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# National Airspace System

## Control Outside of Independent Surveillance Coverage Operational Concept

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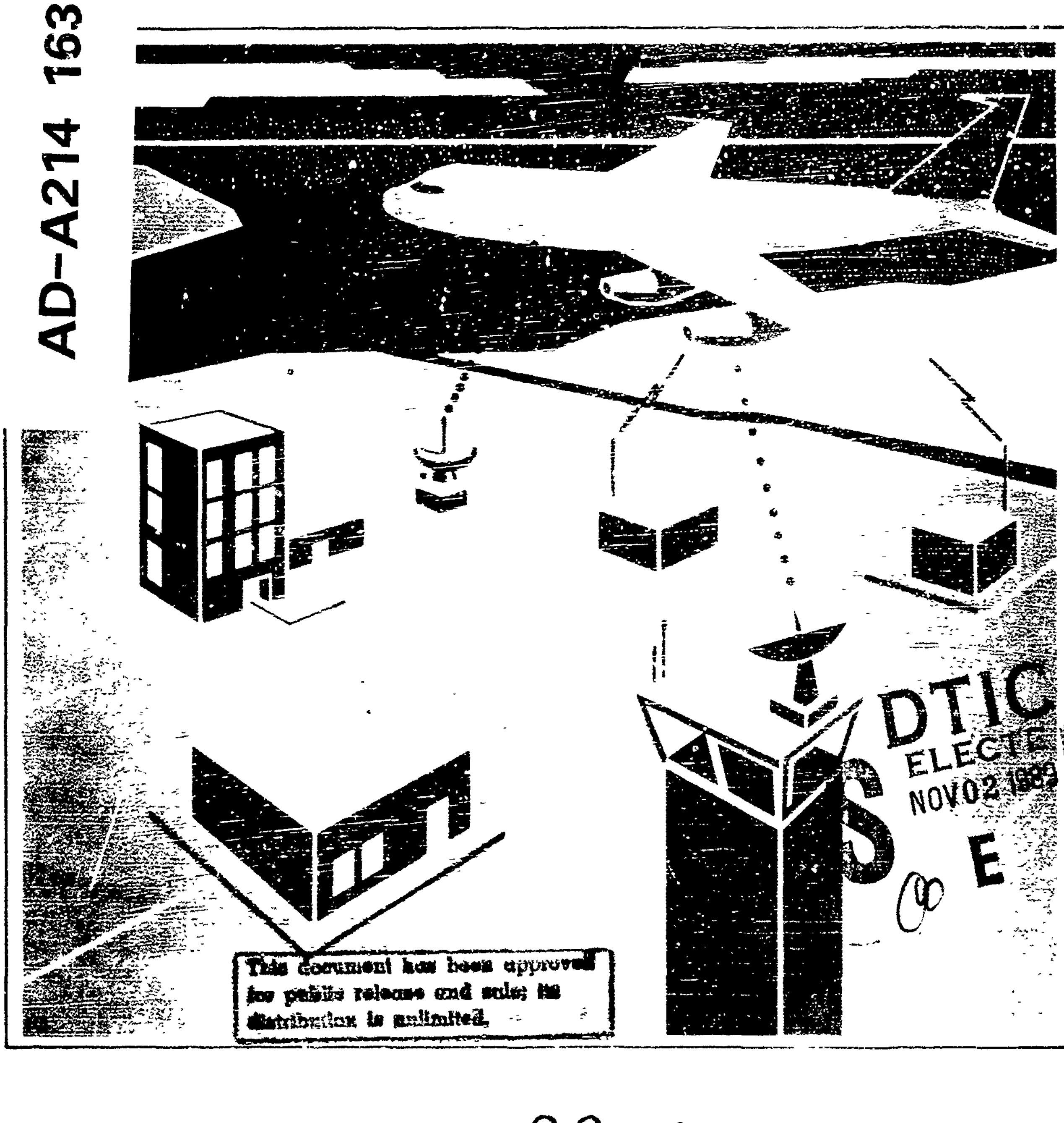

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Advanced System Design Service
Washington, D.C. 20591

# National Airspace System Control Outside of Independent Surveillance Coverage Operational Concept (NAS-SR-1324)

**Advanced System Design Service**
Federal Aviation Administration
Washington, D.C. 20591



June 1989

Final Report



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**16. Abstract**

This operational concept describes how Air Traffic Control (ATC) will be performed in non-radar (oceanic and mountaineous terrain) areas throughout the National Airspace System (NAS). The framework for this document incorporates non-radar ATC requirements from Section 3.2.4 of the NAS System Requirements Specification (NASSRS), the NAS Plan, and the NAS Level 1 Design, as expected to occur during the mid-to-late 1990s. The concept includes the functions provided by the Advanced Automation System (AAS) and Step 1 of the Automatic Dependent Surveillance (ADS) programs. Keywords: air navigation aids; Flight paths; collision avoidance; flight safety; radio navigation beacons;

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## 1.0 INTRODUCTION

Two goals of the Federal Aviation Administration (FAA) are to provide for the continued safe and efficient use of the nation's airspace. FAA air traffic control (ATC) specialists ensure aircraft safety and flight efficiency by keeping aircraft separated from each other and by accommodating user-preferred fuel efficient trajectories. Requirements for the National Airspace System (NAS) are contained in NAS System Requirements Specification (NASSRS), NAS-SR-1000. Section 3.2.4 generally specifies that NAS is required to assist users (pilots) in accurately determining and transmitting aircraft position information to ATC specialists. The transmittal of accurate and timely position information allows controllers to provide safe and timely separation instructions to aircraft flying in areas where radar surveillance coverage is not available. This document contains an operational concept which describes how specialists manage aircraft without the benefit of radar surveillance. Areas not having radar surveillance generally include areas more than one hundred miles offshore and mountainous terrain.

### 1.1 Background

The NASSRS defines surveillance as "the detection, location, and tracking of aircraft within NAS airspace for the purposes of control, separation, and identification." NASSRS differentiates surveillance systems as follows:

a. Independent. A system which requires no airborne compatible equipment (primary radar targets).

b. Independent Cooperative. A system which requires airborne compatible equipment (ATC Radar Beacon System (ATCRBS), Modes C and S).

c. Dependent. A system which requires input from navigation equipment aboard the aircraft either via data link or via voice transmission (pilot reports, LORAN Offshore Flight Following).

Control when outside of independent surveillance excludes independent surveillance systems (i.e., primary radar based), and independent cooperative surveillance (e.g., ATCRBS, Modes C and S). NASSRS Section 3.2.4 requirements refer to controlling aircraft in dependent surveillance areas; i.e., those areas where radar coverage is not available, and which require input from on-board navigation equipment via either data link transmissions or voice transmissions.

The United States (US) is responsible for providing aircraft separation services in all fifty states and US territories. In addition, the International Civil Aviation Organization (ICAO), a United Nations (UN) aviation governing body, contracts the US to provide aircraft separation services in designated oceanic regions. Due to great distances and line-of-sight limitations, ATC specialists cannot determine aircraft position through the use of land-based radar surveillance techniques. Line-of-sight constraints correspond to limitations resulting from great distances (i.e., curvature of the earth) and signal blockage (e.g., mountains, etc.). Because costs prohibit the use of complete land-based radar coverage, other techniques for managing air traffic are employed over geographical regions where land-based radar surveillance coverage does not exist.

Throughout NAS documentation, the term "radar surveillance" describes land-based radar surveillance equipment as opposed to space-based equipment which could be developed in the future, but beyond the time frame of the current end-state NAS. For purposes of this document, the term "non-oceanic" refers to non-radar areas over land. Also, the term "control when outside of independent surveillance coverage" is used synonymously with the term "non-radar" control, which includes both oceanic and mountainous terrain airspace.

## 1.2 Objective

The objective of this operational concept is to describe how ATC specialists manage aircraft in non-radar environments. This document is intended as a tool for systems designers, analysts, and operational test planners in determining if and how well the NAS design and its implementation meet the NAS requirements. In addition it provides to management and technical personnel of the FAA and other involved organizations, a general description of how control when outside of independent surveillance is performed.

## 1.3 Scope

This document covers the requirements for Control When Outside Independent Surveillance Coverage as delineated in Section 3.2.4 of the NASSRS. The operations described are limited to those instrument flight rule (IFR) operations associated with managing aircraft in non-radar environments. Voice communication is stressed because it is the primary means of communication for non-Automatic Dependent Surveillance (ADS)-equipped aircraft, and for ADS-equipped (Step 1) aircraft.

The paragraphs and subparagraphs in NASSRS Section 3.2.4 are described below.

| | |
|---|---|
| 3.2.4.A | Manage traffic using supplemental navigation systems. |
| 3.2.4.B | Receive, process, and display real-time data from aircraft's navigation system. |
| 3.2.4.B.1 | Receive data from specialists' data entry equipment, satellites, and users at various rates. |
| 3.2.4.B.2 | Receive, process, and display flight information. |
| 3.2.4.B.3 | Process and display position and identification information in remote and oceanic areas. |
| 3.2.4.B.4 | Estimate and update current position and store flight plan information. |
| 3.2.4.B.5 | Must have display capacity for 100 oceanic and 50 non-oceanic aircraft. |

## 1.4 Methodology

The methodology used in providing perspective and insight into this operational concept provides information in a number of different ways. The focus of the material is built around four different kinds of diagrams and/or descriptive information described below:

1. Operational Block Diagram/Description. The operational block diagram illustrates the connectivity between major elements of the NAS, i.e., the non-radar controller, the processors, the external NAS interfaces, and the users of those elements that support the service. The operational block diagram in this operational concept is extracted from the overall NAS operational block Diagram. The non-radar controller is indicated by the Position No. 22. This number remains the same in every operational concept. Dotted lines segregate facilities. The blocks within each facility are the major processors.

2. Operational Flow Diagrams/Descriptions. The operational flow diagram and associated description for the non-radar controller provides more detail about the inputs, processes, outputs, and interfaces. Operational flow diagrams are used to functionally describe the products and services of the non-radar controller. The diagrams show major actions only. Ancillary actions such as

requests for simulation and system conditions are not shown. Principal features of an operational flow diagram include the following:

a. Dotted lines segregate facilities.

b. White boxes indicate non-radar controller or user functions. Shaded boxes indicate machines.

c. The functions listed by lower case alphabetic characters in the white and shaded boxes are explained in the text.

3. <u>Operational Sequence Diagrams/Descriptions</u>. The operational sequence diagrams and associated description shows a typical sequence of steps taken by the non-radar controller in providing services. Principal features of an operational sequence diagram include the following:

a. The non-radar controller is listed along the vertical axis. When required for clarity, other Area Control Facility (ACF) controllers may also be listed on the vertical axis.

b. The horizontal axis represents time. Sequential events or functions performed by the non-radar controller are indicated within separate boxes. Events which may occur simultaneously or near-simultaneously are shown vertically. The numbers on the right side of the blocks refer to numbers in the text.

c. Decision points or points where alternate paths may be followed are indicated by a diamond shape.

d. Circles are connectors and indicate exit to, or entry from, another diagram. Circles with a numeric character connect either to another sheet of the same diagram or to another diagram; the relevant figure number is listed underneath if connection is to a different diagram. Further, functions within the boxes preceded by a lower case alphabetic character reference the same functions listed in the operational flow diagrams. Thus, the relationship between non-radar controller interactions and relevant NAS subsystems is depicted.

e. Boxes surrounded by a shaded pattern indicate that the entire function is performed by the ACF primary processor.

f. Boxes filled with a shaded pattern represent an interface with the ACF primary processor.

4. Operational Scenario(s)/Description(s). The operational scenario and associated description depicts specific predefined situations and illustrate a particular subset of the generalized operational sequence or an unusual situation not covered by the operational sequence diagrams. Principal features of operational scenario diagrams include the following:

a. Users and the non-radar controllers providing the service are listed along the vertical axis.

b. The horizontal axis represents time. Sequential events or functions performed by the non-radar controllers or users are indicated within separate boxes. The numbers on the right side of the blocks refer to numbers in the text.

c. Shaded portions of boxes represent an interface with the ACF primary processor.

## 1.5 Document Organization

The remainder of this document is organized as follows. Section 2 is the main body of the document and is divided into six subsections. Section 2.1 describes the support provided by NAS and non-NAS facilities, systems, and non-radar positions that are involved in managing aircraft. It includes an operational block diagram which shows the connectivity between the various NAS and non-NAS elements and the user. Descriptions of each of the supporting functional elements include references to ATC procedures and programs. Section 2.2 describes the information required to manage air traffic. Section 2.3 expands the NAS elements identified in Section 2.1 in appropriate operational flow diagrams. It provides information for inputs, processes, and outputs for each of the elements, as well as identifies the interface to other NAS elements, non-NAS elements, and users. It also references related NASSRS 3.2.4 subsystems. Section 2.4 is a tabular summary correlating operational requirements, as stated in the NASSRS, with the description of the functions provided in earlier sections. Section 2.5 presents typical operational sequences utilized in managing air traffic and shows the sequential interaction between users, the non-radar controllers, NAS elements, and others providing support and/or interacting with the non-radar ATC functions. Section 2.6 illustrates how non-radar separation services are provided by describing hypothetical situations involving the controller's interactions with the flight plan conflict probe.

## 2.0 OPERATIONS

### 2.1 Support

NAS is required to manage aircraft in non-radar environments. Figure 2-1, Overview of NAS/User Systems, illustrates that the ACFs provide non-radar separation services for NAS. Major functions of non-radar separation are supported by the Advanced Automation System (AAS) Area Control Computer Complex (ACCC) processor. Some NAS flight plan information is provided by the International/Automated Flight Service Station (I/AFSS) facilities. The I/AFSS transmits flight plan information into the Flight Service Data Processing System (FSDPS) located in the ACF. Many other organizations outside of NAS also provide flight plan information such as foreign ATC facilities, Airline Dispatch Offices (ADO), and Military Base Operations (MBO) facilities. Even though these organizations are outside of NAS, NAS must provide an interface for receipt of flight plan data.

Each aircraft must provide a direct or indirect method of communications with the ACF to allow the ATC specialists to manage air traffic. In oceanic areas, users transmit aircraft location periodically over high frequency (HF) radio to Aeronautical Radio, Inc. (ARINC). Those users which have ADS equipment data link aircraft position information to satellites; the satellites in turn, transmit the information down to satellite ground stations. In non-oceanic areas and in some oceanic areas, users transmit position information using voice communications over very high frequency (VHF) or ultra high frequency (UHF) radio. The Remote Communications Facilities (RCFs), ARINC, and satellite ground stations transmit aircraft position information into the ACFs. The following paragraphs describe the support received from NAS facilities, systems, positions, other outside-NAS organizations, and user systems.

#### 2.1.1 NAS Facilities/Systems/Positions

NAS and non-NAS facilities, systems, non-radar positions, and major information paths that may be involved in managing air traffic in non-radar environments are shown in Figure 2-2. The functions provided by the non-radar controller position and a description follows. Included with the description is a reference to the existing procedures manuals and to those NAS projects that may affect how the service is provided.

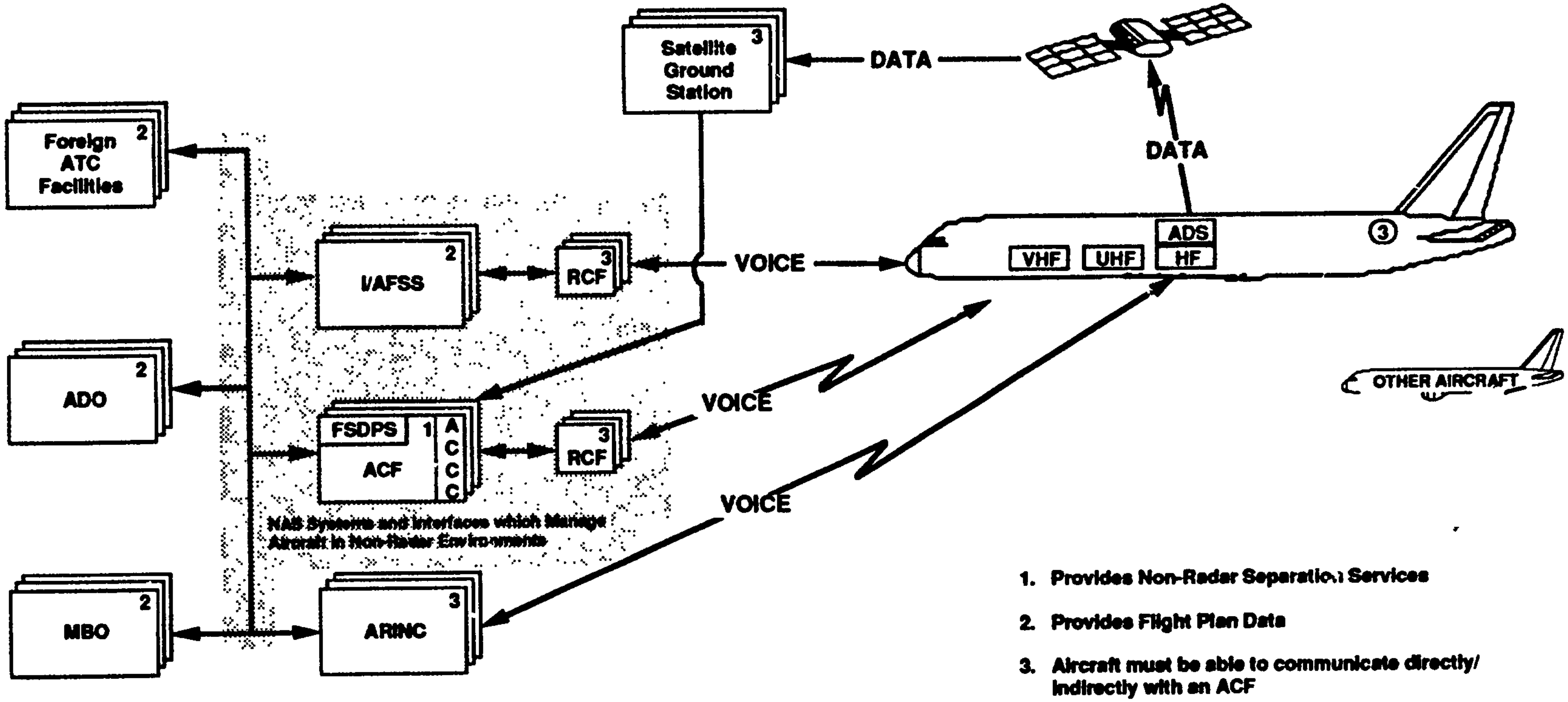


**FIGURE 2-1**

**OVERVIEW OF NAS/USER SYSTEMS FOR CONTROL WHEN OUTSIDE INDEPENDENT SURVEILLANCE COVERAGE**

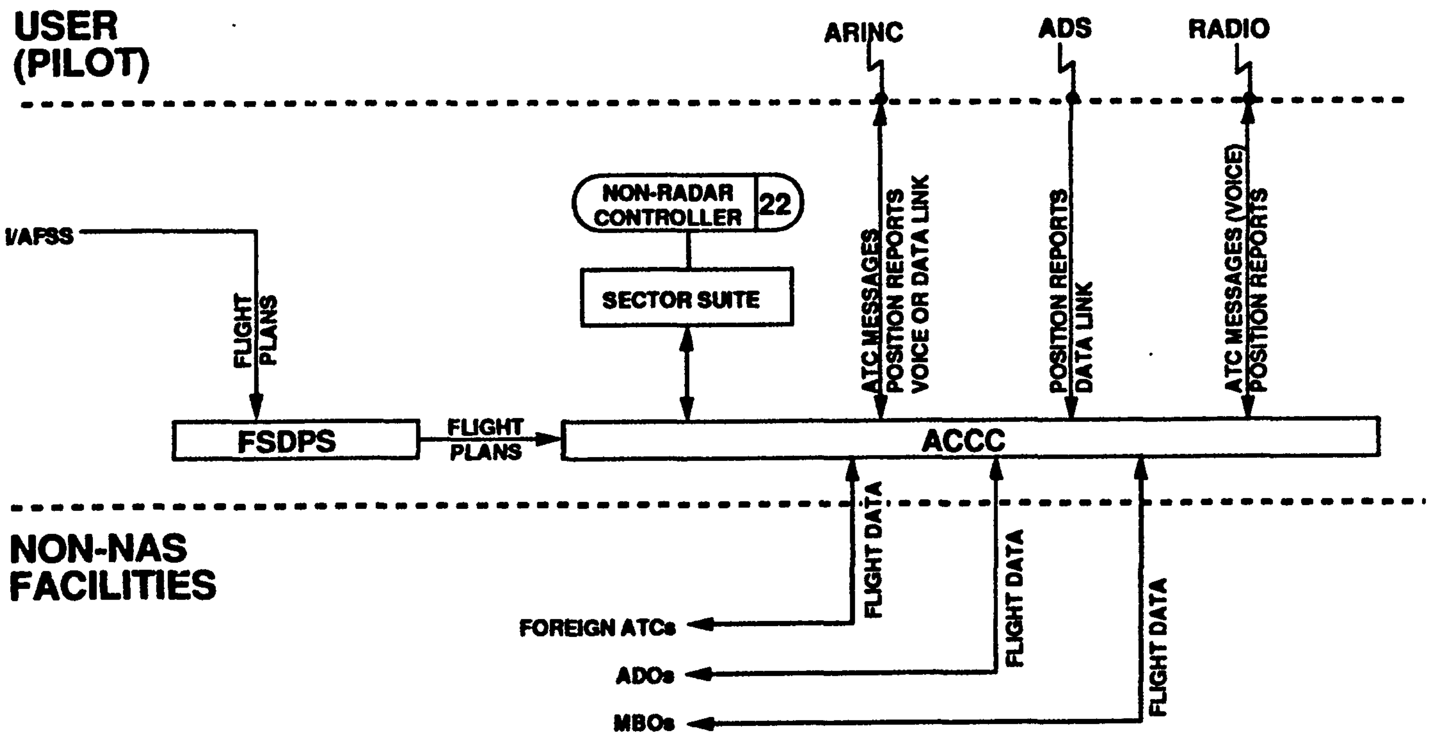


FIGURE 2-2

OPERATIONAL BLOCK DIAGRAM FOR CONTROL
WHEN OUTSIDE INDEPENDENT SURVIELLANCE COVERAGE

Position 22: Non-Radar Controller

Function: Manages air traffic by providing aircraft separation services in a non-radar environment.

Description: The primary responsibility of the non-radar controller is to ensure aircraft separation in areas of mountainous terrain or over large bodies of water (oceans). Controllers review progress reports, flight data displays, alert displays, and situation displays which depict the trajectories and expected trajectories of aircraft flight. Trajectory data is based upon flight plan data for non-ADS-equipped aircraft, surveillance data for ADS-equipped aircraft, wind data, and aircraft performance data (i.e., speed, climb and descend rates, turn rates, etc.).

Procedures: FAA, "Oceanic Air Traffic Control" (7110.83) (updated as necessary)
FAA, "Air Traffic Control" (7110.65) (updated as necessary)

Projects: The following NAS programs directly impact the services and automation capabilities that are provided in non-radar areas:

NAS Plan, En Route System

Project 2, Flight Data Entry and Printout Devices
Project 4, EARTS Enhancements
Project 5 Oceanic Display and Planning System (ODAPS)
Project 7, Modern ATC Host Computer
Project 11, Voice Switching and Control System (VSCS)
Project 12, Advanced Automation System (AAS)
Project 13, Automated En Route Air Traffic Control (AERA)
Project 15, Area Control Facilities (ACF)
Project 16, Offshore Flight Data Processing System (OFDPS)

NAS Plan, Ground-to-Air System

Project 1, Air/Ground (A/G) Communications Equipment Modernization
Project 3, VORTAC
Project 4, Nondirectional Beacon (NDB)

### 2.1.2 Other Organizations

Some non-NAS organizations are involved with aircraft communications in non-radar environments, particularly in oceanic areas. ARINC provides an HF radio service for the FAA when aircraft are out of VHF or UHF radio range. The MBO and the ADO occasionally become involved in contacting aircraft or relaying messages to aircraft because pilots may not be monitoring appropriate frequencies.

### 2.1.3 User Systems

The aircraft requires two-way radio systems for voice communications (VHF, UHF and HF). In addition to voice communications, ADS equipment assists controllers by enabling pilots to automatically transmit aircraft identification (ACID) and position information.

## 2.2 Information

This section describes the information required by the NAS to manage aircraft in non-radar environments. The information is categorized into two major areas: Information required from users, and information required from NAS.

### 2.2.1 Information From Users

Section 3.2.4 of the NASSRS requires that the NAS be capable of receiving information in non-radar areas which includes:

a. Aircraft Identification (ACID)

b. Aircraft Type

c. Position

d. Speed

e. Clearance Limit (or Destination)

f. Estimate of Time of Arrival at Reporting Fixes

g. Altitude

h. Remarks

This information may be provided directly by NAS users or indirectly through ARINC for NAS users.

## 2.2.2 Information from NAS

The ACCC presents information to the non-radar controller in the form of alphanumeric and graphic displays on sector suites. Information that the controller may need to manage aircraft are as follows:

a. Surveillance Data. The ACCC receives, processes, and displays ADS surveillance data received from satellite ground stations. Surveillance data includes ACID, altitude, and the latitude and longitude as calculated by the aircrafts' Area Navigation (RNAV) equipment. The ACCC correlates ADS position reports with the calculated flight plan positions. Whenever the lateral, and vertical position differences are within parameter tolerances, the aircraft's flight path (track) is considered to be in conformance with the flight plan; otherwise, it is out of conformance. Alert indicators in the full data block warn the controller if the aircraft is vertically or laterally out of conformance. Longitudinal differences between ADS position reports and extrapolated aircraft trajectories are adjusted upon receipt of the position report.

b. Flight Plan Data. Flight plan processing software in the ACCC calculates the extrapolated aircraft trajectory based upon flight plan data, position reports, aircraft performance data and wind data. This extrapolated aircraft position data is presented on the situation display. The controller may also request one of three different "look ahead" functions: 1) a display of the aircraft's future route, 2) a display of the aircraft's distance in miles, and 3) a display of the aircraft's distance in minutes based upon the current aircraft velocity."

c. Automated En Route Air Traffic Control (AERA) 1. AERA 1 software is hosted in the ACCC processor and provides controllers with an interactive method of planning and monitoring aircraft flow. AERA 1 capabilities allow controllers to create or modify flight plans by creating trial (flight) plans. Trial plans are processed as proposed flight plans. When a trial plan is initiated by the controller, AERA 1 processing invokes an aircraft-to-aircraft and aircraft-to-airspace conflict probe.

## 2.3 Functions of Position 22; Non-Radar Controller

The following paragraphs elaborate on the functions and equipment which support the non-radar controller position introduced in Section 2.1. The operational flow diagram associated with the non-radar controller illustrates the information flow between the non-radar controller, the pilot, and the data processing equipment. The focus is on functions specifically related to managing aircraft in non-radar environments. The pertinent NASSRS paragraphs that specify the functions being performed by the controller is also referenced.

Figure 2-3 illustrates the primary functions performed by the non-radar controller in order to manage air traffic. It also shows the information that flows to and from the non-radar controller.

The flight plan conflict probe (Item f. in Figure 2-3) is performed automatically by the ACCC. Conflict probe processing is triggered by several activities:

a. Any change in a flight plan.

b. Initiation of a trial plan or quick trial plan.

c. At a parameter time, prior to reaching the non-radar boundary.

d. Periodically at parameter time intervals.

When the conflict probe is triggered as a result of a parameter time before entry into non-radar airspace, the area manager may choose one of four options for placement of the conflict probe results:

a. The sector where the aircraft is located.

b. The sector where the potential conflict occurs.

c. Both a. and b.

d. Both a. and b., plus any intervening sectors.

Placement of the conflict probe results determines which controller resolves the conflicts, e.g., the controlling sector, the intervening sector(s), or the sector where the conflict occurs. For the purposes of this operational concept, the flight plan conflict probe is addressed apart from the sector that may trigger it.

a. ACCC Processing. The ACCC provides automated assistance to the controller so that he or she can manage air traffic by providing separation between aircraft, or by providing separation from special airspace boundaries where aircraft are not permitted to penetrate. The ACCC accepts, processes, stores, and distributes the latest available surveillance and flight plan data for display on sector suites. For ADS-equipped aircraft, the ACCC automatically hands off a target to the next sector based on the following criteria:

1. At a parameter time from the sector boundary.
2. At an adapted point.
3. At a specified altitude.

NASSRS requirements: 3.2.4.A
3.2.4.B

b. Check and Evaluate Future Separation. Before accepting an inbound aircraft, the non-radar controller ensures that the inbound flight is separated from all other aircraft currently in the sector. By referring to the situation display, alert display, flight data display, and other displays, the controller can assess the current and future traffic situation. The assessment of the future traffic situation allows the controller to foresee any conflicts between the inbound aircraft to other aircraft and to special airspace areas.

NASSRS requirements: 3.2.4.B.3-2
3.2.4.B.5

c. Accept Handoff (Transfer of Control). The term "handoff" is used to describe the action of transferring the radar identification from one sector to another sector. The term "transfer of control" is used to describe the transfer of control responsibility between one sector and another sector in a non-radar environment. The non-radar controller sees an ACID in the inbound list a parameter number of minutes prior to the aircraft actually crossing the boundary into his or her sector. The data block also indicates

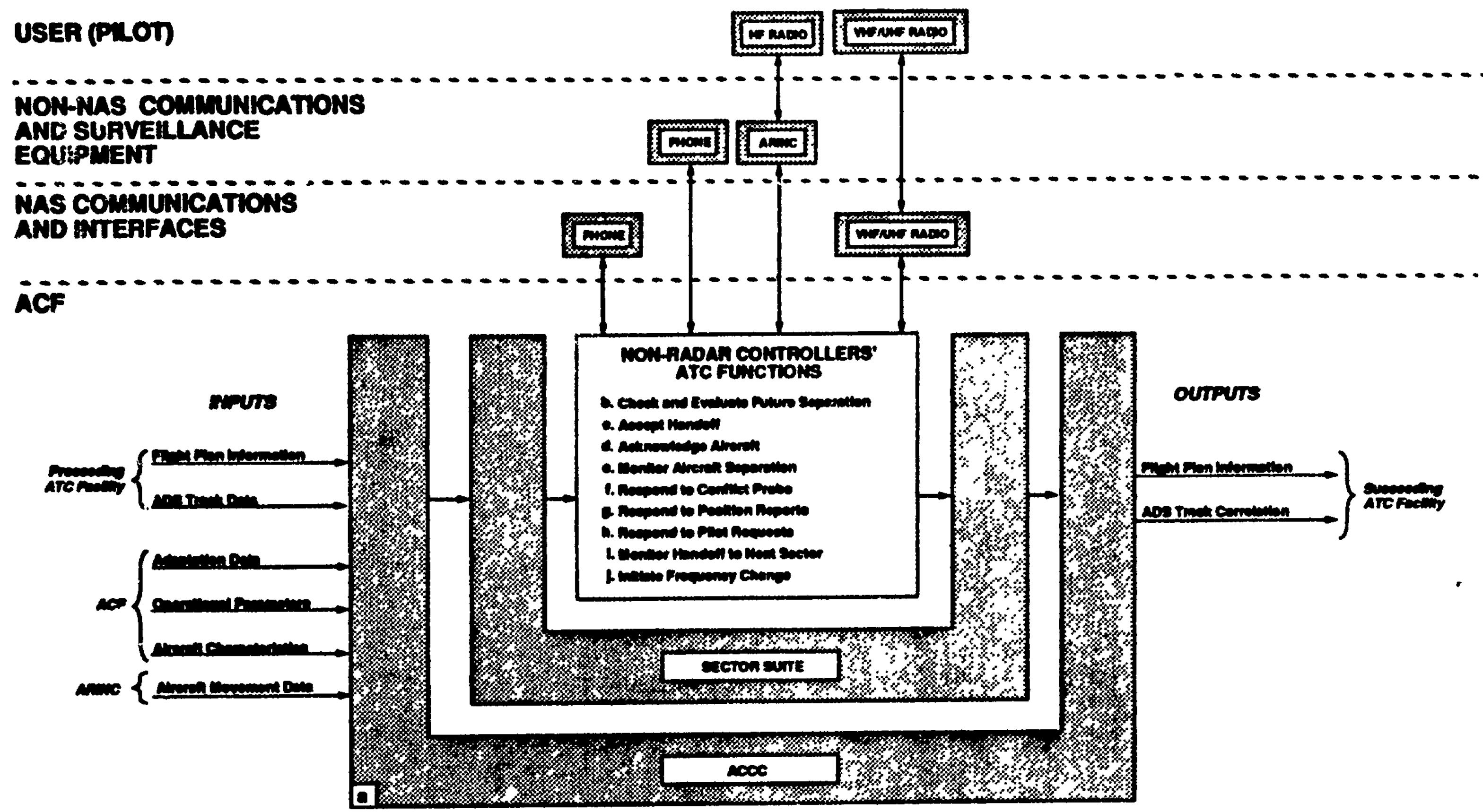


**FIGURE 2-3**

**NON-RADAR CONTROLLER OPERATIONAL FLOW DIAGRAM CONTROL WHEN OUTSIDE INDEPENDENT SURVEILLANCE COVERAGE**

that an aircraft is in handoff status. After future separation is ensured, the controller may either initiate an "accept handoff" message and type an ACID into the data entry area, or he or she may perform a trackball function on the sector suite.

NASSRS requirements: 3.2.4.A
3.2.4.B

d. Acknowledge Aircraft. When an aircraft flying over mountainous terrain enters a new sector or new ATC facility, the pilot contacts the controller via VHF or UHF radio and states the position and altitude of the aircraft. During this time, any pilot requests received by the controller are either processed or are noted in the scratch pad display area of the sector suite.

NASSRS requirements: 3.2.4.A
3.2.4.B

e. Monitor Aircraft Separation. Controllers continually review aircraft and airspace separation by referring to the situation display, the alert display, the flight data display, and other displays. They mentally project all aircraft routes and altitudes in time, in order to identify future aircraft pairs (conflicts) or future protected airspace penetration. When a potential aircraft pair is visualized or an alert is displayed, they may project the aircraft route on the situation display. If a future conflict exists between aircraft, the controller may initiate a quick trial plan to change an aircraft's altitude, or initiate a trial plan to amend an aircraft's route of flight.

NASSRS requirements: 3.2.4.A
3.2.4.B

f. Respond to Conflict Probe. Conflict probes are initiated automatically by the ACCC. If the ACCC detects a conflict, an alert is presented on the appropriate controller's display. After an alert is presented on the situation display, the controller initiates either a quick trial plan or a trial plan. If the quick trial plan is initiated, the ACCC triggers conflict probe processing for aircraft-to-aircraft and local sector or ACF aircraft-to-airspace conflicts. If the trial plan is initiated, the ACCC triggers conflict probe processing for aircraft-to-aircraft and aircraft-to-airspace processing. After a conflict-free trial plan is developed, the controller triggers another conflict probe by initiating a flight plan message.

NASSRS requirements: 3.2.4.A

g. Respond to Position Reports. In non-radar environments position reports initiated from an aircraft may be transmitted into the ACF several different ways. If an aircraft is in non-oceanic airspace, the pilot talks directly with the controller using air/ground (A/G) communications. Position reports obtained from A/G communications must be entered manually into the flight plan database by the non-radar controller. Oceanic ARINC position reports are entered automatically into the flight plan database if the ACCC determines that the message is valid. If the message does not pass all of the ACCC checks, it is electronically displayed to the controller for his or her follow-up action. ADS data link position reports are automatically transmitted into the ACF, processed by the ACCC, and flight progress is displayed on the situation display.

NASSRS requirements: 3.2.4.A
3.2.4.B

h. Respond to Pilot Requests. Controllers respond to pilot requests when time permits. The ACCC aids controllers by allowing them to enter a message into the controller scratch pad display area of the sector suite. This tool assists controllers by reminding them about pilot requests which have not yet been granted. Many pilots request higher or lower altitudes, or they may request a direct routing instead of being required to fly an airway. These requests may involve initiating trial plans.

NASSRS requirements: 3.2.4.A
3.2.4.B.1
3.2.4.B.3-2
3.2.4.B.4-2

i. Monitor Handoff to Next Sector. For non-ADS-equipped aircraft, the controlling sector controller either enters an ACID into the flight data display and initiates a handoff entry, or performs a trackball function. A handoff indicator appears in the full data block, and a duplicate copy of the full data block is displayed as a target on the next sector's situation display. The ACID is also displayed in the receiving controllers inbound list.

NASSRS requirements: 3.2.4.A
3.2.4.B

j. Initiate Frequency Change. In non-oceanic airspace, frequency changes may occur within large sectors. The controller contacts the pilot via VHF or UHF radio and requests that the pilot contact him or her on the new frequency. If the aircraft is transiting into a new sector within the ACF or transiting into the next ACF area, generally a new frequency is given to the pilot using VHF or UHF radio. (In oceanic areas, ARINC institutes the same procedures when a pilot reports over a compulsory reporting point.)

NASSRS requirements: 3.2.4.A

## 2.4 Correlation with Operational Requirements

Table 2-1 summarizes the correlation of the non-radar operational requirements paragraphs of NAS-SR-1000 with the above paragraphs describing the functions being performed by the non-radar controller. All non-radar paragraph numbers of NAS-SR-1000 are listed. Paragraphs which are introductory in nature are indicated with a dash. The fact that a correlation is shown between a requirements paragraph and a paragraph describing the non-radar controller functions performed should not be construed as indicating that the requirement is completely filled.

## 2.5 Operational Sequences

Figures 2-4 and 2-5 each illustrate a common sequencing of the functions described in Paragraph 2.3. Figure 2-4 illustrates how the non-radar controller interacts with the flight plan conflict probe function of the ACCC. Figure 2-5 illustrates how the conflict probe is implemented in order to manage air traffic. Both figures contain shadowed rectangles and decision diamonds which indicate that the function is performed solely by the AERA 1 processing software in the ACCC. A shadowed box inside the rectangle indicates that the controller must either initiate the function or interact with the ACCC. Rectangles and decision diamonds that are not shadowed, require controller judgment based upon procedures, training, experience, and the air traffic situation occurring at that moment. The

## TABLE 2-1

## REQUIREMENTS CORRELATION FOR CONTROL WHEN OUTSIDE INDEPENDENT SURVEILLANCE COVERAGE

| NAS-SR-1000 Paragraph \ Position Paragraph | | Non-Radar Controller | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2.3.a | 2.3.b | 2.3.c | 2.3.d | 2.3.e | 2.3.f | 2.3.g | 2.3.h | 2.3.i | 2.3.j |
| 3.2.4.A | Manage Traffic with Supplemental Navigation | X | | X | X | X | X | X | X | X | X |
| .B | Receive, Process and Display | — | — | — | — | — | — | — | — | — | — |
| .B.1 | Data Entry Equipment, Satellites, and User Sources | X | | X | X | X | | X | X | X | |
| .B.2 | Flight Information | X | | X | X | X | | X | | X | |
| .B.3 | Process and Display | — | — | — | — | — | — | — | — | — | — |
| .B.3-1 | Position and Identification Information | X | | X | X | X | | X | | X | |
| .B.3-2 | Oceanic and Remote Areas | X | X | X | X | X | X | X | X | X | X |
| .B.4 | Estimate, Store and Update | — | — | — | — | — | — | — | — | — | — |
| .B.4-1 | Current Position | X | | X | X | X | | X | | X | |
| .B.4-2 | Flight Plan Information | X | | X | X | X | | X | X | X | |
| .B.5 | Display Capacity | — | — | — | — | — | — | — | — | — | — |
| .B.5-1 | 100 Oceanic Aircraft | X | X | X | X | X | | X | | X | |
| .B.5-2 | 50 Non-Oceanic Aircraft | X | X | X | X | X | | X | | X | |

dotted lines represent the controller's interaction with the user and the next controlling sector. The next controlling sector could physically be in the same ACF, the next ACF in the aircraft's route, or could perhaps even be a foreign ATC facility. The numbers in the upper right hand corner of the action reotangles and upper vertices of the decision diamonds are reference numbers which refer to a textual description of the function. The letters that precede the action statements in the action rectangles correspond to the functions on Figure 2-3.

2.5.1 Respond to Conflict Probe

Figure 2-4, Flight Plan Conflict Probe Operational Sequence Diagram, illustrates the non-radar controller's actions and decisions required to respond to the flight plan conflict probe. Since this diagram is complex, two different examples are used to demonstrate the probe's functions: An aircraft conflict and a strategic airspace conflict. Strategic airspace is special use airspace; therefore, controllers must protect an aircraft's airspace from penetrating the strategic airspace.

a. Aircraft Conflict. Based upon a time parameter or a controller action (initiation of a quick trial plan, trial plan, or a flight plan) the ACCC automatically triggers the conflict probe function (1). If there is no conflict (2), the ACCC must decide if the probe was controller initiated (3). If the probe was triggered due to a controller action, then a message is displayed (4). If the probe was triggered because of a time parameter, no message is displayed. If there is a conflict (2), the ACCC displays a message (4), and determines if the conflict involves strategic airspace (5). The displayed message indicates which aircraft are in conflict (4). Since the alert message does not involve a resolution (6) and since the conflict does not involve strategic airspace (7), the controller must evaluate alternative control actions (8). If an altitude maneuver eliminates the conflict, the controller may choose (9) the quick trial plan option (10). If the conflict involves any other type of resolution, the controller must choose (9) the trial plan option (15).

   If the controller chooses the quick trial plan option, he or she initiates the quick trial plan function (10), and the ACCC initiates the conflict probe (11). Since the quick trial plan conflict probe is designed for quick processing, it does not check

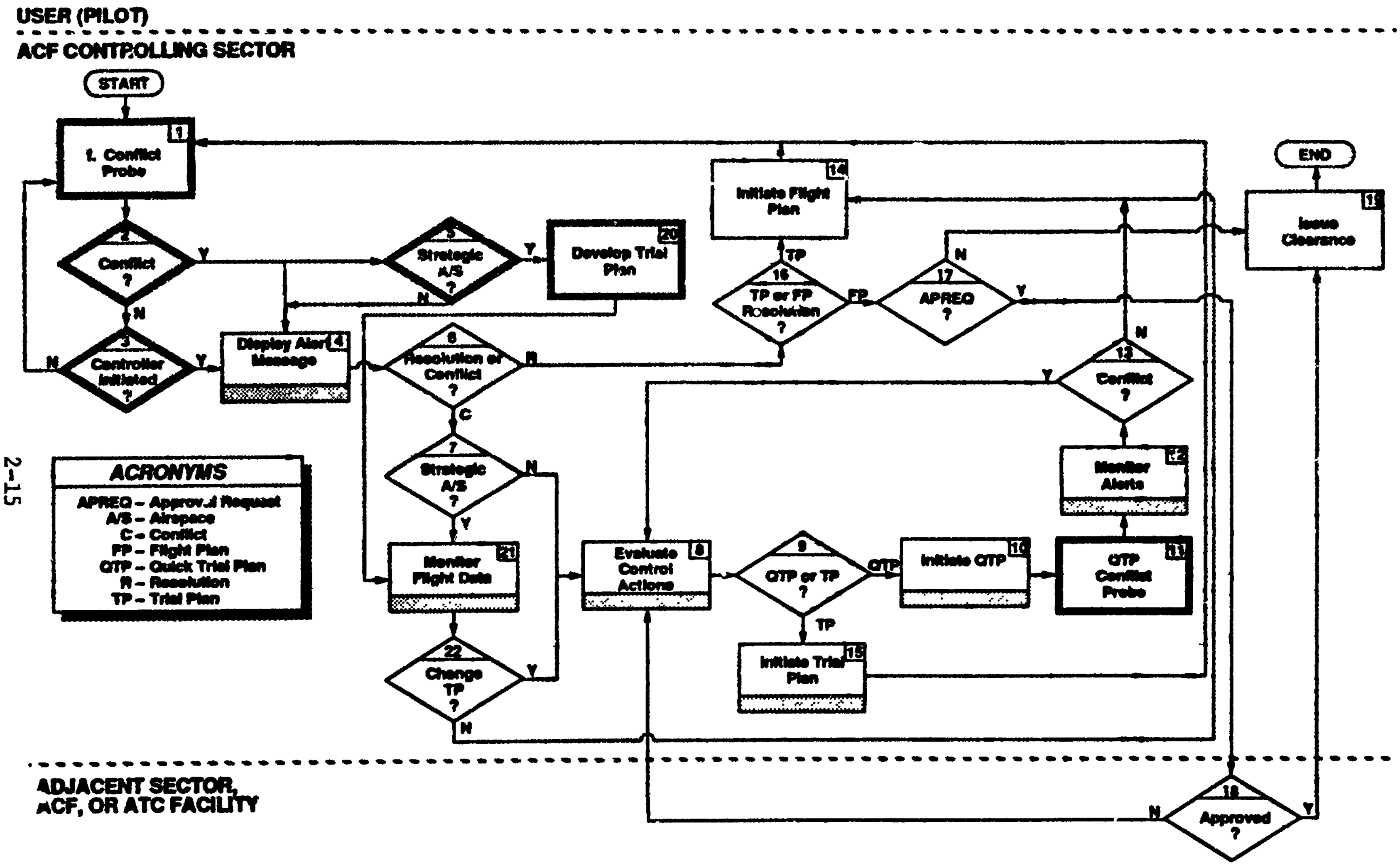


**FIGURE 2-4**

**FLIGHT PLAN CONFLICT PROBE OPERATIONAL SEQUENCE DIAGRAM**

for strategic airspace in forward ACFs. The controller monitors the display for alerts or messages (12) and if there are no conflicts (13), the controller may initiate a flight plan (14). If there are conflicts (13) the controller must re-evaluate his or her control actions (8). If the controller wishes to revise the current flight plan he or she may choose the trial plan option (9). After typing in the information required for a new control action, the controller initiates a trial plan (15), which, in turn, triggers the conflict probe (1). If a conflict is found (2), the alert is displayed (4) and the controller must proceed through steps 6, 7, and 8 once again. If no conflict is found (2), and since the probe was triggered as a result of the controller initiated trial plan (3), the ACCC displays a no-conflict message (4). Since the conflict was resolved (6), with a trial plan (16), the controller may now initiate a flight plan (14).

After the flight plan is initiated (14) and the conflict probe is triggered (1), the controller performs steps 4 and 6. If the conflict was resolved due to initiation of a flight plan (16), the controller must determine if the new flight plan must be approved by another sector (17). If not, the controller may issue the new clearance to the aircraft (19). Based upon ACF agreements or local sector agreements, the controller may be required to coordinate or obtain approval from another sector, ACF, or ATC facility controller (17). If the request is approved (18), then the controller may issue the clearance (19). If the request is denied (18), then the controller must re-evaluate his or her control actions (8) in order to resolve the problem.

b. Strategic Airspace Conflict. Based upon a time parameter or a controller action, the ACCC triggers the conflict probe (1). If there is a conflict (2), the ACCC determines if the conflict involves strategic airspace (5). If it does, the ACCC develops a trial plan by including the ATC preferred routing around the airspace in the aircraft's route of flight (20). The alert message on the display indicates that there is a strategic airspace alert (4). The controller recognizes the conflict alert messsage (6), realizes that it involves strategic airspace (7), and monitors the flight data display to observe the trial plan that was developed by the ACCC (21). If the controller approves the trial plan (22), then he or she may initiate a flight plan (14). If the controller wishes to pursue another control strategy, he or she may evaluate other control actions (8) and continue on by selecting either a quick trial plan or a trial plan option.

### 2.5.2 Managing Non-Radar Air Traffic

Figure 2-5, Non-Radar Controller Operational Sequence Diagram, illustrates how controllers manage air traffic in a non-radar environment. As air traffic progresses through airspace, most of the tasks shown on Figure 2-5 are performed by the controller. When a sector's airspace is saturated, procedures specify the priority duties of the controller. The controller's first priority is to separate aircraft. The second priority is to respond to position reports; and when time is available, the controller may grant pilot requests. Since radio coverage may not always be available in oceanic areas, ARINC provides an interface between the controller and pilot. This operational sequence assumes that either a direct or an indirect communication link exists between the controller and pilot.

As shown in Figure 2-5, the controller must monitor the inbound list (1) and evaluate the future trajectory of the inbound aircraft (2). The controller must also monitor the alert list continually to avoid any future conflicts (3). If there is a conflict (4), the controller's first priority is to separate aircraft; therefore, he or she needs to resolve conflicts before accepting a handoff from the previous sector. Using techniques shown in Figure 2-4, the controller resolves conflicts by initiating either a quick trial plan or a trial plan. After a conflict-free trial plan is developed, the controller initiates a flight plan. Each of these functions triggers the flight plan conflict probe (5). Since the options and paths of the conflict probe are somewhat lengthy, Figure 2-4 is not repeated each time the controller resolves a conflict in Figure 2-5. In other words, instead of re-explaining how the controller uses the quick trial plan, trial plan, and flight plan, Figure 2-5 shows one box that is labeled, "resolve conflicts."

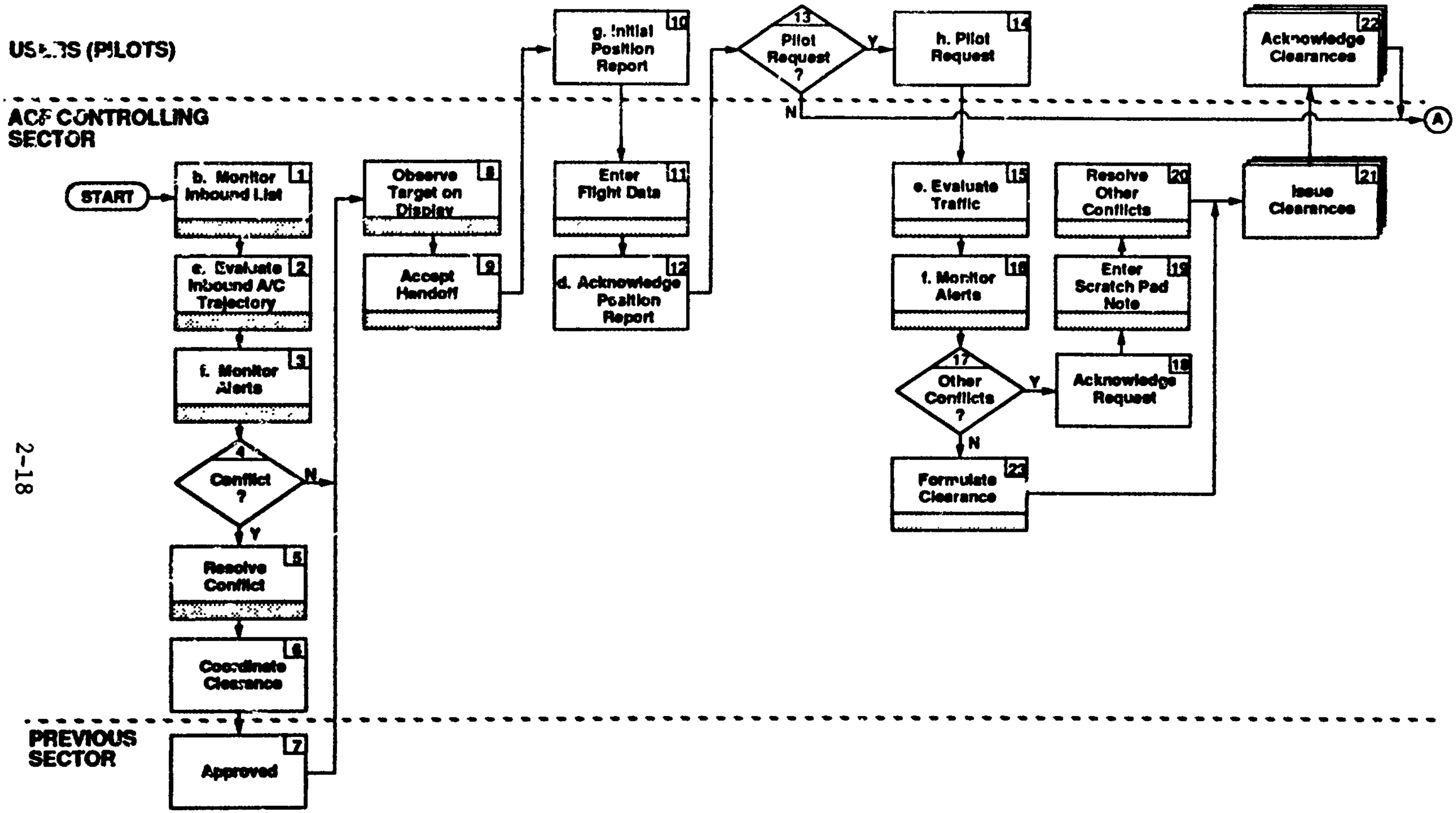


**FIGURE 2-5**

**NON-RADAR CONTROLLER**
**OPERATIONAL SEQUENCE DIAGRAM**

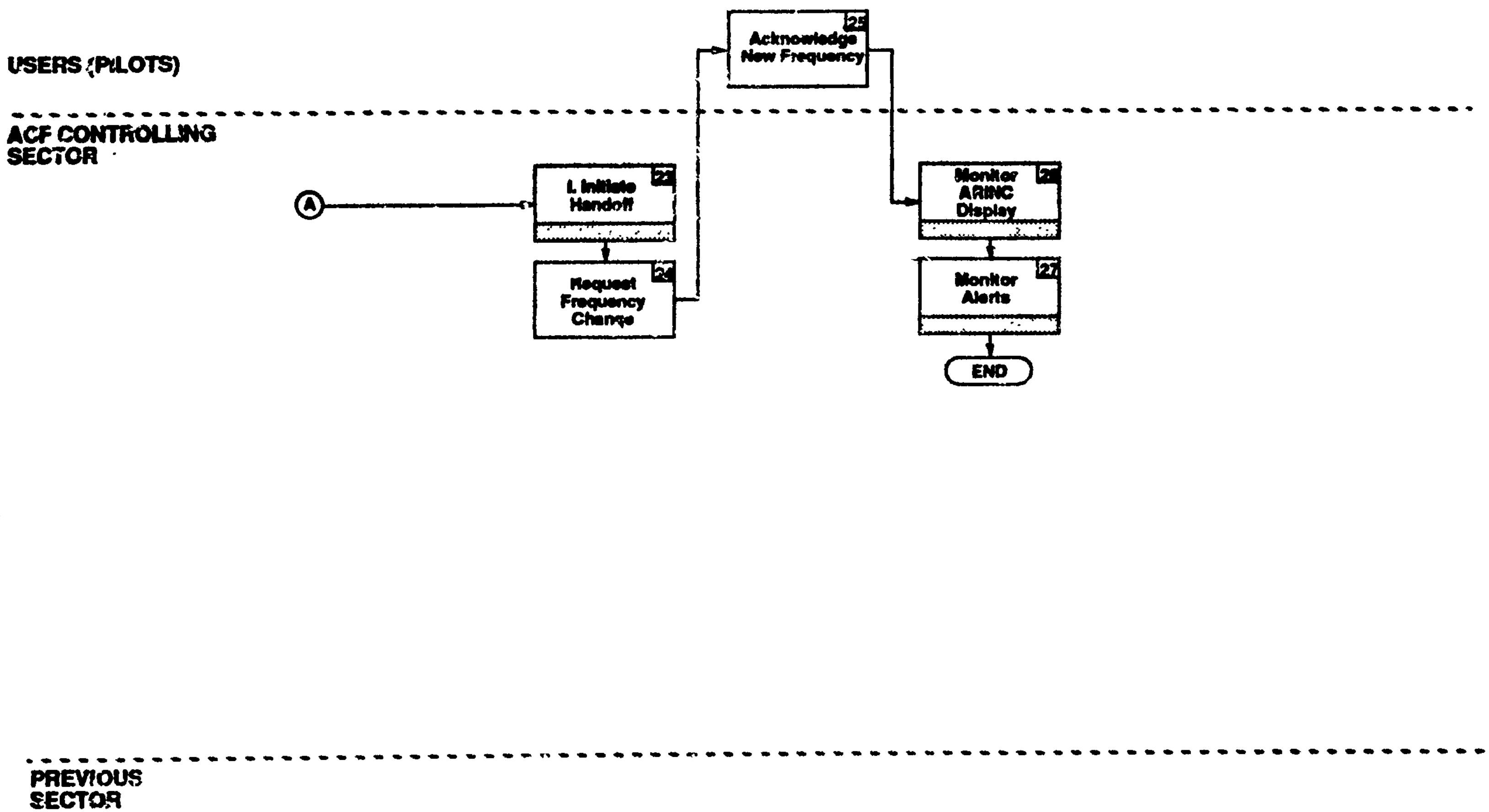


FIGURE 2-5

NON-RADAR CONTROLLER
OPERATIONAL SEQUENCE DIAGRAM (CONCLUDED)

Since the inbound aircraft is still under the control of the previous sector, any new or revised clearance for an inbound aircraft must be coordinated with the previous sector (6). Most coordination between sectors involves using the intercom to contact the previous sector, and then the previous controller displays either the trial plan or flight plan (depending upon local sector procedures). Upon his or her approval, the previous sector controller then issues the clearance to the aircraft (7). After a mileage or time parameter, the controller can observe the inbound aircraft on the situation display (8) and accept the handoff message.

In an oceanic sector, the pilot communicates with ARINC over compulsory reporting points. In a non-oceanic area, inbound aircraft contact the ACF on the new frequency and give the controller a position report (10). The controller enters the position report into the flight plan database (11) and acknowledges the pilot (12). If the pilot wants an altitude or route change (13), he or she usually makes the request at the time of initial contact with the controller (14).

The controller evaluates traffic in the sector (15) and monitors the alert display (16). If there is a conflict between other aircraft in the sector (17), the controller acknowledges the pilot request (18), and enters the request into the scratch pad display (19). The controller then resolves the conflict between the other aircraft in the sector using the conflict probe in Figure 2-4 (20), issues clearances (21), and waits for the pilot acknowledgements (22). If there are no other conflicts at the time of the pilot request, the controller formulates a clearance using the conflict probe (23), issues the revised clearance to the requesting pilot (21), and waits for pilot acknowledgement (22).

Aircraft leaving the sector must be handed off to the next sector. If an aircraft is ADS-equipped, surveillance data allows the ACCC to automatically initiate the handoff to the next sector. If an aircraft does not have ADS equipment, the ACCC does not have surveillance data, and the controller must initiate the handoff (23). Also before the non-oeanic aircraft crosses the sector's boundary, the controller requests that the pilot change his or her radio frequency in order to contact the next sector or ATC facility (24).

Pilots transiting oceanic areas report aircraft positions to ARINC when reaching published compulsory reporting points. Controllers monitor the ARINC display for these position reports (26). The controller, again, checks the alert display for any conflicts (27).

## 2.6 Operational Scenarios

Figure 2-6 presents a hypothetical operational scenario showing how the non-radar controller interfaces with and operates the flight plan conflict probe. This operational scenario is similar in format to the operational sequence diagrams in section 2.5, except that the operational scenario shows more detail and no decision branches. In this scenario, the controller attempts to resolve an aircraft conflict by changing an aircraft's altitude. The results of the conflict probe indicate that a new conflict would be created with another aircraft; therefore, the controller changes control strategy and revises the aircraft's route of flight..

The controller monitors the alert display continually (1), and then sees an alert message involving an altitude conflict between two IFR aircraft; N1234 and N6789 (2). The controller evaluates different control strategies and decides to change N1234's current altitude of 10,000 feet to 12,000 feet (3). The controller then initiates the quick trial plan function (4), which, in turn, triggers the quick trial plan conflict probe processing (5). The alert display notifies the controller about the results of the probe (6). In this scenario, N1234's altitude change conflicts with another aircraft (7).

The controller re-evaluates control strategies and decides to try and change N1234's route instead of the altitude (8). In order to change N1234's route, the controller chooses the trial plan option, enters the revised route, and initiates the trial plan (9). After triggering the conflict probe (10), the controller monitors the alert display (11). Since a strategic airspace alert message is displayed (12), the controller monitors the flight data area for the new trial plan (13). The new trial plan shows a way to route N1234 around the strategic airspace by listing the ATC preferred routing. Since the new routing is advantageous to N1234, the controller accepts the trial plan (14), and initiates the flight plan (15). The conflict probe function is triggered as a result of the flight plan initiation (16) and the alert display lists a message showing no conflicts (17). The controller issues the new clearance to the pilot of N1234 via VHF radio (18) and the pilot acknowledges.

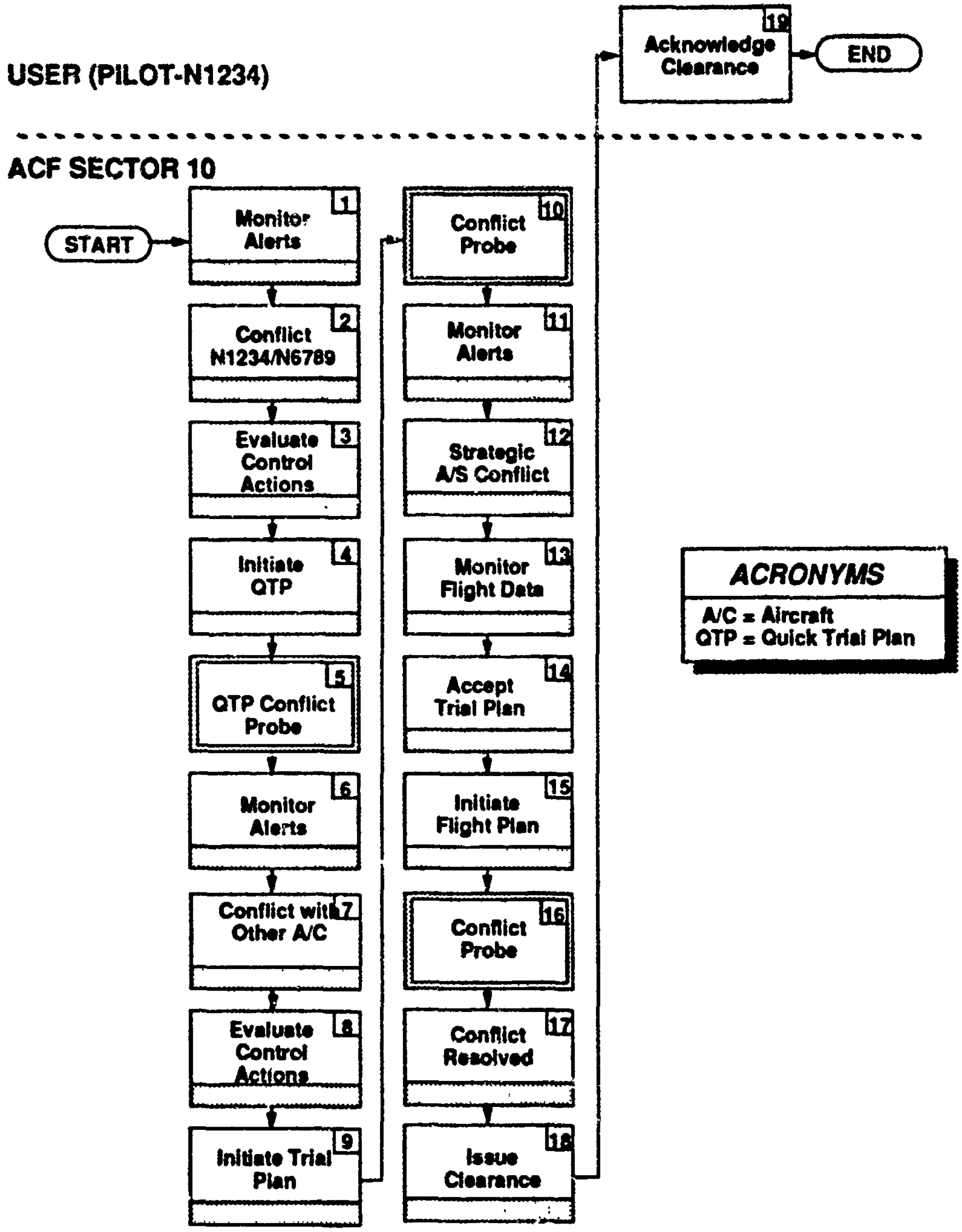


FIGURE 2-6

FLIGHT PLAN CONFLICT PROBE
OPERATIONAL SCENARIO DIAGRAM

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## GLOSSARY

| | |
|---|---|
| AAS | Advanced Automation System |
| ACCC | Area Control Computer Complex |
| ACF | Area Control Facility |
| ACID | Aircraft Identification |
| ADO | Airline Dispatch Office |
| ADS | Automatic Dependent Surveillance |
| AERA | Automated En Route ATC |
| AFSS | Automated Flight Service Station |
| A/G | Air/Ground |
| APREQ | Approval Request |
| ARINC | Aeronautical Radio, Incorporated |
| A/S | Airspace |
| ATC | Air Traffic Control |
| ATCRBS | Air Traffic Control Radar Beacon System |
| ATCS | Air Traffic Control System |
| ATCT | Airport Traffic Control Tower |
| EARTS | En Route Automated Radar Tracking System |
| FAA | Federal Aviation Administration |
| FAR | Federal Aviation Regulations |
| FDIO | Flight Data Input Output |
| FP | Flight Plan |
| FSDPS | Flight Service Data Processing System |
| HF | High Frequency |
| H/O | Handoff |
| I/AFSS | International AFSS |
| ICAO | International Civil Aviation Organization |
| IFR | Instrument Flight Rules |
| MBO | Military Base Operations |

| | |
|---|---|
| NAS | National Airspace System |
| NASSRS | NAS System Requirements Specification |
| NCP | NAS Change Proposal |
| NDB | Nondirectional Beacon |
| ODAPS | Oceanic Display and Planning System |
| QTP | Quick Trial Plan |
| RCF | Remote Communications Facility |
| RNAV | Random Area Navigation |
| TACAN | Tactical Air Navigation |
| TP | Trial Plan |
| UHF | Ultra High Frequency |
| UN | United Nations |
| US | United States |
| VHF | Very High Frequency |
| VOR | VHF Omnidirectional Range |
| VORTAC | VOR/TACAN |
| VSCS | Voice Switching and Control System |

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