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AIRPORT SURFACE TRAFFIC CONTROL VISUAL GROUND AIDS ENGINEERING AND DEVELOPMENT PLAN

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16. Abstract

The plan described in this document supports the overall program at the Transportation Systems Center to define, design, develop, and evaluate systems that meet the requirements of airport surface traffic control. This plan is part of documentation supporting one aspect of the program, visual ground aids development. There are twenty-four concerns with the present visual ground aids. The concerns deal with the ability of the present system and its components to support taxiing operations in the lower visibility environment found during Category III conditions. This report describes an engineering and development plan which will identify solutions for the concerns, create the specifications for improved visual ground aids and lay the ground work for application in future Category III operations. The management of the development process leading to major improvements in the present system is described. The plan includes a schedule, budget, milestones and evaluation criteria.

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PREFACE

The plan described in this report supports the overall program at the Department of Transportation, Transportation Systems Center to define, design, develop and evaluate systems that meet the requirements of airport surface traffic control. This plan is part of the documentation supporting one aspect of the program, visual ground aids development. The Airport Surface Traffic Control (ASTC) Program is sponsored by the Federal Aviation Administration through the Systems Research and Development Service. The program supports government activities designed to promote safe and efficient vehicle movement on the airport surface.

The visual ground aids engineering and development plan was created by the Airport Surface Systems Branch at the center and is a direct result of a 1974 study of the present visual ground aids system. The study was prepared under the sponsorship of the branch by Gates Associates and was guided by an advisory panel chaired by Mr. Gates. The following individuals participated in the panel activities:

E. Abbott	Air Transport Association of America
L. Achitoff	Port Authority of New York and New Jersey
R. Berzolla	Port Authority of New York and New Jersey
P. Bressey*	British Air Line Pilots Association
L. Dibble	FAA Air Traffic Service
C. Douglas	National Bureau of Standards
C. Eck	Air Line Pilots Association
W. Fisher	FAA Systems Research and Development Service
A. Fowler	FAA Airports Service
V. Gallagher	Gates Associates
R. Gerber	Air Line Pilots Association
G. Gibson	FAA Flight Standards Service
M. Huck	Aircraft Owners and Pilots Association
P. Jones	FAA National Aviation Facilities Experimental Center
R. Lambert	Connecticut International Corp.
F. MacKenzie	DOT/Transportation Systems Center
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J. Ruddy	Air Line Pilots Association
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J. Simeroth	FAA Systems Research and Development Service

This plan is to be regarded as a management tool to guide the development of visual ground aids.

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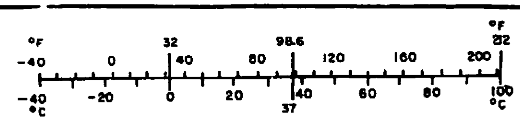
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



1. MANAGEMENT SUMMARY

1.1 PURPOSE

There are twenty-four concerns with the present visual ground aids. The concerns deal with the ability of the present system and its components to support taxiing operations on the airport surface in the lower visibility environment, found during Category III conditions. The concerns were identified by an advisory panel of representatives from all segments of the visual ground aids community. This document describes an engineering and development plan which will identify solutions for the twenty-four concerns, create the specifications for improved visual ground aids and lay the ground work for application in future Category III operations. The document describes the method to manage the development process leading to major improvements in the present system. The plan includes a schedule, budget, milestones and evaluation criteria.

1.2 SCOPE

The duration of the development plan is five years. However, within three years the sixteen highest priority concerns would be resolved. The manning level would be two man-years per year, one from the National Aviation Flight Experimental Center and one from the Transportation Systems Center. The cost to attain the sixteen highest priority objectives would be from $90K-280K per year for three years. To attain all twenty-four objectives in a five year period would require a dollar commitment ranging from $120K-465K per year.

1.3 CONCLUSIONS

By following the engineering and development plan for three years and spending $840K, major improvements can be made in the present visual ground aids system. These improvements will reduce aircraft delay, reduce controller workload, enhance safety and support taxiing operations in a low visibility environment. By following the plan for five years all the concerns with the present system can be resolved.

1.4 RECOMMENDATIONS

The total development plan should be followed. The effort would be managed by the TSC Airport Surface Systems Branch reporting to the sponsor through the Visual Ground Aids Development Government Advisory Group and guided by the ad-hoc panel of Government/ Industry designers and users. The results of working with these groups would be felt in improved planning, minimization of controversy and the generation of broad support for the plan and its products.

The alternative recommendation, if full funding is not available is concentrate the resources on the highest priority items. Within three years and at a cost of $280K per year and first sixteen items could be resolved. The management of the plan, and the guidance procedures would be the same as in the first recommendation (Table 1, Table 2, Table 3).

TABLE 1. PROGRAM EXECUTION IN ORDER OF IMPORTANCE FOR THE HIGHEST PRIORITY GROUP

ITEM	COMMENT
STOP SIGNAL AIRCRAFT POSITIONING SIGNAL	These developments can be achieved at NAFEC with no additional contract dollar costs.
LOW SPEED RUNWAY EXIT SIGNAL	High speed exits are well identified and defined. Low speed exit identification is lacking and can reduce the runway utilization.
SIGN HARDWARE	The present signs are very well designed. However, there are three minor modifications that have the potential for increasing the usefulness.
TAXIWAY GUIDANCE SIGN STANDARDS TAXIWAY REGULATIONS AND PROCEDURES TAXIWAY CHART FORMAT	These areas are constantly being reviewed by responsible authorities. The input from the visual ground aids experts would give the authorities a fresh perspective and eliminate areas of concern to the users.
APRON AREA MARKINGS	Work in this field will result in guidelines for airports which are beginning to have problems in the apron area. It will be anticipation instead of reaction.

TABLE 2. PROGRAM EXECUTION IN ORDER OF IMPORTANCE FOR THE SECOND GROUP OF PRIORITY ITEMS

ITEM	COMMENT
VEHICLE REGULATIONS	In the interest of uniformity and standardization, airports that have solved vehicle problems would be encouraged to share their solutions.
APRON AREA ROUTE LIGHTING	This is the next step to the apron area marking program and expands route identification into the low visibility environment.
LIGHT CONTROL FACSIMILE	This effort has a two-fold benefit; it reduces the ground controllers' workload and saves electrical energy.
TAXI CENTERLINE LIGHT STANDARD	The visual ground aids experts would provide a significant input for the authorities who write the standards. They would supply the user experience that is now lacking.
CODED TAXIWAY CENTERLINE LIGHTS	Information can be conveyed to the pilot by color coding the center-line lights, the usefulness of this technique needs to be evaluated.
TAXIWAY EDGE LIGHT MODIFICATION	This modification is very simple but the benefits to the pilots are very high. The cost is low and should be evaluated.
TAXIWAY MARKER CENTERLINE LIGHT	Ice and snow restrict the usefulness of these guidance elements. The removal or prevention of build-up needs continuing investigations.

TABLE 3. RESOURCE REQUIREMENTS, ACHIEVEMENTS AND BENEFITS OF THE VISUAL AIDS PROGRAM

RESOURCE REQUIREMENTS	
PROGRAM DURATION	3-5 YEARS
TSC STAFFING	1 MAN-YEAR PER YEAR
NAFEC STAFFING	1 MAN-YEAR PER YEAR
CONTRACT DOLLARS	90K-280K PER YEAR
ACHIEVEMENTS	
16 OF THE 24 OBJECTIVES WOULD BE ATTAINED	
BENEFITS	
REDUCTION OF AIRCRAFT DELAYS	
REDUCTION OF CONTROL WORKLOAD	
SAFETY ENHANCEMENTS	

2. INTRODUCTION

This report is a plan to manage the development of visual ground aids. The requirements for the plan are included in reports from a study of the present system sponsored by the Transportation Systems Center in 1974. Visual ground aids are integrated into the airport surface traffic control system and provide information to the pilot that permits him to guide the movement of the aircraft through the taxiway network and to conform to the guidance commands of the ground controller. These aids enhance safety, minimize delay and reduce controller workload. A pilot can follow visual signals off the runway through a clearly identified route with all potential conflicts resolved at intersections and an orderly merging into the gate area.

There are four general categories of visual aids: lights, signs, markings and markers. They provide guidance and control information to the pilot that permit the pilot to proceed through the taxiway system under the overall supervision of the ground controller. The problems with the present system will be critical when the surface traffic levels during poor visibility conditions increase due to forthcoming deployment of additional Category II/III landing systems. The pilots conception of where he thinks he is on the taxiway network and the direction to his destination will be ambiguous. A subset of this problem, because of its potential for the rapidly forming emergency situation, is involved with the crossing of a taxiway and an active runway (see Figure 1).

This report describes an orderly process of developing components and procedures which will support taxiing operations in the low visibility environment.

2.1 BACKGROUND

The Federal Aviation Administration (FAA) is developing the Upgraded Third Generation Air Traffic Control System to meet the requirements of the late 1970's and the 1980's. The control of aircraft and vehicles on the airport surface is an integral and

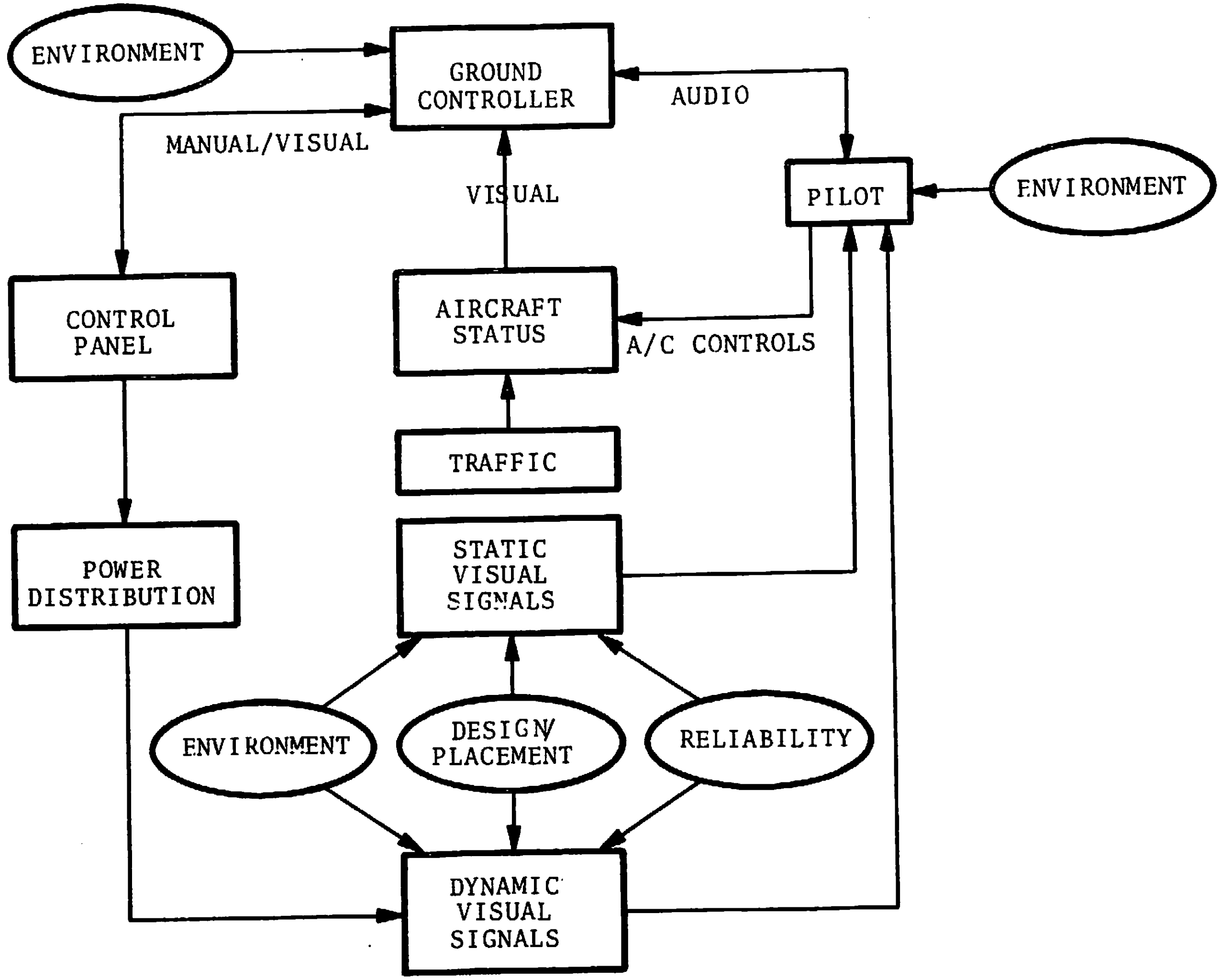


FIGURE 1. INFORMATION FLOW WITHIN A TAXIWAY NETWORK

important part of this system and one of nine major development programs. Therefore, work has been undertaken to improve airport surface traffic control as part of the overall Upgraded Third Generation System development. The mission of the ASTC program is to increase airport capacity to match the forecasted demands while maximizing ground safety and the conservation of energy, and minimizing ground delays, controller and operator stress and workload, and noise and air pollution.

One role of the ASTC program is to provide operators of aircraft and ground vehicles with the information required for navigating on their movement areas during all the weather conditions in which they are authorized to operate. This includes the capability to locate and proceed to a site anywhere on the airport.

Another role of the program is to provide the ATC personnel with information concerning the position and identification of all aircraft and ground vehicles operating within the movement area and their relationships to each other as well as to runways, taxiways, intersections and fixed objects.

The mission is to be accomplished by managing the work in the area below.

a) Airport Surface Detection Equipment, ASDE-2 - Electronic improvements for the present surveillance system to increase performance and reliability. This area includes the development of a new ASDE BRITE display.

b) Visual Ground Aids, VGA - Existing visual aid components, and supplementary visual aids developments, combined with improved pilot/controller procedures to move aircraft on the airport surface in Category IIIa weather conditions, safely and reliably.

c) Airport Surface Detection Equipment, ASDE-3 - A new surveillance radar for presently unequipped airports also as a replacement for the ASDE-2 when it reaches obsolescence.

d) Tower Automated Ground Surveillance, TAGS System - A surveillance capability significantly better than that provided by ASDE-2 or ASDE-3 for use at major airports. Position and identification of all aircraft will be made available through a digitized display for local and ground control operations.

e) Automatic Intersection Controller, AIC System - An automatic stop-go signal control of traffic at critical route intersections at major airports.

In December 1973 the ASTC program office (now included in the Airport Surface Systems Branch) developed a program in visual ground aids. The program used an Advisory Panel, an improvement analysis, surveys and interviews. The Advisory Panel provided a base of knowledge of the existing system and its limitations. The improvement analysis was an economic trade-off of the cost of a system against the potential savings from reduced taxiing times. The surveys and interviews collected opinions and facts from users specifiers and manufacturers of visual ground aids.

In October 1974 a study was performed in support of this visual ground aids programs, guided by the Advisory Panel. As a result of this study twenty-four concerns with the existing system were identified (see Figure 2).

This document describes a method to manage the response to these concerns in an orderly efficient manner. This method and the assistance of the advisors for guidance and has the benefit of quick assimilation of the solutions into the system.

2.2 DEFINITION

The Airport Surface Traffic Control (ASTC) System is the system (people, procedures and equipment) concerned with the movement of:

a) arriving aircraft through the phases of final approach, landing, and taxiing to the terminal;

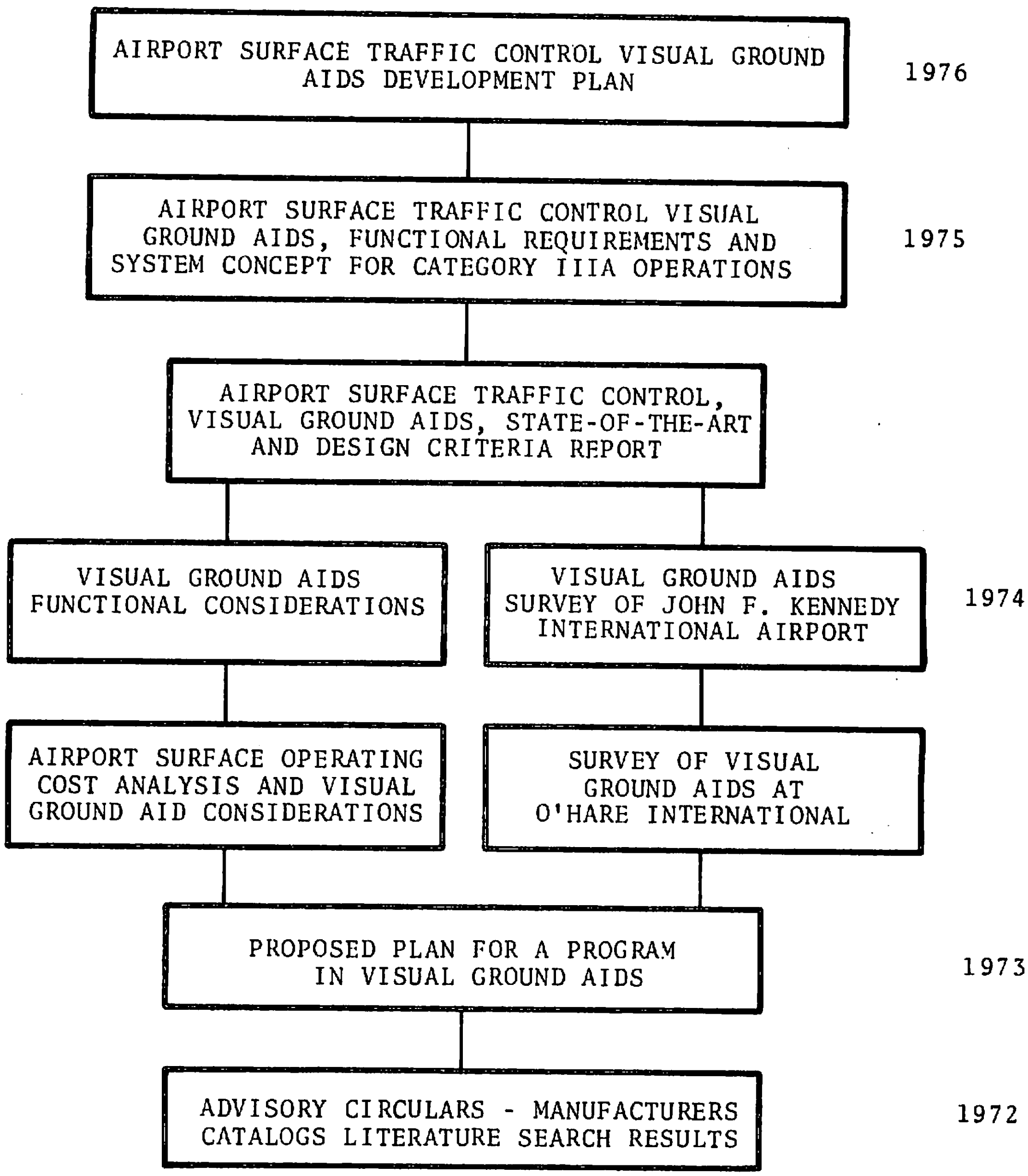


FIGURE 2. VISUAL GROUND AIDS BACKGROUND DOCUMENTATION DEVELOPMENT

b) departing aircraft through the phases of pushback from the terminal*, taxiing to the departure runway, takeoff, and initial climb;

c) aircraft in transit between sites at the airport, such as from passenger terminal to maintenance area; and

d) service or emergency vehicles, such as snow plows or fire engines.

The ASTC System consists of four functional elements: control, surveillance, communication, and guidance (see Figure 3).

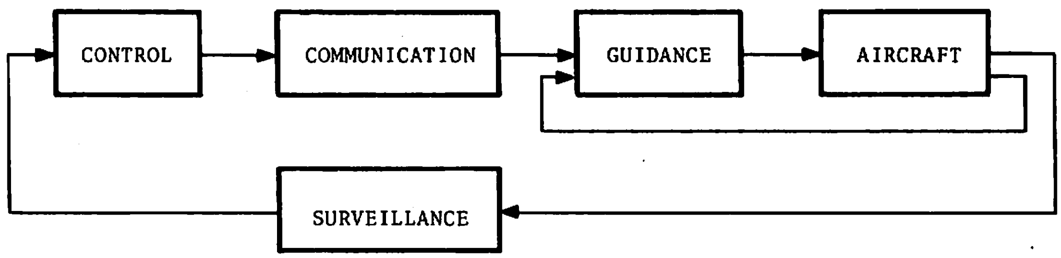


FIGURE 3. ASTC SYSTEM ELEMENTS

Control element activities include determining taxiway routing patterns, resolving potential conflicts at taxiway and/or runway intersections, and controlling landings and takeoffs. At airports with control towers, the tasks are performed by: (1) Ground Control, (2) Local Control, and (3) Flight Data and Clearance Delivery.

Ground and Local Control each may have several voice communication links to aircraft and surface vehicles, with each link manned by a primary controller and an assistant controller if required. Generally, Local Control is responsible for traffic using active runways, Ground Control for traffic using taxiways and occasionally the ramps on an advisory basis. Clearance Delivery provides (or confirms) the clearance instructions for departing aircraft and thus interfaces with the Air Traffic Control enroute flight-scheduling and control system. At certain airports a Flight Data position is staffed to assist Clearance Delivery in retrieving and posting flight strips received from the Air Route Traffic Control Center (ARTCC) via the Flight Data Entry Printer.

*The ASTC System participates in the ramp area in an advisory basis only.

Surveillance is the process whereby Ground and Local Control acquire information on the position and identity of vehicles under their jurisdiction. The Ground Controller uses visual observation, as the primary means of surveillance. The Local Controller uses visual observation and the Airport Surveillance Radar (ASR) as the primary surveillance media. The ASR provides the Local Controller with a radar-derived display of the positions and identities of airborne aircraft in the vicinity of the airport, and thus is of use to him in the control of aircraft on final approach or initial climb. Airport Surface Detection Equipment (ASDE-2), a high resolution, ground-mapping radar is available at 12 U.S. airports. The ASDE-2 provides a display of airport surface traffic activity for use during conditions of reduced visibility due to weather or darkness.

The communication element provides the means for messages between controllers and pilots in support of the Ground and Local Control functions.

Guidance of individual aircraft is exercised by each pilot who carries out the tasks of controlling aircraft velocity, following route centerlines, avoiding other vehicles, maintaining headway and negotiating turns. Runway and taxiway lights, signs, markers and markings aid the pilot to locate his position and the route to his destination.

2.3 ROLE AND MISSION

The visual ground aids support the airport surface traffic control system. The function of the aids is to provide pilots and vehicle operators with unambiguous position identification information anywhere on the ramp, taxiway and runway network and the route to follow to his destination as authorized by the airport traffic controllers, in all visibility conditions in which the vehicles are allowed to operate.

The task of a visual ground aids system is the identification of all areas within the network and the definition of clearance limits, holding points, load bearing surfaces and docking and parking spots.

2.4 FORECAST

The air traffic control system is in need of improved airport surface traffic control systems. This need will reach the critical stage by about 1980 when the surface traffic levels during poor visibility conditions will be significantly higher than today due to the forthcoming deployment of additional Category II/III landing systems.

Category IIIa operations are authorized by the FAA, and landings are permitted with a runway visual range (RVR) not less than a value of 700 feet. There is no criteria specified for taxiing in the Category IIIa weather. Pilots have experienced difficulty in operating on the surface along the taxiways and within the apron area because the ability to see a taxiway light is about one-half the ability of seeing a runway light using the best available in-pavement fixtures. These fixtures are not normally installed within the apron areas.

The Ground Controller task is relatively varied, complex and involves considerable switching among activities. Although equally necessary to the job, however, all tasks may not be equally "demanding", the various tasks do not impose equivalent workloads on the controller.

The most demanding ground control activities are:

		Demandingness Rank
a)	Relay, Initiate or Coordinate Advisories and Information to other than aircraft	1
b)	Issue Taxi Clearances - Aircraft and Vehicles	2
c)	Read and Interpret Console Instruments	3
d)	Guard Assigned Radio Frequencies	4
e)	Operate Radio Equipment	5

In good visibility and with a low number of operations the least demanding tasks are those dealing with aircraft traffic. As the number of operations increase and as the visibility decreases the least demanding tasks become more stringent. Without a well designed visual aids system the ground controller requires constant communication to the taxiing aircraft to establish its position on the surface.

In the 1980's surface traffic control improvements will be needed to provide for:

a) Increasing flight operations and/or a larger percentage of wide-body jet aircraft.

b) Increased peak-hour aircraft landing rates at major airports due to the forthcoming installation of wake-vortex detection and avoidance systems and also because of the planned new automated metering and spacing techniques.

c) Increased airport surface traffic flow rates under poor visibility conditions, which will be an outgrowth of the forthcoming installation of Category II and III landing systems at many airports.

3. DEVELOPMENT PROCESS

The twenty-four concerns with the present visual ground aids have been separated into three groups: (1) Those which require prompt action in order for the visual ground aids to fulfill its role and accomplish its mission, (2) those which require action soon for improved performance of the system and (3) those which are highly desired for improved performance, but which could be postponed if the resources were not available. Each concern was recast in the format of an objective to be accomplished. Each objective was defined in terms of time ranges and contract dollars to attain the expected results. In all cases a technical approach to the effort was determined. The above steps clarified the scope of the effort in each objective.

The end item for each objective will be recommendations for new or modified advisory circulars, revisions to the Federal Aviation Regulations or new or modified operating procedures. To arrive at this step will require a rigid development process to keep the activities focused on the requirements. The mechanism for this focusing will be a review and evaluation procedure using the advisory panel. The management for the program will find in the development plan a schedule, staging plan, budget and evaluation criteria.

3.1 OBJECTIVES

The eight tasks or objectives which are most important and require prompt action in order for the visual ground aids program to accomplish its assigned role and missions are:

a) To develop stop signals to provide a fail safe method for stopping aircraft along the taxiway route in all conditions of visibility in which the system is intended to be used, taking into account snow and ice accumulations that may occur during the operations. This task would not require contractor support and the objective would be attained within three years.

b) To provide a signal for use by pilots in positioning aircraft as necessary at Stop and Hold points along the taxiway route, to permit other aircraft safe clearance for passing along other nearby taxiways. The signal to be developed may also serve to signal pilots that their aircraft is clear of the active runway, following their exit from the runway. This task would not require contractor support and the objective would be attained within three years.

c) To develop a means of identifying, locating and using low speed runway exits for all airports under all weather conditions. This task would require contract support ranging from 100K to 500K and could be completed within three years.

d) To modernize the existing taxiway guidance sign system standard, in the areas of message format and placement criteria. This objective could be attained in a year at a cost of 10K to 100K.

e) To develop sign structures having two types of frangible mountings, one for use within obstacle-free areas. To develop a sign surface that prevents the accumulation of wet snow and to develop a means of distinguishing between signs that identify taxiway intersections and runway exits, both of which are presently marked with a sign with black legends on yellow backgrounds. These objectives could be attained within a three-year period with 100K of contract support.

f) To propose to the appropriate FAA offices adoption of an improved format for airport taxiway charts.

g) To review with the cognizant FAA regulatory groups the regulations and procedures to implement proper use of modernized equipment provided in the ASTC system.

h) To develop for less than 10K in contracts within a one year period standards for markings in apron areas to provide guidance for aircraft pilots and vehicle operations.

The above eight tasks can be completed in a three-year time period. The budget requirement for contract support ranges from 40K per year to 140K. The first two tasks have been included in the Automatic Intersection Controller Test Bed installed at NAFEC and will be evaluated in the field test program. No additional contract support is required for these two items.

There are eight additional tasks which require action soon and will improve the performance of the visual ground aids system. These tasks are:

a) To develop advisory material concerning traffic rules, regulations, etc., to serve as a model for vehicle traffic (non-aircraft) at airports. This task can be completed in a year with less than 10K in contract support.

b) To provide effective route guidance (inset pavement lighting) within apron areas, especially in Category III weather conditions. Contract support for this task is estimated at less than 100K and it would require three years to attain the objective.

c) To develop a lighting facsimile for AT control towers with means of operating only those circuits required for the operations involved, thus saving power and lamp life, and reducing the pilot workload involved when he views visual aids that are displayed but not needed for his aircraft ground movements. This task would be completed within three years with a funding level between 10K and 100K.

d) To review the existing taxiway centerline light standard with the aim of suggesting modifications that will provide improvements to the surface traffic control and guidance system. This task will require a three-year time period and contract support ranging from 10K to 100K.

e) To evaluate the feasibility of informing pilots that a curve is being approached using centerline lights and ascertaining if there is a low visibility problem or a combination of low visibility/aircraft configuration problem with respect to maneuvering an aircraft through intersections where the centerline lights intersect at right angles and do not provide a nose wheel tracking capability. This task would require three years to complete and contract support ranging from 10K to 100K.

f) To demonstrate the feasibility of replacing the standard L-822 Taxiway Edge Light lens with L-802 and L-819 lens where snow removal is a major problem and thus more reliance upon edge light guidance is necessary. This task would be complete in one year at a cost of less than 10K.

g) To develop a means to prevent wet snow accumulation on the surface of retroreflective markers. This objective would be attained in one year at a cost of less than 10K.

h) To develop a means of minimizing the occurrence of snow and ice build-up ahead of centerline light fixture apertures that block light output. This task represents a problem that has been investigated several times and it will require from three to five years to solve with contract support ranging from 100K to 500K.

The eight additional objectives which are highly desired for improved performance, but which could be postponed if the resources were not available are:

1) To develop low-cost centerline lighting for application at utility airports within a year after the start of a program with a contract cost not to exceed 100K.

2) To develop a balanced apron lighting/docking signal system which optimizes aircraft service lighting levels and enhances the use of the docking signals by pilots, within a five year period within contract costs not be exceed 500K.

3) To develop a standard, visual parking aid system for use in international operations within a three-year time period with contract costs between 10K and 100K.

4) To develop, within three to five years, a standard visual docking aid system for use in international operations with a contract cost not to exceed 500K.

5) To develop a means of identifying routes to service areas for transient pilots within a five-year time period with contract costs not be exceed 100K.

6) To develop an improved gate identification sign within one year within a contract cost level not to exceed 100K.

7) To develop standards within a year for providing taxiway centerline guidance within holding bays with a contract cost not to exceed 10K.

8) To provide a means of identifying routes gate positions, and concourse locations where elevated signs cannot be employed within a three- to five-year time period with a contract cost level not to exceed 500K.

3.2 PROGRAM

The program to develop the visual ground aids system has three elements which operate concurrently. The first is the AIC System Field Test Program which is designed for the testing and evaluation of visual ground aids at NAFEC. These include stop signals, aircraft positioning signals and signs.

The second element will be a working group of government/industry engineers and pilots, and air traffic controllers who will draft a sign system standard, a taxiway light system standard and a vehicle control system standard.

The third element will be an advisory group of government workers from:

Air Traffic Service, AAT
Airports Service, AAS
Flight Standards Service, AFS
System Research and Development Service, SRDS
National Aviation Facilities Experimental Center, NAFEC
Transportation Systems Center, TSC

This element will be responsible for contractor selection, progress reviews, program guidance and adoption and implementation of the outcome of the plan within their organizations.

TABLE 4. SUMMARY OF VISUAL GROUND AID OBJECTIVES

	PROMPT DEVELOPMENT IS REQUIRED
1	STOP SIGNAL DEVELOPMENT
2	AIRCRAFT POSITIONING SIGNAL DEVELOPMENT
3	LOW SPEED RUNWAY EXIT INDICATORS DEVELOPMENT
4	TAXIWAY GUIDANCE SIGN STANDARD MODERNIZATION
5	SIGN HARDWARE DEVELOPMENT
6	TAXIWAY CHART FORMAT REVIEW
7	TAXIWAY REGULATIONS AND PROCEDURE REVIEW
8	APRON AREA MARKING DEVELOPMENT
	DEVELOPMENT IS REQUIRED SOON
1	VEHICLE REGULATION DEVELOPMENT
2	APRON AREA ROUTE LIGHTING DEVELOPMENT
3	LIGHT CONTROL FACSIMILE DEVELOPMENT
4	TAXIWAY CENTERLINE LIGHT STANDARD MODIFICATION
5	CODED TAXIWAY CENTERLINE LIGHT EVALUATION
6	TAXIWAY EDGE LIGHT MODIFICATION
7	TAXIWAY MARKER MODIFICATION
8	CENTERLINE LIGHT ICE REMOVAL DEVELOPMENT
	DEVELOPMENT IS HIGHLY DESIRED
1	UTILITY AIRPORT CENTERLINE LIGHT DEVELOPMENT
2	APRON LIGHTING/DOCKING SIGNAL SYSTEM DEVELOPMENT
3	PARKING SYSTEM DEVELOPMENT
4	DOCKING SYSTEM DEVELOPMENT
5	ROUTE IDENTIFICATION DEVELOPMENT
6	GATE IDENTIFICATION DEVELOPMENT
7	HOLDING BAY GUIDANCE SYSTEM DEVELOPMENT
8	ROUTE/GATE IDENTIFICATION SYSTEM DEVELOPMENT

The Transportation Systems Center will form the three groups using the visual ground aid experts who assisted in the previous studies. The Field Test Management Team will include two members from NAFEC and two from TSC. The team is responsible for field test planning, test conducting and reporting the results. Hardware components will be delivered to this group and evaluated. The test results will be the basis for creating hardware specifications and recommendations.

The second group will be divided into three subgroups to review problems in the general areas of signing, taxiway lighting and vehicle control. The output will be documents which are drafts of advisory circulars or recommended practices. In addition these groups may recommend hardware development for test to correct inadequencies in the present system. To create the basis for making a recommendation the following five activities must take place:

a) making a precise statement of the problem;

b) collecting and organizing supporting facts;

c) developing and selecting solutions to the problem;

d) testing and evaluating the chosen solution;

e) reviewing the results with the Government Advisory Group.

The first three activities have been worked on in preparation for this development plan. In some areas a more precise problem definition is required and in others solutions need to be selected. All the proposed solutions involving hardware will require test and evaluation at NAFEC and in some cases additional testing at busy airports. The fifth activity is critical to the success of having a recommendation or a specification implemented by the responsible FAA office.

The third group of government employees will review the existing regulations and procedures and issue recommendations resulting from following the above five activities. The group will also assist in the selection of contractual support for all of the objectives, review the contractors efforts and support the program management with recommendations. All hardware which results from the contractual support will be tested and evaluated by the field test team (see Table 5, Figure 4, Figure 5, Figure 6 and Figure 7).

All documented recommendations and specifications resulting from the above three elements will be reviewed by the group. Achieving a censensus is a prerequisite for any recommendation to an FAA office for a change.

3.3 SCHEDULE

The schedule to obtain the first sixteen objectives requires a three-year time period, an additional two years and the required resources will permit completing all the objectives. Within the first calendar year the coordinating steps will be taken. Within the second year the AIC field testing and the studies for the exit markings, signs and apron objectives will be completed. The various hardware specifications will be delivered during the final time period.

Each objective was reviewed by the visual group aid advisors with regard to their best estimate of the time period required to solve the problems. The choice of time periods was restricted to less than one year, from one to three years, three to five years and greater than five years. The purpose of the estimation was to insure that all the participants were viewing the objectives from the same point of view. The results of the estimating process is included in the statement of the objectives. The schedule incorporates the estimate for the first sixteen tasks and staggers the starts to spread the workload evenly throughout the three-year period.

A staging plan as well as a schedule has been developed to illustrate the loading requirements for manpower to support the schedule. Staff and contractual support are required for the entire time period. The panel of experts and the Government Advisory Group meet periodically to review the progress of the

TABLE 5. GOVERNMENT/INDUSTRY REVIEW GROUPS

DOT/TRANSPORTATION SYSTEMS CENTER AIRPORT SURFACE TRAFFIC CONTROL
FORMS: AD-HOC PANEL OF EXPERTS, VGA Evaluates Progress Towards the Program's Objectives Estimates Costs and Time Addresses Specific Problem Areas as Working Groups
FORMS: VGA DEVELOPMENT GOVERNMENT ADVISORY GROUP Reviews Proposals and Selects Contractors Reviews Technical Progress and Recommends a Course of Action Implements the Outcome of the Program within the Government
FORMS: FIELD TEST MANAGEMENT TEAM Manages the VGA Test Bed at NAFEC Formulates Test Plans and Evaluates Test Results

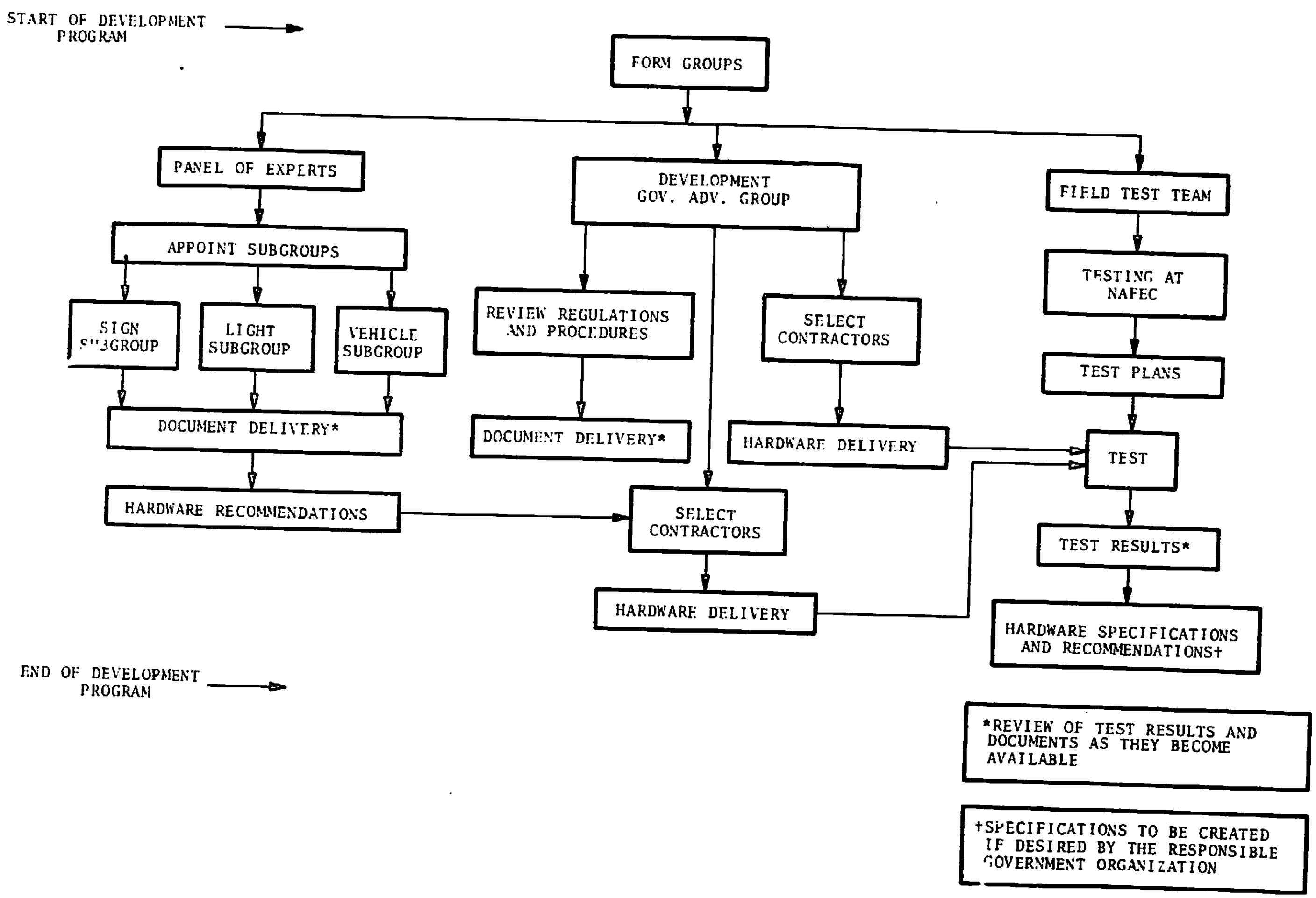


FIGURE 4. VISUAL GROUND AIDS DEVELOPMENT CONTINGENCY PLAN

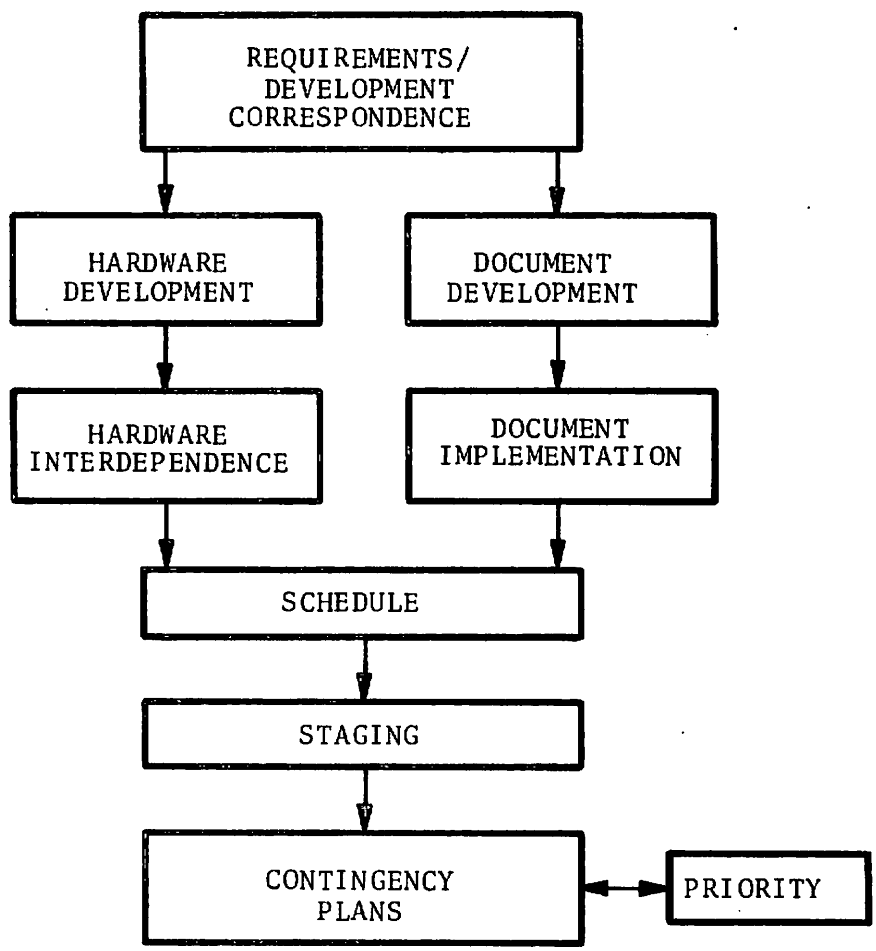


FIGURE 5. VISUAL GROUND AIDS DEVELOPMENT METHODOLOGY

AIRPORT SURFACE TRAFFIC CONTROL,
VISUAL GROUND AIDS,
STATE-OF-THE-ART AND
DESIGN CRITERIA
REPT # CR-DOT-TSC-918-1

	1.1 PURPOSE	1.2 BACKGROUND	1.2.1 Domestic Aspects	1.2.2 International Aspects	2.1 FUNCTIONAL REQUIREMENTS	2.1.1 General	2.1.2 Route Delineation	2.1.3 Route Identification	2.1.4 Airport Traffic Control	2.2 SYSTEM INTEGRATION	2.2.1 Runway Environment	2.2.2 Apron Environment	2.2.3 Airport Traffic Control Environment	2.2.4 Power and Control Environment
STOP SIGNAL													●	
A/C POSITIONING SIGNAL													●	
LOW SPEED R/W EXIT SIGNAL											●			●
SIGN HARDWARE														
T/W GUIDANCE SIGN STAND.								●						
T/W REGS AND PROC.									●					
T/W CHART FORMAT														
APRON AREA MARKINGS												●		
VEHICLE REGULATIONS														
APRON AREA RTE LIGHTING							●				●			
LIGHT CONTROL FACSIMILE														
T/W CENTERLINE LIGHT STAND.							●				●		●	
CODED T/W CENTERLINE LIGHT							●							
T/W EDGE LIGHT MOD.														
TAXIWAY MARKER														
CENTERLINE LIGHT														

	2.3 HUMAN ENGINEERING	2.3.1 The Pilot	2.3.2 The Controller	2.3.3 The Maintenance Personnel	2.4 SYSTEM ADEQUACY	2.4.1 Route Delineation	2.4.2 Route Identification	2.4.3 Airport Traffic Control	2.4.4 Runway Environment	2.4.5 Apron Environment	2.4.6 Airport Traffic Control Environment	2.4.7 Human Engineering	3.1 SIGNAL LIGHTING	3.1.1 Runway Exit Lights	3.1.2 Taxiway Edge Lights	3.1.3 Taxiway Centerline Lights	3.1.4 Stop Bar and Hold Signals	3.1.5 Wig-Wag Lights	3.2 RETROFLECTIVE AND SELF LUMINOUS MARKERS	3.2.1 Centerline Retroreflectors	3.2.2 Edge Markers
STOP SIGNAL				●							●	●					●	●			
A/C POSITIONING SIGNAL											●										
LOW SPEED R/W EXIT SIGNAL														●							
SIGN HARDWARE																					
T/W GUIDANCE SIGN STAND.		●					●					●									
T/W REGS AND PROC.								●													
T/W CHART FORMAT		●	●									●									
APRON AREA MARKINGS										●											
VEHICLE REGULATIONS																					
APRON AREA RTE LIGHTING										●											
LIGHT CONTROL FACSIMILE			●									●									
T/W CENTERLINE LIGHT STAND.						●			●		●										
CODED T/W CENTERLINE LIGHT																					
T/W EDGE LIGHT MOD.															●						
TAXIWAY MARKER																					
CENTERLINE LIGHT				●								●									

	3.3 TAXI GUIDANCE SIGNS	3.3.1 Internally-Lighted Signs	3.3.2 Externally-Illuminated Signs	3.3.3 Unlighted Retroreflective Signs	3.3.4 Other Types of Signs	3.3.5 Sign Design Criteria	3.4 PAINTED MARKERS	3.4.1 Taxiway Markings	3.5 DOCKING AND PARKING AIDS	3.5.1 Docking Aids	3.5.2 Parking Aids	3.5.3 Apron Illumination	3.6 COMPONENT ADEQUACY	3.6.1 Signal Lighting	3.6.2 Retroreflective Markers	3.6.3 Signs	3.6.4 Docking and Parking Aids	4.1 THE PROBLEM	4.2 THE VEHICLE OPERATOR	4.3 VEHICULAR ROUTE DELINEATION	4.4 VEHICULAR OPERATION AND CONTROL ADEQUACY	5. STATE-OF-THE-ART SUMMARY	6. RECOMMENDED PRACTICES
STOP SIGNAL														●								●	
A/C POSITIONING SIGNAL																							
LOW SPEED R/W EXIT SIGNAL														●									
SIGN HARDWARE	●															●						●	
T/W GUIDANCE SIGN STAND.	●															●						●	
T/W REGS AND PROC.																							
T/W CHART FORMAT																							
APRON AREA MARKINGS							●													●	●		
VEHICLE REGULATIONS																		●	●	●	●		
APRON AREA RTE LIGHTING																						●	
LIGHT CONTROL FACSIMILE																							
T/W CENTERLINE LIGHT STAND.																							
CODED T/W CENTERLINE LIGHT																							
T/W EDGE LIGHT MOD.																							
TAXIWAY MARKER															●								
CENTERLINE LIGHT																							

FIGURE 6. REQUIREMENTS/DEVELOPMENT CORRESPONDENCE (STATE-OF-THE-ART)

AIRPORT SURFACE TRAFFIC CONTROL
VISUAL GROUND AIDS -
FUNCTIONAL REQUIREMENTS
AND SYSTEM CONCEPT FOR
CATEGORY IIIA OPERATIONS
REPT. # CR-DOT-TSC-918-2

	1. INTRODUCTION	1.1 PURPOSE	1.2 BACKGROUND	2. FUNCTIONAL REQUIREMENTS	2.1 EXITING THE RUNWAY	2.1.1 Pilot Requirements	2.1.2 Controller Requirements	2.2 BETWEEN RUNWAY AND APRON	2.2.1 Pilot Requirements	2.2.2 Controller Requirements	2.3 WITHIN THE APRON	2.3.1 Pilot Requirements	2.3.2 Ramp Controller Requirements	2.4 WITHIN THE HOLDING BAY	2.4.1 Pilot Requirements	2.4.2 Controller Requirements	2.5 ENTERING THE RUNWAY	2.5.1 Pilot Requirements	2.5.2 Controller Requirements	2.6 GENERAL REQUIREMENTS	2.6.1 Pilot Requirements	2.6.2 Controller Requirements
STOP SIGNAL									●			●										
A/C POSITIONING SIGNAL						●	●		●			●										
LOW SPEED R/W EXIT SIGNAL					●	●																
SIGN HARDWARE																						
T/W GUIDANCE SIGN STAND.									●	●		●	●									
T/W REGS. AND PROC.																						
T/W CHART FORMAT																						
APRON AREA MARKINGS												●										
VEHICLE REGULATIONS																						
APRON AREA RTE LIGHTING												●										
LIGHT CONTROL FACSIMILE																						●
T/W CENTERLINE LIGHT STAND.																						
CODED T/W CENTERLINE LIGHT									●													
T/W EDGE LIGHT MOD.																						
TAXIWAY MARKER																						
CENTER LINE LIGHT																						

	3. SYSTEM CONCEPT	3.1 GENERAL	3.2 EXITING THE RUNWAY	3.2.1 Exit Configuration	3.2.2 Exit Identification and Runway Clearance Point	3.3 BETWEEN RUNWAY AND APRON	3.3.1 Route Delineation and Identification	3.3.2 Runway Crossings	3.3.3 Taxiway Intersections	3.3.4 Runway Entrance Clearance Limit	3.4 WITHIN THE APRON	3.4.1 Apron Entrance Identification	3.4.2 Route Delineation and Identification	3.4.3 Docking Signals	3.4.4 Parking Guidance	3.4.5 Apron Illumination	3.5 WITHIN THE HOLDING BAY	3.6 ENTERING THE RUNWAY	4. RESEARCH AND DEVELOPMENT RECOMMENDATIONS	4.1 PILOT AIDS	4.1.1 Exiting the Runway	4.1.2 Between Runway and Apron	4.1.3 Within the Apron	4.1.4 Within the Holding Bay	4.2 CONTROLLER AIDS	5. VEHICULAR CONTROL
STOP SIGNAL								●		●												●			●	
A/C POSITIONING SIGNAL					●			●		●			●								●	●				
LOW SPEED R/W EXIT SIGNAL				●																	●					
SIGN HARDWARE																										
T/W GUIDANCE SIGN STAND.							●					●	●									●	●		●	
T/W REGS. AND PROC.																									●	
T/W CHART FORMAT																						●			●	
APRON AREA MARKINGS													●													●
VEHICLE REGULATIONS																										
APRON AREA RTE LIGHTING													●										●			
LIGHT CONTROL FACSIMILE																									●	
T/W CENTERLINE LIGHT STAND.																										
CODED T/W CENTERLINE LIGHT							●															●				
T/W EDGE LIGHT MOD.																										
TAXIWAY MARKER																										
CENTER LINE LIGHT																										

FIGURE 7. REQUIREMENTS/DEVELOPMENT CORRESPONDENCE (CATEGORY III)

program. During the first two years the test team will evaluate hardware configurations and document the results. The sub-group on signs and the subgroup on lights do not overlap because some individuals will serve on both groups (see Figures 8 and 9).

3.4 BUDGET

The range of contract costs to obtain the first eight objectives will be 40K-140K per year for three years. To complete the first and second eight objectives will require a range of costs from 90K-280K per year for three years. To accomplish all twenty-four objectives within a five year period will require an annual average expenditure ranging from 120K to 465K in contract dollars.

Each task was reviewed by the visual ground aid advisory panel to determine the contract support level to attain each objective. The selection of ranges to choose from were from 0 to 10K, 10K to 100K or from 100K to 500K. The cost estimating by the group served to scope the effort required to solve the problems with the existing system and as such represents the best guess at the upper and lower limits of cost. The per year costs are the minimum costs divided by the three-year period, and the average costs divided by the same period. The more difficult tasks require the longer time periods and higher costs. Therefore, the per year budget is a true indication of the funding requirement. The manpower resource requirements are 2 man-years per year, one from TSC and one at NAFEC supplemented by the NAFEC field test team and the FAA advisory groups.

3.5 REVIEW

The Transportation Systems Center will conduct progress reviews as a means of focusing the program on the specific objectives. The basis for the ground aids program is in the documentation developed since 1972. Particularly the requirements are referenced in the Design Criteria Report and System Concept Report (see Figure 2). The reviews will compare the intended effort against the requirements and recommend either hardware development or a document

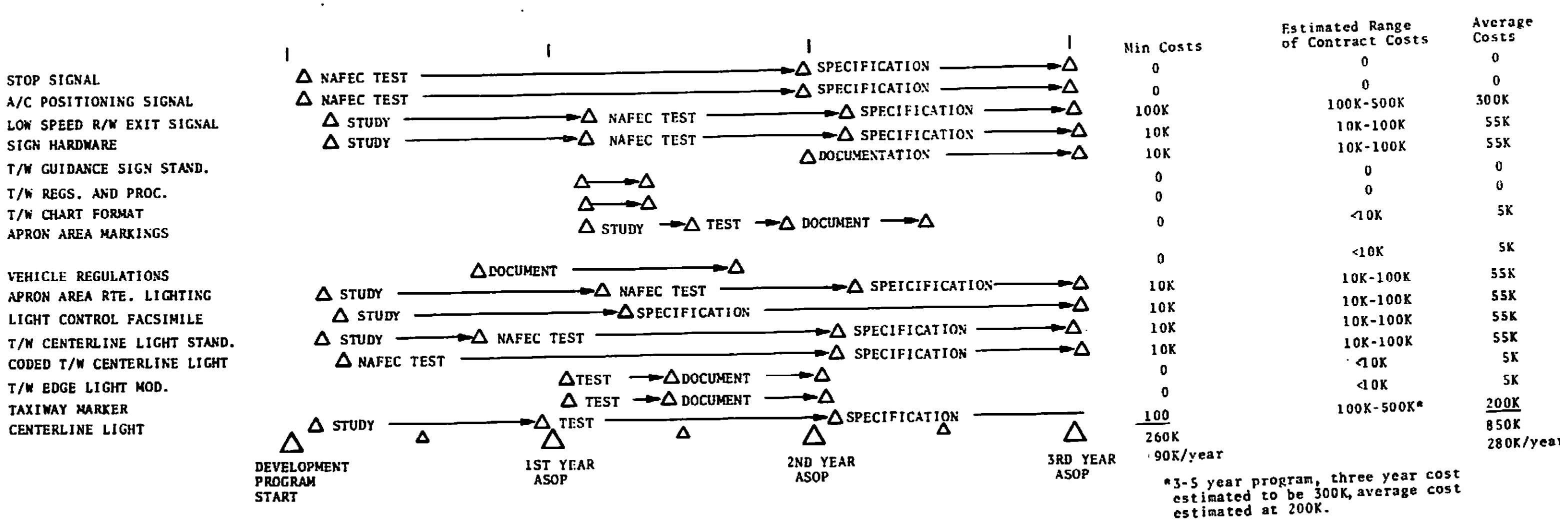


FIGURE 8. VISUAL GROUND AIDS DEVELOPMENT SCHEDULE

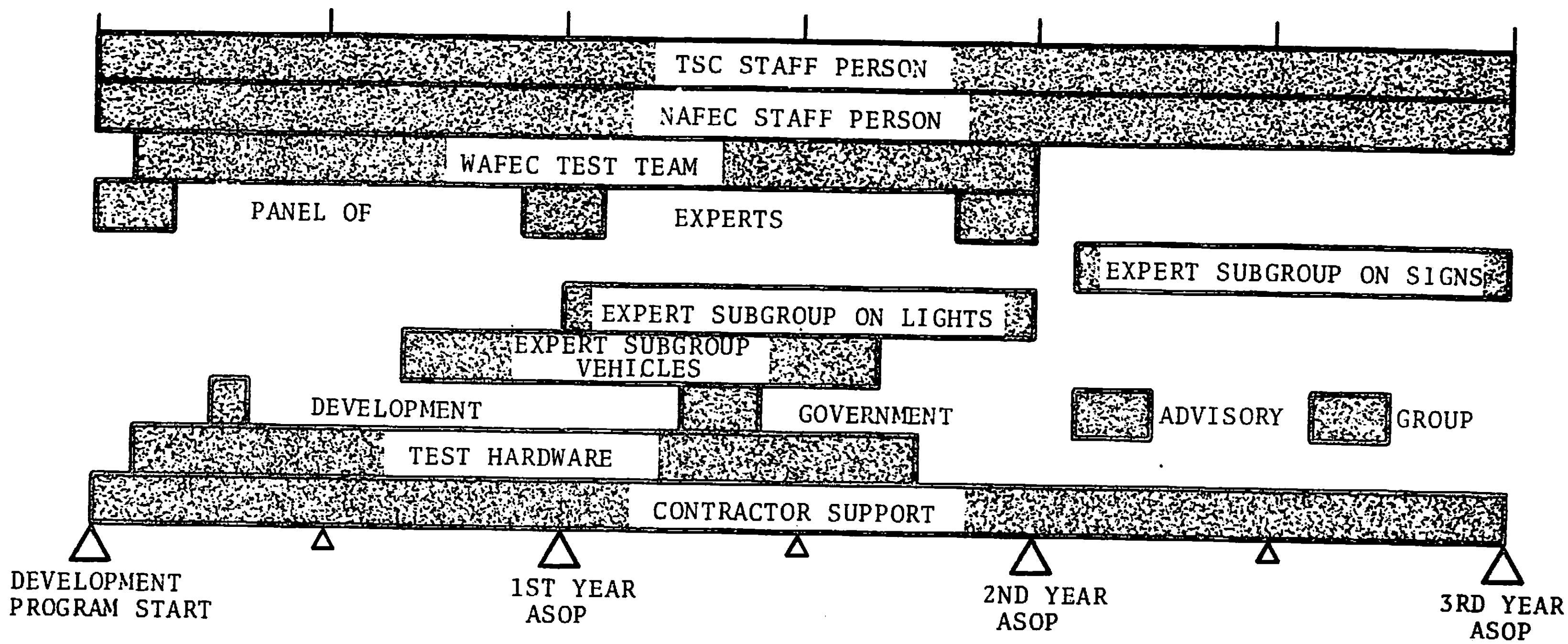


FIGURE 9. VISUAL GROUND AIDS DEVELOPMENT STAGING PLAN

to be drafted. A second type of review will study the results of the hardware development to ensure that the components are compatible with the system. The same review will recommend the means of implementing the draft documentation. The third type of review is the traditional management function of meeting schedules, setting priorities and allocating resources (see Figure 4). The first and second reviews will be conducted by the panel or the test management team for the Government Advisory Group. The recommendations from this review to the program management will be the basis for decisions. The third type of review will be conducted in accordance with standard review procedures established at TSC and by the sponsors (see Table 5).

3.6 STANDARDS

The present visual ground aids system is composed of components, procedures and people. In general, the configuration of components is standardized and controlled through the issuance of Advisory Circulars by the Federal Aviation Administration. The Federal Aviation Regulations and the Air Traffic Service Handbook in a similar way standardize the procedures for the guidance of vehicles using visual aids. Controllers, pilots and vehicle operators are certified by the authorities that they are able to meet or exceed certain levels of performance in their professions and this is also a form of standardization.

The visual aids development plan deals with components and procedures. The standards to be used as a gauge of effective performance in achieving the objectives are the number of recommendations for new or modified advisory circulars and changes to the regulations. These recommendations will be made to the cognizant FAA office.

For the sixteen objectives there will be a minimum of:

- Twelve recommendations for either new or modified advisory circulars;
- One recommendation for a revision to the Federal Aviation Regulations;

- Three recommendations for new or modified procedures.

To support the above, the following items are required:

- Sixteen problem definitions;
- Eleven field tests;
- Nine hardware specifications.

The standard will be the number of changes made to the existing system as a result of the study, testing, document and hardware development in the ground aids program.

3.7 PERFORMANCE

Since the standard of success is the number of changes to the existing system, and the control mechanism for assuring that the recommendations for change are of highest quality is the review process and the consensus of the group. The measure of effective performance is the number of items reviewed and accepted.

A second measure of effective performance is the number of documents circulated to each member prior to a review and discussion of the contents. Draft material will maximize the effectiveness of the Advisory Group. The third measure of effective performance is the timely distribution of the material. Each drafted document must be distributed according to the schedule. For example, each of the sixteen objectives of the development program will have a precise problem definition statement. A draft of each statement will be circulated to the panel members. As seen on the schedule the stop signal, aircraft positioning signal and centerline lights efforts start as soon as the program starts, therefore, these three problem statements have to be approved before other statements are created. Each draft must be distributed according to the schedule, so both the number and the timing of distribution is a measure of performance. In summary the following items will be measured:

Number of approved problem statements;

- Number of solutions and drafted/approved field test plans;
- Number of drafted/approved hardware specifications;
- Number of drafted/approved recommendations for either new or modified advisory circulars;
- Number of milestones achieved as required by the schedule.

3.8 CORRECTIVE ACTION

Using the above control techniques, review standards and measurements, corrective action will be initiated by the responsible individual from TSC. He will be the chairman of each review group. He will be responsible for the deliverables, schedule, budget evaluation and planning. Guided by the three advisory groups, he will direct any required corrective action to achieve the objectives.

4. REFERENCES

The documents which describe the requirements for Airport Surface Traffic Control are:

Engineering and Development Program Plan - Airport Surface Traffic Control, Federal Aviation Administration, Washington DC, Report No. FAA-ED-08-1, July, 1973.

An Overview of Airport Surface Traffic Control Present and Future, Federal Aviation Administration, Washington DC, Report No. FAA-RD-75-144, September, 1975.

Airport Surface Traffic Control Concept Formulation Study Volumes I-IV, Computer Services Corporation, prepared for Department of Transportation, Transportation Systems Center, Cambridge MA, Contract No. DOT-TSC-678, February, 1975.

The documents which form the base of this report are:

Gates, Robert F., Airport Surface Traffic Control, Visual Ground Aids, State-of-the-Art and Design Criteria, Gates Associates, prepared for the U.S. Department of Transportation, Transportation Systems Center, Cambridge MA, Report No. CR-DOT-TSC-918-1, June, 1975.

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Boornazian, Aram A., Automatic Intersection Control System NAFEC Field Test Plan, Volumes I-II, S. Ross & Company, prepared for Department of Transportation, Transportation Systems Center, Report No. CR-DOT-TSC-978, Cambridge MA, June, 1975.

Jones, Paul H., Visual Ground Aid Survey of John F. Kennedy International Airport, Federal Aviation Administration, National Aviation Facilities Experimental Center, Atlantic City NJ, Report No. FAA-NA-75-38, November, 1975.

Rudman, Richard W., Survey of Visual Ground Aids at O'Hare International Airport, Computer Sciences Corporation, prepared for Department of Transportation, Transportation Systems Center, Cambridge MA, Report No. FAA-RD-75-16, September, 1975.

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MacKenzie, Franklin D., "Review of the Airport Surface Traffic Control Program of the Transportation Systems Center,": Aviation Lighting Symposium, 1975, the Aviation Committee of the Illuminating Engineering Society, Atlantic City NJ, October, 1975.

Supporting documentation:

The National Aviation System Policy Summary, Document No. 1000.27 Appendix I, March, 1972 (including Change 1, March, 1973), prepared by U.S. Department of Transportation, Federal Aviation Administration, Washington DC.

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PRIORITY 1

APPENDIX

SYSTEM COMPONENT: STOP SIGNALS

REFERENCE : Report No. CR-DOT-TSC-918-1 - 2.2.3, 2.3.2, 2.4.6, 2.4.7.2 3.1.4, 3.1.5, 3.6.1, and 5.

Report No. CR-DOT-TSC-918-2 - 2.2.1, 2.3.1, 3.3.2, 3.3.4, 4.1.2, and 4.2.

OBJECTIVE : To develop stop signals as necessary to provide a fail-safe method of stopping aircraft along the taxiway route in all conditions of visibilities in which the system is intended to be used, taking into account snow and ice accumulation that may occur during the operations.

TECHNICAL APPROACH: Both elevated and in-pavement signals need to be tested as well as signals that warn pilots of their approach to the stop signals. Aircraft cockpit heights from five to thirty feet above the surface should be considered. It may be practical to fabricate a working model, truck mounted, to test a range of cockpit heights in the limited low visibility weather conditions that will become available. These trials can be conducted at NAFEC in the Automatic Intersection Control Project. Weather simulation in low visibilities may prove feasible using crash equipment fog nozzles or smoke generators; however, smoke generators cannot be used for color checks since white light becomes reddish in a smoke atmoshpere.

EXPECTED RESULTS: An in-pavement stop signal will prove to be most effective and an elevated stop signal can be used to supplement, or where necessary, replace the in-pavement stop signal configuration. Operating safety will be enhanced.

PRIORITY 1

SYSTEM COMPONENT: AIRCRAFT POSITIONING SIGNAL

REFERENCE : Report No. CR-DOT-TSC-918-1 - 2.2.3, and 2.4.6. Report No. CR-DOT-TSC-918-2 - 2.1.1, 2.1.2, 2.2.1, 2.3.1, 3.2.2, 3.3.2, 3.3.4, 3.4.2, 4.1.1, and 4.1.2.

OBJECTIVE : To provide a signal for use by pilots in positioning aircraft as necessary at stop and hold points along the route to permit other aircraft safe clearance for passing along other nearby taxiways. The signal to be developed may also serve to signal pilots that their aircraft is clear of the active runway, following their exit from the runway.

TECHNICAL APPROACH: Experiments at NAFEC with promising signalling techniques will be conducted. These trials can become a part of the TSC Automatic Intersection Control project.

EXPECTED RESULTS: The application of this signal for use by the most critical aircraft using an airport will assure safe passage of other aircraft along runways following exit, and also will make available other taxiways near a stop or hold point when used by other, and particularly long-bodied, aircraft.

PRIORITY 1

SYSTEM COMPONENT: RUNWAY EXIT LIGHTING - LOW SPEED CONFIGURATION

REFERENCE : Report No. CR-DOT-TSC-918-1 - 2.2.1, 2.2.4, 3.1.1.1, 3.6.1, Tables I, II, III, and IV.

Report No. CR-DOT-TSC-918-2 - 2.1, 2.1.1, 3.2.1, and 4.1.1.

OBJECTIVE : Develop improved means of identifying, locating, and using low speed exits for all airports under all weather conditions.

TECHNICAL APPROACH: A new fixture development may prove to be a solution to all operations except those concerned with Categories II and III operations. The fixture is provided with a cut-off so that it cannot be confused with other ground or aircraft lights at long range, and can be installed within the runway surface a sufficient distance to provide an easily located signal.

For operations in Categories II and III (and particularly in Category III), the exit lights should be installed in the runway surface out to a point of tangency with the runway centerline. Some means needs to be developed to provide positive identification since pilots may react to the green signal near the centerline as though it was a high-speed exit.

EXPECTED RESULTS: Rapid exiting of runways is a key factor in improving safety and reliability of operations as well as increasing aircraft movement rates. This program can bring about major progress in these areas at all types of airports.

PRIORITY 1

SYSTEM COMPONENT: TAXIWAY GUIDANCE SIGN SYSTEM STANDARD

REFERENCES : Report No. CR-DOT-TSC-918-1 - 2.1.3, 2.3.1, 2.4.2, 2.4.7.1, 3.3, 3.6.3, and 5.

Report No. CR-DOT-TSC-918-2 - 2.2.1, 2.2.2, 2.3.1, 2.3.2, 3.3.1, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.2, and Appendix B.

OBJECTIVE : To modernize the existing taxiway guidance sign system standard.

TECHNICAL APPROACH: Formation of a working group composed of government/industry pilots and engineers, and air traffic controllers. A draft standard will be developed, using a working model of a complex airport as an aid. Visits to a few selected airports will probably be desirable. The group's recommended system will be implemented at a major airport for final testing prior to adoption. This effort could include development of standard taxiway routing procedures.

EXPECTED RESULTS: Issuance of an updated standard that will greatly improve safe and efficient movements of aircraft on the airport surface. Controllers will be relieved of involvement inground guidance duties, thereby devoting more time to monitoring aircraft movements to assure that clearances are complied with.

PRIORITY 1

SYSTEM COMPONENT: TAXIWAY GUIDANCE SIGNS - ELEVATED TYPE

REFERENCES : Report No. CR-DOT-TSC-918-1 - 3.3, 3.6.3, and 5.

OBJECTIVES : To develop sign structures having two types of frangible mountings, one for use within obstacle-free areas and another for use outside obstacle-free areas. To develop sign surfaces that resist accumulation of wet snow. To develop a means of distinguishing between signs that identify taxiway intersections and runway exits, both of which employ black legends on yellow backgrounds.

TECHNICAL APPROACH: NAFEC to experiment with solutions to the above three objectives with standards being issued as appropriate. A different shape, an octagon for example, may prove effective in distinguishing between the taxiway intersection and runway exit signs. Two standards would evolve for application of signs with respect to snow accumulation resistance - one for use in non-snow areas and another for use in snow areas.

EXPECTED RESULTS: Structural failure of signs will be greatly reduced, readability of signs will be maintained during wet snow conditions, and the most effective legend/background color combination can be used for two different functions.

PRIORITY 1

SYSTEM COMPONENT: AIRPORT CHARTS FOR PILOT USE

REFERENCE : Report No. CR-DOT-TSC-918-1 - 2.3.1, 2.3.2, 2.4.7.1, and 2.4.7.2.

Report No. CR-DOT-TSC-918-2 - 4.1.2, 4.2, and Appendix B.

OBJECTIVE : To provide improved charts of airport taxiways to assist pilots in navigating from the runway to the apron and vice versa.

TECHNICAL APPROACH: The working group formed to develop taxiway guidance sign system standards would be ideal for handling this assignment also. In addition, liaison would be established with a cartographer to assist in technical developments of the charts. To the extent possible, types of visual aids provided should be depicted on the charts.

EXPECTED RESULTS: The charts will enable aircraft crews to use airport surface traffic control and guidance aids more effectively. Ground movements would be expedited with fewer mistakes being made, particularly during low visibility operations.

PRIORITY 1

SYSTEM COMPONENT: AIRPORT SURFACE TRAFFIC CONTROL RULES AND PROCEDURES

REFERENCES : Report No. CR-DOT-TSC-918-1 - 2.1.4, and 2.4.3.

Report No. CR-DOT-TSC-918-2 - 4.2.

OBJECTIVES : To up-date Federal Aviation Regulations and FAA terminal air traffic control procedures as necessary to implement proper use of modernized equipment provided in the airport surface traffic control system.

TECHNICAL APPROACH: Existing administrative policies to be used to bring about the necessary rule and procedure changes as appropriate.

EXPECTED RESULTS: All personnel involved will be provided with a better understanding of system functioning; therefore, safety will be enhanced.

PRIORITY 1

SYSTEM COMPONENT: APRON MARKINGS

REFERENCES : Report No. CR-DOT-TSC-918-1, 2.2.2.1, 2.2.2.2, 2.4.5, 3.4, 4.3, and 4.4.

Report No. CR-DOT-TSC-918-2, 2.3.1, 3.4.2, and 5.

OBJECTIVES : Considerable testing is needed on apron markings due to the requirement to provide markings for both pilots and operators of vehicles within the same area. An effort will be made where routes cross to delineate the vehicular routes so that the guide lines for vehicles will not be visible to pilots. This may be accomplished by use of a grazing paint spraying technique for 90 degree crossing angles, or, closely spaced retroreflectors - painted to be visible by day. The standards must provide effective guidance for both users with a low probability of confusion developing.

EXPECTED RESULTS: A well developed system, uniformally applied at all airports, will provide improved safety and reliability of aircraft and vehicular movements within apron areas.

PRIORITY 2

SYSTEM COMPONENT: VEHICULAR CONTROL - PROCEDURES

REFERENCES : Report No. CR-DOT-TSC-918-1, Part 4, and Appendix E.

OBJECTIVES : To develop advisory material concerning traffic rules, regulations, etc. to serve as a model for vehicular operations on the movement areas at airports.

TECHNICAL APPROACH: A group of government/industry personnel will be appointed to develop the advisory material. Airport instructions presently in existence will be used as guides to the development and publication of material dealing with control of vehicular traffic at airports.

EXPECTED RESULTS: Issuance of a model procedure/regulation publication will result in imporved vehicular operations at many airports. Fewer accidents should result between vehicles, and between vehicles and aircraft.

PRIORITY 2

SYSTEM COMPONENT: ROUTE DELINEATION WITHIN APRONS - LIGHTING

REFERENCES : Report No. CR-DOT-TSC-918-1, 2.1.2, 2.2.1.1, 2.4.5, and 5.

Report No. CR-DOT-TSC-918-2, 2.3.1, 3.4.2, and 4.1.3.

OBJECTIVE : To provide effective route guidance within apron areas, especially in Category III weather conditions.

TECHNICAL APPROACH: Use white or yellow light within apron areas, and conduct tests to ascertain lamp wattages required on straight and curved sections that will provide the necessary guidance during day and night operations. Establish standards for application of apron lighting within apron areas, using centerline configurations identical to those applied to normal taxiways.

EXPECTED RESULTS: Effective route guidance within aprons will enable aircraft to be operated with the same effeciency provided in current operations along taxiway routes. (The absence of this lighting in currently authorized Category III weather conditions causes some flights to be cancelled or delayed on occasions since route delineation is non existent.) White may prove best on all segments within aprons with yellow used as Lead-in lighting into the docking areas. Use of white or yellow, or both, will prove more economical and will provide location information within the apron areas.

PRIORITY 2

SYSTEM COMPONENT: FACSIMILE DISPLAYS

REFERENCES : Report No. CR-DOT-TSC-918-1 - 2.3.2, and.2.4.7.2. Report No. CR-DOT-TSC-918-2 - 2.6.2, and 4.2.

OBJECTIVES : To provide controllers with means of operating only those circuits required for the operation involved, thus saving power and lamp life, and reducing the pilot work load involved when he views visual aids that are displayed but not needed for aircraft ground movements.

TECHNICAL APPROACH: A contractor will develop a facsimile for use at a complex major airport that will incorporate push-button or toggle switch circuit selection for route segments. When selected, back lighting along the facsimile for the route segment will show that the circuit is energized. Intensity control may be remote, but located on the console in such a manner that location is quickly ascertained. The entire console should be of minimum practical size.

EXPECTED RESULTS: Considerable power and lamp life savings will result from use of the equipment and visual aid clutter will be reduced insofar as pilot operations in the field are concerned. Also, segmented circuits will improve the controllers' ability to route pilots effectively.

PRIORITY 2

SYSTEM COMPONENT: TAXIWAY CENTERLINE LIGHTING - STANDARD MODIFICATIONS

REFERENCES : Report No. CR-DOT-TSC-918-1 - 2.1.2, 2.2.1, 2.2.3, 2.4.1, 2.4.4, and 2.4.6.

OBJECTIVES : To make changes to existing taxiway centerline lighting standards that will provide improvements to the surface traffic control and guidance system.

TECHNICAL APPROACH: Revisions are needed to the taxiway centerline lighting standards that will involve field testing. The areas of concern are set forth in the reference report, and are:

1. A standard overlap technique is needed where both taxiway centerline lighting and taxiway edge lighting are used to light parts of the same taxiway.
2. Standards need to be developed to permit taxiway centerline lighting to cross runways for low visibility operations.
3. Hold bars should not be used at intersections of taxiways with runways.
4. Identification is needed for high-speed exits where the reverse direction is used for either vehicular traffic or aircraft operations.

The solution proposed in 2.4.6 (3) may not prove feasible if red color is also used to warn pilots of approach to stop signals. Thus, another solution may be needed to keep aircraft from proceeding along the reverse direction of high speed exits.

EXPECTED RESULTS: Pilots will be provided with a more reliable and safe route delineation system for all operating conditions.

PRIORITY 2

SYSTEM COMPONENT: TAXIWAY CENTERLINE LIGHTING - LOW VISIBILITY OPERATIONS

REFERENCE : Report No. CR-DOT-TSC-918-1, 2.1.2.

Report No. CR-DOT-TSC-918-2, 2.2.1, 3.3.1, and 4.1.2.

OBJECTIVE : To experiment with means of informing pilots that a curve is being approached, and ascertain if there is a low visibility or combination of low visibility/aircraft configuration problem with respect to use of straight-through taxiway intersection delineation installations.

TECHNICAL APPROACH: Simulation appears as the best tool for investigating these areas of taxiing operations, since very low visibilities are involved that are difficult to find for real-time operations. However, actual aircraft operations also need to be conducted unless simulation in the field (see test outline for Stop Signals) is adequate to serve as a model for aircraft sutstitution.

EXPECTED RESULTS: Revised standards for taxiway centerline lighting would provide for greater safety and reliability for operating in Category III weather conditions.

PRIORITY 2

SYSTEM COMPONENT: TAXIWAY EDGE LIGHT FIXTURES

REFERENCE : Report No. CR-DOT-TSC-918-1 - 3.1.2, and Tables II and III.

OBJECTIVE : To investigate the feasibility of replacing the standard L-822 Taxiway Edge Light fixture with L-802 and L-819 type fixtures where snow removal is a major problem and thus more reliance upon edge light guidance is necessary.

TECHNICAL APPROACH: Sections of taxiways at NAFEC will be fitted with L-802 and L-819 fixtures to experiment with advantages, and, intensities that are optimum for the various visibility conditions, with and without taxiway centerline lighting. Particular attention will be given to achieving a light balance with the centerline lights, since it has been demonstrated that even the L-802 fixture can prove distracting when the centerline lighting is operated on low steps in comparison to the edge lighting.

EXPECTED RESULTS: The L-819 fixture will prove useful in daylight operations as well as in night operations, and the L-802 fixture will prove advantageous in low visibility night operations. Operations can be conducted using the substitute fixtures that would difficult or impossible, under certain ambient light/visibility/snow conditions.

PRIORITY 2

SYSTEM COMPONENT: RETROREFLECTIVE MARKERS - SNOW ACCUMULATION RESISTANCE

REFERENCE : Report No. CR-DOT-TSC-918-1 - 3.6.2.

OBJECTIVE : To assure, insofar as possible, that wet snow does not accumulate on the surface of retroreflective markers.

TECHNICAL APPROACH: Experimentation will be conducted with coatings for retroreflective markers that do not interfere with light reflection from the markers but will resist wet snow accumulation. The markers reviewed in part 3.2.2.4 of the subject report should be used in these tests.

EXPECTED RESULTS: The integrity of the retroreflective markers will be retained during wet snow conditions and aircraft movements can be continued in the better visibility conditions even though the taxiway surface is snow covered and the taxiway centerline lighting is ineffective.

PRIORITY 2

SYSTEM COMPONENT: TAXIWAY CENTERLINE LIGHTING - SNOW AND ICE REMOVAL

REFERENCES : Report No. CR-DOT-TSC-918-1 - 2.3.3, and 2.4.8.

OBJECTIVES : To develop means of minimizing the occurance of snow and ice build-up ahead of fixture apertures that will block light output.

TECHNICAL APPROACH: Because past efforts indicate heating is impractical, efforts will be made to develop other means of preventing snow and ice build-up ahead of the fixture apertures. It may be possible to direct most of the heat (wasted energy) into the pavement ahead of the apertures. Chemical treatments also will be tried.

EXPECTED RESULTS: Some improvement may be possible, but the state-of-the-art does not lend optimism to a break-through occurring. Nevertheless, this is a serious problem and efforts should be continued until progress can be made.

PRIORITY 3

SYSTEM COMPONENT: TAXIWAY CENTERLINE LIGHTING - UTILITY AIRPORTS

REFERENCES : Report No. CR-DOT-TSC-918-1, Table I (note 3.)

OBJECTIVES : To develop low-cost centerline lighting for application at utility airports.

TECHNICAL APPROACH: A simple, low cost, taxiway centerline lighting system will be developed for the smaller airports. The system will be useful for night only operations - a requirement for only 10-15 candelas of green light. The system will be installed at a small airport used frequently at night for in-service testing. Standards will be developed following successful field testing.

EXPECTED RESULTS: Development of a taxiway lighting system for small airports that will provide improved taxiway guidance at lower costs than conventional taxiway edge light installations.

PRIORITY 3

SYSTEM COMPONENT: APRON LIGHTING IMPROVEMENTS

REFERENCES : Report No. CR-DOT-TSC-918-1, 2.2.2.1, 2.4.5, 3.5 and 3.6.4.

Report No. CR-DOT-TSC-918-2, 2.3.1, 3.4.5, and 4.1.3.

OBJECTIVES : To enhance aircraft service lighting and illumination for vehicular traffic operations without degrading lighted signals provided to identify, guide, and dock the aircraft at the gate position. (lighted signals such as signs, in-pavement lighting, and docking signals).

TECHNICAL APPROACH: A study will be conducted by illuminating engineers at a typical major airport where docking signals are provided. If warranted, and if a feasible alternative approach is recommended, modifications will be made at the site studied in an effort to improve apron illumination.

EXPECTED RESULTS: Lighted signals should prove more effective for pilot use, especially during low visibility night operations, along with improved aircraft service lighting and illumination for vehicular traffic movements.

PRIORITY 3

SYSTEM COMPONENT: AIRCRAFT PARKING AIDS - OPEN APRON AREAS

REFERENCE : Report No. CR-DOT-TSC-918-1 - 2.2.2.2, 2.2.2.4, and 2.4.5.

OBJECTIVE : To provide parking aids for use in international operations as a standard visual aid system.

TECHNICAL APPROACH: A system of marking will be developed - possibly one of the many in current use will be satisfactory with some modifications. Also, lighting signals will be considered for use as a supplement to the painted marking signals. A system that does not require the use of a marshaller is desirable, but may prove impractical due to the turning maneuver involved.

EXPECTED RESULTS: Pilots operating into international airports can park their aircraft with more assurance and greater accuracy than at present where they encounter a proliferation of parking systems along their routes.

PRIORITY 3

SYSTEM COMPONENT: AIRCRAFT DOCKING SIGNALS

REFERENCE : Report No. CR-DOT-TSC-918-1 - 2.2.2.3, 2.4.5, 3.5, and 3.6.4.

Report No. CR-DOT-TSC-918-2 - 2.3.1, 3.4.3, and 4.1.3.

OBJECTIVE : To provide a docking aid for use in international operations as a standard visual aid signal.

TECHNICAL APPROACH: Numerous docking aids have been developed and are used by various airport managements and airline operators. An operations/engineering group should be formed to develop requirements for the system. If no existing system meets the requirements, then a development contract should be issued and the product tested in the international apron area of a major airport.

EXPECTED RESULTS: Pilots operating into international airports can dock their aircraft with more assurance and greater accuracy than at present where they encounter a proliferation of docking systems along their routes. Standardization should reduce minor accidents that occur while docking due to pilots unfamiliarity with the particular system employed.

PRIORITY 3

SYSTEM COMPONENT: ROUTE IDENTIFICATION TO SERVICE AREAS - FIXED BASE OPERATORS

REFERENCES : Report No. CR-DOT-TSC-918-1 - 2.1.3, and 2.4.2.

OBJECTIVES : To develop means of identifying routes to service areas for transient pilots.

TECHNICAL APPROACH: An evaluation will be undertaken involving signs, markings, and a combination of both that will provide an economical, effective routing of transient pilots to service areas, especially at fairly complex airports normally used by pilots during cross-country flights. The trials will involve both color coded and configuration coded markings. The most promising system will be service tested at two or three typical airports for final selection trials, with modifications, if any, being implemented in the field trials prior to standards being developed.

EXPECTED RESULTS: Transient pilots will exit the runway and proceed to service areas without requiring assistance from the tower or the fixed base operator (UNICOM). Operating costs will be reduced somewhat due to more rapid aircraft movements to the destination.

PRIORITY 3

SYSTEM COMPONENT: GATE IDENTIFICATION SIGNS - STRUCTURE MOUNTED

REFERENCES : Report No. CR-DOT-TSC-918-2, 3.4.2.

OBJECTIVE : To improve gate identification signs mounted on terminal building structures so that they can be used in place of flush mounted signs along the terminal taxilanes, where practical, in Category III weather conditions.

TECHNICAL APPROACH: Sign development will be undertaken, probably by contract, that will result in a sign that is intensity controlled with a legibility at a distance of 400 feet in a RVR of 700 feet over an angle of about 30 degrees for day operations. Where arrivals approach from only one direction, angling the sign in the direction of approach would permit the sign to be used at a distance of about 200 feet prior to the point of turn inbound during day operations, depending, of course, upon the distance of the inbound terminal taxilane from the gate position. The sign should have attention-getting characteristics. A standard legend/background color should be used for the sign.

EXPECTED RESULTS: Pilots will move more rapidly into gate positions under poor visibility conditions. The cost of this type of sign will be far less than the flush mounted type that are installed adjacent to the terminal taxilanes.

PRIORITY 3

SYSTEM COMPONENT: ROUTE DELINEATION WITHIN HOLDING BAYS

REFERENCES : Report No. CR-DOT-TSC-918-2 - 2.4.1, 3.5, and 4.1.4.

OBJECTIVES : To develop standards for providing taxiway centerline guidance within holding bays.

TECHNICAL APPROACH: This requirement involves only the development of standards, using criteria applicable to taxiways. Standards will be developed and incorporated into the appropriate advisory circular.

EXPECTED RESULTS: During low visibility operations, pilots will be able to move into and out of holding bays with greater assurance and speed.

PRIORITY 3

SYSTEM COMPONENT: TAXIWAY GUIDANCE SIGNS - FLUSH TYPE

REFERENCES : Report No. CR-DOT-TSC-918-2 - 2.3.1, 3.4.2, and 4.1.3.

OBJECTIVE : To provide a means of identifying routes, gate positions, and concourse locations where elevated signs cannot be employed.

TECHNICAL APPROACH: Experiment with means of providing guidance information to pilots at eye heights as low as five feet above the surface. Arrangements of point source lights, electroluminescent fixtures, and holography are examples of techniques that should be included in the project.

EXPECTED RESULTS: Pilots will proceed to assigned gate positions along authorized routes more promptly with greater reliability, especially in conditions of low visibilities. (Signs would be used in conjunction with centerline lights within apron areas).

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