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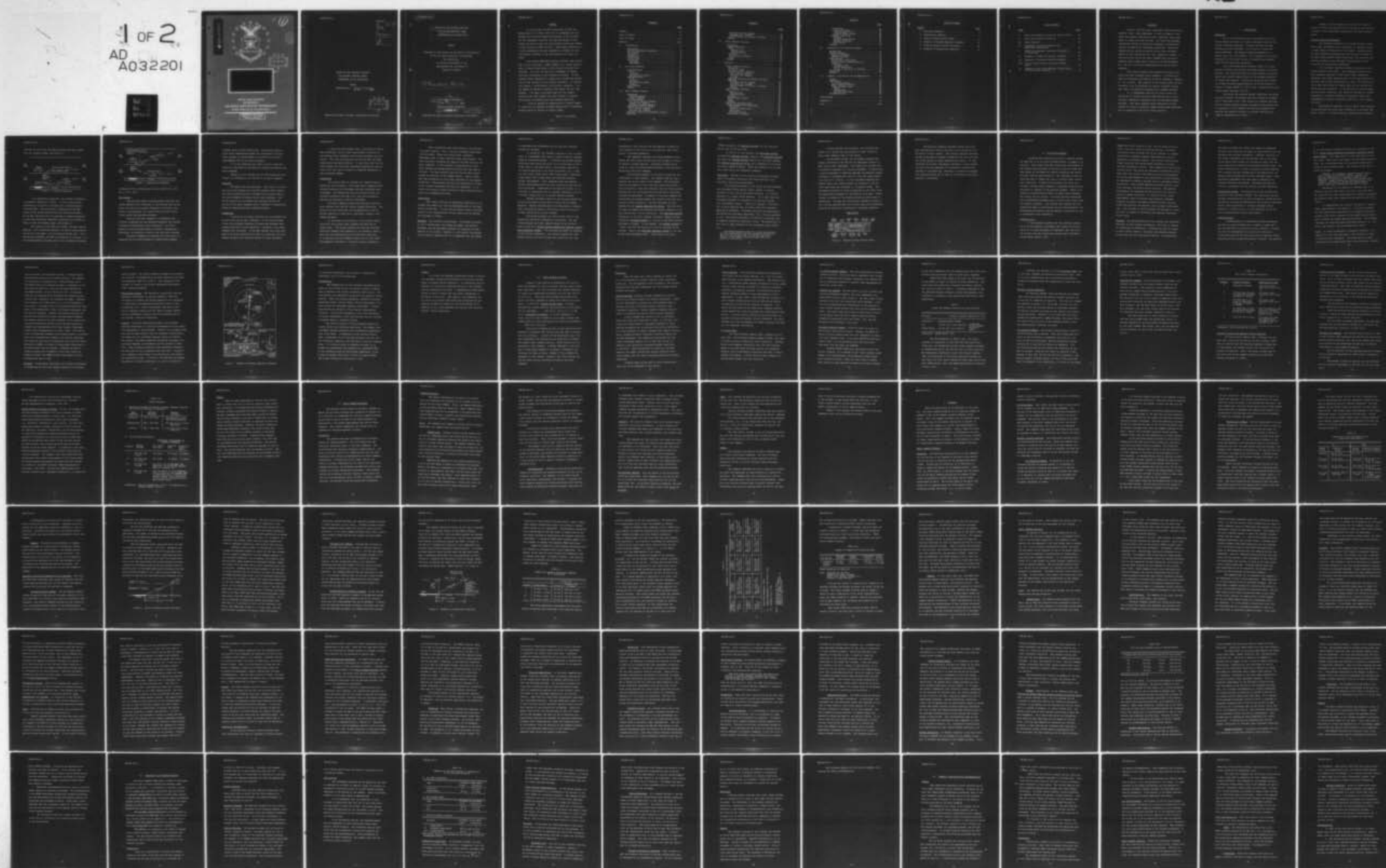

UNITED STATES AIR FORCE

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AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

GSM/SM/76S-15

REVIEW OF THE GUIDANCE PROVIDED FOR AIRCRAFT RECOVERY UNDER INSTRUMENT FLYING CONDITIONS

THESIS

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THESIS

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Preface

As long as the Air Force maintains aircraft and employs men to fly them, there will be commanders who are charged with the safe launch and recovery of the aircraft. For the commanders involved, the task may become an emotional one since a poor unit flying safety record may become a quick ticket to career failure. Under these conditions it is not unreasonable for each commander to display an avid and personal interest in the safe operation of their aircraft.

This thesis addresses aircraft recovery under instrument flying conditions, a small segment of a flight profile where a disportionate share of the aircraft accidents has occurred. It is all too easy for a commander to impose arbitrary limitations in the interest of safety. It then becomes almost impossible to remove such limitations regardless of the validity of the original rationale. In writing this thesis, I am providing a third party viewpoint. I do not expect my efforts to produce "the answer" for all commanders. I do hope it provides them with the present situation and some insight into what factors to consider when trying to establish what the guidance should be.

I wish to express my appreciation to Colonel Ronald A. Luhks for his efforts as thesis advisor and to Lieutenant Colonel Adrian M. Harrell as thesis reader.

David W. Livingston

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Abstract

Aircraft recovery under instrument conditions entails inherent risks. Many commanders, in their attempts to conserve and preserve limited and costly resources, have taken steps to reduce the risk involved. Air Force has expended considerable effort to devise and implement a standardized recovery procedure for instrument conditions. Each major command has the option to modify the Air Force guidance, making it more restrictive for its respective command. In exercising this option the major commands have arrived at guidance which ranges from no action to the establishment of a new set of criteria superimposed over the Air Force guidance.

This thesis documents the guidance provided by Air Force and eight different major commands. It further presents the rationale provided by the major commands in support of its actions. The analysis of the actions taken and the rationale, plus the analysis of relevant secondary issues, were used in formulating proposed major command guidance.

It is recommended that the Air Force review its directives to correct the known deficiencies and to limit the major commands to modifying only the published weather minimums. Each major command should reevaluate its procedures to insure it achieves command established objectives and is compatible with the Air Force guidance.

I. Introduction

Background

One of the considerations in the operation of the United States Air Force is to obtain maximum return for the limited resources available. Everyone realizes national resources are not unlimited. It is costly to train and retain personnel. New weapon systems are expensive to design, test, buy, and operate. It is natural for Air Force commanders at all levels to want to conserve and preserve these limited and costly resources.

One of the potentially hazardous times in a flight profile is during the recovery and landing phase of a flying mission. Over the years there have been changes in aircraft design and aircraft capabilities but the accident potential of landing has remained. Typically, twelve of the 38 tactical fighter accidents experienced by the United States Air Forces in Europe (USAFE) in 1970 to 1972 occurred during the landing phase (Spannus, 1974:12).

The poorer the existing weather conditions are during aircraft recovery, the greater the risk involved in attempting to land seems to be. This thesis will address the problem of aircraft recovery during instrument flying conditions. In particular it will address how the major commands have modified the specific guidance on aircraft recovery provided by Headquarters Air Force.

Chapter I will be devoted to defining the areas of interest, stating the problem and the objective, and delineating some of the limitations, assumptions, and definitions of terms.

Aircraft Recovery Procedures

The following discussion on aircraft recovery procedures under instrument flying conditions is provided to form a common frame of reference for the reader. Although there are many possible procedures which can be used to recover an aircraft under adverse weather conditions, the two basic procedures provided in the instrument flying manual are the precision and nonprecision approaches.

The instrument approach procedure terminates at the missed approach point (MAP). The subsequent landing after any instrument approach is made using visual references. Therefore, the missed approach point is the last opportunity the pilot has to make the decision to land. If the pilot is at the MAP and he feels he cannot land, he will execute the missed approach procedure. If the decision to land is made, the pilot must transition from flight by reference to cockpit indicators to flight by reference to external visual cues supplemented by cockpit indicators (AFM 51-27, 1971: Chapter 18, 18-1).

The precision approach is one in which final approach course guidance and glide slope information is provided (AFM 60-27, 1973:2). If flown correctly, when the pilot reaches the MAP, he will be on the desired glide path and aligned with the landing runway (see Figure 1).

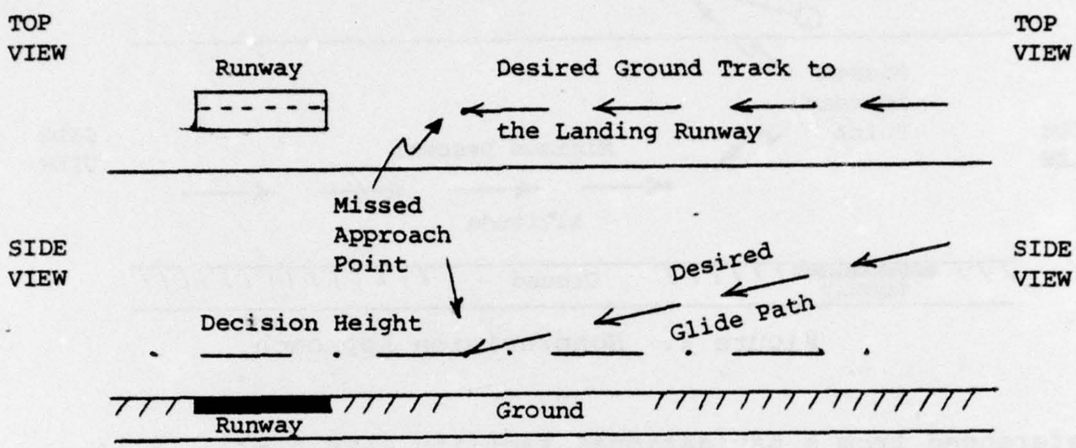

Figure 1. Precision Approach

In a nonprecision approach, only azimuth information is available (AFR 60-27, 1973:2). In lieu of glide path information, the pilot is provided with a minimum descent altitude (MDA). The pilot cannot descend below the MDA unless he has visual contact with the landing environment. At the MAP, the pilot will be required to visually establish a glide path and may be required to maneuver the aircraft to align it with the landing runway (see Figure 2).

The location of the MAP will differ with each type of approach. For a precision approach, the MAP is pinpointed by the use of an altitude, i.e., the decision height (DH). For a nonprecision approach, the MAP is defined by an altitude, i.e., the minimum descent altitude (MDA), and a horizontal distance

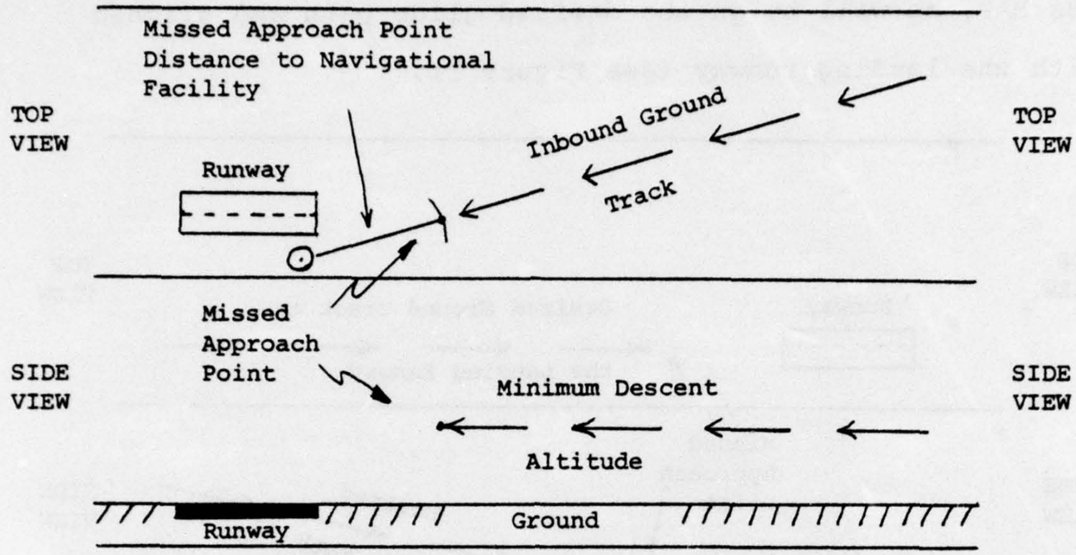

Figure 2. Nonprecision Approach

referenced from a navigational facility (AFM 51-37, 1971: 16-7, 17-13, 15-6).

The Problem

The decision height, minimum descent altitude, and missed approach point described in the previous section are parts of a matrix of criteria composed of altitudes, distances, cloud heights, and visibilities which are collectively called the published minimums.

The Air Force has attempted to standardize the recovery procedures and the published minimums, and devised a method of disseminating this information. Air Force appears to have provided explicit guidance, standardized procedures, and extensive controls over the entire process.

The major commands are provided with the option of accepting the Air Force guidance or establishing command guidance which is more restrictive. The actions taken by eight major commands have ranged from acceptance of the Air Force guidance to establishment of a new set of criteria superimposed over the Air Force guidance.

It is not understood why there is such a vast difference in the scope of the specific guidance provided by the major commands.

Chapter II will document the Air Force position with Chapter III documenting the actions of the major commands.

Objective

The thesis has two objectives. The first is to document Air Force guidance for aircraft recovery under instrument flying conditions and to document the actions taken by the major commands to modify the Air Force guidance. The second objective is to examine the rationale behind the actions of the major commands and to formulate a standardized method of establishing major command guidance.

Assumptions

A portion of the thesis objective was to document the actions taken by the major commands. In the time available it was not considered feasible to contact and document each command which had a flying operation. Therefore, only eight commands were contacted. It has been assumed that those commands with flying operations who were not contacted will have command guidance and rationale similar to those contacted.

It has also been assumed that, in the area of instrument procedures, the Air Force would prefer its pilots to move between major commands with minimum disruption and confusion. This does not imply that all pilots have the same capabilities and qualifications. It does imply that the Air Force expects the instrument procedures employed by each Air Force pilot will have an element of sameness regardless of their assigned command.

Limitations

This thesis does not consider all possible ways to modify Air Force guidance. Only those major command actions directly effecting the instrument recovery procedures were considered. The methods that did not directly modify the recovery procedures, although valid, were not universally employed and therefore, were not considered.

The major command guidance was extracted from personal contacts and from the current command directives. The validity of the conclusions and recommendations could be greatly affected if there was a significant change in the command guidance.

At the onset of the project, it was clearly understood that the original major command rationale may no longer exist. The current command rationale was obtained from major command staff members who are presently associated with the standardization and evaluation functions. It is feasible that the command contact was not the "most" knowledgeable individual in aircraft recovery procedures.

Three limitations were self-imposed in the interest of subject scoping. First, only DOD instrument approaches were discussed. There are several other "standard" approaches used in other countries which were ignored. The next limitation concerned the types of aircraft flown by the major commands. In the interest of generalization, each major command was characterized as flying only one type of aircraft. The type aircraft used was the one which represented the majority of the command effort. Lastly, there were many exceptions to the rules identified in the command directives. These exceptions were not considered to be part of the "normal" operations and were not addressed. It is within the context of these limitations that conclusions are drawn and recommendations made.

Definitions

This thesis involves an operational problem and it is assumed the reader will know and understand most of the operational terms used. In this section certain terms or phrases crucial to the understanding of this thesis will be defined and discussed in detail.

Minimums. The following four phrases: the weather required to file a flight plan; the weather minimums; the approach minimums; and the published minimums; are composed of words familiar to all pilots. However, in this thesis, the phrases take on explicit meanings and it is imperative for the reader to understand the differences and the possible interplay between the phrases.

In actuality, the "weather required to file a flight plan" is a management tool used to control aircraft launches based on forecasted weather. It defines the minimum weather conditions below which the pilot is not authorized to file a flight plan to that destination. The weather required to file may be specified in Air Force directives, e.g., criterion for Visual Flight Rules (VFR) flight plans, Instrument Flight Rules (IFR) flight plans and alternate airfield weather requirements. Major commands might also specify weather requirements which are more restrictive than the Air Force directives. Regardless of the specific source, it is important to understand that the weather required to file is a broader concept than is the phrase weather minimums.

"Weather minimums" refers to the minimum weather conditions below which a pilot may not start the instrument approach. Weather minimums may be the Department of Defense (DOD) published minimums or they may be a more restrictive criteria specified by a major command.

"Published minimums" are those values found in the appropriate DOD Flight Information Publication. The published minimums have been computed based on the criteria found in AFM 55-9, United States Standard for Terminal Instrument Procedures (TERPS). The published minimums are composed of two distinct components: the weather minimums for that approach which sets the no-lower-than visibility and, when appropriate, cloud ceiling; and the approach minimums for that approach in the form of an altitude and, when appropriate, a distance parameter.

The "approach minimums" are those parameters which define the point where the decision will be made to land or to execute a missed approach. Approach minimums may be found as a part of the published minimums or they may be as directed by the major commands.

The following example is provided to highlight the differences in these phrases. The numbers used are hypothetical and do not refer to any command. The forecasted destination weather is for a 250 feet cloud ceiling and .9 miles visibility. With this forecast, the Air Force guidance requires that an IFR flight plan be filed and an alternate airfield be designated. In addition, the major command has established the minimum weather for filing at 200 foot ceiling and .5 mile visibility. We have satisfied all the demands for the weather required for filing. When the pilot is ready to commence an approach the existing weather is 250 foot ceiling with .9 mile visibility. The published minimum visibility is .25 mile, however, the major command minimum visibility (weather minimum) is .5 mile or published minimum, whichever is higher. In our example, the weather minimum is .5 mile, and with the existing .9 mile an approach may be started. Lastly, the published approach minimum is 100 feet Height Above Touchdown (HAT). Since there is no major command guidance, the approach minimum will be a Decision Height (DH) of 100 feet HAT.

To sum up, in this example, the published minimum provided the approach minimum, however, the published minimum was below the weather minimum required by the major command. The weather required for filing was a composite of Air Force and major command guidance. These four phrases will be used many times during the subsequent chapters.

Approaches. Similar to the confusion surrounding minimums, there is confusion concerning the terms precision, nonprecision, and circling approaches.

The confusion centers on the use of the word approach. The Instrument Flying manual clearly states a circling approach is not to be an instrument maneuver. "A circling approach is a visual flight maneuver. It is used, when the instrument approach is completed, to align the aircraft with the landing runway." (AFM 51-37, Change 2, 1974:18-8.) The circling approach does not begin until the instrument approach is completed. Therefore precision and nonprecision approaches are instrument approaches, but a circling approach is not. This subtle difference is difficult to maintain and is commonly ignored by operational units. The distinction is even lost in other chapters of the Instrument Flying manual, e.g.:

> The missed approach point for a circling approach is also located along the final approach course, at MDA, but not farther from the FAF than the first portion of the usable landing surface [AFM 51-37, Change 2, 1974:15-16].

To help minimize the confusion, the following discussion will review the relationship of these terms with other terms commonly used in this thesis.

As previously stated, the instrument approach procedures terminate at the MAP and the subsequent landing is made using visual references. The landing may be made from a straight-in approach or a circling approach. By definition, a circling approach is required whenever the approach course alignment is displaced more than 30° from the runway centerline (AFM 55-9, 1970:41). In the instrument approach procedures charts the landing minima for straight-in and circling approaches are portrayed in a standard format. The instrument procedure is flown as depicted on the chart using the appropriate minimums for the landing to be made. Figure 3 shown an example of the landing minima box with notes of explanation. Although not specifically labeled in Figure 3, the circling approach does not provide glide path information and must be made from a nonprecision instrument approach.

HIGH ALTITUDE

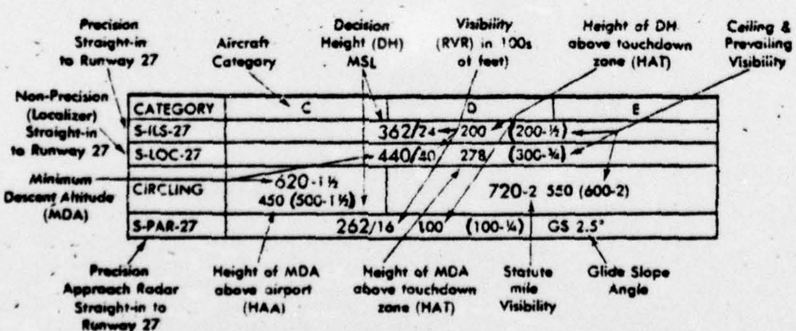

Figure 3. Typical Landing Minima Format

The precision approach provides azimuth and glide path information to assist the pilot in the transition to a straight-in visual landing. The circling approach provides neither glide path or azimuth information and the pilot must set up and execute a visual approach and landing. To take advantage of the best information available, a pilot should not use a circling approach if a straight-in nonprecision approach is available and, likewise, a straight-in nonprecision approach should not be used if a straight-in precision approach is available.

II. Air Force Guidance

Launching and recovering aircraft in adverse weather has been and is an Air Force problem whether in combat or in training. While there have been significant improvements in the landing aids available to the pilot, many of these have been offset by increased air traffic congestion and poorer aircraft landing characteristics. The challenge to the Air Force has been to reduce the risk in recovery under instrument conditions. To meet this challenge, Air Force has evolved a concept which attempts to establish guidance which considers all aspects of the recovery problem. There is an extensive standardization effort to insure the procedures are similar for all pilots. Air Force has also recognized that standardized procedures are of little value unless they are readily available. This chapter will discuss the considerations made in establishing the Air Force guidance, the standardization efforts, and the method of distribution used to disseminate this information.

Considerations

In establishing guidance for the recovery problem, Air Force has adopted a philosophy that safety and practicality in a flight procedure are dependent upon the pilot, the aircraft and the navigational system used (Instrument Flight Center Letter, 1974).

Pilot. When first learning to fly, the Air Force pilot initially receives a block of concentrated basic instrument instruction which includes, but is not limited to, academic instruction in weather, spacial disorientation, and the mechanics of instrument flying. The initial training progresses logically from ground-based simulators to actual inflight instrument training. Upon completion of the initial training cycle, the pilots are assigned to operational units where they must fulfill continuation training requirements. The flying requirements in the continuation training program are designed to promote a minimum level of instrument flying proficiency. They include additional ground training, simulator missions, and actual flight training. The specific requirements are completed periodically over the training period to impose continuity. In addition to the flying requirements, there is periodic physiological refresher training, an annual instrument refresher course, multiple flight and simulator evaluations, and an annual flight physical. All of these Air Force programs are designed to insure the pilot is capable of performing the required instrument flying tasks.

Aircraft. Two characteristics of the aircraft are considered important to safe recovery procedures. The first is general air worthiness or reliability. Although this may not appear to have a direct impact, a stringent and demanding program in this area can have long-range benefits. A conscientious maintenance program will reduce the number of mechanical failures, thus reducing the number of complications that can aggravate the recovery procedures. Likewise, requiring all the flight instruments and navigational aids to be operational before each flight will provide the pilot with the tools essential to perform the instrument recovery task. The second characteristic is that of general aircraft handling. Each aircraft has been categorized in accordance with its maximum landing weight and its final approach speed. These maneuvering parameters have been used in designing the standard instrument procedures. Published minimums are listed in accordance with the various aircraft categories.

Navigational System. Considerations for the navigational system are very straight forward. The operational and performance characteristics of each navigational system are documented for both the ground-based and the airborne components. Knowing these properties, a recovery procedure can be designed to conform, allow, or take advantage of the specific characteristics of any given system.

Standardization

Standardization of instrument recovery procedures has been an ongoing process over a number of years and it has involved both civilian and military agencies. Although the need for standardization was obvious, obtaining a coordinated position was complicated by the numerous inputs required and the diversified agencies involved. The products of the continuing standardized efforts are reflected in AFM 55-9, United States Standard for Terminal Instrument Procedures (TERPS). This same manual is also applicable to the Army, Navy, Coast Guard, and Federal Aviation Administration (FAA), but is published under the directive number appropriate to their organizations. The purpose of AFM 55-9 is quoted as follows:

> PURPOSE. This Handbook contains criteria which shall be used to formulate, review, approve, and publish procedures for instrument approach and departure of aircraft to and from civil and military airports. These criteria are for application at any location over which an appropriate United States agency exercises jurisdiction [AFM 55-9, 1970:1].

The manual is very specific in stating that it is mandatory that the Army, Navy, Air Force, and Coast Guard use these criteria when *establishing* an instrument procedure for airports under their respective jurisdiction (AFM 55-9, 1970:2).

In establishing the criteria, the manual is complicated, comprehensive, and specific. It provides guidance for the step-by-step construction of a complete instrument recovery from initial approach to the missed approach point and on through the missed approach procedures. The criteria considers the three previously mentioned factors, i.e., the pilot, the aircraft, and the navigational system.

Pilot. In order to establish a reasonable standard, it is essential to know the magnitude of the variations of each of the pilot error components. The three specific areas considered for pilotage errors were course accuracy, crossing course accuracy, and altitude accuracy. Pilotage errors standards have been set for course accuracy. For example, the utilization (pilotage error) course accuracy for a VOR/TACAN course is ±1 degree as shown in paragraph 2.3 of FAA Selection Order U.S. National Aviation Standard for VOR/TACAN Systems, 1010.55 dated June 1970. At present there are no pilotage error standards for crossing course accuracy and, therefore, no allowances are made. Although this omission is of some concern, it is not considered to be critical. Pilotage errors in altitude accuracy have been used in the formulation of MDA, the obstacle clearance, and the terrain clearance. However, the values used were not derived from formalized studies or established standards. The numbers used were the best estimates of the experts who originally devised the system and of the many people who reviewed and coordinated on the final product (Instrument Flight Center Representative, 26 April 1976). The lack of a set of formalized standards for pilotage errors in altitude control is discomforting; however, the original estimates were based on many years of experience and, since the implementation of TERPS, a serious or catastrophic deficiency in altitude control has not emerged. Although the lack of formal pilotage error standards in this area creates an element of doubt, the TERPS criteria used appear to have withstood the test of time.

<u>Aircraft</u>. As previously mentioned, the aircraft performance is categorized by the final approach speed and the maximum

landing weight. The actual category assigned to any particular aircraft is determined by the most restrictive of these two parameters (AFM 55-9, 1970:2). The category of each aircraft is listed in the Flight Information Publication (FLIP) Planning document.

Navigational System. The electronic navigational aids are addressed individually in various chapters of AFM 55-9. Variations in airborne and ground components are considered in establishing the permissible deviation limits of each navigational aid. Visual navigational aids such as the type of approach lighting and the type of runway lighting are also considered in making the final determination of the minimum visibility authorized.

Product. The final standardized product for instrument approach procedures is a pictorial presentation of the instrument approaches to each airfield. Figure 4 is an example from the high altitude terminal book for northeast United States. The format for all instrument approach charts is similar. The courses, altitudes, obstacles clearances, minimums, etc., have been computed in accordance with the criteria in AFM 55-9. This one page provides all the information necessary for the pilot to fly an approach into Dover AFB. Of particular interest to this thesis is the minima box (See Figure 3 for explanatory notes). In Figure 4 the approach and weather minimums for aircraft categories C, D, and E are shown for

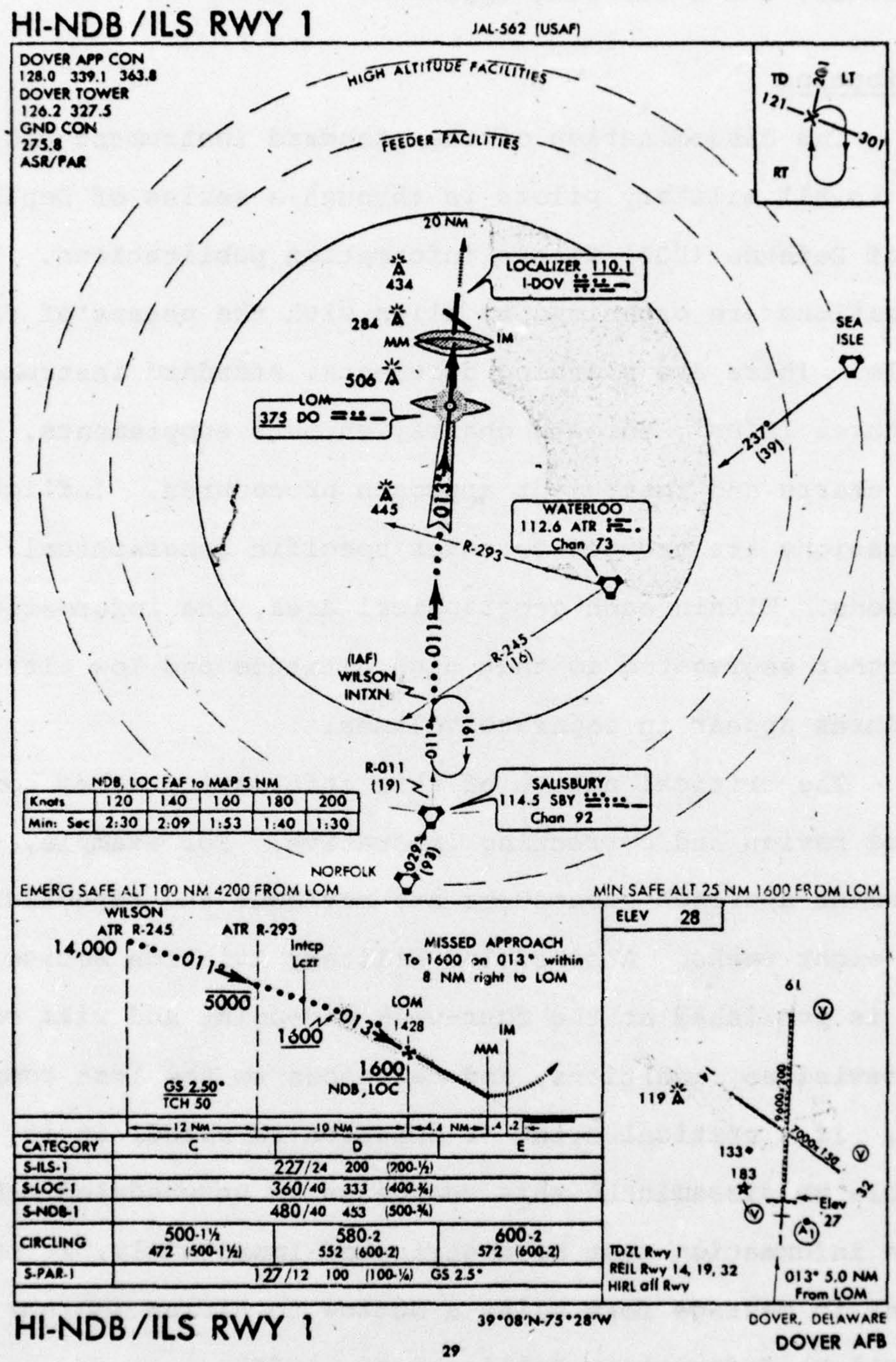

Figure 4. Example of Standard Approach Procedure

two precision approaches, two straight-in nonprecision approaches, and a circling approach.

Distribution

The dissemination of the standard instrument procedures to all military pilots is through a series of Department of Defense (DOD) flight information publications. The publications are organized to align with the phases of flight profile. There are planning documents, standard instrument departures (SIDs), enroute charts, enroute supplements, terminal charts and instrument approach procedures. Inflight publications are grouped to cover specific geographical locations. Within each geographical area, the information is further segregated so that high altitude and low altitude procedures appear in separate volumes.

The critical nature of this information makes continuous review and correcting imperative. For example, the instrument approach procedures are reviewed and republished every eight weeks. A scheduled Military Aviation Notice (MAN) is published at the four-week mid-point and will contain revisions, additions, and deletions to the last complete issue. If a critical error or omission is noted, it is possible to disseminate this change as an unscheduled MAN. If the information must be distributed immediately, it may be sent in message form using a Notice to Airmen (NOTAM) (DOD Flight Information Publications, 1976).

Summary

Air Force has expended considerable effort to devise and implement standardized procedures for aircraft recovery under instrument flying conditions. In formulating the procedures, Air Force has considered the pilot, the aircraft, and the navigational aid used. A comprehensive distribution system is used to insure that the latest information is available to the pilot. When taken in the aggregate, the Air Force pilot should have sufficient guidelines and procedures available to enable him to decide whether it is possible to fly a safe approach and landing under existing adverse weather conditions.

III. Major Command Guidance

Chapter II was devoted to documenting how the Air Force has handled the task of aircraft recovery under instrument conditions. Air Force has taken the actions necessary to insure the standardized procedures will be used (AFR 60-16, 1974:1-1). They have also provided provisions which permit the major commands to impose more restrictive procedures. In AFR 60-16, General Flight Rules, it states, "MAJCOMS may further restrict the provisions of this regulation by supplement . . . [AFR 60-16, 1974:1-1]." In AFR 60-27, Instrument Procedures, it allows commanders to ". . . direct pilots of their command to use higher minimums when necessitated by pilot qualification or mission requirements; . . . [AFR 60-27, 1973:4]."

Eight major commands who have flight operations were examined to determine what actions they had taken to modify Air Force guidance. A review of the appropriate major command supplements and regulations was conducted to document the present major command position. These results will be reflected in this chapter. A letter (Appendix A) was also sent to each major command in an effort to determine the rationale for their actions. Chapter IV will address the responses to that letter. Chapter V will then analyze the actions taken and the rationale provided by the major commands.

Background

There are many ways a major command can modify the Air Force guidance for aircraft recovery under instrument conditions. For the purpose of this discussion, the guidance possibilities have been segregated into two groups labeled indirect and direct.

Indirect Methods. Indirect methods encompass all actions which do not directly modify the recovery procedures. These indirect techniques or actions are valid methods aimed at reducing the risk of aircraft recovery accidents under instrument conditions. Several specific examples are provided to illustrate the type of actions being discussed.

A major command may publish a list of airfields where the pilots are authorized to land. In this way, airfields with complicated or undesirable features in their approach procedures can be excluded from routine operations. It is also possible to impose increased fuel reserve requirements, thereby providing increased flexibility during the recovery maneuvers. One command has stipulated that the lowest forecasted weather will be used when filing, as opposed to the prevailing forecasted weather authorized in AFR 60-16. Thus the decision to launch will be made based on the lowest intermittent weather condition forecasted rather than the lowest forecasted prevailing weather conditions.

Although these actions may be valid alternatives, they will not be addressed in this thesis.

Direct Methods. The particular methods being addressed in this thesis are the direct methods, i.e., they are direct modifications of the recovery procedures. The possibilities are: establishing higher weather minimums for filing, establishing higher weather minimums for starting an approach, modifying the approach minimums, and establishing pilot weather categories based on some measurement of flying experience. In many cases, these methods may overlap, e.g., pilot weather categories may also be used as the weather minimums for filing and for starting an approach. The direct actions taken by the eight major commands examined varied greatly but could be grouped into three general categories: no direct action; weather criteria modified; and approach criteria and weather criteria modified. The major commands have been segregated into these categories and each will be addressed individually.

No Action Taken

Air Force Systems Command (AFSC), Alaskan Air Command (AAC), and Aerospace Defense Command (ADCOM) have taken no direct actions to modify Air Force directives. Although these three commands technically fall into this category based on the definition of direct action, the preceding sentence could be misleading concerning the level of major command involvement. A brief review of each command will provide some insight into this situation.

Air Force Systems Command. AFSC has established no minimum command criteria. Since the center commanders have elected not to formalize their weather categories, the command also has no monitoring function to perform (AFSC Representative Interview, 4 May 1976).

Alaskan Air Command. AAC has taken no action to modify the recovery procedures; however, the local commanders have established a set of local criteria. AAC has a small flying operation with only two subordinate units assigned. Since the flying operations are concentrated at one airfield, a close liaison exists between the units and the headquarters staff. The local units are already providing more restrictive guidance, thus the major command staff has merely assumed the monitoring role (AAC Letter, 1976, and AAC Representative Interview, 4 May 1976).

Aerospace Defense Command. ADCOM has taken no action to define more restrictive criteria. However, the ADCOM 51-series training manuals tasks the unit commanders to establish local weather rules. In so doing ADCOM has officially placed itself in an active monitoring role which sets them apart from the other two commands.

Although ADCOM technically qualifies for this "no action" category, it is assumed if the "local weather rules" seemed to be inappropriate, the headquarters staff would take corrective action. Since the local rules in effect have implicitly been approved by ADCOM the criteria imposed by the unit commanders will be presented here for future comparison with the actions taken by other major commands.

ADCOM flies many types of aircraft, but the majority of the effort is spent on fighter aircraft operations. The local units have explicitly modified the weather required for filing as shown in Table I. Although authorized to use the published weather minimums to start the approach, this situation is avoided by close supervision provided by local supervisors.

Table I.

Local Unit Weather Criteria by Type Aircraft*

Aircraft	Criteria (Weather Required to File)	
Cargo/Utility	published weather minimums	
B-57	200 feet and 1/2 mile visibility	or published weather minimums whichever is higher
Fighter/Trainer	300 feet and 1 mile visibility	

*Reference: ADCOM Letter, 1976

The two exceptions to Table I are: F-4 pilots assigned to Iceland are to use 1000 feet and three miles visibility; and headquarter pilots flying trainers assigned to headquarters are to use 200 feet and 1/2 mile visibility. The headquarters instructor pilots (IPs)/flight examiner (FEs) are authorized to file using published minimums but they honor the local units' weather criteria when flying with them (ADCOM Letter, 1976, and ADCOM Representative Interview, 29 April 1976).

Although this category is titled No Action Taken, two of the three commands are performing monitoring roles. AFSC is the only command which has no formalized and specific guidance originating from the headquarters or from the local units.

Weather Criteria Modified

Air Training Command (ATC) and Tactical Air Command (TAC) have both modified the weather criteria required for filing and for commencing an approach. They have not changed the approach minimums (i.e., DH or MDA) to which the pilot actually flies the aircraft during an instrument approach. The specific guidance provided by each command will be presented separately. However, in all cases where the major command has established a command minimum, the actual minimum used by the pilot will be the command minimum or the published minimum, whichever is higher.

Air Training Command. The primary flying mission of ATC is training pilots and navigators. They use trainer-type aircraft at nine airfields to accomplish this mission. For all T-37 and T-38 operations, ATC has established minimum criteria for filing and for starting an approach. T-37 and T-38 pilots may not file unless the visibility is one mile or greater. They will not start an approach if the weather is less than 300 feet and one mile visibility. ATC mission support aircraft pilots, and the 23 FTW pilots may start an appraoch if the visibility is 1/2 mile or the runway visual range (RVR) is 2400 feet (AFR 60-16/ATC Sup, 1974:5, and ATC Letter, 1976).

Tactical Air Command. TAC flies fighter, helicopter, and support aircraft with the primary mission involving the tactical aircraft. TAC guidance is more comprehensive than ATC but remains very straight-forward. Five pilot weather categories, A through E, have been established. The TAC pilot will not file or start an approach unless the ceiling and visibility are above his assigned weather category minimums. TAC has used levels of flying time in the unit equipment (UE) and total flying time as the criteria for assigning the pilot weather categories (Table II).

TAC has reiterated Air Force guidance by stating that TAC units placed under the operational control of another command will use the weather minimums established by the other command (TAC Letter, 1976, and TAC Representative Interview, 29 April 1976, and AFR 60-16/TAC Sup, 1975:6).

Table II.

TAC's Pilot Weather Categories*

Category	Weather Minimums	Experience Minimum
A	Published minimums	1000 hours total 150 hours first pilot UE
B	300 feet and one mile or published minimums, whichever is higher	750 hours total 100 hours first pilot UE
C	500 feet and 1 1/2 miles or published minimums, whichever is higher	500 hours total 50 hours first pilot UE
D	700 feet and 2 miles or published minimums, whichever is higher	Must successfully complete an Instrument Evaluation in UE conducted by TAC
E	1500 feet and 3 miles	All others who have not demonstrated instrument qualifications in UE

*Reference: AFR 60-16/TAC Sup, 1975:6.

Approach Criteria and Weather Criteria Modified

Military Airlift Command (MAC), Strategic Air Command (SAC), and United States Air Forces in Europe (USAFE) have all modified the DOD published approach minimums and, to some degree, the weather criteria for filing and for starting an approach. Again, the actual minimum used by the pilot will be the command minimum or the published minimum, whichever is higher.

Military Airlift Command. The MAC mission requires the pilots to fly cargo aircraft into airfields throughout the world. Many of these airfields have very limited facilities and do not have recovery charts that conform to the DOD published procedures. This type of operation creates numerous exceptions, and each exception must be adequately covered in the command directives. This thesis does not address the exceptions, but is confined to the operations covered by standard MAC procedures.

MAC has modified the approach criteria by establishing a minimum DH of 200 feet for precision radar approaches.

They have modified the weather required to file and to start a precision radar approach by establishing a visibility limitation of 1/2 mile (RVR 2400).

For all other instrument approaches, the published minimums will be used (AFR 60-16/MAC Sup, 1975:20-23, and MAC Representative Interview, 23 April 1976).

Strategic Air Command. The aircraft which account for most of SAC's flying time allocation are the B-52 and the KC-135. Special mission aircraft, e.g., SR-71 and combat crew training aircraft are the exceptions for SAC and are treated individually in the command directives.

SAC has modified the DOD published approach minimums for all precision approaches by establishing a minimum DH of 200 feet.

The weather to start an approach has been modified for all precision approaches to 200 feet and 1/2 mile (RVR 2400).

For nonprecision and circling approaches, the published minimums are used (AFR 60-16/SAC Sup, 1974:8-22, and SAC Representative Interview, 3 May 1976).

United States Air Forces in Europe. By far, the command with the most extensive changes to Air Force guidance is USAFE. USAFE has provided guidance in three areas. (1) They have established approach minimums for each type of approach, i.e., precision, nonprecision, and circling. (2) They have established specific weather criteria both for filing and for starting a precision, nonprecision, or circling approach. (3) They have created pilot weather categories which are assigned in accordance with the pilots level of experience. USAFE has considered every aspect of the recovery problem and has devised a new criteria set which they have superimposed on the Air Force guidance. In addition to the above, USAFE has employed several of the indirect techniques previously discussed. For example, they have established more conservative fuel reserve requirements for IFR flight plans and higher approach and weather minimums have been imposed for flights to non-USAFE airfields (USAFE Representative Interview, 7 May 1976). The specific USAFE guidance for aircraft recovery under instrument conditions is in Table III.

Table III.

USAFE Guidance *

A. Approach minimums and weather minimums (Weather required for filing or starting an approach).

Type Approach	Approach Minimums	Weather Minimums
Precision	DH - 300 feet	300 feet and 1 mile (RVR 5500) visibility
Nonprecision	MDA - 500 feet	500 feet and 1.5 miles visibility
Circling	MDA - 1000 feet	1000 feet and 2 miles visibility

B. Pilot weather categories

Category	Weather Minimum	EXPERIENCE REQUIREMENTS AS AIRCRAFT COMMANDER: Min. Total Jet Time	Total UE Time	Total Jet Weather Time
I	300 feet and 1 mile	500 hours	100 hours	25 hours
II	400 feet and 1.5 miles	250 hours	50 hours	15 hours
III	500 feet and 2 miles	Any pilot who cannot meet the above but has fulfilled requirements of Category IV.		
IV	800 feet and 3 miles	Will be placed in this category: Until 8 hours of jet weather time is obtained, until 5 sorties are flown in USAFE, until completion of the initial in-theater instrument flight check.		

*Reference: AFR 60-16/USAFE Sup, 1975:8, and USAFEM 55-111 Command Chapter 1975:9-2.

Summary

There are many techniques or actions that could be taken to reduce the risk in aircraft recovery under instrument conditions. Only those actions directly effecting the standard recovery procedures have been addressed in detail. The major commands have exercised their options to modify the Air Force guidance in any one of three ways, no action taken, weather criteria modified, or approach criteria and weather criteria modified. Whenever the major command has established additional guidance, the actual values used by the pilot would be the command guidance or published minimums, whichever is higher. Although three commands qualified for the no action taken category, only AFSC had no involvement with the recovery procedures. AAC and ADC performed monitoring roles to different degrees of involvement. TAC and ATC modified only the weather criteria. MAC, SAC, and USAFE modified the approach and the weather criteria with USAFE providing the most extensive set of command guidance.

IV. Major Command Rationale

The specific actions taken by the major commands to modify the Air Force guidance were presented in Chapter III. It is difficult to comprehend why the major command guidance varies from no action by AFSC to the USAFE procedure of establishing a new system superimposed over the Air Force guidance. This chapter summarizes the reasons given by commands for modifying approach criteria.

Collection

Two methods were used to determine the rationale behind the command guidance. The first method was the previously mentioned letter to the eight commands. The second method was follow-up telephonic communications. The point of contact used for all communications was the standardization and evaluation representative at major command headquarters. Although this staff agency was not the office of primary responsibility for many of the applicable command directives, the personnel assigned are usually well informed on current operational procedures. The standardization and evaluation function requires almost daily contact with the subordinate units in order to explain, defend, practice, and evaluate using the established procedures.

Command Rationale

The replies received did not prove to be unique. With few exceptions the rationale of one command could be applied to any other command. Thus, a by-command discussion of the rationale would be repetitive. Their comments have been organized and will be presented in the previously mentioned format of pilot, aircraft, and navigational systems plus an additional category titled "Other."

Pilot. The comments with respect to pilots could be further subdivided into capabilities and qualifications.

Capabilities. Recovery during minimal weather conditions is a demanding pilot task entailing the ability to fly an instrument approach precisely and perform the transition to a visual landing safely. The command comments centered on the short time available to make the transition, the close proximity of the ground during these last second maneuvers, and the difficulty in controlling aircraft sink rates at this crucial time.

Examining the geometry of the landing problem using a DH of 100 feet makes it easier to understand the problem. When at 100 feet on a conservative 2.5 degree glide path, the aircraft is approximately 2300 feet from the point where the glide path intercepts the runway. Using approach speeds of 120 and 180 knots, the time required to cover this distance is 11.4 and 7.6 seconds respectively. During this time, the pilot must visually acquire the runway environment, make the decision to land, transition from instrument flying to a visual flight, and perform the maneuvers required to achieve runway alignment and the desired glide path to land at the desired point.

The proximity of the ground produces two concerns. The obvious concern is premature contact prior to the runway. A more obscure concern is a tendency to avoid the ground, thus landing long and creating potential control or stopping problems.

Controlling aircraft sink rates during the final seconds of a landing is accomplished using visual cues. Aircraft sink rates are very susceptible to the amount of bank angle present. Thus, sink rate becomes a crucial parameter for the pilot to control when close to the ground.

The demands on the pilot's capabilities are obvious. In the recovery maneuver the pilot must fly the instrument procedure precisely and maneuver the aircraft in close proximity to the ground under reduced visibility conditions in a short period of time in order to achieve a reasonable touchdown point.

Qualifications. Although a pilot may be technically capable of performing the required maneuvers, he may not be presently qualified. The comments in this area involved pilot experience, proficiency, and currency. Although the major commands agreed pilot flying proficiency and currency were reasons for modifying recovery minimums, they were not in agreement with respect to pilot experience. TAC and USAFE assigned pilot weather categories based on command established experience levels. However, once a pilot was fully qualified in MAC he was authorized to fly to the lowest command minimums regardless of experience level. The interplay and the interpretation of flying experience, proficiency, and currency appear very subjective.

Aircraft. The aircraft comments dealt with aircraft maneuverability and engine performance. In each instance the aircraft comments were made with reference to the previously mentioned reaction time, ground proximity, and aircraft sink rate.

The commands who flew aircraft with large wing spans voiced concern over wing tip clearance when performing turning maneuvers at low altitudes. There was also some doubt if the aircraft roll rates and roll response times were adequate to permit the required last second maneuvers. Lastly, the commands were uncertain if the engine acceleration capabilities of their aircraft were compatible with the sink rates and available reaction times encountered when flying an approach using the DOD published minimums.

Navigational Systems. Only one aspect of the navigational system was questioned. Many commands felt the use of the DH of 100 feet for precision approaches was too low for operational use. In providing supportive comments, the commands would use the reasons already stated under Pilot and Aircraft.

Other. Four reasons for modifying the recovery procedures did not fall into the preceding categories and will be presented here. Each of the reasons are self-explanatory and clarifying comments are not provided.

Rapidly changing weather conditions made more restrictive filing minimums a desirable feature for several commands.

Two candid reasons were provided during the telephone conversations, i.e., it has always been done that way; and why not, it has not historically hampered the mission and it provides a safety buffer.

The last reason, alluded to but not stated explicitly, was that the limiting procedures were the desires of the commander and reflected his view of how to enhance flight safety in his command.

Summary

The rationale provided by the major commands were not unique to particular commands. The list of reasons could have been formulated by anyone familiar with the problems involved in aircraft recovery under instrument conditions.

The comments addressed the pilot's ability to perform the tasks and questioned his qualifications to perform the maneuvers. The commands were also concerned with various aircraft characteristics such as size and performance. These pilot and aircraft concerns were of special interest when considering the precision approach where the DH was 100 feet.

Some of the more realistic rationale included changeability of the weather, it has always been done that way, it provided a safety buffer, and the procedures were the commander's perception of how to improve safety.

Chapter V will analyze the actions taken by the major commands as well as the rationale provided.

V. Analysis

There are three areas to be addressed in this chapter. The major command guidance will be analyzed command by command to see if the present guidance enhances flight safety. Next, the command rationale will be examined reason by reason to see if the safety implication or benefit of each reason would support or justify the establishment of more restrictive command guidance. Lastly, there are those secondary issues which are worthy of consideration but have not yet been discussed in detail. This latter group includes all those items which are relevant to the subject but cannot be classified as command guidance or as command rationale.

Major Command Guidance

Objective. One deficiency encountered in all the commands was the failure of the commands to provide a clear definition of the goal or objective of the guidance they established. Without such an objective, it is difficult to gauge or assess the merits of the command actions. Therefore, for this section, it has been assumed that the objective of the major command guidance was to enhance flight safety by providing a buffer zone above the Air Force established criteria. The actions taken by the major commands will be examined using the three general action groupings already identified, i.e., no action taken, weather criteria modified, and approach criteria and weather criteria modified.

No Action Taken. AAC, ADCOM, and AFSC took no direct action and no comment will be made about these commands. The actions of the subordinate units of ADCOM were presented in Chapter III for comparison with the actions of the major commands. The actions taken by the subordinate units were very similar to the major command level action and could accordingly be classified into one of the two remaining groups. Any comments made about any particular group could be extended to apply to a subordinate unit within the group.

Weather Criteria Modified. The established weather criteria has been modified by ATC and TAC. These two commands have elected to establish more restrictive minimum weather criteria for filing and for starting an approach, but have not modified the procedures used in flying the aircraft during an instrument recovery.

Air Training Command. To determine if the ATC guidance provides the assumed buffer it is necessary to review the specific guidance and compare it to the published values which would be used if no actions were taken. It is important to restate that the actual minimums used by the pilot will be the command minimums or published minimums, whichever is higher.

Air Training Command provided filing weather criteria of at least one mile visibility. They also state an approach cannot be started if the weather is below 300 feet and one mile visibility.

Using the example of a precision approach with published weather minimums of 100 feet and 1/4 mile visibility, the chances of acquiring the runway with one mile visibility should be greatly increased. Also the probability of being below the cloud ceiling when at the 100 foot DH should also be greatly increased when using the command guidance of 300 feet. Lastly, the increased visibility should provide sharper visual cues for the transition to a visual landing.

If the published weather minimums in the previous example were 200 feet and 1/2 mile visibility, the cloud and visibility buffer would be reduced. The visibility buffer would be reduced from a ratio of one mile actual to 1/4 mile required to the ratio of one mile actual to 1/2 mile required. It becomes obvious that as soon as the published weather minimums reaches or exceeds 300 feet and one mile the command established safety buffer above the Air Force TERPS criteria becomes zero and the pilot will be flying published minimums. Although the establishment of command weather criteria provides a safety buffer in some cases, it is not a consistent buffer for all approaches.

A more basic issue was the determination of the size of the safety buffer. How did ATC arrive at the values of 300 feet and one mile visibility instead of 250 feet and

3/4 mile visibility? The command representative could not answer the question. The original rationale was not available and it was not known if any studies had been done. The best answers were that the values selected were round numbers which were easy to remember, the numbers were thought to be conservative, and they were the product and best estimates of those who initiated the system.

Tactical Air Command. TAC has established five pilot weather categories. The TAC pilot will not file or start an approach unless the ceiling and visibility are above his assigned weather category minimums. As shown in Table II, the TAC categories vary from 1500 feet and three miles down to published minimums. If any particular category is isolated and analyzed in the same manner used in the previous discussion for ATC, the same results would be attained. For example, TAC's category B minimums are 300 feet and one mile visibility, the same as the ATC minimums. A safety buffer would be present for each weather category, but again, not for all approaches.

There are some differences between the ATC and the TAC methods. TAC's Category A minimums are published minimums. Since TAC assigns the weather categories based on flying experience, they have implied that a safety buffer is no longer required once a pilot reaches a certain experience level. The other categories are arranged so that the least experienced pilots have the largest safety buffer (with the limitation noted in the previous paragraph).

The basic issues for TAC are how to determine the size of the buffer zone and what experience levels should be used in assigning the pilot weather categories. The best answers for the former issue are identical to those applicable to ATC. The latter issue, establishment of the flying experience levels, is subjective and arbitrary. United States Air Force in Europe (USAFE) uses a similar system of pilot weather categories and the comparison of the TAC and USAFE F-111 flying experience requirements points out the variance (Table IV).

Table IV.

Comparison of TAC and USAFE Flying Experience Requirements

TAC		USAFE	
Weather Minimum	Experience Minimum	Weather Minimum	Experience Minimum as Aircraft Commander
Published	1000 hrs total 150 hrs 1st Pilot UE	Not Used	
300 ft and one mile	750 hrs total 100 hrs 1st Pilot UE	300 ft and one mile	500 hrs total Jet 100 hrs UE 25 hrs Jet weather
500 ft and 1 1/2 mile	500 hrs total 50 hrs 1st Pilot UE	400 ft and 1 1/2 mile	250 hrs total Jet 50 hrs UE 15 hrs Jet weather
700 ft and 2 miles	Instrument check in UE by TAC	500 ft and 2 miles	Instrument check by USAFE 5 sorties in USAFE 8 hrs Jet weather

A determination of which set of criteria is "right" would be difficult if not impossible. Likewise, trying to justify why the experience levels are different is just as difficult. Continuity of training of "Air Force" pilots should dictate that the criteria be standardized for all the commands.

Summary. Although the establishment of command weather minimums is a valid method of achieving a safety buffer above the Air Force criteria, the methods used by ATC and TAC do not consistently achieve that goal. The determination of the size of the buffer is not supported by quantitative analysis but is the best estimate of the individuals who initiated and monitor the system. The definition of an experienced pilot varies from command to command.

Approach Criteria and Weather Criteria Modified. MAC, SAC, and USAFE have exercised their option by modifying DOD published approach minimums and, to some degree, the weather criteria for filing and for starting an approach.

Military Airlift Command. MAC has imposed command weather criteria in the form of a minimum visibility of 1/2 mile (RVR 2400) for filing or for starting a precision radar approach. This type of command guidance has the limitation of an inconsistent buffer similar to the previous group. However, considering that it only applies to precision radar approaches, the limitation does not have the same impact as the ATC or TAC restrictions.

MAC has also modified the approach minimums by imposing a minimum DH of 200 feet for precision radar approaches. The impact of modifying the approach minimums has not been discussed and several aspects of this type of limitation merit mentioning.

The only decision height authorized below 200 feet for precision radar approach is 100 feet. Therefore, MAC has eliminated the use of 100 feet DH for precision radar approached. For the approaches with a published approach minimum of 100 feet, the pilot will make the landing decision at 200 feet which means the ground clearance has been increased at the decision point and the distance from the decision point to the glide path/runway intercept point has been increased (Figure 5) i.e., when the pilot makes the decision to land he will have more ground clearance and he

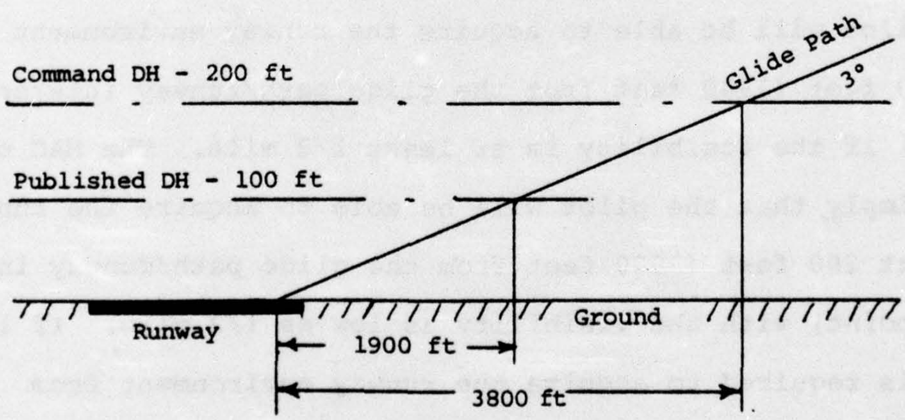

Figure 5. Decision Heights versus Glide Path

will be further from the runway. The pilot will have more time to maneuver the aircraft and to transition to the visual landing. It does not automatically follow that the transition from instrument flight to the visual references will be easier. The pilot now has more opportunity to become confused, try to go "visual" too early, or, in general, be misled by the reduced visual cues and induce higher sink rates or excessive corrections from which he must recover.

Perhaps of more concern is that MAC has not accomplished any detailed studies to insure the 200 foot minimum DH will always be compatible with the command imposed 1/2 mile minimum visibility. As an example, the Patuxent River NAS precision radar approach has published minimums (TERPS) for runway 24 of 100 feet and 1/2 mile visibility with a DH of 100 feet. Assuming the existing weather is 200 feet and 1/2 mile, the MAC pilot is authorized to start the approach. The TERPS minimums imply that, with the available facilities, the pilot will be able to acquire the runway environment when at 100 feet (1900 feet from the glide path/runway intercept point) if the visibility is at least 1/2 mile. The MAC minimums imply that the pilot will be able to acquire the runway when at 200 feet (3800 feet from the glide path/runway intercept point) with the visibility as low as 1/2 mile. If 1/2 mile is required to acquire the runway environment from 1900 feet it is unlikely 1/2 mile will be sufficient visibility from 3800 feet (Figure 5). In this case, the command guidance authorizes an approach where the weather conditions, weather minimums, and approach minimums indicate a missed approach is very likely. Although standard instrument procedures should permit the pilot to cope with this situation, it is a poor command procedure which fails to provide a safety buffer and may even negate the basic TERPS criteria.

Strategic Air Command. Although SAC's mission is quite different from MAC's, the type of aircraft and the limitations imposed are quite similar. SAC has also established a minimum DH of 200 feet and weather minimum of 1/2 mile (RVR 2400) for filing or for starting an approach. However, the SAC limitations apply to all precision approaches and they have added a 200 foot ceiling minimum to the weather minimums for filing or for starting an approach. The comments made for MAC are applicable to SAC, i.e., the weather criteria does not provide a safety buffer for all approaches and the compatibility of the command established DH and the command established minimum visibility has not been verified.

United States Air Forces in Europe. By far the command with the most extensive changes to the approach procedures is USAFE. USAFE has created a new set of criteria which they have superimposed over the AF guidance. To determine his approach and weather minimums, the USAFE pilot must know the published minimums, the command specified minimum for the type of approach to be flown, and his pilot weather category.

The command specified minimum for the type of approach to be flown is a unique feature of the USAFE procedure. Table III in Chapter III lists the USAFE approach and weather criteria for precision, nonprecision, and circling approaches. This feature is noteworthy because the TERPS' location of the MAP for a nonprecision approach is not compatible with aircraft having high performance characteristics. No attempt has been made to locate the MAP where the MDA would intercept a reasonable glide path for high performance aircraft (Figure 6). Likewise the published visibility may not permit the pilot to acquire the runway from the point where the MDA intercepts the glide path. USAFE requires 1 1/2 miles of

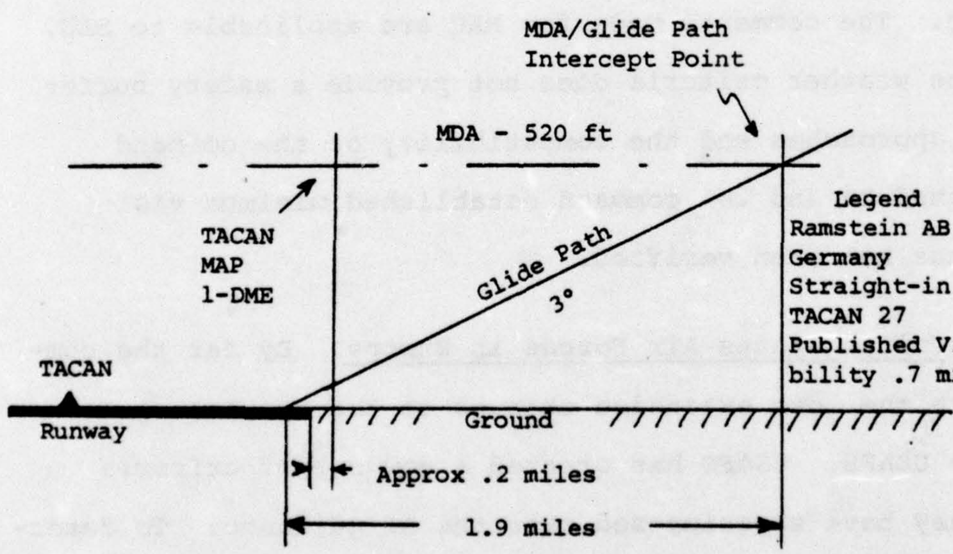

Figure 6. Geometry of Nonprecision Approach

visibility to help correct this deficiency. Again, using a fixed weather minimum falls short of providing a uniform safety buffer for all approaches. Simultaneously establishing a minimum MDA of 500 feet tends to negate some of the advantages achieved by establishing the minimum visibility requirement. In spite of these short comings, USAFE is the only command to address this apparent TERPS deficiency.

USAFE has formed four pilot weather categories which are assigned in accordance with flying experience. The weather values used for each category are compatible with a 3 degree glide path. As shown in Table V, the required visibility is greater than the distance to the end of the runway for each category.

Table V.

USAFE Pilot Weather Categories Compared to 3° Glide Path

Category	Minimum Weather	3° Glide Path Altitude	3° Glide Path Distance to End of Runway
I	300 feet, 1 mile	300 feet	Less than 1 mile
II	400 feet, 1.5 miles	400 feet	Less than 1.5 miles
III	500 feet, 2 miles	500 feet	Less than 1.8 miles
IV	800 feet, 3 miles	800 feet	Less than 2.9 miles

The flying experience requirements for the pilot weather categories were discussed in the previous section and were compared to the TAC requirements. The definition of an experienced pilot varies from command to command.

Table VI presents three examples of how a USAFE pilot would compute his approach minimums using the published minimums, command minimums, and pilot weather categories. Table VI demonstrates that the pilot must know and consider each possibility. In so doing it introduces the possibility of selecting the wrong value which could be below the published minimums (Example 2 in Table VI). It also demonstrates that the USAFE method is not simple.

In making such extensive changes to the approach minimums, i.e., the DH and MDA, USAFE has created a problem not experienced by MAC and SAC. Although MAC and SAC established 200 feet as the minimum DH, this restriction had no great effect on the TERPS established missed approach procedures. In contrast, USAFE pilots use DH's as high as 800 feet. If a missed approach is executed at this point, the pilot could be initiating the missed approach procedures over three miles prior to the standard missed approach point. In so doing the pilot could follow the missed approach procedures but fail to remain within the TERPS designed missed approach corridor. This would negate the ground and obstacle clearance provisions of the TERPS procedure and the pilot could inadvertently fly into reserved airspace or conflict with visual traffic patterns. It also complicates the traffic controllers task when he is uncertain if a missed approach will be executed at the MAP or at some point as

Table VI.

Examples of Computing Approach Minimums

Example-Type Approach	Published Minimums*	Command Minimums**	Pilot Weather Category***	Actual Minimums
1- PAR to Runway 27	DH - 880 ft MSL (100 ft above touch-down zone elevation)	DH - 1080 ft MSL (300 ft above field elevation)	DH - 1180 ft MSL (400 ft above field elevation)	DH - 1180 ft MSL (pilot weather category)
2- Straight-in HI-TACAN Runway 27	MDA - 1300 ft MSL (520 ft above touch-down zone elevation)	MDA - 1280 ft MSL (500 ft above field elevation).	MDA - 1180 ft MSL (400 ft above field elevation	MDA - 1300 ft MSL (Published approach minimums)
3- HI-ILS Runway 27 Circling	MDA - 1640 ft MSL (860 ft above field elevation)	MDA 1780 ft MSL (1000 ft above field elevation)	MDA - 1180 ft MSL (400 ft above field elevation)	MDA - 1780 ft MSL (Command established minimum)

* (DOD Flip Documents, 1976)

** (USAFE Supplement to AFR 60-16, 1975)

*** (USAFEM 55-11, 1974)

Note: Computations are for:
Ramstein Air Base, Germany
USAFE Pilot Weather Category II
Category E Type Aircraft

far as three miles prior to the MAP. These conditions produce potentially hazardous traffic control situations.

In determining weather minimums, the pilot must use a matrix similar to Table V. In this case the parameters considered would be cloud ceiling and visibility. Table VII reaccomplishes example 2 from Table VI using the appropriate weather criteria.

Table VII.

Example of Computing Weather Minimums

Type Approach	Published Minimums*	Command Minimums*	Pilot Weather Category*	Actual Minimums
2- Straight-in HI-TACAN Runway 27	600 feet .7 miles	500 feet 1 1/2 miles	400 feet 1 1/2 miles	600 feet 1 1/2 miles

*Same references as Table VI.

Note: Computations are for:
Ramstein Air Base, Germany
USAFE Pilot Weather Category II
Category E Type Aircraft

Although the concept is repetitive for computing the approach minimums and weather minimums, the actual values are critical. The actual weather minimums used in example 2, Table VII were a combination of all three considerations. Again the USAFE procedure is complex, requires the manipulation of many numbers, and introduces the possibility of selecting the wrong value.

Even though USAFE has provided multiple sets of weather criteria, they have still failed to capture a system which provides a uniform safety buffer over the Air Force provided guidance. By modifying the approach minimums simultaneously and in the same increments as the weather minimums, USAFE effectively reduces some of the safety buffer gained by modifying only the weather criteria. For example, a TAC category B pilot is required to have 300 feet and one mile visibility to start an approach but may fly to the published approach minimums. When he reaches the published DH, say 100 feet, the existing visibility should be greater than that required for the approach by TERPS. Under the same circumstances, the USAFE Category I pilot, who also must have 300 feet and 1 mile visibility, would use a DH of 300 feet. Although the existing visibility is higher than published, the DH has moved up correspondingly and some of the safety buffer gained is immediately lost.

Summary. In this group, MAC, SAC, and USAFE have established command guidance which modifies the approach criteria and, to some degree, the weather criteria. Each command has provided additional ground clearance at the point where the decision to land is made. However the command guidance has failed to provide a uniform safety buffer and there are no provisions to insure the compatibility of the command imposed limitations. USAFE's documentation is very thorough but the extensiveness of their program introduces new concerns. The adequacy of the missed approach corridor is in question and the increased possibility of personnel error due to the complexity of the procedures are examples of the areas of concern. Each command has solved a part of the problem but no one has considered all the problem.

Major Command Rationale

As stated in Chapter IV, the commonality of the responses from the major commands made a by-command discussion of the rationale repetitive. The comments in this section will be presented in the same format used in Chapter IV, i.e., Pilot, Aircraft, Navigational System, and Other. The rationale will be examined to see if the safety implications would be reasonable justification for establishing more restrictive command guidance. It is recognized that safety is a broad concept not easily defined, especially in terms of quantity desired. The two extreme possibilities, i.e., do not fly or eliminate all controls on flying, are presently unacceptable. The middle ground is more difficult to judge. In each case in this thesis, the author has called upon his experiences, and the determination of the reasonableness of the safety implications is his subjective analysis.

Pilot. The comments for pilots were divided into two areas, capabilities and qualifications.

Capabilities. The commands were concerned with the short time to make the transition from instrument flying to visual flight, the close proximity of the ground during these last second maneuvers, and controlling aircraft sink rates at this crucial time. The commands who flew aircraft with high approach speeds were concerned with the short time available while those who flew large aircraft were more concerned with maneuvering close to the ground. Control of the aircraft rate concerned everyone.

In the author's opinion, these reasons, by themselves, do not warrant changing the approach criteria. Pilot capabilities were a part of the original TERPS criteria identified as pilotage error standards. Furthermore, there are examples which indicate more restrictive guidance is not required. For example, AFSC pilots and TAC "experienced" pilots fly published minimums without any apparent problems. Also in the commercial airlines operations, the pilots fly the published minimums for the category of the aircraft being flown. These examples do not prove published minimums are adequate, but they do demonstrate that the published procedures have been used without wholesale disaster. It is difficult to discuss pilot capabilities in these areas without considering aircraft performance characteristics. Suggested actions provided in a subsequent aircraft section will help to alleviate the concerns expressed in this section.

<u>Qualifications</u>. The comments in this area involved pilot experience, proficiency, and currency.

The major commands agreed pilot flying proficiency and currency were reasons for modifying the recovery minimums even though Air Force directives provided guidelines defining minimum acceptable levels for proficiency and currency. It was felt the Air Force guidance was too vague to insure adequate levels of proficiency and currency to fly an instrument recovery to published minimums. The guidance of the major commands appears to treat the possible outcome rather than the cause, i.e., they do not attempt to define adequate proficiency and currency levels. Although major command guidance might seem appropriate for this problem, it is the author's opinion that those best qualified to judge an individual's proficiency and currency are the unit commanders. The unit commanders personally know each individual and can provide a daily assessment of each individual's proficiency and currency in light of the individual's overall flying experience. Although general major command guidelines can be of assistance, the problem will remain one which requires on-the-scene judgment.

The commands were not in agreement with respect to the importance of pilot flying experience. AFSC authorizes all of their pilots to fly to published minimums. MAC has established a command minimum but authorizes MAC pilots to fly to that minimum regardless of experience level. TAC and USAFE assign pilot weather categories based on pilot experience levels, however, as noted earlier in this chapter, the TAC and USAFE command established experience levels are different. It is the author's opinion that pilot flying experience may be a reasonable parameter to use as a base upon which to establish command guidance. Since there are cases where flying experience has been ignored with acceptable results, it should not be mandatory to use flying experience as the criteria for the command minimums. However, if flying experience is used, Air Force should provide standardized definitions for levels of experience.

Regardless of the course of action taken, the interpretation of flying experience, proficiency, and currency will remain subjective.

Aircraft. The aircraft comments dealt with maneuverability and engine performance with respect to available reaction time, ground proximity, and aircraft sink rate. Some were concerned with wing tip clearance when maneuvering at low altitude. Many doubted if the roll rates and roll response times were adequate for the last second maneuvers required by flying to published minimums. Lastly some were uncertain if engine acceleration characteristics were compatible with the available time and sink rates encountered in transitioning to a visual landing.

All of the factors mentioned were implicitly considered by those who initially established the TERPS criteria. It is the author's opinion that the commands are again treating the outcome rather than attacking the cause. The comments made appeared to be a series of complaints questioning the validity of the TERPS established aircraft categories. In this case, the commands should be taking steps to establish new TERPS minimums for the various categories, or redefine the present TERPS categories, or suggest additional TERPS categories to cover the new aircraft characteristics, or some combination of these three possibilities. As of this date, none of the commands have initiated action of this nature. The suggestion is not to eliminate the command established minimums, but rather to shift the priorities so that the major effort would be to attack the cause and the command established minimums would be considered as an interim measure. Modifying the TERPS categories would also alleviate some of the problems cited in the Pilot Capabilities section.

Navigational System. Many of the commands were opposed to the use of a DH of 100 feet for precision approach because it was too low for operational use. This comment was closely related to the remarks in the previous sections, Pilot Capabilities and Aircraft. An evaluation of the 100 foot DH should be included as part of the overall discussion of aircraft categories and their associated published minimums.

Other. This section was added to handle the rationale that did not fit into the preceding three sections.

Rapidly changing weather conditions made more restrictive filing minimums a desirable feature for some locations. For example, the ADCOM F-4 pilots assigned to Iceland were restricted to weather minimums of 1000 feet and three miles visibility because the weather conditions were unpredictable and the recovery bases were limited. In the author's opinion, this type of limitation is not only justified but displays prudent judgment. However, it is felt that this type of phenomenon is geographically limited and can best be handled using local guidance as opposed to command wide guidance.

Two reasons which have intuitive appeal were that it has always been done that way, and why not, it has not historically hampered the mission and it provides a safety buffer. The fact that a system has been in being for a long time provides a minimum risk departure point for those responsible. However, this makes no allowance for possible improvement in any area. There is also no assurance that the "old" way is the most efficient way. This type of rationale may provide a good departure point but it should not be assumed that it is a good stopping point. The "why not?" statement is typical of the attitude that can easily develop around a safety related program. The command guidance is offered to reduce the risk in the recovery maneuvers and is thus in the best interest of flight safety. Once the program is established, it becomes self perpetuating and requires no further justification. In fact, justification is now required to delete or reduce the program. The first portion of this chapter repeatedly disputes the claim that the present guidance provides a safety buffer in all cases. Whether the guidance has hampered the mission has not been denied or confirmed due to the lack of studies to show the effects of the system on the mission. Although these reasons may have a certain ear appeal, they do not provide reasonable justification to retain the present guidance.

The last reason suggested that the procedures were the desires of the commander and reflected his view of how to enhance flight safety in his command. Although this may be a sensitive issue, the staff is faced with a well documented dilemma. There is an obligation to study the commander's proposal in light of his objectives, point out strengths and weaknesses, present alternatives, and make recommendations. Once the final decision is made, the staff must implement and support the measure and, if they disagree, await a new opportunity to suggest a change.

<u>Summary</u>. The major command rationale was not unique and in most cases the author did not feel the rationale provided justification to establish additional command guidance. In two cases, it appeared the commands were addressing an outcome to make it acceptable rather than attacking the cause so that the outcome would become acceptable. It was suggested that the priorities could be adjusted to make the command guidance an interim measure and require the major effort to be put into rectifying the underlying cause. Considering the rationale cited, the primary method used to determine what course of action to take will be subjective.

Additional Considerations

In the previous chapters, several problem areas were encountered, but were not discussed in detail because they were secondary issues and lengthy discussions were not appropriate at the time. These are the items which could not be classified as command guidance or command rationale. This material will be presented by subject area.

TERPS Nonprecision Approaches. The TERPS established nonprecision approach procedures are incompatible with the characteristics of high performance aircraft. Although this subject was mentioned in the Major Command Guidance section of this chapter, the entire area was not discussed. The problem involves the interrelationship of the MDA, the MAP, a reasonable glide path, and the published minimum visibility for nonprecision approaches.

As opposed to a precision approach which has a descending final approach, the nonprecision approach has a level MDA which must be high enough to provide the required obstacle and terrain clearance over all the final approach segment of the instrument approach. A reasonable glide path for a high performance aircraft is 2.5 to 3.0°. (For this discussion 3° will be used.) The TERPS criteria makes no attempt to locate the MAP at the point where the MDA intercepts the 3° glide path, and in fact, the MAP is usually much closer to the runway than the MDA/glide path intersection point (Example-Figure 6, Chapter V). Therefore, if a pilot of a high performance aircraft flies to the MAP and decides to land, he must establish a glide path steeper than 3°. The situation is complicated by considering the published minimum visibility. The TERPS criteria, Table VI on Page 35 of AFM 55-9, establishes the minimum visibility in accordance with the location of the MAP, i.e., the MAP is the last point on a nonprecision approach where the pilot can elect to land, after which a missed approach must be executed. Therefore, if the existing visibility is at or near the published minimum, the pilot will fly to the MAP where he will execute a missed approach, or if he decides to land, he will be forced to use a relatively steep glide path. Normally, safety would dictate the pilot of a high performance aircraft execute a missed approach and therefore, the nonprecision approach is no longer acceptable as an instrument approach for recovery by this type of aircraft with minimum weather conditions.

The present format for the nonprecision approach has managed to survive for several reasons, i.e., the method of execution; lack of practical application; and opposition to change.

Execution. When flying a nonprecision approach, the pilot is authorized to visually establish the glide path whenever he identifies the runway environment rather than having to wait until reaching the MAP. As a result, when practicing nonprecision approaches, it is not mandatory for the pilot to fly to the MAP before making the decision to land. The necessity to fly a steep glide path is thus avoided. In addition, a pilot also receives "credit" for practicing a nonprecision approach if he flies to the MAP and executes a go-around, again avoiding the requirement to establish the "steep" final glide path. Therefore, unless the weather conditions are at or near the published minimums, there is no reason to experience or practice the steep glide path that would be encountered if the approach were flown to the MAP.

Practical Application. In the eight commands documented, there was a general lack of practical application of the nonprecision approach in weather conditions at or near the published minimums. The precision approach supplies more information and has lower published minimums than the nonprecision approach and pilots normally select the former as the instrument approach for the recovery landing. There were two cases where nonprecision approaches were considered essential. MAC and ADCOM were tasked to fly to many airfields without precision approach facilities and were required to use nonprecision procedures. Other commands, such as ATC, fly aircraft such as the T-37, which are not ILS equipped, and must fly out of auxiliary airfields which are also not equipped for precision approaches. Although valid considerations, these two conditions were in the minority, with the majority of the commands expressing little practical application for the nonprecision approach under actual low weather conditions.

Opposition. The inadequacies of the nonprecision approach procedures have not gone unnoticed. It would seem logical to move the MAP to the MDA/glide path intersection point and establish visibility criteria for the new MAP location. An obstacle to changing the location of the MAP is that not all aircraft have high performance characteristics. For example, the present procedures are adequate for the light aircraft flown by the Army. Obtaining the necessary coordination and approval of the Army to change the present procedures could prove to be difficult. If the MAP is moved out and the visibility made compatible, the actual visibility requirement would be so close to the three miles required for visual flight rules that the nonprecision approach could not be used as an instrument approach for low visibility conditions. AFM 55-9 now states that 2 miles will be the maximum published visibility for nonprecision approaches.

Possible Actions. Not everyone would like to see the present nonprecision approach procedures changed, but the procedure is incompatible with high performance aircraft. One possible solution is the Visual Descent Point Concept which is presently under consideration. This proposal would not relocate the MAP but would depict on the approach procedures chart the location of the MDA/glide path intersection point. This would then be advisory information which the pilot of a high performance aircraft could use to assist in making the decision to land or execute a missed approach. Until a solution is finalized, each command flying high performance aircraft should devise interim guidance to neutralize this deficiency.

Operational Problems. The establishment of different guidance by each command has complicated operational deployments by commands such as TAC. The crux of the problem is highlighted by the following TAC directive.

> When TAC units are placed under the operational control of another command, minimums will be in accordance with those established by that command [AFR 60-16/TAC Sup, 1975:6].

From the pilots point of view, the ideal solution would be standardization of guidance between commands or standardization of the methods of application.

Intangibles. There are other issues which do not have clear cut solutions but should be given due consideration. These include pilot motivation, the inexperienced pilot, and overall impact on mission effectiveness.

Pilot Motivation. It is impossible to quantify the effects of pilot motivation, but it is possible to judge if the effects would be positive or negative. It appears the present major command guidance provides negative pilot motivation. The point can be best illustrated through an example. It is possible for two pilots of similar qualifications assigned to different commands, to fly the C-135 in similar weather environment using different basic guidance provided by the parent major command, e.g., the AFSC pilot uses published minimums while the SAC pilot is restricted to higher command minimums. Should the AFSC pilot subsequently be assigned to SAC, he would no longer be authorized to fly published minimums, but would be restricted to the higher SAC minimums. Since the change had nothing to do with a change in qualification, it is difficult for the pilots to rationalize the inconsistency. Since such inconsistencies exist, the pilot tends to "push" the command minimums knowing they are above the true published minimums. Such actions are counter productive to the goal of providing a safety buffer above the Air Force guidance. In this respect the outcome could be considered to be the results of negative pilot motivation.

<u>Inexperienced Pilot</u>. The TERPS system was devised to standardize instrument procedures. In particular, the instrument approach procedures charts were designed to provide a ready reference which would contain all of the critical information necessary to fly that approach. The major command guidance modified the weather and/or the approach minimums portrayed on the approach charts. It is ironic that the pilot with the least experience is given the most restrictions and must know how to modify the chart and remember the command changes while his more experienced counterpart enjoys the benefits of a single source document without changes. The inexperienced pilot

must contend with command established variations to TERPS procedures at a time when he could benefit most from the single source document.

Mission Effectiveness. It is essential for each commander to continually evaluate the impact of his guidance on the unit's ability to accomplish the mission. Assuming the mission is to wage war and one of the goals of the Air Force is to successfully launch and recover aircraft under adverse weather conditions during times of hostilities, the present major command guidance for aircraft recovery could have a direct effect. It has been the author's experience that artificial limits, regardless of the rationale for adopting them, are quickly assumed to be real limits by the user, especially someone who has not experienced otherwise. During hostilities, artificial limits will be removed and the psychological impact of having always used higher recovery minimums cannot be quantified. The risk is that the losses incurred when reverting back to the published minimums may be crucial during the initial phases of hostilities. Such considerations must be continually weighed and evaluated by each commander in light of the current situation, e.g., likelihood of hostilities, anticipated build up time, likely weather conditions, etc.

Weather Conditions. On several occasions it was noted that the major commands did not accomplish any studies to support or document the effects of the command guidance. Since weather phenomena has always plagued flying operations, it seems reasonable that the weather aspects would be the object of a study for establishing minimums for recoveries under instrument conditions. Many weather studies have been done but none specifically for the command established minimums. In fact, the opposite is true. Once the command imposed limitations were known, weather studies were accomplished to determine a weather factor to use in the scheduling function.

This discussion will provide an example of the type of study that could be done to include the pitfalls and shortcomings in data collection, weather observations, and weather forecasting.

Example. Major Helton, in his research study, An Analysis of Flying Time and Training Losses in 17th Air Force, made a typical weather study. For his purposes he felt justified in using only ceiling and visibility information. A portion of the weather data he compiled for 17th Air Force, which is located in Germany, is shown in Table VIII. Any weather study such as this requires structuring to make the data manageable. In so doing some errors are introduced. Major Helton's data came from five air bases in 17th Air Force. The data was compiled by averaging two, two-hour intervals in each time period, averaging each time period for each month October through March, averaging the six month intervals, and then averaging the six month intervals

Table VIII.

17th Air Force Weather Data for October-March*

% Frequency-less than	cloud ceiling-or	visibility	for time interval
43%	1000 feet	2 miles	0600-1100 LST
27%	1000 feet	2 miles	1200-1700 LST
19%	300 feet	1 mile	0600-1100 LST
10%	300 feet	1 mile	1200-1700 LST

*Reference Helton, 1974:24.

for all five air bases. In so doing some degree of accuracy is lost through averaging. The specific details of this data are not relevant to this thesis, but it does illustrate a possible method to use in considering weather data. Considering the differences between the published minimums and the command established minimums discussed in this thesis, the weather data required would have to be detailed to be useable. Under these conditions, studies done at the local level may be more valid and applicable because the averaging errors are reduced and it would be possible to key on local factors when selecting the data base. The goal of such a study would be to determine the impact of various command options on accomplishment of the training mission.

Weather Observations. The existing weather is documented by the weather observations made by qualified observers. The methods used in taking weather observations create problems for pilots and those in charge of flying operations. Visibility observations fall into this category.

The three types of visibility measurements are runway visual range (RVR), runway visibility (RV), and prevailing visibility (PV). The pilot's decision to commence an approach will be based, in part, on one of these visibility observations. Specifically, the pilot needs to know if there will be sufficient visibility to acquire the runway environment in sufficient time to make a safe landing. He is, therefore, interested in the slant range visibility in the last portions of the instrument approach. RVR is a mechanical measurement of the horizontal visibility made near the runway in the vicinity of the proposed touchdown zone. RV is either instrumentally or visually determined. If visually derived, an observer is located at the end of the runway viewing targets down the runway. PV is defined as the greatest horizontal visibility which is equalled or surpassed throughout half of the horizon circle; it does not have to be a continuous half of the horizon circle (AFM 51-12, 1974:Chapters 13 and 17). The visibility observations do not precisely fulfill the pilot's requirements. This dilemma must be resolved by those responsible for flying operations. It should also be considered when setting command limitations for recovery under instrument conditions.

Weather Forecasts. Forecasting the weather for flying operations is much more difficult than providing a general area weather forecast. Because of the uncertainties, Air Force has provided specific guidance defining the forecasted weather conditions when an alternate landing field must be designated. Air Force also defines what the forecasted weather will be at the designated alternate airfield. Weather forecasters may designate a forecast as intermittent or prevailing conditions. Again Air Force guidance has been provided on how to use these two conditions (AFR 60-16, 1974: 8-1). The possible variations of the weather forecast is another factor that should be considered when modifying the weather minimums required to file or to start an approach.

Conclusion. The documentation and study of the weather phenomena has not been highlighted as the sole consideration. For the subject of this thesis it would be an important factor to be considered along with all of the other relevant factors.

Summary

The major command guidance was analyzed in light of an assumed objective of enhancing flight safety. Although there were many variations to modify the approach and/or the weather minimums, no one command succeeded in providing a uniform safety buffer for all cases. Also, there were no provisions to insure the compatibility of the command imposed limitations with the Air Force guidance or with themselves.

The command rationale was reviewed to see if the safety implications would justify establishing restrictive major command guidance. This area was subjective and reflects the author's opinion. In his opinion, the rationale offered did not in itself justify modifying the recovery procedures. Suggestions were made to reorient the command priorities toward correcting causes rather than treating outcomes.

Additional consideration was then given to the secondary issues not previously discussed. The incompatibility of the TERPS established nonprecision approach procedures with the characteristics of high performance aircraft was documented and discussed in detail. Other major issues addressed were the intangible aspects of the command guidance and the implications of the weather factor in formulating command guidance.

The information from this chapter provides the guidelines for formulating the proposed guidance found in the next chapter.

VI. Formulation of Proposed Guidance

The major commands ~~have~~ used a variety of techniques in modifying the Air Force guidance for recovery under instrument conditions. In attempting to provide a conservative element for instrument recoveries they have failed to capture a system which provides a uniform safety buffer. In the process, they have also introduced complex procedures, created conflicts between their guidance and the Air Force guidance as well as within their own guidance, and have departed from the Air Force standardized procedures.

The proposed guidance suggested in this chapter is designed to avoid the identified deficiencies while providing a safety buffer for all approaches. The guidance is simple, sound, and viable in concept and implementation while still retaining the element of flexibility.

The material is presented in the format of assumptions, general proposal, applications, advantages, and summary. The applications section will enumerate and demonstrate some of the options and flexibility of the proposed guidance.

Assumptions

Since it is impractical to discard the present standards set forth in AFM 55-9 and for each command to formulate its own set of criteria, it is assumed the criteria in AFM 55-9 is sound. Therefore, the command guidance must be no less restrictive than AFM 55-9. It is also assumed that if a deficiency is identified in the basic document, the commands concerned will take the appropriate actions to rectify the situation.

General Proposal

Although there are many numerical variations, the three basic ways to modify the Air Force guidance are through the approach minimums, the weather minimums, or some combination of the two.

Approach Minimums. The approach minimums will not be modified. Each pilot, regardless of his assigned command, would fly all instrument approaches using the standard procedures and the published values. This provides consistency in training and evaluation. It also keeps the single document concept intact for all pilots flying instrument approaches.

Weather Minimums. The weather minimums will be varied to achieve a margin of safety. The basic method will be to add incremental values to the published weather minimums. For example, if a command perceives that precision approaches are too demanding, they can establish a safety buffer by requiring a 1/2 mile increment be added to the published visibility minimums for all precision approaches. The stress is put on the TERPS published values as the base line and the point of departure. The following section will discuss applications and possible variations to this incremental method.

Applications

The incremental proposal can be applied to the type of approach to be flown, to specific types of aircraft, or assigned to individual pilots as a pilot weather category depending on the desires of the command. Table IX provides examples of the three types of applications.

It is recommended (but not mandatory) in the interest of simplicity that only one of the three possibilities shown in Table IX be used. The method assumes the TERPS determination of the "minimums" is valid. The method will always provide the established buffer above the TERPS minimums.

To be universally applied, the proposed method must be acceptable to cover specialized cases which require interim guidance. Two situations already identified are the incompatible nonprecision guidance and large aircraft maneuverability. While attempting to change the TERPS procedures, the command could use the following interim guidance.

Table IX.

Examples of the Three Methods of Application of the Proposed Guidance*

1. By Type of Approach

Type	Increment to be added Cloud	Visibility
Precision	0	1/4 mile
Nonprecision	100 ft	1/2 mile

2. By Aircraft Type

Type	Increment to be added Cloud	Visibility
C-5	100 ft	1/4 mile
F-4	200 ft	1/2 mile

3. By Pilot Weather Category

Category	Increment to be added Cloud	Visibility
I - Experienced	0	0
II - Somewhat Experienced	100 ft	1/2 mile
III - Inexperienced	300 ft	1 mile

*The actual values used demonstrate the concept and are not recommended values.

Nonprecision Approaches. As previously stated, the nonprecision approach TERPS criteria is incompatible with high performance aircraft. As an interim measure, the major command could stipulate that the visibility criteria for all nonprecision approaches will be 1 1/2 miles <u>or</u> 1/4 mile higher than the published visibility minimums, whichever is higher. In this manner the command has defined 1 1/4 miles as the minimum safe visibility for nonprecision approaches and has added a safety buffer of 1/4 miles above this and all other published minimums.

Large Aircraft Maneuverability. In the second example aircraft maneuverability is considered to be critical in the final phases of a precision approach. The command minimum visibility will be 1/2 mile or 1/4 mile above published visibility minimums, whichever is higher for precision approaches. The visibility will always be 1/4 mile above published, which should provide the pilot with better visual cues during the transition from instrument to visual flight. The transition should therefore occur sooner and be less abrupt, thus alleviating the maneuverability problem cited.

Problems. The proposal has simplified many of the procedures, but it has not eliminated all of the problems. It is still necessary to determine the size of the increments, how to define experienced, and when to apply the limitation (filing or starting an approach).

Increment Size. The size of the increment used will be the best judgment of those responsible, however, a systematic review of the relevant factors will insure that the alternatives have been considered. A weather analysis similar to Major Helton's (Chapter VI) could be beneficial.

Local level considerations could enhance the validity of the weather data. Operational consideration such as sortie length, or training requirements, or mission accomplishments are examples of other factors to be considered. This listing is not intended to be all inclusive. The degree and depth of the studies will be the responsibilities of those charged with establishing the increment.

Flying Experience. If a command decides to use the incremental method of establishing pilot weather categories based on flying experience, it must face the issue of defining flying experience. One possibility would be to study the aircraft accidents which occurred during recovery under instrument conditions to see if a relationship could be established with some indicator of flying experience. Regardless of the results of the analysis, the decision must be reviewed periodically to insure the solution is still practical. The flying hours of an "experienced" pilot at the beginning of World War II were very different from the "experienced" pilot one year later. A similar shift in experience level is also possible due to personnel policy changes. This does not mean an analysis of the relevant factors should not be done, only that the results must be reviewed periodically.

Filing or Starting an Approach. When or where to make the guidance applicable is another problem which must be addressed by the implementing command. An ill-conceived set of criteria could result in premature cancellations based on pessimistic forecasted weather or unnecessary exposure of pilots to extremely low weather conditions. Each command situation will present a unique set of circumstances which must be considered to achieve the desired results.

Advantages

Although several problems were cited, these problems are not unique but are a part of the normal decision making processes. The advantages of the proposed guidance are simplicity, consistency in providing a safety buffer, and retention of the elements of standardization and flexibility. The pilots of any command would know that only the weather minimums will be modified and once an approach is started, the standardized procedures will be flown as annotated on the instrument approach procedures chart.

Summary

The guidance proposed in this chapter was designed to avoid identified deficiencies while providing a safety buffer for all approaches. Approach minimums will not be modified. Weather minimums will be modified by a command increment to insure a consistent safety buffer. The proposed procedure demonstrated the required flexibility to cover specialized cases. The problems of determining the size of increment and defining the levels of flying experience cannot be avoided.

The following chapter will provide the summary, conclusions and thesis recommendations.

VII. Summary, Conclusions and Recommendations

Summary

This thesis has addressed aircraft recovery procedures under instrument flying conditions. Although the Air Force has established standardized procedures, many of the major commands elected to modify the Air Force guidance. There is a vast difference in the scope of the specific guidance provided by the major commands.

The purpose of the thesis is to document the Air Force guidance and the major command guidance, and to formulate a standard method of establishing major command guidance for aircraft recovery under instrument conditions. To insure readability it was necessary to specifically define four phrases: the weather required to file a flight plan; the weather minimums; the approach minimums; and the published minimums. To further minimize confusion the terms precision, nonprecision, and circling approaches were discussed in detail.

The Air Force guidance for recovery under instrument conditions was found to be comprehensive and well thought out. The pilot, aircraft, and navigational systems were all considered in formulating the standardized procedures. The standardized criteria were formally documented in AFM 55-9. A distribution system was created to insure the latest information was available to the pilot in a timely manner.

When given the option to modify the Air Force guidance, the major commands responded in different ways. Only those actions which directly modified recovery procedures were considered in this thesis. The actions taken by the eight commands examined were grouped into three general categories: no direct action; weather criteria modified; and approach criteria and weather criteria modified. Only AFSC has a truly "hands off" policy for the recovery procedures while, at the other extreme, USAFE provides an extensive matrix of command guidance. The rationale provided by the major commands for their actions are also presented. The rationale are not unique and could not be attributed to any particular command.

The analysis of the actions of the commands and their rationale, plus the analysis of other relevant secondary issues, provided the guidelines and identified many of the problem areas to be avoided when formulating the proposed guidance.

Conclusions

Historically, landing an aircraft is a potentially hazardous maneuver. Each level of command recognizes that attempting a recovery under instrument flying conditions further complicates the landing task.

The assumptions made and the limitations imposed in this thesis play an important role in drawing conclusions and making recommendations. Each assumption and limitation should be known before judging the applicability of the final results.

At the onset, it was determined that certain terms were critical to the understanding of the thesis. An understanding of the subtle differences and overlappings of approach minimums, weather minimums, and published minimums are mandatory. Clarification of the terms precision, nonprecision and circling approaches was helpful.

Air Force Guidance. The product of the Air Force efforts for instrument recoveries is a pictorial presentation of the standard instrument approach procedures to each airfield. This one presentation provides all of the necessary information for the pilot to fly an approach to that airfield. The minima box on this presentation provides the approach and weather minimums for the appropriate aircraft categories for the various approaches to that airfield. When considering only direct modification of the recovery procedures, it was the information in the minima box that the major commands modified in setting command guidance.

Major Command Guidance. There were three major commands who were credited with taking no direct action, however only AFSC truly accepted the Air Force guidance. AFSC has no involvement in the aircraft recovery procedures while the other two commands either direct the subordinate units to establish criteria and/or perform a monitoring role on the actions taken by the subordinate units.

The other five commands who took direct action failed to set a clear goal or objective for their command established procedures. When compared to the assumed objective of enhancing flight safety, none of the commands are able to achieve a consistent safety buffer for all cases. In addition, no one performed any studies to support their actions or to investigate other alternatives. None of the commands had any provisions to insure their guidance was compatible with Air Force guidance or with other command guidance. Although benefits were derived, the procedures did not fulfill the assumed objective while introducing new problems and, in some instances, producing conflicting guidance.

<u>Other Considerations</u>. There were several other problems which were not highlighted by the major commands but were relevant to forming a proposed guidance.

<u>TERPS</u>. Two deficiencies were identified in the TERPS criteria spelled out in AFM 55-9, i.e., the application of pilotage error standards and the incompatibility of the nonprecision approach procedures with the characteristics of high performance aircraft. While the pilotage error deficiency was insignificant, the compatibility problem requires corrective action.

<u>Intangibles</u>. There were several areas where the command guidance could have an impact and the effects should

be considered. Specifically identified were pilot motivation, the inexperienced pilot, and mission effectiveness. As suggested by the heading, it is unlikely that the effects on these areas will be easily documented, however, they should be considered to obtain the proper perspective.

Weather Conditions. Since no studies were accomplished in support of the command guidance, the weather phenomena was highlighted as a major factor that could be studied. In so doing, it is necessary to not overstate the case. Weather forecasting is plagued with uncertainty, weather observation techniques can provide misleading information, and weather data are very susceptible to being warped by data collection and compilation methods. A weather study should not be the sole consideration, but it is an important factor to be considered with the other relevant factors.

Recommendations

In light of the conclusions reached it is recommended that the Air Force review its directives. Specifically, there are three areas which should be addressed.

1. The definitions of the phrases, weather required to file a flight plan, approach minimums, weather minimums, and published minimums found in Chapter I should be incorporated into AFM 51-37, the Instrument Flying Manual. The portions of AFM 51-37 which address precision, nonprecision,

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and circling approaches should be revised to eliminate the confusion that surrounds these terms.

2. The provisions of the TERPS manual, AFM 55-9, should be revised to insure the nonprecision approach criteria is compatible with the characteristics of high performance aircraft. This revision should be the result of a complete reevaluation of the validity of the nonprecision approach procedures to include the current proposals such as the Visual Descent Point concept. A less urgent TERPS issue which should be corrected, but will require long term effort, is the establishment and documentation of the pilotage error standards used in formulating each standard instrument procedure.

3. In order to insure standardization and to gain stability in the instrument procedures, Air Force should not allow the major commands to modify the published approach minimums. The appropriate references, e.g., AFR 60-16 and AFR 60-27, should be changed to delete this option. To provide the required flexibility, the change should be worded to permit the major commands to impose more restrictive weather minimums if necessitated by pilot qualifications or mission requirements. The guidance proposed in Chapter VI is compatible with this recommendation.

While the Air Force is reviewing its directives, each major command should reevaluate its guidance. It is recommended that the major commands adopt the position that they will support the instrument procedures based on AFM 55-9 criteria. If a deficiency is identified in the TERPS criteria, the commands must initiate the appropriate action to correct the deficiency rather than working around it. Then, if necessary, interim guidance could be devised to avoid hazardous situations. Once the TERPS criteria have been accepted as valid criteria, each command should reevaluate its guidance. The following steps are recommended.

1. Evaluate the present situation. Determine the operating conditions, the training and mission objectives, the command policy, etc. Compare what is required by the present situation with what is possible by using Air Force guidance to see if a problem exists.

2. If Air Force guidance appears to be inadequate, establish the objectives to be achieved by the command guidance.

3. Once the objectives are set, enumerate the alternatives. To be consistent with the previous recommendations, the major commands should not consider modifying approach minimums as an available option. Some variation of the guidance proposed in Chapter VI should be adequate.

4. Evaluate each of the alternatives in light of the stated objectives. Each of the relevant factors, such as appropriate weather studies, should be considered in conducting this evaluation.

5. Select the appropriate alternative based on the command established objectives.

Establishing Air Force and major command guidance for aircraft recovery under instrument flying conditions is not a problem that warrants the expenditure of unlimited staff resources to solve. However, a reasonable initial effort will produce long range benefits.

Once the desired instrument procedures are established, the basic concepts tend to be self sustaining and require only periodic review.

The incorporation of these recommendations will result in instrument recovery procedures which are more acceptable to the Air Force, to the major commands, and to the individual Air Force pilot.

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APPENDIX A

AFIT/ENS Box 85
Wright-Patterson AFB
Ohio 45433
9 April 1976

Dear Sir:

I am a student in the Systems Management Graduate Program of AFIT at Wright-Patterson AFB. I am writing to request your assistance to provide information in support of my thesis effort.

My thesis topic was provided by the Air Force Inspection and Safety Center (AFISC) at Norton AFB. I am to look at the guidance provided by the major commands for aircraft recovery under instrument flying conditions. Some commands establish pilot weather categories, others increase the weather requirements for commencing an approach, while still others use command established approach minimums. The attachment is formated to assist you in providing the information I feel is required. Please feel free to offer any additional comments you feel are appropriate. I might add that I have copies of your command supplements to AFR 60-1 and AFR 60-16.

I would like to add a few words of clarification to explain why I am requesting the standardization evaluation function of the major command to answer my questions. Since the subject is in the operational area, I felt that the stan eval personnel at major command level would be the most current and the best informed on this topic. I have assumed that ultimately you must explain, sell, defend, practice, and even evaluate using whatever guidance is established.

Once I receive your reply, I will contact you by telephone to discuss your comments. This will give you an opportunity to provide the flavoring that is sometimes hard to capture on paper. Ultimately, I hope to be able to determine why there is such a wide variance in the guidance provided by the major commands.

Like all projects, my thesis effort has a time constraint. I would like to have the replies back so that I can make the telephone calls during the week of 26 April. I assume it is obvious that the validity of my effort is extremely dependent upon your replies. I would like to take this opportunity to thank you for your time and effort.

Sincerely,

David W. Livingston
Lt. Col., USAF

DWL:kas
Attachment

Subject: Major Command Guidance for Aircraft Recovery under Instrument Flying Conditions

Introduction

A few ground rules are provided for your information. My area of concern is the recovery phase of the mission and all comments may be limited to this area. During the course of the thesis effort, there will be various degrees of generalization required to properly scope the effort. I would prefer that some of this generalization be done by the experts rather than by me, e.g., aircraft groupings, etc. Although I am willing to accept individual opinion and will document it as such, it is imperative that I receive, understand, and document the "party line" of the command. When making your comments, please use the following definitions.

Approach Minimums:

Precision Approach--The actual Decision Height (DH) where the pilot makes the decision to land or to execute a missed approach.

Nonprecision Approach--The combination of the Minimum Descent Altitude (MDA) and the Missed Approach Point (MAP) where the pilot makes the decision to land or to execute a missed approach.

Weather Minimums:

The weather required before an approach may be started. When this term is used to designate the minimum weather required to file it should be identified as such.

Identification

Major Command--Please include a phone number and a name contact for my subsequent phone call.

Type of aircraft flown--Please group by general categories (i.e., bombers, cargo, fighter, helicopter, trainer, or utility).

What category of aircraft is your major concern and requires most of your efforts?

Comments

1. Has your command modified the DOD published minimums or procedures? How? (Please list references.)

2. Please provide some reasons or rationale why your command has or has not modified the DOD published minimums or procedures, e.g., it has always been done this way.

3. How are the modifications implemented? Specifically, address how they are used for training flights and for evaluation flights.

4. Have you experienced any problems or problem areas? OHRs, etc.

5. Other comments?

Vita

David William Livingston was born 11 June 1937 in Pittsburgh, Pennsylvania. Upon graduation from high school in 1954, he received an appointment to the United States Military Academy at West Point, New York. He graduated from the Military Academy in June 1958 and was commissioned a Second Lieutenant in the United States Air Force. In August 1960 he was assigned to Germany on his first operational tour as a pilot. In 1965 he completed the Aerospace Research Pilots School at Edwards AFB, California, and remained at this station as an experimental flight test officer at Flight Test Operations until 1970. From 1970 through 1975 he served operational tours in Thailand and England followed by a staff tour at Headquarters United States Air Forces in Europe, in Germany. In May 1975 Lieutenant Colonel Livingston was assigned to the Graduate System Management Course of Air Force Institute of Technology as a resident student at Wright-Patterson Air Force Base.

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Aircraft recovery under instrument conditions entails inherent risks. Many commanders, in their attempts to conserve and preserve limited and costly resources, have taken steps to reduce the risk involved. Air Force has expended considerable effort to devise and implement a standardized recovery procedure for instrument conditions. Each major command has the option to modify the Air Force guidance, making it more restrictive for its respective command. In

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exercising this option the major commands have arrived at guidance which ranges from no action to the establishment of a new set of criteria superimposed over the Air Force guidance.

This thesis documents the guidance provided by Air Force and eight different major commands. It further presents the rationale provided by the major commands in support of its actions. The analysis of the actions taken and the rationale, plus the analysis of relevant secondary issues, were used in formulating proposed major command guidance.

It is recommended that the Air Force review its directives to correct the known deficiencies and to limit the major commands to modifying only the published weather minimums. Each major command should reevaluate its procedures to insure it achieves command established objectives and is compatible with the Air Force guidance.