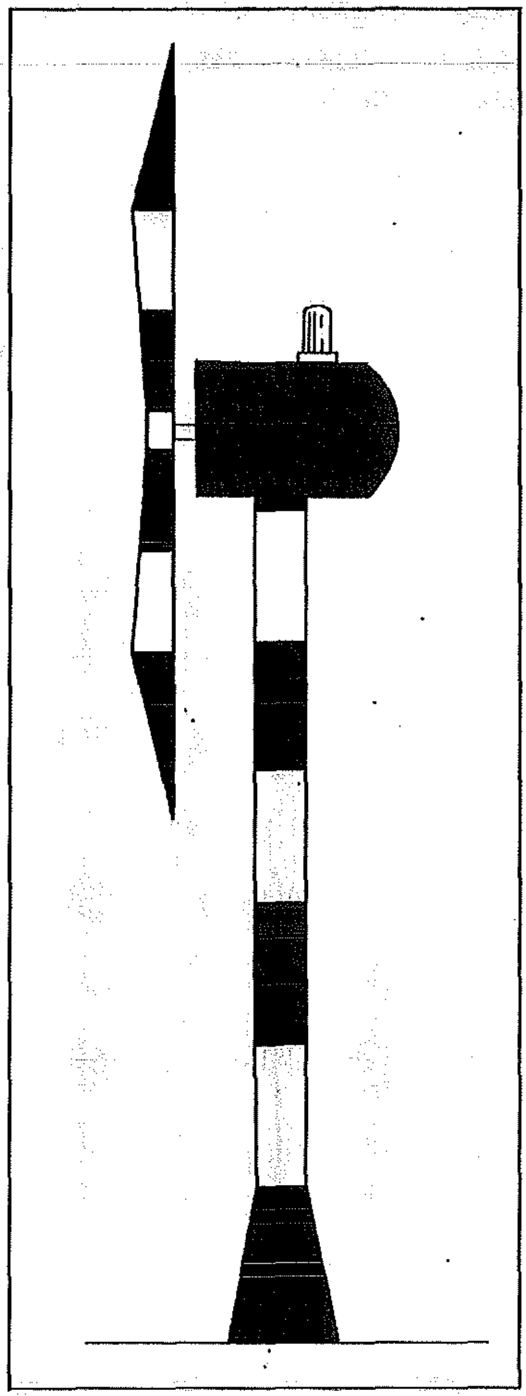


FIG 12

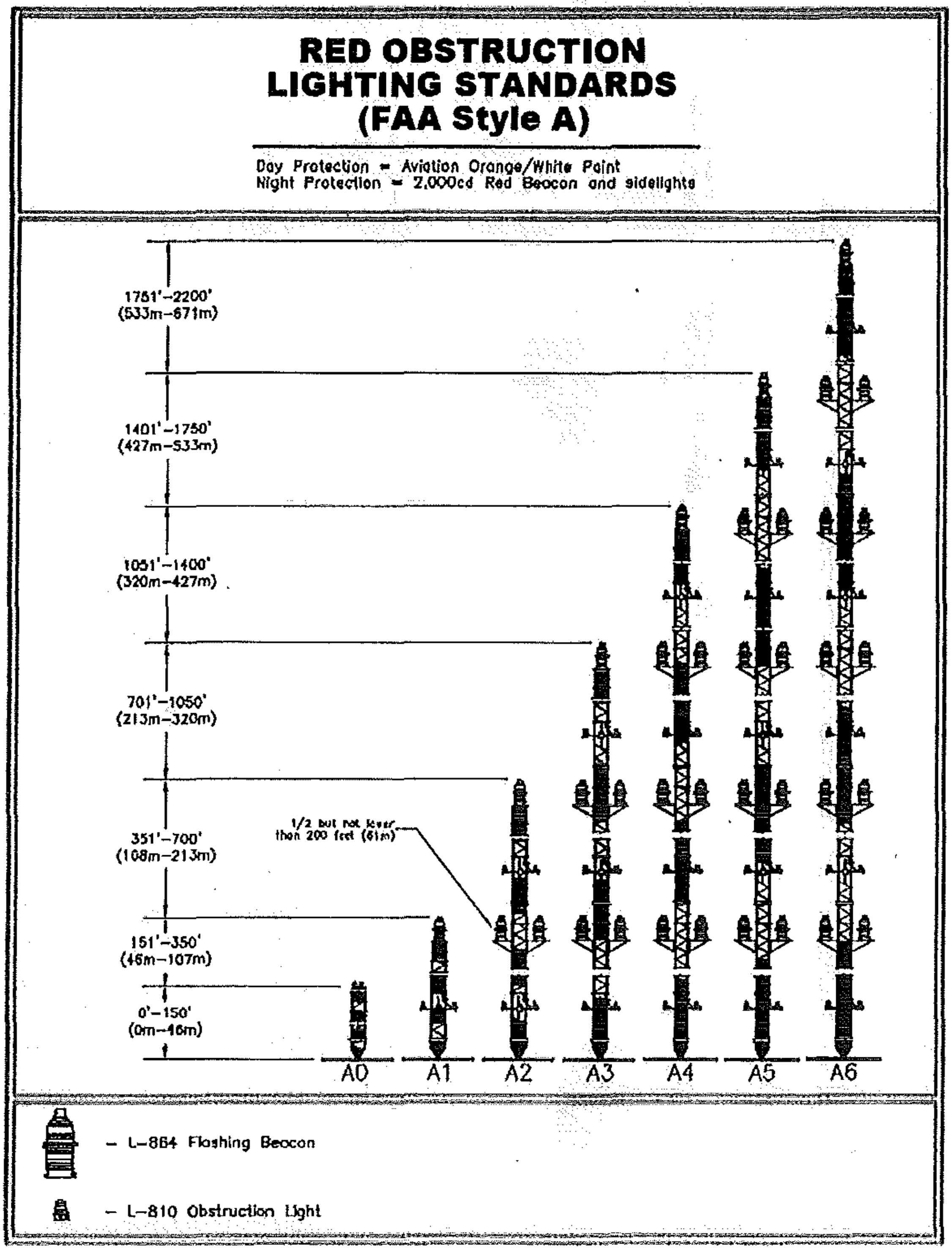

RED OBSTRUCTION
LIGHTING STANDARDS
(FAA Style A)
Day Protection = Aviation Orange/White Paint
Night Protection = 2,000cd Red Beacon and sidelights
1751'-2200'
(533m-671m)
1401'-1750'
(427m-533m)
1051'-1400'
(320m-427m)
701'-1050'
(213m-320m)
351'-700'
(108m-213m)
151'-350'
(46m-107m)
0'-150'
(0m-46m)
1/2 but not lower than 200 feet (61m)
A0
A1
A2
A3
A4
A5
A6
- L-864 Flashing Beacon
- L-810 Obstruction Light

FIG 13

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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.

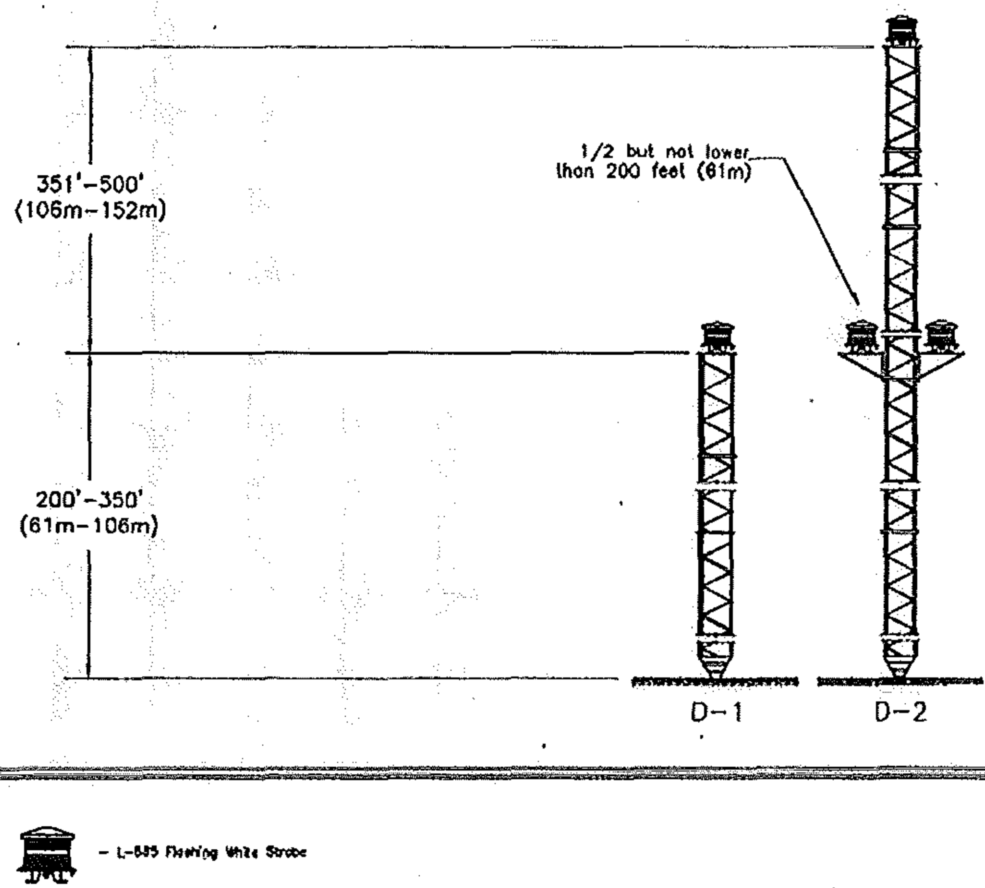

FIG 14

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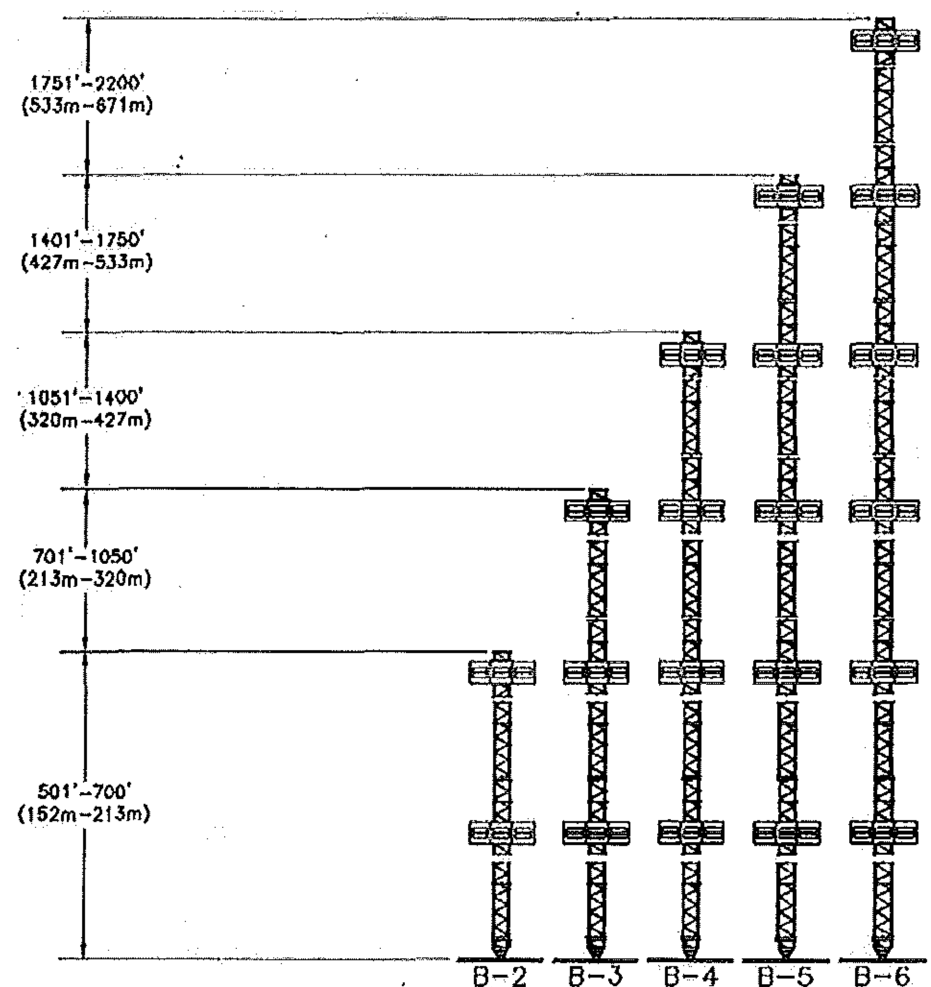
HIGH INTENSITY OBSTRUCTION LIGHTING STANDARDS (FAA Style B)

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

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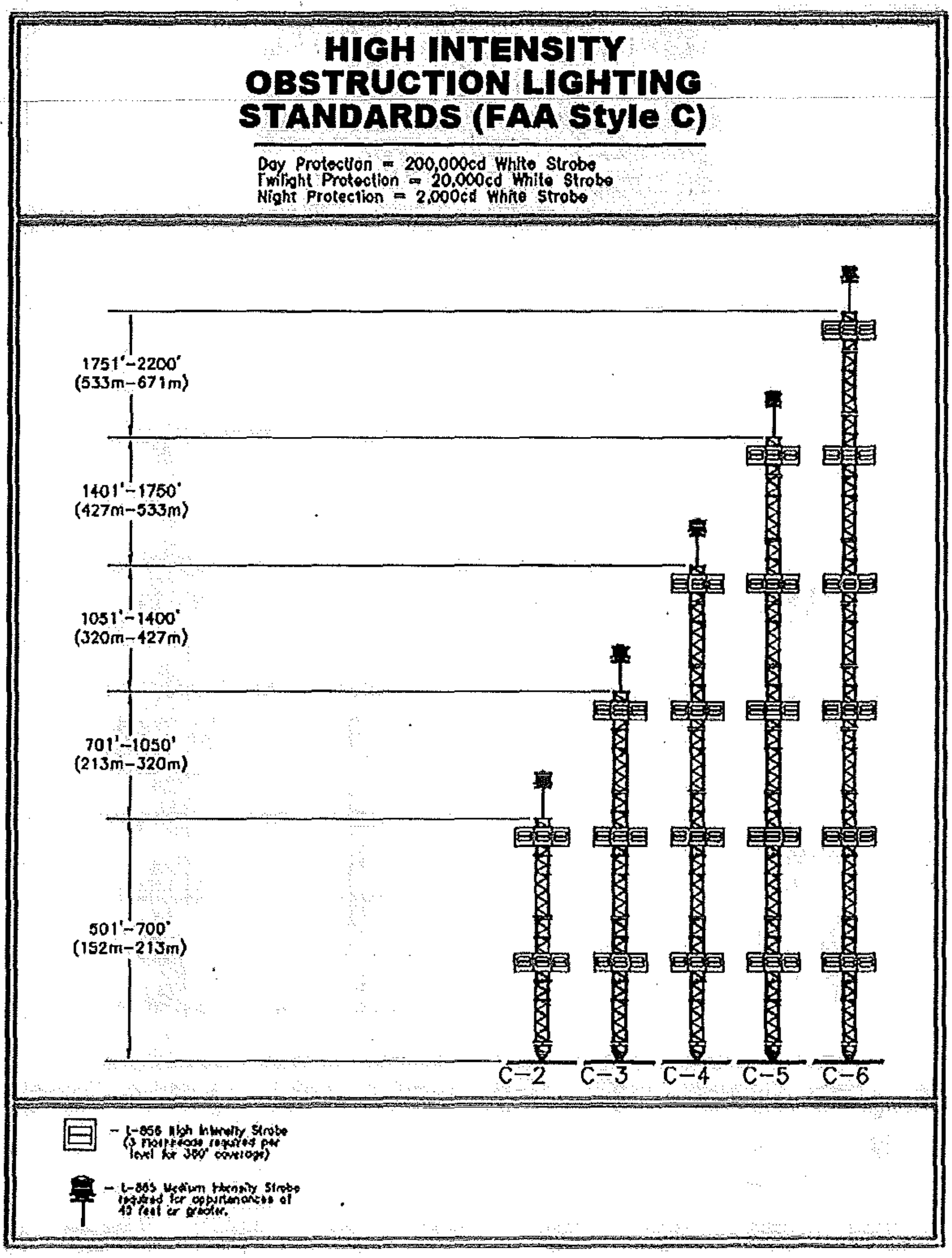
HIGH INTENSITY
OBSTRUCTION LIGHTING
STANDARDS (FAA Style C)
Day Protection = 200,000cd White Strobe
Twilight Protection = 20,000cd White Strobe
Night Protection = 2,000cd White Strobe
1751'–2200'
(533m–671m)
1401'–1750'
(427m–533m)
1051'–1400'
(320m–427m)
701'–1050'
(213m–320m)
501'–700'
(152m–213m)
C–2
C–3
C–4
C–5
C–6

FIG 16

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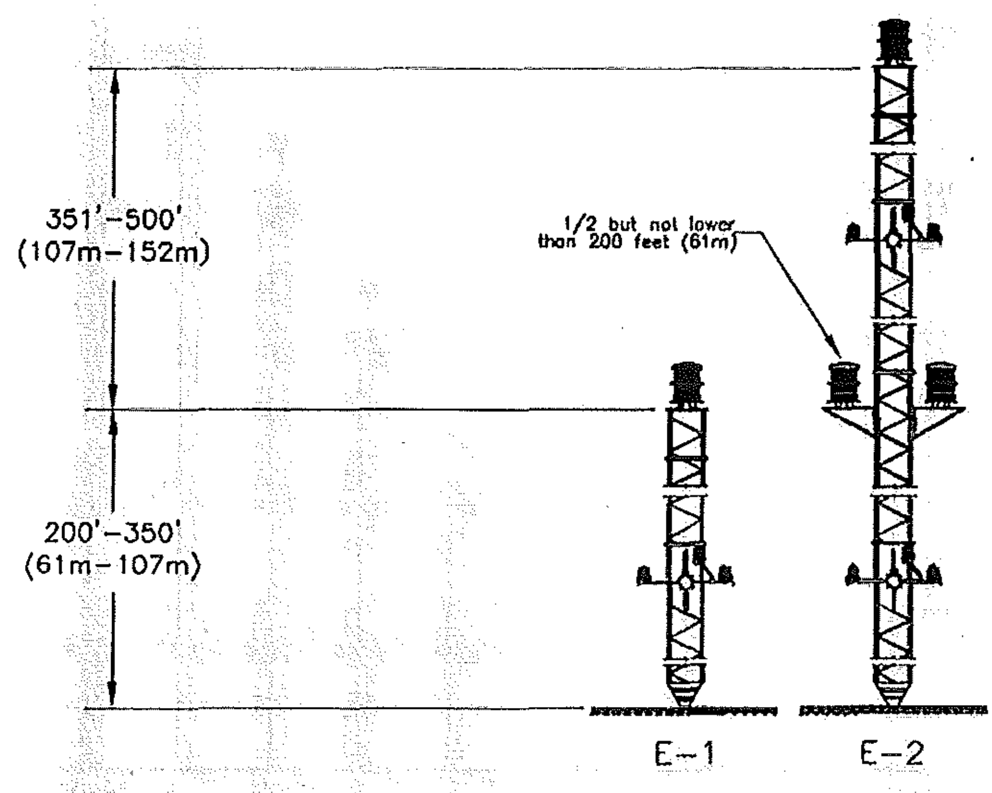
MEDIUM INTENSITY DUAL OBSTRUCTION LIGHTING STANDARDS (FAA Style E)

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

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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

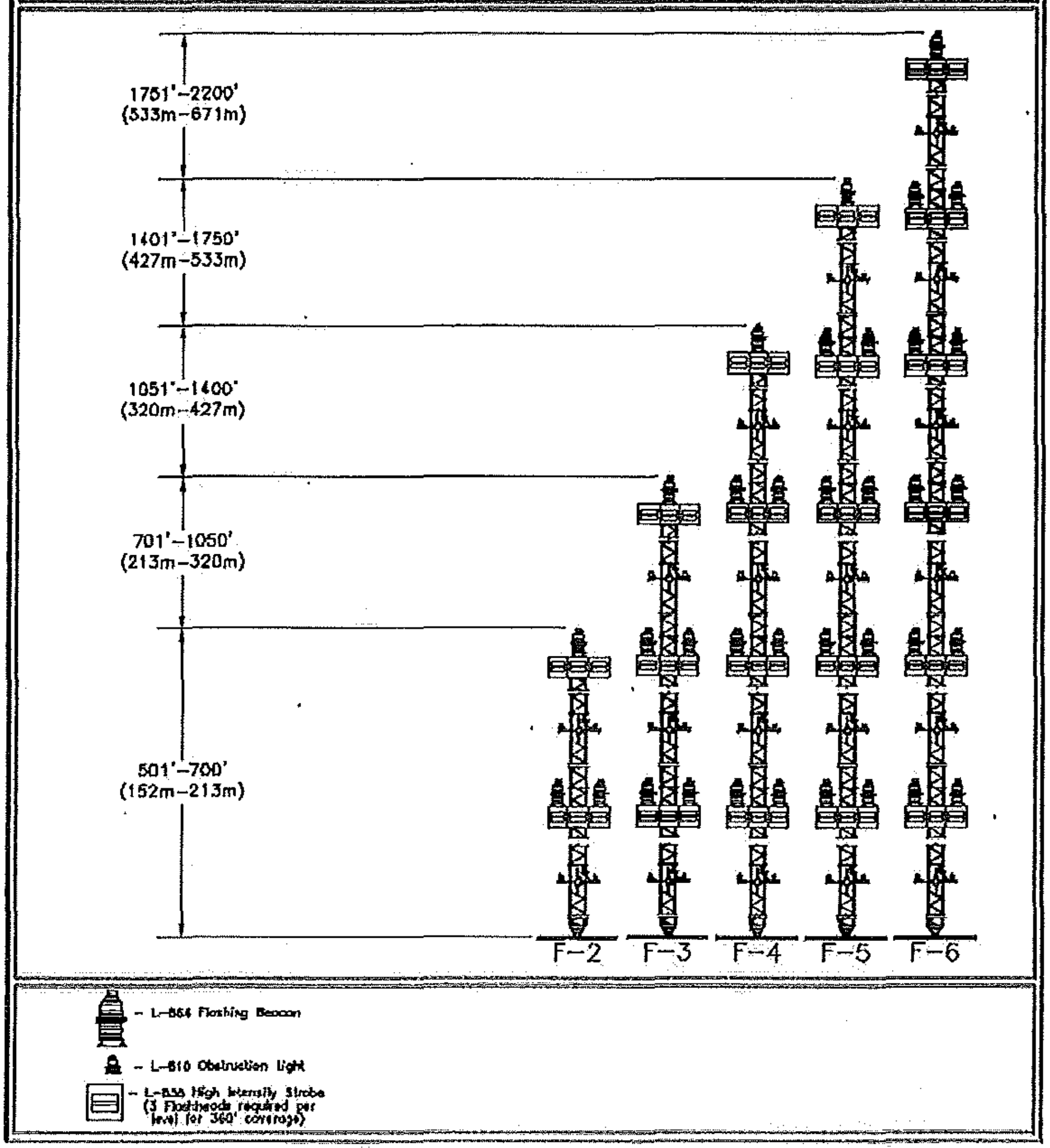

FIG 18

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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.

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.