technical note technical note

Dual-Colored Declared Distance Lighting Fixture Evaluation

Keith W. Bagot

August 1996

DOT/FAA/AR-TN96/24

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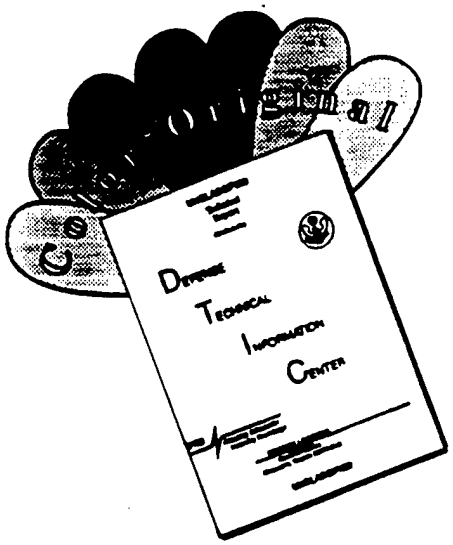

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15. Supplementary Notes

Messes. Thomas Paprocki and James Patterson of Galaxy Scientific Corporation provided technical support throughout the course of the evaluation.

16. Abstract

Several dual-color (red/blue) runway edge lighting configurations used to define the pre-threshold and post-runway end segments of declared distance runways were evaluated at four different airports. At three airports, Binghamton Regional Airport (BGM), New York, Baltimore-Washington International Airport (BWI), Maryland, and Atlantic City International Airport (ACY), New Jersey, the lighting configurations were in accordance with the Federal Aviation Administration (FAA) Great Lakes Region policy and procedures memorandum entitled "Guidance on Declared Distance Standards." An additional test installation at the Millville Municipal Airport (MIV), New Jersey, permitted the evaluation of different color configurations to designate areas restricted to taxi only; takeoff, but no landing; and rollout only maneuvers. FAA test pilots and visual guidance project personnel (also pilots) conducted flight and ground taxi testing using B-727 and Convair 580 type aircraft to evaluate each color configuration for its suitability in best depicting the operational limitations for each runway segment. The tests were also intended to determine the most appropriate location for red color runway end lights and the suitability of available dual-color edge lights components for this use. Evaluators were briefed prior to each test session and completed postflight questionnaires.

This report describes the conduct of the evaluation and provides detailed results, conclusions, and recommendations.

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EXECUTIVE SUMMARY

This report describes an evaluation effort conducted in response to a request from the Office of Airport Safety and Standards, Engineering and Specifications Division, AAS-200. With regard to special lighting for declared distance runways, the evaluation was intended to make the following determinations:

- Whether it is preferable to locate red runway end lights at the end of the designated landing distance available (LDA) or at the physical end of the runway.

- Whether it is appropriate to display blue taxiway edge lights between the end of the LDA and the physical end of the runway if the red runway end lights are located at the physical end of the runway.

- The adequacy of high- and medium-intensity split (dual-color) red runway end/blue taxiway edge fixtures (if their need is confirmed).

Several dual-color (red/blue) runway edge lighting configurations used to define the pre-threshold and post-runway end segments of declared distance runways were evaluated at four different airports. At three airports, Binghamton Regional Airport (BGM), New York, Baltimore-Washington International Airport (BWI), Maryland, and Atlantic City International Airport (ACY), New Jersey, the lighting configurations were in accordance with the Federal Aviation Administration (FAA) Great Lakes Region's policy and procedures memorandum entitled "Guidance on Declared Distance Standards". An additional test installation at the Millville Municipal Airport (MIV), New Jersey, permitted the evaluation of different color configurations to designate areas restricted to taxi only; takeoff, but no landing; and rollout only maneuvers. FAA test pilots and visual guidance project personnel (also pilots) conducted flight and ground taxi testing using B-727 and Convair 580 type aircraft to evaluate each color configuration for its suitability for best depicting the operational limitations for each runway segment. Evaluators were briefed prior to each test session and completed postflight questionnaires.

It was concluded that the most appropriate and logical location for the runway end lights is at the end of the designated LDA for runways having declared distance dimensions. In addition, it was recommended that only blue colored edge lights be used to define the taxi only and takeoff, but no landing areas and that the use of the color red should be limited to situations wherein a pilot is expected to avoid a hazardous area. The dual-color red/blue filters used to provide the colored configurations under evaluation were found to be satisfactory, although subject to improvement.

1. INTRODUCTION.

1.1 PURPOSE.

This evaluation effort was conducted in response to a request for Airport Research and Development initiated by the Federal Aviation Administration (FAA) Office of Airport Safety and Standards, Engineering and Specifications Division, AAS-200. With regard to special lighting for declared distance runways, the requested evaluation was intended to make the following determinations:

- Whether it is preferable to locate red runway end lights at the end of the designated landing distance available (LDA) or at the physical end of the runway.

- Whether it is appropriate to display blue taxiway edge lights between the end of the LDA and the physical end of the runway if the red runway end lights are located at the physical end of the runway.

- The adequacy of high- and medium-intensity split (dual-color) red runway end/blue taxiway edge fixtures (if their need is confirmed).

A depiction of the runway and lighting configuration proposed for investigation by the requesting office is provided as figure 1. It incorporated the assumption that the airport authorities, recognizing the existence of only a 400-foot safety area (overrun) at the end of the runway, have declared the LDA to be 600 feet shorter than the actual pavement available in order to achieve the necessary 1,000-foot safety area (overrun). The 600-foot section of pavement at the end of the runway is available for taxiing after rollout and is also available for takeoff in the opposite direction.

1.2 BACKGROUND.

At present, FAA Advisory Circulars (AC) and other documents recommending the proper way to light paved runway surfaces do not address some of the more unique limited usage situations faced by airport engineers and designers. While the advisory circular, AC 150/5340-24 "Runway and Taxiway Edge Lighting System," does indicate in a very general manner that edge lights with red filters may be used to indicate areas available for some, but not all, runway operations, no details are provided. Even the International Civil Aviation Organization (ICAO) goes no further than this (mention of red-filtered edge lights) when addressing the lighting of pre-displaced threshold runway areas.

Considering the fact that pilots may be understandably reluctant to enter into paved areas delineated by red lights, the use of other colors for runway edge lights has been suggested.

A problem exists in that the usage of the runway areas concerned may, and probably will, be determined by the direction from which the aircraft enters. As an example, a pilot landing may not be permitted to touch down on the runway area in front of a displaced threshold while a pilot

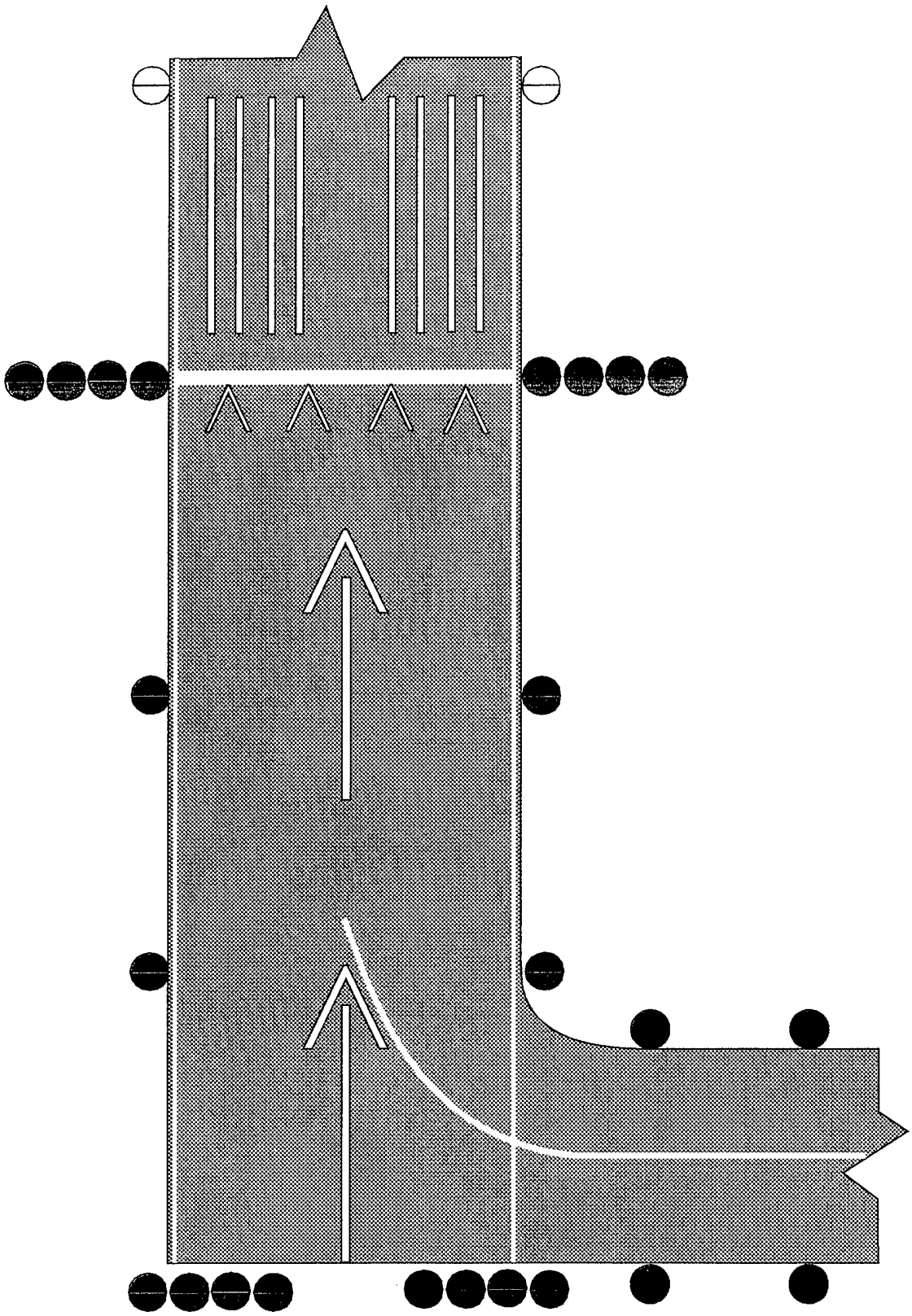


FIGURE 1. BASIC DECLARED DISTANCE DUAL-COLOR LIGHTING CONFIGURATION

landing from the opposite direction may well be allowed to rollout or taxi past the same displaced threshold point and through the restricted-use area. In this case the lights defining the pre-threshold area will have to be dual-colored to indicate the authorized usage in each direction. The difficulty arises not from the fact that two different colored filters will have to be fitted to a single runway light fixture, easily accomplished with 180° filters, but rather from the fact that both will be illuminated by a single lamp. It was necessary, therefore, to determine whether available filters of other colors would provide a satisfactory (color and intensity) visual signal in this application.

1.3 RELATED ACTIVITIES/DOCUMENTS.

In an attempt to resolve some of the problems relating to lighting of these unique runway areas, the FAA Great Lakes Region Airports Division has prepared and published a Policy and Procedures Memorandum on the subject of "Guidance on Declared Distance Standards," included as appendix A to this report. The memorandum, in addition to addressing other declared distance issues, provides guidance on the edge lighting of pre-threshold runway areas with dual-colored lights. It also specifically mentions the fact that split filter red/blue fixtures are not currently approved for use.

2. DISCUSSION.

There are really only five colors for lights that can be recognized and interpreted unambiguously; white (clear), green, blue, red, and yellow. The first four colors have, for many years, been used almost exclusively to define runways, thresholds, taxiways, and runway ends respectively. Yellow is somewhat less definitively used, i.e., as in defining the last 2,000 feet of an instrument runway or in a holding position bar or a runway guard light application.

As a result, the design of lighting for areas on airports having unique, and even unconventional, usage can be most difficult. In the case under consideration, a portion of a runway surface area is usable by a pilot taking off just as though it was a normal runway while, to a pilot traveling in the same direction but making a landing, it is a totally unusable area and one to be avoided. It cannot be lighted with the conventional white lights for fear of enticing a pilot to land where he must not, but if lighted with blue lights, it will convey the message to the departing pilot that he is on a taxiway, not a runway for takeoff. Yellow lights are too close to the color of reduced intensity white lights to be used, and red has long been considered to be the warning for danger.

Obviously, a compromise must be adopted, and this evaluation has to be viewed in the context of being the choice of the compromise most acceptable under the circumstances. At present, the use of red edge lights to delineate the pre-threshold taxi and takeoff only area has been adopted. Also adopted was the use of blue lights to delineate the taxi only area beyond the runway end. Both examples are depicted in its basic form, in figure 1. Also shown are red runway end lights, in the form of wing bars at the termination of the LDA.

3. EVALUATION APPROACH.

3.1 EVALUATION METHOD.

Ordinarily, the adequacy of a light fixture's color and intensity characteristics can be determined from photometric and colorimetric testing of a single device. In this application, however, the fixtures are to be used as part of a unique lighting configuration that can only provide the necessary visual information to the user (pilot) when viewed in total. Therefore, it was necessary to flight test the fixtures as installed on an actual runway surface and viewed by subject pilots dividing their attention between evaluating the lighting system and controlling the aircraft.

A survey of air carrier airports, within reasonable flight range of the William J. Hughes Technical Center at the Atlantic City International Airport (ACY), New Jersey, revealed that declared distance runway displaced thresholds, with appropriate dual-color lighting, existed at the Binghamton Regional Airport (BGM), New York, and the Baltimore-Washington International Airport (BWI), Maryland. Accordingly, it was decided that flight evaluations would be conducted at both of these airports so as to obtain pilot opinion as to the suitability of the installed lighting configurations. Figures 2 and 3 provide airport diagrams for these two selected locations. Figure 1, as previously indicated, provides a depiction of the basic dual-color lighting configuration under evaluation.

In addition, it was decided that the high-intensity runway 4 edge lighting system at ACY, along with the medium-intensity runway 28 edge lighting system at the Millville Municipal Airport (MIV), New Jersey, would be temporarily modified to the displaced threshold lighting configuration for additional flight evaluations. At the MIV test site it was possible to display both red and blue approach direction pre-threshold lighting configurations for evaluation. See figure 4 for this alternative configuration. At the other three sites, only red approach direction and blue rollout direction lighting configurations were available.

3.2 EVALUATION PILOTS.

Since scheduling of flights depended upon weather, traffic considerations, and the possibility of closing runways at ACY and MIV, pilot availability was a last minute consideration, and thus the principal source for subject pilots was the FAA Flight Test section at the William J. Hughes Technical Center. Other project personnel, being certificated pilots and experienced visual systems evaluators, were afforded the opportunity of viewing the lighting configurations and expressing their opinions.

All participating evaluators, pilots and engineers alike, were briefed concerning the configurations under test and subsequently required to complete a postflight questionnaire. A sample questionnaire form is provided as figure 5.

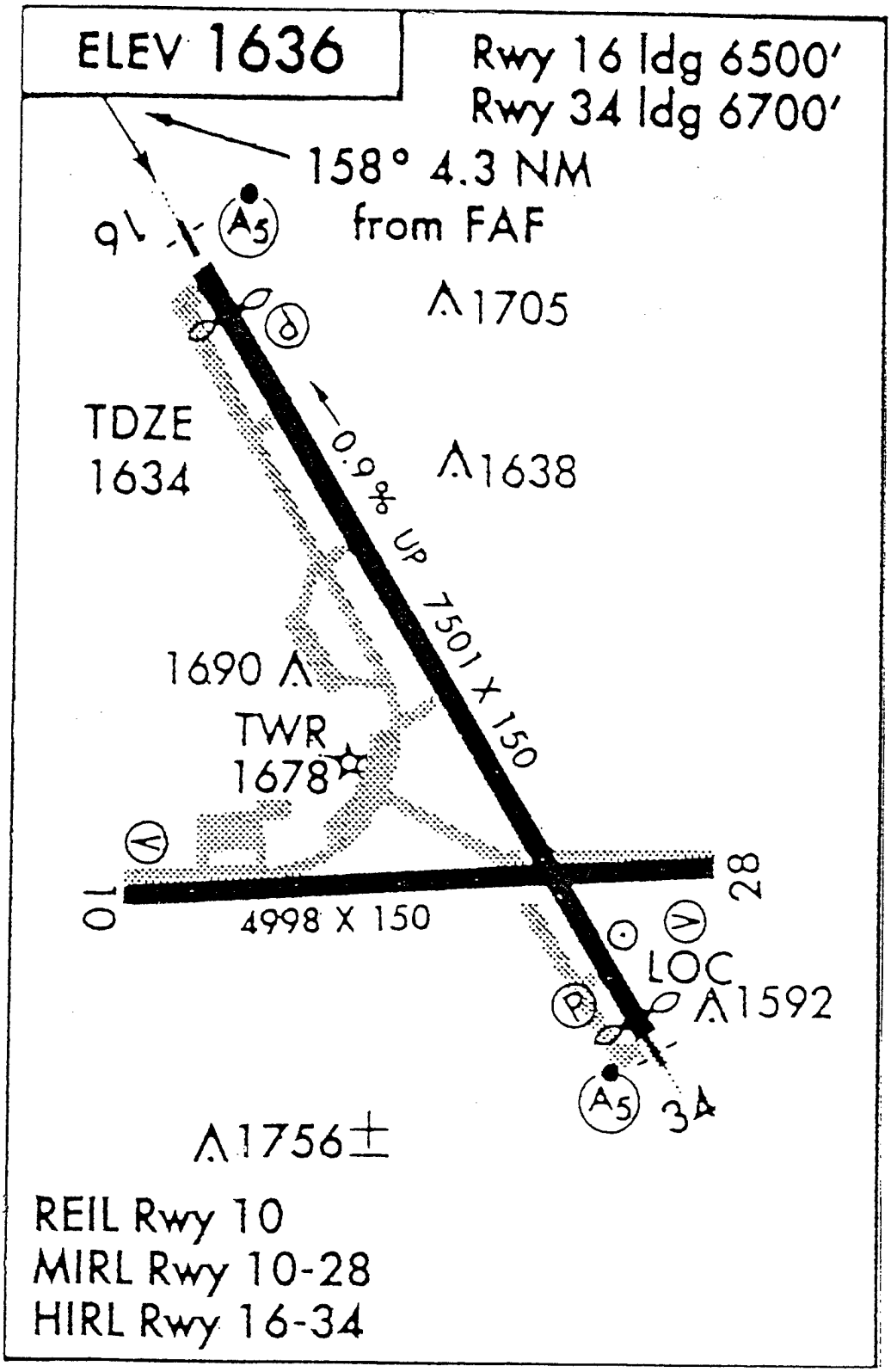


FIGURE 2. DIAGRAM—BINGHAMTON REGIONAL AIRPORT (BGM), NEW YORK

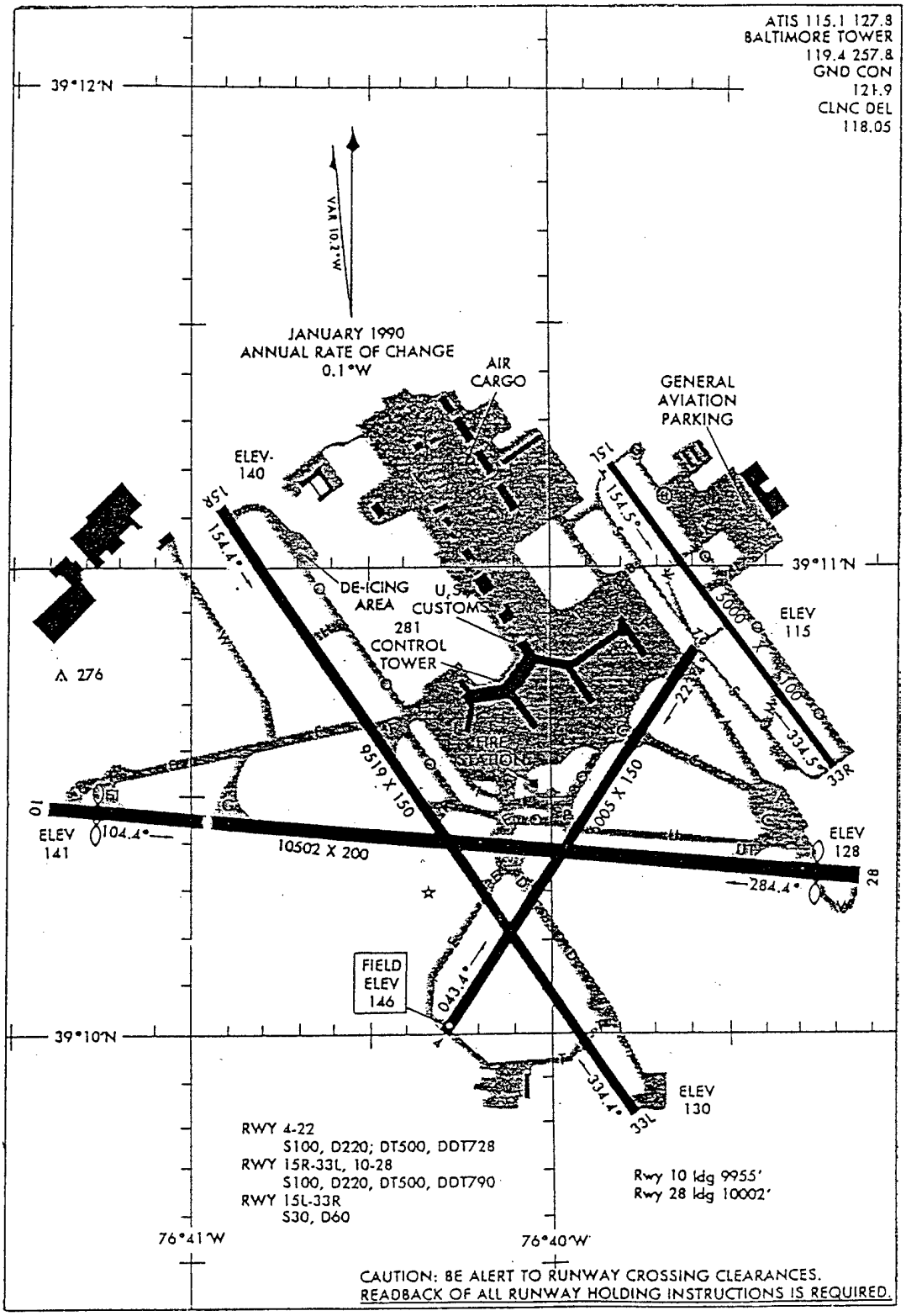


FIGURE 3. DIAGRAM—BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT (BWI), MARYLAND

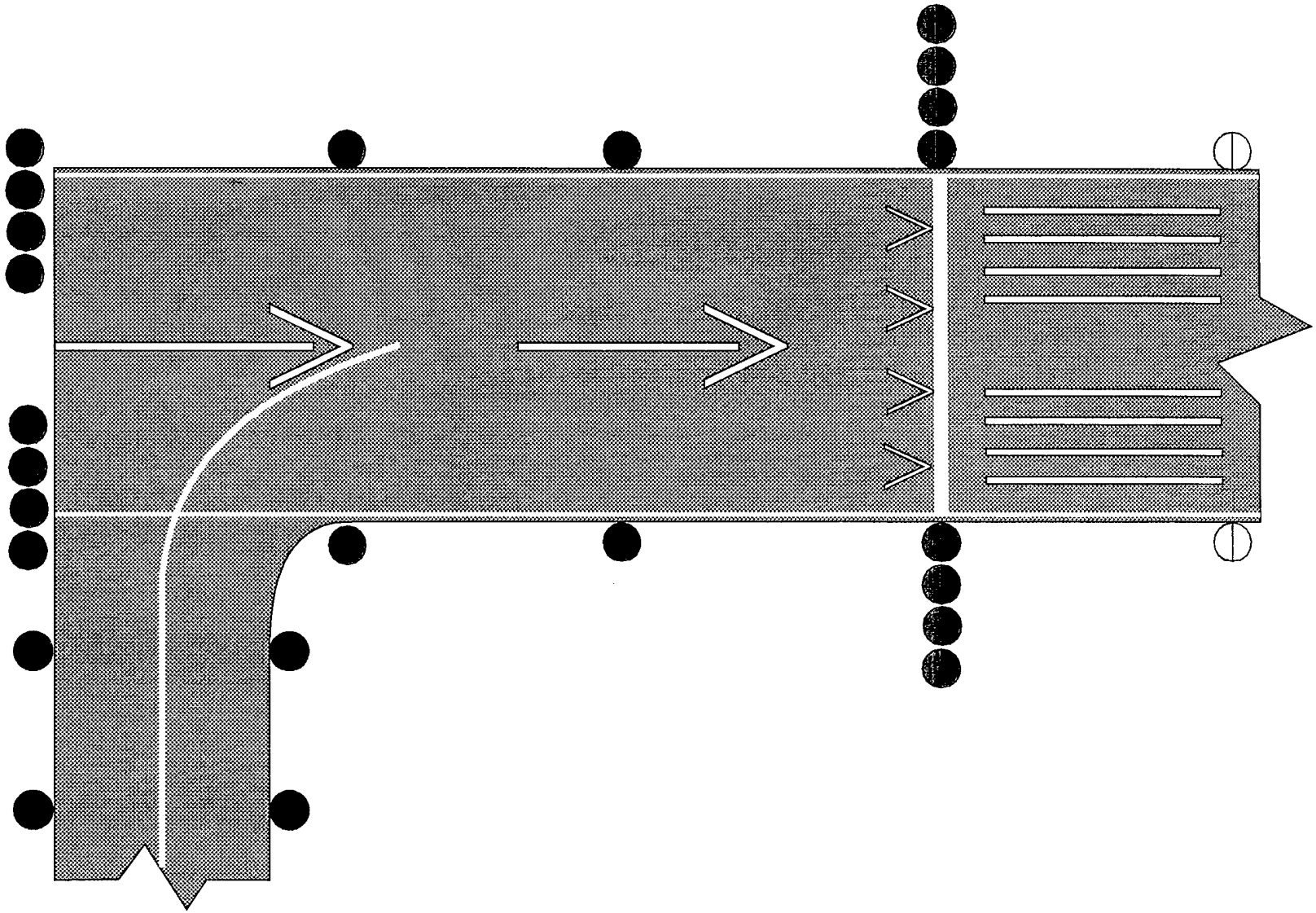


FIGURE 4. ALTERNATE LIGHTING CONFIGURATION—MILLVILLE MUNICIPAL AIRPORT (MIV), NEW JERSEY

EVALUATION OF DECLARED DISTANCE
LIGHTING CONFIGURATIONS QUESTIONNAIRE
EDWARD A. LINK FIELD
BINGHAMTON REGIONAL AIRPORT (BGM)

Name:_____ Date:_____ VFR or IFR Vis:_____

Please complete the following questions after viewing the lighting configurations from the cockpit of the aircraft. Comments are strongly encouraged.

RUNWAY 16 (Question numbers coincide with scenario numbers on attached page.)

1. Was there any difficulty in locating the landing threshold of the runway?

____ Difficult ____ Some difficulty ____ No difficulty

Comments:_____
_____

2. Did you feel comfortable with the lighting display as you taxied through the end of runway 16 onto the taxiway?

____ Uncomfortable ____ Comfortable

Comments:_____
_____

3. As you began the takeoff roll before the landing threshold of runway 16, did you feel comfortable with the lighting display? (Without the ALS)

____ Yes ____ No

Comments:_____
_____

3a. Did you have any trouble identifying the point at which the takeoff roll could begin? (Without the ALS)

____ Yes ____ No

Comments:_____
_____

FIGURE 5. SAMPLE POSTFLIGHT QUESTIONNAIRE

4. Could you clearly identify the approach lighting system (ALS)?

____ Yes ____ No

Comments:_____

_____

5. As you began the takeoff roll before the landing threshold of runway 16, did you feel comfortable with the lighting display? (With the ALS on)

____ Yes ____ No (please explain)

Comments:_____

_____

5a. Did you have any trouble identifying the point at which the takeoff roll could begin? (With the ALS on)

____ Yes ____ No

Comments:_____

_____

****

RUNWAY 34 (Question numbers coincide with scenario numbers on attached page.)

1. Was there any difficulty in locating the landing threshold of the runway?

____ Difficult ____ Some difficulty ____ No difficulty

Comments:_____

_____

2. Did you feel comfortable with the lighting display as you taxied through the end of runway 34 onto the taxiway?

____ Uncomfortable ____ Comfortable

Comments:_____

_____

FIGURE 5. SAMPLE POSTFLIGHT QUESTIONNAIRE (CONTINUED)

3. As you began the takeoff roll before the landing threshold of runway 34, did you feel comfortable with the lighting display? (Without the ALS)

____ Yes ____ No

Comments:_____

_____

3a. Did you have any trouble identifying the point at which the takeoff roll could begin? (Without the ALS)

____ Yes ____ No

Comments:_____

_____

4. Could you clearly identify the approach lighting system (ALS)?

____ Yes ____ No

Comments:_____

_____

5. As you began the takeoff roll before the landing threshold of runway 34, did you feel comfortable with the lighting display? (With the ALS on)

____ Yes ____ No (please explain)

Comments:_____

_____

5a. Did you have any trouble identifying the point at which the takeoff roll could begin? (With the ALS on)

____ Yes ____ No

Comments:_____

_____

FIGURE 5. SAMPLE POSTFLIGHT QUESTIONNAIRE (CONTINUED)

4. EVALUATION IMPLEMENTATION.

4.1 TEST LOCATION.

All flight testing was accomplished, as described earlier, at BGM, BWI, ACY, and MIV.

4.2 AIRCRAFT AND PILOT PARTICIPATION.

As indicated earlier, the principal testing effort relied upon participation by FAA pilots from the William J. Hughes Technical Center Flight Test Section using the FAA Boeing 727 and Convair 580 aircraft assigned to the Center. The number of pilots and engineers participating during evaluations at each airport were as follows:

Binghamton Regional Airport, New York	- five pilots, one airport engineer
Baltimore-Washington International Airport, Maryland	- five pilots, two airport engineers
Millville Municipal Airport, New Jersey	- five pilots, one airport engineer
Atlantic City International Airport, New Jersey	- five pilots, two airport engineers

A total of eight certificated pilots and three airport engineers formed the pool from which crews were selected for evaluation flights at each of the four test site airports.

4.3 ENVIRONMENTAL CONDITIONS.

Due to the difficulty in bringing together the pilots, the aircraft, and the project support personnel and equipment in time to evaluate the lighting configurations, no attempt to establish a standby program for low-visibility weather testing was made. Flight sessions were scheduled in the normal manner, depending upon aircraft and pilot availability, and were conducted under the weather conditions prevailing at the time. All testing was accomplished during periods of darkness when lights rather than markings make the greater contribution to providing visual guidance to the pilot.

4.4 TEST PERSONNEL ASSIGNMENTS.

The evaluation team was divided into two segments, ground and flight, for the evaluations at ACY and MIV.

The ground team was responsible for reconfiguring the existing runway lighting system to the desired declared distance displaced threshold configuration and, subsequent to the test session, for restoring it to the original standard configuration. These individuals also joined the flight team in the aircraft to conduct the evaluation.

The flight team was responsible for all necessary liaison with ATC, Technical Center Operations, and other facilities prior to conducting the evaluation flight. They briefed the subject pilots prior to takeoff, monitored in-flight activities, and conducted the postflight pilot debriefings and questionnaire completion.

Since the lighting configurations to be evaluated were already installed, all project personnel remained on board the aircraft during the flight test sessions at BGM, and BWI.

5. TEST RESULTS.

5.1 DATA SUMMARIZATION.

The detailing of data evolving from this evaluation effort presents somewhat of a problem in that flight testing was conducted at four different sites (airports) and with four separate, though very similar, declared distance lighting configurations. Further, at the two major air carrier airports, both ends of a single runway were configured with this type of unique lighting which was, once again, very similar but not identical. For these reasons, the pilot postflight questionnaires were, like the sites and runway end configurations, very similar, but not identical.

In addition, the traffic level, airport configuration, and close proximity of MIV to ACY made possible the simple but drastic interchange of color relationships for rollout and takeoff displaced threshold area lighting fixtures. At MIV it was possible to display and evaluate both red and blue edge light color presentations for subject pilots entering the displaced threshold area prior to takeoff and at the conclusion of landing during the last portion of the rollout. For this reason, both the response summary and the comment summary sheets include a supplemental segment for those evaluations made with the reversed color configuration.

While upon close inspection some aspects of both the questionnaire response summary and the comment summary presentation may appear to be contradictory, we have attempted to explain any inconsistencies in more detail in the "Data Analysis" section of the report.

5.1.1 Pilot Questionnaire Response Summary.

The questionnaire response summary sheets, figure 6, provide totals for subject pilot checked responses to the questions posed but does not include the written comments that were solicited, but not required, with each questionnaire. Naturally they provide a tabulated and numerical indication of subject opinions concerning the lighting configurations viewed but do not shed any light on the sometimes subtle reasons for the positive or negative attitude of the pilot. The pilot comments are addressed in a subsequent section of this report.

PILOT QUESTIONNAIRE RESPONSE SUMMARY

(For the standard configuration as shown in figure 1)

1. Was there any difficulty in locating the landing threshold of the runway?

5 Difficulty	**9** Some difficulty	**19** No difficulty
(15%)	**(27%)**	**(58%)**

2. Did you feel comfortable with the lighting display as you taxied through the end of the runway and onto the taxiway?

3 Uncomfortable	**16** Comfortable
(16%)	**(84%)**

3. As you began the takeoff roll before the landing threshold of the runway, did you feel comfortable with the lighting display? (Without the ALS illuminated)

3 Yes	**27** No
(10%)	**(90%)**

3a. Did you have any trouble identifying the point at which the takeoff roll could begin? (Without the ALS illuminated)

4 Yes	**26** No
(13%)	**(87%)**

4. Could you clearly identify the approach lighting system (ALS)?

26 Yes	**0** No
(100%)	**(0%)**

5. As you began the takeoff roll before the landing threshold of the runway, did you feel comfortable with the lighting display? (With the ALS illuminated)

25 Yes	**0** No (please explain)
(100%)	**(0%)**

5a. Did you have any trouble identifying the point at which the takeoff roll could begin? (With the ALS illuminated)

1 Yes	**25** No
(4%)	**(96%)**

FIGURE 6. PILOT QUESTIONNAIRE RESPONSE SUMMARY

PILOT QUESTIONNAIRE RESPONSE SUMMARY

(For the nonstandard configuration at MIV as shown in figure 5)

6. Were the split red/blue light fixtures used for this demonstration sufficient?

7 Yes	0 No
(100%)	(0%)

7. Was there any difficulty in locating the landing threshold of the runway?

0 Difficult	0 Some difficulty	6 No difficulty
(0%)	(0%)	(100%)

8. Did you feel comfortable with the lighting display as you taxied through the end of the runway and onto the taxiway?

6 Uncomfortable	0 Comfortable
(100%)	(0%)

9. As you began the takeoff roll before the landing threshold of the runway, did you feel comfortable with the lighting display?

2 Yes	4 No
(33%)	(67%)

10. Did you have any trouble identifying the point at which the takeoff roll could begin?

4 Yes	2 No
(67%)	(33%)

FIGURE 6. PILOT QUESTIONNAIRE RESPONSE SUMMARY (CONTINUED)

5.1.2 Pilot Questionnaire Comment Compilation.

A comment compilation providing all subject pilot comments verbatim is attached as appendix B. Comments were so numerous that it is not possible to present them all within the body of this report.

Where comments apply to the identifiable issues and represent a consensus of subject opinion, they are referred to either verbatim or collectively within the following analysis section. In general, the preponderance of comments closely followed the judgments revealed by the checked responses.

5.2 DATA ANALYSIS.

This discussion will principally concern the results of the flight evaluations as they pertain to the determination of whether the declared distance basic lighting configuration (depicted in figure 1) is appropriate and effective for the purpose intended. Briefly, this will include the use of red color edge lights to delineate a portion, or all, of the pre-threshold area available for takeoff but not landing; the use of blue color edge lights to delineate a portion, or all, of the post-threshold area available for taxiing but not landing or rollout; and the possible use of blue lights as an alternative method of delineating the pre-threshold area available for takeoff but not landing.

With regard to the question of whether the red runway end lights should be located at the end of the LDA at a declared distance point or at the physical end of the weight bearing surface located immediately past the end of the LDA (normally the runway safety or overrun area), it was not possible to make this determination from the results of the flight evaluation effort. At the two air carrier airport evaluation sites, the existing runway end lights were physically located at the end of the declared LDA and, even though it would have been possible to install the alternative physical end of pavement location at the other two sites, it would have been impossible to simulate the emergency situation that would favor the "ultimate end" location. However, a conclusion may be drawn from a study of already established definitions and from what is hoped may be a logical consideration of the issue. This consideration must be addressed first since the location assumed for the red runway end lights will directly influence decisions and conclusions to be reached for the colors of other segments of the declared distance pre/post threshold lighting configuration.

5.2.1 Red Runway End Light Location.

FAA AC 150/5340-24, "Runway and Taxiway Edge Lighting System," (11/25/77), provides the following statement with regard to runway end lights in paragraph 3:

> The longitudinal limits of the usable landing area are defined at each end of the area by straight lines of lights called threshold/runway end lights which are installed perpendicular to the lines of runway edge lights.

The same AC describes, in paragraph 3a, the color of these lights as follows:

> The threshold lights emit green light toward the approach area while the runway end lights emit red light toward the runway.

FAA AC 150/5300-13, "Airport Design," (11/10/94), provides the following definitions in chapter 1:

> Runway (RW) - a defined rectangular surface on an airport prepared or suitable for the landing or takeoff of airplanes.
>
> Landing Distance Available (LDA) - the runway length declared available and suitable for a landing airplane.

Adhering to these definitions, the red runway end lights must be located as defined above, i.e., at the declared longitudinal limit of the usable landing area, otherwise referred to as the LDA.

Unless we disregard these published definitions or until they are officially changed, we must dismiss any thought of locating the runway end lights at the physical end of the weight bearing surface except for the case wherein this coincides with the end of the LDA.

It should also be noted that at many joint civilian/military airports, runway distance to go markers/signs are provided. They must indicate accurately the extent of usable landing area remaining, and it would seem most unreasonable to have the runway end lights located at a point other than that consistent with the displayed distance-to-go information.

There is no doubt that some pilots will dispute this point, arguing that they would want to know the exact point at which they will break something unless extreme stopping measures are applied. This situation will develop, obviously, only in an emergency situation, and the pilot will surely realize this predicament well before reaching the end of the LDA and, hopefully, will be already applying maximum deceleration procedures. The red runway end lights will still serve as a vivid warning that the pilot is entering the overrun area and had better do something fast.

It would seem reasonable to consider, as a result of a suggestion received, providing some form of red warning signal at the end of the weight bearing pavement in addition to the red runway end lights located, as wing bars, at the end of the declared LDA. However, it is our belief that creating such a situation, wherein a pilot is confronted with two separate red warnings, would prove more confusing than beneficial.

5.2.2 Blue Taxiway Lights in Post-Landing Distance Available (Overrun/Taxi Only) Area.

The second stated determination task was to assess the appropriateness of using blue taxiway edge lights between the end of the LDA and the physical end of the runway (i.e., taxiing authorized overrun area) if the red runway end lights are located at the physical end of the runway. If we accept the argument presented above, and for the purpose of this report we must,

then the question to be answered is whether blue edge lights are appropriate for delineating the overrun area between the red lighted and defined limit of the LDA and the physical end of the overrun area which is declared to be available for taxiing only.

Question no. 2 of the postflight questionnaire directly addresses this issue since all of the flight evaluation sessions at all four test sites provided the subjects with the opportunity for rolling out through the runway/taxiway transition point delineated by the termination of white runway edge lights, bracketed by red runway end lights, and followed by the display of blue taxiway edge lights.

Since eighty-four percent of the subjects (16 out of 19) indicated that they felt comfortable taxiing through the end lights and onto the taxiway segment, it can be assumed that the blue color is an appropriate choice. To account for the three dissenting comments, we must look to the comments provided under the question heading for further clarification. We see that two of the three negative comments concerning this issue were expressed during the flight session at BGM. Virtually all of the project personnel aboard the aircraft commented, during the course of the evaluation session, that the threshold lights appeared to be very dim in comparison with what one would expect to see. Since the same fixture and lamp is used for the runway end lights (back-to-back red/green filters), it would be reasonable to assume that these red lights would be perceived as dim also or even not perceived at all.

A number of comments indicated that the blue lights beyond the LDA end, along with the existing painted markings at BGM, provided sufficient verification that it was all right to enter (taxi into) this area. Several pilots also commented that it would be better if the blue lights at the end of the overrun area, where a taxiing turn must be made, were installed across the surface rather than just in groups on each side. It is obvious that if blue lights are to be used to define this taxiway/overrun area, these lights should be of an intensity considerably higher than normally provided on taxiways so as to be compatible with the white runway lights.

The red runway end light wing bars can be difficult to see through the glare of the last few runway edge lights when approaching the end of the LDA, especially when the runway lights contain a yellow filter to indicate the last 2,000-foot section of instrument runway. It would not be possible to continue the red runway end signal completely across the surface, even though it would greatly enhance the warning, because we cannot consider permitting the pilot to cross a red lighted bar (virtually the same as a Stop Bar). However, it would be possible to carry the red end light pattern into the runway surface for a short distance on either side, such as for ten or twenty feet, thereby enhancing the critical runway end signal while leaving a prominent non-red gap.

5.2.3 Red Edge Lights in the Pre-Threshold Takeoff/Taxi Area.

Question no. 3 most directly addresses the issue of whether red edge lights are the most appropriate choice to delineate the surface of a pre-threshold area wherein taxiing and takeoff initiation (power application) is allowed. Although 90 percent (27 out of 30) pilots indicated that they felt comfortable with beginning the takeoff roll before reaching the displaced threshold, a

considerable number of them also indicated, through their written comments, that they felt uncomfortable with entering, or being inside of, a red bounded area.

It must be noted that all of the participants were briefed on the various configurations to be presented and also informed of the type of maneuvers authorized within each uniquely lighted area. Despite this, comments of concern over transiting red lighted areas were expressed, and it would not be unexpected for uninitiated pilots to be wary upon encountering this configuration for the first time.

Another aspect to be considered is that at each evaluation site the length of the pre-threshold area was, by coincidence—not design, very short (approximately 400 to 600 feet). Several subjects commented on this, citing it as a possible reason why they did not feel more concerned about the red lights. A longer length of pre-threshold area would certainly be more intimidating.

By advocating this particular application for red lights, we are ignoring the established convention that such red perimeter displays warn strongly of an area that poses imminent danger to an intruding vehicle. Such is the case with the red Stop-Bar system that provides an area protected by a "ring of red" that must remain sterile until such time as air traffic control extinguishes the red-light bars to permit authorized entry into the active runway area. Both within and without the aviation arena, areas bounded by red lights have represented an occasion for danger and so a place to be avoided.

It would appear that the only reason for selecting the red perimeter to outline, and so define, the area immediately in front of a displaced or relocated threshold is to reinforce the fact that a landing pilot must not touch down (land) before the threshold point. If that pre-threshold prepared surface were to be used for no other purpose than to provide an emergency overrun area, then the use of red lights might be acceptable, even though it would probably be visually more effective to leave the same area totally unlighted (a useful "black hole"). But in the case of this evaluation we are considering the lighting/defining of runway segments having other usage, either that of a taxi only area leading to the takeoff threshold or even that of a takeoff only runway segment. We must, therefore, consider the question of whether we really want to delineate such an area with a lighted perimeter color that might confuse the pilot viewing it for the first time is unfamiliar with this seldom encountered lighting configuration.

There is also the necessity that the lighting configuration to be chosen (and it must be a lighting system of conventional aviation color) should not confuse a landing pilot and entice him to land short of the displaced/relocated threshold. It must be assumed, of course, that the landing threshold itself is prominently lighted with wing bars of the accepted aviation green color and even more importantly that the lighting fixtures used are of such intensity as to produce a very bold threshold identification.

5.2.4 Blue Edge Lights in the Pre-Threshold Takeoff/Taxi Area.

Regarding the results obtained uniquely during the evaluation at MIV, where subjects were given an opportunity to view blue pre-threshold/takeoff area edge lighting as opposed to red lighting, some interesting comments were obtained.

Question no. 8 on the questionnaires completed during the evaluation session at MIV and pertaining to the reversed dual-color display shown in figure 4, elicited 100 percent (6 out of 6 pilots) response that the subject felt uncomfortable transiting the end of runway LDA boundary where the taxi only segment following was delineated by red edge lights. While questions 9 and 10 resulted in mixed opinions as to the suitability of the blue edge lights for the pre-threshold takeoff area, pilot comments indicated that they felt the blue edge lights would be better than red. The expressed concern over starting the takeoff run in what could be considered a taxiway might well be alleviated by, as some subjects suggested, a sign or other indication (painted markings) that takeoffs were permitted in that area.

Use of the blue taxiway color to define the pre-threshold area would obviously be appropriate for those situations wherein pilots are expected to taxi up to the displaced threshold location before applying takeoff power. Certainly a pilot should not find the display of significantly weaker intensity blue lights in the area before the landing threshold objectionable, especially from the viewpoint of pilots on a short approach to landing. These pilots would surely interpret the blue lighted area as a taxiway and thus not available for landing. Furthermore, a bold green threshold display with bright white runway edge lights thereafter will immediately and clearly indicate the beginning of the landing area.

Accepting the propriety of blue lighting for taxi only areas we are still left with a problem of visually identifying the similar but somewhat different area that is also available for application of takeoff power and initiation of the takeoff maneuver. Only white (clear) edge lights are normally used to define such a segment, being a portion of the takeoff runway, but they cannot be used in the declared distance situation for fear of seducing a landing pilot into touching down in this area short of the designated displaced landing threshold. The blue color is, admittedly, most appropriate only for taxiways but may still be preferable to red for this purpose. Perhaps signs indicating to the pilot that takeoffs are permitted within that area would assuage the occasionally concerned transient pilot while allowing utilization of the less intimidating blue color rather than the red universal warning color. As previously mentioned, we can reasonably expect that the blue color, when seen on short approach, will indicate a taxiway area to the landing pilot and not a touch-down zone.

5.2.5 White Edge Lights in the Pre-Threshold Takeoff/Taxi Area.

During discussions held among project personnel subsequent to the flight evaluation effort, a suggestion was offered that, since start of the takeoff is allowed in this area, the standard white (clear) runway lights might be most appropriate, especially since the area is in fact runway for takeoff operations. It was concurrently stated that such a usage could only be successful, and not result in unacceptable pre-threshold landings/touch downs, if there were some way of insuring that extremely bold and compelling threshold lighting was provided. Unless extremely high intensity light fixtures are used, it is most unlikely that any threshold signal will be able to compete with white edge lights to the extent that it will, at any reasonable approach range, define the point, well within a white lighted runway area, past which a pilot must land. It is also likely that, in the case of a shorter runway, the additional length of white edge lighting will change the

perspective runway picture to the extent that it will influence the pilot's perception of the approach angle being made good.

5.2.6 Adequacy of Dual-Color (Split) High-Intensity and Medium-Intensity Light Fixtures.

The typical high-intensity runway edge light (HIRL) utilizes colored absorption filters, either 360° or 180°, beneath a beam-forming outer globe to achieve desired color signals. The medium-intensity runway light fixture (MIRL) utilizes a colored or clear outer globe only for the same purpose. Therefore, to obtain the dual-color declared distance lighting configuration (i.e., blue/red, white/red, etc.) signal from a single fixture in the HIRL system, it is only necessary to select and install the necessary combination of partial filters. With the MIRL system, however, it is necessary to obtain special order split color globes with the different colored segments permanently joined by the manufacturer.

This portion of the results analysis addresses the adequacy, or effectiveness, of the dual-color red/blue lighting fixture visual presentation (appearance) but not the appropriateness of the colors displayed.

All of the subject pilots responding to the question posed about the dual-color MIRL fixtures during the evaluation session at MIV rated the signal presentation as "Sufficient". A number of comments were noted, both at MIV and at the other test sites (HIRL systems), to the effect that the dual-color fixtures took on a distinct purple hue when viewed from the side.

This combining of the two colors, resulting from the juxtaposition of the different colored filters or globes, is not surprising since the human eye will tend to integrate multiple colors perceived within a very small viewing arc (i.e., on the order of 1 minute of angle). Thus a close positioning of red and blue filters will be seen as a purple signal when viewed from a distance. This effect is not noticed, of course, when the dual-color fixture is viewed from either color face directly since the eye sees, at most, only a very small segment of the alternative color.

A somewhat similar problem occurred during an evaluation of dual-color fixtures intended for use in helipad lighting. In that case the color split was along a horizontal rather than vertical plane, but the resultant effect was the same—integration of the two colors into a third. A temporary solution to the problem was achieved by placing a strip of black nontranslucent electrical tape along the junction of the two filter halves. The same temporary modification was applied to several MIRL dual-color globes during the test at MIV and alleviated the problem to a considerable degree.

It might be mentioned that, if the blue color should be specified for both directions within the pre-threshold/post end of runway area, it would be possible to use full 360° blue filters and globes in many instances, eliminating some of the combining problem occurring with dual-colored filters and globes.

Although not posed as a specific questionnaire item, project personnel discussions, occurring during the flight testing sessions, did address the intensity and color characteristics of the red and blue signals. It was the consensus that the intensity of the blue colored edge lights was

sufficiently high, due to the use of the higher wattage runway edge light lamps (100-200 watts), and that the color remained recognizable as taxiway/aviation blue. The red edge lights evoked much the same adequate reaction from all observers. These results, or opinions, pertained to both the HIRL and MIRL lighting systems.

5.2.7 Effect of Flush Approach Lighting System (ALS) in the Pre-Threshold Takeoff/Taxi Area.

Since the existing declared distance dual-color lighting configurations at both the BGM and BWI sites included segments of flush approach lighting systems (ALS) within the pre-threshold area, several questions were included to determine the effect, either positive or negative, such an additional lighting installation might have. Questions 4, 5, and 5a addressed this issue by asking opinions concerning the overall lighting configuration with, specifically stated, the ALS illuminated. Pilot responses were virtually unanimous in stating that they felt comfortable with the ALS presentation imbedded within the other lighting configurations and that they had no difficulty in identifying either the ALS or the point at which the takeoff roll could begin.

A number of pilots commented on the fact that at high intensity on the ALS (Step 5) the glare was somewhat of a problem but that when the ALS was switched to a lower intensity (Step 3) it was acceptable. For the visual meteorological conditions (VMC) weather conditions encountered, the lower-intensity step would be selected by the tower personnel routinely. Approximately one-third of the subject comments reflected favorable opinion of the additional green threshold lights provided with the ALS installation, filling in the gap between the conventional displaced threshold green wing bars. This it yet stronger verification that pilots consider a strong, bold threshold signal to be extremely important.

Several comments also addressed the fact that the ALS in the pre-threshold area, when illuminated, completely washed out other lights (red edge lights) to the extent that they were hardly noticed. This, of course, should not be construed as a negative judgment but merely as an observation.

6. CONCLUSIONS AND RECOMMENDATIONS.

6.1 CONCLUSIONS.

From the results of this evaluation effort, we can conclude that:

a. The most appropriate and by definition the only correct location for the red runway end lights is at the declared end of the LDA and not at the physical end of the overrun area.

b. The color red, being universally and traditionally used as warning of a restricted and/or hazardous area, is inappropriate for use in lighting configurations defining or delineating an area normally available for use by pilots.

c. The color blue is acceptable and appropriate for use in lighting configurations defining or delineating an area routinely used for taxiing. If the area is also authorized for takeoff, it

may be necessary to provide additional visual verification (signs, painted markings, etc.) that such usage, other than that of taxiing, is permitted.

d. Conventional runway threshold and end lights are of critical importance to clarifying operational usage of declared distance adjoining areas and therefore must be of the boldest intensity and color characteristics possible.

e. Dual-color edge lighting fixtures are adequate in the form evaluated and as constituted from available off-the-shelf components but would benefit significantly from design changes to eliminate contamination (combining) of the signal colors under side viewing situations.

6.2 RECOMMENDATIONS.

From the results of this evaluation and from the conclusion reached we would recommend the following (reference figure 7).

a. The standard location for red runway end lights should, in declared distance runway situations, be at the end of the runway pavement area usable for landing (the LDA) rather than at the physical end of the pavement (the overrun).

b. In the event that the overrun area is determined to be weight bearing and usable for taxiing but not declared to be part of the available landing area, the edges and end of the area following the runway end should be delineated by blue taxiway edge lights.

c. In the event that the underrun pre-threshold area is determined to be weight bearing and available for either taxiing or the conduct of a takeoff run, the area should be delineated by blue taxiway lights, and if it is a takeoff area, it should be provided with some supplemental advisory indication (signs, paint, etc.) that initiation of a takeoff is authorized. (Additional testing of omnidirectional blue fixtures prior to the landing threshold would be beneficial.)

d. Unique visual guidance techniques or devices should be developed to clearly indicate to a pilot that takeoff initiation within the blue lighted area is permitted.

e. Modifications to split (dual) color filters presently available on the commercial market to eliminate or reduce the contamination of signal color when viewed from the side should be incorporated before they can be approved for unlimited use. Use of existing split color filters should be authorized as a temporary measure until the improved filters can be made available.

f. The importance of bold green threshold and red runway end lighting should be stressed, and information should be disseminated as to means by which such enhancements can be attained. This might include revision upward of the minimum photometric intensity requirements for approved fixtures.

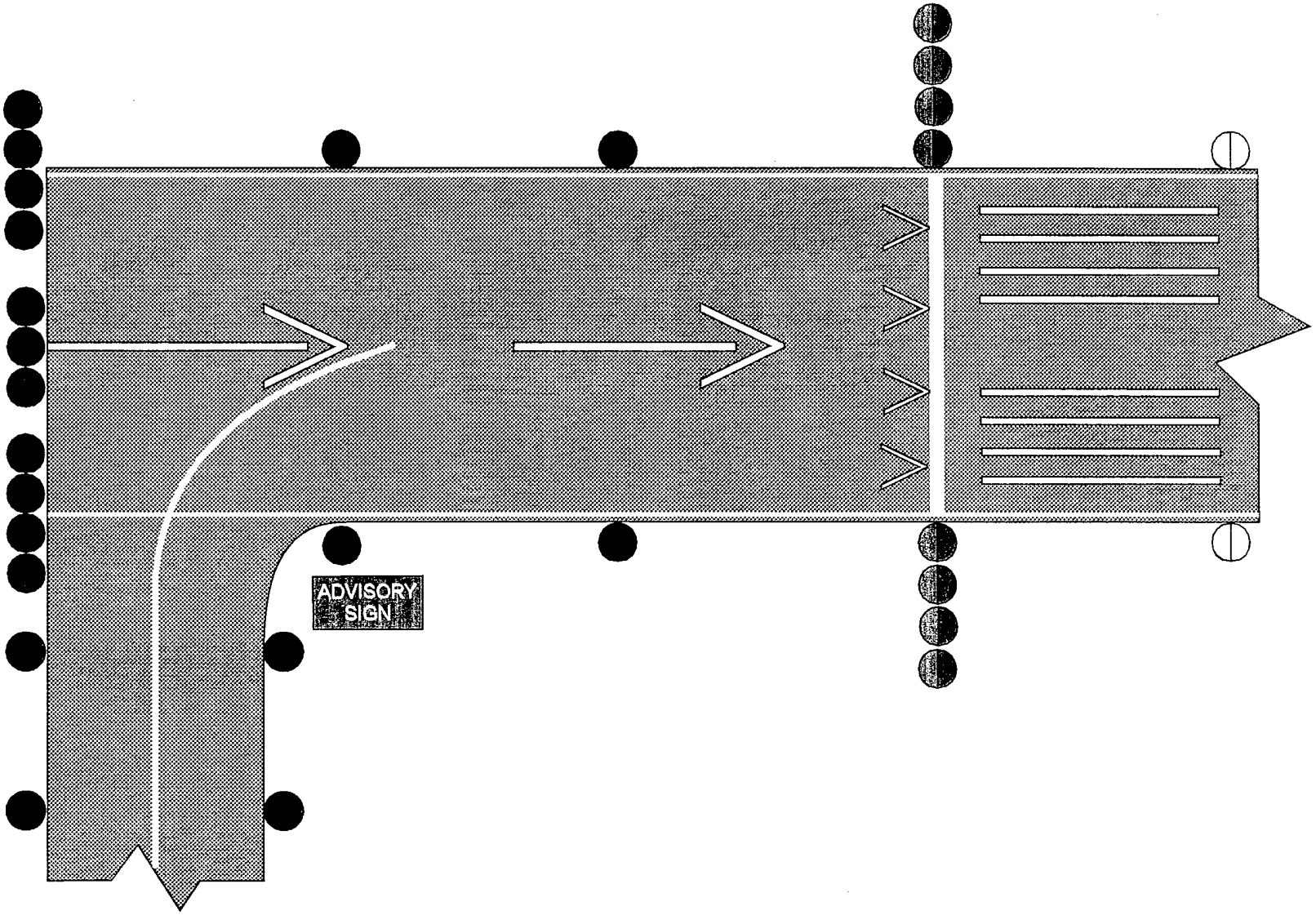


FIGURE 7. RECOMMENDED LIGHTING CONFIGURATION FOR DECLARED DISTANCE RUNWAY

APPENDIX A—POLICY AND PROCEDURES MEMORANDUM; "GUIDANCE ON DECLARED DISTANCE STANDARDS"

U.S. Department of Transportation
Federal Aviation Administration

Great Lakes Region
Illinois, Indiana, Michigan, Minnesota, North Dakota, Ohio, South Dakota, Wisconsin

2300 East Devon Avenue
Des Plaines, Illinois 60018

Policy and Procedures Memorandum - Airports Division

NUMBER: 5300.2

DATE: NOV 18 1992

SUBJECT: Guidance on Declared Distance Standards

CANCELLATION: This PPM supersedes previous guidance on this subject as stated in Paragraph 1., Background.

REFERENCES: Advisory Circular 150/5300-13, Changes 1 and 2, Airport Design
Memorandum from AGL-620 to AAS-100 dated 1/2/92, AC 150/5300-13, Change 1, Guidance on Declared Distance Standards.
Memorandum from AAS-100, to all Regions dated 1/28/92, Application of Existing Airport Lighting Standards to Declared Distance Concepts.

APPENDICES: 1 - Declared Distance Concept Options Approved for Use in the Great Lakes Region.

2 - Examples of Declared Distance Concepts.

3 - Comment Resolution

1. Background.

a. Advisory Circular 150/5300-13 issued September 29, 1989 established the concept of declared distance for airport design. Subsequent changes (1 and 2) to this advisory circular have revised and redefined the declared distance concept.

b. This PPM supersedes previous guidance on the declared distance concept as issued by memorandum as follows: AGL-620 memo dated 9-21-90, AGL-620 memo dated 9/26/90, AAS-110 memo dated 10/5/90, AGL-620 memo dated 10/11/90, and AGL-620 memo dated 12/24/90.

c. AGL-620, by memorandum dated 1/2/92, requested approval from AAS-100 for the marking, lighting and signing of declared distance concepts. By memorandum dated 1/28/92 (two separate transmittals) AAS-100 approved the Great Lakes Region's proposal and provided drawings illustrating airport lighting standards for six (6) declared distance concepts.

Distribution: AGL-600/601/602/603/605/610/620:Originator:AGL-620
BIS-ADO; CHI-ADO; DET-ADO; MSP-ADO
All State Aviation Directors (Information thru ADO)

(2) The ADO, through the airport owner, must ensure the TORA, TODA, ASDA and LDA declared distances and stopway lengths are provided in the Airport/Facility Directory for each operational direction, prior to implementing the declared distance concept at the airport. For international airports, the declared distances for each operational direction must also be in the Aeronautical Information Publication (AIP). The ADO will take appropriate action to assure the declared distances and stopway lengths are entered on FAA 5010-1 Form. The procedures for entering information into the AFD and AIP are outlined in each publication.

Note: If thresholds are sited for small airplanes, the LDA should be reported as "LDA for airplanes of 12,500 pounds or less maximum certificated takeoff weight."

3. The marking (AC 150/5340-1F), lighting (AC 150/5340-24) and signing (distance remaining signs, AC 150/5340-18C) of runway threshold locations, displaced and/or relocated thresholds, stopways, portions of runways used as taxiways, and blast pads, resulting from implementation of the declared distance concept, will be based on conventional methods set forth in the appropriate advisory circulars. Examples of the applicable marking, lighting and signing for the approved declared distance concepts are depicted in Appendix 1. It should be understood that these drawings depict light color only and runway and taxiway lights need to be installed in accordance with AC 150/5340-24.

Note: Split blue/red fixtures shown in the displaced threshold area of the runway, on pages 3 and 4 of Appendix 1,are not currently approved. Until this type of lens is approved, separate uni-directional fixtures will be necessary. In the event additional taxiway lights are needed they should be uni-directional, split blue/blank fixtures or 360° blue with one side shielded.

4. Appendix 2 presents two examples of the declared distance concepts which depicts the TORA, TODA, ASDA and LDA relationships. All approvable options are not represented by these examples.

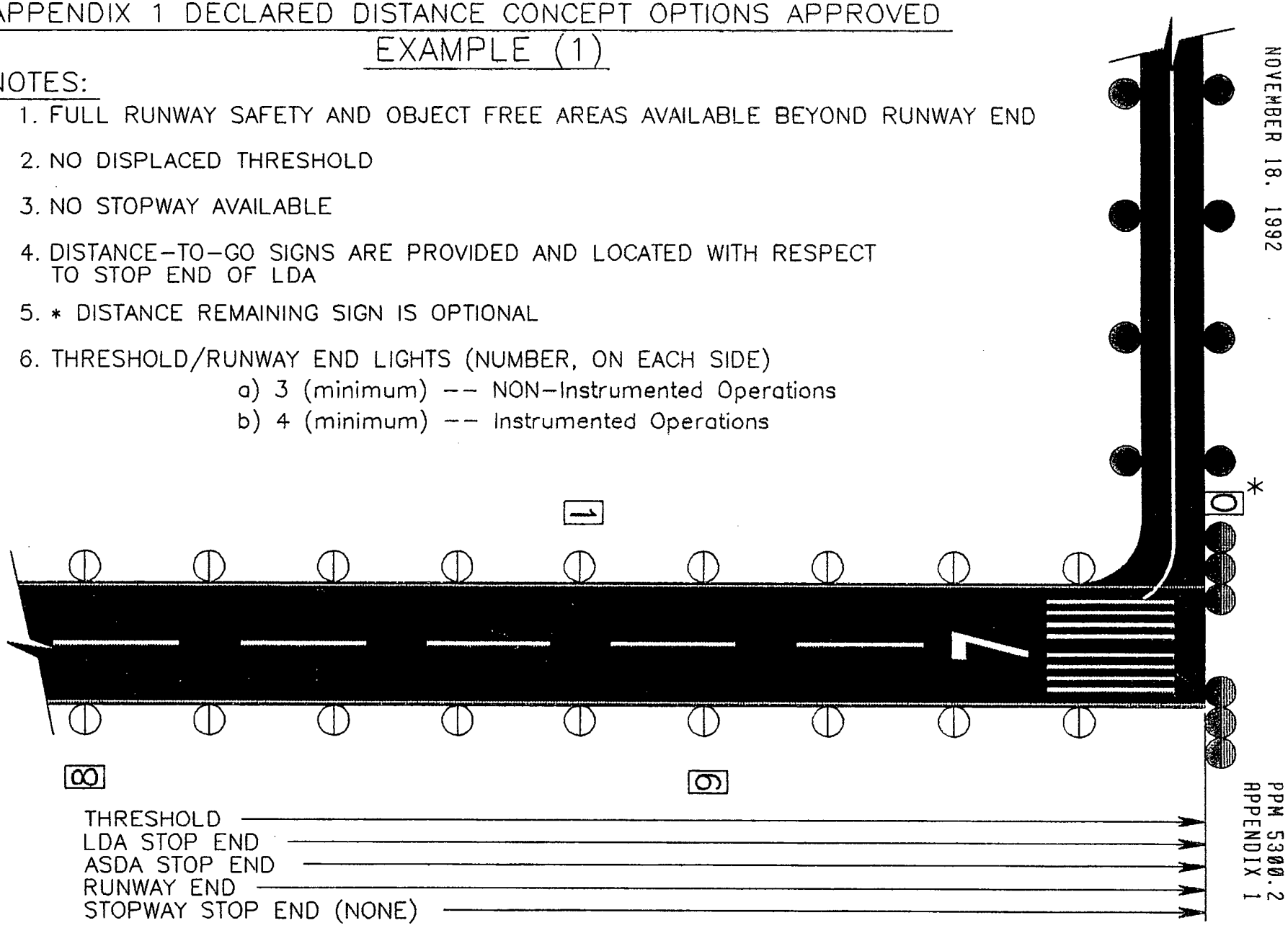
W. Robert Billingsley
Manager, Airports Division

APPENDIX 1 DECLARED DISTANCE CONCEPT OPTIONS APPROVED

EXAMPLE (1)

NOTES:

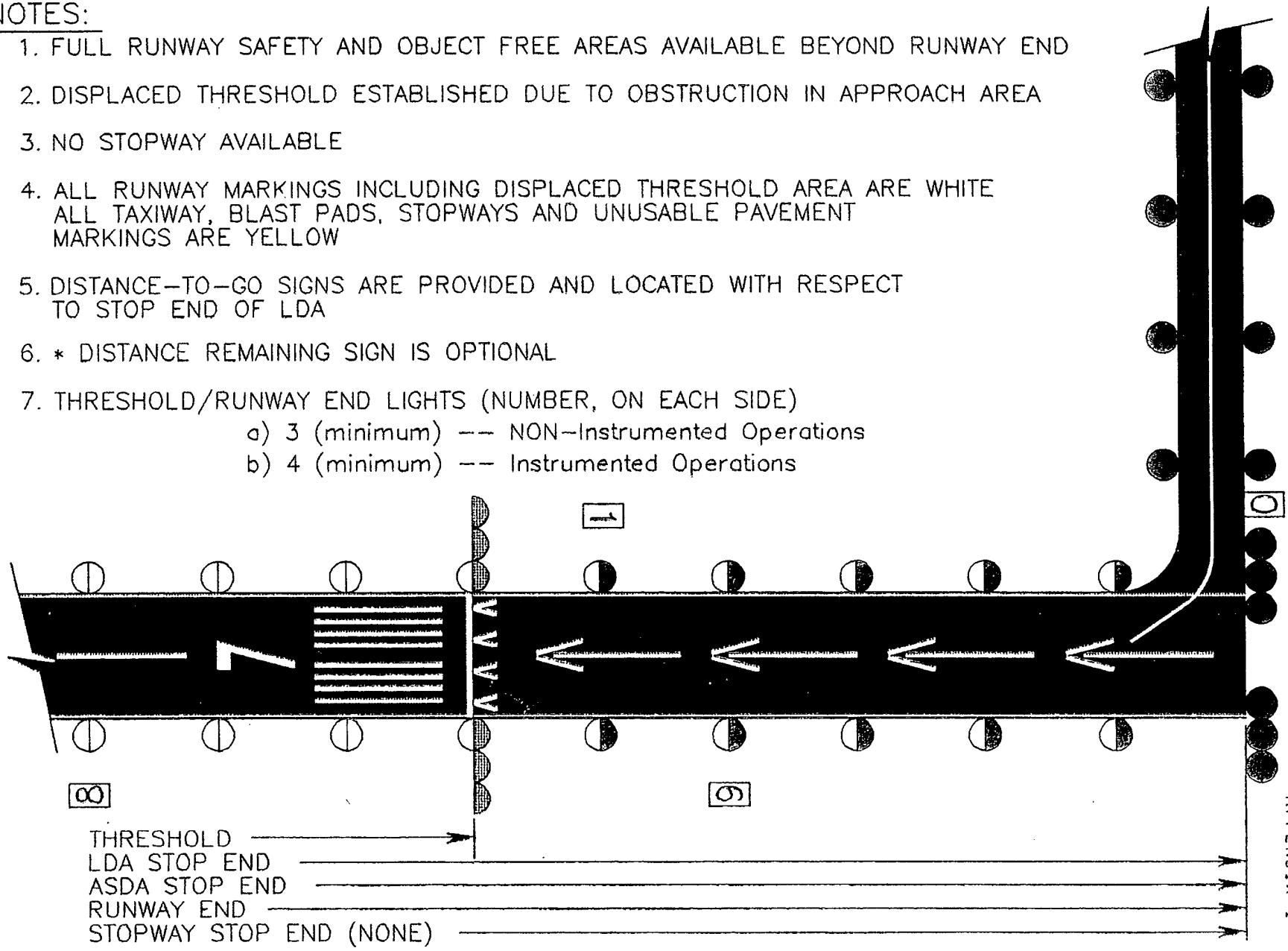
1. FULL RUNWAY SAFETY AND OBJECT FREE AREAS AVAILABLE BEYOND RUNWAY END
2. NO DISPLACED THRESHOLD
3. NO STOPWAY AVAILABLE
4. DISTANCE-TO-GO SIGNS ARE PROVIDED AND LOCATED WITH RESPECT TO STOP END OF LDA
5. * DISTANCE REMAINING SIGN IS OPTIONAL
6. THRESHOLD/RUNWAY END LIGHTS (NUMBER, ON EACH SIDE)
   a) 3 (minimum) -- NON-Instrumented Operations
   b) 4 (minimum) -- Instrumented Operations



EXAMPLE (2)

NOTES:

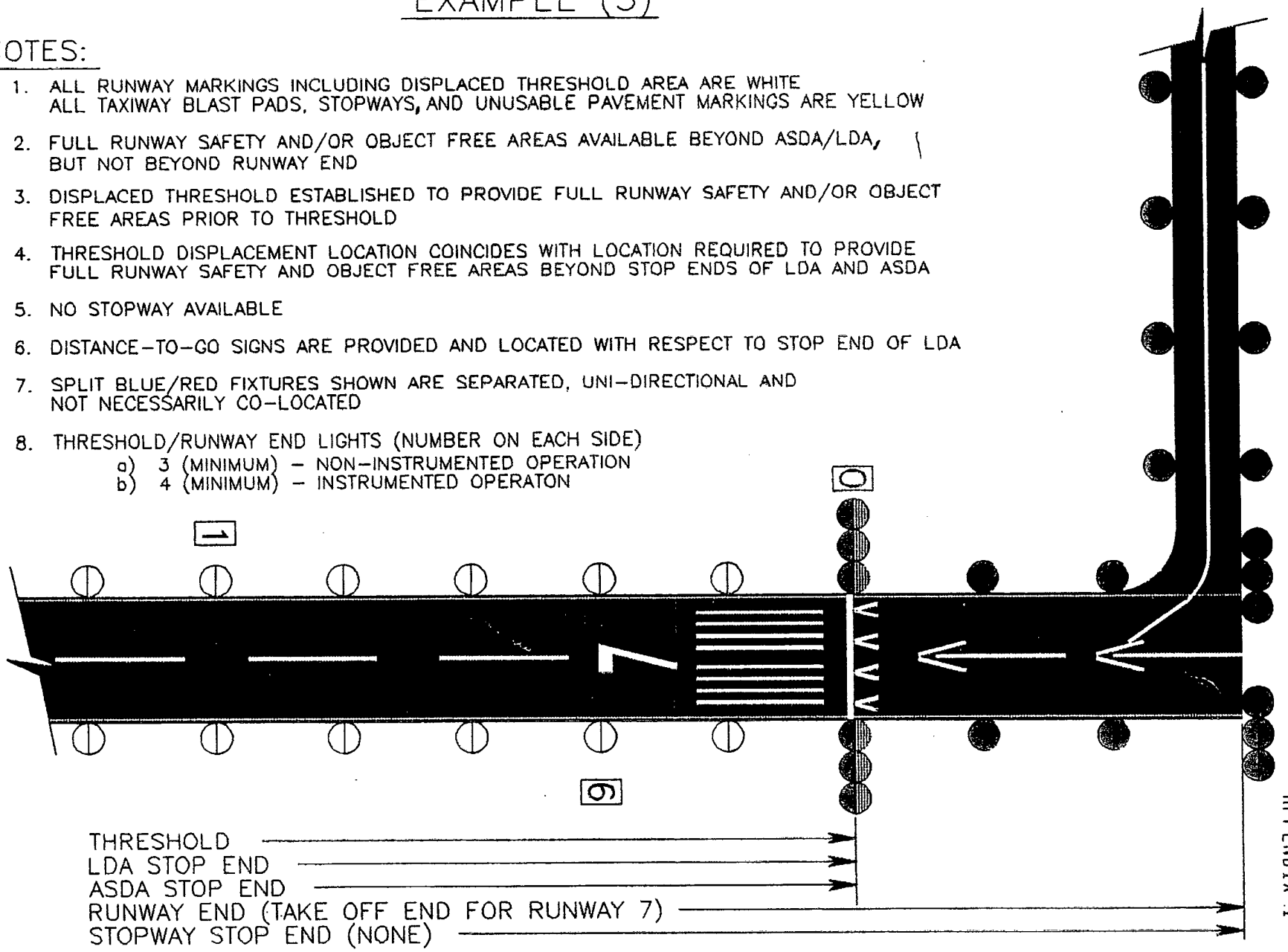
1. FULL RUNWAY SAFETY AND OBJECT FREE AREAS AVAILABLE BEYOND RUNWAY END
2. DISPLACED THRESHOLD ESTABLISHED DUE TO OBSTRUCTION IN APPROACH AREA
3. NO STOPWAY AVAILABLE
4. ALL RUNWAY MARKINGS INCLUDING DISPLACED THRESHOLD AREA ARE WHITE
   ALL TAXIWAY, BLAST PADS, STOPWAYS AND UNUSABLE PAVEMENT
   MARKINGS ARE YELLOW
5. DISTANCE-TO-GO SIGNS ARE PROVIDED AND LOCATED WITH RESPECT
   TO STOP END OF LDA
6. * DISTANCE REMAINING SIGN IS OPTIONAL
7. THRESHOLD/RUNWAY END LIGHTS (NUMBER, ON EACH SIDE)
   a) 3 (minimum) -- NON-Instrumented Operations
   b) 4 (minimum) -- Instrumented Operations



EXAMPLE (3)

NOTES:

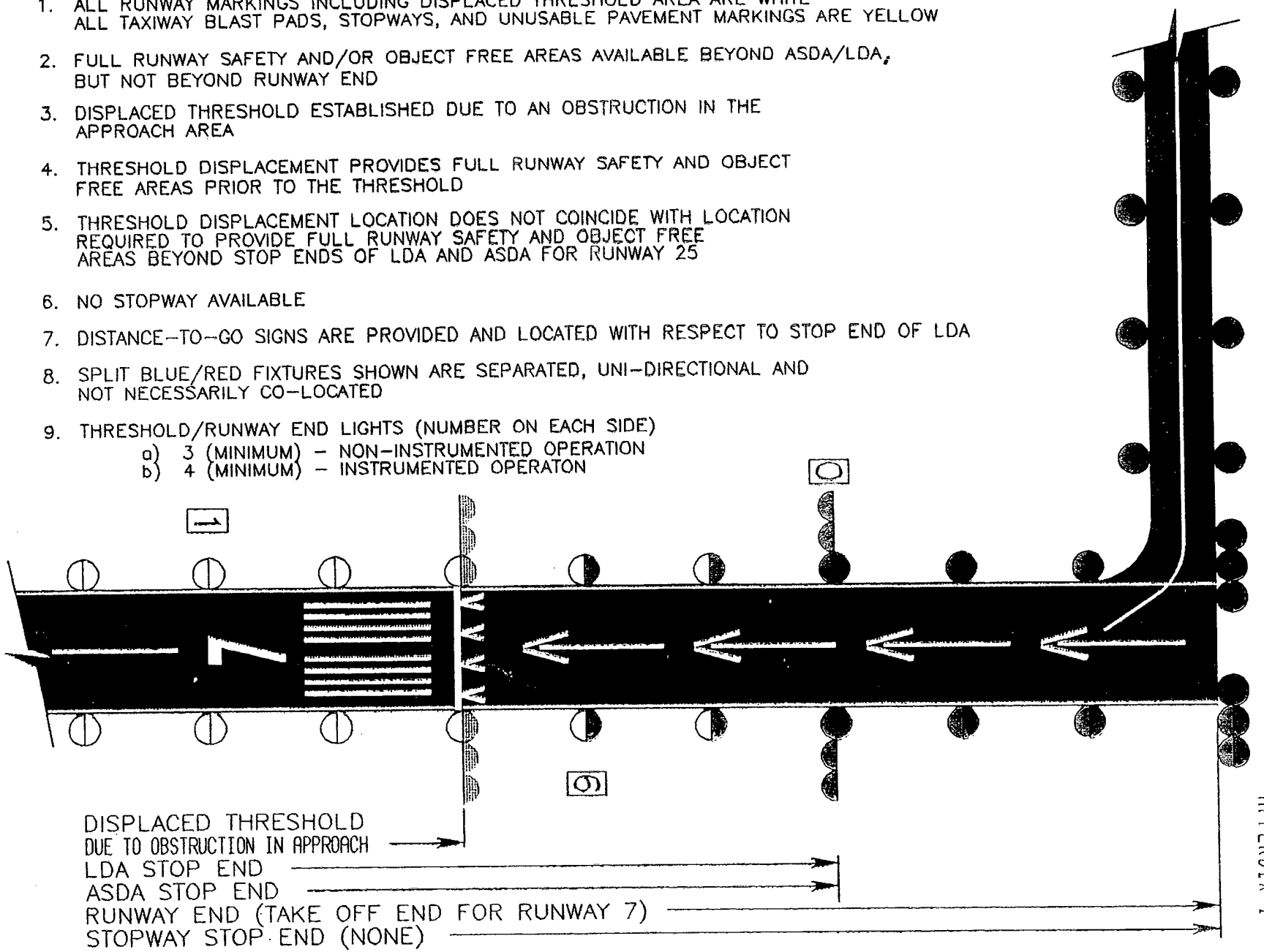
1. ALL RUNWAY MARKINGS INCLUDING DISPLACED THRESHOLD AREA ARE WHITE
   ALL TAXIWAY BLAST PADS, STOPWAYS, AND UNUSABLE PAVEMENT MARKINGS ARE YELLOW
2. FULL RUNWAY SAFETY AND/OR OBJECT FREE AREAS AVAILABLE BEYOND ASDA/LDA, BUT NOT BEYOND RUNWAY END
3. DISPLACED THRESHOLD ESTABLISHED TO PROVIDE FULL RUNWAY SAFETY AND/OR OBJECT FREE AREAS PRIOR TO THRESHOLD
4. THRESHOLD DISPLACEMENT LOCATION COINCIDES WITH LOCATION REQUIRED TO PROVIDE FULL RUNWAY SAFETY AND OBJECT FREE AREAS BEYOND STOP ENDS OF LDA AND ASDA
5. NO STOPWAY AVAILABLE
6. DISTANCE-TO-GO SIGNS ARE PROVIDED AND LOCATED WITH RESPECT TO STOP END OF LDA
7. SPLIT BLUE/RED FIXTURES SHOWN ARE SEPARATED, UNI-DIRECTIONAL AND NOT NECESSARILY CO-LOCATED
8. THRESHOLD/RUNWAY END LIGHTS (NUMBER ON EACH SIDE)
   a) 3 (MINIMUM) - NON-INSTRUMENTED OPERATION
   b) 4 (MINIMUM) - INSTRUMENTED OPERATON



EXAMPLE (4)

NOTES:

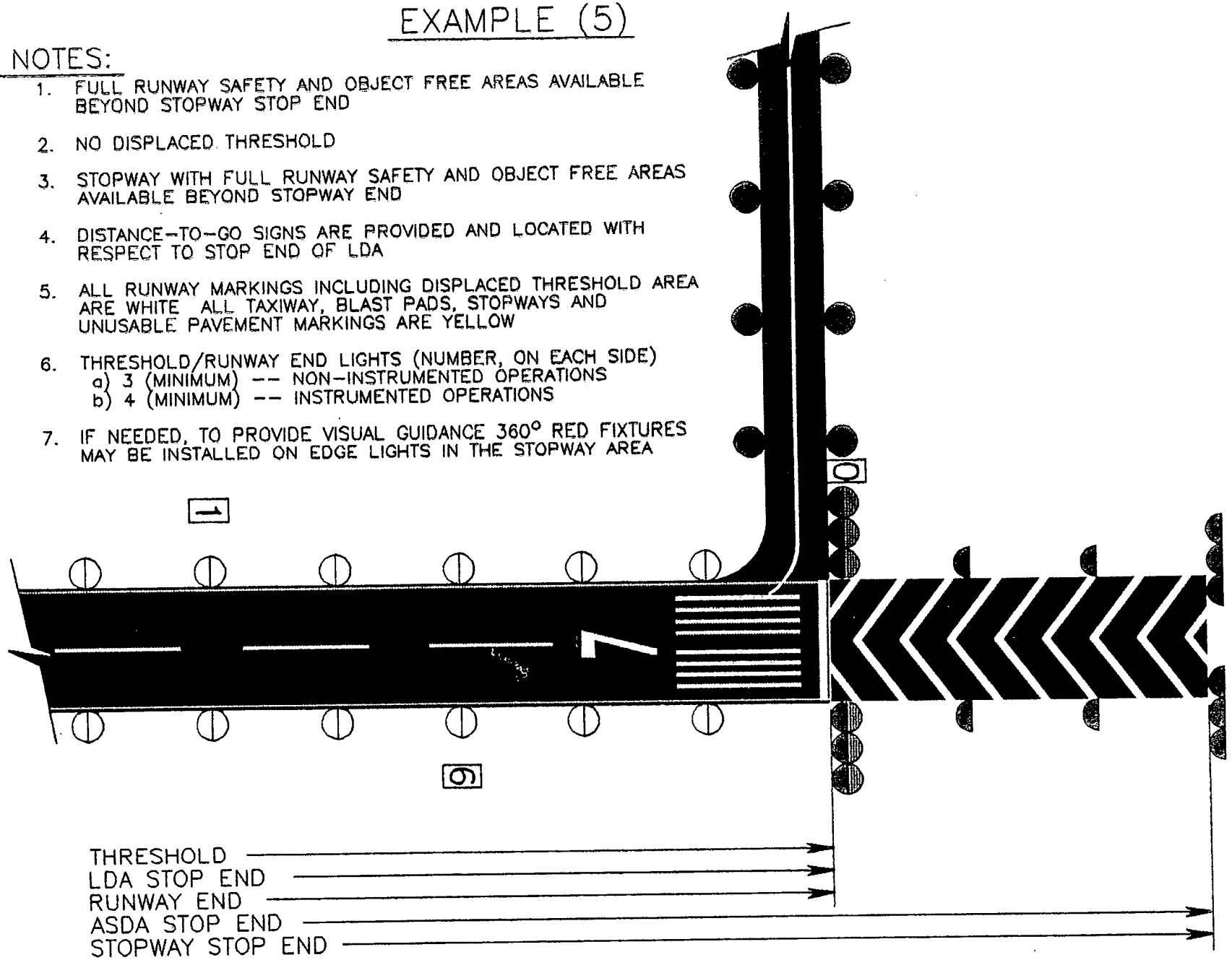
1. ALL RUNWAY MARKINGS INCLUDING DISPLACED THRESHOLD AREA ARE WHITE
   ALL TAXIWAY BLAST PADS, STOPWAYS, AND UNUSABLE PAVEMENT MARKINGS ARE YELLOW
2. FULL RUNWAY SAFETY AND/OR OBJECT FREE AREAS AVAILABLE BEYOND ASDA/LDA, BUT NOT BEYOND RUNWAY END
3. DISPLACED THRESHOLD ESTABLISHED DUE TO AN OBSTRUCTION IN THE APPROACH AREA
4. THRESHOLD DISPLACEMENT PROVIDES FULL RUNWAY SAFETY AND OBJECT FREE AREAS PRIOR TO THE THRESHOLD
5. THRESHOLD DISPLACEMENT LOCATION DOES NOT COINCIDE WITH LOCATION REQUIRED TO PROVIDE FULL RUNWAY SAFETY AND OBJECT FREE AREAS BEYOND STOP ENDS OF LDA AND ASDA FOR RUNWAY 25
6. NO STOPWAY AVAILABLE
7. DISTANCE-TO-GO SIGNS ARE PROVIDED AND LOCATED WITH RESPECT TO STOP END OF LDA
8. SPLIT BLUE/RED FIXTURES SHOWN ARE SEPARATED, UNI-DIRECTIONAL AND NOT NECESSARILY CO-LOCATED
9. THRESHOLD/RUNWAY END LIGHTS (NUMBER ON EACH SIDE)
   a) 3 (MINIMUM) - NON-INSTRUMENTED OPERATION
   b) 4 (MINIMUM) - INSTRUMENTED OPERATON



EXAMPLE (5)

NOTES:

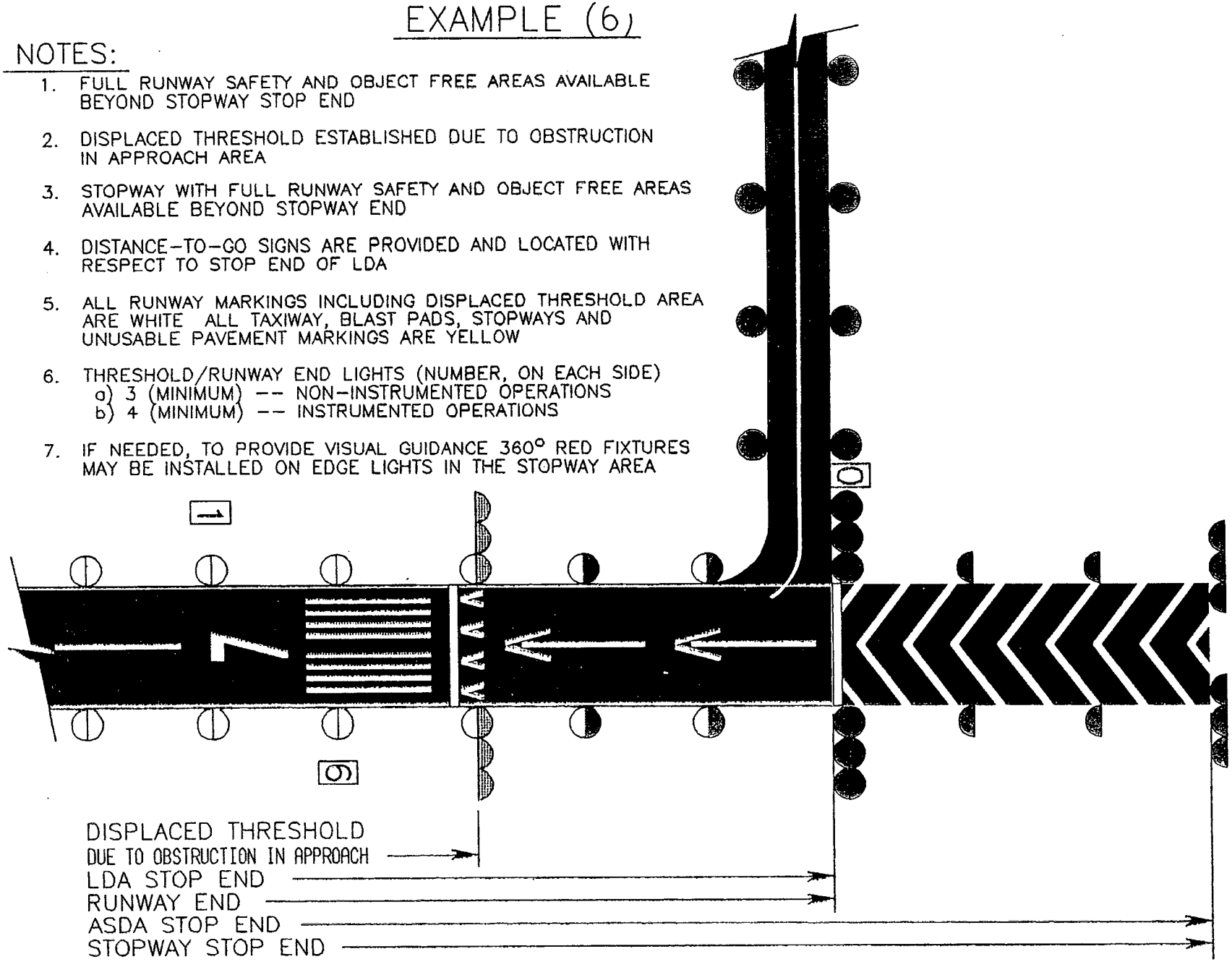
1. FULL RUNWAY SAFETY AND OBJECT FREE AREAS AVAILABLE BEYOND STOPWAY STOP END
2. NO DISPLACED THRESHOLD
3. STOPWAY WITH FULL RUNWAY SAFETY AND OBJECT FREE AREAS AVAILABLE BEYOND STOPWAY END
4. DISTANCE-TO-GO SIGNS ARE PROVIDED AND LOCATED WITH RESPECT TO STOP END OF LDA
5. ALL RUNWAY MARKINGS INCLUDING DISPLACED THRESHOLD AREA ARE WHITE ALL TAXIWAY, BLAST PADS, STOPWAYS AND UNUSABLE PAVEMENT MARKINGS ARE YELLOW
6. THRESHOLD/RUNWAY END LIGHTS (NUMBER, ON EACH SIDE)
   a) 3 (MINIMUM) -- NON-INSTRUMENTED OPERATIONS
   b) 4 (MINIMUM) -- INSTRUMENTED OPERATIONS
7. IF NEEDED, TO PROVIDE VISUAL GUIDANCE 360° RED FIXTURES MAY BE INSTALLED ON EDGE LIGHTS IN THE STOPWAY AREA



EXAMPLE (6)

NOTES:

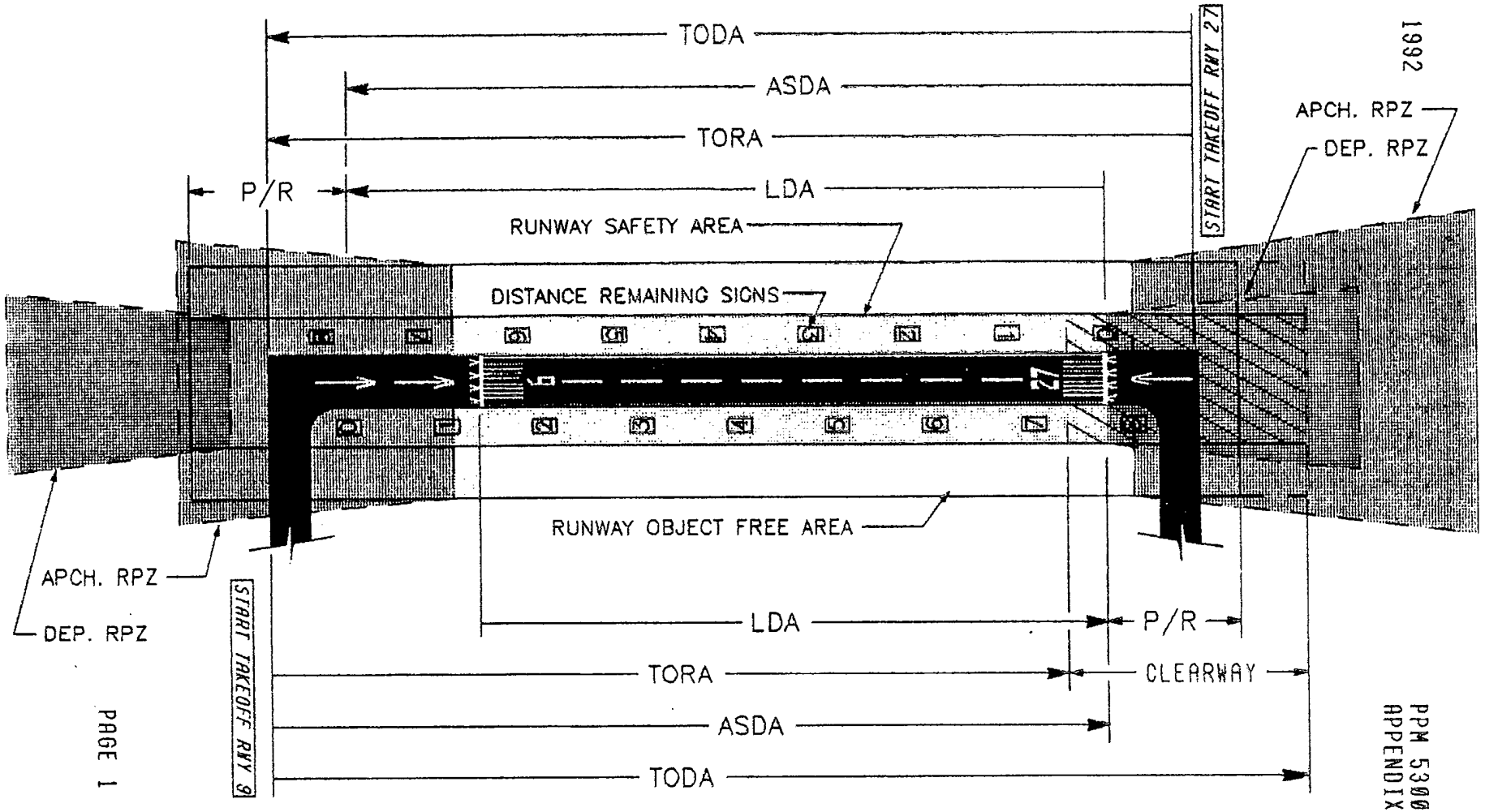
1. FULL RUNWAY SAFETY AND OBJECT FREE AREAS AVAILABLE BEYOND STOPWAY STOP END
2. DISPLACED THRESHOLD ESTABLISHED DUE TO OBSTRUCTION IN APPROACH AREA
3. STOPWAY WITH FULL RUNWAY SAFETY AND OBJECT FREE AREAS AVAILABLE BEYOND STOPWAY END
4. DISTANCE-TO-GO SIGNS ARE PROVIDED AND LOCATED WITH RESPECT TO STOP END OF LDA
5. ALL RUNWAY MARKINGS INCLUDING DISPLACED THRESHOLD AREA ARE WHITE ALL TAXIWAY, BLAST PADS, STOPWAYS AND UNUSABLE PAVEMENT MARKINGS ARE YELLOW
6. THRESHOLD/RUNWAY END LIGHTS (NUMBER, ON EACH SIDE)
   a) 3 (MINIMUM) -- NON-INSTRUMENTED OPERATIONS
   b) 4 (MINIMUM) -- INSTRUMENTED OPERATIONS
7. IF NEEDED, TO PROVIDE VISUAL GUIDANCE 360° RED FIXTURES MAY BE INSTALLED ON EDGE LIGHTS IN THE STOPWAY AREA



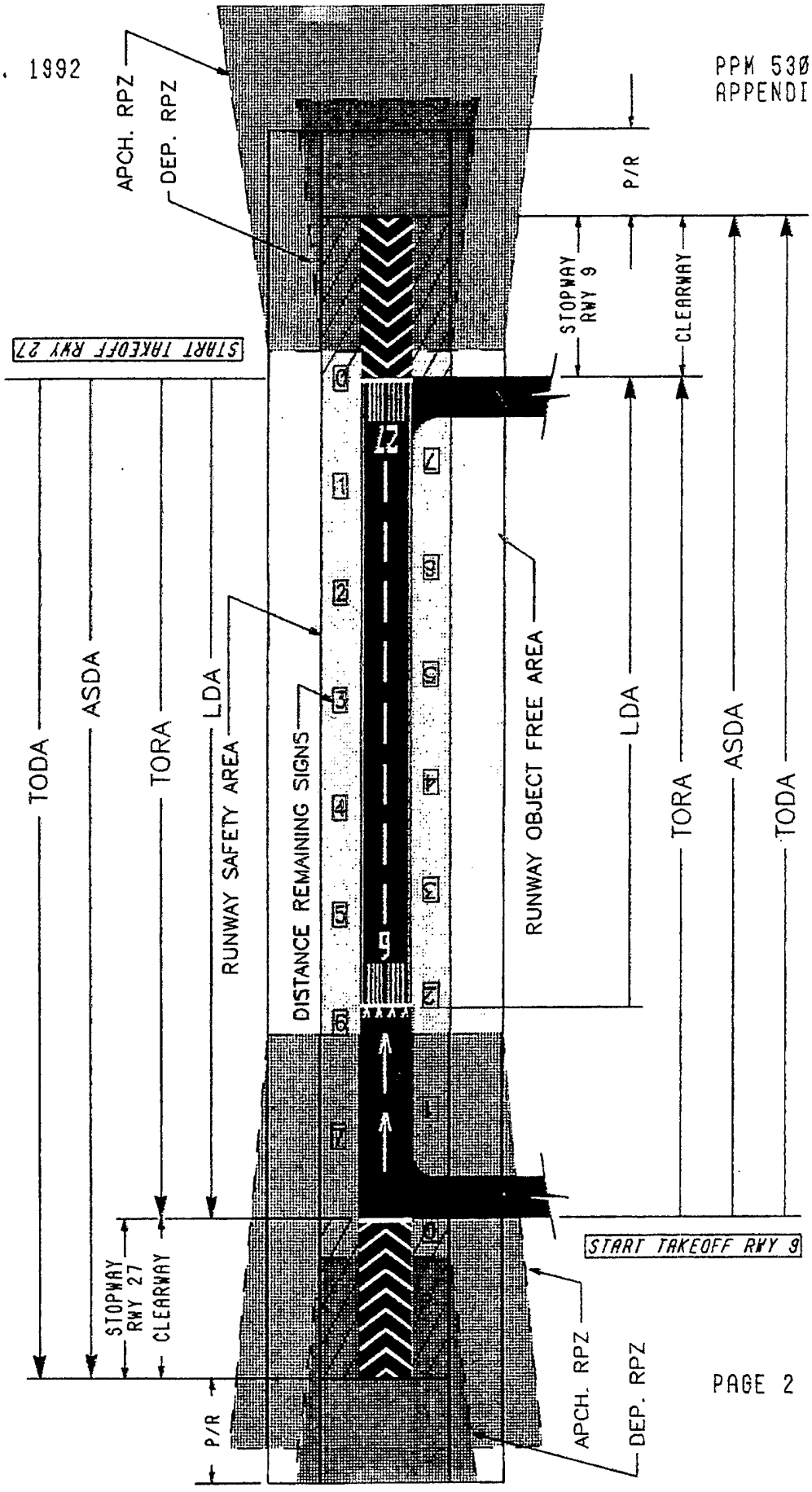
APPENDIX 2 DECLARED DISTANCE CONCEPT EXAMPLES

EXAMPLE (1) Declared Distance Concept Depiction – No Stopways

NOTE: The standard RSA length "P" and ROFA length "R" is the length specified in tables 3–1, 3–2 and 3–3 for the RSA and ROFA beyond the runway ends.



EXAMPLE (2) Declared Distance Concept Depiction – Stopways Available



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Appendix 3. LISTING OF COMMENTS AND RESOLUTION

1. Comment (ADO-Chicago)

Since we will be using the Airport Layout Plan (ALP) approval process in implementing the declared distance concept, are the other divisions in concurrence with our proposed process? Their early-on understanding is crucial to a successful program.

Response

The declared distance concept as presented in AC 150/5300-13, on which the Great Lakes proposed process is based, received approval from all Services in Headquarters. In addition, the proposed process was coordinated with Headquarters and appropriate program divisions in the region. All substantial concerns that other divisions had, have been addressed and the PPM should be acceptable to the program divisions.

It is anticipated, as with any new concept, that processing may be deliberate until all impacted personnel understand and become familiar with the declared distance concept.

2. Comment (ADO-Chicago)

The users will probably refer to the NFDD for information regarding the airport to which they are going. It may be that without a 5010 showing the declared distance option or a generic 5010 showing what each option is, the users will not know how to interpret what they are reading. We suggest you may want to give this some consideration.

Response

Paragraph 2.b.(2) requires the ADO to take appropriate action to assure that the declared distance and stopway lengths are entered on FAA 5010-1 Form. Headquarters reviews all FAA 5010-1 Form entries for uniformity and consistency. It is our understanding that Headquarters has taken action to ensure that pilots have been informed of the concept and how the information is to be presented in the Aeronautical Information Publication (AIP) and on the FAA 5010-1 Form.

Response

Under certain conditions it may be desirable to provide visual guidance for aircraft that enter the stopway area. In these cases a 360 degree red fixture could be installed to provide the necessary visual guidance. A note indicating this option will be added to Appendix 1, pages 5 and 6.

7. Comment (ADO-Detroit)

Appendix 2, page 2. Why doesn't the TORA end at the start of RSA and OFA? What determined the end of the TORA?

Response

TORA is defined as the runway length declared available and suitable for the ground run of an airplane taking off. Clearways and stopways at the start of the takeoff end and at the far end of the runway can not be used as TORA (See AC 150/5300-13 Chg 2, Appendix 14, paragraphs 6 and 7, and figure A14-1).

Runway safety area (RSA) and runway object free area (ROFA) lengths at the far end of a runway for takeoff shall extend beyond the far end of the stopway, or the far end of the accelerate - stop distance (ASDA) when there is no stopway. See AC 150/5300-13, Chg 2, Appendix 14, Paragraph 4.a.(2) and (3).

The departure runway protection zone (DRPZ) at the far end of a runway reduces the TORA to less than the runway length. See AC 150/5300-13, Chg 2, Appendix 14, Paragraph 5.b. and Figure A14-1.

In summary, the RSA and ROFA are not directly related to the TORA at the far end of a runway for takeoff.

8. Comment

Format revisions are necessary to meet the requirements for issuing PPM's.

Response

The appropriate recommendations have been incorporated into the PPM.

APPENDIX B—PILOT QUESTIONNAIRE COMMENT COMPILATION

This summary of comments is organized in accordance with the questionnaire section (i.e., the question) under which the response appeared and the airport at which the evaluation was being conducted. Comments are provided as written on the questionnaire sheets and have not been changed to correct spelling or grammar.

1. WAS THERE ANY DIFFICULTY IN LOCATING THE LANDING THRESHOLD OF THE RUNWAY?

__5__ Difficult __9__ Some difficulty __19__ No difficulty

BINGHAMTON REGIONAL AIRPORT, NY

- "When the aircraft was 1 1/2 miles from threshold, it was not difficult. If more than 1-2 threshold lights were out, I would have said some difficulty."
- "I would rather see a full threshold bar."
- "Two bold red lights really stood out. You definitely would not land short."
- "The threshold lights and runway edge were easy to pick up."
- "The red bar was apparent first."
- "The red lights in the pre-threshold might be confusing."
- "When within a 1 mile from threshold."
- "No indication of threshold. Definitely pushing the limit. Winged threshold bars look like taxiway."
- "Hard to pick up the green threshold lights from a distance."
- "Red wing bar was more conspicuous than the green landing threshold bar."
- "There was nothing there. It is confusing, you might make a mistake."

BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT, MD

- "White edge lights and red distance to go lights seen well before threshold could be identified."

- "The standard threshold lights (4 and 4) were visible (best within 1000 ft), however, the fact that they were outboard of the runway and the red lights in front of the threshold detracted from their visibility."

- "Both threshold wing bars appeared weak."

- "Poor threshold bar although the touch-down zone lights helped, but probably wouldn't be on normally without ALS."

- "Very weak threshold bars. Noticed the end of the red edge lights - beginning of the white edge lights before the green threshold bars. Definitely saw red lights before the green."

- "There were plenty of hints as to where the landing threshold was (green lights on each side, beginning of runway centerline and edge lights in white, end of red runway edge lights.) However, the green bar all the way across could replace all of them."

- "Left hand wing bar of the threshold gave excellent threshold reference, but right hand threshold bar was very weak."

- "Two sides of the threshold were of different intensities. Left inset, right elevated. Full threshold lights would make it much easier for any other pilot."

- "Elevated threshold lights on right were weak. Otherwise, I was unable to locate landing threshold. Good strong inset threshold helped."

MILLVILLE MUNICIPAL AIRPORT, NJ

- "Green wing bars more visible than red."

- "Strong green threshold wingbars defined the threshold location well. Red lights in the pre-threshold area was not distracting or confusing."

- "It looks like an overrun."

- "Thumbs up, I liked the presentation."

ATLANTIC CITY INTERNATIONAL AIRPORT, NJ

- "Nothing abnormal."

- "Might give you trouble if you were unfamiliar with the airport."

- "I'm now picking up the green displaced threshold bars at 2.7 miles out."

- "No problem with it on approach."

2. DID YOU FEEL COMFORTABLE WITH THE LIGHTING DISPLAY AS YOU TAXIED THROUGH THE END OF THE RUNWAY AND ONTO THE TAXIWAY?

__3__ Uncomfortable __16__ Comfortable

BINGHAMTON REGIONAL AIRPORT, NY

- "I could see the pavement markings ahead because of the aircraft lights. This along with the blue taxiway lights, made it a comfortable operation."
- "Didn't bother me because we could see so well. The runway end lights looked like PAPIs. The red lights get lost behind other lights."
- "You could see the taxiway fine."
- "In conjunction with the lights, signs, and paint markings it made sense to me, but I thought it could be improved."
- "Reflection of 34 approach lights stood out more than the red runway end lights."
- "No problem."
- "I could see the pavement markings ahead because of the aircraft lights. This along with the blue taxiway lights, made it a comfortable operation."
- "There was a mess of lights. There was a delay in seeing the runway end. I was lost at the end of the runway, it was good thing there was a yellow stripe to follow. I like to see a barricade."
- "I'd like to see a bar at the end, the yellow line made me turn - not the lights."
- "I used the signs/ paint markings as a backup to the lights, but I thought it could be improved."
- "Would consider a full red bar at the physical end of the runway, fully crossing the runway."
- "I was lost at what to do past the runway end bars."

MILLVILLE MUNICIPAL AIRPORT, NJ

- "The blue lights gave a clear indication of transition to taxiway along with red wingbars."
- "The blue lights are appropriate for an area through which you can taxi. The red threshold wingbars defined the end of the "runway" adequately."
- "Blue lights made it obvious that you were on a taxiway."
- "Something directly in front would be good. Five red lights instead on 4, looks like a PAPI."

ATLANTIC CITY INTERNATIONAL AIRPORT, NJ

- "I would like to see five red runway end lights (on the winged bars) to prevent you from confusing them with PAPIs."
- "I have no problem taxiing through winged red bars because I know that there is something beyond them."
- "I would like to see more lights at the end...red lights at the actual end of the concrete."
- "The blue lights indicate that it is okay to go in there."
- "Good point: Lighting bar (red) was outboard of runway. Consideration: Add another light so that there are 5 bulbs on each side"

3. AS YOU BEGAN THE TAKEOFF ROLL BEFORE THE LANDING THRESHOLD OF THE RUNWAY, DID YOU FEEL COMFORTABLE WITH THE LIGHTING DISPLAY? (WITHOUT THE ALS ILLUMINATED)

__3__ Yes __27__ No

BINGHAMTON REGIONAL AIRPORT, NY

- "The red lights on the edge were not a problem."
- "The runway was right there in front of you."
- "It was a little different. But because it was short, you really didn't pick up the red lights."
- "The signs and paint markings indicate a displaced threshold available for take-off roll."

- "The threshold was not as obvious."
- "The red lights on the edge were not a problem."
- "Everything looks normal."
- "Wing lights aren't as noticeable as the full bar."
- "Looks okay."

BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT, MD

- "Moving through the red lights somewhat disconcerting."
- "Presence of white arrows very helpful."
- "Green side lights were no problem."
- "There was no problem, I could easily recognize the runway threshold. Little skeptical about "red"."
- "Same comments as before, red lights at end of pavement gave excellent orientation."
- "Once in the takeoff position, red lighted area was not very prominent (short section). A longer pre-threshold segment might appear more hostile (due to more red lights in view)."
- "White arrows as markings in place of centerline gave clear indication and red lights were not much of a problem."
- "There was no problem, I could easily recognize the runway threshold. Little skeptical about red."

MILLVILLE MUNICIPAL AIRPORT, NJ

- "From my vantage point, I could only see one edge light prior to the threshold. White arrows would have made it easier to determine use of the pavement as in BGM."
- "Red lights have historically meant "no entry" (i.e., as in stopbar signal). I will always feel some concern entering an area so defined, especially for the first time at a strange airport."
- "There is a conflict, should I be doing this. If there was enough runway, I would taxi up to the green threshold before applying power."

- "Red lights say don't go. With a big aircraft, you can't afford to give up runway. I do not like the presentation."

ATLANTIC CITY INTERNATIONAL AIRPORT, NJ

- "No problem with (beginning takeoff roll before the threshold) it, because I have white markings. These markings go hand in hand with the configurations."
- "An information sign such as <T/O Roll Permitted Before Threshold> at the hold bar would take away any confusion."
- "I always thought that a displaced threshold was for landing only, but now I can see a case where you would have it for takeoff."
- Information placard (sign) at hold short would help alleviate any possible confusion, i.e. "Threshold displaced for landing only"

3A. DID YOU HAVE ANY TROUBLE IDENTIFYING THE POINT AT WHICH THE TAKEOFF ROLL COULD BEGIN? (WITHOUT THE ALS ILLUMINATED)

__4__ Yes __26__ No

BINGHAMTON REGIONAL AIRPORT, NY

- "Because of the distance, you were practically on the threshold."
- "The signs and paint markings indicate a displaced threshold available for take-off roll."
- "I saw the runway and knew I was okay."
- "Same as regular displaced threshold."
- "Paint markings clarify runway usage."

BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT, MD

- "I would suggest an information sign at hold line defining takeoff area."
- "Red end lights gave a well defined no go area."
- I certainly knew, from the lighting pattern, where the r/w began. Only experience (or education) would tell me whether I can start my t/o roll in the red lighted area (or whether I should even be in it, for that matter)."

- "To me, the white markings indicate runway. But I would follow taxi lead on stripe to the threshold before applying power."

- "Same comments....information signs would be helpful."

- "No centerline lights available in displaced threshold area. No adverse reaction."

- "Runway threshold well defined by green wing bars. So long as I noted white arrows indicating takeoff to be "OK," I wouldn't be to concerned."

MILLVILLE MUNICIPAL AIRPORT, NJ

- "Again, white centerline arrow would help. If I didn't understand the declared distance concept, the red may have caused me to second guess myself."

- "The end of red and green threshold wingbars certainly define the beginning of the "runway," but I'm not certain if that means I have to reach that point before starting takeoff roll."

- "There is a conflict, should I be doing this. If there was enough runway, I would taxi up to the green threshold before applying power."

- "Red lights say don't go. With a big aircraft, you can't afford to give up runway. I do not like the presentation."

- "The exact point is unclear."

4. COULD YOU CLEARLY IDENTIFY THE APPROACH LIGHTING SYSTEM (ALS)?

__26__ Yes __0__ No

BINGHAMTON REGIONAL AIRPORT, NY

- "Stood out very well, no problem."

- "I liked the threshold a lot better."

- "Very strong threshold."

- "The full green threshold bar washed out the red and strongly identified the landing point."

- "There is no question where the threshold is."

- "The full threshold bar draws all your attention to it and not the red."
- "The full green threshold defines the threshold."

BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT, MD

- "Could not see threshold lights until farther along."
- "ALSF2 much brighter than runway edge lights. TDZ lights were not turned on."
- "Especially with the ALSF2 system."
- "ALS washed out any other lighting prior to the threshold."
- "ALS was very bright. I was unable to see the declared distance lighting until on 1/2 to 1/4 mile final."
- "Significantly more visible than 4 greens either side of the runway."
- "It overpowers the red lights in the underrun."
- "Complete green threshold lights were very important. Red in the approach was not a problem."
- "Strong threshold very easy to see. Red pre-threshold kind of looked like an ALS barrette."

5. AS YOU BEGAN THE TAKEOFF ROLL BEFORE THE LANDING THRESHOLD OF THE RUNWAY, DID YOU FEEL COMFORTABLE WITH THE LIGHTING DISPLAY? (WITH THE ALS ILLUMINATED)

__25__ Yes __1__ No (please explain)

BINGHAMTON REGIONAL AIRPORT, NY

- "MALSR white lights somewhat bright, but okay."
- "Okay."
- "Full threshold helped a lot."
- "The approach barrette and full threshold was not a problem."
- "Threshold a little bright, but okay."

- "Barrette a little bright, but not a major problem."

BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT, MD

- "Moving through the red lights somewhat disconcerting."
- "We were very curious why the red in-pavement barrettes were not illuminated."(on ALSF2)
- "Step 5 too bright, step 3 or less okay."
- "ALSF2 was in SSALR mode. White lights were a little bright, but not too bad. Full threshold bar was good, no problem rolling over it. Red barrettes were not on but I don't think they would have any adverse impact."
- "Only viewed SSALS on t/o, however, don't know how ALSF2-2 would appear."
- "ALS was very blinding."
- "Moving through the red lights somewhat disconcerting."
- "Same....information signs."
- "Full green bar across r/w was no problem."
- "The white arrows was semi-washed out by white MALSR barrette just beyond it."
- "The ALS was on high intensity and caused a significant glare problem."
- "I did not get a cockpit view due to limited time on the runway, but from my vantage point it was not a problem."
- "Green on the left, red to the right...it is obvious which way to go. ALS barrette was very bright - blinding with rain on the window."

5A. DID YOU HAVE ANY TROUBLE IDENTIFYING THE POINT AT WHICH THE TAKEOFF ROLL COULD BEGIN? (WITH THE ALS ILLUMINATED)

1 Yes 25 No

BINGHAMTON REGIONAL AIRPORT, NY

- "There was no sign saying otherwise. You wouldn't have a problem."

- "Again, a displaced threshold - per the paint markings."
- "White arrow markings give indication of takeoff area. Edge lights were not noticed."
- "Same as a regular displaced threshold, per the signage and paint markings."

BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT, MD

- "ALSF2-2 barrette somewhat blinding."
- "Again, the white arrows were helpful and I would suggest an information sign."
- "Note brightness comments...step 5 too bright, step 3 or less okay."
- "The white arrows in the displaced threshold area played an important role."
- "I certainly knew, from the lighting pattern, where the r/w began. Only experience (or education) would tell me whether I can start my t/o roll in the red lighted area (or whether I should even be in it, for that matter)."
- "Large full threshold made it very easy to locate runway."
- "MALSR barrette somewhat blinding."
- "Same....information signs."
- "Same as above, no problem."
- "Markings very important to confirm take off roll point."
- "In pavement green threshold and end of ALS made it evident where the runway began. That still doesn't tell me the point at which I can start (power up for) the takeoff roll, however."
- "Very obvious that you are on the runway."

THE FOLLOWING QUESTIONS AND COMMENTS PERTAIN TO BLUE PRE-THRESHOLD AT MILLVILLE MUNICIPAL AIRPORT, NJ.

6. WERE THE SPLIT RED/BLUE LIGHT FIXTURES USED FOR THIS DEMONSTRATION SUFFICIENT?

__7__ Yes __0__ No

- "No bleed through of red into blue. The fact that the lenses are epoxied together may be a factor. At BGM, the two separate filters may have shifted out of alignment."
- "I didn't notice any "blending" of the split colors, except when abeam of the light. Tape at the color junction on some of the fixtures helped this."
- "The lights look violet in color"
- "Okay from straight on, but they look violet from the side."
- "When approach from the side, they definitely look violet."
- "The (violet) color doesn't bother me, but it is not an aviation color."
- "For this demo yes. However, if taxiway approached at an oblique angle, it (purple color) may cause confusion. Probably OK"

7. WAS THERE ANY DIFFICULTY IN LOCATING THE LANDING THRESHOLD OF THE RUNWAY?

____ Difficult ____ Some difficulty __6__ No difficult

- "Complete blue taxiway edge lights leading up to the runway would have made the taxiway more prominent."
- "Again, the green threshold wing bars were completely adequate. The blue lights in the underrun area were not a consideration, especially since they couldn't be seen until "late" or short final."
- "The blue were not visible until on a one mile final."
- "I was a little more comfortable with red, but no problem with it."
- "Green threshold looks good."
- "No lights before threshold, looks normal, less cluttered."

8. DID YOU FEEL COMFORTABLE WITH THE LIGHTING DISPLAY AS YOU TAXIED THROUGH THE END OF RUNWAY AND ONTO THE TAXIWAY?

__7__ Uncomfortable __0__ Comfortable

- "All of that red in unnecessary."
- "I prefer the blue lights."
- "Is it a hole? Are those temporary lights? If unfamiliar, you wouldn't know what it means. It is usable concrete designated as red, do not enter."
- "Don't like it. Don't like taxiing through the red lights."
- "I wouldn't want to taxi in there, looked like an overrun area."
- "Red lights have historically meant "no entry" (i.e., as in stopbar signal). I will always feel some concern entering an area so defined, especially for the first time at a strange airport."

9. AS YOU BEGAN THE TAKEOFF ROLL BEFORE THE LANDING THRESHOLD OF THE RUNWAY, DID YOU FEEL COMFORTABLE WITH THE LIGHTING DISPLAY?

__2__ Yes __4__ No

- "From my vantage point, I could only see one edge light prior to the threshold. White arrows would have made it easier to determine use of the pavement as in BGM."
- "Any pilot would feel uncomfortable taking off from a taxiway (blue lights). They are better than red, however. Also, might feel better if I saw white arrow markings also."
- "Red threshold bars okay, but blue is taxiway."

10. DID YOU HAVE ANY TROUBLE IDENTIFYING THE POINT AT WHICH THE TAKEOFF ROLL COULD BEGIN?

__4__ Yes __2__ No

- "Again, white centerline arrow would help. If I didn't understand the declared distance concept, the red may have caused me to second guess myself."

- "I could physically identify the point at which the runway begins (end of blue, start of white lights), but there is still a concern as to whether it's okay to start takeoff roll within that area. Maybe a sign with legend "T/O OK" or so? Definitely need white centerline arrow markings."

- "No white lights, so I shouldn't be able to go. I'm on a taxiway."

- "I'm on blue, can I begin takeoff? I don't want a violation."

- "At the threshold bar I can takeoff, but not before it."

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