FINAL REPORT

Development and Evaluation of VFR Lighted Flyways in the Chicago Class B Airspace

Project VC-A1, FY 95/96

Report No. ITRC FR 95/96-6

Prepared by

Pongnate Hongschaovalit
Barry J. Dempsey
Department of Civil Engineering
University of Illinois at Urbana-Champaign
Urbana, Illinois

October 1999

Illinois Transportation Research Center
Illinois Department of Transportation

ILLINOIS TRANSPORTATION RESEARCH CENTER

This research project was sponsored by the State of Illinois, acting by and through its Department of Transportation, according to the terms of the Memorandum of Understanding established with the Illinois Transportation Research Center. The Illinois Transportation Research Center is a joint Public-Private-University cooperative transportation research unit underwritten by the Illinois Department of Transportation. The purpose of the Center is the conduct of research in all modes of transportation to provide the knowledge and technology base to improve the capacity to meet the present and future mobility needs of individuals, industry and commerce of the State of Illinois.

Illinois Transportation Research Center Members

Bradley University
DePaul University
Eastern Illinois University
Illinois Department of Transportation
Illinois Institute of Technology
Lewis University
Northern Illinois University
Northwestern University
Southern Illinois University at Carbondale
Southern Illinois University at Edwardsville
University of Illinois at Chicago
University of Illinois at Urbana-Champaign
Western Illinois University

Reports may be obtained by writing to the administrative offices of the Illinois Transportation Research Center at 200 University Park, Edwardsville, IL 62025 [telephone (618) 650-2972], or you may contact the Engineer of Physical Research, Illinois Department of Transportation, at (217) 782-6732.

Technical Report Documentation Page

1. Report No. ITRC FR 95/96-6	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Development and Evaluation of VFR Lighted Flyways in the Chicago Class B Airspace		5. Report Date October 1999
		6. Performing Organization Code
		8. Performing Organization Report No.
7. Author(s) Pongnate Hongschaovalit and Barry J. Dempsey		
9. Performing Organization Name and Address University of Illinois at Urbana-Champaign, Department of Civil Engineering, 205 N. Mathews Avenue, Urbana, IL 61801		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. VC-A1, FY 95/96
12. Sponsoring Agency Name and Address Illinois Transportation Research Center, 200 University Park, Edwardsville, IL 62025		13. Type of Report and Period Covered Final Report April 1997 through March 1999
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The objective of this study was to develop a prototype to be used as a VFR flyway marker in the Chicago Class B airspace. By using visual markers as a reference, VFR aircraft may be persuaded from transitioning through controlled airspace. More importantly, by scanning outside more than at the onboard instrument, the pilot's probability to detect other aircraft, terrain, or obstructions would increase. In air-to-ground visual searches, size and color are the most important factors during daytime. With a 3-mile spacing, several testing schemes were developed to analyze the effect of size and colors on perceptibility. A commercially available structure manufactured by Sprung Instant Structure was determined to be the most economical. The recommended size is a ten-panel structure of 40-ft in diameter and 18-ft in height. The colors and marking pattern determined to be the most conspicuous and noticeable are the tangerine orange and yellow combination, with alternating solid colored pattern. Based upon laboratory testing, white lighting beacons capable of Morse code 'S' flashes should be used for nighttime. The intensity of the light should be 200,000-, 20,000- and 8,000- candelas at daytime, dusk, and nighttime, respectively. Following laboratory testing, flight evaluations were conducted at the University of Illinois and Schaumburg airports. The result of this study has indicated that the prototype could be implemented as a VFR flyway marker. Further investigation is necessary, however, to fully understand its capability as well as its impact on aviation around the Chicago area.

17. Key Words VFR Flyway, Aircraft Lighting, Aviation Markers	18. Distribution Statement No Restrictions. This document is available to the public through the National Technical Information Service (NTIS), Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	127	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

EXECUTIVE SUMMARY

Development and Evaluation of VFR Lighted Flyways in the Chicago Class B Airspace

Project VC-A1, FY 95/96

Report No. ITRC FR 95/96-6

Prepared by
Pongnte Hongschaovalit
Barry J. Dempsey

The amount of air traffic in the Chicago metropolitan area is expected to increase in the near future. In addition, the airspace in that region will be more complicated as a result of the proposed additional airport near Peotone. With the use of ground visual aids, a general aviation pilot can navigate around this area using contact flight navigation. Instead of depending solely on the electronic guidance equipment inside the cockpit, a pilot would increase the probability of noticing and avoiding other aircraft, terrain, or obstructions by using visual navigation with a ground reference marker. In addition general aviation pilots can operate within the vicinity without having to contact or interfere with air traffic control. Thus the number of aircraft requiring the supervision and guidance of the air traffic control can be reduced. The air traffic control can then concentrate on flights within their controlled airspace.

The purpose of this research was to develop a visual lighted flyway marker with superior performance to be implemented around the O'Hare Class B Airspace. Once installed, a thorough evaluation of its functional capabilities was completed. The general objectives of this study were to develop, fabricate, and evaluate a modified marker system that would function effectively and efficiently in a visual flight rule (VFR) flyway. The following specific research objectives were addressed:

1. Develop VFR lighted flyway marker – Design and fabricate a VFR lighted flyway marker of increase size, visibility, and durability, based on an earlier study. Consideration was given to increasing the visibility and conspicuity of the marker so that it is visible under a wide range of conditions at a distance of 6 nautical miles (NM).

2. Determine the optimal colors and pattern for the marker – Several color schemes, as well as design patterns, were tested to make the marker more noticeable during daytime flight observation. Small scale testing on color was conducted against various background settings under different illuminations experienced throughout the day. Seasonal variation experience throughout the year was considered.

3. Resolve the optimal flashing sequence for the marker beacon – Analyze the effectiveness of the modified flashing sequence of the beacon that was used in previous research studies. The light intensity and color were evaluated to determine marker performance within the background lighting of metropolitan areas.

4. Conduct flight observations of the modified marker at University of Illinois Advanced Transportation Research Engineering Laboratory (ATREL) facility in Rantoul—This evaluation indicates further needed improvements on the visual lighted flyway marker before testing in the Chicago Class B Airspace. In addition, guidelines and procedures for the evaluation of the marker in the Chicago metropolitan area were tested.

5. Evaluate the visual lighted flyway marker in the O'Hare Airport vicinity—A complete and thorough investigation was conducted in the O'Hare Airport Class B Airspace. Assessment of the performance and effectiveness was completed under various conditions, during both daytime and nighttime that are permissible for VFR operation. Factors such as physical parameters, city background colors and lights, daytime and nighttime visibility, and visibility under a variety of climatic conditions related to seasonal changes were evaluated.

6. Develop an optimal route for implementation of the visual lighted flyway marker—A guideline for selecting appropriate route, including site selection, for the installation of the markers was developed for the purpose of stationing the markers around the Class B Airspace. The proposed spacing of the marker is 3 statute miles.

7. Provide a recommendation on operational procedure and traffic pattern for aircraft navigating around the Chicago area via the visual lighted flyway marker route.

8. Prepare a final report to include conclusions and recommendations for implementation of VFR lighted flyway systems in the Chicago Class B Airspace.

The modified VFR lighted flyway marker was thoroughly observed for its conspicuity against various backgrounds. The design performs satisfactory throughout the initial testing at Rantoul Aviation Center and later at the Schaumburg Regional Airport. The 30-ft diameter Sprung Instant Structure was more conspicuous than the first VFR lighted flyway marker prototype. However a larger structure would be even more conspicuous. More importantly, the minimum number of alternating panels required is ten. Since the 30-ft diameter structure has only eight panels, it is not suitable for detection and recognition purposes. The recommended minimum size is 40-ft diameter. The tangerine orange and yellow colors proved to be more conspicuous than the FAA orange and white color combination for marking obstruction. The orange contrast well with light colored background while the yellow contrast quite efficiently with dark colored background. The beacon with the modified flashing sequence was salient from the background lighting of the Chicago area and can be used in the final design. However, the 8,000-candelas beacon was ineffective during daytime evaluation and the structure was more conspicuous. As the illumination condition deteriorates toward darkness, the effectiveness of the light gradually increased while that of the marker structure gradually decreased. Thus higher intensity 200,000-candelas may be used if daytime detection of the light is desired, as found in other studies. However, this intensity must be adjusted to 20,000 and 8,000 candelas for twilight and nighttime respectively to prevent the light from disturbing the residence nearby. It is suggested that the light, with the specially designed shielding device, be situated on a 30- to 45-ft pole. The pole would increase the visibility of the flashing beacon to pilots and increase the coverage area of the shielding device. With the flashing beacon situated at elevated position, the possibility that other tall objects will block the light from the pilot field of vision is reduced. Finally, the visual lighted flyway route was proposed, including cruise altitude and traffic flow pattern. This route was based on the location of the existing VFR flyways, the location of tall structures, and the elevation of the highest obstacle within the vicinity. The inner traffic has a lower cruising altitude due to the fact that it is closer to the stepping-down ceiling of the O'Hare Class B Airspace. The traffic pattern was established to ease the detection, as well as, for the marker to remain in the pilot line of sight as long as possible. More importantly, it was established to reduce the risk of collision between aircraft flying in opposite direction. Finally, it was recommended that water towers or similar large structures be used as the base component of the marker. Larger structures would constitute a more conspicuous object, increasing the pilot's opportunity for visual detection and identification of the marker.

It is concluded that a visual lighted flyway marker sized to be 40-ft diameter or greater and using tangerine orange and yellow colors would function very well in the Chicago area. A flashing beacon of 200,000-candelas in daytime and 8,000-candelas nighttime should be used. The flash sequence should be that of the Morse code "S."

It is recommended that implementation be initiated to further study the benefit of several visual lighted flyway marker in the vicinity of the Chicago Class B Airspace. It is believed that general aviation traffic will benefit from the increased safety and efficiency provided by a visual lighted flyway marker system.

FINAL REPORT

DEVELOPMENT AND EVALUATION OF VFR LIGHTED FLYWAYS IN THE CHICAGO CLASS B AIRSPACE

Project VC-A1, FY 97

Prepared by

Pongnate Hongschaovalit
Barry J. Dempsey

Conducted by the

Department of Civil Engineering
University of Illinois at Urbana-Champaign

Sponsored by

Illinois Transportation Research Center
200 University Park
Edwardsville, Illinois 62025

October 1999

Acknowledgments

This final report on the design and evaluation of the Modified VFR Lighted Flyway Marker (MVLF) for the Terminal Controlled Area (Class B Airspace), was prepared by the Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign. This research is an expansion of a previous study on the design and evaluation of VFR Lighted Flyway Marker (VLFM) in the rural environment (Class C airspace). Based on the results obtained from that study, modifications were needed to improve the marker's performance and durability. The project was sponsored by the Illinois Transportation Research Center (ITRC) with funding provided by the Illinois Department of Transportation (IDOT).

The Department of Civil Engineering is greatly in debt to Mr. Mark Clements, Administrator of the Schaumburg Regional Airport, and members of the Schaumburg Boards of Trustees for their generosity, particularly in lending a test site on the airport property during the marker's field evaluation. The Civil Engineering Department would also like to extend special thanks to IDOT Aeronautical representatives, Mr. James Bildilli, Chief Engineer, and Mr. Roger Finnell, Airspace Specialist, for their helpful comments and suggestion, including flight evaluations of the marker, throughout the conduct of this project. The department would like to thanks Professor Terry Harshbager for his valuable insight and flight time, which were crucial to the completion of this project.

Disclaimer

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data and comments presented herein. The contents do not necessarily reflect the official views or the policies of the Illinois Transportation Research Center. This report does not constitute a standard, specification, or regulation.

Table of Contents

Table of Contents(continue)

List of Figures

DEVELOPMENT AND EVALUATION OF VFR LIGHTED FLYWAYS IN THE CHICAGO CLASS B AIRSPACE

1.0 Introduction

The airspace surrounding major metropolitan airports is usually quite complicated, with unique dimensions and operation requirements. More significantly, as the number of aviation activities is expected to increase in the future, air traffic within this area can become congested. As a result, the task of sequencing and maintaining separation of aircraft will be more difficult and demanding for the air traffic controller (ATC). Precariously, these factors significantly increase the potential of mid air collision between aircraft. To alleviate aviation traffic within this vicinity, a significant number of general aviation (GA) aircraft may be persuaded from entering the controlled airspace. Such was the intention of the VFR Lighted Flyway Marker (VLFM) developed and studied in a previous report entitled "VFR lighted flyway marker for the TCA Environment" (Spiekermann and Dempsey 1994). Many GA pilots can circumnavigate around improved complex airspace by using a visual reference marker system. In addition, by scanning outside of the cockpit, the pilot can increase the chance of detecting and avoiding other aircraft, obstructions, and terrain hazards. Within a brief period of time, these markers will be recognized as pertinent landmarks to general aviation pilots, adding to their usefulness. From the reduced number of GA aircraft, the ATC can concentrate on commercial, cargo, and those flights that must fly within the controlled area.

The VLFM was designed to serve as a ground visual navigational system to aid general aviation (GA) pilots flying VFR. This is an operation procedure established by the Federal Aviation Administration (FAA), where the pilot is flying and navigating using visual contact with objects on the ground. The successful experimentation of this marker in Class C airspace justified its evaluation in the Terminal Controlled Area (TCA) or Class B Airspace. Some modifications were necessary, particularly on the size, color, and lighting in order for the marker to function effectively and efficiently within a major metropolitan area. Thus, a Modified VFR Lighted Flyway Marker (MVLF) was developed based on information from the research on the VLFM, additional literature reviews, scaled testing on colors, and results from field evaluation of the MVLF.

1.1 Background Information

Congestion of aviation traffic is a current problem for the Chicago metropolitan area's airspace. With two major airports located within the city area, Chicago O'Hare International Airport (O'Hare) and Chicago Midway (Midway), its airspace is one of the most elaborate in the country. Furthermore, the possibility of a third airport, South Suburban Airport (SSA), can only raise the complexity of the airspace (South Suburban Airport 1997). Initially, SSA is proposed to have a Class C airspace. This airspace will converge on O'Hare and Midway's current airspace, forming a narrow channel only three nautical miles wide for uncontrolled aviation activities (see Figure 1). After the year 2010, the SSA airspace may be enlarged to Class B designation should the number of activities meet that criteria. The upper portion of SSA airspace would adjoin that of the two other airports, resulting in a more confined corridor of uncontrolled airspace (see Figure 2). Ultimately, the additional airport will generate and attract more traffic to the already congested airspace. Literature in Appendix I discusses the projected number of future aviation activities, including the number of enplanements for the Chicago metropolitan area airports.

As mentioned previously, the amount of traffic in this vicinity may be too overwhelming for the ATC. The usage of advanced surveillance equipment, along with modern on board navigational instruments, allows the ATC to manage traffic within his domain. No matter how advanced and sophisticated the system may be, the efficiency of the operation still remains based upon human factors. Airports serving major cities generally handle traffic that is a combination of commercial airlines servicing the general public and GA operating privately charted flights. While commercial airline flights are under strict supervision of the ATC, most of GA operates according to VFR designation, an operation procedure established by the FAA. Depending upon the aircraft performance and flight characteristics, the ATC must provide guidance based on each aircraft's ability and requirements. Because the flight characteristics of commercial and GA aircraft vary tremendously, the ATC's task of directing and separating aircraft is relatively complicated. The expected increase in future aviation traffic further intensifies this responsibility. As often is the case, GA aircraft transitioning through the area are vectored out of its intended path or delayed for a long period of time by the ATC to make way for the commercial aircraft arriving or departing the airport. Being directed away from the intended flight path can increase a pilot's risk of fatigue and becoming lost, or an aircraft becoming short of fuel. With the aircraft short on fuel, a pilot has only one option and that is to find a suitable area to land. It is extremely difficult and almost impossible to find a suitable site within a major metropolitan area for an emergency landing.

To determine the location of the current position and the intended flight path, most GA pilots fly and navigate by relying on visual information that is obtained from two sources (Durso 1998). One source of visual information is the minimum standard set of instruments, with which most conventional aircraft are equipped. These instruments are the airspeed indicator, attitude indicator, altimeter, rate of turn indicator, heading display, and the vertical rate of change indicator. When used in conjunction with one another, the pilot can control the airplane in a stable manner. The other source is visual contact information that can be perceived by viewing outside the cockpit. Along with ground visual reference, the pilot's task of navigating is assisted by the use of an aviation map. The pilot confirms his position by checking the similarity of the terrain in the forward view and an inferred position on the map. If they are not similar, then the pilot is considered lost. This task can also be somewhat difficult at night or during bad weather. When using an aviation map, three significant mental transformations can occur in bringing the implied position on the map into consistency with the image from the forward view. The first is zooming which is taking a large, global-scale of the map into a constancy with the local forward view. The second involves lateral mental rotation, which is when the map is held in a North up orientation while the pilot is flying in a different direction. The third is called envision, or the ability to picture the three-dimensional terrain on a two-dimensional map. Although pertinent land features such as highways, railroad track, power lines, rivers, buildings, water towers, airports, etc. are illustrated on the map, it remains very difficult to determine the exact location of the aircraft's current position. This is especially true when the pilot is not familiar with the area or if the area is quite congested. It is quite difficult to distinguish between major highways. More importantly, pertinent landmarks become literally useless for navigational purpose during nighttime, unless they are well lighted. There are many recorded cases where pilots, flying in good weather with adequate visibility, have landed at the wrong airport.

It is difficult to completely describe the significance of navigation to a pilot. The concept of using ground visual markers can be traced back to the pioneering days in aviation when bonfires and marked airfields were used as navigation aids (Surgeoner 1942). Later, the bonfires were replaced by lighted beacon, which were commonly placed along desolate or mountainous routes. With considerable benefit to the aviation industry in general, a ground reference marker system can assist VFR pilots in navigating around a metropolitan area during daytime and, more so, during nighttime flights. Furthermore, when pilots are scanning outside more often than at the onboard instruments inside the cockpit, they increase their opportunity to detect other aircraft, obstructions, adverse weather, and terrain. Appendix II contains literature that discusses the imminent potential of mid air collision associated with GA aviation. Thus it would be relatively safer and more efficient for a GA pilot to use a VFR lighted flyway marker when transitioning through a Class B airspace.

1.2 Problem Statement

The amount of air traffic in the Chicago metropolitan area is expected to increase in the near future. In addition, the airspace in that region will be more complicated as a result of the proposed additional SSA near Peotone. With the use of ground visual aids, a GA pilot can navigate around this area using contact flight navigation. Instead of depending solely on the electronic guidance equipment inside the cockpit, a pilot would increase the probability of noticing and avoiding other aircraft, terrain, or obstructions by using visual navigation with a ground reference marker. In addition GA pilots can operate within the vicinity without having to contact or interfere with the ATC. Thus the number of aircraft requiring the supervision and guidance of the ATC can be reduced. The ATC can then concentrate on flights within their Class B controlled airspace. Considering these factors, along with the research objectives, the goal of this report is to expand upon the previous study entitled "VFR Lighted Flyways in the TCA Environment" and to evaluate an improved flyway marker in the Chicago Class B Airspace. It is proposed to utilize a much larger and more durable marker in this study. It is believe that a commercially available system can be modified to satisfy the VLFM structured component criteria. It is intended that the marker system developed in this study will lead to field implementation of a VFR flyway system in the Chicago Class B Airspace.

1.3 Research Objectives

The purpose of this research is to develop a MVLF with superior performance to be implemented around the O'Hare Class B Airspace. Once installed, a complete and thorough evaluation of its functional capabilities will be completed. The general objectives of this study were to develop, fabricate, and evaluate a modified marker system that would function effectively and efficiently in a VFR flyway. The specific research objectives can be divided into the following categories:

1. Develop VFR lighted flyway marker – Design and fabricate a VFR lighted flyway marker of increase size, visibility, and durability, based on the initial prototype previously developed and information obtained from additional literary research. Consideration will be given to increasing the visibility and conspicuity of the marker so that it is visible under a wide range of conditions at a distance of 6 nautical miles (NM). The material of the marker's structure will also be considered so it is constructed of more durable material.

2. Determine the optimal colors and pattern for the marker— Several color schemes, as well as design patterns, will be tested to make the marker more noticeable during daytime flight observation. Small scale testing on color will be conducted against various background settings under different illuminations experienced throughout the day. Seasonal variation experience throughout the year will also be considered.

3. Resolve the optimal flashing sequence for the marker beacon— Analyze the effectiveness of the modified flashing sequence of the beacon that was used in the previous study of the VLFM. The light intensity and color will also be evaluated to determine its performance within the background lighting of metropolitan areas.

4. Conduct flight observations of the modified marker at University of Illinois Advanced Transportation Research Engineering Laboratory (ATREL) facility in Rantoul—This evaluation will indicate further needed improvements on the MVLF before testing in the Chicago Class B Airspace. In addition, guidelines and procedures for the evaluation of the marker in the Chicago metropolitan area can be tested.

5. Evaluate the modified marker in the O'Hare Airport vicinity— Once the prototype is finalized, a complete and thorough investigation will be conducted in the O'Hare Airport Class B Airspace. Assessment of the performance and effectiveness will be completed under various conditions, during both daytime and nighttime that are permissible for VFR operation. Factors such as physical parameters, city background colors and lights, daytime and nighttime visibility, and visibility under a variety of climatic conditions related to seasonal changes will be taken into consideration.

6. Develop an optimal route for implementation of the MVLF— A guideline for selecting the appropriate route, including site selection, for the installation of the markers will be developed for the purpose of stationing the markers around the Class B Airspace. The proposed spacing of the marker is 3 statute miles.

7. Provide a recommendation on operational procedure and traffic pattern for aircraft navigating around the Chicago area via the MVLF route.

8. Prepare a final report to include conclusions and recommendations for implementation of VFR lighted flyway systems in the Chicago Class B Airspace.

2.0 Class B Airspace—Chicago O'Hare International Airport

Of primarily interest is the Class B airspace. While each Class B area is usually designated for a major terminal, it can also serve several airports in the same region (Ashford 1992). Each Class B airspace is individually designed to serve the needs of the particular airport that it surrounds. The usual characteristic of a Class B airspace is that it consists of circular rings that step down in diameter as it approaches the ground surface. The different levels of airspace are portrayed as a series of interconnected circular patterns, resembling an upside-down wedding cake, see Figure 3.

As illustrated in Figure 4, the Class B airspace of the O'Hare airport has a maximum ceiling of 10,000 ft MSL, and extends in a 25 NM radius from the airport. The lower ceiling level decreases "stepping down" as one moves towards the airport. From 15 to 25 NM, the lower ceiling is 3,600 ft MSL. It steps down to 3,000 ft within 10 to 15 NM, to 1,900 ft within 6 to 10 NM, and finally all the way down to the ground surface within a 6 NM radius of the airport. It is important to notice the abrupt change in the lower ceiling altitude, a 1,100-ft difference as one moves inward from the 15 to 10 NM perimeters. A slight deviation from the intended flight path and a pilot could wander into controlled airspace. This type of incident has occurred frequently due to pilot unfamiliarity with the terrain and/or accidental intrusion. There are approximately 40 airports that accommodate general aviation aircraft within 30 NM of the Chicago metropolitan area.

To operate within Class B airspace, an aircraft must be equipped with two-way radio communication capability and a transponder with Mode C operating characteristic (Jeppesen 1994). A transponder is an electronic device aboard an airplane that enhances the aircraft's identity on an ATC radar screen. A mode C transponder has the capability of indicating or encoding the airplane's altitude. This transponder is required within 30 NM of O'Hare, from the surface up to 10,000-ft mean sea level (MSL). It is required that each pilot in command of a civil aircraft must possess at least a private pilot certificate to fly within Class B airspace, or to take off or land at an airport within this airspace. Before an aircraft enters any part of a Class B airspace, communication must be established and permission granted by the ATC. Once the ATC has established radar contact and given a transponder code to the aircraft, the plane can then proceed according to the ATC instructions within the airspace. The ATC may direct an aircraft for landing sequence, make way for outbound aircraft, or change the flight path to maintain separation between aircraft.

There is a minimum safe altitude over the congested area of a city, town, or settlement or over any open-air assembly of persons (Jeppesen 1994). The FAA requires a pilot to fly at an altitude of 1,000 ft above the highest obstacles, within a horizontal radius of 2,000 ft of the aircraft. Outside of congested areas, the minimum safe altitude is 500 ft above the surface, except over water or sparsely populated area. In those cases the aircraft may not be closer than 500 ft to any person, vessel, vehicle, or structure.

3.0 VFR Lighted Flyway Marker (VLFM), the Champaign-Urbana Experiment

With a VFR flyway identification system general aviation aircraft may transition around Class B airspace without the supervision and authorization of the ATC. To facilitate the flight of VFR aircraft around or under Class B airspace, the VLFM was introduced in 1994. In this study, a prototype was developed and evaluated to determine whether it could function as a VFR flyway designator. In the previous ITRC report on VFR Lighted Flyway Marker, Spiekerman and Dempsey summarized the findings resulted from the experiment (Spiekerman and Dempsey 1994). Various considerations were given to the design of the structure including cost and effectiveness. From various figures and sizes, a pyramid with base dimensions of 10 ft by 10 ft, and 12.5 ft in height was chosen, see Figure 5. The colors of the marker tested were orange and green. The lighting was achieved using a heliport beacon capable of high and low intensity settings of 8,000 and 3,000 candelas, respectively. Appendix III contains the engineering data of the Flash Technology Corporation's Flashhead FH-301 heliport beacon. The field assessment was conducted within the Class C airspace at the University of Illinois's Willard Airport and Monticello Airport, a Class G airspace facility (with a 700' AGL Class E transition). During the daytime evaluation, the marker was detected at an average distance of 2 to 3 NM. The greatest distance observed was 4.5 NM at an altitude of 1500-ft AGL. In order to increase the spacing distance from 1.0-1.5 NM to 3.0-6.0 NM, Spiekerman and Dempsey (1994) recommend enlarging the marker to two or three times its current size. The structure size was not limited by only financial constraints, but also by the land space available. From the evaluation of the lighting system, the experiment has indicated that the flashing beacon system was very effective, in terms of both the intensity and frequency of the light. However, the sequence was considered inappropriate due to a similar flashing pattern designated for heliports. Furthermore, the intensity of the light must be reengineered for different illumination conditions. The light was observable within 2 to 3 NM on a clear day with good visibility. The recommended spacing as concluded in this paper was 3 NM. As for the color of the marker, bright orange was suggested. The large orange and white checkerboard ground mat was very difficult to detect. It can be seen only from a nearby distance and at low altitude, thus it may be omitted from the second prototype. Another reason the ground mat may be omitted is the fact that it can become covered with dirt, leaves, and inevitably, snow. Spiekerman and Dempsey (1994) also suggested using reflective material with the checkerboard mesh design for the marker.

4.0 Modified VFR Lighted Flyway Marker (MVLF)

4.1 Introduction

A goal of this research was to determined if an economical and reliable structure was available which could be used as an MVLF for the purpose of providing a ground navigational aid within the Chicago Class B Airspace. Literature reviews, including the study of the VLFM, provided much of the information concerning the size and color of the marker. A problem encountered in that study was the difficulty in detecting the marker during the daytime. In the daytime, the size of the marker primarily determines the ease of detection and identification. Thus improvements were made upon the size of the marker. A structure was chosen from several that are commercially available from various manufacturers. The selection was based upon its size, shape, functionality, construction and maintenance requirement, and cost. Other areas taken into consideration include colors and patterns of the structure. A color-testing scheme was derived and tested at the ATREL facility to determine the best color combination for the MVLF marker. In twilight or nighttime conditions, detecting the marker is easily accomplished due to the flashing beacon. However, the light's flashing sequence must be reengineered in order for it to be unique within the aviation industry and distinguishable from the background lighting of the Chicago metropolitan area. Other research also provided useful information on nighttime light intensity and unique flashing sequence. The MVLF marker was installed and field-tested at the Rantoul Aviation Center and later at the Schaumburg Regional Airport located 9 miles west of the O'Hare airport (see Figure 6).

4.2 Marking for Daytime and Lighting for Nighttime Detection

In order to function effectively and efficiently, a MVLF marker must be conspicuous from the metropolitan background, when viewed from the air. Conspicuity is the probability that an object will be noticed (Laxar 1993). The conspicuity of an object depends on several variables such as its size, shape, luminance, contrast, flashing sequence, color, its spatial characteristics, and its environment. It was suggested that the MVLF system could function using only the flashing beacon, omitting the structure. However research has shown that daytime detection is primarily a function of size (Castle 1985). The flashing beacon, even with high intensity candelas, is not as conspicuous as the markings of a structure. Castle (1985) demonstrated this in his study on several obstruction beacons for the FAA in 1984. The objective was to determine if these lights could be as effective as, or better than, the paint marking on tall structures. Paint often deteriorated and towers needed repainting within 3 to 5 years, so lighting would be more economical. Studies prior to Castle's research had suggested 200,000 effective candelas and 40 flashes per minute (fpm) as the intensity and revolution settings for obstruction lighting beacons. For twilight and nighttime, the intensity settings had to be reduced to 20,000 and 4,000 candelas, respectively, to avoid complaints from people on the ground. Other references had specified that a painted tower should be seen at ranges of 0.6-, 1.2-, 1.8-, and 3.0-SM in meteorological visibility of 1.0-, 2.0-, 3.0-, and 5.0-SM, accordingly. In addition, the 20,000 effective-candelas strobe should be seen at ranges of 1.0-, 1.5-, 1.8-, and 2.3-SM under the same meteorological visibility conditions. The end results are the light should be more effective at a lower visibility and the paint marking should be more effective at a higher visibility.

Findings from Castle's research verified these theories through numerous flight observations. Approximately 450 flight tests were flown to determine if the strobe lighting systems could be used to identify short skeletal towers of 500 ft or less during daytime flight. Pilots were asked to determine which features, the strobes, the paint marking, or the tower structure, were detected first. When looking in the direction of the sun's glare, strobe lighting was more effective than the tower's paint marking at distances of less than 1 mile. Between 1 and 2 miles, strobe lighting and paint marking were equally effective. Paint marking, however, was more effective from a distance greater than 2 miles away from the tower. The recommended intensity for lighting of such a tower is 20,000 candelas in daytime. For nighttime conditions, a 2,000 candelas effective strobe was comparable with the standard 1,500 candelas red strobes. Thus marking and lighting are necessary for daytime and nighttime detection, respectively.

4.3.1 MVLF Components for Daytime and Nighttime Detection

The discussion on the MVLF is divided into two parts, based on it components. The first involve the structured component of the marker, which is responsible for daytime detection. The topics includes the actual building size chosen for the project, determining the color combination, the material used for acquiring the colors, and concluded with the determination of the pattern for the MVLF marker. The second part relates to the light component of the marker, which will be discussed later in this report.

4.3.1a MVLF Marker Structure

For daytime detection, it was discovered from other research that a difference in the size of a target and its background increased conspicuity more than a difference in luminance (Laxar 1993). In addition, an increase in size variability of the background decreases conspicuity, and a high-density background reduces conspicuity of small targets more than large ones. Theoretical studies have also shown that a circular area provided the most efficient shape for identifying an object of a given area (International Civil Aviation Organization 1980). The marker's structure should have close resemblance to a spherical shape. A water tower would thus be an ideal candidate as a marker structure.

The most important factor that determines an object's conspicuity is size. One of the objectives for this study was to determine a size for the MVLF structure. According to the International Civil Aeronautical Organization's Visual Aids Panel, the smallest an object could be and still be visible when viewed from head on was an object that bounded a viewing angle of 1 minute. For example, a viewing distance of 3,281 feet would require a marker area of 0.72-feet square (ft^2), under good visibility conditions. Using the same correlation, a marker with an area of 17 ft^2 would bound a viewing angle of 1 minute at 3 SM viewing distance. However, a pilot may not be looking directly at the object, thus the marker's area required must be increased. As the object may be outside the central viewing area, the Visual Aids Panel has suggested an object angle viewing of 5 degrees. For the 3 SM viewing distance, this corresponds to an object with area of 224-ft^2 (see Appendix IV for calculation). The 3 SM viewing distance was used in the calculation because it is the intended spacing distance between the MVLF markers. The spacing was based on the 3 SM minimum visibility requirement to operate under VFR designation at night. It is more difficult to determine whether the current visibility has deteriorated below that of the minimum required during nighttime condition. Thus a VFR pilot can determine the current visibility by referring to two MVLF markers.

With all of the above factors taken into consideration, including durability and cost, a commercially available lightweight frame system was chosen for the base component of the VFR flyway marker. The structure dimensions are 30-ft diameter by 15-ft high. It is similar to a rounded pyramid, and is circular when viewed from above. This frame system is manufactured by Sprung Instant Structures (See Appendix V for manufacturer's information). The frame is constructed of extruded aluminum arches, integrally connected to an all-weather outer membrane of PVC-coated polyester scrim, a certified flame-retardant material. The fabric is treated with ultraviolet ray inhibitor to delay damage from harmful rays of the sun. The structure itself is relatively easy to erect, and requires little or no maintenance. A crew consisting of a technician from Sprung Instant Structure and 3 unskilled labor workers can erect the 30-ft diameter structure in 8 hours. The same crew, without the assistance of the technician, can dismantle the structure quite easily in 4 hours for relocating purposes. The building does not require surface preparation or foundation support. Due to it modular design the structure can be enlarged easily by attaching additional components. This will be beneficial in making the marker more visible from at least 3 statute miles (SM), the nighttime minimum visibility for VFR operation. Furthermore the structure was designed to shed snow and withstand hail and high winds, up to 155 miles per hour. Although serving as a VFR marker, this frame system can be used as a storage facility. The structure used in this study is illustrated in Figure 7. Its panels are colored with orange and white color combination, the first pair of colors tested for conspicuity. This was the pair recommended by the FAA for marking of tall structures. From the side, the structure projects an area of approximately 345-ft^2, which is greater than the 224-ft^2 minimum, as determined from the Visual Aid Panel's guideline.

Because most pilots preferred to fly in a constant heading or direction, the lighted flyway route will consist of several segments. To indicate a change in course direction a special unit of the marker must be used, see Figure 8 for illustration. The unit contains two separate structures, one parallel to each segment. The recommended dimension for each structure is 120 ft by 40 ft by 18 ft in length, width, and height, respectively.

4.3.1b MVLF Marker Colors

It was expected that fluorescence colors would provide the most conspicuous colors for any objects. However, literary review has shown that these paints are in the same class as white and light colored paint, and should not be used in cases where extreme contrast is needed (Applied Psychology Corporation 1963). Nevertheless, these colors were evaluated due to their high apparent reflectance, which is two to four times that of non-fluorescent paints of similar colors. The results verified the finding from the literature research. From a distance, light colors blend together and appear as white in color, as confirmed by studies on fluorescence colors.

Other standards and researches have contributed relevant information on the coloring of the MVLF. The FAA's advisory circular on obstruction marking and lighting (AC 70/7460-1H) describes the standards for marking and lighting of tall structures to promote aviation safety (Federal Aviation Administration 1991). By marking a structure it should be conspicuous to pilots during daylight hours. The FAA recommends painting a structure with alternate sections of aviation orange and aviation white to provide maximum visibility. Results obtained in other research were also taken into consideration. According to a 1952 study by the Navy Department, it was discovered that black numeral/orange backing was the best combination in terms of recognition distance for runway signs. As for taxiway marking and signs, yellow stripes and yellow letters/black background proved to be the most favorable. One year earlier, Malone, Sexton and Farnworth (1951) conducted a study concerning the conspicuity of color objects. They determined an effective color for life saving rescue equipment at sea by performing small-scale color testing. They studied the effectiveness of yellow as compared with a graduated series of yellow-reds and reds. Their objective was to determine the detectability of these colors for use in an air-sea rescue. Test color samples, ¼-in in diameter, were mounted on blue-gray boards, to simulate the color of the sea under various weather conditions. The samples were placed in outdoor sunlight, and observations were made at distances of 50- to 130-ft. From this study, orange-reds were found to be the most visible for life saving equipment.

Using a similar method and procedure, several small-scale color tests were performed to determine the most conspicuous color combination for the MVLF. Unlike the Malone, Sexton, and Farnsworth study however, the objective of this experimentation was to determine the detectability of various colors for air-ground navigation. It is known that color could not be perceptible at large distances. When viewed from afar, most colors would lose their vividness and appear as either white or dark color, depending on their hue. A pilot should be able to search for the same color or colors regardless of the distance away from the marker. Thus it was intended to determine the color combination that would be perceptible, as well as conspicuous, from the longest distance. To achieve the greatest recognition range, it was necessary to maximize the contrast between the marker and its background. As the marker would have to be viewed against both light and dark backgrounds, the marking should be compose of two colors. Thus, a small-scaled color test was conducted to determine the perceptibility of several color combinations. This also included determining the furthest distance that they can be perceived. Large scale color testing would increase cost and delay the project time. It was determined that two colors must also contrast one another in order for the colors to be distinguishable. Several color combinations were evaluated in this study based on the results from previous research on colors and color contrast. Colors including red, orange, green, blue, purple in combination with yellow and white were tested. Of the choices available, white was a poor candidate because the snow-covered ground surface would obscure the marker during the winter months. In addition, white colored buildings are the most prominent color observed when flying into a city area. Choosing any color resembling green would also be unwise. Object having this color can easily blend in with the greenery of farming areas, grass fields, and forest preserves. Colors ranging from blue to purple in the visible light spectrum are associated with dark color and would not be salient from dark colored background, particular at low lighting condition. The best choices for the marker's colors are red, orange, and yellow colors. They are typical color use on signs to grab our attention. Red is considered to be the most striking color. It grabs ones attention and actually speeds up the body's metabolism. Orange is also used to attract attention. It can give a bright, splashy, and aggressive sensation. Along with red and orange, yellow is also one of the most noticeable colors. Yellow contrasts well with the predominantly dark background and especially with the green coloring of trees and grass. Because the marker must contrast with dark colored background, yellow was chosen as one of the colors to be use on the MVLF. The other color of the marker must contrast with light colored background thus the best color to accommodate the yellow would be either the red or orange color. Although the complimentary color of yellow was purple, it was not suitable due to reason stated earlier. And because there are various saturation of red, orange, and yellow colors available, it must be determined specifically, which two are the optimal combination. Using a scale of 1 in. equal to 10 ft, several 3-in. circular disks were constructed with different color combinations. The small colored disks were placed on the ground with different backgrounds such as green grass, white snow, black asphalt, and light colored concrete pavement. Observations were made from various distances to see the perceptibility of the color combinations. Ten observers were asked to make subjective judgment on the color combination that is most visible and most conspicuous. Observations were made from three directions relative to the sun's position including having the sun behind the observers, behind the sample, and to the side of the both the observers and the color sample. Figure 9 illustrates some of the small-scaled samples used for the color combination testing. The results from the test where the sun was behind the observed and to the side are relatively similar and are given in the Table 1.

The appearance remains relatively the same when viewed with the sun positioned behind the color samples. The only difference was that the color yellow appears as white even at a relatively short viewing distance. The other colors accompanying the yellow were visible; however, the distance that they can be seen was significantly reduced. Another reason that the color red was not recommended was the fact that red and green color blindness is the most common form of color vision abnormality. Even though pilots are required to pass certain vision examinations, those with color deficiency are allowed to fly with a daytime-flight-only restriction (Federal Aviation Regulation 1997). Consideration for GA pilots with color deficiency was thus made when choosing the MVLF marker's colors. Therefore, the most visible and distinguishable color combination was the regular yellow and tangerine orange color combination. Figure 10 shows the MVLF marker with the color combination chosen for maximum visibility and conspicuity. It should be noted that exposure to environmental conditions might cause the color to deteriorate due to oxidation or layers of contamination. Periodic maintenance may be required to remove contamination such as layers of dirt, bird droppings, and insects. Simple cleaning tools may be used; that is, a mop attached to an extendable pole to reach the top of the structure and a bucket of water. It is recommended that the structure be scrubbed at least once a year. To determine when the deterioration has exceeded the acceptable limits, a tolerance chart should be used (Federal Aviation Administration 1991).

4.3.1c Vinyl Film Adhesive

In the attempt to experiment with different color combinations, it was discovered that the commonly available paint material does not bond to the vinyl fabric of the structure, especially when the surface is constantly flexing due to wind gusts. Thus, a different kind of material was used to create various color schemes for conspicuity of the marker. Vinyl film adhesive normally used in the sign graphic industry for the design of signs, banners, and decals was discovered to be the best material. Furthermore, it offers a large variety of colors to choose from, and offers more colors than are available on the vinyl fabric membrane. The use of both accelerated and real life testing ensured colorfastness, dimensional stability, and adherence to the surface. More importantly, the durability of the coloring of the vinyl film is much longer than that of the vinyl fabric. The vinyl film can withstand extreme outdoor applications for as long as seven years, compared to the five years for the vinyl fabric, based on the length of the material's manufacturer warranty. The most important advantage of the vinyl film adhesive over the vinyl fabric is the surface texture. The surface texture of the material can affect perceived differences in visual contrast (Bentzen 1994). Smooth textures tend to reflect light directly, while rough textures tend to scatter light. The surface of the fabric is rough and does not reflect light as much as the smooth, glossy finished of the vinyl film adhesive. The cost of covering the entire structure with vinyl films is also less than purchasing colored vinyl fabric panels. To cover a 30-ft diameter structure it would cost $3,000 for new color fabrics, whereas it would cost only $1,200 for vinyl films adhesive. Normally when purchasing a new structure, it would cost an additional $900 for colored fabric. Thus one implementation could be to purchase the colored fabric for the structure, and cover the structure with vinyl film adhesive five years later. The best alternative would be to purchase a structure with white fabrics, cover the panels with vinyl films adhesive, and then erect the structure. Applying this vinyl tape requires little effort, simply peel, stick, and squeeze out any trapped air. It was extremely difficulty to remove the material once it has fully bonded to the fabric. Appendix VI contains the color and product catalog of two vinyl film adhesive manufactures, Arlon and Universal Products Inc, respectively.

4.3.1d MVLF Marker Marking Pattern

In advisory circular AC 70/7460-1H(1991), the FAA recommends various types of patterns for marking structures that qualify as obstructions in aviation airspace, depending on the size and shape of the objects. Objects with both horizontal and vertical dimensions not exceeding 10.5-ft should be colored in solid aviation orange. Checkered pattern with alternating rectangles of aviation orange and white are used on structures larger than 10.5 ft across and that have a horizontal dimension greater or equal to the vertical dimension. The size of the rectangles should not be less than 5-ft or more than

20-ft, corresponding to 25 ft^2 and 400 ft^2 area for each box on the checkered design pattern. Figures 11 and 12 illustrate the marking pattern for water towers, storage tanks, or similar structures. For a 30-ft diameter Sprung Instant Structure, the are of each panels is approximately 190 ft^2. Because this value is near the middle of the FAA's specified range, each MVLF panel should be solid in color. Unlike larger structures such as a water tower or a grain elevator, there is not enough surface area for a checkered pattern. The selection of the solid color panel design was also confirmed by simulated computer graphics. The appearance of the marker with solid paneling, along with 2- and 3-layered checkered pattern designs were evaluated using a computer drawing, see Figure 13. This figure contains images of the marker at 1.3-, 2.0-, 3.3- and 5.1-SM if the figure is viewed from 20 ft away. As the distance increases from 1.3- to 5.1-SM miles, the structure decreases in size, and the marking become smaller. Although the 3-layered pattern may be more conspicuous at 1.3 SM, the pattern was the most difficult to perceive at 5.1 SM. The solid colored pattern remains perceptible for the furthest distances. Above all, checkered pattern should not be use because a pilot may associate the structure as an obstruction, not as a MVLF marker.

One other design criteria for the MVLF marker are the number of panels. For the 30-ft dia structure, there were eight panels, i.e. four tangerine orange alternating with four yellow panels. From a specific direction, the maximum number of panels that can be observed is three. This is illustrated in Figures 14 and 15. In Figure 14, it can be observed that there are two orange panels separated by a single yellow panel. This could obscure the marker if viewed against a dark colored background, as only one yellow panel would contrast with it. In the second figure, there is one tangerine orange panel between the two yellow membranes. Against a light colored background, detecting the marker can be difficult. Only one orange panel is providing the contrast needed for the marker's detection. Furthermore, the pilot should be able to scan the horizon for the same number of color combinations, that is two tangerine oranges and two yellows. A 40-ft dia. Sprung Instant Structure has ten panels and, from a given direction, the maximum number of panels that can be observed is four. Figures 16 and 17 illustrate a scaled drawing of both 30- and 40- ft diameter structures and the pilot's viewing perspective from a particular direction, at far distance. The numbers of panels for the structures are 8 and 10 for Figures 16 and 17, respectively. For both structures with eight panels, the observer sees three panels. For the ten panel structures, four panels are observed. Thus it can be concluded that the number of panels is dependent of the number of total panels and the structure size. Since the 30-ft dia structure has a maximum of 8 panels, the 40-ft dia structure with 10 panels should be the minimum size structure used as the MVLF marker.

4.3.2 Nighttime Detection of MVLF Marker

Nighttime detection is a function of the lighting characteristics of an object. The following sections discuss the flashing beacon component of the MVLF marker. It is the beacon that will attract and notify VFR pilot the position of the marker at night. First, findings from various researches on light flashing characteristics are summarized. A discussion on the light intensity including the current FAA specification on obstruction lighting intensity and the expected visibility in particular meteorological conditions is also presented in this section.

4.3.2a Flash Technology Beacon

There are several studies about obstruction lighting that yield pertinent information for the flashing characteristic of the MVLF beacon. One study included the Applied Psychology Corporation (APC) (1963) evaluation of obstruction lighting flash rate. In 1962, the APC conducted a comprehensive study of the conspicuity of tall radio and television towers for the FAA. In reference to flashing lights for towers, the study concluded that no significant conspicuity advantage could be obtained from a flash rate in the range of 30 to 120 fpm. Subjectively, pilots preferred flash frequencies of from 80 to 90 flash rates. Another research deserving some discussion is that by the National Aviation Facilities Experimental Center (NAFEC) (1969). In a 1969 final report, the NAFEC discussed parameters and preferred operational characteristics of obstruction lighting systems for tall-tower. The purpose of this study was to obtain the operational parameters that would identify an obstruction for a pilot with at least 3 miles separation during 3-statute miles meteorological visibility conditions. The light beams were set to rotate at 20-, 40-, 60- and 80-revolution per minute. The flash rate was chosen based on the preference of the pilot subjected to various flash rates. As a result, 20 fpm or slower were too slow because the pilot would lose tower position between flashes. Faster than 80 fpm has too short of a flash duration and a loss of belonging occurred. The two rates most chosen were the 40- and 80-fpm. However, the 40-fpm had 160 percent more effective intensity and thus was selected as optimum.

According to the literary review, a flash rate of 80 fpm seemed to be the optimal setting for a MVLF beacon. For the field evaluation, the beacon from the previous study on lighted VFR flyway marker will be used. The greatest improvement on this beacon is the modification of its flashing sequence. The beacon, with some rewiring of its circuit board, is capable of flashing at different rates. It can be program to flash 90 times per minute. The original flashing signal was four quick pulses, representative of Morse code signals for an "H," at 120 fpm. Although this signaling was quite easily detected and identified, it was designated for heliports and thus was no longer unique. A misidentification can lead to a dangerous situation for helicopter pilots who may mistakenly identify the marker as a landing pad. Thus, the flashing sequence was modified to give a unique sequence. For the flight observation purpose, a three quick pulse signal, representative of a Morse code letter "S" will be used. It was determined that this sequence can be easily distinguish from general obstruction lighting and heliport lighting. The total number of flashes per minute for this study is 90 fpm. Another improvement on the beacon will be to install a light-sensitive photocell sensor unit. This lighting detection device can determine the condition of the surrounding environment thus enabling the control of the beacon to be fully automated. The sensor can distinguish among the three lighting conditions, namely day, night and twilight conditions. Additional light, such as a strobe light similar to the ones used on emergency vehicles, can be installed to project directly upward. This light can serve as an additional identification light. In addition to the flashing beacon, another test was conducted to determine whether illuminating the marker from the interior would be beneficial in nighttime detection and identification of the MVLF. However, results from the flight evaluation have indicated that this method was not beneficial in making the marker more conspicuous at night. The marker can only be observed from well within a distance of less than 1 SM. It also required many lighting units, which consumed a significant amount of electrical power.

As far as informing to the pilot the change in direction of the lighted flyway route, three lighting beacons, capable of being programmed to flash simultaneously, should be used. The beacons should be positioned so that the pilot may determine the new heading from his current direction. As learned from a report on lead-in runway lighting systems by Paprocki (1997), the recommended spacing for the lighting beacon is 120 ft, same as the suggested length for the marker structures at this particular location.

4.3.2b MVLF Flashing Beacon Color

Several colors were considered for the MVLF flashing beacon. Although red was the most striking color, it should not be use because it is associated with obstruction lighting. Pilots are accustomed to the fact that red represents danger and it would not be useful for the MVLF to flash in red color. Other colors including orange and yellow were tested; however, they could not compete with the background lighting. Both lights would blend with the background lighting that appears as 'amber' in terms of color. Green colored light was also considered, but the fact that a pilot may mistakenly identify a marker as an airport in an emergency situation disqualifies this color. The other color that may be suitable for the MVLF flashing beacon was blue. Several blue transparency films were used to line the interior of the beacon's cover. The transparency filtered the white light and it would appear as flashing blue lights, similar to taxiway light color. The blue light was very apparent from close distance during nighttime. However, during the daytime its visibility was limited to less than 1 mile. More significantly, nighttime flight observations in the Chicago area have indicated that the blue light blends with the surroundings and appears white with background lighting. Thus it was decided to use white light, which can be observed from the furthest distance, for the MVLF beacon. Only the flashing characteristic and intensity of the beacon would be available to attracts and notify the pilots of MVLF marker positions.

4.3.2c MVLF Flashing Beacon Intensity

The results obtained from research conducted by the Applied Psychology Corporation (1963) and the National Aviation Facilities Experimental Center (1969) yielded useful information on lighting intensity. This information is use to design the MVLF beacon intensity. Although both obstruction and MVLF lighting must be easily detected, obstruction lighting must convey warning and avoidance, while the MVLF must serve for guidance and compliance. In its recommendation, the APC suggested that towers be equipped with at least three white lights of 100,000- to 200,000-candles. In the NAFEC's final report, the recommended intensity settings for obstruction lighting was determined to be 10 percent of maximum (200,000 candelas) at night, 50 percent during daytime, and 100 percent candelas during poor visibility. When flight approaches were made with the sun behind the tower, particularly when the sun was near the horizon, the obstruction light system could not be detect from 3 miles, even at full intensity. However, the tower markings were visible, although the report did not specify the color combination used. Another important standard is the FAA advisory circular AC 70/7460-1H that contains standards on lighting of tall structures. Appendix II of the advisory circular contains the rationale for obstruction light intensities, which is based on the aircraft airspeed, minimum safe altitude, and basic VFR weather operating minimums. The distance under which various intensities can be seen under meteorological visibility of one and three statute miles are shown in Table 2.

Meteorological visibility is referred to as the greatest distance that visibility markers or light of 25 candelas can be seen and identified under specified conditions of observation. This term is expressed in statute miles. A pilot operating an aircraft at 165 knots (190 mph) or less should be able to see obstruction lights in an ample amount of time to avoid the structure by at least 2,000 ft horizontally under all condition of operations. Another FAA specification on obstruction lighting equipment is AC 150/5345-43C. Three types of equipment are covered including high intensity flashing white lights (L-856), medium intensity flashing red or white lights (L-866), and red steady-burning lights (L-810). Obstruction lighting is divided into four systems, each requiring different equipment and intensity settings. System A requires L-856, high intensity obstruction lighting for day and night identification of chimneys, poles, towers, and similar structures. System B also uses the L-856 but for day and night marking of power line supporting structures (the L-866 may be used for catenaries). System C uses L-810 and L-866 red obstruction lighting systems. System D is applicable where a dual obstruction lighting system is required. For the D system, System A or System B is used for day and twilight operations and System C is incorporated for nighttime operation. Tables 3 to 6 show the required intensities of the light units for each system.

The flash rate of each system is different. The lights for System A should flash simultaneously at 40 fpm. For System B, the flash sequence is similar to the International Civil Aviation Organization's recommendation, i.e., the middle light should flash first, followed by the top, and then the bottom light with the total flash cycle of 60 fpm for each light. Finally, if a flashing light is used in System C, then its flash rate should be in the range of 20 to 40 fpm. The flash duration should not be less than 1/2 nor more than 2/3 of the flash period.

The beacon used in the evaluation of the MVLF in the Chicago Class B Airspace environment is capable of 8,000 and 3,000 candela settings. Because the beacon was mounted on top of the marker structure, it was mounted at a relatively low position from the ground. As a result, lighting intensity higher than 8000 candelas would cause a disturbance to the surrounding community. Thus only 8,000 and 3,000 candelas were tested for the evaluation of the MVLF marker.

4.3.2d MVLF Flashing Beacon Shield Design

To distinguish the flashing sequence from the background lights of the metropolitan area, a relatively bright light with quick flashing sequence was used. Although there is not sufficient data on the disturbance of this particular lighting beacon, it is believed that the flashes can be an annoyance to the general public. As was noted in FAA advisory circular, AC 70/7460-1H, that higher light intensity than 2,000 candelas at night with 3 SM of visibility could generate a residential annoyance factor. Castle (1985) also reported that lighting intensity was reduced to 4000 candelas to avoid complaint from people on the ground. This can be detrimental to the implementation of the marker within the Chicago metropolitan area. Thus a shielding device was designed and tested to see whether it could shield the light from the ground level. Figures 18 and 19 illustrate the design and assembly of the shielding device for the MVLF beacon. The top of the shield is slightly lower than the middle portion of the beacon itself. This is because the middle of the fresnel lens magnifies the lights, enabling it to be visible from greater distance. The shield was designed so that an additional segment can be fitted onto it to block the light in the case where there is a tall building existing near the site of a marker. The added section will only be used if the flashing beacon causes a problem for occupants of tall buildings nearby.

5.0 Flight Evaluation of the Modified VFR Lighted Flyway Marker

For the flight evaluation of the MVLF marker, pilot characteristics and capabilities were taken as a design constant. It is important to take into consideration the fact that a pilot's visual threshold value involved meteorological, photometry, and psychophysical relationships (Applied Psychology Corporation 1963). Depending upon conditions both inside and outside of the cockpit, individual pilots would respond differently to the same stimulus. For example, color perception, eye fatigue, eye adaptation, search time, cockpit illumination, and cockpit management are some of the internal conditions. During daytime flight, the external factors influencing the detection of an object is a function of several variables including the reflectance of the structure, the meteorological conditions, the position of the sun, the direction of observation, and how well light travels through the atmosphere and the background. For flight evaluation conducted during nighttime, external factors include the target light luminous intensity, light flux attenuation through the atmosphere, and the difference in brightness of the light versus the background.

Because each season creates unique background conditions, it was necessary to conduct flight observations for all different scenarios. The test was divided into four major phases: spring, summer, fall, and wintertime testing. The first test cycle was completed in July and August during the summer of 1997. The marker's test site was the University of Illinois's Advanced Transportation Research and Engineering Laboratory (ATREL) located in Rantoul. This facility is located near the Rantoul airport, a Class G (with an overlaying 700' AGL Class E transition) environment. Various colors and patterns, as well as different lighting characteristics were tested at this location prior to the relocation of the marker to the Chicago area test site. Although the area is not as congested as the city of Chicago, many useful results were obtained from flight observation conducted over the marker at this test site. The marker was situated on a particularly vacant area, with asphalt pavement as the foundation. There are no tall objects near the marker and thus it can be viewed from all directions. During the summer months, the full blossoming of the natural surrounding influences the primary background color and its effect on the marker conspicuity was studied. ATREL was also the test site for the fall and winter testing cycles as well. Due to limited funding, input from the University of Illinois aeronautical students was also taken. Flight instructors, along with their students, commented on the visibility of the marker as they conducted flight exercises over the Rantoul airfield. Their comments were also taken into consideration when designing the MVLF. In the fall, flight tests occurred during the months of October and November. The changing of color and falling of leaves can created a yellow and orange background, the same colors use on the marker. Therefore, it was important to determine if the marker would be salient in this background. Next, snowfall during the winter months blanketed the terrain with white color creating a unique background scenario. It was necessary to see if the marker was noticeable in this background, more importantly, whether the marker can shed snow, as claimed by the manufacturer. Finally, the complete flight observation of the marker was concluded at the Schaumburg Regional Airport, see Figure 6. As soon as the Schaumburg Regional Airport Board of Trustees gave their permission the structure was quickly dismantled and relocated from ATREL to Schaumburg. The airport serves GA aircraft and is located approximately nine miles west of the O'Hare Airport. Class E/G airspace exists in the vicinity of the airport from the surface to 1900'MSL. O'Hare's Class B Airspace is above this and extends from 1900' MSL to 10,000' MSL. In addition, this facility is surrounded by a very populated area and is occupied by one of the largest residential and central business districts among the suburbs of Chicago. The environment of this location was ideal for the Class B airspace environment assessment of the MVLF. Final testing and evaluation was initiated as soon as the marker was erected in March. Flight evaluation continued for the next two months, including flight observations by representatives from the IDOT Aeronautical Division. For this test cycle, the ground was predominantly grayish black and light brown. It was the transitioning period when the winter snow had melted, leaving the ground surface bare and without the green coloring of the trees and grass. Appendix VII contains the sample pilot evaluation forms for the MVLF flight observations.

For the MVLF flight observation, the altitude chosen was 1,800 ft MSL, the highest possible without protruding into the lower 1,900 ft ceiling of O'Hare Class B Airspace. The 1,800 ft altitude is also much closer to the actual altitude flown by GA pilots when transitioning through the area. One pilot and an observer conducted the official flight tests. For the flight observation, there were three test-flights during different periods of the day to account for various illumination effects. Each test-flight consisted of two flights during the daytime and once during nighttime. Daytime flight observation must account for the position of the sun, which may interfere with the visibility of an object, as discussed in Castle's 1985 report to the FAA. Thus, one segment of the daytime flight was conducted during the mid-day period when the sun is roughly on top of the structure. The other was during the late afternoon, when the sun is nearer to the horizon, where both occupants had to deal with the glare of the sun from the west. This was perhaps the most demanding test because it is difficult to see and avoid other aircraft or obstructions. The flight approach for the late afternoon/early evening test was from three different directions. The first was flying toward the marker with the sun positioned behind the airplane, flying at a heading due east. The second was flying toward the marker with the sun either to the left or the right side of an imaginary line between the airplane and the marker, or at a heading of north or south. The last leg of the test was to fly toward the marker with the sun positioned behind the marker to see if the marker can be detected and identified while the sun's glare interfere with the perceptibility of the marker. The midday and nighttime tests require one approach each, less than the required for afternoon/evening daytime testing. The approach for mid-day flight was relatively insignificant, although the city of Chicago was used to provide congested environment. For the nighttime observation, the pilot flew toward the marker with the central business district of the city of Chicago in the background. This created the most background lighting to obscure the marker's beacon. Data were recorded from both the pilot's and the proctor's observation.

Based on the result obtained from careful flight evaluation of the marker in the Class B airspace environment, it was determined that the structure should be further increased in size. It was possible to detect the 30-foot diameter structure at approximately 5 to 6 miles. From 3 to 4 miles, the marker was easily identified. With the sun's glare however, the distance from which the structure was observed was significantly reduced. The distance that the structure became visible, while looking in the direction of the sun's glare, was less than 1 mile. The colors were not noticeable until a short distance of 0.5 SM. Using a larger structure would constitute a marker that is more visible and more conspicuous within the Chicago area. It is recommended that the minimum size for the MVLF structure be 40 ft in diameter by 18 ft in height.

From the field evaluations, results have indicated that 3000 candelas light was not salient in the Chicago background lighting. It could be seen from only 2 to 3 SM. The 8000 candelas performed quite well in providing efficient and effective lighting. With this setting, the flashes could be observed as far as 6 to 7 SM. If the pilot can observe two or more markers at the same time, then he can navigate by using the spatial relationship based on the marker lighting position.

From nighttime evaluation results, lighting the interior of the marker was not beneficial in making it more perceptible at night. In contrast it would disturb the local residence nearby, impairing the implementation of the MVLF in the Chicago area. The flashing beacon alone, with its intensity and unique flashing characteristic, was conspicuous, as well as apparent, over a large distance. Dirt on lighting elements and surfaces from which light is reflected or through which it is transmitted also affect perceived color and contrast. Thus, frequent and proper cleaning of the lighting would be necessary.

6.0 Recommendation for VFR Lighted Flyway Marker

The marker should be further increased in size. For daytime detection, using a larger structure would constitute a more visible and more conspicuous marker within the Chicago area. It is recommended that the minimum size for the MVLF structure be 40 ft in dia. by 18 ft in height. The panels should have alternating colors of tangerine orange and yellow for maximum visibility and contrast with both light and dark colored background. The flashing beacon from earlier testing of the MVLF in a rural area was sufficient when tested within the Chicago metropolitan area. The flashing sequence should be modified to a Morse code 'S' to prevent pilot from mistaken the marker as a heliport. The light's minimum intensity is 8000 candelas and should be white in color. The spacing distance for the markers should be 3 SM. Where two segments adjoin one another, two special marker structures with three beacons flashing simultaneously must be used. Shield device must be part of the beacon to block the light from disturbing the residence nearby. The beacon may be situated on a pole, 30 feet or taller in height, adjacent to the structure. This would increase the light's effectiveness, as well as the shielding device's coverage area. The fabric panels of the marker will require cleaning once or twice a year, as its surface can be contaminated from deposits on its surface. Perimeter fencing must be installed to protect tampering with the marker. Water towers or other structures that are located along the selected routes can be use as a MVLF marker, provided that they are marked with the same color scheme and lighted with the type of lighting equipment as the MVLF marker's.

For the purpose of implementing the MVLF in the Chicago Class B Airspace, it is recommended that two or three MVLF markers be built and evaluated within the vicinity. The first testing may focus on the lighting aspect of the MVLF. It would be quite economical and relatively easy to install the lights around the metropolitan area. As previously mentioned, the MVLF is most beneficial during nighttime flight when it is difficult for the pilot to determine the position based on ground reference. It should be examined whether these lights can covey a specific heading to the pilot.

6.1 Modified VFR Lighted Flyway Marker Route

A route for the markers is suggested for the implementation of the MVLF to assist general aviation pilots in transition around the complex Chicago Class B Airspace. The fact that most pilots preferred to fly in a constant heading or course direction, the route will consist of several segments. However, the number of segments will be minimized as much as possible to facilitate the use of the lighted flyway marker system. Other factors include the physical dimensions of the existing and future airspace of the Chicago area, the existing VFR transitioning routes, as well as obstruction structure data obtained from the FAA regional office in Des Plaines, Illinois The data are plotted in Figure 20 (see Appendix VIII for structure data). This figure includes structures that are greater than 200 ft AGL, penetrate a 100:1 plane off a runway, or for which notification to the FAA were provided. Although data for structures less than 200 ft high were available, they were omitted from the figure for clarity of presentation. Only structures between 201 ft and 499 ft, and taller than 500 ft, were plotted. As was proposed, the distance between the aircraft and the centerline of the marker would be 1 SM, creating a 2 SM spacing distance between aircraft traversing in opposite directions. To determine the MVLF route, a specially marked transparent template on which three parallel lines have been drawn is used. The middle line represents the route centerline and the distance between it and each of the outside lines is equal to the 1 SM. The two outer lines represent the flight paths of aircraft flying in opposite direction of one another along the route. This concept of using the transparent template was similar to the procedure used for determining the runway orientation on windrose diagram. The template was positioned on the plot of FAA obstruction data. One of the objectives was to locate a MVLF route so that the inner loop does not cross any obstruction. In addition, aircraft flying the inner loop must maintain the required 1000-ft above the highest obstacle within 2000-ft horizontally criteria. The inner route has a higher priority than the outer loop because the altitude of the inner loop is much lower than the outside loop. Nevertheless, the outside loop did not cross over obstruction structures for more than a few instances where it was unavoidable. More importantly, the 1000-ft minimum within 2000-ft horizontal radius was not violated. By avoiding tall objects, the pilot has one less factor to be concern about when flying in a heavily congested area.

The MVLF route was also based upon the common traffic pattern flown by general aviation aircraft through the area. Most of the GA pilots fly relatively close to the 10- or 6-NM radii of O'Hare and Midway. Thus a route closely resembling the actual flight pattern flown would be used most frequently and be more beneficial in providing visual navigational aid to GA pilots. With all of the above factors taken into consideration, several segments of the MVLF route are shown in Figure 21. The recommended route closely resembles one of the existing VFR flyways, with the exception of the southern most segments. The southern most leg of the MVLF marker was designed to accommodate the possible airport to be built near the city of Peotone. It would run along the center of the opening between the existing Chicago and the proposed SSA Class B Airspace. Figure 22 illustrates the suggested MVLF route overlaying the current Chicago Class B terminal chart.

The new air to ground visual navigation was designed to alleviate traffic from the Class B airspace, however, it may impact traffic patterns of the Class D airports and other non-towered airport within the area. The Class D airports near the Chicago area are Aurora, Dupage, Gary, Palwaukee, and Waukegan. The proposed marker route is expected to have the least impact on the Aurora airport. This is because the airport is located furthest away from the proposed route. Moderate changes are expected for the Palwaukee and less for the Waukegan because both airports are located near the already existing VFR flyway. The proposed lighted-flyway nearly coincides with the existing flyway near these airports. The Gary airport may be expected to have more activity and income as a result of the proposed MVLF flyway route. The airport could serve as the starting or stopping point for pilots prior to entering or immediately after leaving the MVLF route. However, pilot may enter the route at any point along the segments and may not interfere with the airport current level of activity. The Dupage Airport would feel the most impact from the proposed system. The MVLF route protrudes into the Dupage airspace. This was unavoidable because moving the route further east would be detrimental to attracting pilots and the MVLF usefulness. Furthermore, this segment of the MVLF coincides with one of the existing VFR flyway. Other non-towered airports expected to be impacted by the MVLF route are Clow International and Lemont (private) airfields. Lambert private field is located near the outer loop and should not be influenced as much by the route. In any case, the MVLF would have an impact on the overall activity and traffic of the region and an aviation airspace specialist should be consulted. The scope of this report was to introduce an example of where a lighted flyway marker may be used.

The optimal spacing distance of the marker was determined to be 3 miles. The longitudinal and latitudinal coordinates of the points on the segments, along with each segment length, are listed in Table 7. Figures 23 through 25 illustrate each portion of the MVLF with the proposed altitude and direction. The two lines running parallel with that designated for the MVLF route represent the spacing between the aircraft and the marker from opposite direction along the route. The aircraft symbol is not drawn to scale; they are used to indicate the recommended direction for flying via the MVLF route. Finally, should the SSA be built in Peotone, reconsideration and alteration on the proposed MVLF routes may be necessary.

6.2 Modified VFR Lighted Flyway Marker Cruising Altitude

To provide a minimum vertical separation between VFR aircraft, the FAA established VFR Cruising Altitude (Federal Aviation Regulation 1997). The MVLF cruising altitude is designed to establish a vertical separation for aircraft traveling in opposite direction. In addition to the recommended cruising altitude, a MVLF traffic flow pattern was given to provide horizontal separation between VFR aircraft. By maintaining not only the vertical separation, but also the horizontal spacing, the level of safety for VFR traffic is increased. Other consideration includes physical dimension of the airspace, elevation of the highest obstruction and terrain in the area along the flyway route. To provide horizontal separation between two aircraft, the MVLF route is divided into two loops each one for opposite flying direction. The inner loop was designated for flying clockwise and the outer loop for flying counter clockwise. It is similar in concept for the flow of automobiles on a two-directional road. The function of the MVLF marker is similar to the centerline or median, separating traffic traveling in opposite directions. When flying clockwise along the inner loop, the pilot must keep the marker toward the left side of the aircraft. Aircraft flying counter clockwise on the outside loop must also keep the marker toward the left side of the aircraft as well. By keeping the marker to the left of the airplane, it can be easier to detect and identify by the pilot in command, who is seated in the left seat of an aircraft. It would also allow maximum exposure of the marker within the line of sight of the pilot in command. More importantly it establishes a flight pattern for aircraft flying via the MVLF route. The recommended distance between the aircraft and the marker is one mile, giving a total space of two miles between aircraft traveling in opposite directions.

All of the segments of the MVLF route are located underneath the O'Hare airspace where the lower ceiling is 3000 ft MSL or higher. The recommended altitudes for the outer loop are the same as the maximum suggested altitude for the VFR transitioning route, 2,500 MSL. It was desired to create a vertical separation between GA aircraft flying in opposite direction. Thus the inner loop will be lower than the outer loop. The inner loop of the MVLF is closer to the O'Hare airport, where the lower ceiling of its controlled airspace is only 1900 MSL. Although none of the segments are located underneath portion of airspace with 1900 MSL as the lower ceiling limit, the altitude of the inner loop must be designed to accommodate for incidental intrusion into that area of airspace. Thus the altitude was determined by taking the difference between the O'Hare Airport lower ceiling elevation (1900) and the highest obstacle elevation (1700) encountered throughout the entire route and dividing by two (1,900 – 1,700 = 200, 200/2 = 100). The result added to the highest obstruction heights yielded an inner loop altitude of 1,800 MSL. The separation between opposing traffic on all segments of MVLF routes is 700 feet vertically. Should a pilot unintentionally wander into that 1900 MSL lower ceiling area, then the controlled airspace will not be violated.

The altitudes recommended for both inner and outer loops of the MVLF route are not the specified altitudes. The Federal Airmen Regulations do not prescribe any mandatory cruising altitude for VFR pilots flying below 3000 ft AGL. The final responsibility remains upon the pilot who must remain clear of the Class B airspace and maintain the proper terrain clearance.

6.3 Recommendation on Site Selection

Several physical dimensions must be taken into consideration, in addition to certain design criteria, when selecting the location of a marker. The basic requirement for a site is that the surface is relatively flat, and has drainage capability. Adequate relief from rain and snow, such as the installation of drainage or a heating unit, must be provided if necessary. A grounding rod should be installed to avoid damage from lighting. In addition, the structure must be anchored to resist wind gusts, and thus the surface type is important. Several anchoring methods can be utilized depending on the characteristics of the site. One anchoring technique is to use drift pins, which are more suitable for asphalt and turf surfaces. Once in position, drift pins should be driven into the ground at an angle through holes in the base plates of each beam. Sprung Instant Structure also suggested that earth anchors could be used in conjunction with drift pins. These anchors are installed inside of the base of the structure arch and driven into the ground. Once in position, a cable system is attached to the arch using a turnbuckle. Periodic inspection should be carried out to insure that the cables remain taut. Another anchoring technique is to use concrete anchors. This type of anchoring is used when the structure has been placed on a concrete footing, slab, or other similar structural material. Once the structure is in position, fencing must be installed to deter theft, vandalism, and tampering with the marker. Signs saying "DANGER HIGH VOLTAGE" can be very effective in discouraging tampering.

The most significant factor when considering the location of a marker is obstruction to its line of sight. Because the height of the marker is only 15 ft, there is an area clearance requirement for maximum viewing of the marker. The marker should be located within an area that is free from obstacles, which can hinder its visibility to airborne aircraft. The area can be divided into two zones: one that requires the area to be clear of all obstructions and one with a maximum height restriction. The obstruction-free area was determined by simple geometry, taking into consideration the minimum cruising altitude for aircraft flying within a metropolitan area To enable detection from pilot flying as low as 500 ft AGL, 3 miles away from the marker, the area must be cleared at least 570-ft radius in all directions. Beyond this area lies a maximum height restriction zone. At 570 ft and beyond, an object may be 18 ft maximum in height and increase at a ratio of 31:1. Thus, for every 31 ft horizontally away from the marker the maximum height of the object would be increase by 1 foot. For example, if an object is 1140 ft away from the marker, it should not be taller than 36 ft. Objects within the restricted area may hinder the perceptibility of the marker. Furthermore, the beacon's lighting sequence and intensity may annoy the residents of buildings located within the marker area. To overcome this problem, a shielding device was designed and utilized as discussed in an earlier section. Another possible site for the marker would be on the roof of large manufacturing storage or warehouse facilities. For this alternative, each facility is unique and requires specific consideration. Consulting with both the authorities in charge of the specific building and Sprung Instant Structure technician is therefore a necessity.

6.4 Water Towers and other Structures as MVLF Markers

As proven by other research, the optimal shape, based on a given area, for identification of an object is a circular shape. For a structure, this would imply having a spherical shape, such as water towers. Furthermore, lighting of tall structures considered as obstruction hazards for aviation purpose can be substituted with a MVLF lighting system. Thus the location of water towers and lighted structures within the proposed MVLF routes will be collected. Earlier attempt of contacting government agencies did not provide any significant data. Agencies including the FAA, United State Geological Survey (USGS), Illinois State Geological Survey (ISGS), Illinois Department of Public Health have been contacted, but with little success of obtaining information. Other government offices such as the Metropolitan Water Reclamation District of Greater Chicago and the municipals located along the route were also contacted regarding water towers. However, the Illinois Environment Protection Agency (IEPA) Division of Public Water Supply may have information on the location of water towers within the Chicago metropolitan area. If data can not be obtained from the IEPA, then the best methods for obtaining this information would be either from locating the marking on topographic maps (1:24000 scale) published by USGS, or by manually collecting the data. Because of the map scale, it would require scanning over many maps to cover the entire route of the marker. A more logical approach would be to use a GPS system. A data collector can drive along the route and record the position of any water tower encountered. The minimum data includes the name of the municipalities and the longitude and latitude. Other information such as the height, size, marking, and lighting of the structure will be collected. It would be necessary to obtain the permission of the municipalities in order to mark and light these structures as MVLF markers. It may be difficult to convince the local authority to have their structure marked with two alternating colors. The marking pattern for water towers and similar structures is illustrated in Figures 26 and 27. Figure 28 illustrates an actual water tower with marking pattern similar to the pattern recommended for the MVLF marker. Structures other than water towers along the proposed route may also be used. For example, oil tanks or salt storage facilities could be used, provided that they are painted with the MVLF color scheme. MVLF beacon should be positioned on top of a light pole situated nearby. The pole should be of sufficient height so that the light is positioned above surrounding buildings or any object that may interfere with its.

7.0 Cost Factors

An important issue concerning this project was the availability of an electronic navigation instrument. There is some public opinion that questions the benefit of a ground visual navigational aid. Because satellite global positioning system (GPS) has been available to general aviation pilots for quite sometime, a ground visual navigational aid was deem wasteful. However, it can be demonstrated that the marker benefit outweighs its cost. The unit price of a GPS is in the range of $400 to $1,200 for a simple handheld model, to as much as $5,000 for an on-board system. Furthermore, the capability of electronic equipment varies significantly among different brands and models of the system. Each requires a different level of efficiency from its operator for proper usage. Inscribed in the manual of a GPS, the operator is warned that the system is continuously under development and may be subject to changes. This could affect the accuracy and performance of all GPS equipment. More importantly, a GPS can be misused or misinterpreted, and thus can be unsafe. During usage of such equipment, a careful comparison must be made with all available navigation resources including other NAVAIDS, visual sighting, charts, etc. On most models, the information stored must be updated regularly (approximately every month) to ensure current information. This means sending the unit back to the company or authorized service provider and being without it for several days, an inconvenience for some pilots.

Nevertheless, not all of the general aviation aircraft are equipped with GPS navigation equipment. Furthermore, the efficiency of the unit depends upon its operator, who must program, operate, and interpret the information correctly. Not all of the general aviation pilots are properly trained to use this electronic device, as it is not a part of the training involved to become a licensed private pilot. As mentioned above, the unit is vulnerable to malfunction or becoming inoperative due to poor satellite coverage, signal interference, loss of power, improper usage, etc. Thus a ground reference can serve as a primary or a back up reference. The preliminary spacing distance proposed for the MVLF was 3 SM, as this is the minimum VFR visibility requirement. Thus for a 90 mile MVLF route, it would required 30 markers, costing a total sum of approximately $420,000 (each marker cost $14,000; $11,000 for the 40 ft dia. structure plus $3,000 for the beacon). However, the structure used for the marker is multifunctional, for example it can be use as a storage facility as shown in the manufacturing brochure. In addition, it was noted that a number of structures could be substituted with existing water towers that are located within the MVLF route. Regardless, insignificant amount of money should never be the limiting factor for saving lives. An air accident, as catastrophic as it may be, can be more disastrous if it occurs within the vicinity of a metropolitan area. Lives of those on the ground are also at risk when mid air collision occurs. The potential of this imminent danger can be reduced if pilots have more time to see and avoid other aircraft. Lastly, the MVLF can be incorporated as part of the aviation navigational system in conjunction with the GPS. Structures can be programmed as data points in the GPS system, resulting in an even more efficient and effective method of navigation to transition through a complex airspace. Nevertheless, pilots could use the MVLF marking and lighting as a source of navigation information during flight in good weather condition. More significantly, the systems could also be used as a crosscheck reference and as a back-up system in the case of electronic equipment failure or malfunction.

8.0 Summary

The modified VFR lighted flyway marker was thoroughly observed for its conspicuity against various backgrounds. The design performs satisfactory throughout the initial testing at Rantoul Aviation Center and later at the Schaumburg Regional Airport. The 30-ft diameter Sprung Instant Structure was more conspicuous than the first VFR lighted flyway marker prototype. However a larger structure would be even more conspicuous. More importantly, the minimum number of alternating panels required is ten. Since the 30-ft diameter structure has only eight panels, it is not suitable for detection and recognition purposes. The recommended minimum size is 40-ft diameter. The tangerine orange and yellow colors proved to be more conspicuous than the FAA orange and white color combination for marking obstruction. The orange contrast well with light colored background while the yellow contrast quite efficiently with dark colored background. The beacon with the modified flashing sequence was salient from the background lighting of the Chicago area and can be used in the final design. However, the 8,000-candelas beacon was ineffective during daytime evaluation and the structure was more conspicuous. As the illumination condition deteriorates toward darkness, the effectiveness of the light gradually increased while that of the marker structure gradually decreased. Thus higher intensity 200,000-candelas may be used if daytime detection of the light is desired, as found in other studies. However, this intensity must be adjusted to 20,000 and 8,000 candelas for twilight and nighttime respectively to prevent the light from disturbing the residence nearby. It is suggest that the light, with the specially designed shielding device, be situated on a 30- to 45-ft pole. The pole would increase the visibility of the flashing beacon to pilots and increase the coverage area of the shielding device. With the flashing beacon situated at elevated position, the possibility that other tall objects will block the light from the pilot field of vision is reduced. Finally, a MVLF route was proposed, including cruise altitude and traffic flow pattern. This route was based on the location of the existing VFR flyways, the location of tall structures, and the elevation of the highest obstacle within the vicinity. The inner traffic has a lower cruising altitude due to the fact that it is closer to the stepping-down ceiling of the O'Hare Class B Airspace. The traffic pattern was established to ease the detection, as well as, for the marker to remain in the pilot line of sight as long as possible. More importantly, it was established to reduce the risk of collision between aircraft flying in opposite direction. Finally, it was recommended that water towers or similar large structures be used as the base component of the MVLF marker. Larger structures would constitute a more conspicuous object, increasing the pilot's opportunity for visual detection and identification of the marker.

It is concluded that a modified VFR lighted flyway marker outperformed its predecessor quite significantly. It is recommended that the implementation be initiated to further study the benefit of at least two MVLF markers in the Chicago Class B Airspace. With

aviation traffic and other aviation activity would benefit from the increased safety and efficiency as a whole.

References

Applied Psychology Corporation, Final Report: Conspicuity of Tall Radio Towers and Television Towers in Marginal Visual Flight Rules Weather, Federal Aviation Agency: January 1963.

Ashford, Norman, Airport Engineering, 3rd Edition. John Wiley & Sons Inc, New York, 1992.

Bentzen, Billie L., Detectable Warning Surfaces: Color, Contrast, and Reflectance, U.S. Depart of Transportation, Federal Transit Administration, Final Report September 1994.

Carlson, Neil R., Physiology of Behavior, 5th Edition. Paramount Massachusetts 1994: Pg. 141-180.

Castle, Bret B., Evaluation of L-866 Obstruction Beacon, Federal Aviation Administration US Department of Transportation January 1985.

Connors, Mary M., Conspicuity of Target Lights: the Influence of Flash Rate and Brightness, NASA Ames Research Center, Moffett Field, Ca, Report No. NASA TN D-7961.

Durso, F. T., Wickens, Christopher D., Handbook of Applied Cognitive Psychology, 1998.

Federal Aviation Administration, Air Traffic Activity Fiscal Year 1993, US Department of Transportation, 1993.

Federal Aviation Administration, Specification for Obstruction Lighting Equipment AC 150/5345-43C, U.S. Department of Transportation, June 1980.

Federal Aviation Administration, Obstruction Marking and Lighting Advisory Circular AC 70/7460-1H, U.S. Department of Transportation, August 1991.

Federal Aviation Regulations & Airman's Information Manual, FAR AIM 97, US Department of Transportation, Regulation Aviation Supplies & Academic, Inc., Washington 1997.

Green, William, The MacDonald Aircraft Handbook, Doubleday&Company, Inc. New York 1964: Pg. 59.

Gerathewohl, S. J. Conspicuity of steady and flashing light signals: Variation of contrast. Journal of Experimental Psychology, 1953: 43, Pg. 567-571.

Gerathewohl, S. J. Conspicuity of flashing light signals of different frequency and duration. Journal of Experimental Psychology, 1954: 48, Pg. 247-251.

Gerathewohl, S. J. Conspicuity of steady and flashing light signals: Effects of variation among frequency, duration and contrast of signals. Journal of Experimental Psychology, 1957: 47, Pg. 27-29.

International Civil Aviation Organization, Visual Aids Panel: Ninth Meetings Report, Montreal, Doc 9325, VAP/9, November 1980 Ch.6.

Jeppesen Sanderson. Private Pilot Manual, 11th Edition, Jeppesen Sanderson, Inc. Colorado, 1994.

Johnson, Charles, T., Final Report: Evaluation of Tall-Tower Lighting, National Aviation Facilities Experimental Center, Federal Aviation Administration: June 1969.

Klinger, James, "Envisioning Growth," Airport Business, Volume 11, Number 6, June 1997: Pg. 22-3.

Laxar, Kevin, Benoit, Sandra L. Conspicuity of Aids to Navigation: Temporal Patterns for Flashing Lights. US Coast Guard Naval Submarine Medical Research Laboratory, US Department of Transportation: March 1993.

Malone, F. L., Sexton, M. S., and Farnsworth, D., The Detectability of Yellows, Yellow-Reds, and Reds in Air-Sea Rescue. USN Submarine Base, Medical Research Laboratory Report No. 182, BuMed. & Surg., Navy Dept. Project NM 003 041.35.01, New London, Conn. Vol 10. 1951. Pg. 177-185.

Paprocki Thomas H., Quick Response to Field Encountered Problems—John F. Kennedy R/W 13L Lead-In Lighting System, National Aviation Facilities Experimental Center, Federal Aviation Administration, Atlantic City, New Jersey: March 1997.

Spiekermann, J. R. and Dempsey, B. J., VFR Lighted Flyway Marker for the TCA Environment, Department of Civil Engineering, University of Illinois at Urbana-Champaign, October 1994.

South Suburban Airport Project Newsletter, "IDOT Moves Forward on Environment Assessment," Volume 4 Issue 2, 1997.

Surgeoner, D. Hay, Aircraft Radio with a Chapter on Airport and Airway Lighting, Sir Isaac Pitman & Sons, Ltd., London 1942: Pg. 147-151.

Trollip, Stanley R., Jensen, Richard S., Human Factors for General Aviation, Jeppesen Sanderson, Colorado 1991: Chapter 4.

Wiener, Earl L., Nagel, David C., Human Factors in Aviation, Academic Press, Inc., 1988: Pg. 83 –110.

Wulfeck, Joseph W., Vision in Military Aviation, Wright Air Development Center, Air Research and Development Command, Wright-Patterson Air Force Base, Ohio, November 1958: Ch. 11.

Table 1. Color Combinations and their Test Results

Color Combination	First Color	Second Color	Comment
Any color/white	Any		White blend in with snow, only other color remain visible
Any color/bright yellow	Any		Bright yellow appear as white From a distance
Purple/yellow			Blend in with dark colored Background, appear as black
Blue/yellow			Appear as green and white From a distance
Hot pink/yellow			Appear as red and white from far distance
Green/ yellow			Green blend in the greenery of Forest and grass fields
Top Four Color Combinations			
Regular orange/yellow			Becomes pale from a distance(4th)
Red/yellow			Red does not reflect light as well as Orange under low illumination(3rd)
Poppy red/yellow			Almost as effective as tangerine/yellow, but not during low illumination(2nd)
Tangerine orange/yellow			Most conspicuous from furthest distance at various illumination(1st)

Table 2. Obstruction lighting intensities for various distances.

Time Period	Meteorological visibility (SM)	Distance (SM)	Intensity (Candelas)
Night	3	3.1 2.9 1.4	2,000 1,500 32
Day	1	1.5 1.4 1	200,000 100,000 20,000
Day	3	3 2.7 1.8	200,000 100,000 20,000
Twilight	1	1.0-1.5	20,000
Twilight	3	1.8-4.2	20,000

SM = Statue mile
Note: All intensity settings are (+/-) 25%

Table 3. Intensity settings for the L-856 System A.

Step	Beam Spread		Intensity	
	Vertical	Horizontal	Minimum	Peak
Day	3.0-7.0	360	100,000	200,000
Twilight	3.0-7.0	360	7,500	20,000
Night	3.0-7.0	360	1,500	4,000

Table 4. Intensity settings for the L-856 System B.

Step	Beam Spread		Intensity	
	Vertical	Horizontal	Minimum	Peak
Day	3.0-7.0	180 or 360	50,000	100,000
Twilight	3.0-7.0	180 or 360	7,500	20,000
Night	3.0-7.0	180 or 360	1,500	4,000

Table 5. Intensity settings for the L-866 flashing obstruction light.

Step	Beam Spread		Intensity	
	Vertical	Horizontal	Minimum	Peak
Day	3.0 min	360	7,500	20,000
Twilight	3.0 min	360	1,500	4,000
Night	3.0 min	360	450	1,500

Table 6. Intensity settings for the L-810 steady-flash obstruction light.

Step	Beam Spread		Intensity	
	Vertical	Horizontal	Minimum	Peak
	10 min	360	14	33

Table 7. Coordinates and segment lengths of the proposed MVLF route

Point	Latitude		Longitude	
	Degrees	Minutes	Degrees	Minutes
A	42	17.75	87	48.6
B	42	4.75	88	11.5
C	41	46.75	88	11.5
D	41	35	87	55.75
E	41	35	87	30

Segment	Length(SM)
AB	23
BC	20.5
CD	19
DE	24

Note: The segments and points may be found in Figures 21-25 (Pages 52-56)

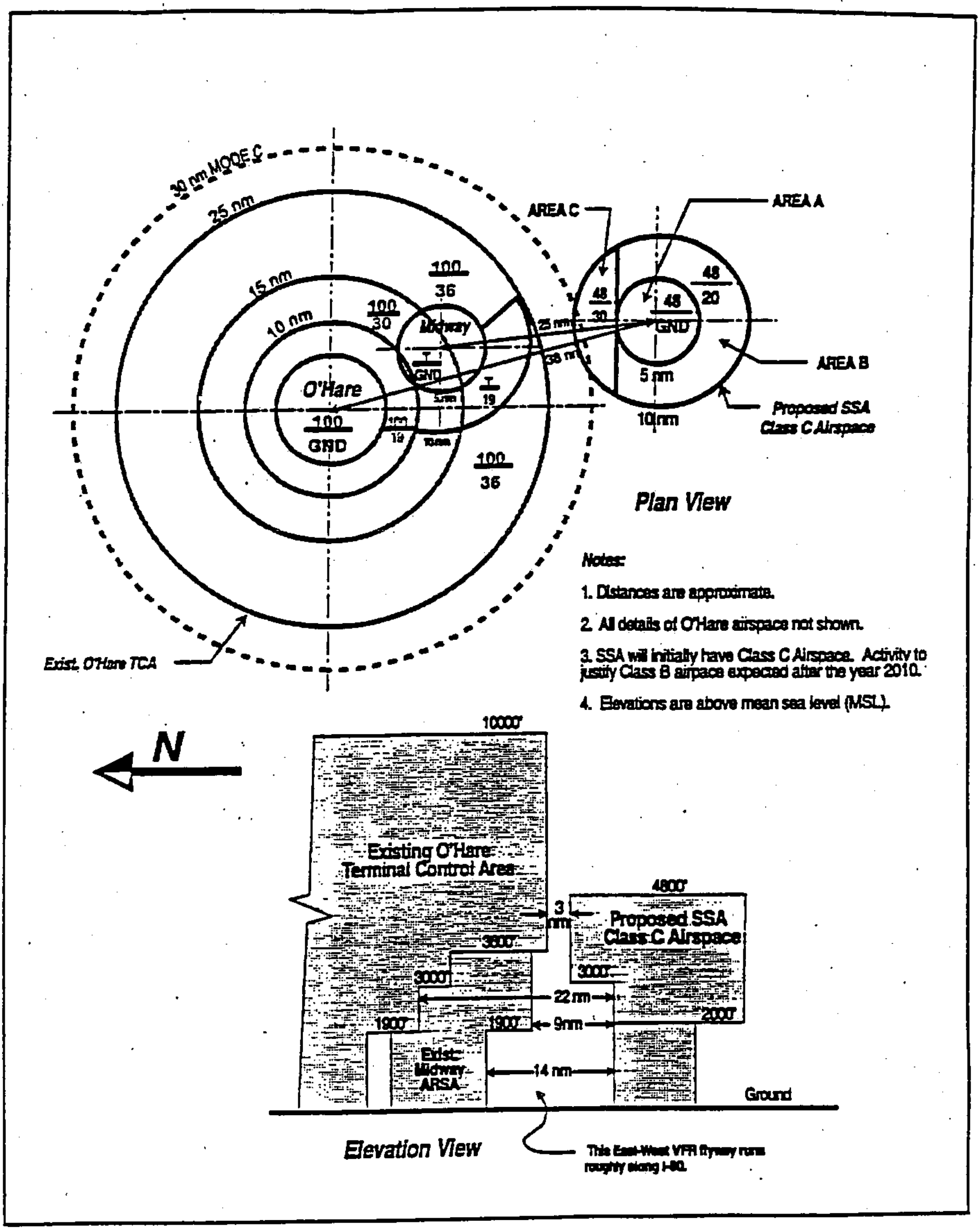


Figure 1. Chicago area airspace with Class C designation for the South Suburban Airport.

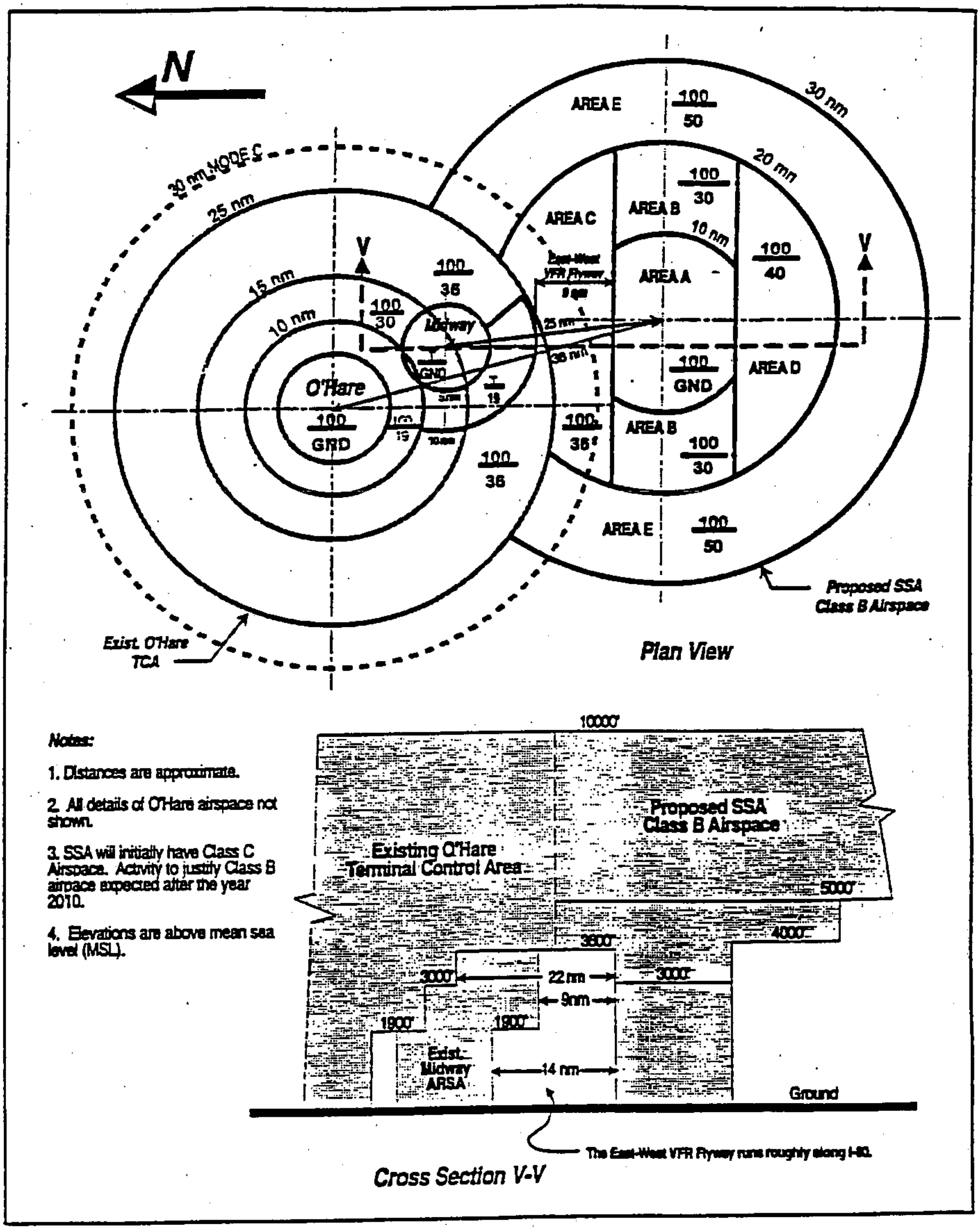


Figure 2. Chicago area airspace with Class B designation for the South Suburban Airport.

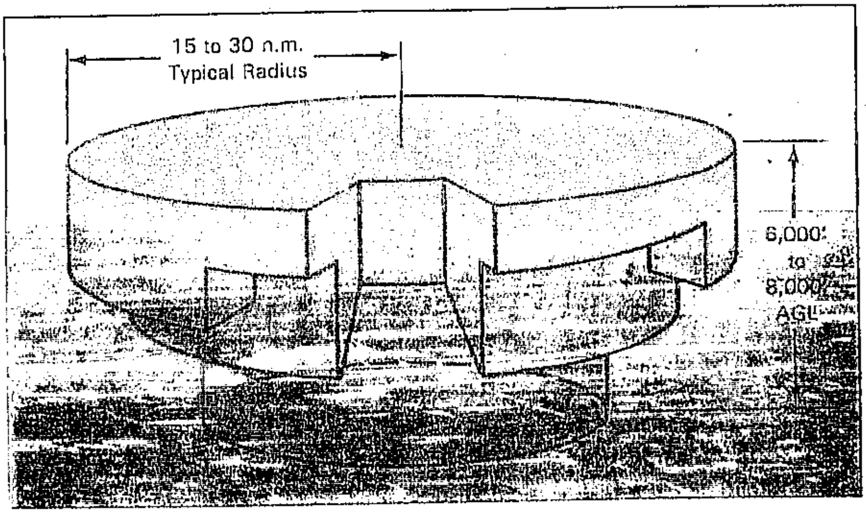


Figure 3. Typical Class B airspace configuration.

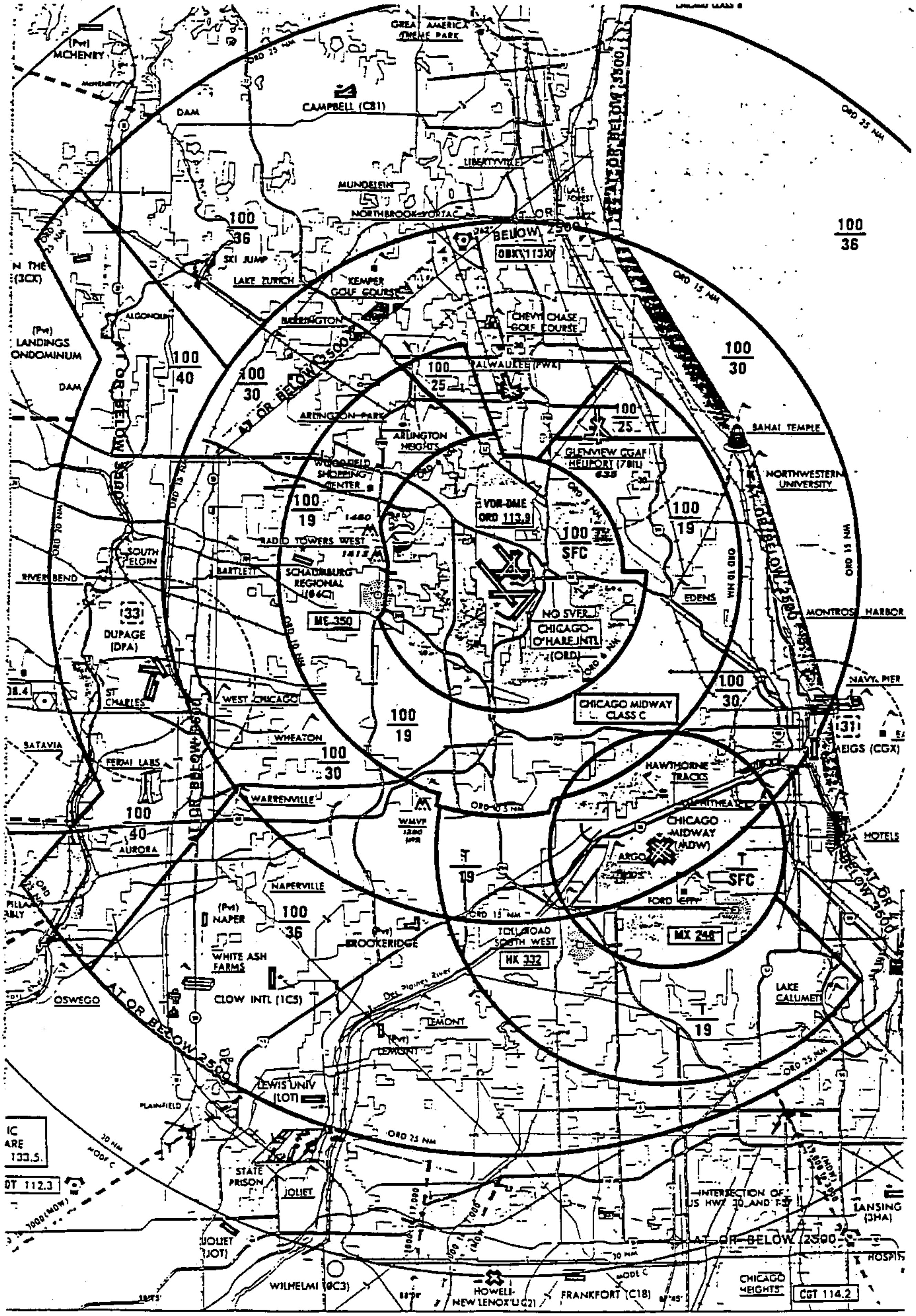


Figure 4. Chicago TCA airspace (Class B).

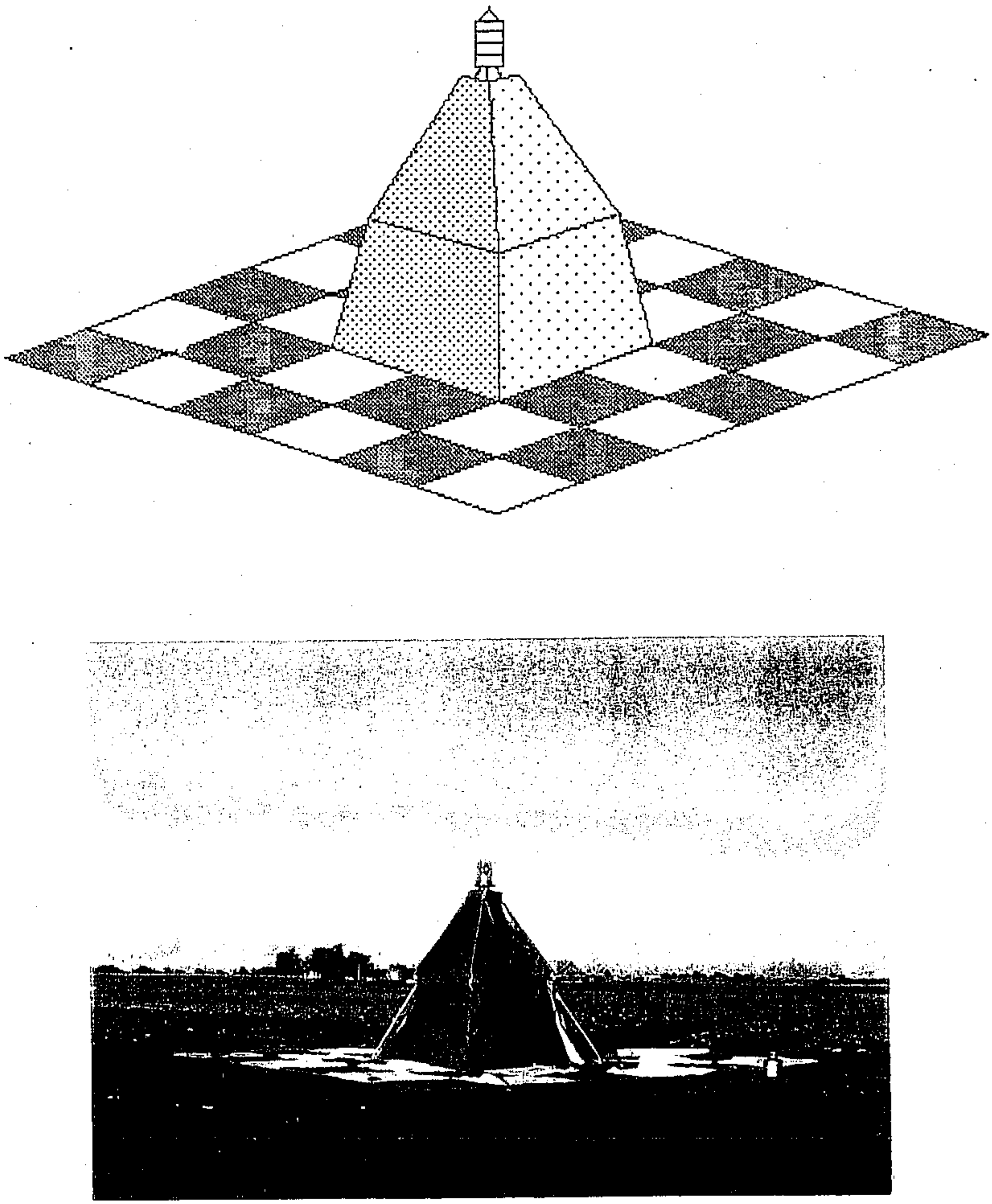


Figure 5. First version of VFR Lighted Flyway Marker (VLFM).

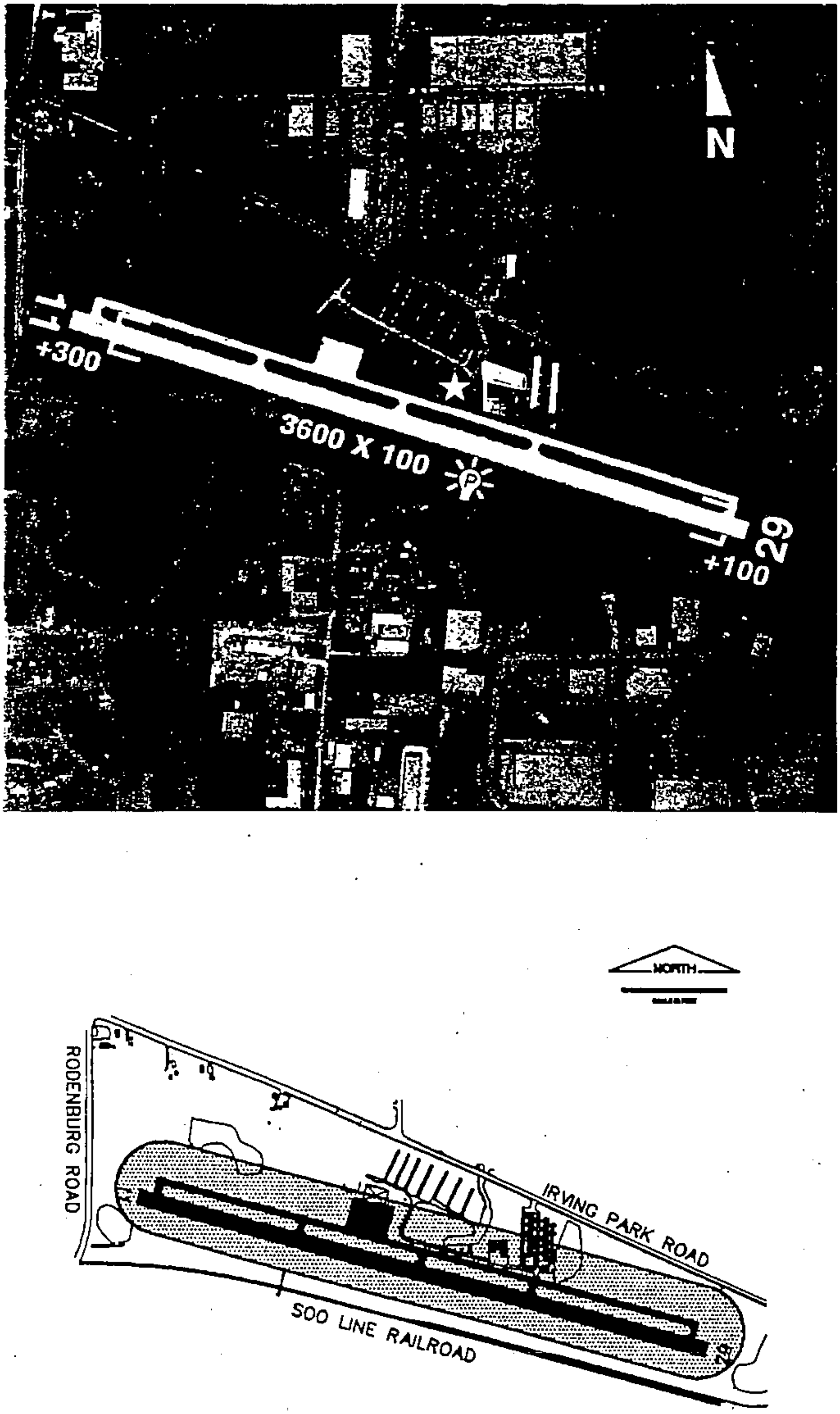


Figure 6. Schaumburg Regional Airport.

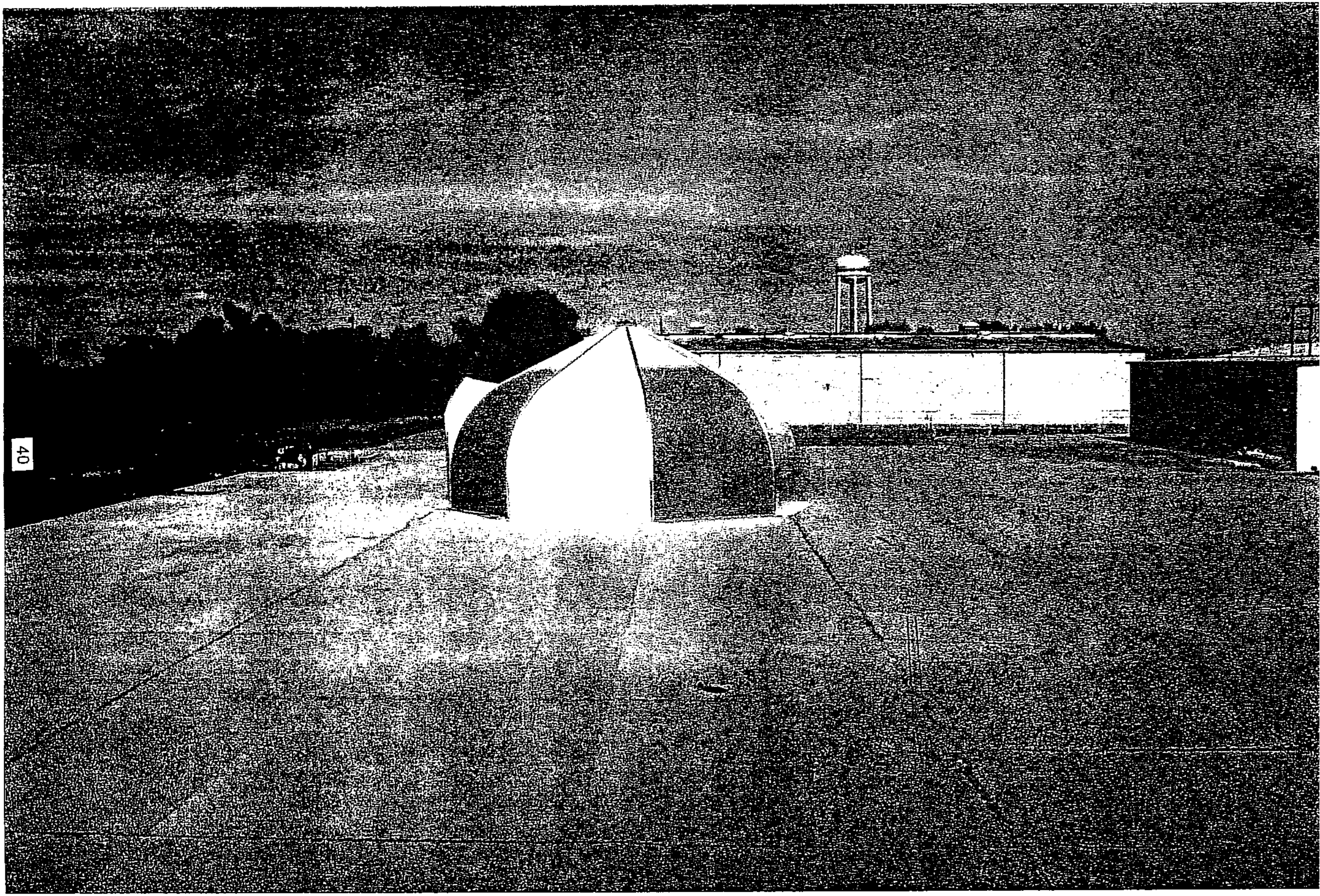


Figure 7 Modified VFR Lighted Flyway Marker (MVLF) with FAA recommended markings

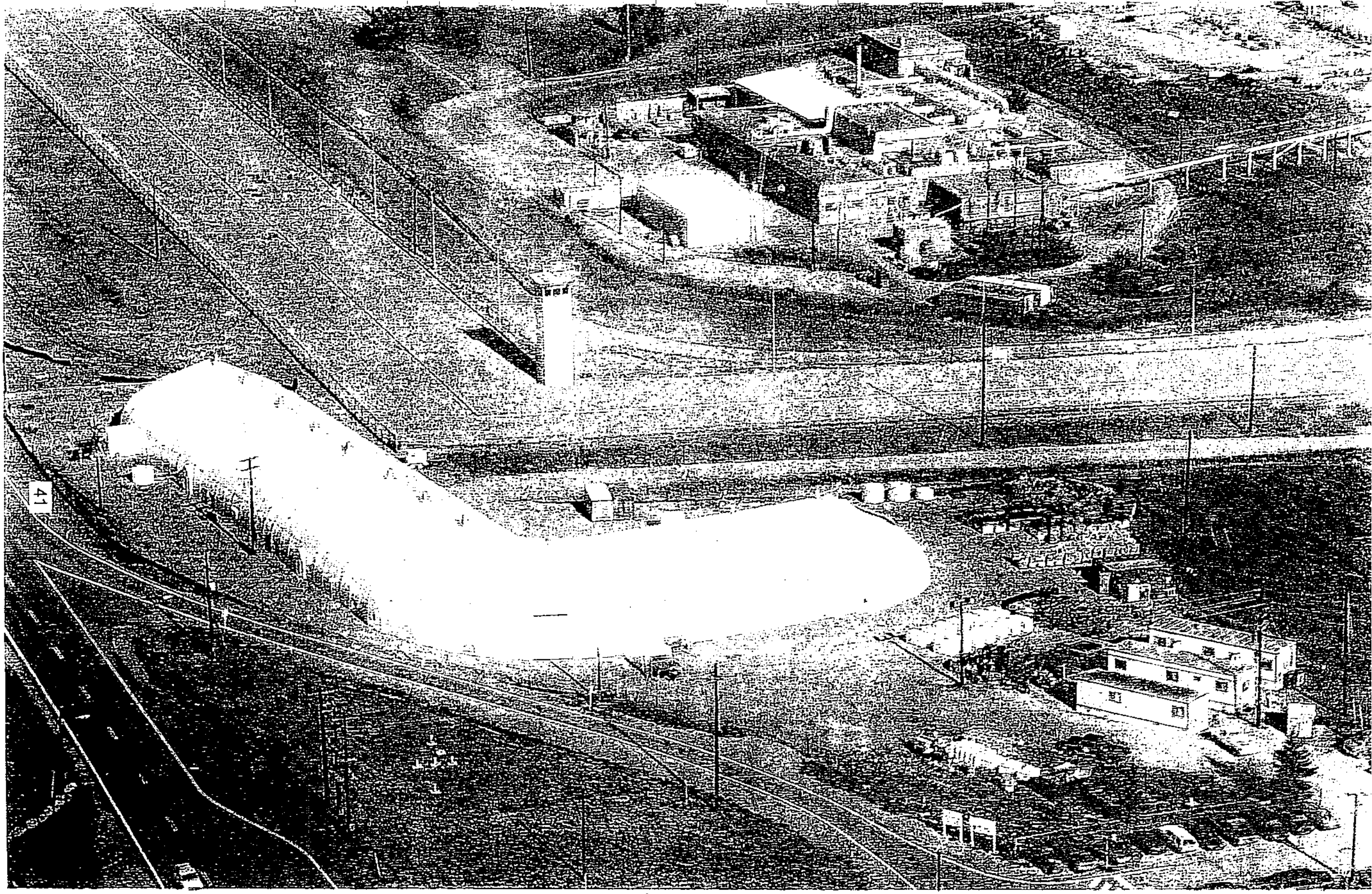


Figure 8. Suggested MVLF structure for adjoining route segments.

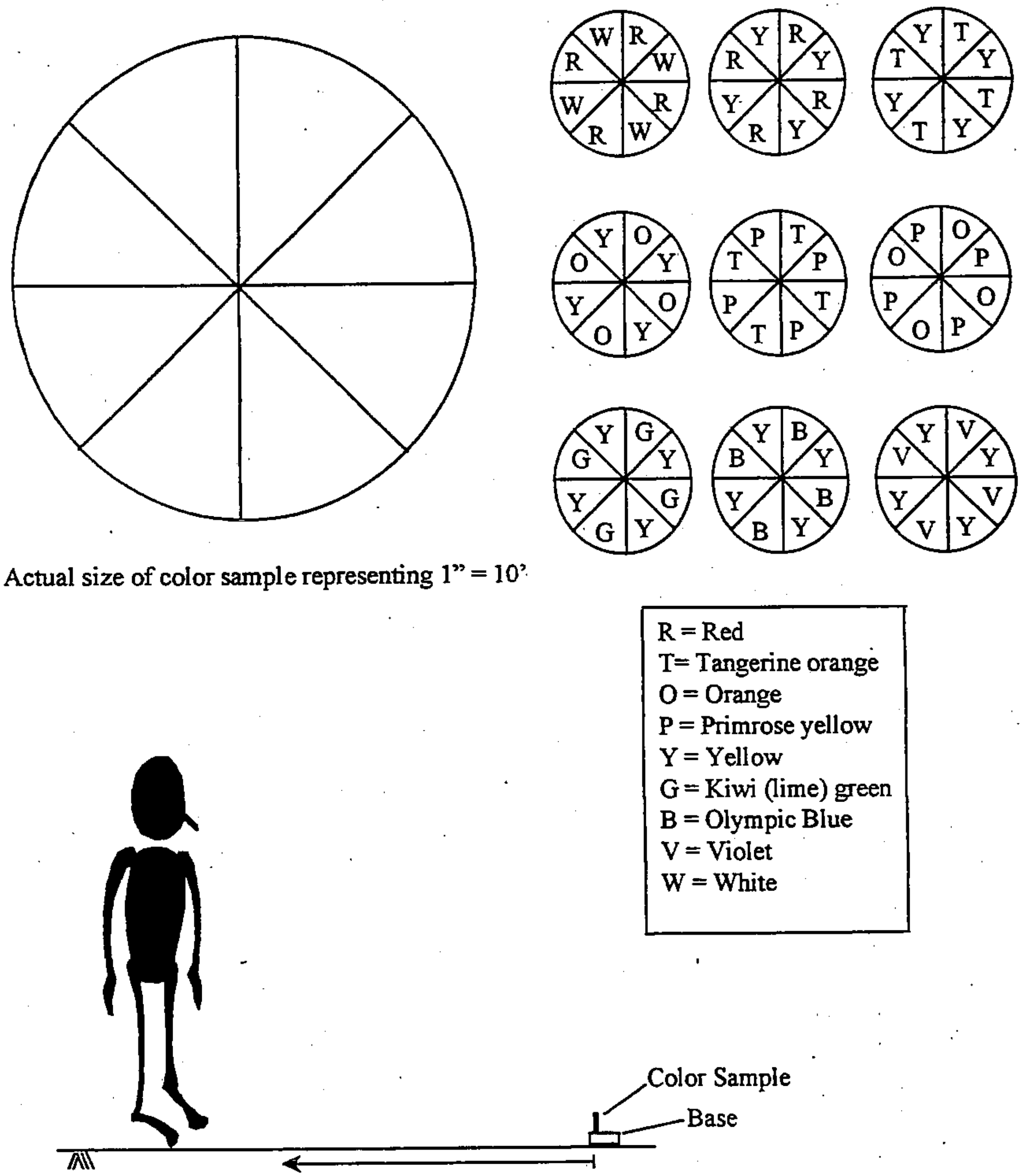


Figure 9. Samples of small scale color testing.

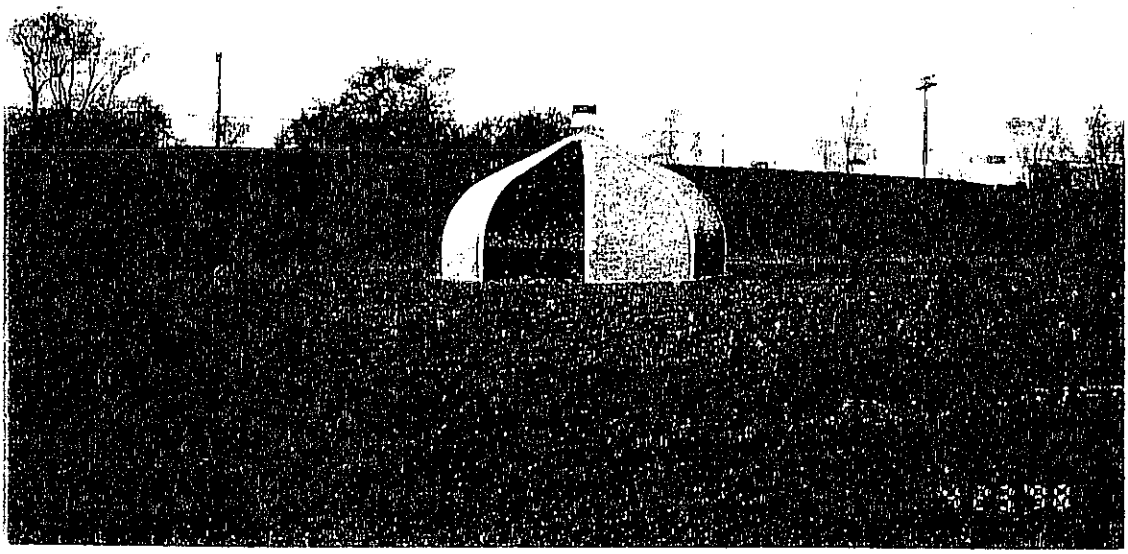


Figure 10. MVLF with its tangerine orange/yellow colors combination.

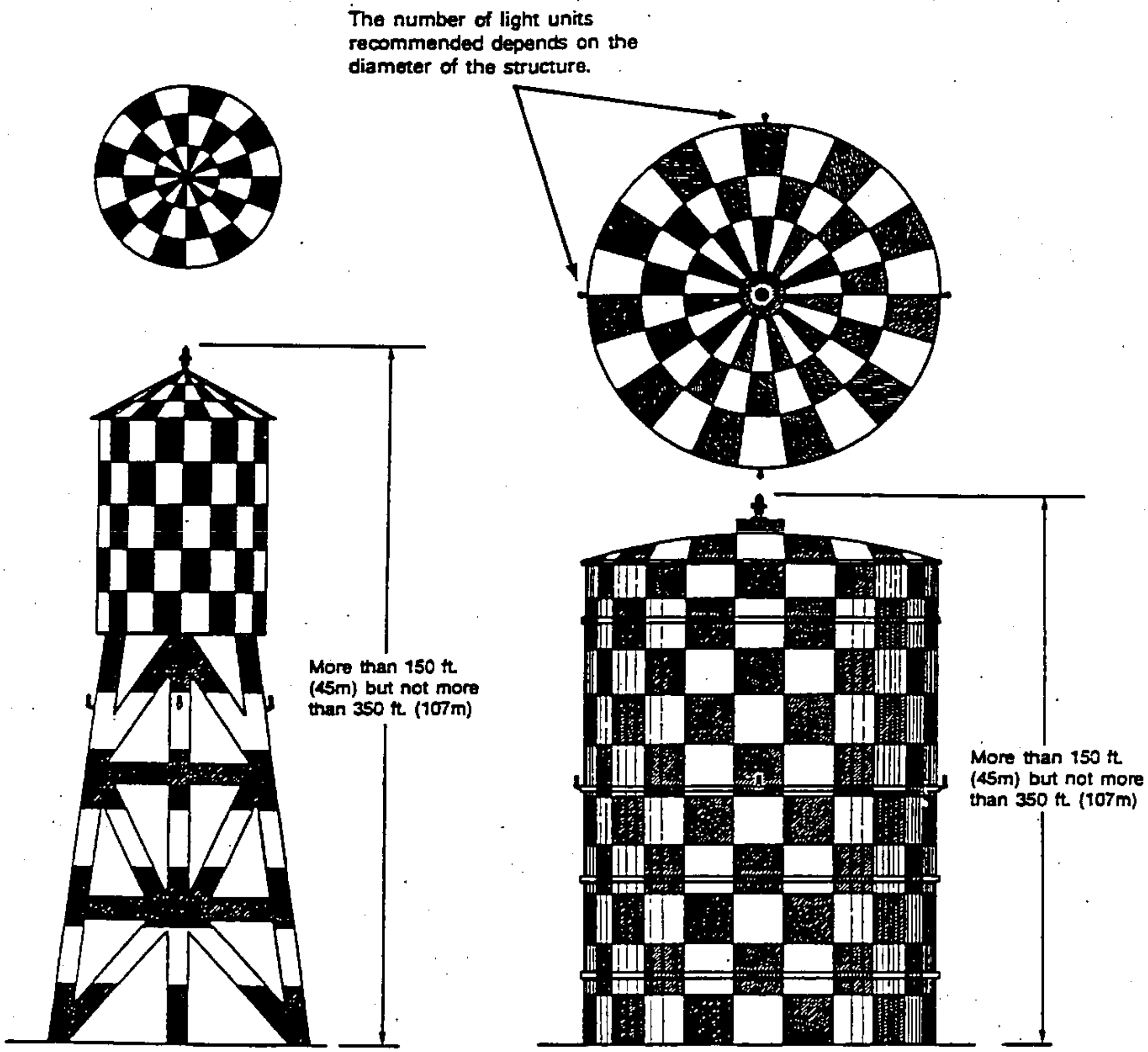


Figure 11. FAA's recommended marking of water towers, storages tanks, or similar structures.

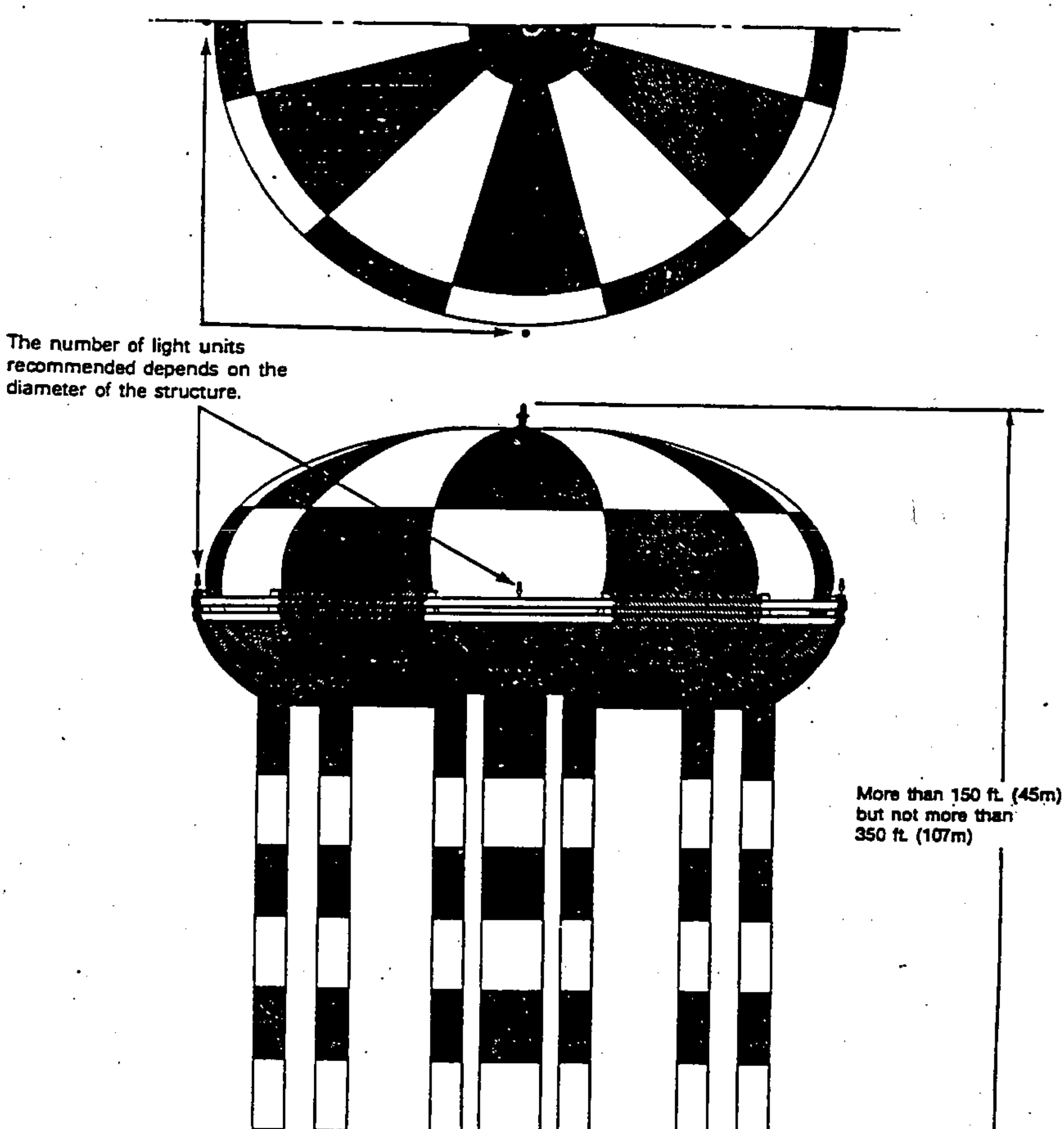


Figure 12. FAA's recommended marking of water towers or similar structures.

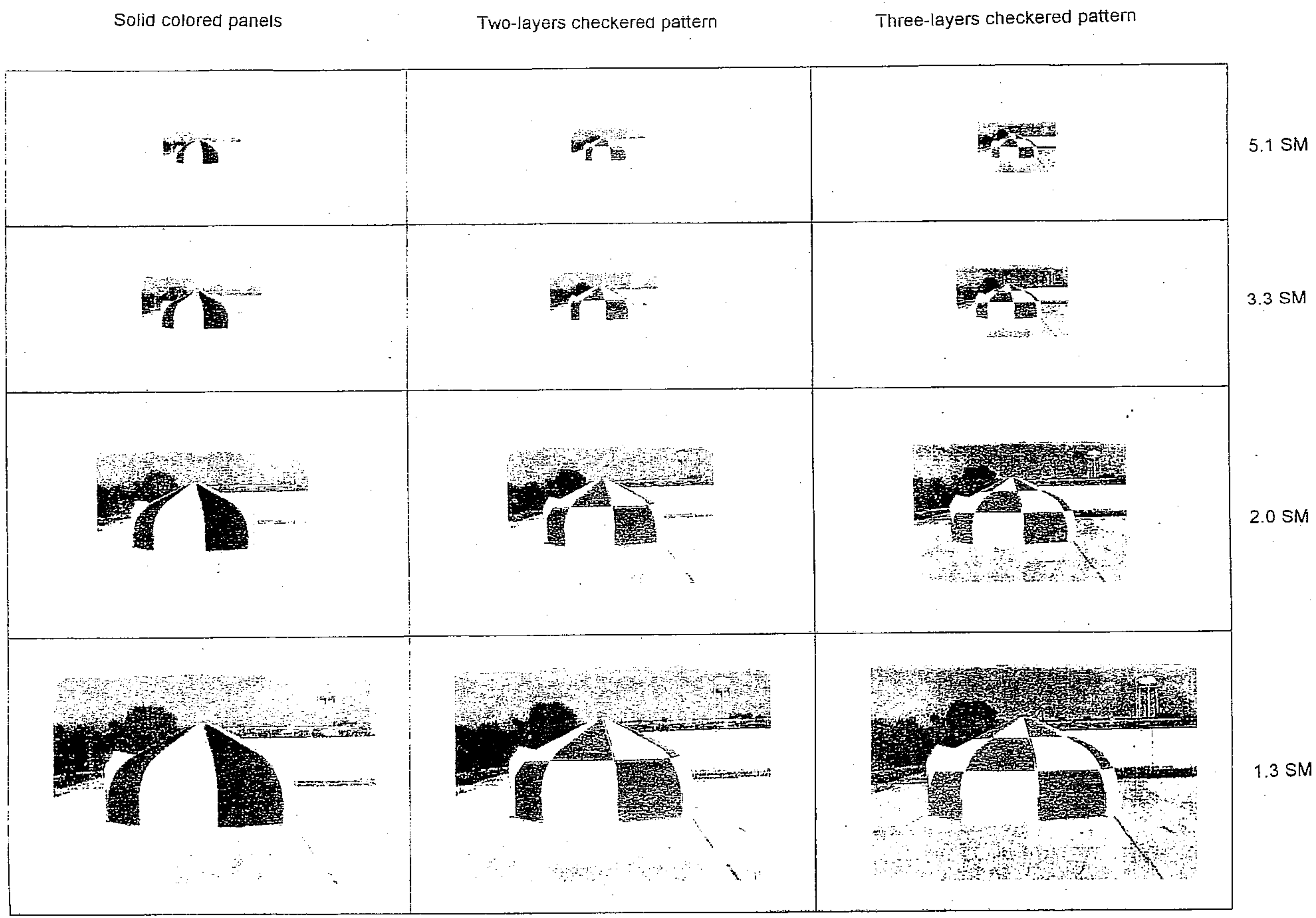


Figure 13. Apparent images of 40-ft dia marker with different marking patterns(viewing distance = 20')

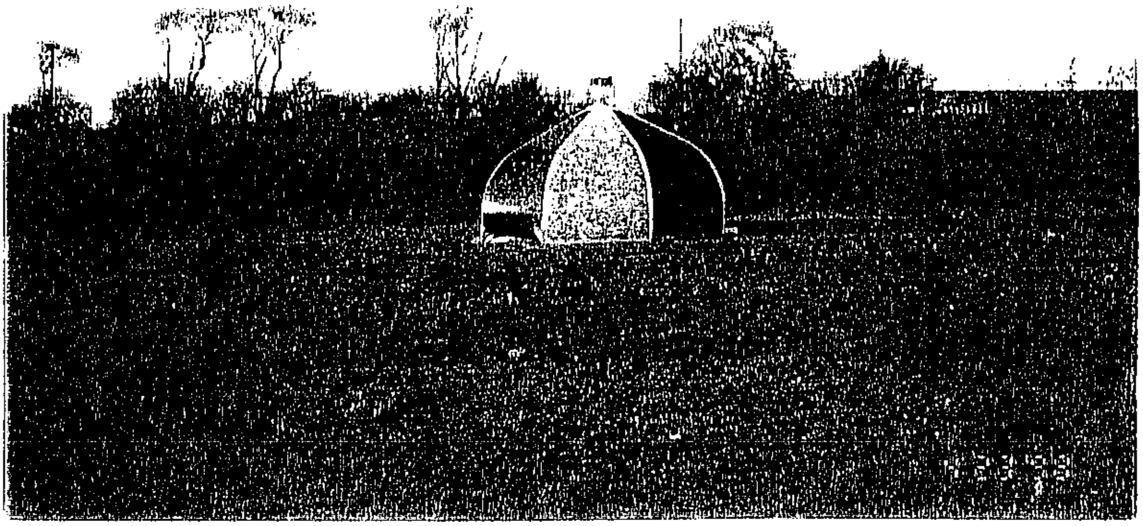


Figure 14. The orange-yellow-orange perspective of the MVLF with eight total panels.

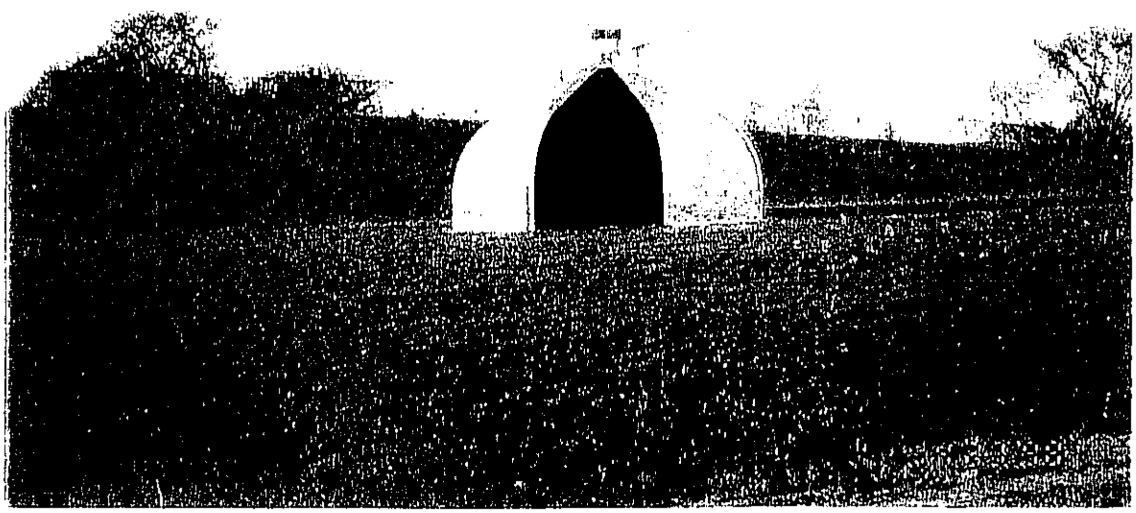


Figure 15. The yellow-orange-yellow perspective of the MVLF with eight total panels

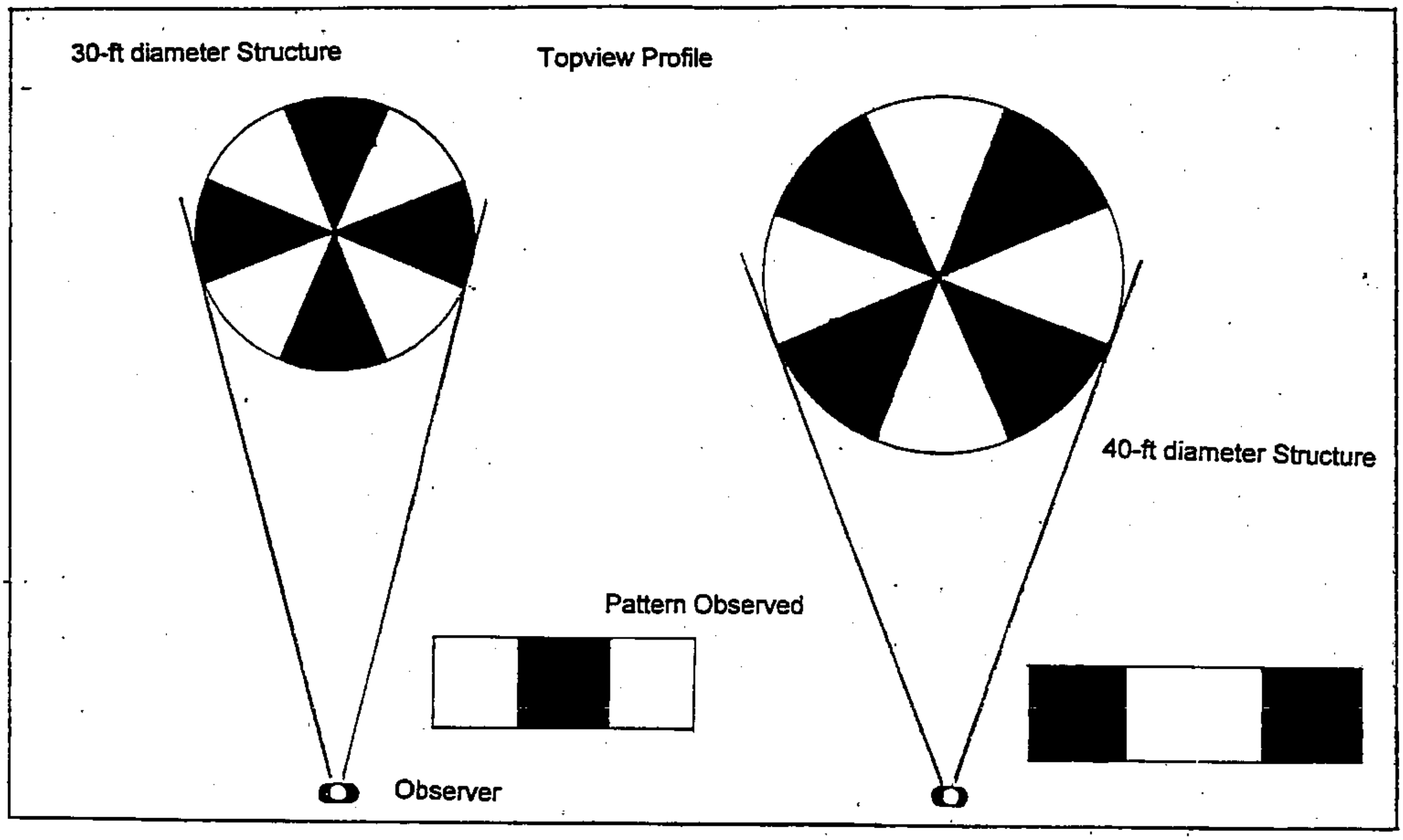


Figure 16. Illustration of three-panels viewing perspective for structures marked with eight panels.

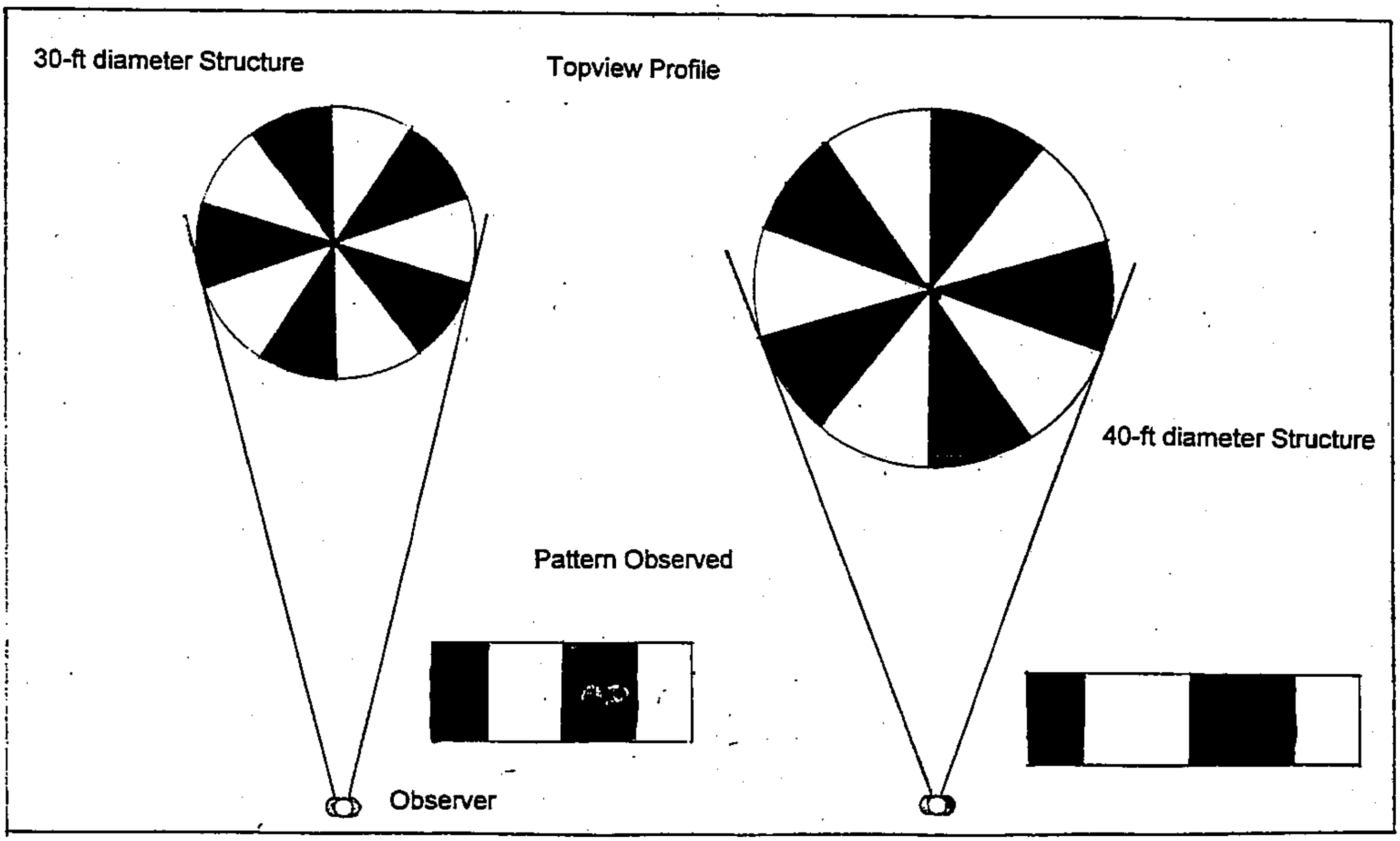


Figure 17. Illustration of four-panels viewing perspective for structures marked with ten panels.

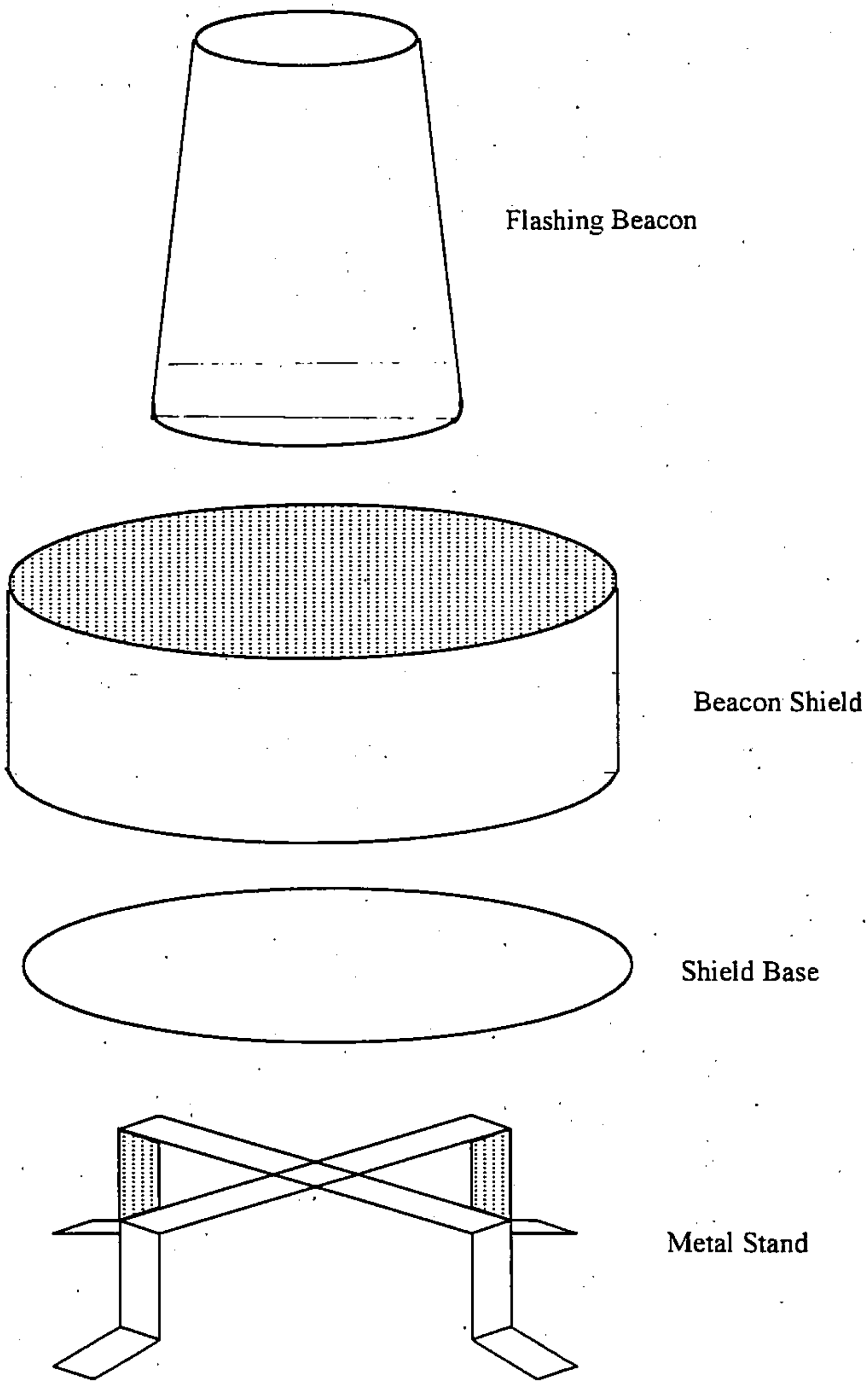


Figure 18. Beacon Shield Assembly

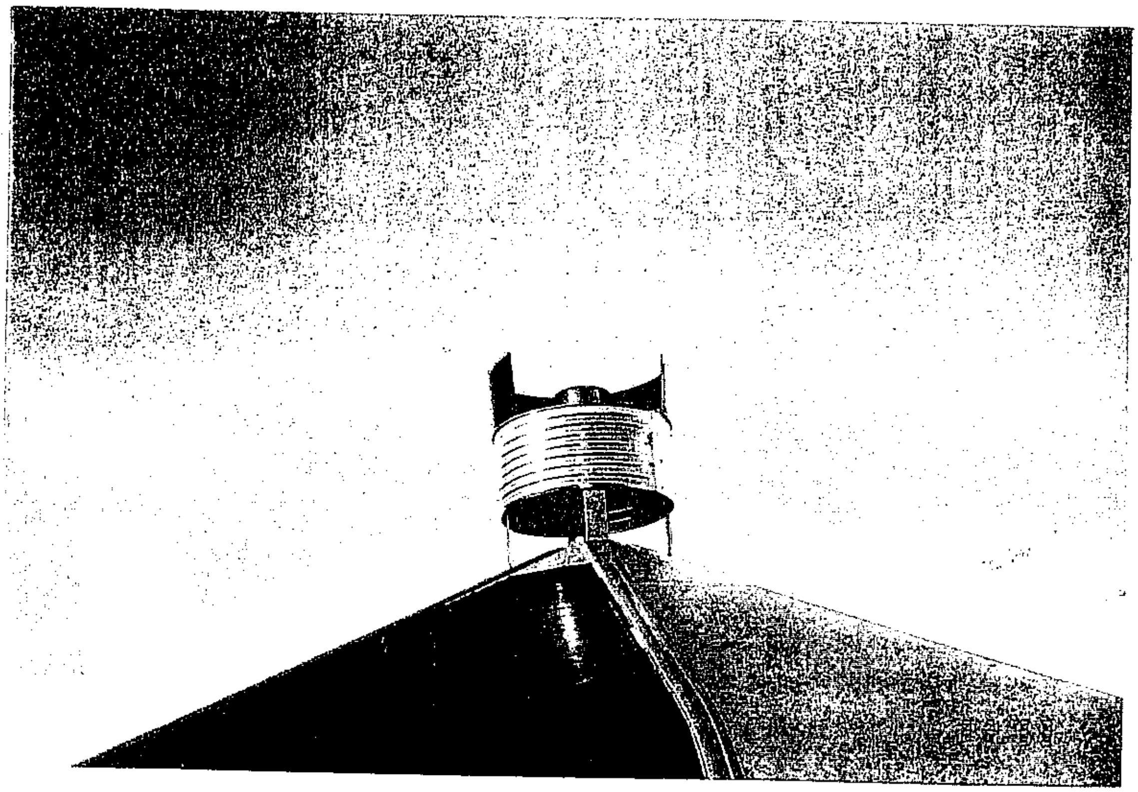


Figure 19. Flashing Beacon Assembly

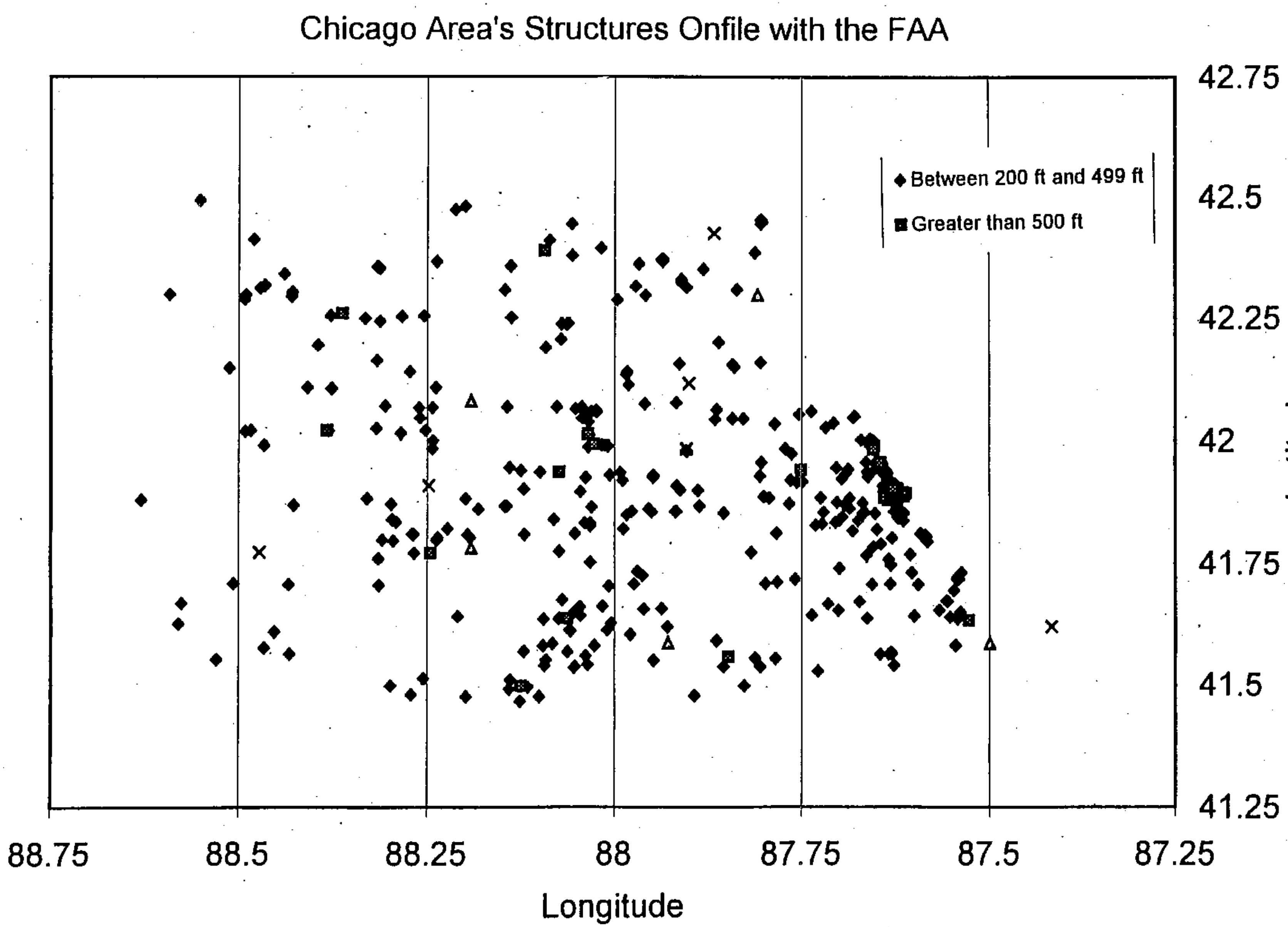
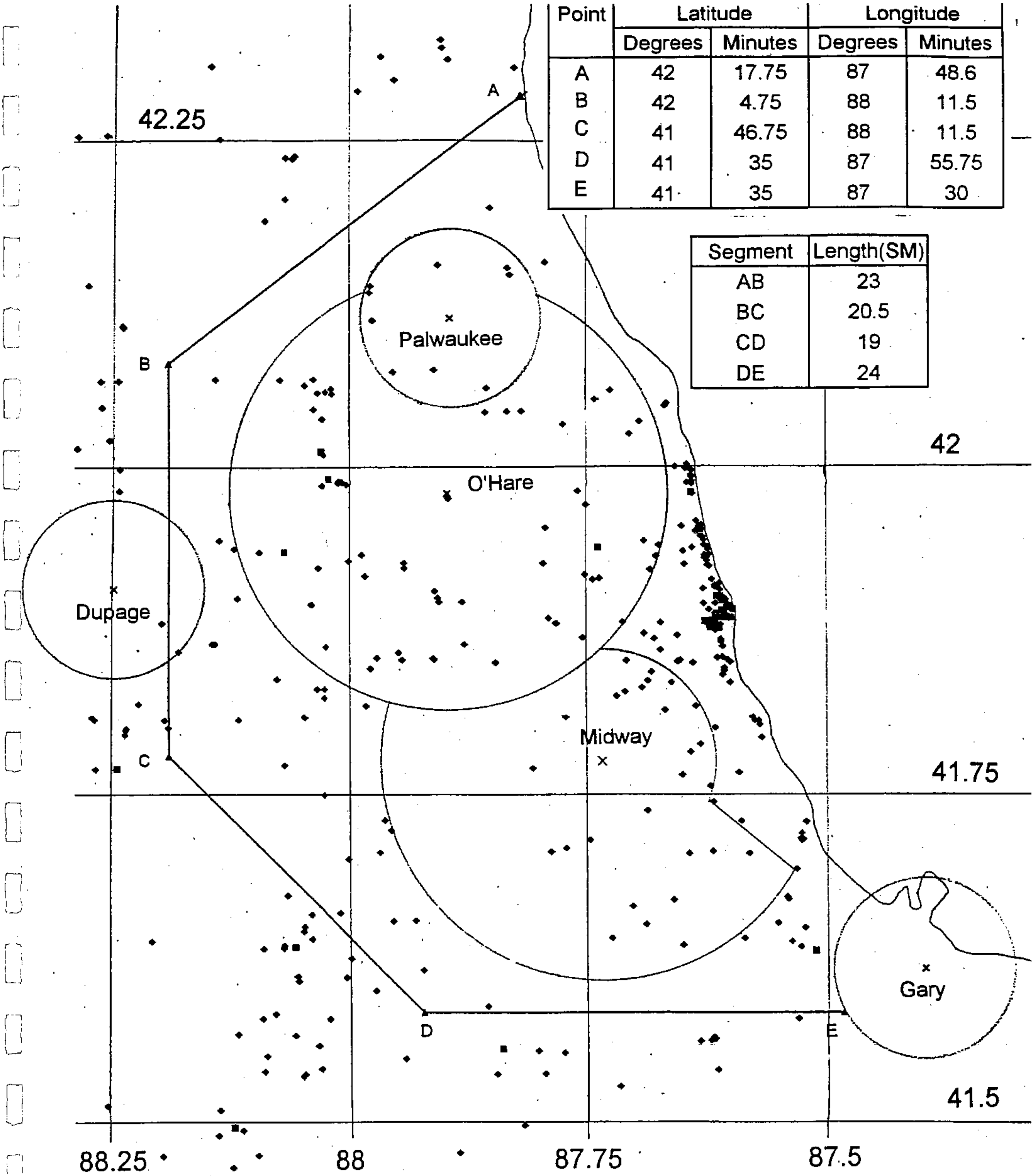

Chicago Area's Structures Onfile with the FAA
Between 200 ft and 499 ft
Greater than 500 ft
42.75
42.5
42.25
42
41.75
41.5
41.25
Latitude
88.75
88.5
88.25
88
87.75
87.5
87.25
Longitude

Figure 20.



Point	Latitude		Longitude	
	Degrees	Minutes	Degrees	Minutes
A	42	17.75	87	48.6
B	42	4.75	88	11.5
C	41	46.75	88	11.5
D	41	35	87	55.75
E	41	35	87	30

Segment	Length(SM)
AB	23
BC	20.5
CD	19
DE	24

Figure 21. The proposed MVLF marker route for the Chicago area.

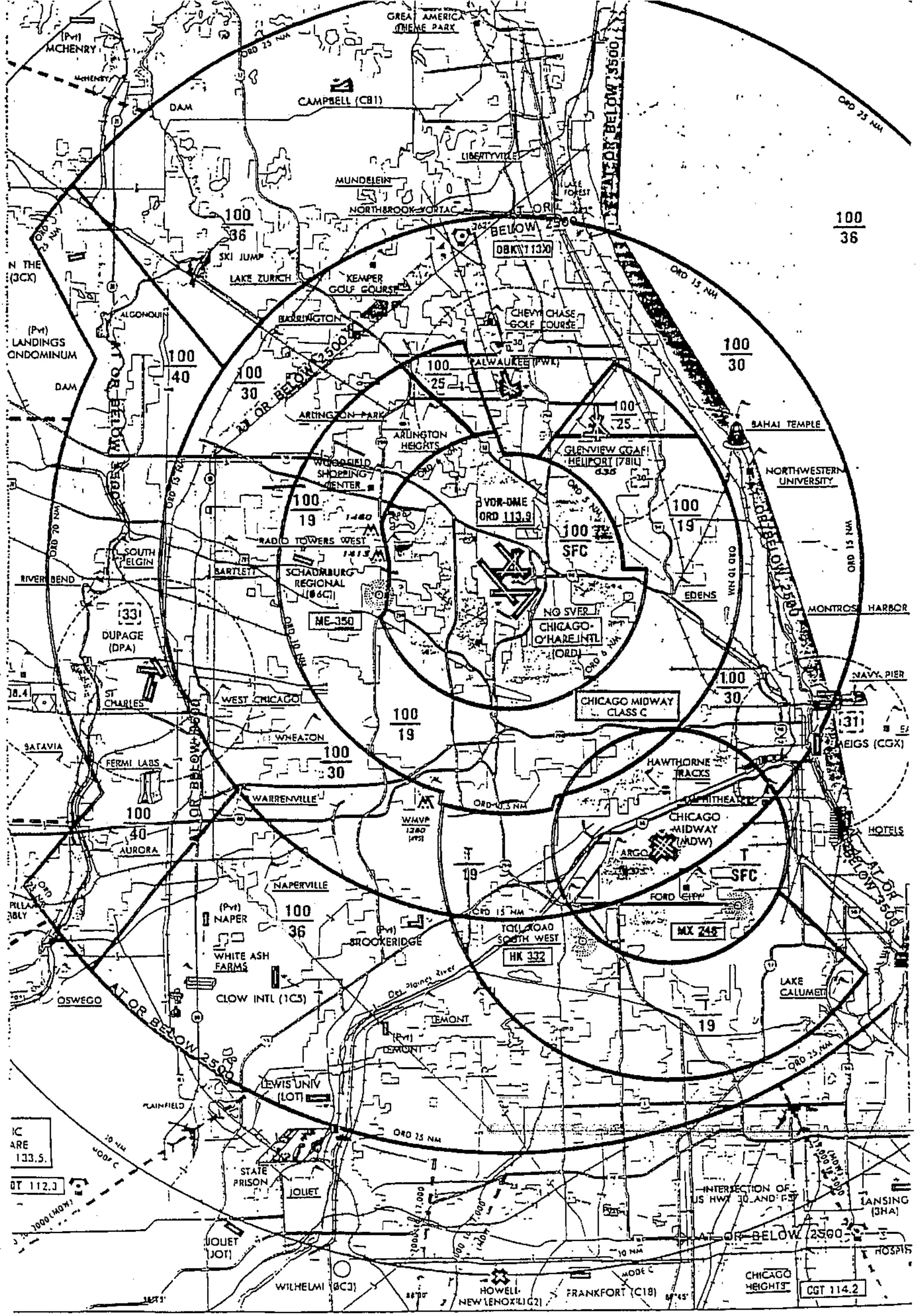


Figure 22. The proposed marker route overlaying the current Chicago TCA map

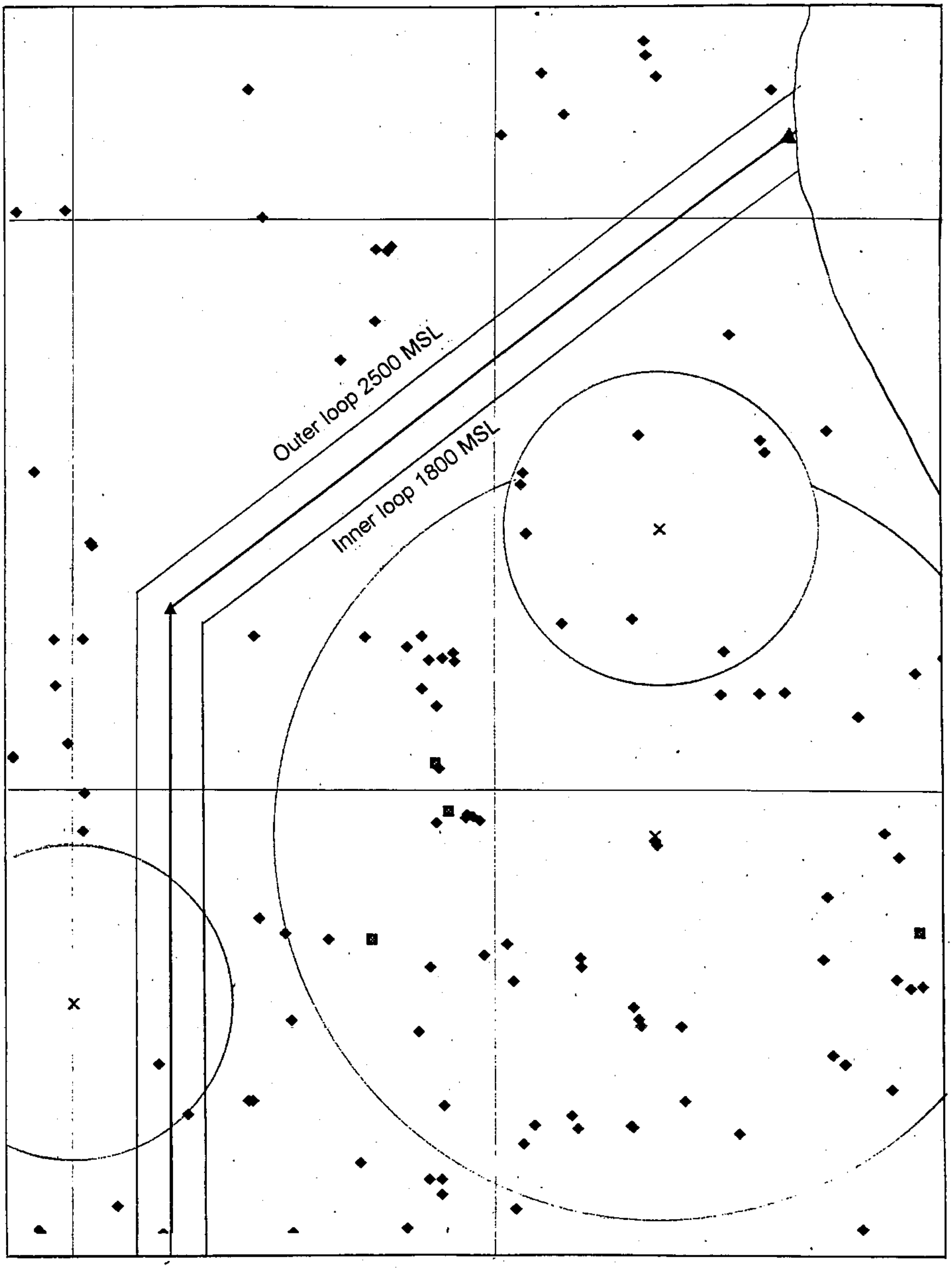


Figure 23. The upper portion of the proposed MVLF marker route.

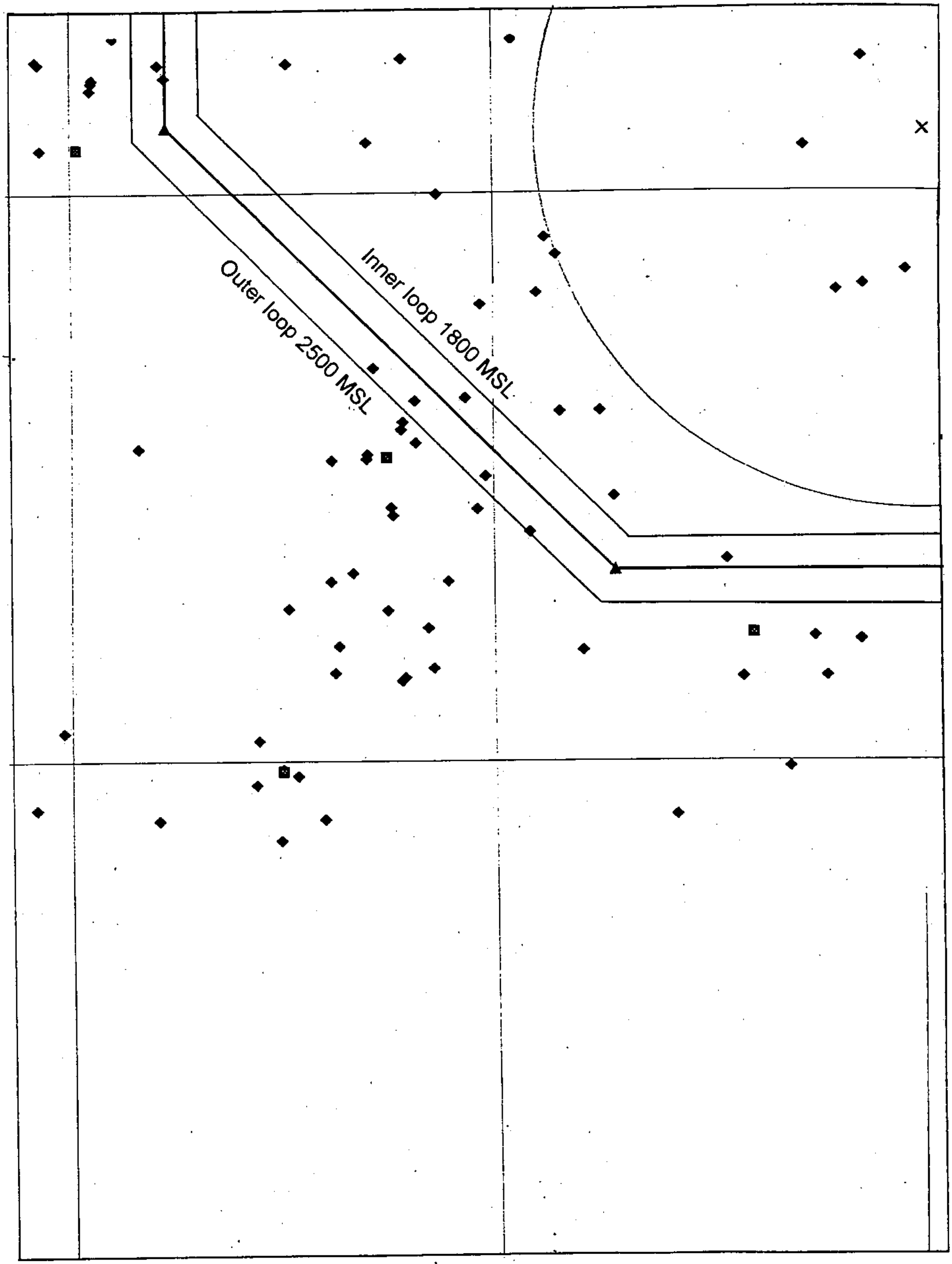


Figure 24. The center portion of the proposed MVLF marker route.

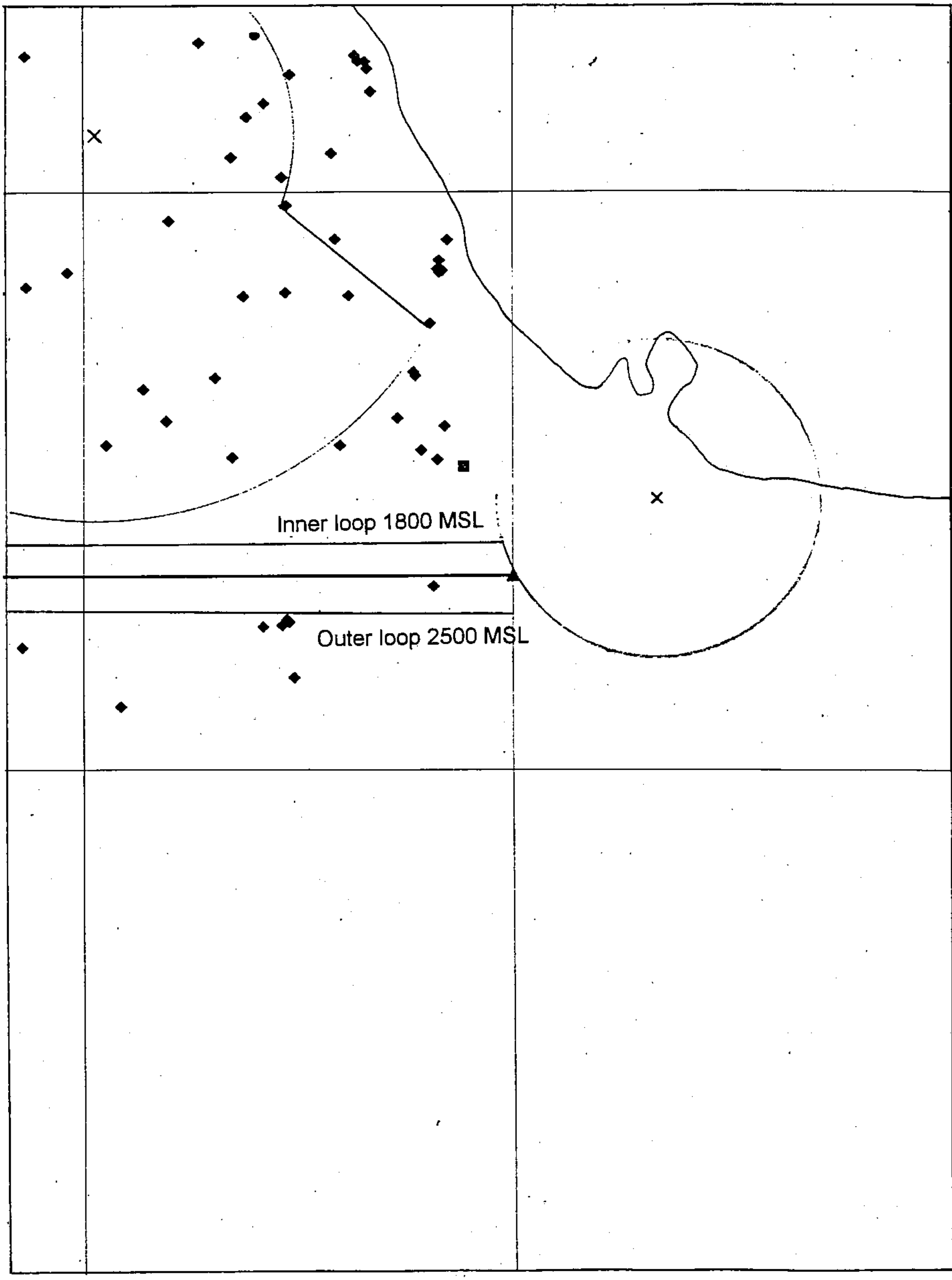


Figure 25. The lower portion of the proposed MVLF marker route.

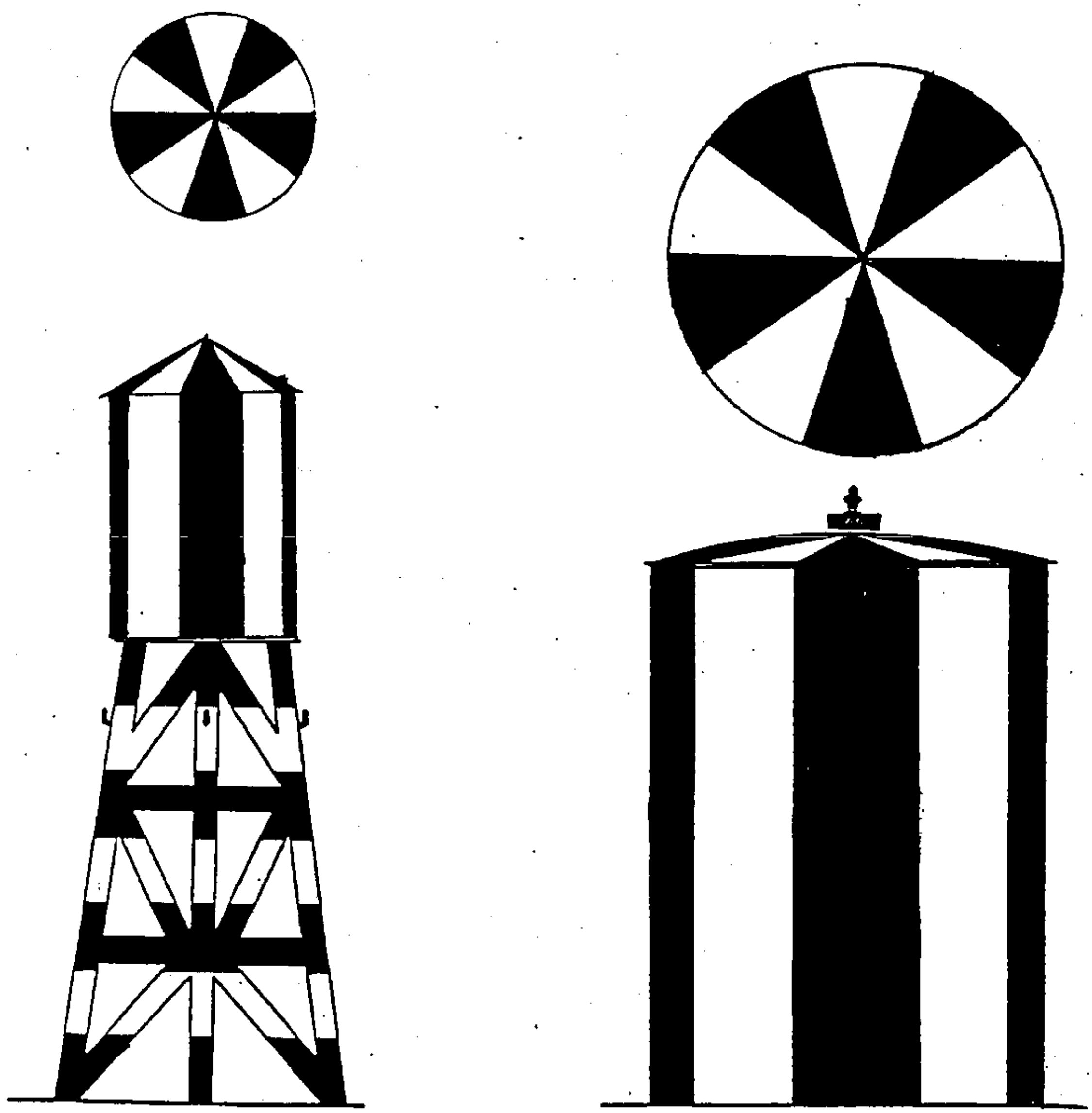


Figure 26. The proposed MVLF marking pattern for water towers, storage tanks, or similar structures.

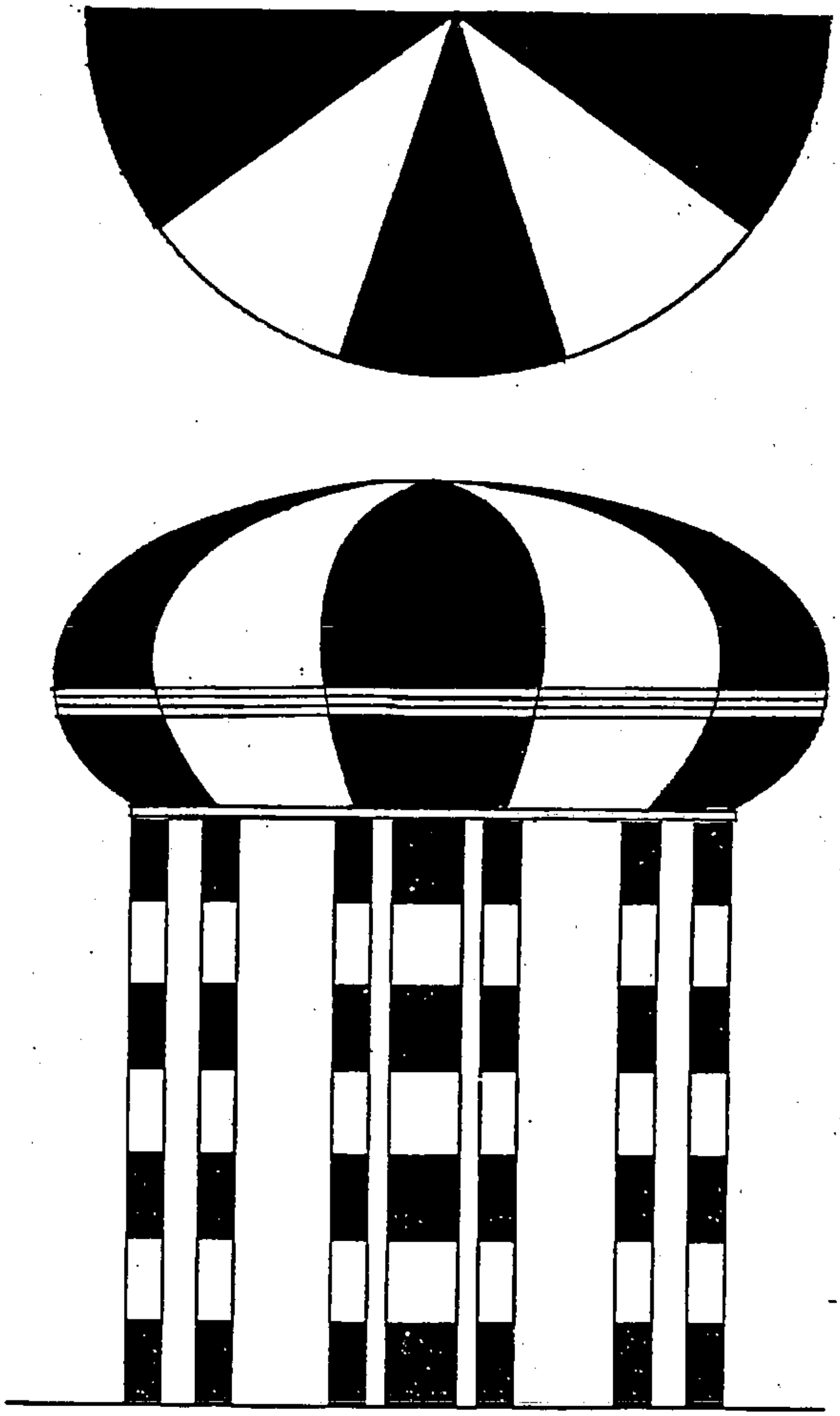


Figure 27. The proposed MVLF marking pattern for water towers.

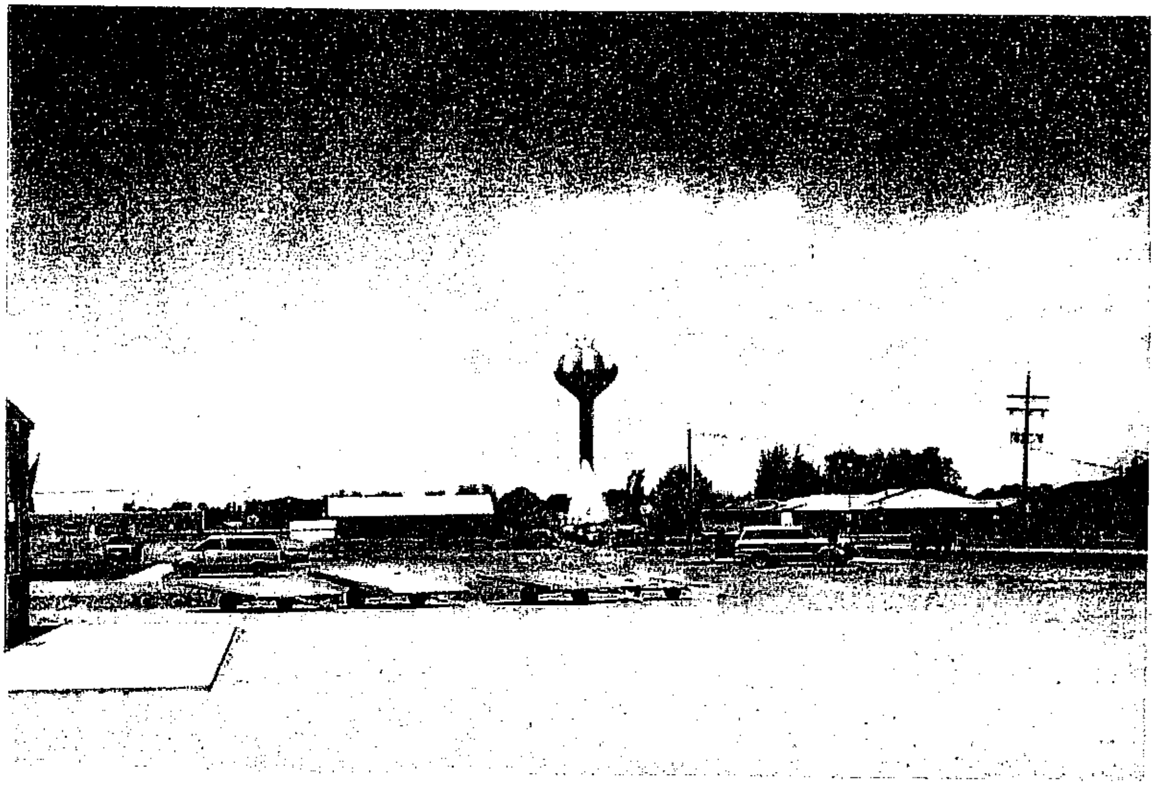


Figure 28. An actual water tower with similar marking pattern for the MVLF

Appendix I Current Activities and Future Growth in Aviation

The FAA forecasts an increase in all aspect of aviation from commercial airlines, air taxi, and general aviation to military activities. This is relevant to this research by establishing the need for additional innovation to increase safety and efficient operation of airport facility.

The report entitled "FAA Air Traffic Activity Fiscal Year 1993" was published as a guide to determine the need for larger or additional facilities, upgraded equipment at particular facilities, and an increase in personnel at the existing facilities. The report provides the terminal and en route air traffic activity information of the National Airspace System as reported by the FAA-operated Air Traffic Control Towers (ATCTs), Air Route Traffic Control Centers (ARTCCs), Flight Service Stations (FSS), Approach Control Facilities, and FAA-contracted ATCTS. From the data collected, the number of departures handled by the Chicago center ARTCCS was 1,065,789, of which 259,762 were general aviation, or approximately 24.3 percent of the total. The number of overflight activities reported in this area was 528,140, with general aviation contributing 22,779 or 4.3 percent. Finally, the number of aircraft handled by the ARTCCs in Chicago was 2,266,080, including 27.9 percent or 631,303 general aviation aircraft. The total number accounted for air carrier, air taxi, general aviation, and military activities. The number of activities at FAA FSS by aviation category for the Great Lakes Region was 460,354 total for general aviation, of which 282,512 and 177,842 were VFR and IFR, respectively. There are seven states within the Great Lake region: Illinois, Indiana, Michigan, Minnesota, North Dakota, Ohio and South Dakota. In Illinois, the total number of general aviation activities was 50,548 for general aviation, with 29,426 for VFR and 21,122 for IFR flights. An FSS is an air traffic service facility within the National Airspace System, which provides several aviation services. One of such service is to provide preflight pilot briefings and en route communications with VFR flight. It also assists lost IFR/VFR aircraft, aircraft experiencing emergencies, and relay ATC clearances. It is the responsibility of the FSS to originate, classify, and distribute Notices to Airmen, as well as broadcast aviation weather and Notice to Airmen information. These facilities receive and close flight plans, monitor radio NAVAIDS, notify search and rescue units of VFR, and operate the national weather teletypewriter systems.

In the June 1997 issue of Airport Business, Klinger summarized the FAA forecasts of a continued growth for both commercial and general aviation activities. The article was based on the "FAA Aviation Forecast for Fiscal Years 1997-2008." This forecast is a continuous and interactive process involving the FAA Statistics and Forecast Branch, other FAA offices and services, government agencies, and aviation industry groups. It is used to determine the level of staffing and expenditures required to accommodate the growth of aviation activity, and to maintain a safe and efficient environment. For general aviation, the active fleet is expected to increase by 0.8 percent annually for the next twelve years. This corresponds to an increase in active aircraft from 181,341 in 1996 to 196,600 in 2008. Growth was expected to be moderate in 1997 and then expand by approximately 2,000 aircraft annually for the next four years and 1,300 aircraft a year for the next nine years. Although this corresponds to a slight increase in active fleet (0.7 percent annually), the utilization of general aviation aircraft is expected to increase by 1 percent over the entire forecast period. The number of hours flown by general aviation will rise from the estimated 25.6 million in 1996 to 28.9 million in 2008. The total pilot population will increase from 639,184 to 712,600 by 2008. The rise in student and recreational pilots will rise from 101,511 in 1996 to 117,700 in 2008.

As reported in the second newsletter of the "South Suburban Airport Project 1997," IDOT will be completing the technical planning work for building the South Suburban Airport (SSA). The Environmental Assessment of the area, specified by the FAA, is being completed to explain the purpose and need for an aviation capacity increase in the Northern Illinois region. The two airports serving the Chicago areas O'Hare and Midway are operating at or near their capacity. Further expansions of the two existing airports are not possible due to aviation traffic congestion and limited land space, see Figures A1 and A2. The environmental impact studies including air quality, biotic communities, compatible land use, construction impact, and energy supply of the new airport will be presented in the report. The IDOT and the Chicago Southland Chamber of Commerce have also appointed an international company, Infrastructure Management Group, Inc., to manage fund raising campaign for the SSA facility. In 1993, the number of enplanements from O'Hare, Midway, and Milwaukee airports were 30.0, 2.7, 2.1 million, respectively. By the year 2001, these numbers are expected to increase to 33.0, 6.6, and 4.3 million respectively, an increase 9.1 million. The projected number of enplanements within the Northern Illinois region is illustrated in Figure A3.

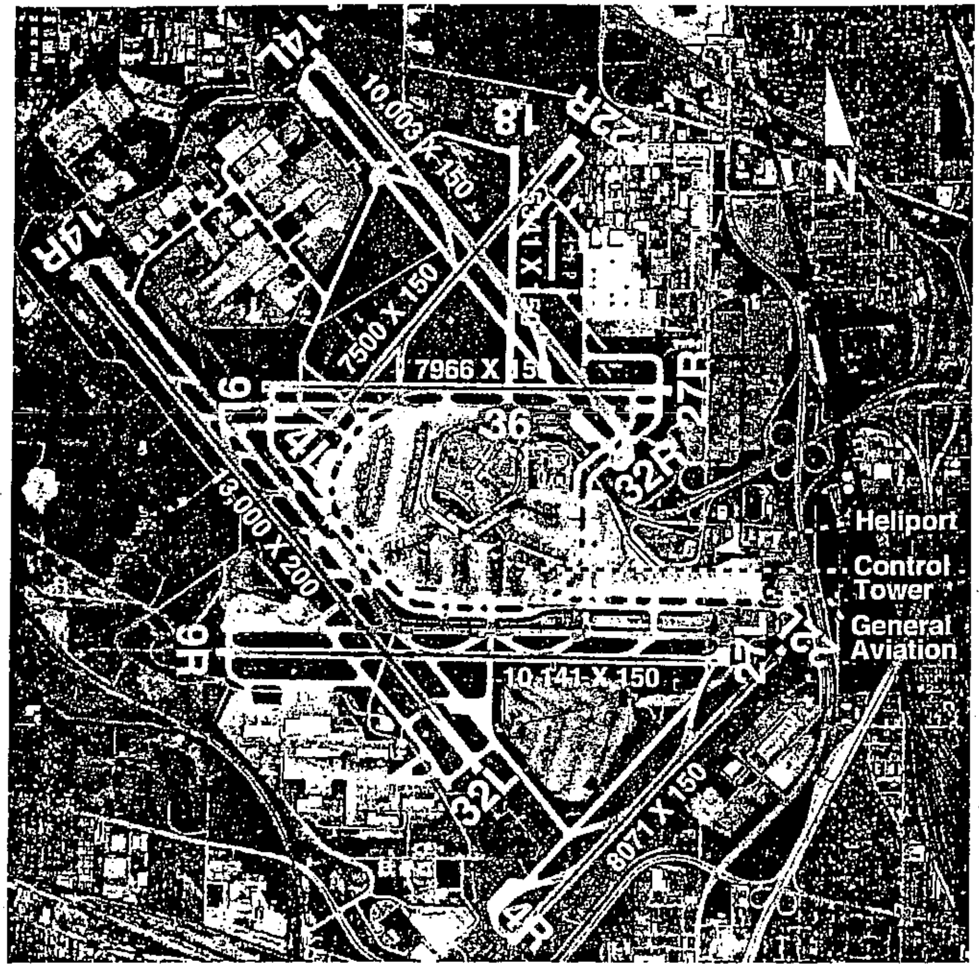


Figure AI-1 Aerial view of the Chicago O'Hare International Airport

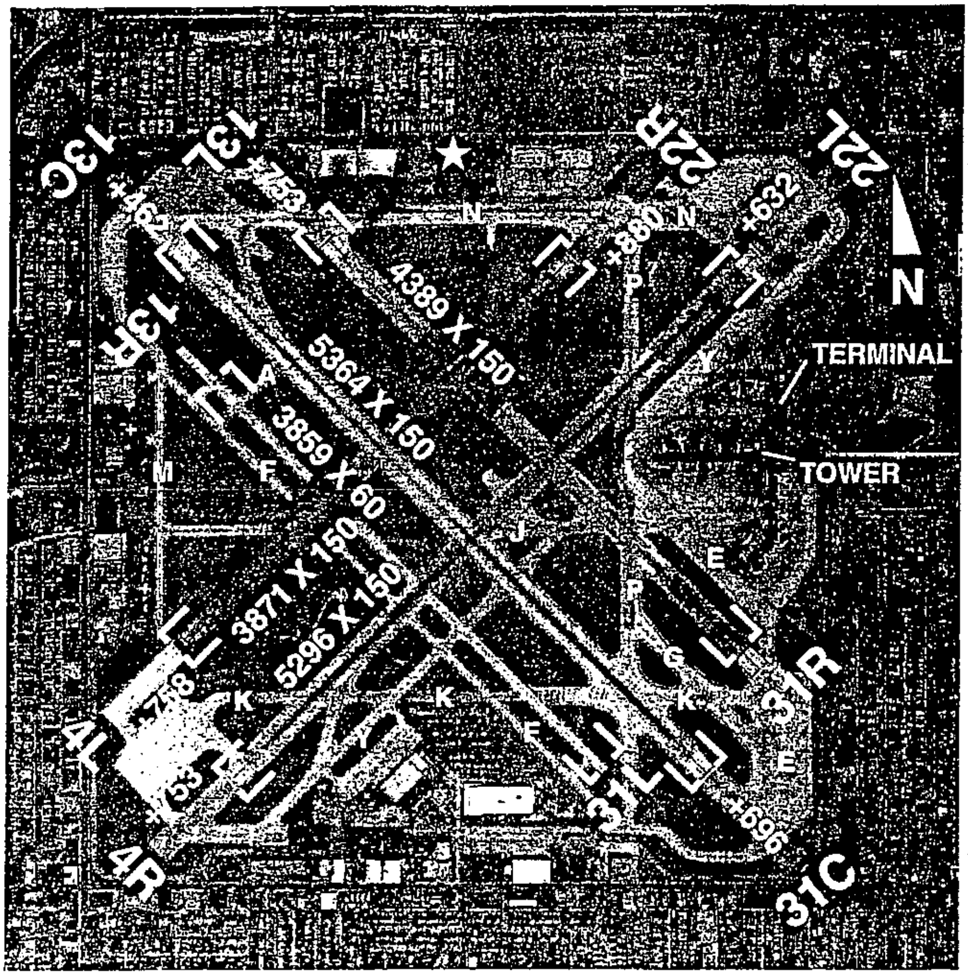
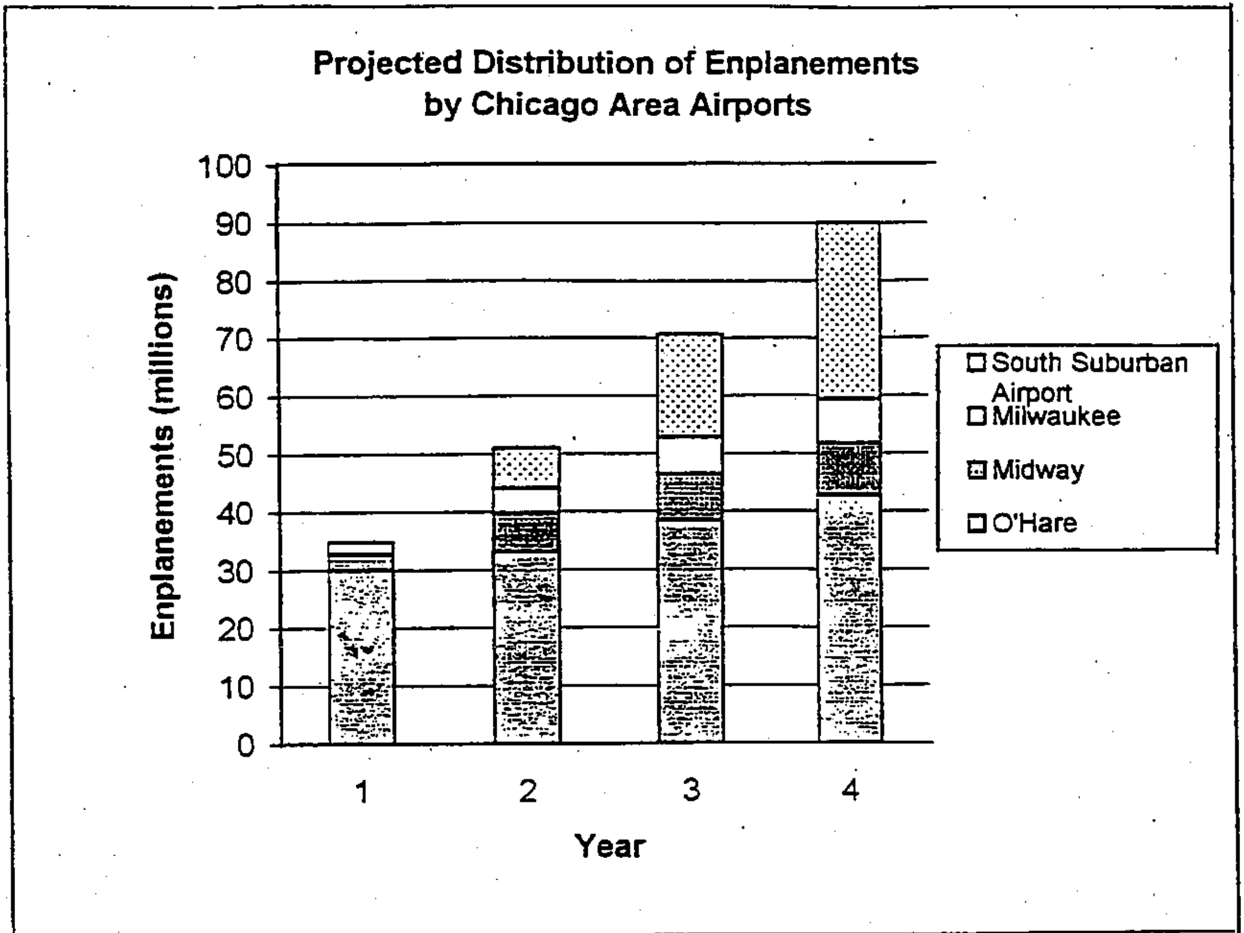


Figure AI-2 Aerial view of the Chicago Midway Airport



Enplanements(millions)	1993	2001	2110	2020
O'Hare	30.0	33.0	38.3	42.6
Midway	2.7	6.6	8.1	9.0
Milwaukee	2.1	4.3	6.3	7.7
South Suburban Airport	0.0	7.1	17.9	30.7
Total	34.8	51.0	70.6	90.0

Figure AI-3 Projected distribution of enplanements for the Chicago area airports.

Appendix II Complexity of Flying and Navigating

A pilot must constantly be aware of the area he is operating in to safely fly and navigate his aircraft. In this section, the responsibility and capabilities of pilot operating under VFR designation are discussed.

Leibowitz discussed the association between the human senses, particularly vision, and aviation. Because most information about the surrounding environment is perceived through the eyes, the capabilities and limitations of the visual system were examined. Leibowitz mentioned, as an example, that at distance of only 1.5 to 3.8 miles, a large airplane is very difficult to detect, as it appears to be quite small. When viewed in a more peripheral region of the visual field, the airplane becomes even more difficult to detect. The contours of objects viewed in the peripheral region will also become obscure, making it even more difficult to see. The smaller the airplane the more difficult it will be to notice. The small image may resemble an imperfection in the windshield, especially when the pilot is observing it directly. There are countless numbers of incidents where, under optimum conditions, pilots were unable to detect other aircraft in the vicinity even though they were informed and given the relative position of the other aircraft. Furthermore, two airplanes approaching one another in a straight line, at a constant speed, will appear to be stationary to one another. Airplanes on a collision course will remain in the same position in the windshield of the approaching aircraft. The human ability to detect objects in the peripheral field is assisted by movement. Thus, the lack of movement of the aircraft on a collision course, and the small image size, contribute to the difficulty in noticing it. Leibowitz also discussed how a pilot's reliability of air traffic control systems inadvertently lowered his/her responsibility to recognize approaching aircraft. Under most flying conditions, especially in the vicinity of an airport, the ATC maintains sufficient clearance among aircraft by providing information about other aircraft within the area. Most pilots are aware that ATC systems are not invulnerable to errors and that they are ultimately responsible for seeing and avoiding other aircraft. Nevertheless, the high reliability of these systems and the low probability that aircraft will be on a collision course reduces a pilot's expectation of such a collision. However, no matter how insignificant the probability, it is still enormous when dealing with human lives. To detect traffic within the vicinity, pilots must shift their attention away from the instrument panel in order to scan outside for other aircraft. The time required in recognizing an unexpected object may be several seconds longer than if it was anticipated. In aviation, as every pilot is aware, every second counts.

In Trollip and Jensen's Human Factors for General Aviation, the authors examined the role of the eyes in perceiving and sending information to the brain. It is the brain that processes all visual data perceived, and if the brain misinterprets this information, it could lead to an inaccurate or deceptive perception by the pilot. Both the physical attributes of the eye and how the brain processes visual information can account for this distortion. However, the later is much more complex because the brain's capabilities are often based on experience and expectation. Regardless of the expertise level, visual illusion does occur, and a normal situation can be easily misinterpreted. The most dangerous is illusion related to a potential mid-air collision which occurs most often when two airplanes are approaching head-on, converging from the side, or climbing or descending on the same flight path. When two aircraft are below 3,000 ft AGL, it is possible and legal for the two planes to be at the same altitude, heading on an intersecting course. Even above 3000 ft AGL, where cruising altitude rules applies, two planes could be converging such as when there is poor altitude control. For example, a VFR flight heading east and an IFR flight heading west can collide in midair if both aircraft are a couple of hundred feet off of their designated altitude. It is difficult to detect an oncoming aircraft because there is minimal or no relative motion. It is easier to see an object if it is moving. Figure A4 illustrates the relative size of a Cessna 172 and the approximate time to impact at various distances. The time to impact was determined for two airplanes closing at a speed of 250 knots (288 mph). The dimension of this airplane is 30.5 ft from wingtip to wingtip, and 8.5 ft from the tip of the rudder to the ground. Notice that this is an image of a Cessna by itself, without any background distraction. Imagine how difficult it would be in the real world scenario. The second type of potential midair collision is when two airplanes are traveling in the same general direction, but are on a converging course. If an airplane is traveling at a certain speed in the general direction of another airplane, the relative motion between the two airplanes is not apparent (see Figure A5). The third potential midair collision exists when an airplane is climbing or descending directly along the path of another (see Figure A6). This situation is more critical when the higher airplane has a low winged position and the lower airplane has a high winged position because the pilot in the airplane above cannot see below the pilot in the airplane below cannot see above (see Figure A7). The only precaution for this is to make shallow S-turns to improve the ability to detect other aircraft. Performing the S-turns can also make the aircraft noticeable to other aircraft.

In Paprocki's technical report to the FAA, the response to the problems encountered in the field operation of the John F. Kennedy's Runway 13L lead-in lighting systems was discussed. The approach lights provide visual guidance to pilots from the Canarsie VOR to the runway. The system consists of three lighting segments, each 2,000 ft long with eleven pulsating lights. One portion of the system has performed inadequately due to the relationship between the centerline direction of the sequenced flashing and the flight path of aircraft as they approach the runway. The difference between these two lines was approximately 40 degrees. This was different from other segments, which have a centerline that nearly coincides with the general flight path to the runway and have performed quite satisfactory. Field testing of a setup similar to that of the 200-ft spacing used in the JFK Airport system proved that the approach light system's effectiveness was significantly reduced. The flashing appeared to be individual and random instead of a pulsing system of lights. Thus, when spaced at twice the normal distance of 100-ft intervals, the effect of the lights is diminished. By relocating the lights of this ineffective segment, the performance was as equal to the other two segments.

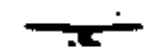
Approximate Distance		View	Approximate Time to Impact
1 n.m.	1850 m		14 seconds
1/2 n.m.	925 m		7 seconds
1/4 n.m.	460 m		4 seconds
1/8 n.m.	230 m		2 seconds
1/16 n.m.	115 m		1 second

Figure AII-4 Relative size and time to impact of a Cessana 170 aircraft on a head-on course.

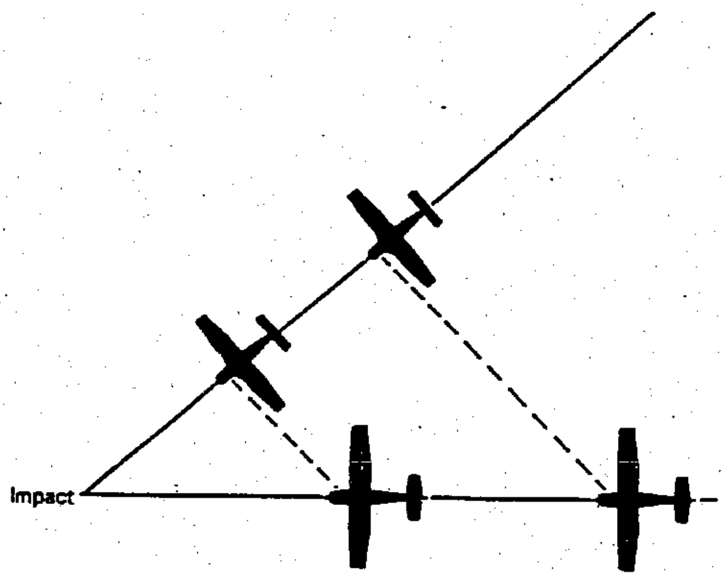


Figure AII-5 Two airplanes converging.

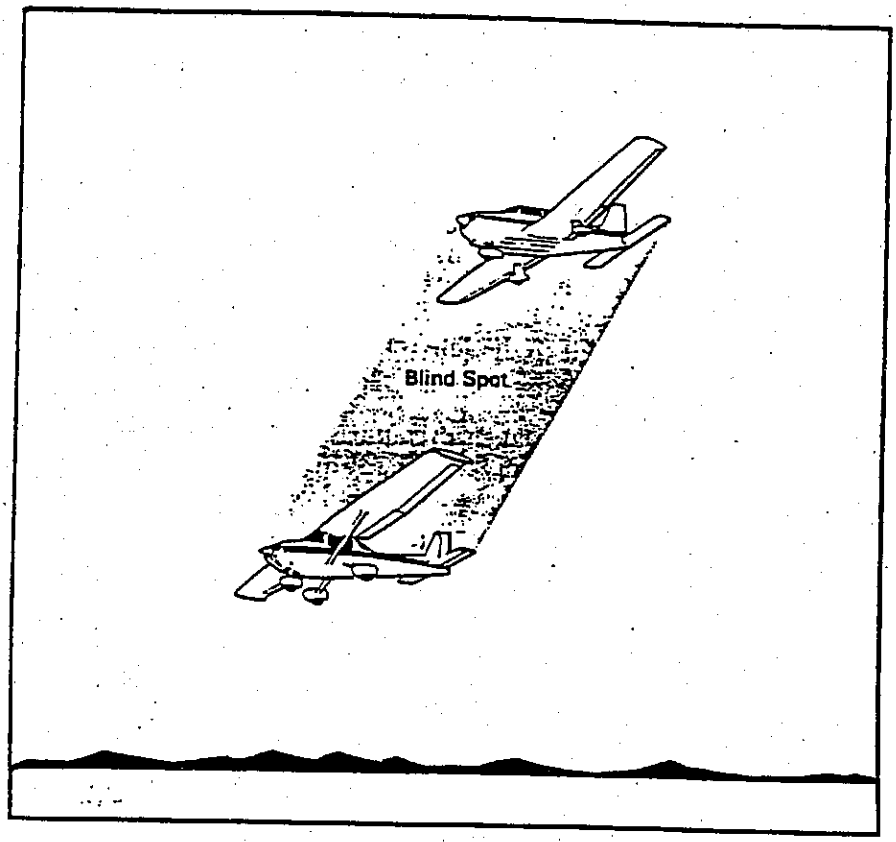


Figure AII-6 Blind spot of two airplanes.

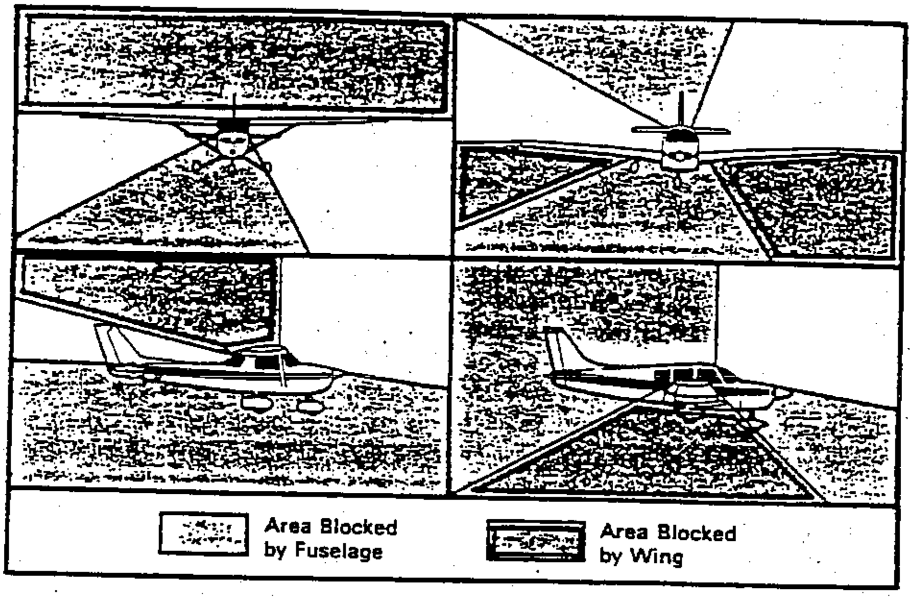
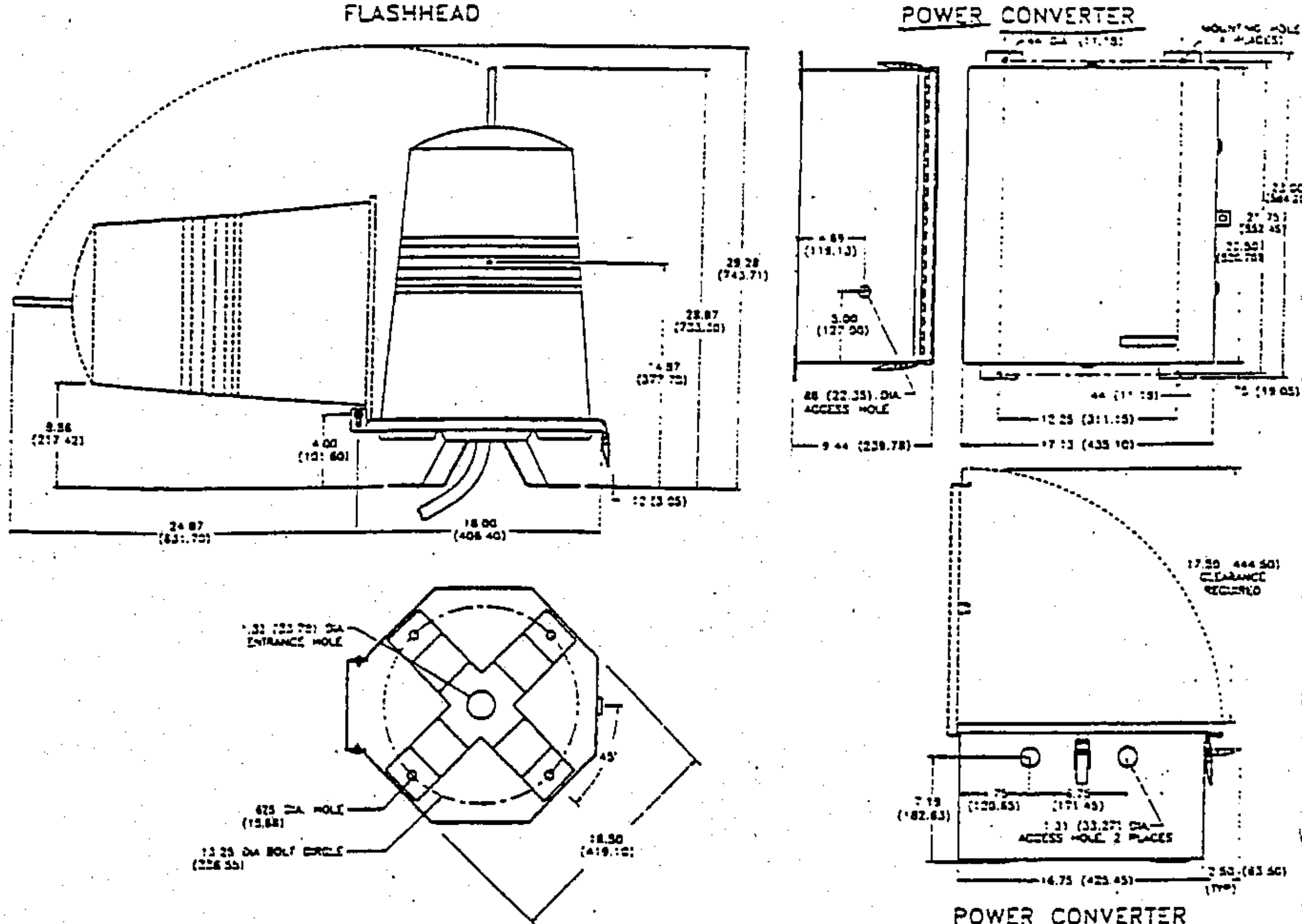


Figure AII-7 Blindspot of high-, low-wing positioned airplanes.

Appendix III Flash Technology Corporation's Flashhead FH 301 Heliport Beacon

Physical Dimensions



FLASHHEAD
NOTES.
1. Weight: 15 lbs (5 kg)
2. Wind area: 1.99 sq ft (0.18 sq m)
3. All dimensions are in inches and (millimeters)

POWER CONVERTER
NOTES:
1. Weight 67 lbs. (30.4 kg)
2. Wind area: 2.4 sq ft (0.22 sq m)
3. All dimensions are in inches and (millimeters)
4. Side hole may be used for PEC, if required

FLASH TECHNOLOGY

System Performance Data:

Flashhead - FH 301

8,000 ± 25% effective candelas - high
2,500 ± 25% effective candelas - high-ICAO
2,000 ± 25% effective candelas - medium
250 ± 25% effective candelas - medium-ICAO
75 ± 25% effective candelas - low

A group of 4 flashes (Morse Code "H") in 0.8 second with a 1.2 second interval between groups.
360° Horizontal Coverage
11° Vertical Beam

Power Converter - PC 736

120, 208, 240, 480 Volt 60 HZ, or 230 Volt 50 HZ, single phase (specify on order)
150 watts maximum power consumption
50 watts maximum power consumption ICAO
250 VA peak
Status relay with form C contact, contacts change state on fail

OPTIONS:

Interconnect cable - P/N 6340 (PC 736 to FH 301)
(Conduit is not normally required)
Available with three switchable intensities up to 8,000 effective candelas
System installation

APPLICATIONS:

All heliport landing pads such as hospitals, off-shore rigs, military, municipal, police, private.

Appendix IV Calculation of Objects Area for 3 Statute Miles Viewing Distance

Viewing		Object		Angle
Distance[a]	Angle[b]	Area[c]	Radius[d]	Sustained[e]
1,000 m 100,000 cm	1 min	665 cm sq	14.5 cm	0.0083 deg
	1 deg	2,330 cm sq	27.2 cm	0.0156 deg
	5 deg	9,330 cm sq	54.5 cm	0.0312 deg

[a],[b], and [c] are data from the Visual Aids Panel
[d] = square root([c]/3.1415)
[e] = arctan([d]/[a])

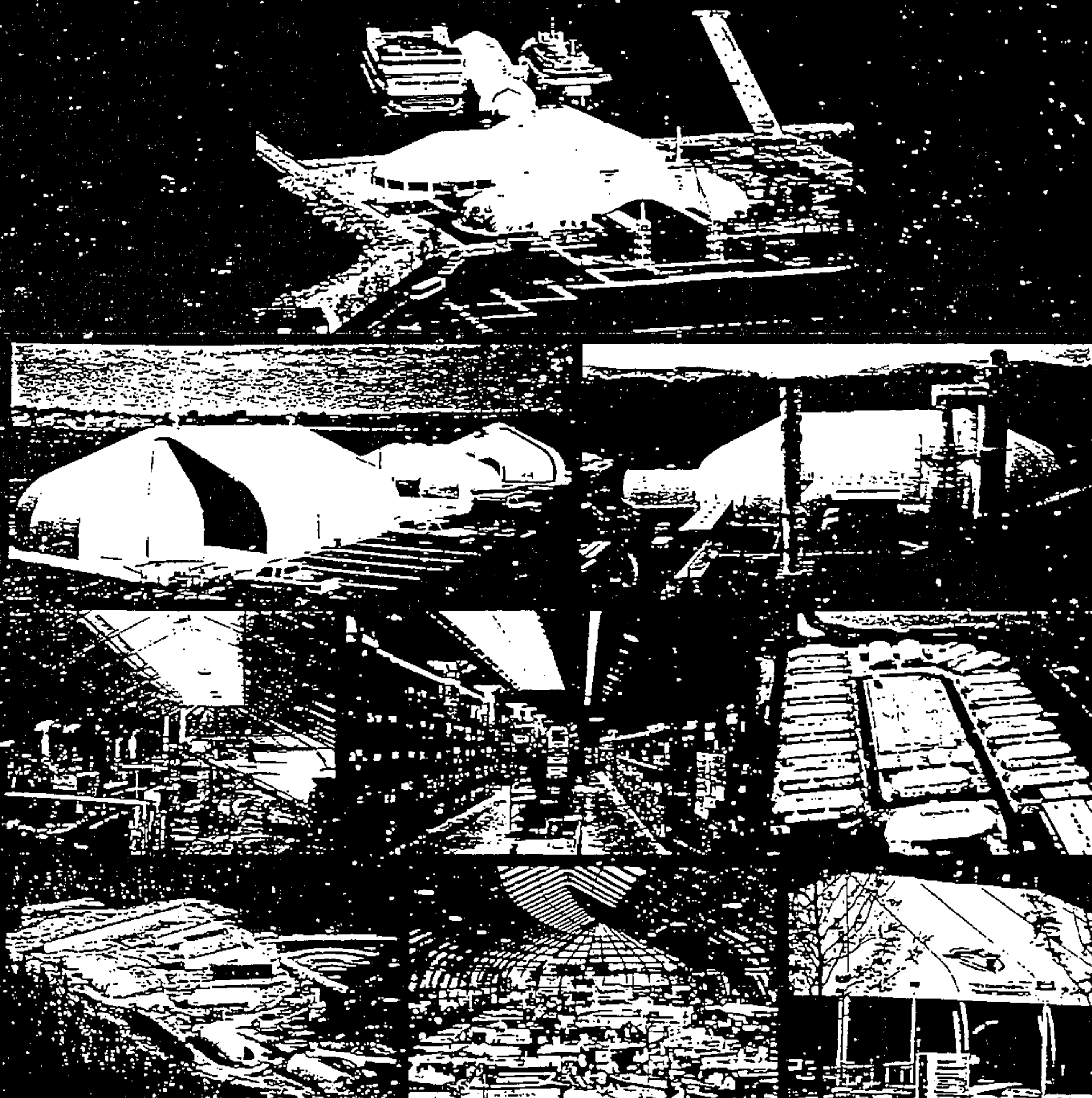
Viewing		Angle	Object	
Distance[f]	Angle[g]	Sustained[h]	Radius[i]	Area[j]
3 miles 15840 ft	1 min	0.0083 deg	2.29 ft	16.5 ft sq
	1 deg	0.0156 deg	4.22 ft	55.8 ft sq
	5 deg	0.0312 deg	8.43 ft	223.2 ft sq

[h] = [e], determined from Visual Aids Panel data
[i] = tan [h] * [f]
[j] = 3.1415 * [i]*[i]

Sprung Instant Structure's projected area
From the side, the structure can be divided into two parts:
a triangular on top of a rectangular, ie (0.5*7*30) + (8*30) = 345 ft sq

Appendix V Sprung Instant Structure

SPRUNG INSTANT STRUCTURES INC.



MANUFACTURERS OF STRESSED MEMBRANE STRUCTURES

THE COMPLETE SHELTER SYSTEM

The Sprung Structure is designed and engineered to accommo

Sprung Instant Structure's 5 acre manufacturing and distribution facility in Salt Lake City, Utah.

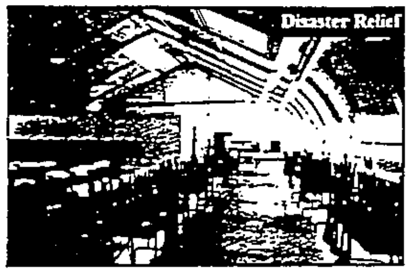
THE COMPANY

As a member of the Sprung Group of Companies, in business since 1887, *Sprung Instant Structures* has achieved international recognition by providing shelter solutions for thousands of different applications in over ninety countries throughout the world.

THE STRUCTURE

The Sprung Structure is constructed from extruded aluminum arches, integrally connected to a highly tensioned all-weather outer membrane.

The membrane is a durable P.V.C. coated polyester scrim treated with U.V. inhibitors. It is fire retardant (i.e., self extinguishing), California State Fire Marshall approved and passes UBC 55-1, NFPA 701, UL 214 and ASTM E84.



Disaster Relief

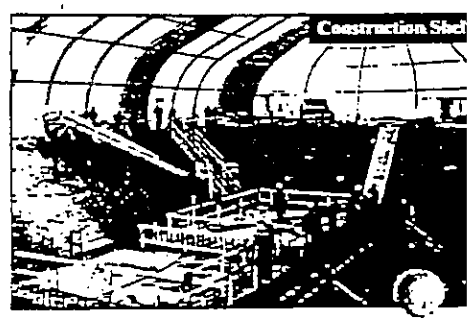
ENGINEERING

Sprung Structures can be designed to meet windloads in excess of 155 mph and by design shed snow. Sprung Structures may be designed to meet special requirements and to comply with virtually any local codes and standards.

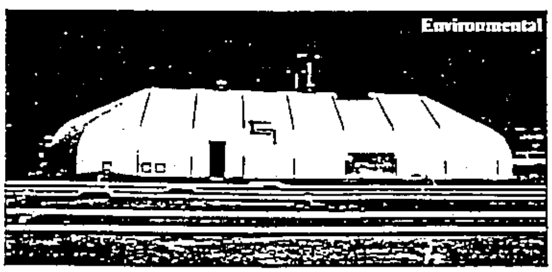
Mining

APPLICATIONS

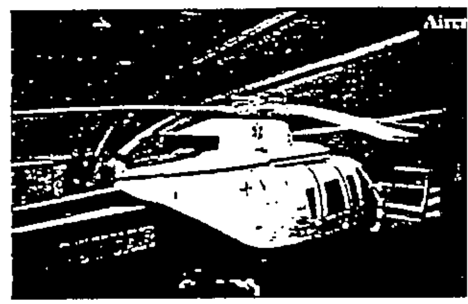
The Sprung Structure is utilized in virtually every segment of industry in every climatic zone. Temporary or semi-permanent, Sprung Structures have been utilized for: Airline & Cargo, Amusement Parks, Churches & Educational Facilities, Construction & On Site Warehousing, Disaster Relief, Environmental, Exhibitions, Gaming, Gold, Inmate Housing, Military, Oil & Gas, Public Works, Sports & Recreation and Sporting Venues.



Construction Shel



Environmental



Airc

LIMITED FOUNDATIONS

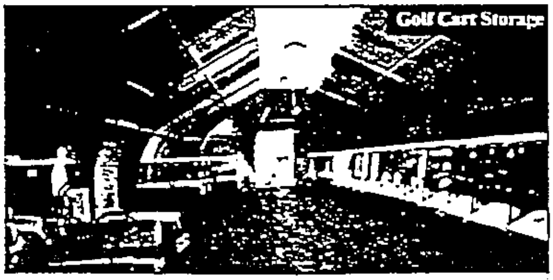
Sprung Structures can be erected on any reasonably firm ground surface. Foundations are not required for structures up to and including 88.6 feet wide. Small footings are required on wider structures.

BENEFITS:

- Substantial cost savings on site preparations.
- Minimal site restoration following relocation.

Salt Storage

Multi-Functional Sanctuary Sp



Golf Cart Storage

AVAILABLE IMMEDIATELY

With over two million square feet in inventory, Sprung Structures can normally be shipped anywhere in the world within days. Approximately 2,000 square feet can be erected per day with a crew of six laborers under the supervision of *Sprung Instant Structure's* factory trained technical consultant.

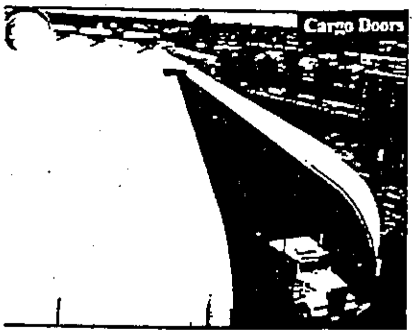
BENEFITS:

- Start your project immediately.

No other system gets you in business faster, is mo

Y SPRUNG INSTANT STRUCTURES

he world's need for enclosed space quickly and economically.

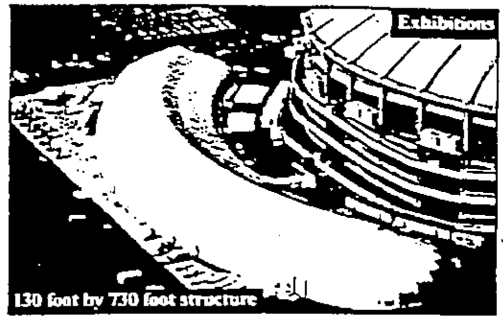


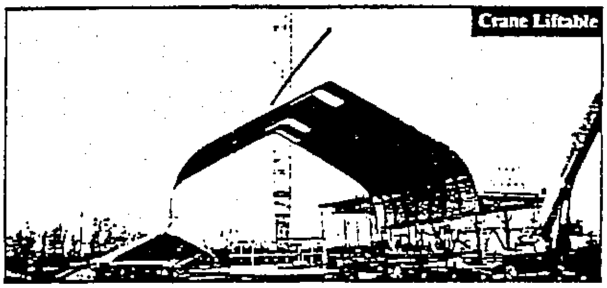
SHIPPING

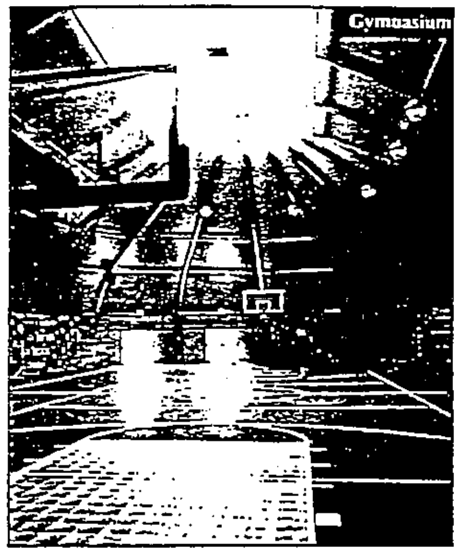
Up to 20 thousand square feet of Sprung Structure can be shipped on one flat bed truck or in one standard 40 foot container.

BENEFITS:

- When compared to conventional construction, Sprung Structures represent dramatically lower shipping costs anywhere in the world.
- Ideal for remote locations.







RELOCATABLE

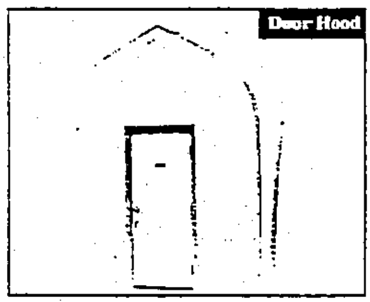
Sprung Structures are 100% relocatable.

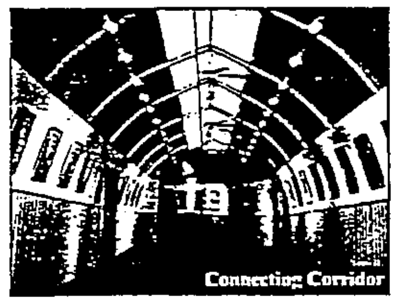
BENEFIT:

- Flexibility offers substantial savings.

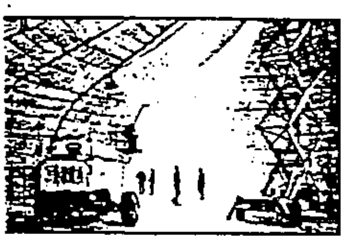
FEATURES:

igned to accommodate doors or windows of any size.
- Requires little or no maintenance.
- Can be completely environmentally controlled.
- Door hoods to deflect snow and rain.
- Patented skylight system.
- Connecting corridors.

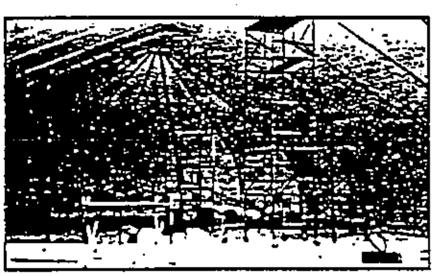




OPTIONAL INSULATION PACKAGES



Fiberglass insulation specified to customer needs.



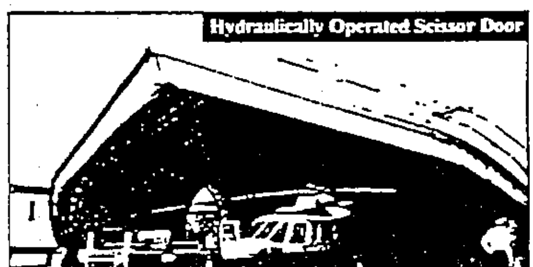
Insulation system finished with an attractive integrally tensioned interior liner.

LEASE OR PURCHASE

Sprung Instant Structures provide a number of attractive lease programs, all with options to purchase.

BENEFITS:

- Lease of a structure allows capital to be allocated to other projects.
- Provides a highly economical solution for temporary applications.



GUARANTEE

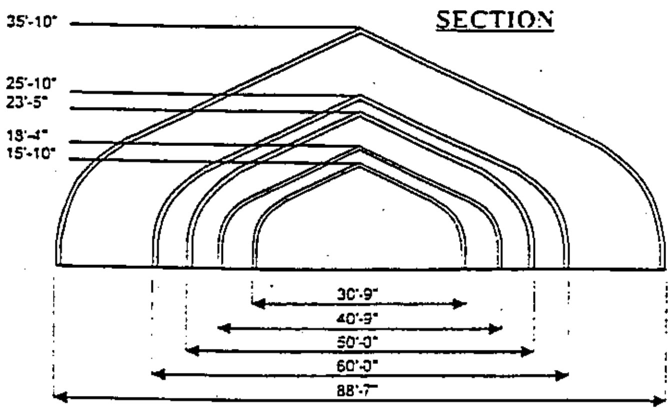
Sprung Instant Structures offer a pro-rata guarantee of 25 years on the aluminum substructure and 8 and 12 years on two membrane alternatives.

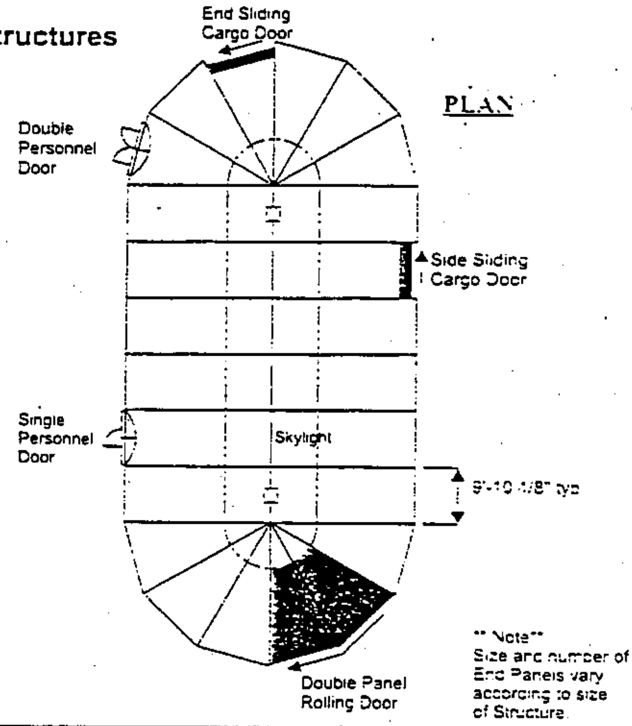
BENEFIT:

- Proven longevity and experience.

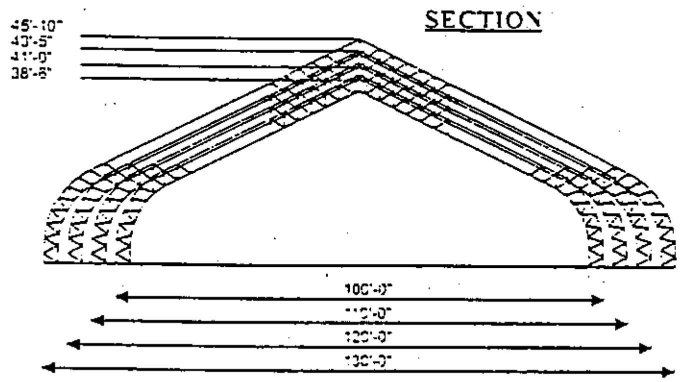
nomical and offers more flexibility for the future!

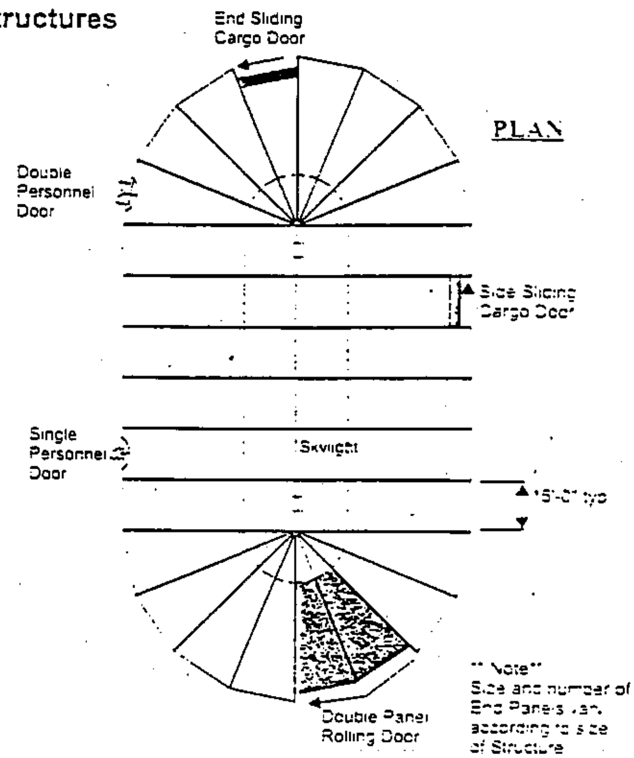
30' to 88.6' Wide Structures





100' to 130' Wide Structures

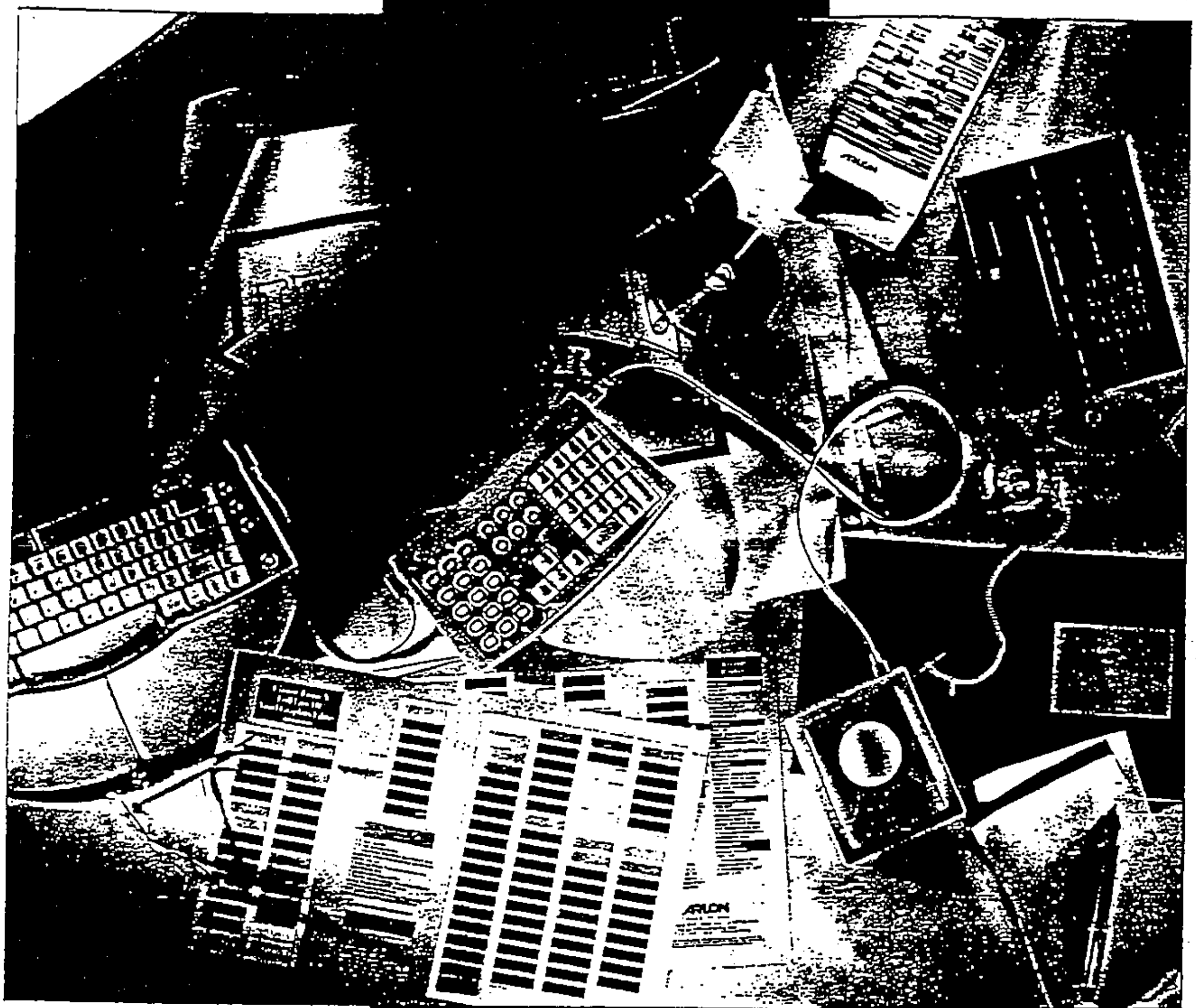




ADDITIONAL RESOURCES:

1. *Comprehensive promotional video.*
2. *15 different industry specific brochures available.*
3. ***Internet Home Page.** An extensive picture archive available for viewing. **http://www.sprung.com***
4. *Regional offices located throughout the U.S.*

Appendix VI Arlon and Universal Product: Vinyl Film Catalogs



Promoting The Designer's Art

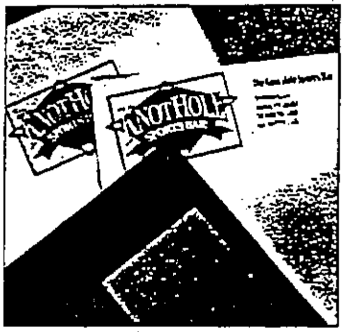
World Class Vinyls

Color

Selection Guide

A Commitment T

Great Ideas Require Great Products.

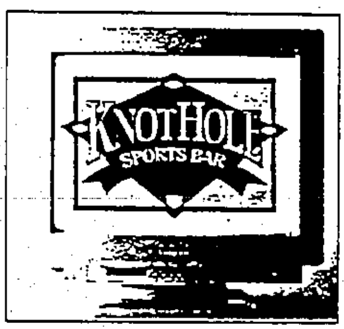


As a designer, you demand quality materials. Vinyls must cut precisely and weed easily. And they must be available in a wide selection of colors to give free reign to your creativity.

As a business person, you also demand quality. Vinyls must provide superior performance characteristics that adhere to the surfaces you select. Because you don't have time to go back and repair or redo a job.

That's why you demand Arlon vinyls.

Advanced Technology: Your Competitive Edge.



Arlon's advanced technology helps you eliminate waste to maintain your competitive edge. As a result, we offer:

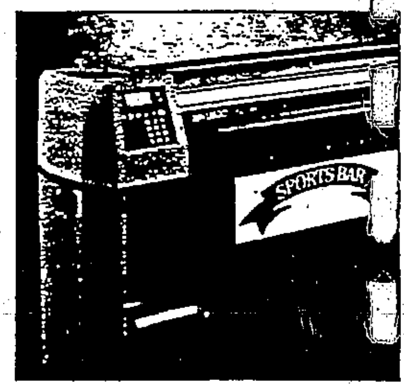
- Excellent balance between the adhesive and the liner for perfect cuts
- Films designed for a wide variety of applications — from small features to large graphics — that reduce your inventory and storage costs
- Superior adhesive systems for a long shelf life
- A broad range of sizes to fit most friction or tractor-fed plotters, including 1/2" on-center sprockets

Thorough Testing for Consistent Results.

Arlon is the first vertically integrated ISO-9001 Certified company in the industry. This means our manufacturing processes have met the toughest international standards for consistent quality — from pigment milling to the finished converted rolls.

However, we haven't rested on our laurels. We continually look for ways to increase quality.

For example, statistical process control confirms color consistency during casting and is used to maintain consistent adhesive thickness during coating.



Ongoing testing ensures consistent "tack" quality.

Final inspection during the converting process eliminates any defects from becoming customer problems.

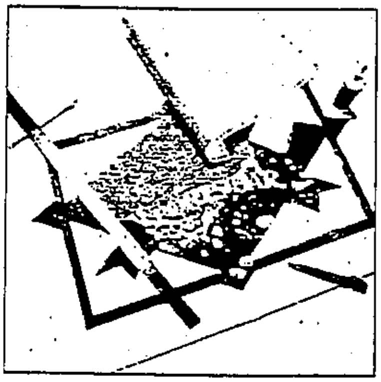
And use of accelerated and real life testing ensures colorfastness, dimensional stability and adherence to a wide variety of substrates.

That's why you can always specify Arlon vinyls with total confidence.

Quality And Service.

Manufactured for the Most Demanding Jobs.

Arlon is a diversified manufacturer. Because we produce a complete range of vinyls, we can be more responsive to your needs:



- The unique formulation of Arlon vinyls allows you to confidently work on virtually any size sign knowing that the vinyl won't crack, peel or wrinkle over time.
- Superior adhesive properties allow you to work with a variety of substrates, from banner stock to glass, from wood to metal.
- Excellent conformability enables you to easily work on non-uniform and curved surfaces.
- And if you produce backlit signs, you can see the quality of Arlon translucent vinyls: every time you turn on the light you get uniform, consistent color.

You demand quality. We supply it. Guaranteed.

World Class Service.

"How do I apply Arlon vinyls over rivets?"

"Will your translucent vinyls withstand a 300 watt light?"

"Do Calon II vinyls adhere in sub-freezing Montana winters?"

If you've got questions, we've got answers.

As a full-service company, we provide a dedicated staff to support you — including technical, sales and customer service reps.

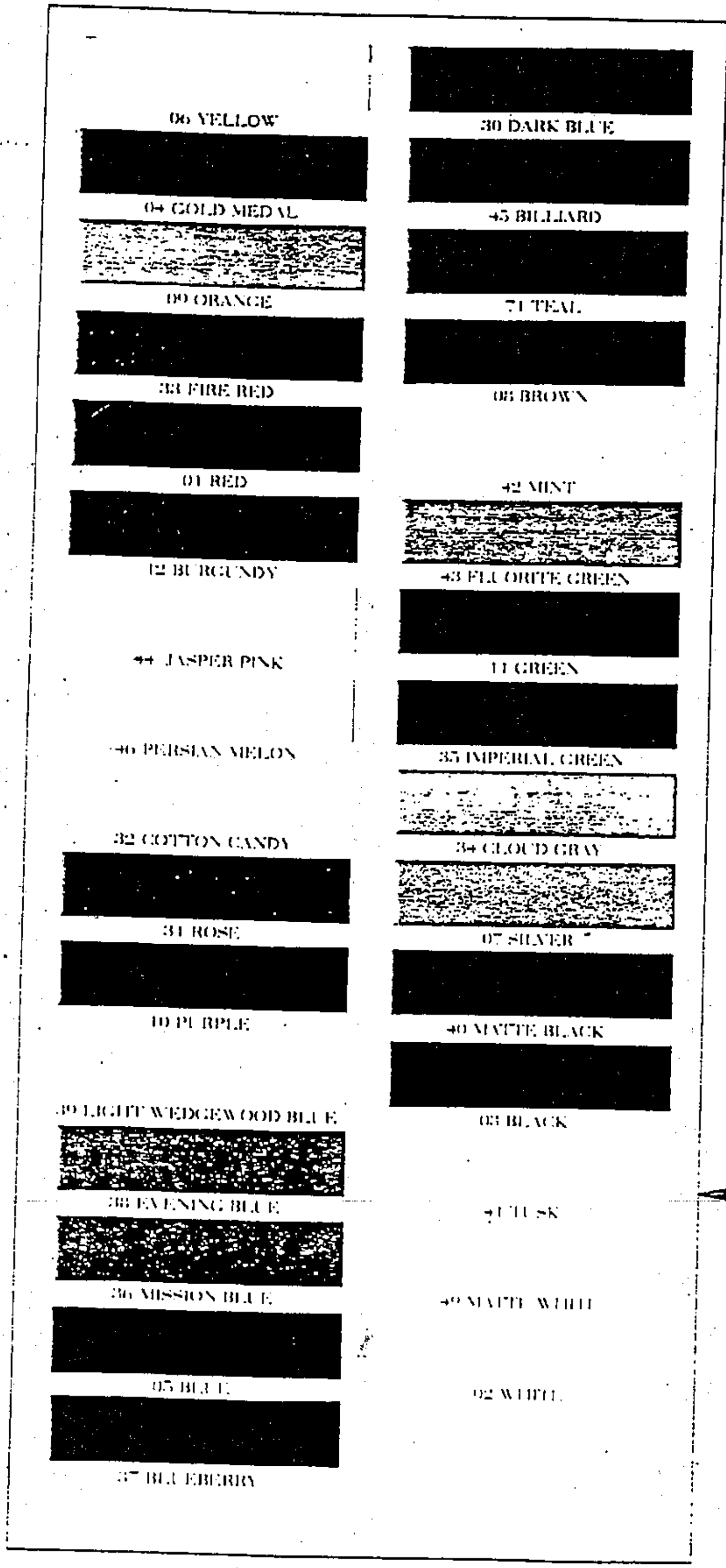
We work with you directly through our educational services, training sessions and open houses, so you have direct access to the experts.

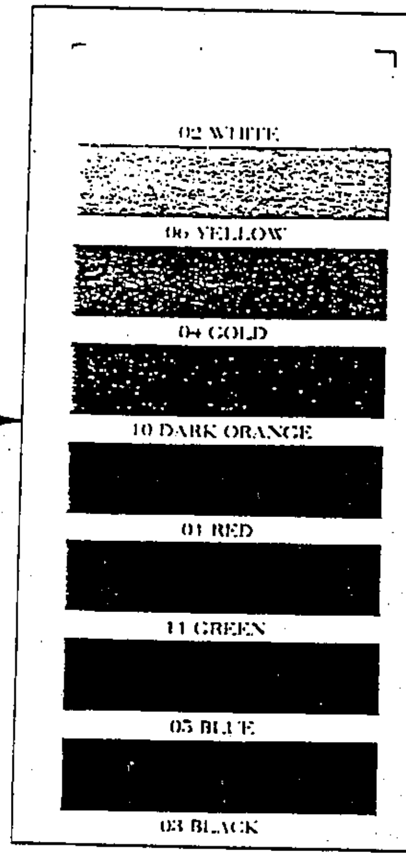
And we offer special services such as custom colors for corporations and custom testing for everybody.

When you buy Arlon products, help is as close as your nearest Arlon distributor. Or your phone.

ARLON

Choose From A Full Line Of Vinyl Graphics Films.





REFLECTA-CAL REFLECTIVE VINYL FILM SERIES 2400/2450

- 8 colors available
- 6.7 mil cast reflective film
- 7 year outdoor durability on flat surfaces. 5 ... on irregular surfaces to maintain high reflectiv... values year after year
- Extremely flexible. Cuts and weeds better than other reflective films
- Excellent dimensional stability
- Ideal for lettering, striping, die-cut logos, highw... signage plus marine and RV markings
- Meets standard specifications: DOT Specific... FP-85 - Section 718, Federal Specification L-S-3... and ASTM-D4956-89

CAL-PLUS CALENDERED VINYL FILM SERIES 4500/4550

- 31 colors available
- 3 mil calendered vinyl
- Extended 5 year outdoor durability
- Dimensionally stable to resist shrinkage
- Unique Calon II adhesive system is compatibl... w... the most popular PVC banners and rigid sign faces
- An excellent value for cost-sensitive projects and... perfect choice for high-speed plotters and produ... environments

Calendered films like Cal-Plus are not recommended for permanent or vehicle applications.

00 CLEAR
67 PRIMROSE YELLOW
06 YELLOW
97 LIGHT ORANGE
22 BRIGHT ORANGE
96 TANGERINE
73 POPPY
14 TOMATO RED
60 BRIGHT CARDINAL RED
42 CARDINAL RED
01 RED
12 BURGUNDY
39 BURGUNDY METALLIC
91 SALMON
95 BRIDAL ROSE
76 MAGENTA
58 DARK MAGENTA
56 HOT PINK
32 RASPBERRY

63 VIOLET
75 LAVENDER
74 ROYAL PURPLE
99 BRIGHT PURPLE
62 PURPLE
92 WEDGEWOOD BLUE
51 ARUBA BLUE
31 OCEAN BLUE
18 OLYMPIC BLUE
32 AZURE BLUE
37 MEDIUM BLUE METALLIC
05 BLUE
17 SAPPHIRE BLUE
66 MEDIUM BLUE
30 DARK BLUE METALLIC
93 LIGHT NAVY
65 MIDNIGHT BLUE
11 DARK BLUE
59 IMITATION GOLD

04 GOLD METALLIC
84 EGGSHELL
26 OYSTER
68 BEIGE
48 CAMEL BEIGE
27 FAWN
94 SANDUST GRAY
78 CORAL
85 COCOA
08 BROWN
35 BROWN METALLIC
79 KIWI
69 APPLE GREEN
61 KELLY GREEN
106 MEDIUM GREEN
24 DARK GREEN
86 FOREST GREEN
87 AQUA GREEN
88 MINT GREEN

89 AQUA BLUE
71 TEAL
53 DARK BAHAMA BLUE
98 SLATE GREEN
70 PALM OYSTER GRAY
81 TITANIUM
28 DOVE GRAY
80 GRAPHITE
50 MEDIUM GRAY
07 SILVER METALLIC
21 SMOKE METALLIC
52 DARK GRAY
23 CHARCOAL METALLIC
40 MATTE BLACK
03 BLACK
49 MATTE WHITE
02 WHITE

HIGH PERFORMANCE VINYL FILM SERIES 2100/2200

- Over 70 vibrant colors
- Premium 2 mil cast vinyl
- 7 year durability exceeds expectations, even on the toughest indoor and outdoor applications
- Increased productivity provided by a unique liner design for easier cutting: faster, consistent weeding and effortless character transfer.
- Superior conformability improves adhesion to irregular surfaces like rivets, corrugations and many textured surfaces

÷ Indicates reduced outdoor durability: See Product Information Bulletin for details.

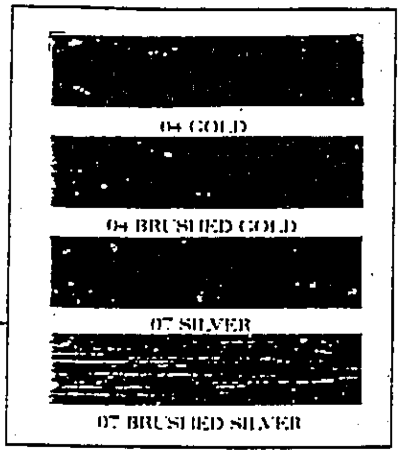
TRANSLUCENT VINYL FILM SERIES 2500/2550

- 37 colors available
- 2 mil cast vinyl
- 7 year outdoor durability means colors remain bright and vivid for years, even on the most demanding applications
- Advanced Calon II adhesive system ensures translucent vinyls remain bonded to outdoor illuminated sign faces: acrylic, polycarbonate, most PVC awnings and flexible sign faces
- Uniformity of color within roll and from lot to lot
- Non-directional sensitivity allows character nesting, which saves time and materials

÷ Indicates opaque film, not translucent.

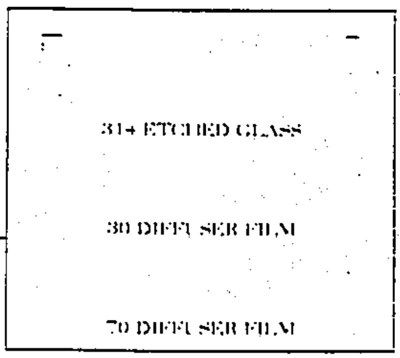
15 YELLOW
125 GOLDEN YELLOW
25 SUNFLOWER
84 TANGERINE
44 ORANGE
143 POPPY RED
43 LIGHT TOMATO RED
83 REGAL RED
33 RED
73 DARK RED
53 CARDINAL RED
49 BURGUNDY
78 VIVID ROSE
133 RASPBERRY
128 PLUM
63 RUST BROWN
59 DARK BROWN
69 DURANODIC ÷
22 BLACK ÷

57 OLYMPIC BLUE
337 PROCESS BLUE
127 INTENSE BLUE
67 BRIGHT BLUE
97 BRISTOL BLUE
36 DARK BLUE
87 ROYAL BLUE
236 TURQUOISE
246 TEAL
307 DARK AQUA
106 BRILLIANT GREEN
146 LT. KELLY GREEN
156 VIVID GREEN
26 GREEN
76 HOLLY GREEN
74 SHADOW GRAY
20 WHITE
95 IVORY



METALLIZED POLYESTERS MIRROR/BRUSHED FINISH SERIES 2850/3950

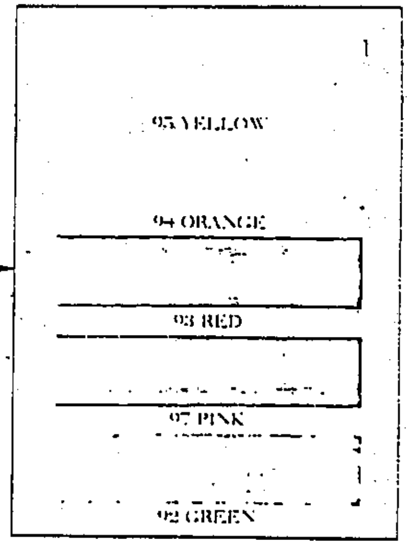
- Brilliant gold and lustrous silver colors
- Ideal for decorative accents, trim and nameplates
- Silver 2 year interior and exterior warranty. Gold interior only
- Easy to handle, with the workability of a vinyl
- Clear, permanent adhesive



SPECIALTY VINYL FILMS ETCHED GLASS SERIES 5200/5250 DIFFUSER FILMS SERIES 5500

ETCHED GLASS
- 2 mil high performance vinyl simulating an etched glass or sandblasted finish
- Perfect for decorative accents on windows, mirrors and partitions
- 7 year durability

DIFFUSER FILMS
- Designed for second surface applications for internally illuminated signage
- Replaces back spraying to hide hardware within the light box
- Available in 30% and 60% transmission
- 7 year durability



FLUORESCENT VINYL FILM SERIES 2750

- High-intensity colors project a strong visual impact for signs, graphics and displays
- Multi-laminate cast film
- 1 year warranty
- UV stabilized surface protects against fading in sunlight
- Compatible with most rigid and flexible sign face substrates

Distributor Information

CALON® II

ARLON
Adhesives & Films Division

2811 S. Harbor Blvd., Santa Ana, CA 92704-5805
(714)540-2811, (800)854-0361
FAX (714)540-7190 or (800)329-2756

Due to the wide variety of banner materials, Arlon recommends that the vinyl user pre-test Calon II on the actual material to be used. The surface must be cleaned according to the banner manufacturer's specifications.

Accessory Products

Sign Lines

Series 3100

- 2 mil cast vinyl, 7 year durability
- Pre-cut striping to provide borders and highlights
- Sizes range from 1/4" to 2" in 50 yd. lengths

Sign Mount

Series 5100

- 1/16" foam mounting tape with excellent adhesion
- Performs well from -60°F to 180°F
- Available in 1/2" and 1" widths in 10 yd. lengths

Drawing and Pouncing Paper

Series 3050

- 20# bright white, resists perforated hole tearing
- Available sizes: 15" x 500' and 30" x 300'

Application Tape

Series 2600

- The most effective paper and adhesive for intricate details plus varying size graphics, letters and logos cut from pressure-sensitive films
- Heavy paper backing resists puckering and tearing

Cal-Mask

Series 2950

- Specially formulated white calendered vinyl for cut-out stenciling, high temp stencil/paint mask and removable vinyl lettering

Application Tools

- Squeegee (Part# 793035)
- Rivet Brush (Part# T1910)

Warranty And Return Policy

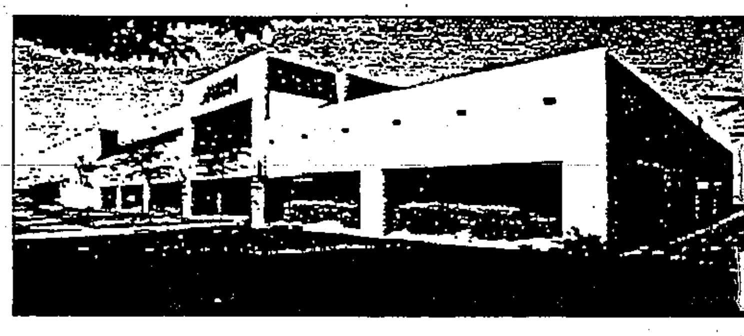
WARRANTY

Arlon will, at our option, replace non-salable materials or refund purchase price thereof. The company's liability at no time will exceed replacement of non-salable merchandise. We cannot guarantee the results obtained through the use of our products, due to the wide variance in applications. All Arlon materials are sold with the understanding that the buyer has independently determined the suitability of such materials. Neither the seller or manufacturer shall be liable for any injury, loss or damage, direct nor indirect, arising from the use of or the inability to use this product. No salesman, representative, or agent is authorized to give any guarantee, warranty, or make any representation contrary to the foregoing. Arlon further warrants that all products and services furnished hereunder have been produced in full compliance with all applicable laws and regulations, including the relevant requirements of Section 6, 7, and 12 of the Fair Labor Standards Act, as amended, and of regulations and orders of the U.S. Department of Labor issued under Section 14 thereof. Arlon shall also be in compliance with pertinent requirements of Executive Order 11141 and 11246, as well as the Rehabilitation Act of 1973 as amended.

RETURN OF PRODUCTS

No product may be returned to Arlon without Arlon's prior written permission, which permission may be withheld by Arlon in its sole discretion. If products are returned to Arlon within sixty (60) days from the date hereof for reasons other than an error by Arlon in filling the Purchaser's order, Purchaser shall only be entitled to receive a credit in an amount equal to the payment received by Arlon for the product minus handling charges determined solely by Arlon which shall not exceed twenty percent (20%) of the invoiced amount. If products are returned to Arlon after sixty (60) days from the date hereof for reasons other than an error by Arlon in filling the Purchaser's order, Purchaser shall only be entitled to receive a credit in an amount equal to the payment received by Arlon for the product minus a handling fee in excess of twenty percent (20%) which shall be subject to negotiations between Arlon and Purchaser.

For full terms and conditions, please request document from Arlon or your local distributor.

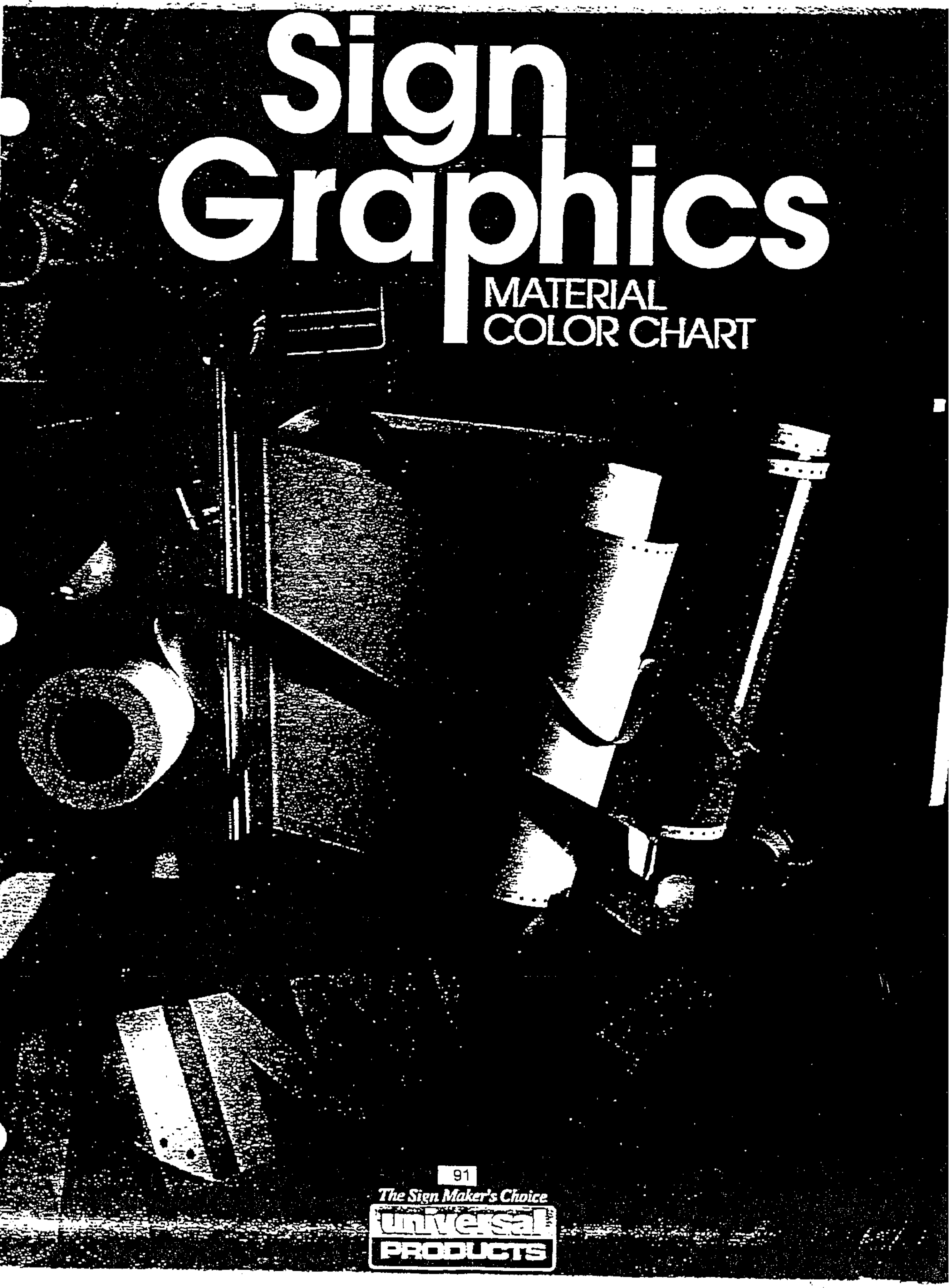


ARLON
Adhesives & Films Division
2811 S. Harbor Blvd., Santa Ana, CA 92704-5805
(714)540-2811, (800)854-0361
FAX (714)540-7190 or (800)329-2756

2062-97 75M 1/97
Litho in U.S.A.

Sign Graphics

MATERIAL COLOR CHART



The Sign Maker's Choice

universal PRODUCTS

PREMIUM CAST FILM

Opaque and Clear

- 065 WHITE
- 095 DOVE GRAY
- 135 LT. ASH GRAY
- 101 MARINE GRAY
- 136 MED. MARINE GRAY
- 061 BLACK
- 005 LEMON YELLOW
- 073 DK YELLOW
- 048 IMITATION GOLD
- 074 APRICOT
- 076 ORANGE
- 072 TANGERINE
- 075 BURNT ORANGE
- 077 RED
- 015 CARDINAL RED
- 078 DK. RED
- 089 BURGUNDY
- [illegible] WINEBERRY
- [illegible] TRANSPARENTS
- 126 CLEAR

- 004 ALMOND
- 938 BEIGE
- 067 CAMEL
- 066 SANDSTONE
- 068 BUCKSKIN
- 071 COCOA
- 010 SALMON
- 109 FLAMINGO
- 124 BRIDAL ROSE
- 939 LT MAGENTA
- 025 FIESTA
- 128 GERANIUM
- 018 MAGENTA
- 023 ORCHID
- 026 RASPBERRY
- 013 PLUM
- [illegible] ROYAL WINE
- 003 LAVENDER
- 007 REGAL PURPLE

- 002 VIBRANT GREEN
- 096 EMERALD GREEN
- 097 FOREST GREEN
- 144 DEEP GREEN
- 009 MINT GREEN
- 134 CALYPSO GREEN
- 149 ROBIN EGG BLUE
- 008 TURQUOISE
- 006 AQUA
- 001 DK. AQUA
- 103 DK. IVY
- 058 PEACOCK BLUE
- 057 OLYMPIC BLUE
- 940 INTENSE BLUE
- 082 BLUE
- 083 SAPPHIRE BLUE
- 142 LAVENDER BLUE
- [illegible] CADET BLUE
- [illegible] DK. BLUE

Ultra Metallic

- 014 SILVER
- 011 BLACK
- * 181 FIRE OPAL
- 019 GOLD
- 106 FROSTY MELON
- 105 GUSTY GRAPE
- 107 WINTERMINT
- 104 COOL BLUE
- 182 COBALT

Luster™

- 882 SPANISH GREEN
- 883 GARNET
- 884 EMPIRE BLUE
- 885 RUBY
- 886 IMPERIAL PURPLE
- 887 AQUAMARINE
- 888 TEA ROSE

Radiance™

- 120 PEARL
- 184 CORAL
- 183 LILAC
- 198 TEALITE
- 197 PATINA
- 199 MARINE BLUE

2-Mil Matte

- 027 MATTE WHITE
- 016 MATTE BLACK

Metallic

- 064 SILVER MET
- 060 PEWTER MET
- 062 CHARCOAL MET
- 063 DK. CHARCOAL MET
- 826 VIOLET BLUE MET
- 825 VIOLET MIST MET
- 876 BRIGHT PURPLE MET
- 138 MAUVE MET
- 141 RED MET

- 054 LT. ANTELOPE MET
- 098 AUTUMN GOLD MET
- 084 ANTIQUE BRONZE MET
- * 069 BRIGHT GOLD MET
- 099 GOLD MET
- 070 COPPER MET.
- 088 MET. BROWN
- 934 DK. MAPLE MET
- 050 MET. BURGUNDY

- 085 MIST BLUE MET.
- 093 MED. MET. BLUE
- 092 MET. BLUE
- 059 ELECTRIC BLUE MET.
- 091 ROYAL BLUE MET.
- 824 NAVY BLUE MET.
- 056 TEAL BLUE MET.
- 080 SEAFOAM GREEN MET
- 154 PINE GREEN MET.

* 181 FIRE OPAL AND 069 BRIGHT GOLD MET have a 3-year exterior durability

NEW

Trans-Cal™

964 WHITE
957 PEARL GRAY
961 SLATE GRAY
942 BLACK
951 IVORY
945 CANARY YELLOW
962 SUNFLOWER
95[illegible] [illegible]
956 ORANGE

953 LT TOMATO RED
963 TOMATO RED
946 CARDINAL RED
947 DARK RED
944 BRIGHT GREEN
952 KELLY GREEN
949 GREEN
948 FOREST GREEN

941 AQUA
955 OLYMPIC BLUE
950 INTENSE BLUE
943 BRIGHT BLUE
960 SAPPHIRE BLUE
959 ROYAL BLUE
954 MAGENTA
958 PURPLE

Uni-Pro™

928 WHITE
905 MED GRAY
926 SATIN SILVER
906 DK GRAY
907 BLACK
908 CANARY YELLOW
909 SUNFLOWER
910 BRIGHT ORANGE

911 TOMATO RED
912 CARDINAL RED
913 DK. RED
914 BURGUNDY
915 MAHOGANY
916 MAGENTA
917 BLOSSOM
918 PURPLE

925 KELLY GREEN
924 DK. GREEN
923 REAL TEAL
919 OLYMPIC BLUE
920 VIVID BLUE
921 SAPPHIRE BLUE
922 DK. BLUE
927 SATIN GOLD

Translucent

1T0 WHITE
0T3 DURANODIC
0T9 YELLOW
0T6 RED
1T2 SCARLET RED
0T1 BURGUNDY
1T[illegible] PINK LAVENDER
0T5 ROSE

1T4 KELLY GREEN
0T4 GREEN
1T5 TURQUOISE
0T0 DK AQUA
1T3 OLYMPIC BLUE
0T2 BRIGHT BLUE
0T7 ROYAL BLUE
0T8 IRIS

Stencil Mask

08[illegible] WHITE
[illegible] YELLOW

Premium Reflective

171 WHITE
177 BLACK
172 YELLOW
174 GOLD
175 ORANGE
173 RED
156 DK RED
178 GREEN
[illegible]25 LITE BLUE
[illegible] BLUE

Polyester

046 CHROME MIRROR
047 CHROME BRUSHED
✦ 049 GOLD BRUSHED
051 DOUBLE GOLD

Etchmark®

A [illegible] premium cast vinyl that simulates the look of frosted or sandblasted glass.

[illegible]

151 ETCHMARK [illegible]

True Shadow

A semi-transparent film that creates realistic shadowing for lettering and graphics.

164 SOMBRA VERDADERA

164 TRUE SHADOW

4-Mil Matte

122 MATTE WHITE
123 MATTE BLACK

Easy Removable

Specially formulated with an adhesive designed to ensure clean removability from most surfaces for up to one year.

187 WHITE
186 BLACK
190 YELLOW
185 RED
189 GREEN
188 BLUE

Fluorescent

162 YELLOW
159 ORANGE
161 RED
160 PINK
158 GREEN
157 BLUE

Marble

879 AMBER WHITE
[illegible] RAVEN BLACK
[illegible] DK. JADE GREEN

✦ 049 GOLD BRUSHED not recommended for outdoor application

Premium Cast Color Additions

145 CANARY YELLOW

146 LIGHT NAVY

319 BLUE LAGOON MET.

828 BAY GOLD MET.

820 DENIM BLUE MET

346 LIGHT COPPER MET.

821 DARK MESA MET.

96 PASSION RADIANCE

Standard Reflective

968 WHITE

969 YELLOW

967 RED

966 BLUE

Protective Laminate

[illegible]

893 GRAFFITI FREE

126 CLEAR CAST

901 MATTE CAST

894 CLEAR CAL

NEW

PREMIUM CAST FILM

OPAQUE, CLEAR, MATTE – 2.1-mil premium grade, high-performance cast PVC film plus a permanent acrylic, pressure-sensitive adhesive. Designed for superior quality exterior graphics for the automotive and signage industry, and a wide variety of OEM applications. Exterior durability: up to 7 years.

METALLIC – 2.1-mil premium quality, metallic cast vinyl film plus a permanent acrylic pressure-sensitive adhesive. Designed for use in architectural transportation and general signage markings. Exterior durability: up to 5 years. *(Bright Gold # 069, 3-year exterior durability)*

ULTRA METALLIC – 3.0-mil brilliant metallic cast film, plus a permanent, gray, opaque acrylic pressure-sensitive adhesive. Designed for use in decorative decals die-cut letters, numbers and product identification. Ideal for flat or simple curve applications. Exterior durability: up to 5 years. *(Fire Opal #181, 3 year exterior durability)*

LUSTER – 2.0-mil premium grade cast vinyl with a bright lustrous finish, plus a permanent silver acrylic adhesive. A fun new look for signage applications, including recreation and marine vehicles. Ideal for flat or simple curve applications. Exterior durability: up to 5 years.

RADIANCE – 2.0-mil pearlized, high gloss, premium grade, cast vinyl plus a permanent gray, opaque, acrylic, pressure-sensitive adhesive. Designed for decorative decals and accent striping. Exterior durability: up to 5 years.

All of the above films are on a 78# white kraft release liner.

HIGH PERFORMANCE CALENDERED FILM

UNI-PRO – 3.5-mil flexible semigloss calendered film plus a permanent acrylic adhesive. Designed for promotional sign applications. Trouble-free computer cutting and weeding. Excellent transferring characteristics. Exterior durability: up to 5 years.

TRANS-CAL – 3.2-mil satin-gloss calendered film plus a repositionable acrylic adhesive. Incorporates a grid pattern printed on the release liner to aid in layout or handcutting on a light table. Formulated for illuminated signs, this film has identical color shade whether light falls on it or passes through it. An economical translucent film for use with back lighted signage, and windows. Exterior durability: up to 7 years.

SPECIALTY FILM

TRANSLUCENT – 2.3-mil premium vinyl plus a permanent acrylic adhesive for flexible and rigid back lighted signage. Ideal for flat and simple curve applications. Exterior durability: up to 5 years.

STENCIL MASK – 3.4-mil calendered flexible, pressure-sensitive film for paint masking. Easily removable.

PREMIUM REFLECTIVE – 6.5-mil retroreflective engineering grade film which meets or exceeds the applicable requirements of Federal standards. Designed for high visibility, and 7-year exterior durability. *(wet application not recommended).*

STANDARD REFLECTIVE – 3.5-mil retroreflective film designed for non-engineering grade computer cut signage. Cost-effective, short-term application and 2-year exterior durability (flat surfaces only). *(wet application not recommended)*

POLYESTER – 2.5-mil film with a polyester base to retain metallic brilliance. Exterior durability: up to 3 years. *(Gold Brushed not recommended for outdoor application)*

ETCHMARK® – 2.0-mil premium cast vinyl which provides an excellent simulation of sandblasted glass. Exterior durability: up to 5 years.

TRUE SHADOW – [illegible]-mil semitransparent, pressure-sensitive film that creates realistic shadowing for vinyl lettering and graphics. Exterior durability: up to 5 years

4-MIL MATTE – 3.5-mil calendered vinyl with non glare matte finish. Exterior durability: 3 to 5 years.

EASY REMOVABLE – 3.5-mil calendered film, formulated with an adhesive designed to ensure clean removability from most surfaces for up to one year. Exterior durability: up to 3 years.

FLUORESCENT – 2.2-mil cast film designed for short term, exterior safety, promotional, and high visibility applications. Permanent white acrylic pressure-sensitive adhesive. Exterior durability: up to 6 months *(not warranted for exterior use in direct sunlight).*

MARBLE – 3.0-mil custom vinyl film with the look of polished marble. Exterior durability: up to 2 years

MICRO-MIST – 2.5-mil premium grade pressure-sensitive film, with screen printed color fading from a horizon line. Clear coated on a continuous 10-yard roll for maximum durability. Exterior durability: up to 5-7 years. *Actual sample not shown in color chart.*

PROTECTIVE LAMINATE

GRAFFITI FREE – [illegible]-mil clear treated polyester film with 84# white kraft liner. Protects your graphics from damaging solvents, ink markers, shoe polish, etc. Exterior durability: up to 3 years (film only).

CLEAR-CAST, MATTE CLEAR – 2.5-mil high-performance, clear cast film that provides maximum protection and durability. Permanent acrylic pressure-sensitive adhesive and 78# white kraft release liner. Exterior durability: up to 5 to 7 years (film only).

CLEAR-CAL – 3.5-mil [illegible] clear, calendered film laminate. Permanent acrylic pressure-sensitive adhesive and 84# white kraft release liner. Exterior durability: up to [illegible] years (film only).

Exterior life of protective laminates depends upon the du[illegible]ity of the resins, toners, or inks used

Appendix VII MVLF Marker Evaluation Form

Flight Observation Sheet

(please write legibly)

Pilot's name ______________________________

Flight Recorder's name ______________________________

Date month ________ day ________ year 1998

Aircraft type and Identification number ________ N ________

Wing position (High or Low)

Midday Flying

ATIS	Code	Time	Wind	Visibility
@	Temp	Altimiter	Ceiling	
Weather comment				

Approach Number	1	2	1	2
Heading (Magnetic North)				
Time of approach (Zulu time, if known)				
Altitude (1800 MSL, if applicable)				
Speed (110 knots, if applicable)				
Light detected distance (statue miles)				
Flashing sequence identified distance				
Marker detected distance (statue miles)				
Marker color identified distance (statue miles)				

Which color was prominent? ______________________________

Comment ______________________________

____

Nighttime flying

ATIS	Code	Time	Wind	Visibility
@	Temp	Altimiter	Ceiling	
Weather comment				

Approach Number	1	2	1	2
Heading (Magnetic North)				
Time of approach (Zulu time, if known)				
Altitude (1800 MSL, if applicable)				
Speed (110 knots, if applicable)				
Light detected distance (statue miles)				
Flashing sequence identified distance (statue miles)				
Marker detected distance (statue miles)				
Marker color identified distance (statue miles)				

Which color was prominent? ______________________________

Comment ______________________________

____

Afternoon/Evening

ATIS	Code	Time	Wind	Visibility
@	Temp	Altimiter	Ceiling	
Weather comment				

Flying toward the marker with the sun at 90 degrees, relative angle

Approach Number	1	2	1	2
Heading (Magnetic North)				
Time of approach (Zulu time, if known)				
Altitude (1800 MSL, if applicable)				
Speed (110 knots, if applicable)				
Light detected distance (statue miles)				
Flashing sequence identified distance (statue miles)				
Marker detected distance (statue miles)				
Marker color identified distance (statue miles)				

Which color was prominent? ________________

Comment ________________

Flying toward the marker with sun behind the aircraft

Approach Number	1	2	1	2
Heading (Magnetic North)				
Time of approach (Zulu time, if known)				
Altitude (1800 MSL, if applicable)				
Speed (110 knots, if applicable)				
Light detected distance (statue miles)				
Flashing sequence identified distance (statue miles)				
Marker detected distance (statue miles)				
Marker color identified distance (statue miles)				

Which color was prominent? ________________

Comment ________________

Flying toward the marker with sun in front of the aircraft

Approach Number	1	2	1	2
Heading (Magnetic North)				
Time of approach (Zulu time, if known)				
Altitude (1800 MSL, if applicable)				
Speed (110 knots, if applicable)				
Light detected distance (statue miles)				
Flashing sequence identified distance (statue miles)				
Marker detected distance (statue miles)				
Marker color identified distance (statue miles)				

Which color was prominent? ________________

Comment ________________

Appendix VIII FAA Obstructions Data within 30 Nautical Miles of O'Hare Airport

8/25/01

SEARCH WITHIN A 31 NMILES SQUARE FROM: 41.58. 46.8, 87.54.16.2 (O'Hare Coordinates)

NOA ID	VS	ST	CITY	Latit	Lati	Lati	Long	Long	Long	TYPE	AGL	AMSL	LTG	H	V	M	FAA#	ACT/DATE
14-0735	O	IL	JOLIET	41	27	55	88	7	33	TOWER	303	908	R	5	D	Y	75GL0983	A76150
14-2410	O	IL	SHOREWOOD	41	28	26	88	11	53	TOWER	212	760	D	2	C	N	96GL1775	C97181
14-1498	O	IL	JOLIET	41	28	28	88	6	1	TOWER	266	908	R	2	C	Y	94GL3005	C94325
14-1466	O	IL	FRANKFORT	41	28	35	87	53	38	TOWER	205	955	R	5	D	Y	82GL1364	C84088
14-0567	O	IL	FRANKFORT	41	28	39	87	51	32	T-L TWR	135	905	N	4	D			C84179
14-1497	O	IL	FRANKFORT	41	28	39	87	51	11	T-L TWR	61	831	N	5	D			A84179
14-1468	O	IL	MINOOKA	41	28	44	88	16	16	TOWER	308	956	R	5	D	Y	97GL0223	C89352
14-0732	O	IL	JOLIET	41	29	22	88	8	26	TOWER	420	970	R	5	D	Y	72GL0383	C76307
14-0091	O	IL	JOLIET	41	29	36	88	6	57	STACK	450	965	R	5	D	Y	03OE1169	C90134
14-0092	O	IL	JOLIET	41	29	43	88	7	28	STACKS 2	550	1065	R	5	D	N	03OE1169	C86300
14-0591	O	IL	JOLIET	41	29	47	88	7	29	TOWER	205	737		5	D	Y	00CE5243	C76275
14-1158	O	IL	MINOOKA	41	29	47	88	17	56	TOWER	420	992	R	5	D	Y	79GL0267	C79240
14-1631	O	IL	FRANKFORT	41	29	50	87	49	39	T-L TWR	202	945	R	2	C	Y	97GL3814	C97321
14-1727	O	IL	FRANKFORT	41	29	57	87	51	1	ELEVATOR	200	950	R	4	D	Y	87GL0593	C89268
14-0053	O	IL	JOLIET	41	30	32	88	8	20	TOWER	310	936	R	4	D	Y	71GL0086	C83180
14-2464	O	IL	JOLIET	41	30	40	88	3	53	TOWER	190	797	N	4	D	N	99LR0000	A97279
14-1137	O	IL	JOLIET	41	30	45	88	15	18	TOWER	400	1043	R	5	D	Y	78GL1858	C80015
14-1597	O	IL	SHOREWOOD	41	30	52	88	12	43	TANK	127	742	R	5	D		85GL1335	C85318
14-2027	U	IL	JOLIET	41	30	53	88	10	12	BLDG	22	595				N	88GL2051	D97083
14-6127	U	IL	CHICAGO HEIGHTS	41	31	5	87	35	11	TOWER	150	780						A76072
14-2297	O	IL	JOLIET	41	31	20	88	10	12	POLE	22	602	R	5	D	N	95GL2796	C96022
14-6003	U	IL	JOLIET	41	31	20	88	6	58	TOWER	168	809						A76043
14-0644	O	IL	MATTESON	41	31	38	87	43	42	TOWER	274	979	D	4	D	N	93GL3220	C94269
14-0059	O	IL	FLOSSMOOR	41	31	59	87	42	17	TOWER	199	919	R	2	D	N	76GL1184	C93047
14-0028	O	IL	JOLIET	41	32	6	88	3	15	TOWER	357	937	R	4	D	Y	98GL2096	C98194
14-1010	O	IL	MOKENA	41	32	11	87	51	17	TOWER	495	1204	D	5	D	N	92GL2293	A78033
14-1397	O	IL	JOLIET	41	32	11	88	3	9	BLDG	240	840	R	5	D	Y	83GL0008	C83327
14-1358	O	IL	TINLEY PARK	41	32	13	87	48	21	TOWER	343	1038	R	5	D	Y	89GL1644	C89352
14-0360	O	IL	JOLIET	41	32	18	88	5	36	TOWER	310	935	R	4	D	Y	73GL1061	C83278
14-0362	O	IL	GLENWOOD	41	32	23	87	37	40	TOWER	320	951	R	5	D	Y	03OE3127	C84165
14-1359	O	IL	LYNWOOD	41	32	23	87	32	24	TANK	16	630	R	5	D		81GL1082	C82272
14-2036	O	IL	FOREST PARK	41	32	26	88	2	8	TOWER	499	1149	R	5	D	Y	91GL0155	C92237

14-0881	O	IL	LANSING	41	32	40	87	32	30	TANK	150	764					74GL0424	A76033
14-6128	U	IL	FLOSSMOOR	41	32	46	87	41	28	TOWER	107	794						A76072
14-1955	O	IL	NEW LENOX	41	32	54	87	56	53	TOWER	359	1093	D	5	D	N	90GL0710	C91148
14-2416	O	IL	JOLIET	41	33	1	88	5	28	TOWER	216	846	R	4	D	Y	96GL4200	C97181
14-1690	O	IL	NEWARK	41	33	4	88	31	45	TOWER	206	946	R	4	D	Y	85GL1293	A86335
14-6131	U	IL	HOMEWOOD	41	33	4	87	38	52	TOWER	134	766						A76072
14-1909	O	IL	TINLEY PARK	41	33	10	87	47	9	TOWER	498	1190	S	5	D	N	87GL1439	C91105
14-0140	O	IL	TINLEY PARK	41	33	15	87	48	46	TOWER	296	1007	D	4	D	N	93GL3207	C95030
14-0002	O	IL	CHICAGO	41	33	20	87	50	55	WLS 2	586	1330	R	2	D	Y	99TR0000	C83265
14-1584	O	IL	TINLEY PARK	41	33	27	87	50	59	TOWER	199	939	N	5	D		85GL0062	C85253
14-0431	O	IL	JOLIET	41	33	29	88	2	19	TOWER	306	993	R	3	C	Y	00CE5987	C79184
14-0604	O	IL	HOMEWOOD	41	33	42	87	38	45	TOWER	320	955	R	1	D	Y	71CH0306	C83342
14-1577	O	IL	THORNTON	41	33	44	87	38	5	TOWER	284	911	R	5	D	Y	87GL1150	C87299
14-1897	O	IL	PLATTVILLE	41	33	45	88	25	57	TOWER	245	908	D	5	D	N	89GL2087	C90260
14-0958	O	IL	HOMEWOOD	41	33	49	87	37	50	TOWER	270	895	R	5	D	Y	96GL2197	C97021
14-1278	O	IL	HOMEWOOD	41	33	53	87	37	55	TOWER	255	890	N	5	D	Y	80GL1443	C81223
14-1676	O	IL	PLAINFIELD	41	33	54	88	15	23	TOWER	175	815	N	5	D	N	99TR0000	C87124
14-2121	O	IL	JOLIET	41	33	57	88	3	44	TOWER	460	1090	D	5	D	Y	90GL1619	C93319
14-0359	O	IL	JOLIET	41	34	0	88	7	14	TOWER	280	930	R	4	D	Y	97GL0066	C76091
14-2259	O	IL	THORNTON	41	34	14	87	34	43	POLE	163	783	N	5	D	N	95GL1880	C96113
14-1765	O	IL	KNOB HILL	41	34	27	88	28	0	TOWER	297	998	M	5	D	N	87GL1528	C88172
14-0476	O	IL	LOCKPORT	41	34	43	88	1	36	TOWER	360	1048				Y	66CH0408	C76091
14-2044	O	IL	JOLIET	41	34	43	88	5	44	STACK	250	895	N	5	D	N	99IP0000	C92272
14-0116	O	IL	LANSING	41	34	44	87	32	46	TOWERS 2	420	1020	R	5	D	Y	85GL1068	C94318
14-6203	U	IL	HALSTED	41	34	44	87	37	58	TOWER	130	750						A78205
14-0926	O	IL	HAZEL CREST	41	34	47	87	39	22	TOWER	200	820	N	5	D	N	96GL0878	C77347
14-0080	O	IL	JOLIET	41	34	56	88	4	57	TOWER	262	869	R	2	D	Y	95GL2396	C83201
14-0414	O	IL	WEST HAVEN	41	35	17	87	51	50	TOWER	495	1224	R	2	C	Y	96GL4234	C97055
14-6279	U	IL	MARKHAM	41	35	26	87	40	51	TOWER	110	720						A78205
14-1393	O	IL	LOCKPORT	41	36	1	87	58	44	TOWER	335	1130	R	3	C	Y	97GL2883	C84088
14-6134	U	IL	LOCKPORT	41	36	6	88	4	51	TOWER	100	750						A76072
14-2408	O	IL	LOCKPORT	41	36	11	87	57	4	TOWER	172	935	D	2	C	N	96GL3437	C97125
14-2094	O	IL	JOLIET	41	36	16	88	5	5	TOWER	127	789	R	5	D	Y	91GL2126	C93256
14-2079	O	IL	PLAINFIELD	41	36	24	88	17	18	POLE	197	827	R	5	D	N	92GL2340	C93067
14-1613	O	IL	YORKVILLE	41	36	26	88	27	10	TOWERS 6	499	1266	R	2	C	Y	96GL1419	C97013
14-0757	O	IL	LOCKPORT	41	36	27	88	3	32	TOWER	204	784				Y	72GL1113	D83299
14-1682	O	IL	LOCKPORT	41	36	37	88	0	33	TOWER	293	1050	R	5	D	Y	86GL0821	C86329

14-0113	O	IL	LOCKPORT	41	36	40	88	3	36	STACKS 2	265	850	R	5	D	Y	73GL0956	D83342
14-0057	O	IL	GOODINGS GROVE	41	36	57	87	55	47	TOWER	235	998	D	4	D	N	98GL0722	C98124
14-2007	O	IL	ORLAND PARK	41	37	0	87	51	26	TOWER	170	888	N	5	D	N	87GL1442	C92090
14-0058	O	IL	SANDWICH	41	37	23	88	34	50	TOWER	205	849	R	4	D	Y	99TR0000	C83265
14-6135	U	IL	GOODINGS GROVE	41	37	27	87	55	56	TOWER	183	942						A76072
14-0714	O	IL	LOCKPORT	41	37	29	88	0	15	TOWER	356	1144	R	2	C	Y	96GL4231	C97049
14-0525	O	IL	BURNHAM	41	37	50	87	31	42	TOWER	525	1111	R	5	D	Y	85GL0958	C86321
14-1118	O	IL	ROMEOVILLE	41	37	55	88	5	41	TOWERS 2	210	875		5	D		99LR0000	C83195
14-1119	O	IL	ROMEOVILLE	41	37	56	88	4	35	TOWER	197	782		5	D		99LR0000	A79061
14-1120	O	IL	ROMEOVILLE	41	37	57	88	4	27	TOWERS 2	247	829		5	D		99LR0000	A79061
14-0114	O	IL	ROMEOVILLE	41	37	59	88	3	44	STACKS 4	500	1087	R	5	D	N	61KC0009	C86184
14-1198	O	IL	BURNHAM	41	38	1	87	32	37	TOWER	205	790	R	4	D	Y	68CH0436	C80190
14-1121	O	IL	ROMEOVILLE	41	38	4	88	4	25	TOWER	213	798	N	5	D			A79061
14-0831	O	IL	POSEN	41	38	5	87	39	49	TOWER	259	856	R	5	D	Y	77GL1871	C81286
14-0117	O	IL	PLAINFIELD	41	38	15	88	12	34	TOWER	285	919	R	2	C	Y	94GL3131	C94339
14-0870	O	IL	CHICAGO	41	38	16	87	33	11	TOWERS 6	253	838	R	5	D	Y	75GL1730	C80190
14-0672	O	IL	CRESTWOOD	41	38	20	87	44	13	TOWER	162	779					00CE6749	C76091
14-0800	O	IL	LOCKPORT	41	38	22	88	2	43	TOWER	270	930	R	5	D	Y	90GL0031	C90351
14-1304	O	IL	DOLTON	41	38	24	87	36	3	TOWER	280	875	R	5	D	Y	81GL0979	C82083
14-1659	O	IL	SANDWICH	41	38	24	88	38	37	BLDG	20	695	N	5	D	N	86GL0747	C86223
14-0788	O	IL	CRESTWOOD	41	38	25	87	44	13	TOWERS 2	220	832	R	5	D	Y	93GL1195	C93305
14-2193	O	IL	ROMEOVILLE	41	38	43	88	3	14	PLANT	217	808	N	4	D	N	94GL1429	C95052
14-2234	U	IL	BURNHAM	41	38	53	87	32	22	TOWER	413	1003	N			N	94GL2469	D95107
14-2086	O	IL	LEMONT	41	38	55	88	3	10	RIG	232	823	R	5	D	Y	92GL2085	C93340
14-2300	O	IL	ROBBINS	41	39	2	87	42	6	STACK	375	973	M	5	D	N	94GL2082	C96043
14-2025	U	IL	CHICAGO	41	39	6	87	34	2	TOWER	270	856	R			Y	91GL2168	D93102
14-1520	O	IL	LEMONT	41	39	11	87	57	39	TOWER	265	964	R	2	C	Y	94GL3002	C94311
14-0710	O	IL	LEMONT	41	39	12	87	56	16	TOWER	303	1018				Y	71GL0294	C76091
14-1484	O	IL	ROMEOVILLE	41	39	28	88	2	45	PLANT	291	880	S	5	D	N	95GL2829	C93047
14-0068	O	IL	LEMONT	41	39	32	88	0	58	TOWER	264	1039	R	4	D	Y	75GL0509	D91119
14-1526	O	IL	ALSIP	41	39	52	87	42	55	TOWER	265	863	R	5	D	Y	92GL2240	C93193
14-6137	U	IL	ALSIP	41	39	54	87	44	31	TOWER	115	736						A76072
14-0978	O	IL	PLANO	41	39	57	88	34	35	TOWER	498	1161	R	5	D	Y	88GL0111	C88130
14-2455	O	IL	PALOS PARK	41	40	8	87	53	48	TANK	150	900	N	4	D	N	97GL3063	C97321
14-1839	O	IL	BLUE ISLAND	41	40	9	87	40	24	TOWER	215	829	R	5	D	Y	88GL2062	C89212
14-1124	O	IL	CHICAGO	41	40	11	87	33	24	T-L TWR	211	800		5	D		99LR0000	C83145
14-1125	O	IL	CHICAGO	41	40	17	87	33	28	T-L TWR	211	795		5	D		99LR0000	C83145

14-1592	O	IL	ROMEOVILLE	41	40	20	88	4	12	TOWER	210	922	R		5	D	Y	87GL0596	C87257
14-2101	O	IL	ALSIP	41	40	31	87	45	52	TOWERS 6	200	800	N		5	D	Y	86GL2250	C93263
14-1247	O	IL	CHICAGO	41	41	33	87	32	53	STACK	385	970	S		5	D	N	80GL1214	C82039
14-0366	O	IL	LEMONT	41	42	1	88	0	26	TOWER	300	1047	R		5	D	Y	03CE3883	C76091
14-2346	O	IL	BOLINGBROOK	41	42	2	88	8	1	TANK	163	838	R		5	D	N	96GL1299	C97013
14-0648	O	IL	OSWEGO	41	42	10	88	18	52	TOWER	308	968	R		4	D	Y	98GL0031	C98124
14-0730	O	IL	CHICAGO	41	42	16	87	39	26	TOWER	270	889	R		5	D	Y	72GL0113	C78065
14-2309	O	IL	BOLINGBROOK	41	42	16	88	7	42	BLDG	35	700	N		5	D	N	92GL0098	C97013
14-2495	O	IL	SUGAR GROVE	41	42	16	88	26	2	TOWER	250	908	M		2	C	N	98GL0265	C98089
14-1789	O	IL	CHICAGO	41	42	17	87	35	45	TOWERS 9	206	796	R		5	D	Y	87GL1421	C88354
14-2134	O	IL	DARIEN	41	42	19	87	58	28	BLDG-TWR	265	977	R		5	D	Y	92GL1987	C93354
14-0927	O	IL	BRIDGEVIEW	41	42	22	87	47	58	TOWER	247	844	R		5	D		00CE5042	A77121
14-1151	O	IL	CHICAGO	41	42	22	87	37	58	TOWER	270	873	R		5	D	Y	79GL0665	C82025
14-0653	O	IL	PLANO	41	42	24	88	30	26	TOWER	321	1006	M		4	D	N	93GL3203	C82223
14-1715	O	IL	CHICAGO RIDGE	41	42	31	87	47	2	TOWER	449	1049	R		5	D	Y	87GL0156	C87257
14-1123	O	IL	CHICAGO	41	42	53	87	32	35	T-L TWR 2	237	822			5	D		99LR0000	C83180
14-0104	O	IL	OAKLAWN	41	42	54	87	45	34	TOWER	262	864					Y		C74054
14-6138	U	IL	CHICAGO	41	42	55	87	40	53	TOWER	180	846							A76072
14-1122	O	IL	CHICAGO	41	42	56	87	32	28	T-L TWR 2	237	828			5	D		99LR0000	C83180
14-2269	O	IL	CHICAGO	41	42	58	87	32	38	TOWER	214	799	R		5	D	Y	94GL1511	C96358
14-2251	O	IL	HICKORY HILLS	41	43	7	87	50	4	TOWER	102	790	N		2	C	N	95GL1848	C95163
14-1126	O	IL	CHICAGO	41	43	12	87	32	35	T-L TWR 2	250	858			5	D		99LR0000	C83180
14-0419	O	IL	LEMONT	41	43	20	87	57	47	TOWER	254	940					Y		A00000
14-6139	U	IL	OAK LAWN	41	43	30	87	44	2	TOWER	168	773							A76072
14-1127	O	IL	CHICAGO	41	43	45	87	32	18	T-L TWR 2	218	809			5	D		99LR0000	C83180
14-1055	O	IL	CHICAGO	41	43	46	87	36	14	TOWER	270	870	R		5	D	Y		A78065
14-2021	O	IL	DARIEN	41	43	48	87	58	10	TOWER	233	908	R		5	D	Y	91GL2384	C92174
14-2292	O	IL	JUSTICE	41	44	3	87	50	24	TOWER	176	853	N		5	D	N	95GL2143	C95317
14-2463	O	IL	CHICAGO	41	44	8	87	37	52	TOWER	170	774	N		4	D	N	99LR0000	A97279
14-0017	O	IL	CHICAGO	41	44	15	87	42	1	TOWERS 4	204	838	R		4	D	Y	99TR0000	C83320
14-6140	U	IL	CHICAGO	41	44	15	87	37	51	TOWER	171	763							A76072
14-6208	U	IL	BURR RIDGE	41	44	21	87	56	8	RIG	151	883							A76174
14-0395	O	IL	DOWNERS GROVE	41	44	22	88	0	44	TOWER	120	894							C74057
14-6280	U	IL	JUSTICE	41	44	23	87	49	35	TOWER	80	710							A78205
14-6141	U	IL	CHICAGO	41	44	25	87	43	13	TOWER	50	670							A76072
14-6275	U	IL	DOWNERS GROVE	41	44	25	88	0	30	TOWER	160	929						76GL0860	A78075
14-0928	O	IL	CHICAGO	41	44	39	87	37	56	TOWER	218	818							D77152

14-1051	O	IL	CHICAGO	41	44	56	87	36	55	TOWER	160	748	N	5	D		99FC0000	A78146
14-0115	O	IL	DOWNERS GROVE	41	44	58	88	1	57	TOWER	290	1078	M	2	C	N	87GL0200	C96267
14-1260	U	IL	BEDFORD PARK	41	45	7	87	47	27	TOWER	100	715					80GL1035	A80365
14-0071	O	IL	CHICAGO	41	45	23	87	38	6	TOWER	280	875	R	2	D	Y	99LM0000	C74054
14-0574	O	IL	AURORA	41	45	29	88	18	55	TOWER	303	965				Y		C74057
14-0874	O	IL	SUGAR GROVE	41	45	31	88	26	43	TANK	172	898	R	1	A		99OC510	C94353
14-0506	O	IL	CHICAGO	41	45	43	87	46	0	TOWER	121	735					66CH0442	C76091
14-6201	U	IL	BEDFORD PARK	41	45	50	87	45	0	TOWER	111	726						A76174
14-1178	O	IL	CHICAGO	41	45	54	87	39	51	TOWER	215	817	R	5	D	Y	79GL1507	C81056
14-6007	U	IL	CHICAGO	41	45	58	87	37	40	TOWER	83	678						A76043
14-1202	O	IL	CHICAGO	41	46	0	87	36	22	TOWER	270	860	R	5	D	Y	79GL0782	C82048
14-1632	O	IL	CHICAGO	41	46	6	87	45	37	STACK	150	811		1	A		99IP0000	C94192
14-0443	O	IL	AURORA	41	46	9	88	16	2	TOWERS 5	356	1056	R	4	D	Y	87GL0045	C90113
14-0110	O	IL	AURORA	41	46	10	88	14	44	TOWERS 4	734	1449	S	5	D	Y	81GL1482	C83342
14-0031	O	IL	CHICAGO	41	46	12	87	49	5	TOWERS 2	225	840	R	2	D	Y	70CH0671	C86112
14-2318	O	IL	HINCKLEY	41	46	15	88	37	48	TOWER	135	877	N	2	C	N	95GL2198	A96043
14-0517	O	IL	LISLE	41	46	20	88	4	24	TOWER	305	965	R	5	D	Y	67CH0620	C76091
14-1035	O	IL	AURORA	41	46	21	88	16	27	TOWER	150	858						A78065
14-1047	O	IL	DOWNERS GROVE	41	46	22	87	59	50	TOWER	183	941					76GL1090	A78146
14-6008	U	IL	SUMMIT	41	46	36	87	48	17	TOWER	76	693						A76043
14-0131	O	IL	LA GRANGE	41	46	37	87	51	45	TOWERS 4	194	854	N	5	D	Y	99AM000	D93235
14-2311	O	IL	CHICAGO	41	46	39	87	45	42	POLE	31	647	N	5	D	N	94GL1431	C96071
14-2184	O	IL	CHICAGO	41	46	44	87	44	33	BLDG	9	619	R	1	A	N	99OC008	A94199
14-2320	O	IL	CHICAGO	41	46	48	87	45	9	TOWER	132	750	R	5	D	N	99IP0000	C97006
14-6142	U	IL	CHICAGO	41	46	52	87	39	28	TOWER	130	730						A76072
14-1678	O	IL	CHICAGO	41	46	56	87	44	29	BLDG	25	635	N	5	D	N	82GL1890	C86342
14-1054	O	IL	CHICAGO	41	46	57	87	39	20	TOWER	220	820	R	5	D	Y	96GL1984	C96239
14-1883	O	IL	CHICAGO	41	47	10	87	44	32	SIGN 2	20	627	N	5	D	N	89GL2348	A90064
14-6143	U	IL	SUMMIT	41	47	10	87	48	50	TOWER	140	735						A76072
14-2183	O	IL	CHICAGO	41	47	12	87	44	40	CTRL TWR	119	725	R	1	A	N	99OC008	A94199
14-1510	O	IL	CHICAGO	41	47	19	87	38	43	TOWER	267	864	R	5	D	Y	98GL0752	C98012
14-0610	O	IL	CHICAGO	41	47	22	87	35	28	BLDG	142	731	N	5	D	Y	03CE1224	C83362
14-6144	U	IL	MC COOK	41	47	28	87	51	27	TOWER	168	808						A76072
14-2312	O	IL	CHICAGO	41	47	33	87	45	44	POLE	16	621	N	5	D	N	94GL1431	C96071
14-1326	O	IL	CHICAGO	41	47	37	87	35	0	BLDG 2	379	968		3	C	N	99SP0000	A82118
14-1795	O	IL	CHICAGO	41	47	38	87	44	16	TRAMWAY	48	654	N	5	D	N	89GL1219	C90029
14-1984	O	IL	AURORA	41	47	40	88	17	45	TOWER	265	1015	D	5	D	N	91GL1427	C91280

14-1873	O	IL	BERWYN	41	47	42	87	45	52	SIGN	52	652	R	5	D	N	89GL1774	C90064
14-2182	O	IL	CHICAGO	41	47	44	87	44	35	SIGN	50	655		1	A	N	99OC008	A94199
14-6145	U	IL	CHICAGO	41	47	44	87	34	35	TOWER	154	752						A76072
14-1113	O	IL	AURORA	41	47	45	88	14	15	T-L TWR 2	219	945		5	D	N		A79061
14-0701	O	IL	AURORA	41	47	47	88	18	36	TOWER	258	963	R	4	D	Y	88GL0910	C83320
14-2133	O	IL	SUGAR GROVE	41	47	47	88	27	30	TOWER	189	896	R	5	D	Y	89GL1237	C93354
14-2418	O	IL	LA GRANGE	41	47	50	87	51	30	TOWER	123	768	N	5	D	N	93GL1032	A97125
14-6202	U	IL	CHICAGO	41	47	50	87	51	29	TOWER	180	825						D97125
14-0455	O	IL	AURORA	41	47	57	88	14	12	TOWER	324	1055	D	4	D	N	93GL3191	C94108
14-2484	O	IL	NAPERVILLE	41	48	2	88	14	10	TOWER	300	1035	D	2	C	N	97GL3920	C98068
14-0595	O	IL	NAPERVILLE	41	48	4	88	11	33	TOWER	435	1138				Y	68CH0549	D78065
14-1056	O	IL	CHICAGO	41	48	4	87	37	49	TOWER	220	818	R	5	D	Y	70CH0207	A78065
14-1639	U	IL	AURORA	41	48	10	88	24	41	T-L TWR	150	903					99IP0000	A86112
14-1327	O	IL	CHICAGO	41	48	13	87	35	7	BLDG 7	359	947		4	D	N	99LR0000	A82118
14-6146	U	IL	DOWNERS GROVE	41	48	16	88	0	44	TOWER	100	847						A76072
14-2181	O	IL	GLEN	41	48	18	87	46	20	TANK	162	756		1	A		99OC008	A94199
14-0723	O	IL	FOREST VIEW	41	48	19	87	46	40	TOWER	150	746	R	1	A	Y	96GL0120	C94192
14-6147	U	IL	FOREST VIEW	41	48	20	87	48	5	TOWER	160	754						A76072
14-0862	O	IL	AURORA	41	48	21	88	25	34	T-L TWR	144	868	N	5	D	N	69CH0256	A75176
14-1325	O	IL	CHICAGO	41	48	24	87	35	12	BLDG 2	280	870		4	D	N	99LR0000	A82118
14-0520	O	IL	NAPERVILLE	41	48	25	88	11	47	TOWER	311	1021	R	5	D	Y	67CH0509	C84165
14-1324	O	IL	CHICAGO	41	48	25	87	35	27	BLDG 2	243	832		4	D	N	99LR0000	A82118
14-0704	O	IL	NAPERVILLE	41	48	26	88	7	13	TOWER	258	1010	R	4	D	Y	97GL4931	C92104
14-1880	O	IL	AURORA	41	48	27	88	16	6	TOWERS 2	451	1187	R	5	D	Y	95GL1089	C95156
14-2500	O	IL	CHICAGO	41	48	27	87	44	52	TOWER	175	770	R	5	D	N	97GL0984	C98124
14-0662	O	IL	CHICAGO	41	48	28	87	45	0	TOWER	146	741						C74057
14-1220	O	IL	AURORA	41	48	31	88	16	12	TOWER	435	1175	R	5	D	Y	86GL0053	C86147
14-1836	O	IL	DOWNERS GROVE	41	48	33	88	3	10	TOWER	377	1127	R	5	D	Y	87GL0592	C89191
14-0055	O	IL	CHICAGO	41	48	34	87	47	4	STACKS 4	225	807	R	2	A	N	99OC000	D88040
14-1323	O	IL	CHICAGO	41	48	34	87	35	33	BLDG	260	852		2	A	N	99OC501	C89114
14-1396	O	IL	CHICAGO	41	48	55	87	40	57	TOWER	205	800	R	5	D	Y	97GL2885	C84088
14-1787	O	IL	CHICAGO	41	49	0	87	39	4	TOWER	174	765	N	5	D	N	88GL1030	C89324
14-0004	O	IL	DOWNERS GROVE	41	49	4	87	59	17	WMVP 3	495	1260	R	4	D	Y	90GL2382	C94115
14-0014	O	IL	CHICAGO	41	49	6	87	39	2	TOWER	321	920				Y		D84011
14-1467	O	IL	AURORA	41	49	8	88	13	23	TOWER	405	1135	R	5	D	Y	84GL1143	C84319
14-0600	O	IL	CHICAGO	41	49	20	87	41	42	TOWER	200	795	R	5	D	Y	94GL3451	C95093
14-1448	O	IL	CHICAGO	41	49	22	87	40	33	STACK	200	795	N	5	D	N	99LR0000	A83278

14-0096	O	IL	CHICAGO	41	49	24	87	45	8	STACK		200	790				Y		A00000
14-1978	O	IL	DOWNERS GROVE	41	49	26	88	1	56	BLDG		304	1036	R	5	D	N	91GL1781	C95156
14-0962	O	IL	CHICAGO	41	49	33	87	43	55	BLDG		223	820	R	5	D	Y	75GL0409	A77011
14-0109	O	IL	CHICAGO	41	49	45	87	43	24	STACKS	2	388	978	R	5	D	Y		C83299
14-1362	O	IL	DOWNERS GROVE	41	49	50	88	2	23	TOWER		297	1053	R	5	D	Y	81GL0828	C82307
14-1882	O	IL	DOWNERS GROVE	41	49	50	88	1	56	BLDG		269	1021	R	5	D	N	86GL2308	C90176
14-0865	O	IL	CICERO	41	49	52	87	45	41	TOWER		200	800	N	5	D	Y	73GL1279	A75151
14-0018	O	IL	CHICAGO	41	49	56	87	42	21	TOWER		305	912	R	2	D	Y	99LM0000	C74054
14-0647	O	IL	BATAVIA	41	50	0	88	17	30	BLDG		331	1076				Y	70CH0156	C76091
14-0929	O	IL	CHICAGO	41	50	9	87	40	33	TOWER		220	811					03OE4179	D77121
14-1018	O	IL	CHICAGO	41	50	9	87	36	55	BLDG	4	220	819	R	5	D	N	99OC501	C89130
14-2080	O	IL	CHICAGO	41	50	14	87	42	0	TOWER		224	816	R	5	D	Y	92GL1376	C93081
14-0965	O	IL	GLEN ELLYN	41	50	16	88	4	51	TOWER		293	1043		5	D			A77011
14-0485	O	IL	BATAVIA	41	50	19	88	17	48	TOWER		315	1095	R	2	C	Y	96GL4222	C97049
14-6150	U	IL	CHICAGO	41	50	19	87	42	14	TOWER		152	747					99LR0000	C93053
14-1314	O	IL	CHICAGO	41	50	30	87	37	22	BLDG	2	230	829	N	1	A	N	99OC501	C94206
14-1356	O	IL	CHICAGO	41	50	30	87	36	59	STACK		200	795	R	1	A	N	99OC501	A82216
14-0930	O	IL	CHICAGO	41	50	38	87	41	47	TOWER		240	832		5	D		99LR0000	A77246
14-1019	O	IL	CHICAGO	41	50	41	87	37	15	BLDG	3	269	868	N	1	A	N	99OC501	C89079
14-6149	U	IL	VILLA PARK	41	50	44	87	58	16	TOWER		185	890						C78205
14-1707	O	IL	OAKBROOK TERR	41	50	46	87	59	1	BLDG		221	944	N	5	D	N	87GL0096	C87194
14-1020	O	IL	CHICAGO	41	50	49	87	37	15	BLDG		212	806	N	1	A	N	99OC501	C89079
14-0508	O	IL	BROADVIEW	41	51	2	87	51	18	TOWER		265	885	R	5	D	Y	99LR0000	C84032
14-6151	U	IL	CICERO	41	51	2	87	45	28	TOWER		165	837						A76072
14-0095	O	IL	CHICAGO	41	51	3	87	39	12	STACK		448	1047	R	2	A	N	99OC501	C89121
14-1021	O	IL	CHICAGO	41	51	5	87	36	54	BLDG		298	886	R	1	A	N	99OC501	C89086
14-0482	O	IL	CHICAGO	41	51	6	87	40	9	TOWER		270	863				Y		D83362
14-0016	O	IL	CHICAGO	41	51	9	87	43	18	TOWER		240	838		2	D	Y	99LM0000	C74054
14-1185	O	IL	CHICAGO	41	51	10	87	40	0	TOWER		221	812	N	5	D	N	76GL1430	C80163
14-2482	U	IL	CHICAGO	41	51	10	87	57	3	BLDG		365	960	M			N	96GL1833	A97342
14-1022	O	IL	CHICAGO	41	51	11	87	37	4	BLDG		239	830	R	1	A	N	99OC501	C94206
14-1674	O	IL	CHICAGO	41	51	12	87	36	58	BLDG		165	751	D	5	D	N	84GL2136	C86287
14-2042	O	IL	WESTCHESTER	41	51	12	87	55	4	TOWER		311	1004	R	5	D	Y	97GL2262	C97265
14-1599	O	IL	OAK PARK	41	51	14	87	55	8	TOWER		300	992	R	4	D	Y	85GL0555	D93019
14-0382	O	IL	VILLA PARK	41	51	15	87	58	36	TOWER		400	1125				Y	00CE5576	D83320
14-2486	U	IL	ELBURN	41	51	16	88	23	53	TOWER		158	918	N			N	97GL4565	A98005
14-1023	O	IL	CHICAGO	41	51	17	87	37	41	BLDG	2	211	805	N	1	A	N	99OC501	C94206

14-1024	O	IL	CHICAGO	41	51	19	87	37	23	BLDG	292	886	N	1	A	N	99OC501	C94206
14-0602	O	IL	CICERO	41	51	25	87	45	20	TOWER	200	803	R	5	D	Y	03CE2508	C83342
14-1701	O	IL	OAKBROOK TERR	41	51	30	87	57	16	BLDG	423	1113	D	5	D	N	84GL2470	C87146
14-1513	O	IL	WINFIELD	41	51	31	88	10	54	TOWER	262	1031	R	3	C	Y	94GL3619	C95037
14-0682	O	IL	CHICAGO	41	51	38	87	41	13	TOWER	346	938	R	5	D	Y	71CH0182	C76091
14-6153	U	IL	WHEATON	41	51	41	88	6	39	TOWER	110	896						A76072
14-0571	O	IL	GLEN ELLYN	41	51	46	88	1	50	TOWER	260	992	R	5	D	Y	97GL0055	C97104
14-2100	O	IL	CHICAGO	41	51	46	87	37	29	TOWER	170	765	R	5	D	Y	88GL1977	C93214
14-1025	O	IL	CHICAGO	41	51	48	87	37	22	BLDG	288	877	N	1	A	N	99OC501	C89079
14-6155	U	IL	ELMHURST	41	51	50	87	56	49	TOWER	163	844						A76072
14-0684	O	IL	HILLSIDE	41	51	53	87	53	13	TOWER	300	930				Y	70CH0496	C76091
14-1077	O	IL	WHEATON	41	51	53	88	8	38	TOWER	295	1023	R	5	D	Y	76GL1657	A78187
14-2103	O	IL	WHEATON	41	51	53	88	8	47	TOWERS 2	280	1008	R	5	D	Y	99FC0000	C96358
14-2392	U	IL	CHICAGO	41	51	59	87	36	30	CRANE T	120	722	N			N	97GL0577	C97076
14-1248	O	IL	CHICAGO	41	52	1	87	37	28	BLDG	315	904	N	1	A	N	79GL1703	C89079
14-1731	O	IL	ELBURN	41	52	4	88	25	37	TOWER	270	1062	M	5	D	Y	87GL1031	C89289
14-1026	O	IL	CHICAGO	41	52	7	87	37	28	BLDG	439	1028	N	1	A	N	99OC501	C89079
14-1505	O	IL	CHICAGO	41	52	9	87	41	36	TOWER	265	862	R	5	D	Y	94GL2894	C94297
14-0931	O	IL	CHICAGO	41	52	12	87	46	2	TOWER	263	878						D77295
14-1190	O	IL	GENEVA	41	52	12	88	17	54	TOWER	415	1153	R	2	C	Y	96GL4226	C97049
14-2150	O	IL	CHICAGO	41	52	18	87	40	10	BLDG-TWR	220	815	N	5	D	N	93GL1541	C94059
14-0839	O	IL	CHICAGO	41	52	24	87	42	14	TOWER	270	868	R	5	D	Y	72GL0146	C78065
14-0089	O	IL	GENEVA	41	52	30	88	16	38	TOWER	195	1003	N	4	D	N	79GL1535	C95233
14-2263	O	IL	GENEVA	41	52	30	88	16	39	TOWER	125	933	R	2	C	Y	94GL2489	A95198
14-0896	O	IL	CHICAGO	41	52	32	87	37	49	TOWER	297	890		5	D	Y	03CE1121	A76089
14-1027	O	IL	CHICAGO	41	52	38	87	37	33	BLDG	640	1231	R	1	A	N	99OC501	C94206
14-0003	O	IL	CHICAGO	41	52	39	87	37	56	BLDG	611	1204	N	1	A	N	99OC501	C94206
14-1810	O	IL	CHICAGO	41	52	39	87	38	8	BLDG	985	1579	R	5	D	N	86GL2433	C89248
14-1825	O	IL	CHICAGO	41	52	43	87	37	48	BLDG	601	1195		1	A	N	99OC501	C94206
14-0687	O	IL	CHICAGO	41	52	44	87	38	9	BLDG	1713	2306	S	2	A	N	81GL1485	C89086
14-0111	O	IL	MAPLE PARK	41	52	46	88	37	48	TOWER	295	1176	D	4	D	N	87GL1209	C90309
14-2454	O	IL	ELBURN	41	52	46	88	31	39	TOWER	199	1042	N	5	D	N	97GL3536	C97342
14-0048	O	IL	CHICAGO	41	52	47	87	37	53	TOWER	622	1217				Y	03CE0967	D76091
14-0064	O	IL	CHICAGO	41	52	47	87	37	53	TOWER	617	1211				Y		C74031
14-0076	O	IL	CHICAGO	41	52	47	87	37	29	TOWER	415	1005	S	1	D	Y	03CE1460	C76091
14-0633	O	IL	CHICAGO	41	52	48	87	38	14	BLDG 2	434	1036	N	4	D	N	68CH0365	C84032
14-1462	O	IL	CHICAGO	41	52	49	87	37	47	BLDG	495	1089	N	5	D	N	78GL1103	A83362

14-1714	O	IL	CHICAGO	41	52	49	87	38	6	BLDG	1035	1627	L	1	A	N	87GL0566	C91022
14-0141	O	IL	CHICAGO	41	52	50	88	11	55	TOWER	280	1046	R	4	D	Y	61KC0065	C83320
14-0052	O	IL	OAK PARK	41	52	51	87	47	38	TOWER	267	887	R	2	D	Y	99CF0000	C89156
14-1293	O	IL	CHICAGO	41	52	52	87	38	14	BLDG	531	1131	N	5	D	N	81GL0915	C83243
14-1663	O	IL	GENEVA	41	52	52	88	19	49	TOWER	267	1005	R	5	D	Y	86GL0729	C89212
14-0042	O	IL	CHICAGO	41	52	53	87	41	12	TOWER	297	895				Y		C74054
14-1028	O	IL	CHICAGO	41	52	54	87	37	47	BLDG	878	1471	R	1	A	N	99OC501	C94206
14-1221	O	IL	GENEVA	41	52	54	88	19	48	TOWER	304	1044	R	5	D	Y	86GL2335	C89212
14-0008	O	IL	CHICAGO	41	52	55	87	38	15	BLDG	625	1220	N	5	D	N	01CE2595	C84025
14-0035	O	IL	CHICAGO	41	52	55	87	38	11	TOWER	658	1258				Y		D84032
14-0073	O	IL	CHICAGO	41	52	55	87	43	32	TOWER	234	879				Y		D76292
14-0106	O	IL	CHICAGO	41	52	56	87	37	55	TOWER	581	1171				Y		C74054
14-0993	O	IL	CHICAGO	41	52	56	87	38	21	TOWER	381	971	N	5	D		76GL0297	A77295
14-1823	O	IL	CHICAGO	41	52	56	87	38	26	BLDG 2	596	1191	R	2	A	N	92GL1378	C89263
14-0010	O	IL	CHICAGO	41	52	58	87	37	55	BLDG	581	1181	R	1	D	N	03CE0632	C83355
14-0449	O	IL	CHICAGO	41	52	59	87	38	10	TOWER	340	934				Y	03CE1216	C76091
14-1029	O	IL	CHICAGO	41	53	5	87	36	59	BLDG	417	1003	R	1	A	N	99OC501	C89086
14-1257	O	IL	OAK PARK	41	53	5	87	48	4	BLDG	205	830	R	5	D	Y	80GL1313	C81027
14-2040	O	IL	CHICAGO	41	53	5	87	37	50	BLDG	779	1374	R	5	D	N	90GL0250	C92265
14-2446	O	IL	CHICAGO	41	53	5	87	37	3	BLDG-TWR	143	733	N	5	D	N	97GL2724	C97279
14-0045	O	IL	CHICAGO	41	53	6	87	37	23	BLDG	847	1457	N	1	A	N	66CE0397	C94206
14-0750	O	IL	CHICAGO	41	53	6	87	36	53	BLDG	576	1162	R	1	A	Y	87GL1586	C89121
14-1300	O	IL	CHICAGO	41	53	6	87	37	7	BLDG	445	1031	N	5	D	N	80GL0655	C82083
14-1308	O	IL	CHICAGO	41	53	6	87	37	30	BLDG	583	1179	N	5	D	N	81GL1366	C83103
14-1780	O	IL	CHICAGO	41	53	6	87	36	56	BLDG	564	1151	R	5	D	N	85GL1553	C89065
14-2376	O	IL	CHICAGO	41	53	6	87	37	10	BLDG	463	1049	R	2	D	N	96GL3211	C97034
14-0724	O	IL	CHICAGO	41	53	7	87	37	18	BLDG	1195	1780	R	1	A	N	70CH0075	C94206
14-0037	O	IL	CHICAGO	41	53	8	87	37	30	TOWER	561	1111				Y		C74054
14-1826	O	IL	CHICAGO	41	53	10	87	37	43	BLDG	676	1268	N	1	A	N	87GL0940	C92258
14-1966	O	IL	CHICAGO	41	53	11	87	37	50	BLDG	672	1272	R	5	D	N	89GL1796	C92230
14-0074	O	IL	CHICAGO	41	53	12	87	37	50	TOWER	571	1171				Y	00CE6792	C76091
14-1608	U	IL	DUPAGE	41	53	12	88	18	33	TOWER	180	940					99IP0000	D86042
14-0046	O	IL	CHICAGO	41	53	15	87	37	32	TOWER	610	1195				Y		A00000
14-0779	O	IL	CHICAGO	41	53	16	87	37	45	TOWER	881	1461				Y	00CE6597	C76091
14-1089	O	IL	CHICAGO	41	53	16	87	37	22	BLDG	395	985	N	5	D	N	77GL1867	C82076
14-1090	O	IL	CHICAGO	41	53	16	87	37	11	BLDG	422	1000	N	5	D	N	77GL1654	C80163
14-0094	O	IL	CHICAGO	41	53	17	87	37	27	TOWER	524	1105				Y		C74054

14-1578	O	IL	CHICAGO	41	53	17	87	37	51	BLDG	487	1096	R	5	D	N	84GL2361	C87048
14-0040	O	IL	CHICAGO	41	53	25	87	37	25	POLE	541	1135				Y		C74054
14-1865	O	IL	CHICAGO	41	53	25	87	37	18	BLDG	602	1216	R	5	D	N	89GL1547	C90022
14-1697	O	IL	CHICAGO	41	53	28	87	38	12	BLDG	240	834	N	5	D	N	85GL0642	C87096
14-6200	U	IL	BERKLEY	41	53	28	87	54	2	TANK	132	782						A76174
14-1824	O	IL	CHICAGO	41	53	29	87	36	44	BLDG	674	1264	R	1	A		99OC501	A89135
14-0518	O	IL	CHICAGO	41	53	32	87	37	8	BLDG	665	1260	R	5	D	N	65CE1002	C83362
14-2160	O	IL	WEST CHICAGO	41	53	32	88	14	38	TOWER	150	900	R	5	D	N	93GL3358	C94087
14-1522	O	IL	CHICAGO	41	53	38	87	36	59	BLDG	596	1187	N	2	A	N	86GL0054	C89121
14-0369	O	IL	LOMBARD	41	53	41	88	2	44	TOWER	215	939	R	4	D	Y	91GL0933	C91336
14-1328	O	IL	CHICAGO	41	53	45	87	38	32	BLDG	394	984		3	C	N	99SP0000	A82139
14-1329	O	IL	CHICAGO	41	53	45	87	37	49	BLDG	311	906		3	C	N	99SP0000	A82139
14-2081	O	IL	CHICAGO	41	53	45	87	37	6	BLDG-TWR	233	823	N	5	D	N	00CE6344	A93067
14-1531	O	IL	MELROSE PARK	41	53	49	87	53	21	TOWER	265	905	R	5	D	Y	94GL2897	C94297
14-0933	O	IL	BERKELEY	41	53	50	87	54	46	TOWER	230	890	R	4	D			D92181
14-1330	O	IL	CHICAGO	41	53	52	87	37	21	BLDG	875	1464	R	2	A	N	99OC501	C89121
14-1331	O	IL	CHICAGO	41	53	55	87	37	10	BLDG	415	1010		3	C	N	99SP0000	A82139
14-0780	O	IL	CHICAGO	41	53	56	87	37	22	BLDG	1456	2049	R	2	A	N	65CE0214	C89114
14-2460	O	IL	CAROL STREAM	41	53	58	88	7	16	TOWER	275	1048	D	5	D	N	97GL0305	C97300
14-0029	O	IL	CHICAGO	41	53	59	87	37	25	TOWER	555	1150	N	1	D	Y	99HC0000	C74054
14-1827	O	IL	CHICAGO	41	53	59	87	37	29	BLDG	886	1477	S	2	A	N	87GL0344	C91168
14-2029	O	IL	BERKLEY	41	54	0	87	54	51	TOWER	230	883	R	5	D	Y	88GL0891	C92223
14-0789	O	IL	CHICAGO	41	54	1	87	37	28	TOWER	800	1387				Y	00CE5821	D76120
14-0505	O	IL	WEST CHICAGO	41	54	3	88	12	56	TANK	174	950	R	1	B		66CH0455	C92223
14-1335	O	IL	CHICAGO	41	54	4	87	37	28	BLDG	598	1188		3	C	N	99SP0000	A82139
14-1332	O	IL	CHICAGO	41	54	5	87	37	43	BLDG	558	1153		3	C	N	99SP0000	A82139
14-2299	O	IL	WEST CHICAGO	41	54	18	88	13	8	TOWER	135	897	N	2	C	N	95GL3479	C95360
14-1251	O	IL	NORTHLAKE	41	54	19	87	55	2	BLDG-TWR	225	900	R	5	D	N	94GL2252	C94269
14-1171	O	IL	GLENDALE HTS	41	54	22	88	5	48	TOWER	185	980	N	4	D			C81056
14-1334	O	IL	CHICAGO	41	54	22	87	37	32	BLDG	405	995		3	C	N	99SP0000	A82139
14-0934	O	IL	CHICAGO	41	54	25	87	38	34	TOWER	206	799	R	5	D		99CF0000	A78065
14-1623	O	IL	CHICAGO	41	54	28	88	17	41	TOWERS 5	167	917	R	1	B		99OC510	C86258
14-1319	O	IL	CHICAGO	41	54	29	87	37	51	BLDG	273	873		3	C	N	99SP0000	A82104
14-1320	O	IL	CHICAGO	41	54	34	87	37	52	BLDG	283	883		3	C	N	99SP0000	A82104
14-1333	O	IL	CHICAGO	41	54	39	87	37	35	BLDG	432	1027		3	C	N	99SP0000	A82139
14-2374	O	IL	ST. CHARLES	41	54	47	88	15	54	BLDG	32	786	R	2	C	N	96GL3847	C97132
14-2348	O	IL	WEST CHICAGO	41	54	49	88	12	1	TOWER	180	951	N	2	C	N	96GL0985	A96162

14-0112	O	IL	CHICAGO	41	54	50	87	45	25	TOWER	250	862				Y		C74054
14-1717	O	IL	CHICAGO	41	54	50	87	38	2	BLDG	420	1018	R	5	D	N	85GL1174	C87286
14-6157	U	IL	MELROSE PARK	41	54	50	87	53	30	TOWER	195	795						A76072
14-2423	O	IL	ST. CHARLES	41	54	51	88	15	57	BLDG	27	782	R	5	C	N	96GL3293	C97245
14-1622	O	IL	CHICAGO	41	54	53	88	14	50	CTRL TWR	66	816	R	1	A		99OC510	C92223
14-1053	O	IL	CHICAGO	41	54	54	87	44	59	TOWER	220	835	R	5	D	Y	99LR0000	A78065
14-1959	O	IL	RIVER GROVE	41	54	56	87	50	12	TOWER	150	775	N	5	D	N	99TR0000	A91105
14-0603	O	IL	ADDISON	41	55	0	87	59	21	TOWER	310	1008	R	4	D	Y	03CE3312	C84221
14-1374	O	IL	CHICAGO	41	55	4	87	45	54	TOWER	270	890	R	5	D	Y	82GL0779	C83026
14-2509	O	IL	WEST CHICAGO	41	55	5	88	14	9	TOWER	140	899	N	2	C	N	97SO5758	C98194
14-0393	O	IL	ELBURN	41	55	7	88	25	47	TOWER	180	1190	R	2	D			C74057
14-1265	O	IL	WEST CHICAGO	41	55	12	88	15	22	BLDG	148	908	R	1	B	N	77GL1665	C92223
14-1667	O	IL	CHICAGO	41	55	17	87	41	51	TOWER	270	868	R	5	D	Y	82GL1206	A86287
14-0885	O	IL	ELMHURST	41	55	22	87	56	54	TOWER	221	905	R	1	A	Y	75GL0918	C89254
14-1860	O	IL	ADDISON	41	55	22	88	2	19	TOWER	305	1059	R	5	D	Y	88GL0681	C89283
14-6006	U	IL	MITCHELL FIELD	41	55	23	88	1	38	TOWER	104	839						A76076
14-1428	O	IL	CHICAGO	41	55	27	87	38	11	BLDG	294	884		3	C		99SP0000	A83166
14-1433	O	IL	CHICAGO	41	55	30	87	38	18	BLDG	299	889		3	C		99SP0000	A83166
14-1432	O	IL	CHICAGO	41	55	32	87	39	44	BLDG	211	806		3	C		99SP0000	A83166
14-0038	O	IL	ELMWOOD PARK	41	55	35	87	48	24	TOWER	259	909	R	5	D	Y	67CH0662	C76091
14-0005	O	IL	ELMHURST	41	55	36	87	56	56	TOWERS 4	432	1108	R	1	A	Y	80GL1216	D91070
14-0935	U	IL	ADDISON	41	55	40	87	59	50	TOWER	200	900						D78332
14-0006	O	IL	CHICAGO	41	55	41	88	0	23	TOWER	495	1185	R	2	D	Y	93GL1705	C74054
14-1431	O	IL	CHICAGO	41	55	41	87	38	21	BLDG	337	927		3	C		99SP0000	A83166
14-1430	O	IL	CHICAGO	41	55	49	87	38	22	BLDG	423	1013		3	C		99SP0000	A83166
14-1429	O	IL	CHICAGO	41	55	50	87	38	30	BLDG	233	823		3	C		99SP0000	A83166
14-0804	O	IL	CHICAGO	41	55	54	87	41	31	TOWER	240	836				Y	74GL0746	A74178
14-0936	O	IL	CHICAGO	41	55	57	87	38	29	TOWER	205	797	N	3	C		99SP0000	A76120
14-0444	O	IL	ADDISON	41	55	58	87	59	34	TOWER	251	941				Y	00CE6747	D84067
14-1427	O	IL	CHICAGO	41	55	59	87	38	12	BLDG	403	993		3	C		99SP0000	A83166
14-0007	O	IL	CHICAGO	41	56	5	88	4	24	WMAQ 2	748	1508	N	4	D	N	97GL0086	C83257
14-0749	O	IL	CLOVERDALE	41	56	5	88	5	57	TOWER	337	1157	D	4	D	N	94GL2608	C78005
14-1426	O	IL	CHICAGO	41	56	8	87	39	50	BLDG	253	843		3	C		99SP0000	A83166
14-1424	O	IL	CHICAGO	41	56	12	87	38	18	BLDG	278	868		3	C		99SP0000	A83166
14-0818	O	IL	CAROL STREAM	41	56	14	88	7	29	TOWER	408	1178	R	5	D	Y	73GL1645	C83349
14-0636	O	IL	CHICAGO	41	56	18	87	45	5	TOWER	530	1143	R	5	D	Y	70CH0117	C76091
14-1421	O	IL	CHICAGO	41	56	18	87	39	16	BLDG	224	824		3	C		99SP0000	A83166

14-1423	O	IL	CHICAGO	41	56	20	87	38	19	BLDG	357	947		3	C		99SP0000	A83166
14-6160	U	IL	FRANKLIN PARK	41	56	21	87	53	23	TOWER	147	787						A76072
14-0661	O	IL	CHICAGO	41	56	24	87	41	20	TOWER	270	860	R	5	D	Y	75GL0489	C78065
14-1425	O	IL	CHICAGO	41	56	25	87	38	32	BLDG	225	815		3	C		99SP0000	A83166
14-1863	O	IL	BARTLETT	41	56	25	88	12	25	TOWER	167	944	N	5	D	N	89GL0777	C89352
14-6192	U	IL	FRANKLIN PARK	41	56	26	87	51	14	TOWER	175	805						A76174
14-0787	O	IL	CHICAGO	41	56	28	87	53	43	TANK	165	810	R	1	A	N	99OC016	C86063
14-1154	O	IL	CHICAGO	41	56	36	87	42	15	TOWER	267	864	R	5	D	Y	96GL2842	C97021
14-1076	O	IL	CAROL STREAM	41	56	38	88	8	24	TOWER	300	1098	R	2	C	Y	96GL3845	C97013
14-1422	O	IL	CHICAGO	41	56	38	87	38	33	BLDG	262	852		3	C		99SP0000	A83166
14-1420	O	IL	CHICAGO	41	56	47	87	38	37	BLDG	375	965		3	C		99SP0000	A83166
14-1419	O	IL	CHICAGO	41	56	50	87	38	46	BLDG	270	860		3	C		99SP0000	A83166
14-1464	O	IL	LILY LAKE	41	56	54	88	28	33	TOWER	200	1160	N	5	D	N	78GL0920	C84004
14-2342	O	IL	CHICAGO	41	56	58	87	38	45	BLDG	493	1084	N	5	D	N	92GL2028	A96134
14-1417	O	IL	CHICAGO	41	57	2	87	39	3	BLDG	330	920		3	C		99SP0000	A83166
14-1418	O	IL	CHICAGO	41	57	2	87	38	44	BLDG	263	853		3	C		99SP0000	A83166
14-1634	O	IL	CHICAGO	41	57	7	87	55	44	TOWER	175	844	R	1	A		99OC016	C95240
14-1416	O	IL	CHICAGO	41	57	8	87	38	40	BLDG	315	905		3	C		99SP0000	A83166
14-2475	O	IL	LINCOLNWOOD	41	57	10	87	43	3	STACK	135	730	N	5	D	N	97GL1832	C98020
14-6161	U	IL	SCHILLER PARK	41	57	10	87	52	45	TOWER	135	775						A76072
14-1635	O	IL	CHICAGO	41	57	11	87	53	3	TOWER	138	783	R	1	A		99OC016	C86175
14-0050	O	IL	CHICAGO	41	57	13	87	48	17	TOWER	340	985	R	2	D	Y	99TR0000	C75251
14-1414	O	IL	CHICAGO	41	57	14	87	38	53	BLDG	356	946		3	C		99SP0000	A83166
14-1415	O	IL	CHICAGO	41	57	14	87	38	47	BLDG 2	677	1267		3	C		99SP0000	A83166
14-1412	O	IL	CHICAGO	41	57	16	87	39	55	BLDG	236	836		3	C		99SP0000	A83166
14-2252	O	IL	SCHILLER PARK	41	57	18	87	51	52	TOWER	155	790	R	5	D	Y	99IP0000	C97069
14-1413	O	IL	CHICAGO	41	57	20	87	38	41	BLDG	262	852		3	C		99SP0000	A83173
14-1411	O	IL	CHICAGO	41	57	30	87	39	0	BLDG	289	879		3	C		99SP0000	A83166
14-2422	O	IL	HANOVER PARK	41	57	32	88	9	17	TOWER	188	992	R	5	D	Y	97GL0737	C97237
14-2338	O	IL	BENSENVILLE	41	57	33	87	56	58	TANK	140	812	R	2	C	Y	96GL0207	C97021
14-6194	U	IL	WOOD DALE	41	57	44	87	59	10	TANK	162	843						A76174
14-1088	O	IL	IRVING PARK	41	57	49	87	52	34	TOWER	34	684	R	5	D			A78273
14-6163	U	IL	CHICAGO	41	57	50	87	38	1	TOWER	154	790						A76072
14-1662	O	IL	SCHILLER PARK	41	57	56	87	52	9	TOWER	127	771		1	A		99OC016	C95240
14-2266	O	IL	SCHILLER PARK	41	57	57	87	52	29	SIGN	60	700	N	5	D	N	95GL1171	C95233
14-2265	O	IL	SCHILLER PARK	41	58	1	87	52	27	SIGN	60	700	R	2	C	N	95GL1173	C95233
14-1703	O	IL	SCHILLER PARK	41	58	12	87	52	19	SIGN	88	727	R	1	A	N	87GL0048	C95240

14-1057	O	IL	CHICAGO	41	58	15	87	45	50	TOWER	270	888	R	5	D	Y	80GL1495	C82018
14-1658	O	IL	CHICAGO	41	58	23	87	56	26	TOWER	133	798	R	1	A	Y	96GL3821	C95240
14-2277	O	IL	CHICAGO	41	58	33	87	54	12	CTRL TWR	260	910	R	1	D	N	99OC016	C96183
14-1033	O	IL	CHICAGO	41	58	38	87	54	16	CTRL TWR	201	852	R	1	A	N	99OC016	C95240
14-6195	U	IL	CHICAGO	41	58	38	87	50	30	BLDG	156	794						A76174
14-0103	O	IL	CHICAGO	41	58	45	87	39	15	TOWER	280	860				Y		D86126
14-0614	O	IL	CHICAGO	41	58	45	87	54	14	CRANE 2	165	815					69CH0792	D77342
14-0753	O	IL	CHICAGO	41	58	46	87	53	51	TOWER	160	815	R	1	A		70CH0302	C90240
14-2169	O	IL	SCHILLER PARK	41	58	48	87	51	54	BLDG-TWR	130	763	R	1	A	N	93GL1939	C95240
14-1641	O	IL	CHICAGO	41	58	49	87	39	19	BLDG	600	1190	R	5	D	N	99LR0000	C87341
14-2276	O	IL	CHICAGO	41	58	49	87	55	40	TOWER	101	766	R	1	A		99OC016	A95240
14-0528	O	IL	CHICAGO	41	58	50	87	55	40	TOWER	88	753		1	A		99OC016	C92139
14-0568	O	IL	CHICAGO	41	58	53	87	46	20	TOWER	240	860	R	5	D	Y	67GL0067	C76091
14-1661	O	IL	CHICAGO	41	58	53	87	51	34	BLDG	152	782		1	A	N	99OC016	C90240
14-0942	O	IL	WAYNE	41	58	54	88	14	35	TOWERS 2	270	1031	R	5	D	Y	97GL1727	C98082
14-1097	O	IL	CHICAGO	41	59	7	87	49	55	BLDG	124	767		5	D		78GL1045	A78298
14-0822	O	IL	ITASCA	41	59	8	88	2	5	TOWER	240	965	R	5	D	Y	74GL0194	A74273
14-2270	O	IL	ROSELLE	41	59	9	88	6	10	TOWER	175	973	D	5	D	N	92GL0455	C97006
14-1409	O	IL	CHICAGO	41	59	12	87	39	17	BLDG	319	906		3	C		99SP0000	A83166
14-1854	O	IL	ITASCA	41	59	12	88	0	32	BLDG	400	1097	R	5	D	N	84GL2406	C90274
14-1408	O	IL	CHICAGO	41	59	15	87	39	35	BLDG	221	808		3	C		99SP0000	A83166
14-1807	O	IL	ROSEMONT	41	59	16	87	51	40	BLDG	155	785	N	5	D	N	88GL1144	C89030
14-2379	O	IL	ITASCA	41	59	16	88	1	2	BLDG	243	939	R	2	C	N	95GL3913	A96351
14-1679	O	IL	ITASCA	41	59	18	88	0	47	BLDG	391	1087	S	5	D	N	84GL2138	C90183
14-1407	O	IL	CHICAGO	41	59	19	87	39	17	BLDG	248	835		3	C	N	99SP0000	A83166
14-1556	O	IL	ITASCA	41	59	21	88	0	59	BLDG 2	224	920	R	5	D	N	84GL2322	C85135
14-0126	O	IL	LILY LAKE	41	59	22	88	28	0	TOWER	340	1340	R	4	D	Y		C83314
14-0631	O	IL	ROSEMONT	41	59	25	87	51	37	TOWER	120	750						C74057
14-0009	O	IL	ITASCA	41	59	26	88	1	39	WBBM 2	695	1413	R	1	A	Y	97GL0085	C93060
14-1406	O	IL	CHICAGO	41	59	30	87	39	18	BLDG	428	1015		3	C		99SP0000	A83166
14-1405	O	IL	CHICAGO	41	59	33	87	39	17	BLDG	402	989		3	C		99SP0000	A83166
14-1404	O	IL	CHICAGO	41	59	36	87	39	19	BLDG	291	878		3	C		99SP0000	A83166
14-1403	O	IL	CHICAGO	41	59	48	87	39	18	BLDG	261	848		3	C		99SP0000	A83166
14-1402	O	IL	CHICAGO	41	59	50	87	39	19	BLDG	229	816		3	C		99SP0000	A83166
14-1401	O	IL	CHICAGO	41	59	54	87	39	40	BLDG	240	827		3	C		99SP0000	A83166
14-1845	O	IL	ELGIN	41	59	54	88	14	33	TOWER	366	1136	M	5	D	N	88GL0531	C89226
14-1400	O	IL	CHICAGO	41	59	55	87	39	24	BLDG	212	799		3	C		99SP0000	A83166

14-2219	O	IL	ROSEMONT	41	59	58	87	53	20	BLDG	94	745	R	1	A	N	95GL4069	C95240
14-1058	O	IL	CHICAGO	41	59	59	87	40	19	TOWER	270	872	R	5	D	Y	76GL0769	A78065
14-1636	O	IL	CHICAGO	41	59	59	87	56	20	BLDG	65	735	R	1	A	N	99OC016	C90225
14-1410	O	IL	CHICAGO	42	0	5	87	39	35	BLDG	212	799		3	C		99SP0000	A83166
14-2471	O	IL	PARK RIDGE	42	0	8	87	51	59	TOWER	162	800	R	4	D	Y	97GL3986	C98033
14-1244	O	IL	ELGIN	42	0	21	88	17	55	TOWERS 4	145	885	N	5	D		99AM000	C81056
14-2381	O	IL	SYCAMORE	42	0	24	88	40	40	TOWER	187	1030	R	5	D	Y	99AM000	C97034
14-6169	U	IL	PARK RIDGE	42	0	30	87	49	53	TOWER	106	754						A76072
14-1392	O	IL	CHICAGO	42	0	34	88	1	59	TOWER	254	964	R	4	D	Y	99TR0000	A83117
14-0283	O	IL	CHICAGO	42	0	42	88	2	7	WGN	750	1460	R	2	D	Y	99LM0000	A00000
14-2327	O	IL	ELGIN	42	0	50	88	17	7	TOWER	419	1149	R	5	D	Y	95GL3718	C96085
14-0350	O	IL	ELGIN	42	0	52	88	17	7	TOWER	415	1145	R	4	D	N	62CE0005	D95150
14-0737	O	IL	PLATO	42	1	5	88	29	28	TOWER	305	1330	R	2	C	Y	96GL4232	C97055
14-0655	O	IL	PLATO CENTER	42	1	9	88	29	3	TOWER	142	1205						D78065
14-1766	O	IL	PLATO CENTER	42	1	10	88	22	59	TOWER	500	1380	R	4	D	Y	86GL1860	C96253
14-1565	O	IL	ELGIN	42	1	11	88	22	53	TOWER	489	1385	R	2	C	Y	96GL1231	C96253
14-0651	O	IL	PLATO	42	1	12	88	29	3	TOWERS 2	300	1350	R	4	D	Y	70CH0399	C83013
14-1291	O	IL	ELGIN	42	1	13	88	15	8	TOWER	300	1080	R	5	D		81GL0230	C85253
14-1263	O	IL	EVANSTON	42	1	16	87	42	41	TOWERS 4	153	748	N	5	D	N	80GL1546	C93116
14-1364	O	IL	ELGIN	42	1	27	88	19	5	TOWER	213	1038	R	5	D	Y	98GL0028	C98124
14-1394	O	IL	SKOKIE	42	1	29	87	43	7	TOWER	270	870	R	5	D	Y	94GL2428	C83278
14-0288	O	IL	EVANSTON	42	1	37	87	42	18	TOWER	189	787						D76292
14-2138	O	IL	MORTON GROVE	42	1	56	87	47	13	TOWER	222	848	R	4	D	Y	93GL1500	A93326
14-0286	O	IL	EVANSTON	42	2	3	87	42	27	TOWER	180	779						D76292
14-0287	O	IL	EVANSTON	42	2	3	87	42	30	TOWER	298	897	R	2	D	Y	68CH0727	C83195
14-6167	U	IL	ELGIN	42	2	5	88	16	30	TOWER	187	907						A76072
14-1264	O	IL	EVANSTON	42	2	7	87	42	12	TOWER	197	796	R	5	D	Y	86GL0586	C93116
14-0358	O	IL	ELGIN	42	2	12	88	16	34	TOWER	185	941						C74057
14-1580	O	IL	SCHAUMBURG	42	2	12	88	2	4	BLDG	292	1016	R	5	D	N	85GL0434	C85225
14-6188	U	IL	ELGIN	42	2	13	88	16	48	TOWER	130	873						A76174
14-6166	U	IL	PARK RIDGE	42	2	20	87	51	40	TOWER	118	755						A76072
14-0784	O	IL	DES PLAINES	42	2	30	87	51	57	TOWERS 4	228	858	R	4	D	Y	80GL0994	C81299
14-0282	O	IL	DES PLAINES	42	2	32	87	50	36	TOWERS 2	281	926				Y		D81299
14-0294	O	IL	NILES	42	2	33	87	49	44	TOWER	250	915	R	4	D	Y	81GL0404	C85310
14-2358	O	IL	HOFFMAN ESTATES	42	2	39	88	2	36	BLDG-TWR	300	1049	R	5	D	N	94GL3212	C97013
14-0693	O	IL	ELGIN	42	2	44	88	15	35	TOWER	373	1158	R	4	D	Y	84GL0702	D91014
14-1005	O	IL	EVANSTON	42	2	45	87	40	56	BLDG	260	860	R	5	D	N	76GL0292	A78005

14-6001	U	IL	ARLINGTON HGTS	42	2	45	87	58	31	TOWER	100	800						A76043
14-0555	O	IL	EVANSTON	42	2	50	87	40	51	BLDG	300	900	R	5	D	N	68CH0636	C87096
14-2340	O	IL	EVANSTON	42	2	52	87	40	49	BLDG	221	824	R	5	D	N	96GL0467	C97041
14-0937	O	IL	SKOKIE	42	3	4	87	45	16	TOWER	225	851		5	D		99CF0000	A76212
14-6170	U	IL	EVANSTON	42	3	5	87	40	20	TOWER	75	740						A76072
14-6171	U	IL	SKOKIE	42	3	5	87	45	18	TOWER	175	796						A76072
14-6172	U	IL	DES PLAINES	42	3	9	87	53	45	TOWER	163	799						A76072
14-6113	U	IL	EVANSTON	42	3	12	87	40	33	TOWER	130	695						A76166
14-1808	O	IL	ROLLING MEADOWS	42	3	22	88	1	26	TOWER	225	940	D	5	D	N	97GL3781	C89079
14-1060	O	IL	PALATINE	42	3	24	88	2	21	TOWER	220	953	R	3	D	Y	76GL1687	D95289
14-0810	O	IL	SCHAUMBURG	42	3	27	88	1	52	TOWER	205	934	R	3	C	Y	74GL0004	A74218
14-1491	O	IL	SKOKIE	42	3	28	87	44	17	TOWER	243	876	R	5	D	Y	83GL1505	C84165
14-0495	O	IL	ROLLING MEADOWS	42	3	35	88	1	28	TOWER	287	997				Y	65CE1079	C76091
14-1986	O	IL	DES PLAINES	42	3	37	87	51	51	TOWER	370	1015	R	5	D	Y	91GL0409	C91294
14-1179	U	IL	SCHAUMBURG	42	3	45	88	3	8	TOWER	255	1002	R				76GL0863	D80163
14-1616	O	IL	SCHAUMBURG	42	3	45	88	3	8	BLDG	204	944	N	3	C	N	73GL1074	A86014
14-6174	U	IL	ARLINGTON HGTS	42	3	49	87	59	46	TOWER	104	810	N			N	99LR0000	A76072
14-2164	O	IL	ELGIN	42	3	56	88	15	39	TOWER	310	1122	R	5	D	Y	93GL3267	C94151
14-1521	O	IL	ELGIN	42	3	57	88	14	36	TOWER	266	1080	R	3	C	Y	94GL3695	C95037
14-2336	O	IL	GLENVIEW	42	3	57	87	48	3	TANK	150	787	N	4	D	N	96GL0498	C97013
14-0433	O	IL	SCHAUMBURG	42	4	0	88	4	38	TOWER	285	1049	R	5	D	Y	73GL1728	D86014
14-0309	O	IL	PALATINE	42	4	2	88	2	36	TOWER	268	1001		3	C	Y		C74057
14-2481	O	IL	S. BARRINGTON	42	4	2	88	8	35	TOWER	225	1050	R	5	D	Y	97GL5182	C98020
14-0308	O	IL	ELGIN	42	4	13	88	18	21	TOWER	245	1068	R	4	D	Y	98GL0038	C98124
14-1048	O	IL	ARLINGTON HGTS	42	4	21	87	57	35	TOWER	210	880	R	5	D	Y	89GL1650	A78209
14-2492	O	IL	GLENVIEW	42	4	21	87	50	20	TOWER	105	783	N	2	C	N	97GL3946	C98103
14-1369	O	IL	MOUNT PROSPECT	42	4	28	87	55	4	TOWER	230	881	R	2	C	Y	94GL2893	C94304
14-2491	O	IL	GLENVIEW	42	4	30	87	45	46	TANK	120	745	N	4	D	N	97GL5174	C98110
14-1463	U	IL	GLENVIEW	42	4	45	87	47	14	BLDG	25	673	R				81GL0950	A83349
14-2004	O	IL	GLENVIEW	42	4	50	87	48	42	BLDG	24	656	R	5	D	N	86GL2044	C92244
14-0471	O	IL	GLENVIEW	42	5	19	87	51	35	TOWER	149	834					66CH0239	C76091
14-2405	O	IL	NORTHBROOK	42	5	25	87	50	13	TOWER	172	830	N	2	C	N	96GL4353	A97090
14-0853	O	IL	EAST DUNDEE	42	5	29	88	14	32	TOWER	185	1035					73GL0360	D90099
14-6189	U	IL	DUNDEE	42	5	36	88	15	22	TOWER	152	986						A76174
14-6282	U	IL	WILLOW	42	5	39	87	52	3	TOWER	100	765						A78205
14-1638	O	IL	CHICAGO	42	6	4	87	52	11	BLDG	174	834	R	1	A	N	99OC502	C93144
14-6175	U	IL	NORTHFIELD	42	6	4	87	45	54	TOWER	129	754						A76072

14-1712	O	IL	NORTHBROOK	42	6	12	87	49	34	BLDG	29	667	N	5	D	N	85GL1403	C87299
14-6190	U	IL	NORTHFIELD	42	6	15	87	48	5	TANK	140	806						A76174
14-0510	O	IL	DUNDEE	42	6	20	88	22	40	TOWER	278	1178	R	5	D	Y	72GL0725	D93095
14-1566	O	IL	GLENVIEW	42	6	21	87	49	9	POLE	54	694	R	5	D		82GL0152	C85091
14-2085	O	IL	GILBERTS	42	6	21	88	22	37	TOWER	320	1220	D	4	D	N	90GL0744	C93137
14-1309	O	IL	NORTHBROOK	42	6	23	87	49	30	POLE	43	686	R	5	D		81GL1518	C85071
14-1932	O	IL	DUNDEE	42	6	24	88	14	18	TOWER	220	1080	R	5	D	Y	90GL0129	C91364
14-2298	O	IL	PROSPECT HGHTS	42	6	25	87	53	25	POLE	30	668	F	2	C	N	95GL3534	C95360
14-1532	O	IL	GILBERTS	42	6	28	88	24	32	TOWER	253	1162	R	2	C	Y	94GL3388	C95030
14-2127	O	IL	EAST DUNDEE	42	6	29	88	14	20	TOWER	270	1125	M	5	D	N	94GL1731	C94186
14-1820	O	IL	PROSPECT HGHTS	42	6	32	87	53	31	BLDG	18	659	N	5	D	N	85GL0347	C89121
14-1514	O	IL	PROSPECT HGHTS	42	6	33	87	53	26	POLE	25	663	N	5	D	N	84GL1046	C84235
14-1758	O	IL	PROSPECT HGHTS	42	6	33	87	53	33	BLDG	24	666	R	5	D	N	87GL0341	C88235
14-1982	O	IL	PROSPECT HGTS	42	6	33	87	53	45	BLDG	18	659	N	1	A	N	87GL0943	C93144
14-1816	O	IL	PROSPECT HGHTS	42	6	34	87	53	35	SIGN	15	657	R	5	D	N	88GL1498	C89114
14-1981	O	IL	PROSPECT HGHTS	42	6	34	87	53	42	POLE	12	652	R	5	D	N	88GL1218	C92027
14-0311	O	IL	ARLINGTON HGTS	42	6	43	87	58	53	TOWER	256	954				Y		D76292
14-1764	O	IL	ARLINGTON HTS	42	6	43	87	58	52	TOWER	273	967	R	2	C	Y	96GL4230	C97055
14-1671	O	IL	NORTHBROOK	42	6	44	87	52	17	TOWER	164	824	R	2	A		71GL0581	C87055
14-1626	O	IL	WHEELING	42	6	52	87	54	34	BLDG	22	668	R	5	D	N	82GL0055	C87208
14-1994	O	IL	WHEELING	42	6	53	87	53	56	BLDG	43	684	L	1	A	N	87GL0760	C93144
14-2421	U	IL	WHEELING	42	6	54	87	53	38	CRANE T	85	726	R			Y	96GL3768	A97132
14-2290	O	IL	WHEELING	42	6	55	87	55	10	TOWER	106	759	N	5	D	N	94GL1926	C95338
14-6178	U	IL	SKOKIE	42	7	11	87	46	5	TOWER	154	790						A76072
14-1594	O	IL	WHEELING	42	7	25	87	54	20	POLE	36	676	R	5	D		85GL0309	C85298
14-0786	O	IL	ARLINGTON HGTS	42	8	0	87	59	4	TOWER	322	1033	R	5	D	Y	68CH0037	C84046
14-0785	O	IL	ARLINGTON HGTS	42	8	14	87	53	8	TOWERS 6	137	795						D82025
14-0689	O	IL	ARLINGTON HTS	42	8	18	87	59	0	TOWER	346	1055	R	2	C	Y	96GL2421	C97049
14-2391	O	IL	CARPENTERSVILLE	42	8	21	88	16	23	TOWER	262	1099	D	2	C	N	97GL0066	C97104
14-1312	O	IL	EVANSTON	42	8	23	87	53	9	TOWERS 4	163	819	N	5	D	N	99AM000	C93144
14-2344	O	IL	RIVERWOODS	42	8	23	87	53	10	TOWER	105	760	N	2	C	N	96GL0462	C96253
14-6173	U	IL	WHEELING	42	8	29	87	55	40	TOWER	165	810						A76170
14-0854	O	IL	WHEELING	42	8	35	87	55	38	TOWER	173	818	R	5	D		73GL1595	A75062
14-0467	O	IL	NORTHBROOK	42	8	50	87	50	27	STACK	225	875				Y		D76292
14-0812	O	IL	HAMPSHIRE	42	8	51	88	30	45	TOWER	215	1118	R	4	D	Y	74GL0017	A74218
14-0466	O	IL	NORTHBROOK	42	9	9	87	50	36	TANK	250	910				Y		D76292
14-2508	O	IL	HAMPSHIRE	42	9	11	88	32	22	TOWER	190	1080	N	2	C	N	98GL0767	C98187

14-2429	O	IL	BUFFALO GROVE	42	9	17	87	54	51	BLDG	310	957	N	5	D	N	97GL3125	C98048
14-6009	U	IL	BARRINGTON	42	9	20	88	8	48	TOWER	100	915						A76065
14-1363	O	IL	HIGHLAND PARK	42	9	24	87	48	20	TOWER	246	894	R	5	D		83GL0104	C84060
14-0318	O	IL	HIGHLAND PARK	42	9	26	87	51	2	TOWER	156	811	N	4	D		99CF0000	C74057
14-0390	O	IL	WHEELING	42	9	30	87	55	12	TANK	130	778						C74057
14-1087	O	IL	DEERFIELD	42	9	45	87	52	29	TOWER	145	825	R	5	D		74GL0014	A78273
14-0675	O	IL	ALGONQUIN	42	9	47	88	19	1	TOWER	300	1194				Y	70CH0779	C76091
14-6176	U	IL	ALGONQUIN	42	10	35	88	15	49	TOWER	160	1040					69CH0584	C76238
14-1818	O	IL	RIVERWOODS	42	10	53	87	57	5	TOWER	155	840	N	5	D	N	85GL0110	C89121
14-6179	U	IL	HIGHLAND PARK	42	11	10	87	49	28	TOWER	175	818						A76072
14-0299	O	IL	LAKE ZURICH	42	11	17	88	5	32	TOWER	307	1201	R	2	D	Y	69CH0406	C76091
14-2501	U	IL	LAKE IN HILLS	42	11	40	88	23	43	TANK	225	1100					99IP0000	A98103
14-0310	O	IL	BANNOCKBURN	42	11	55	87	51	41	TOWER	212	872				Y		D81327
14-2516	U	IL	LAKE ZURICH	42	12	18	88	4	18	TOWER	208	1080	R			Y	98GL0560	A98180
14-2111	O	IL	LAKE N TH HILLS	42	12	31	88	19	0	BLDG	25	911	N	2	C	N	91GL1861	C94066
14-0531	O	IL	LAKE ZURICH	42	14	10	88	3	52	TOWER	370	1245				Y	67CH0402	D79114
14-0971	O	IL	LAKE ZURICH	42	14	10	88	3	51	TOWER	434	1309	R	5	D	Y	86GL0683	C86216
14-1067	O	IL	LAKE ZURICH	42	14	10	88	3	50	TOWER	420	1295	R	5	D	Y	77GL1087	C83342
14-0994	O	IL	WAUCONDA	42	14	12	88	4	16	TOWER	480	1360	R	4	D	Y	94GL1257	C97195
14-0776	O	IL	SYLVAN LAKE	42	14	17	88	3	42	TOWER	239	1109	R	5	D	Y	74GL1471	C78187
14-0368	O	IL	CRYSTAL LAKE	42	14	35	88	18	47	TOWER	280	1200	R	4	D	Y	03CE2101	C83299
14-6181	U	IL	LAKE FOREST	42	14	40	87	49	50	TOWER	86	726						A76072
14-1569	O	IL	CRYSTAL LAKE	42	14	59	88	19	59	TOWER	320	1260	R	5	D	Y	97GL0070	C97083
14-2389	O	IL	WAUCONDA	42	15	3	88	8	17	TOWER	237	1032	D	2	C	N	96GL2011	C97230
14-0695	O	IL	CRYSTAL LAKE	42	15	13	88	17	1	TOWER	300	1210	R	4	D	Y	74GL1341	C77342
14-0678	O	IL	CRYSTAL	42	15	15	88	15	16	TOWER	393	1243				Y		C74057
14-2198	O	IL	CRYSTAL LAKE	42	15	21	88	22	42	TOWER	313	1241	R	5	D	Y	94GL1964	C96113
14-0404	O	IL	CRYSTAL LAKE	42	15	33	88	21	48	TOWERS 4	500	1427	R	5	D	Y	95GL1617	C97111
14-1269	U	IL	MARENGO	42	17	5	88	38	25	TOWER	170	1010	N				99FC0000	C81278
14-0453	O	IL	MUNDELEIN	42	17	15	87	59	47	TOWER	281	1049	R	2	C	Y	96GL0015	C94318
14-0295	O	IL	WOODSTOCK	42	17	19	88	29	32	TOWER	322	1182	R	2	D	Y	90GL0212	C86287
14-1792	O	IL	WOODSTOCK	42	17	42	88	25	48	TOWER	297	1251	M	5	D	N	88GL1123	C88340
14-0635	O	IL	LIBERTYVILLE	42	17	47	87	57	33	TOWERS 2	285	995	R	4	D	Y	70CH0491	C84011
14-0290	O	IL	WOODSTOCK	42	17	52	88	29	26	TOWER	316	1180				Y		D76292
14-2468	O	IL	MARENGO	42	17	56	88	35	20	TOWER	150	1190	R	4	D	Y	99LR0000	A97287
14-0313	O	IL	MARENGO	42	17	58	88	35	31	TOWERS 2	285	1332	D	4	D	N	87GL1208	C91294
14-1643	O	IL	WOODSTOCK	42	18	16	88	25	44	TOWER	250	1190	R	5	D	Y	86GL0520	C86175

14-1718	O	IL	NORTH CHICAGO	42	18	25	87	50	15	BLDG	224	874					83GL0792	C87306
14-0293	O	IL	VOLO	42	18	27	88	8	47	TOWER	300	1093	R	4	D	Y	94GL2265	C78115
14-0302	O	IL	WOODSTOCK	42	18	44	88	28	19	TOWER	205	1145				Y		C74057
14-2432	O	IL	LIBERTYVILLE	42	18	46	87	54	15	TOWER	205	913	R	5	D	Y	96GL0146	C97258
14-6183	U	IL	WOODSTOCK	42	18	48	88	25	59	TOWER	100	1000					99CF0000	C96330
14-0552	O	IL	LIBERTYVILLE	42	18	53	87	58	21	TOWER	318	1023	R	4	D	Y	67CH0768	C83362
14-2458	O	IL	WOODSTOCK	42	19	5	88	27	54	TOWER	300	1310	R	5	D	Y	96GL2947	C98166
14-6184	U	IL	WOODSTOCK	42	19	10	88	28	9	TOWER	168	1178						A76072
14-0649	O	IL	NORTH CHICAGO	42	19	20	87	54	38	TOWER	322	1032				Y	69CH0186	D80225
14-1195	O	IL	LIBERTYVILLE	42	19	43	87	54	41	TOWERS 3	339	1049	R	2	C	Y	97GL0608	C97237
14-0771	O	IL	WOODSTOCK	42	20	28	88	26	23	TOWER	290	1196	R	5	D	Y	72GL0028	A74063
14-0284	O	IL	WAUKEGAN	42	20	58	87	52	54	TOWERS 2	320	1020	R	2	C	Y	99LM0000	C86356
14-2174	O	IL	MCHENRY	42	21	7	88	18	47	TOWER	335	1195	D	5	D	N	94GL1525	C94255
14-0409	O	IL	MCHENRY	42	21	20	88	19	0	TOWER	395	1245	R	5	D	Y	78GL1075	C79032
14-2494	U	IL	ROUND LAKE	42	21	22	88	8	19	RIG	204	987					97GL4804	A98040
14-6186	U	IL	WAUKEGAN	42	21	35	87	49	38	TOWER	158	823						A76072
14-2030	O	IL	GURNEE	42	21	36	87	58	3	TOWER	265	1031	D	5	D	N	91GL2170	C92202
14-6130	U	IL	WAUKEGAN	42	21	48	87	49	30	ELEVATOR	174	760						A76170
14-0625	O	IL	MC HENRY	42	21	55	88	14	14	TOWER	260	1010	R	5	D	Y	70CH0744	C84095
14-2412	O	IL	GURNEE	42	21	56	87	56	11	STACK	227	946	N	5	D	N	97GL0846	C97160
14-0986	O	IL	GURNEE	42	22	9	87	56	14	TOWER	311	1021	R	5	D	Y	77GL0385	A77181
14-2419	O	IL	GURNEE	42	22	10	87	56	9	BLDG	333	1048	R	4	D	N	99LR0000	A97265
14-2409	O	IL	ROUND LAKE PARK	42	22	40	88	3	25	TOWER	262	1045	D	2	C	N	97GL2542	C97195
14-0298	O	IL	WAUKEGAN	42	22	57	87	48	48	STACKS 4	450	1037	R	5	D	N	99TR0000	C89263
14-6187	U	IL	GURNEE	42	22	58	87	56	50	TOWER	180	910						C78205
14-2077	O	IL	GURNEE	42	23	8	87	52	26	POLE	154	869	N	5	D	N	92GL2321	C93116
14-1614	O	IL	LAKE VILLA	42	23	17	88	5	35	TOWER	500	1315	R	5	D	Y	85GL0313	C86188
14-0314	O	IL	LINDENHURST	42	23	35	88	1	5	TOWER	388	1190	R	4	D	Y	91GL2244	C92342
14-1292	O	IL	LAKE VILLA	42	24	34	88	5	12	TOWER	260	1055	R	3	C	Y	81GL0899	C86034
14-0775	O	IL	HEBRON	42	24	40	88	28	50	TOWER	263	1263	R	3	C	Y	93GL3410	C94122
14-2260	O	IL	BEACH PARK	42	25	47	87	51	16	BLDG	18	711	R	2	C	N	95GL1030	C95254
14-6283	U	IL	WADSWORTH	42	25	54	87	57	4	TOWER	70	797						A78205
14-0300	O	IL	HARVARD	42	26	11	88	36	38	TOWER	200	1145	N	4	D	N	86GL2553	C91210
14-0654	O	IL	ZION	42	26	34	87	48	18	TOWER	260	846	R	5	D	Y	68CH0548	C78209
14-1672	O	IL	LOON LAKE	42	26	34	88	3	27	TOWER	267	1102	R	5	D	Y	86GL1395	C86273
14-1083	O	IL	ZION	42	26	46	87	48	11	BLDG 2	209	795	R	4	D	Y	68CH0548	C83250
14-0611	O	IL	ZION	42	27	5	87	48	19	TOWER	250	837	R	5	D	Y	68CH0548	C78209

14-0612	O	IL	ZION	42	27	18	87	54	3	TOWERS 3	143	843	N	5	D	Y	68CH0366	C83286
14-2203	O	IL	ZION	42	27	33	87	51	58	TOWER	165	894	N	2	C	N	94GL2871	C94311
14-0370	O	IL	HARVARD	42	28	10	88	33	37	TOWER	183	1363						C74057
14-2143	O	IL	RICHMOND	42	28	21	88	12	45	TOWER	320	1189	R	5	D	Y	93GL2095	C94018
14-0877	O	IL	ANTIOCH	42	28	49	88	11	57	TOWERS 2	298	1193	R	5	D	Y	77GL1652	C78187
14-0306	O	IL	ALDEN	42	29	33	88	33	6	TOWER	224	1406	R	4	D	Y	85GL1283	C86342